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Military & Aerospace Electronics

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Backpack- and pocket-size robots take off for infantry warfighters. PAGE 16

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VPX becomes industry choice for high-performance embedded computing. PAGE 23

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Avionics in combat aircraft

Military planes benefit from the best of commercial technology.

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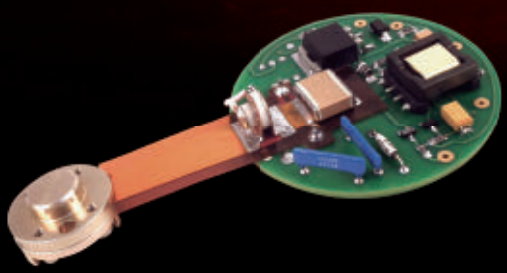

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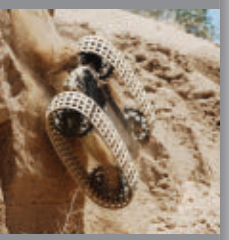

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BY **JOHN KELLER**, EDITOR IN CHIEF

Time for a change? Industry suggests terms to replace COTS

In one of my first acts of the new year, I put the question to the aerospace and defense electronics industry: Do we need a new term for COTS? Some of the results are in, and the answer, overwhelmingly, is yes.

In a new year's blog post I made the case that COTS—short for commercial off-the-shelf—began its life as a poor term, and it remains a poor term to this day. The problem is COTS covers a too-broad range of technology, lacks specifics, and is too-easily misinterpreted. COTS can describe Radio Shack- and Best Buy-types of consumer-grade technology, right up through the most rugged and reliable electronics available off the shelf, rather than as a custom order. How do we tell them apart?

A tablet computer purchased at Walmart certainly is COTS. At the same time, however, a ruggedized tablet built to military specifications also is COTS—just as long as it's available off the shelf and is not a custom design. The confusion has been going on for a long time.

For years we debated COTS vs. Mil-Spec, or what we mistakenly saw as separate poles in electronics design. On hindsight, we never should have pitted COTS vs. Mil-Spec. Instead, we should have put COTS and custom designs on the playing field. Misperceptions and misinterpretations of COTS have muddied the waters for two decades, and I'd say the damage is done.

This is unfortunate for the companies that do COTS right: Curtiss-Wright Controls Defense Solutions, Mercury Systems, GE Intelligent Platforms, Aitech, Extreme Engineering Solutions, Phoenix International, and so many other deserving companies—too many to list here—that over the past two decades have refined COTS products so as to offer the military the best of both worlds—commercial design and military-rugged quality.

If we stick with the term COTS, then we lump the military suppliers in with the Best Buys and the Radio Shacks. Isn't it time that we admit this is neither fair nor accurate? Perhaps it's time for something new.

Now to be sure, the sentiment in industry to retire the term COTS is far from unanimous. "Nowadays the acronym COTS is well known and should not be thrown away too easily," says Con Kranenburg of the National Aerospace Laboratory (NLR) in Amsterdam, The Netherlands. Still, he acknowledges the breadth of the term, and suggests a new one: R3-COTS, short for rugged, reliable, and remaining for decades COTS.

Another suggestion is CORT, short for commercial origin ruggedized technology, which comes from Tom Forselles, product support engineer at Rantec Power Systems Inc. in Los Osos, Calif. Several suggestions involve a term many of us have heard before: MOTS, short for military off-the-shelf. Others suggested MIL-COTS for military commercial off-the-shelf, D-COTS for defense COTS, R-COTS for ruggedized COTS, A&D COTS for aerospace and defense COTS, ASD-COTS for aviation, space, and defense COTS, Rz COTS for standard COTS with ruggedized packaging, and X-COTS for extreme COTS built specifically to handle harsh-environment applications.

We received several suggestions for consumer-grade COTS, including Standard COTS, which describes commercial-grade electronics for benign-environment military applications that comes with program and life cycle support. C-COTS would describe COTS of Radio-Shack quality.

I got some tongue-in-cheek suggestions, as well, about what COTS actually stands for: cannot operate to specifications, continuously obsoletes the software, and common ordinary telecom stuff. Many in our industry have experience with components that meet these descriptions.

E-mail your suggestions and votes to me at jkeller@pennwell.com.

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Raytheon to develop strategic SATCOM system for nuclear command and control

BY JOHN KELLER

HANSCOM AIR FORCE BASE, Mass.—Satellite communications (SATCOM) experts at the Raytheon Co. Space and Airborne Systems segment in Marlborough, Mass., are designing a nuclear command and control system to transmit and receive emergency action messages to strategic bomber, tanker, and reconnaissance aircraft crews.

Raytheon is designing an advanced satellite communications system to enhance control of U.S. nuclear forces.

Officials of the Air Force Lifecycle Management Center at Hanscom Air Force Base, Mass., have awarded a $134.4 million contract to Raytheon to design and build the Global Aircrew Strategic Network Terminal (ASNT).

The Global ASNT system will use Extremely High Frequency (EHF) and Advanced EHF waveforms to provide protected communications to nuclear bomber, missile, and support aircraft crews in difficult environments. The terminal also will provide wing command posts and mobile support teams with survivable communications to send and receive special alerts involving nuclear forces called Emergency Action Messages.

The Global ASNT terminals that Raytheon is designing will replace existing mission-deficient unsustainable systems at bomber, tanker, and reconnaissance wing command posts and mobile support teams, Air Force officials say.

The Global ASNT terminals will provide AEHF, very-low-frequency (VLF), low-frequency (LF), and UHF aircrew alerting communications. Air Force program managers are directing Raytheon to design the Global ASNT system with an eye to future growth and systems upgrades.

The new strategic communications system will enhance the existing system by delivering increased capacity and capability.

Raytheon is in production on three different AEHF terminals for the U.S. Army, Navy, and Air Force. All three have tested with the on-orbit AEHF satellite and have demonstrated interoperable communications.

The Global ASNT SATCOM system will provide new satellite terminals for the global command-and-control system that provides for management of nuclear forces by the president.

Raytheon will design the new terminals to receive signals from the five satellites in the MILSTAR constellation launched between 1994 and 2003 and the newer AEHF satellite system. Two AEHF satellites are in orbit today, and the Pentagon plans to launch a total of five.

The new nuclear command-and-control terminals will be installed at 50 fixed sites including fixed nuclear command-and-control facilities (wing command posts, nuclear task forces, and munitions support squadrons) and forward deployed nuclear command-and-control mobile support teams.

The Air Force plans to buy 48 transportable terminals.

Raytheon will do the work in Marlborough, Mass., and should finish system design and development by December 2016. Production, installation, and sustainment will extend through the end of 2020.

FOR MORE INFORMATION visit **Raytheon Space and Airborne Systems** at *www.raytheon.com*.

IN BRIEF

Demand for ISR technology shifting from military to counter-terrorism

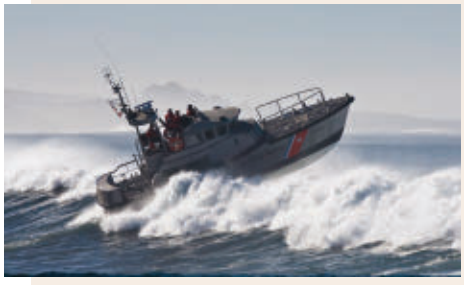
U.S. demand for intelligence, surveillance, and reconnaissance (ISR) video analytics solutions for processing and communicating full-motion video has increased significantly in the U.S., primarily for counter-terrorism, market analysts say. Necessary intelligence to fend off increasing terror attacks sustains the market and presents future commercial market opportunity, according to analysts at market researcher Frost & Sullivan in Mountain View, Calif. The new U.S. ISR Video Analytics report from Frost & Sullivan says that despite reduced U.S. military ISR spending, the need to provide actionable, real-time intelligence to U.S. troops on the ground is a main driver for the market. The importance of video surveillance, electro-optical/infrared technologies, and the exploitation of social media within the country is growing considering recent terrorist attacks such as the Boston Marathon bombings, analysts say.

FOR MORE INFORMATION
visit **Frost & Sullivan** online at *www.frost.com*.

Coast Guard to develop integrated navigation systems for 1,800 boats and ships

BY JOHN KELLER

WASHINGTON—Shipboard electronics experts in the U.S. Coast Guard in Washington plan to develop a new integrated navigation system for Coast Guard boats and cutters



The U.S. Coast Guard is considering new integrated navigation systems for as many as 1,800 vessels.

called the Standardized Scalable Integrated Navigation System-Two (SINS-2).

The system will be installed on about 1,800 vessels. It will be the primary navigation system on Coast Guard boats ranging in size from 12-foot harbor boats to 47-foot motor life boats. SINS-2 also will provide backup navigation capability on Coast Guard cutters ranging from 65-foot small harbor tugs to 418-foot national security cutters.

The SINS-2 will allow for scalable integration of all installed electronic navigation equipment and sensors as required per vessel. Scalability notes a wide range of configuration depending on vessel size and mission.

The proposed system will be a standardized suite of commercial off-the-shelf (COTS) electronic equipment and sensors consisting of a low power radar and chart plotter multifunction display, fluxgate compass, GPS receivers, depth sounder, and marine-grade power supplies. SINS-2 will be installed on all future boat acquisitions and retrofitted onto legacy boats as the original equipment wears out.

SINS-2 also will allow for interfacing with other installed electronics equipment including sensors and communications gear, and will support Coast Guard missions to include port, waterways, and coastal security; search and rescue; drug interdiction; migrant interdiction; living marine resources; other law enforcement; marine safety; marine environmental protection; and defense readiness.

The primary purpose of SINS-2 is to provide standard navigation systems for Coast Guard boats and cutters that are easy to operate and maintain.

SINS-2 will allow for additional networked multifunction and remote instrument displays at several crew stations. The SINS-2 system also will include a data recorder to record selected sensor data, and will support two X-band GHz radar options, one for a radome, and other for an open array.

The SINS-2 system must have full functionality without the use of touch-screen viewing in direct sunlight, and compatible with night operations with a dimmable display.

The full draft specification for SINS-2 is available online in PDF form at http://ow.ly/t0lWr.

NASA to partner with industry to develop advanced fuel cell technology for space

BY JOHN KELLER

HOUSTON—Researchers at the U.S. National Aeronautics and Space Administration (NASA) are looking to partner with industry to speed development of next-generation hydrogen and hydrocarbon air-independent fuel cells for future pow-

NASA wants to work with industry to develop advanced hydrogen and hydrocarbon fuel cells for a wide range of applications.

er electronics on space missions, as well as for applications on Earth.

Officials of the NASA Johnson Space Center (JSC) in Houston have issued a sources-sought notice (NNJ14ZBH025L) for the Hydrogen and Hydrocarbon Air Independent Fuel Cells project to accelerate technology development and strengthen commercialization of hydrogen and hydrocarbon air-independent fuel cells.

NASA JSC has a long history of developing fuel cell systems using

pure oxygen as the oxidant and pure hydrogen as the fuel. Such a system was the primary power source for the space shuttle orbiter, NASA officials point out.

Along with spacecraft applications, enhanced fuel cell technology could enhance the capability of unmanned underwater vehicles (UUVs) that must independent of surface power sources.

Fuel cells convert the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent. Hydrogen is the most common fuel, but hydrocarbons such as natural gas and alcohols like methanol are sometimes used.

NASA officials particularly are interested in advanced fuel cells for future spacecraft power, and want to push this technology in three directions: higher reliability; higher-temperature heat rejection; and efficient use of fuel from reformed hydrocarbons.

Potential solutions for the first requirement include dead-headed fuel cells of any chemistry, which have no active components for reactant management in the balance-of-plant. Potential solutions for the other two requirements center on solid oxide fuel cell chemistries, which can operate above 800 degrees Celsius, can minimize the mass of heat rejection radiators, and can use carbon monoxide and hydrogen as fuel.

NASA partners on the fuel cell project may own the intellectual property together with NASA on technologies jointly developed. JSC has been working in collaboration with the U.S. Navy to conduct testing programs and understand the system integration issues of potential fuel cell solutions.

Companies interested should email statements of interest forms no later than 11 April 2014 to NASA's Mark Dillard at mark.a.dillard@nasa.gov. Statement of interest forms, in Microsoft Word format, are available online at http://prod.nais.nasa.gov/eps/eps_data/159203-OTHER-001-001.docx.

For questions or concerns, contact NASA's Mark Dillard by phone at 281-244-8460 or by e-mail at mark.a.dillard@nasa.gov, or Dana Altmon-Cary by phone at 281-483-8228 or by e-mail at dana.altmon-cary-1@nasa.gov.

MORE INFORMATION IS available online at *http://ow.ly/t0m80.*

Combat aircraft with advanced avionics

Myriad military aircraft, both new and old, benefit from modern avionics.

BY **Courtney E. Howard**

Air power is key in combat. Militaries worldwide rely increasingly on combat aircraft for missions ranging from intelligence, surveillance, and reconnaissance (ISR) to search and rescue, cargo and personnel transport, and precision weapons targeting.

"Combat is done with air power now," Lockheed Martin Test Pilot Billie Flynn affirmed in his talk on military fighter aircraft at the Aerospace Innovation Forum in Montreal. The key to pushing the technology envelope, to push what the aircraft itself can do, is to take the human, who has historically been the limiting factor, out of the equation, he says. Yet, to do more with less, innovation is required. Modern avionics are answering the need for increased situational awareness, greater performance, and various military-operations and peace-keeping capabilities.

Comprehensive cockpit

Connectivity and visualization in the cockpit are critical, and

that means: "big screens, touchscreens not buttons, high fidelity in front of the pilot's head so that wherever he looks he sees what's around him, and broadband connectivity to ensure everyone has the same amount of information," Flynn says.

Aerospace and defense engineers set a new standard for combat aircraft avionics with the 8-by-20-inch panoramic cockpit display on the F-35 Lightning II Joint Strike Fighter (JSF) from Lockheed Martin in Bethesda, Md. The large, active-matrix liquid crystal display (AMLCD) is designed by L-3 Display Systems in Alpharetta, Ga., to lessen the pilot's traditional workload while increasing situational awareness.

The touchscreen "display system delivers information for all the major functions of the F-35, including flight and sensor displays, communication, radio and navigation systems, as well as an identification system which gives the pilot total situational awareness," says a representative of LynuxWorks in San Jose, Calif.

L-3 Communications Display Systems engineers selected the LynuxWorks DO-178B-certifiable LynxOS-178 real-time operating system (RTOS) to power a portion of the F-35 panoramic cockpit display subsystem. L-3 engineers chose the RTOS based on key factors, such as adherence to open standards, Linux compatibility, POSIX API interoperability, and support for the ARINC 653 specification, officials say.

Integrated information

"Avionics are doing a better job of providing an integrated situational awareness picture for the pilot," explains Curtis Reichenfeld, chief technology officer of the system solutions

group at Curtiss-Wright Controls Defense Solutions, headquartered in Ashburn, Va. “Instead of the pilot having to look at data from the radar and infrared or electronic warfare sensors and put all the data together, the processing capability on military aircraft enables that whole process to be done automatically so the pilot is seeing the complete situational-awareness picture without having to fuse the data himself.

“Older avionics architectures had independent systems, each with its own displays; now, we are seeing integrated and network-centric systems fusing data and presenting the combined data on a single display for the pilot to access more quickly and efficiently,” Reichenfeld continues. “All the formerly separate data is now presented as a single resource.”

Today’s combat aircraft are “much more highly integrated and have much higher levels of data fusion, all for the purpose of reducing pilot workload so they can better focus on the mission at hand and reduce the need to do the data analysis by checking three or four different sensors or instruments,” Reichenfeld notes.

Pilots have long had sensors to help them, Lockheed Martin’s Flynn affirms but pilots have historically had to manage sensors. “They would decide what to look at and do their best to figure out what’s important while [also] busy flying the airplane. It was never going to get better as long as the human was in the loop.” The Lockheed Martin F-22 Raptor marked a paradigm shift, he says. “With the F-22, we finessed sensor fusion—fusion of sensor data and 8.6 million lines of software code to figure out if information is relevant.”

Increased situational awareness in the cockpit is a game-changer for military pilots, lending to faster and better-informed decisions. “The pilot is no longer a limiter and he’s more effective,” Flynn says. “Let him fly the airplane.”

Sensor-laden aircraft

The F-35 is indicative of a growing trend wherein manned and unmanned military airframes sport a growing number of sensors. The

The Lockheed Martin F-35 aircraft boasts modern sensors, communications, and flight-control systems.

prevalent and ever-increasing use of airborne sensors is driving the need for powerful embedded computing and networking systems.

The ability to fuse data into a cohesive combat picture provides pilots with a better understanding of what the threats are and how to overcome them, says Mark Grovak, avionics business development manager at Curtiss-Wright Controls Defense Solutions. "What makes this possible is putting more processing onboard the aircraft." A robust processing infrastructure, including thermally efficient, high-performance computing systems, is needed to handle the large data sets and run the advanced algorithms that provide the pilot with the desired situational awareness, he adds.

Advanced avionics on the F-35 Lightning II furnish the pilot with real-time access to comprehensive battle-space information and the ability to share sensor data and actionable information. The Lockheed Martin-led team behind the F-35's advanced avionics includes Northrop Grumman, BAE Systems, Pratt & Whitney, Raytheon, and Mercury Systems.

Engineers at Raytheon's Space and Airborne Systems (SAS) segment in El Segundo, Calif., licensed the Mercury Systems RACE++ Series multicomputers for the F-35 JSF's Integrated Core Processing (ICP) system. The ICP is the sensor processing system with an open-system architecture designed to maximize the use of standards-based, commercial off-the-shelf (COTS) products.

"Incorporating COTS technology into an open system architecture

throughout the F-35 will enable frequent technology updates at low cost," explains Bob Coultas, hardware program manager for the ICP for Lockheed Martin.

The onboard system incorporates a liquid-cooled, ruggedized multicomputer capable of performing 40 billion sustained operations per second and of multi-mission computing to process electronic warfare, electro-optical, infrared, and radar data. Mercury's multiprocessor technology is used in the signal processor (SP) and signal processor input/output (SPIO) modules of the ICP. Mercury's signal processing systems were used in the Concept Demonstration Phase (CDP) of the JSF, and its RACE++ Series PowerStream systems were selected for the System Development and Demonstration (SDD) phase.

The Eurofighter Typhoon from Airbus Group, Alenia Aermacchi, and BAE Systems is assembled with state-of-the-art avionics. (Image: Airbus Group.)

JSF software

The F-35 takes advantage of considerable software resources, in addition to modern avionics hardware. The fifth-generation fighter jet reportedly comprises more than 20 million lines of software code, segmented into blocks and largely written in C and C++; yet, it also uses software code in the Ada computer programming language from the Lockheed Martin/Boeing F-22 Raptor military fighter aircraft.

The F-35 Lightning II, among the most complex military platforms to date, has suffered some production and deployment setbacks due the sheer volume of software code employed. Yet, aerospace and defense technology firms are working hard to remedy the situation.

The F-35 runs the Integrity DO-178B securely partitioned, safety-critical, certified real-time operating system (RTOS) from Green Hills Software in Santa Barbara, Calif. Datel engineers implemented the LDRA tool suite for software verification related to the F-35 engine, and developers at Parasoft Corp. in Monrovia, Calif., are working directly with Lockheed Martin engineers on static code analysis for JSF.

Engine assurances

Engineers at Ultra Electronics Controls (formerly Datel) in West London, England, selected LDRA software verification tools for their work on the Pratt & Whitney F135, the engine of choice for the F-35 Lightning II fifth-generation tactical fighter developed by Lockheed Martin in conjunction with BAE Systems and Northrop Grumman.

Datel engineers had specific technical requirements related to their work on the Engine Ice Protection System (EIPS) for the Pratt & Whitney F135 Engine on the Lightning II Joint Strike Fighter project, and the Wing Ice Protection System (WIPS) for the Boeing 787 Dreamliner. They needed a software verification tool able to integrate with their target environment, which included the Texas Instruments TMS320F2812 and TMS320F2808 digital signal processors (DSPs). Datel personnel made use of LDRA's complete structural coverage analysis solution at unit, integration, and system test levels. These tests were applied to source and object code, making use of the LDRA tool suite's red-box mode.

"It was important to Datel that it was able to develop their software to a known coding standard and, consequently, MISRA-C:1998 was selected to be applied to this code," a company representative says. The LDRA tool suite simplifies the process by enforcing various standards using drop-down menus, which proved important for Datel.

Datel staff also needed an automated, intuitive unit testing tool which would save time, free up highly qualified staff, increase test efficiency, and improve motivation to test through a repeatable, less error-prone process. They found their solution in TBrun, LDRA's tool for the automated generation and management of unit tests. In the end, Datel reduced the time needed to confirm the verification results and increased the repeatability of its internal process.

QA on JSF

Lockheed Martin officials in the

Maritime Systems & Sensors (MS2) business unit selected Parasoft's Jtest, C++test, and Insure++ tools in 2004 to support quality testing for its software. (The MS2 unit became the Lockheed Martin Mission Systems and Training, or MST, unit in 2012.)

"Our systems provide critical support when lives are on the line," Martina DelRocini, software subcontract management at Lockheed Martin, explains. "Quality assurance throughout our processes ensures our systems meet their demanding requirements."

Jtest and C++test automatically verify compliance to coding rules while generating and executing unit tests to ensure quality early in the software development cycle. Insure++ detects memory errors, such as corruption, leaks, and allocation errors in C/C++ code.

This relationship with Lockheed Martin "demonstrates Parasoft's ability to help large-scale software development organizations prevent software errors in what are some of the most complex systems being developed today," adds Larry Johnsen, Parasoft director of military/aerospace solutions.

Parasoft's Software Development Compliance solution provides code analysis for compliance with the Joint Strike Fighter Air Vehicle C++ Coding standards.

Combat-ready resources

Without ground support, there is no air support. Maintenance technicians are an important part of the equation, as are the various electronics and mechanical tools they employ.

In the U.S., every time a sailor or marine has flown a mission over the past 20 years, the Consolidated Automated Support System (CASS) has validated that the aircraft is combat ready, a Lockheed Martin representative says. U.S. Navy officials are now replacing CASS with a new version, the electronic CASS (eCASS), designed to simplify testing and accommodate new weapons systems over the next 30 years. Aircraft maintenance personnel will use eCASS to troubleshoot and repair aircraft assemblies at sea and ashore to return equipment to readiness status quickly and efficiently.

CASS is credited with saving the Navy more than $2 billion through standardized training and test programs. Yet, it was designed more than two decades ago and would be more costly to maintain than to replace with an open-architecture system.

"eCASS will be the workhorse for avionics repair across the Naval Aviation Enterprise," explains Chris Giggey, deputy program manager for Automatic Test Systems, of the U.S. Navy's Naval Air Systems Command's Aviation Support Equipment Program Office (PMA-260). "This system provides us with capabilities critical to support of naval aircraft and gives us the ability to launch combat-ready aircraft from carriers anytime and anywhere in support of the nation."

"eCASS runs 20 percent faster, is even more reliable, and is highly compatible with legacy CASS stations," says Randy Core, director of enterprise test solutions at Lockheed Martin Mission Systems and Training. "This speed and reliability will ultimately help the Navy increase aircraft availability."

eCASS is based on the LM-

STAR commercial automated testing system, featuring open software and hardware architectures to provide eCASS with long-range upgrade capabilities. LM-STAR is being called "the cornerstone of the F-35 harmonization plan," enabling avionics manufacturers to develop tests that will seamlessly transition from the factory floor to fleet maintenance depots.

Lockheed Martin is producing 36 eCASS stations and associated support equipment under a $103 million U.S. Navy contract.

Lockheed Martin engineers have completed development of the eCASS architecture, paving the way for initial production to begin. The first station will be delivered in November 2014. Naval Air Systems Command officials plan to deploy eCASS on every aircraft carrier and at many Fleet Readiness Centers.

Typhoon technologies

The Eurofighter Typhoon combat aircraft, currently the largest military procurement program in Europe with 719 aircraft under contract and 571 on order, was designed to accommodate avionics upgrade packages to ensure its longevity.

"Eurofighter Typhoon was designed, from the outset, for capability growth. It is something we firmly believe sets us apart from the competition," says NATO Eurofighter and Tornado Management Agency (NETMA) General Manager Jesus Pinillos Prieto.

The latest Typhoon, known as a Tranche 3, includes provisions that future-proof the combat aircraft, enabling it to take on additional capability in the future, including a high-speed data network. Taken together, there have been hundreds of modifications, changes, and additions,

F-35 variants will replace A-10 and F-16 for the U.S. Air Force, F/A-18 for the U.S. Navy, and F/A-18 and AV-8B for the U.S. Marine Corps.

which effectively means Typhoon has now taken a massive step forward, says a BAE Systems representative.

"For casual observers, the aircraft is little changed from its sleek predecessor but it has a number of provisions that will allow it to take on additional capability in the future," says Mark Kane, BAE Systems managing director–combat air. "At the nose, a new internal structure has been built and work has been carried out on power, cooling, and electronics so a new E-Scan radar could easily be accommodated."

Eurofighter Jagdflugzeug GmbH manages the Eurofighter Typhoon program on behalf of partner companies Alenia Aermacchi/Finmeccanica, BAE Systems, and Airbus Defence and Space (formerly Cassidian, the defense division of EADS).

Northrop Grumman Italia in Rome, Italy, provides the Eurofighter Fiber-optical Gyro Inertial Navigation System and a global positioning system (GPS) receiver for Tranche 3 of the Eurofighter Typhoon multirole combat aircraft Eurofighter aircraft in all participating nations (United Kingdom, Germany, Italy, and Spain).

Northrop Grumman's inertial navigation system and GPS receiver are based on fiber-optic gyro technology and feature an anti-jam antenna system and selective availability/anti-spoofing module architecture. The GPS unit also supports such future enhancements as digital maps and direct drive display, which employ a graphics processor capable of controlling the aircraft's multifunctional displays for improved viewing and integration in the aircraft's avionics.

The F-35 and Eurofighter Typhoon, representing modern airframes with novel avionics, have set the bar by which militaries will judge future combat aircraft. At the same time, avionics innovations of the future will continue this trend of enabling military personnel to do more with less, predicts Lockheed Martin's Flynn.

Manpackable, throwable robots hit their stride on the battlefield

Use of backpack- and pocket-size robots is taking off among infantry warfighters who need mechanical help to investigate and enter dangerous areas like buildings and other urban terrain.

BY **J.R. Wilson**

When U.S. forces went into Afghanistan and Iraq after 9/11, their contingent of robots consisted of medium-sized unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs), each ranging from 40 to 500 pounds. At the turn-of-the-century, having a useful capability in a military robot small enough to fit into a single warfighter's backpack was a dream.

But as U.S. ground forces found themselves deeply involved in urban-based counter-insurgency (COIN) warfare in Iraq and the rugged mountains of Afghanistan, that dream quickly became an urgent requirement. Calls for small, lightweight, and capable robots forced industry to fill the bill with rugged commercial off-the-shelf (R-COTS) technologies.

The resulting first generations of robots for individual warriors fell into three categories—micro, mini, and classic manpackables—says Tim Trainer, vice president of international robotic products at iRobot Corp. in Bedford, Mass.

"Many of our customers are interested in our mesh networking capability so robots can communicate within a steel-reinforced building and allow comms links to continue deeper in places where LOS [line of sight] is a challenge," Trainer says. "You can use the FirstLook [iRobot's five-pound throwable, tracked vehicle] as a node to extend the range of other FirstLooks or larger robots."

Using R-COTS is a two-sided proposition. First, it makes the resulting systems immune from International Traffic in Arms Regulations (ITAR), but R-COTS means the underlying technologies are available to anyone, anywhere. That might not be as serious as it sounds, however,

Small enough to fit inside a rucksack but tough enough to be thrown, the Dragon Runner 10 micro unmanned ground vehicle is a lightweight, compact, multi-mission remote platform developed for supporting small unit dismounted operations.

says Jack Klobucar, vice president of marketing at small robot maker ReconRobotics in Edina, Minn.

"While our system is COTS, building it in such a way that it is durable, robust, and dependable is a challenge," Klobucar says. "We have been at this for seven years and no one has been able to match us or they already would have significant market share. So it's really our know-how and work with our customers that enable us to add to the capability of our systems."

Each new advance in robotic size, weight, and capability has whetted the military's interest and individual warfighter demand.

"We developed the first hand-launched UAV for information gathering, the Pointer, in 1987, which the U.S. Marine Corps used in a limited basis in Operation Desert Storm," says Steven Gitlin, vice president of marketing strategy at AeroVironment Inc. in Monrovia, Calif. "They were so effective, it drove a resurgent demand for small UAVs through the military and into Congress."

The frontline warfighter carries these types of man-portable UAVs with him to find out what is happening on the other side of a ridgeline or in a building. "Man-pack systems can be deployed immediately, day or night, and help determine the critical information needed to turn data into actionable intelligence," Gitlin says.

As each new small UAV and UGV entered service, new and more complex requirements came from the battlespace to industry.

"As the war has progressed, not only have traditional counter-IED [improvised explosive device] customers wanted smaller and lighter

robots, so have other dismounted forces," says Charlie Dean, director of unmanned systems business development at QinetiQ North America in Reston, Va.

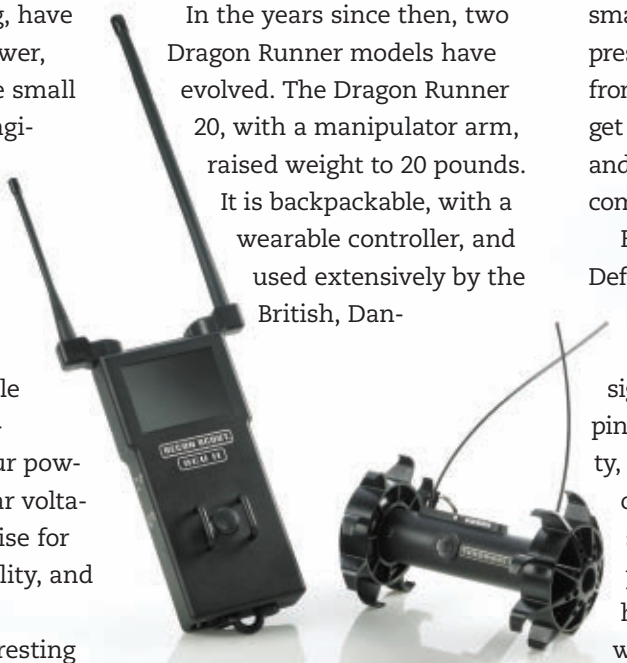
Robot power

"Component hardware, such as sensors and onboard computing, have gotten smaller and lower power, so you can do more on those small systems," says Jon Salton, engineering project management development at Sandia National Laboratories in Albuquerque, N.M. "Right now we're working primarily on component technologies, our advantage being able to pull from the larger Sandia. We interface a lot with our power research folks, whose solar voltaic research shows real promise for lighter weight, higher reliability, and much greater efficiencies.

"There also is a lot of interesting work being done on batteries, but it is much more in the early research realm for now," Salton continues. "The onset of lithium-ion and other chemistries being combined with lithium are offering the possibility of smaller but more powerful batteries. However, the smaller you go down in platform size, the more limited you are in available power sources. After a while, heat dominates, so there are limits in physics on what you can do with most types, leaving a lot of room for development."

The first lightweight "throwable" robot into Southwest Asia in any number was the Dragon Runner, a 14-pound reconnaissance device for dismounted Marines developed by the National Robotics Engineering Center in Pittsburgh, in collaboration with Automatika in O'Hara Township, Pa., under contract to the Marine Corps during 2002-03. In the next few years, a dozen Dragon Runners were deployed to Marines for sentry and urban reconnaissance. Automatika was acquired by QinetiQ in May 2007.

In the years since then, two Dragon Runner models have evolved. The Dragon Runner 20, with a manipulator arm, raised weight to 20 pounds. It is backpackable, with a wearable controller, and used extensively by the British, Danish, Spanish, and Australian armies. Carried on the back with two harness straps, along with the controller, it has become an important part of those countries' missions in Afghanistan, Dean says.



The ReconRobotics Throwbot is small enough to be carried to the battlefield front lines by individual warfighters.

The Dragon Runner 10, which warfighters carry on their backs, uses the same lightweight controller as the Dragon Runner 20. "In the past couple years, it has become extremely popular with the U.S. Army and Marine Corps, primarily as a reconn platform in Afghanistan, without a manipulator arm," Dean says.

In addition to being ruggedized as a throwable robot, the Dragon Runners can move across uneven terrain using their optional manipulator arms to remotely set them upright should they flip over. Both models can run up and down stairs.

Obstacles from small rocks to stairs, however, can be insurmountable barriers for any UGV much smaller than the DR-10. Nature also presents problems for small UAVs, from trees, rain, and wind. "As they get smaller and smaller, both ground and aerial robots can be quickly overcome by the terrain," Dean says.

Experts from Sandia and the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have looked to a unique design to overcome obstacles by hopping over them. Hopping capability, however, involved a daunting set of requirements, Sandia's Salton says. "So you can drive where you can, hop where you must," he says. "That's where we left it with DARPA, but since then things have advanced to the point we could make it lighter. We also transitioned some of the technology out to industry; Boston Dynamics [bought by Google in December 2013] has a heavier version called the Sand Flea."

First demonstrated publicly in early 2012, the 11-pound Sand Flea can jump more than 30 feet high, with the precision to go through a second- or third-story window, and operate by remote control at distances as far as 215 feet.

"I would say key enabling technologies include the continuing advancement of autonomy, combined with the ability for unmanned systems to work together," says QinetiQ's Dean. "That will be, if not already, the focus on where unmanned systems are going."

Continuing goals

Power, sensors, communications—audio, video, data—mobility through rough terrain or urban canyons, faster and more capable processing, high levels of ruggedization, decreased costs, simplified training and maintenance, small and light enough to be carried in an already over-burdened warfighter's pack—those goals of the past decade of combat will continue into the foreseeable future.

The Pacific pivot places greater demand on the Navy and Marine Corps, and will require robots to be water-tight and saltwater-resistant. Many military robots going to the Pacific will be far larger than man-packable systems—such as the C-Talon, an underwater crawler variant of QinetiQ's top-selling Talon EOD (explosive ordnance disposal) robot. Its mission to locate underwater mines or booby-traps in many ways mirrors the help it provided EOD and counter-IED teams in the Iraqi and Afghan deserts.

"Certainly the Pacific pivot will change the role of unmanned systems, especially due to water obstacles, with a greater use of unmanned maritime vessels," Dean says. "Maritime requirements for environmental protection, especially protection against saltwater spray and immersion, will put some pressure on systems that have operated essentially on dry land."

iRobot's Trainer says he believes small robots will face many of the same requirements in Asia/Pacific as they did in Southwest Asia—but also must be adapted to some significantly different environments. "There will still be IED threats, hostile forces barricaded in buildings and such, so in those cases there won't be a lot of difference," he says.

The real robot challenge of the Pacific pivot will be operating in jungles. "You'll never get a small robot that can operate in a jungle, although one that can be thrown can get some distance for the users," Trainer says. "Small flying robots have some advantages in a jungle environment, but also have heavy foliage and canopy constraints."

In December 2013, the U.S. Department of Defense (DOD) released the Unmanned Systems Integrated Roadmap: Fiscal Years 2013 to 2038 report to assess the future of all unmanned systems and the technology investments required. The report says unmanned systems must provide capabilities more efficiently through modularity and interoperability; be more effective through greater automation and greater performance; be more survivable with improved and resilient communications, development for anti-permissive environments and more security from tampering; and take the 'man' out of unmanned. Personnel costs are the greatest single cost in DOD, and unmanned systems must strive to reduce the number of personnel required to operate and maintain systems, the report says.

"The redistribution of forces will rely more on rapid response, with quickly deployable forces that must be ready to fight battles in a variety of environments. And an even greater dependence on situational awareness, knowing enemy positions and capabilities," predicts Klobucar of ReconRobotics. "Our forces will co-train with indigenous forces wherever they are located, whether in Asia, Africa, or the Middle East, so they can respond together

to regional threats. That will create more opportunities for robotics companies because U.S. forces will expose those allies to our technologies and capabilities, opening the door to wider and quicker adoption of those technologies throughout allied forces around the globe."

QinetiQ's Dean also foresees a significant post-OEF/OIF shift in how combat robots are developed, acquired, and controlled—changes that may influence the warfighters using them as greatly as did their introduction into the battlespaces of Southwest Asia.

"The different U.S. military services, in looking at future unmanned systems acquisitions, are seeing the formation of programs of record for many categories of unmanned air and ground platforms, but there have been very few programs of record to date in ground robots," Dean says. "The plan is to increase military use of robots—both types and utility—to help deal with fluctuating personnel numbers and, through PORs, control expenditures.

"So moving through the second half of this decade, the Marines, Army and Air Force are planning many programs of record to carry their robot plans into the 2020s," Dean continues. "Those will be very tightly controlled—the cost of robots will go down, for example, with the government better able to control what they pay than when they were buying essentially COTS products during this war."

Programs of record also are required to assure funding; during the Second Gulf War, many systems were rapidly acquired and immediately fielded using the Joint Urgent Operational Needs process. JUONs were funded largely through overseas contingency operations (OCO) funding, a source no longer available with the U.S. drawdown.

The second major change may negate—or at least postpone—the need for every warfighter to carry some type of robot in his or her kit, while simultaneously improving combat coordination of robotic assets—air, land, and sea.

The ReconRobotics Throwbot provides increased situational awareness and standoff distance to warfighters conducting compound clearing missions and urban warfare operations.

Universal controllers

"The Marines want to simplify training, logistics, acquisitions, so through considerable experimentation and working with other companies the Corps has brought in, QinetiQ developed the Tactical Robotic Controller [TRC], which the Navy and Marines already have used to control more than 20 different types of unmanned systems using software the UAV/UGV manufacturers loaded into TRCs provided by the Corps," Dean says.

One of the keys was simplicity. Dean reported one company integrated their aircraft into a TRC in a tradeshow booth in 20 minutes, while four or five UGV companies have integrated their robots into the universal controller, as well.

The need arose when the Marines discovered they often had combat units employing a range of small robots, built by different companies and requiring the use of unique controllers, thus increasing the load warfighters had to carry into the field, as well as training, maintenance, and logistics requirements. For typically small field units such as used by the Corps, that often meant the same Marine had to be trained in and operate three or four controllers on a single mission.

The Navy and Marine Corps put out a bid to industry to develop a wearable common controller weighing less than eight pounds that could handle all Corps UGVs, Class 1 UAVs, and unattended ground sensors.

"Little, medium, and big robots tend to have different controllers, but the Marines were getting increasingly concerned about the multiple controllers, batteries, etc., they were seeing. We won that competition about three years ago and have been steadily developing that type of controller, although getting it down to eight pounds took a lot of hard engineering," Dean says. "Other typical controllers able to handle this kind of variety may weigh up to 30 pounds for just one type of robot. Most were too awkward for dismounted ops. And if a company had been using a laptop-based controller, it frequently had commercial batteries that were hard to recharge in the field. Even worse, it is not unusual with even small UAVs to have

two different controllers to fly just one UAV."

The biggest challenge in controlling several unmanned vehicles simultaneously is twofold—first, the software operating system such as Windows or Linux, and second, the type of radio interface. The latter is the larger of those because there is no common radio across unmanned air and ground systems, although the military has requested development of one or more families of common radios for air-to-air, air-to-ground, ground-to-ground, etc.

"We have shown we can drive two robots at the same time, although we believe we can do more than two. And the Army, which has become very involved in the TRC, has shown they can fly a Class One UAV at the same time the operator can drive a ground robot," Dean says. "When doing two simultaneously, you are giving command and control instructions to one while monitoring the other platform, then switch. So you're basically juggling the C2 functions. But eventually we will be able to give independent C2 instructions at the same time. The TRC is a small tablet with a cable running to the console and can have one or two touchscreens. When doing ground and air simultaneously, the dual-screen TRC has become very popular and useful because you can segregate the information you're getting on those two screens. You also can use a monocular device, so you're not limited on that score and can use your own imagination, depending on display and input requirements."

Although developed to meet a Marine Corps requirement, the Army has taken the TRC into combat in the largest quantities to date, using them in Afghanistan since the Fall of 2011.

While a manpackable, lightweight device such as the TRC would give one warfighter the ability to control multiple robots, Dean and some others believe every warfighter will be able to access everything coming from every robot in the area, perhaps even using a smartphone app. If so, such a multifunctional device could make it unnecessary to provide each with a personal manpackable robot, as well.

Evolving technologies are also giving some or all those robots varying degrees of autonomy, reducing the need for warfighters to handle robot operations instead of pursuing more direct missions against an enemy.

"Autonomy definitely will become a more prevalent part of robotic technologies in the years to come, but that is a major step from where we are today. It is very hard to put even semi-autonomy on ground systems that are accurate enough to meet user needs while keeping the price down. At this point, we're just beginning to add semi-autonomy on field-ready systems," Dean says. "But as commercial industry, especially automotive, moves forward, they will play a big role in bringing down the size and cost of the sensors required. The military will benefit greatly from those. As to full autonomy and the software required to

make decisions, those should come together with less expensive systems in about 10 years. That means the onboard computer can work with those to start to make its own decisions and aid the warfighter."

Smaller, more capable manpackable robots can significantly improve individual warfighter and small unit capabilities, but still face a barrier stretching back to the Roman Legions—the amount of weight a warrior must carry into battle—versus warfighter demand. After their experiences in Southwest Asia, Trainer notes, no EOD team will go out without some form of robot—and the rest of the nation's ground troops are quickly adopting the same attitude.

"The benefits of robotics are well known and infantry troops are pulling for that capability, but not at the expense of the load on their backs. So how do you balance robots against UAVs, weapons, supplies, and everything else they have to carry? That may be a high-low mix, with individual warfighters having something like FirstLook, then the squad having a larger, more capable robot," Trainer says. "There are always tradeoffs. How do you work that into your combat logistics and what is acceptable in a combat situation? I think robotics will be an integral part of the infantry going forward, but we really haven't defined what that will look like. Much of it will require more experimentation, but lessening the load will always be considered critical."

There also is a non-technical development in the increased use of "personal" robotics by warfighters and the interaction between them, what the Roadmap calls part of the Marine Corps' Middle-Term Future State (2017–2022)—"enhanced human-robot interaction that enables teaming and trust."

University of Washington researcher Dr. Julie Carpenter interviewed numerous EOD personnel and found warfighters in combat and first responders at home were developing an almost anthropomorphic relationship with their robots—something that might become even more prevalent as more and more warfighters carry personal robots in their packs. Carpenter's research led to what she identifies as Robot Accommodation Dilemma and attachments that she believes are continuing to evolve as robotic technology advances.

"Simply put, RAD describes how the people I spoke with described a challenge of conflicting emotions, expectations and experiences when interacting with EOD robots and how they struggle to fix the identified problems in order to succeed. They were very clear it was a tool, but at the same time, patterns in their responses indicated they sometimes interacted with the robots in ways similar to a human or pet," Carpenter wrote. "The act of attachment and its related concepts of bonding, cohesion and trust may impact operator decision-making. Some operators also described robots as an extension of themselves, literally or figuratively. You don't want someone to hesitate using one of these robots if they have feelings toward the robot that goes beyond a tool. If you feel emotionally attached to something, it will affect your decision-making."

Coming off a decade of combat in which personal robots became increasingly vital to the success and safety of U.S. warfighters and into one in which the methods of development and acquisition will change radically as budgets continue to decline, the future is both technologically bright and programmatically murky.

Equipped with video, audio and infrared sensors, the ReconRobotics Throwbot XT can be deployed in three seconds and thrown as far as 120 feet.

"The ability for every individual warfighter to be able to extend beyond themselves using manpackable robotics technology would be a critical component of how capable the force as a whole will be. But what form it takes is anybody's guess, probably varying according to the specific needs of each soldier," Salton concludes. "But I think we also will transform emergency response in the next couple of decades, with better comms, situational awareness, status of responders, locating victims, etc. Having a combination of manned and unmanned systems working together will be critical to providing a more rapid response with integrated capabilities between people and machines."

VPX emerging as the industry choice for high-performance embedded computing

BY **John Keller**

The embedded computing industry has seen a lot of fragmentation over the past several years due to a proliferation of new form factors, industry standards, and high demand for small-form-factor systems for new generations of unmanned vehicles.

While this market fragmentation may be true across the board in the embedded computing world, it is not so for high-end aerospace and defense applications, such as radar processing, signals intelligence (SIGINT), and electronic warfare (EW). In these kinds of applications, the consensus clearly is on 3U and 6U VPX.

Reasons that VPX is becoming the technology of choice for high-end systems designers include high performance per watt; VPX open-systems standards that lend themselves to interoperability and a broad technology ecosystem; and the inherent ruggedness of VPX that enables it to stand up to high shock and vibration environments that demand conduction cooling and high signal integrity.

VPX, the high-performance descendent of the VME designs of previous generations, essentially comes in two form factors: 6U and 3U. The larger 6U VPX boards are finding a niche in the most demanding applications where size and weight are not driving issues, while 3U VPX is becoming the mainstream choice for a growing range of high-performance mobile applications, such as unmanned vehicles and manned ground vehicles that operate at the front lines of the battlefield.

High performance

"VPX is really rugged and the mechanicals and the thermals are extremely well understood," says Jeff Milrod, president and CEO at BittWare in Concord, N.H. "Rugged deployment is far and away the huge advantage of 3U VPX." BittWare specializes in high-performance embedded computing involving field-programmable gate arrays (FPGAs).

The applications drivers for VPX tend to be intelligence, surveillance, and reconnaissance (ISR), radar, EW, "and those types of applications that tend to be the highest speed," says Bob Sullivan, chief technology officer for the Curtiss-Wright Controls Defense Solutions engineer packaging group in Littleton, Mass. For these kinds of applications, the VPX combination of performance, ruggedness, and relatively small size, weight, and power consumption (SWaP) is key.

With VPX "we've done a lot with radar, STAP radar, synthetic aperture radar (SAR), and video SAR," says Marc Couture, director of product management at Mercury Systems in Chelmsford, Mass. Space-time adaptive processing (STAP) uses adaptive array signal processing for target detection. Video SAR involves processing streams of radar data to produce a moving radar image that looks like video. Both approaches involve staggering amounts of embedded computing power.

The high performance of VPX also enables designers to put big computing power in small packages. "That 19-inch box that took 1,000 watts years ago, now it's a tenth of the size and power consumption, and that 3U VPX box today is going to be a fraction of the cost [compared to] years ago," says David Pepper, product manager and technologist for single-board computers at GE Intelligent Platforms in Huntsville, Ala.

Open architecture

Among the most appealing aspects of VPX is its rich and growing ecosystem that accommodates a wide variety of embedded computing technologies. "We're doing a lot with heterogeneous processing, by combining FPGAs, server-class and general-purpose processors, and GPGPUs [general-purpose graphics processing units]," explains Mercury's Couture. "We need a foundation to put that into, and VPX has been that. It is starting to be more cohesive into common profiles and into an ecosystem."

As far as aerospace and defense applications are concerned, U.S. military leaders are looking for open-systems architectures now more than ever to facilitate interoperability and future systems upgrades, and to help keep system costs down.

"OpenVPX is a clearly identified

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open-systems standard, and the government is asking for that," says Paul Monticciolo, chief technology officer at Mercury Systems. "The government continues to push toward open-systems architectures for radar, EW, ISR, and similar applications."

The OpenVPX industry standard not only accommodates a wide variety of technologies, but also is designed to evolve over time and accommodate new technologies as they are developed. Some call the standard a "living specification," which is not set in stone and is designed for future growth.

"The VPX infrastructure, the tools, and the ways we put together the system are not changing dramatically," says David Jedynak, chief technology officer of Curtiss-Wright Controls Defense Solutions in Ashburn, Va. "It has RF and optical connectors, all in one big ecosystem. VPX is up to the task of future requirements, and is evolving with the future in mind."

Built rugged

Perhaps the most profound interest in VPX among the aerospace and defense community is its toughness and resiliency in environmentally challenging environments for systems reliability and longevity, as well as for the integrity of signals that are traveling at increasing speeds through connectors and backplanes.

"Signal integrity is becoming a bigger issue, because of high-speed Infiniband and Gigabit Ethernet, and in some cases of Generation 3 PCI Express," says Mercury's Couture. "This is stressing the connector technology in back of these VPX payloads."

Today some of the most advanced VPX systems are moving data at 40 gigabits per second, and the future promises even faster speeds.

"A lot of our R & D dollars are going into sustaining these high bandwidths while you are vibrating on platforms like helicopters," Couture says. "We also have to think about temperature extremes, and this is driving VPX technology."

Still, signal integrity remains a core issue for the most advanced VPX systems. Designers face the stark choice of designing innovative electronic connectors able to stand up to physical punishment and ever-faster data speeds, or put their efforts into developing a new generation of optical systems interconnects.

"Signal integrity issues come down to the need for speed," says Curtiss-Wright's Jedynak. "Higher-and-higher-speed processors go on boards, and need a lot of data moving to be consumed by that processing power. If processors consume a lot of data from sensors, the data coming in needs to move quickly."

Curtiss-Wright has introduced its Fabric40 program to increase the interconnect speeds of high-performance embedded computing (HPEC) standard products to 40 gigabits per second. Other VPX manufacturers are not far behind. Curtiss-Wright's Fabric40 program aims at HPEC implementations in the most demanding defense and aerospace rugged deployed applications, such as next-generation radar and signal processing, as well as command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) applications.

With speeds like that, signal integrity isn't simply an option, experts say.

Getting COTS Right

BY **Mike Macpherson**

Military & Aerospace Electronics has put new focus on some key strengths and concerns of using commercial off-the-shelf (COTS) components in today's military systems designs.

In two recent blog postings, John Keller, this publication's editor-in-chief, celebrated the goal and achievements of the COTS approach for system design which, in his words, enables the U.S. military to leverage "the commercial market for leading-edge military technology, rather than inventing its own custom-designed technology."

Recognizing the economic and technology benefits that it has delivered, Mr. Keller stated that COTS is "without a doubt the best thing that has happened to military procurement in decades, perhaps much longer."

At the same time though, Mr. Keller has identified an ongoing source of market confusion that actually results from the term "COTS" itself. Simply put, the term COTS—in wide use since Defense Secretary William Perry launched the highly successful "COTS Initiative" in 1994—fails to distinguish between commercial-grade electronics components on one hand, and the specially designed, rugged COTS hardware supported with comprehensive and proven life cycle support services on the other.

While Mr. Keller lauds Curtiss-Wright and other leading defense and aerospace solutions vendors for "refining and enhancing" COTS technology, he also points out that an undesirable result of the term's broad reach is that "COTS is easily misinterpreted" due to the fact that the term "still contains that confounded word commercial."

The harm results when a system designer confuses COTS with "commercial-grade electronics" and fails to understand the vast amount of work and expertise applied daily by defense and aerospace COTS vendors to mitigate commercial parts obsolescence, design advanced packaging for harsh environments, provide configuration management services, reduce the risk of counterfeit devices, and ensure longevity of supply for long-life military programs.

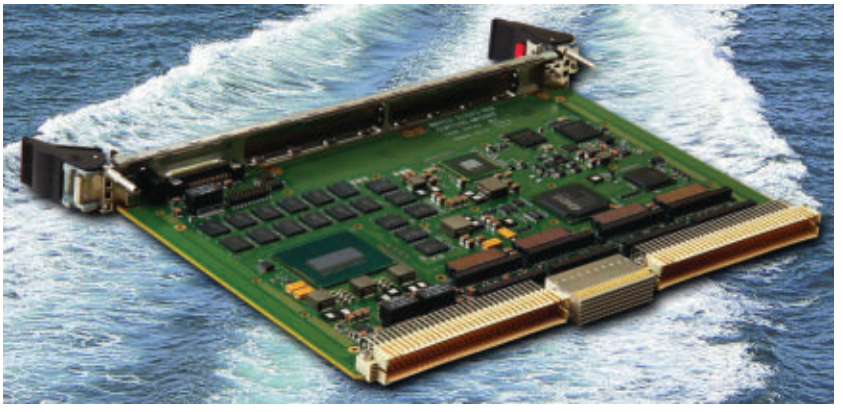
For more than 20 years, Curtiss-Wright and other military electronics vendors have worked hard to fulfill the promise of the COTS Initiative. We have unique insight into the nature of this challenge by working for decades with a large number of COTS industry participants within standard bodies such as VITA to define the most rigorous bus and board open architectures, starting with industrial-grade components. Together we've established a strong competitive base of suppliers that build COTS solutions designed to be rugged from inception.

In hundreds of programs, sup-

This rugged COTS Gigabit Ethernet switch from Curtiss-Wright is going aboard the F-16 jet fighter.

Mike Macpherson is vice president for strategic planning at Curtiss-Wright Controls Defense Solutions in Ashburn, Va.

ported in many cases for more than two decades, we've shown again and again how COTS satisfies the rigors and programmatic requirements of the most demanding deployed military programs. As the U.S. Department of Defense (DOD) moved away from proprietary and custom designs and the use of mil-spec electronics, the result has been enormous cost savings. It's also enabled the rapid fielding of today's most advanced technology to our warfighters to ensure their security and the success of their mission.



This rugged COTS 6U VPX board from Curtiss-Wright is based on the 4th-generation Intel Core i7 processor.

One key differentiator between those COTS suppliers who directly meet the needs of defense and aerospace programs and those that can't is the sophistication of the life cycle management services that they offer to reduce the risk of obsolescence.

Our Continuum Lifecycle Services, for example, provide a broad and range of lifecycle management services designed to help identify and reduce the risks of COTS component obsolescence, provide control over product configuration changes when required, and extend the availability of product builds and repairs to meet program demands.

These services include a visibility service that tracks engineering change orders, Control services to give customers control over a product's configuration, and Longevity of Supply services to track and provide supply options before the end of the volume production phase of a particular commercial device. Our longevity of repair service ensures support for repair over the program's life cycle, while our variant creation services support future builds and repairs. We also provide component storage and handling services to store a customer's component inventory which helps facilitate timely card builds and repairs.

COTS vendors who get COTS right meet the challenge of commercial obsolescence and support the long life cycle requirements of military programs on a daily basis. Working with the electronics industry's top suppliers, such as Freescale, Intel, Xilinx, and AMD, we are able to provide system designers with high-performance components supported by their manufacturers with long-term supply commitments.

Through close partnerships with semiconductor vendors, COTS suppliers are able to provide extended technology roadmaps that ensure smooth transition between generations of devices for technology refresh when required.

To win the fight against obsolescence while delivering the full performance and economic benefits of COTS electronics requires a comprehensive product life cycle management plan. The payoff, especially when lifecycle management is put in place at the front-end of the program development cycle, is application stability and predictability.

Even better, early adoption of these services is economic, in that it enables the costs to be more effectively amortized over the program's overall budget. Proactive life cycle management, especially in today's budget environment, enables deployed systems to stay in service, which is an increasingly attractive option compared to the high cost of system redesign. A life cycle management plan to mitigate COTS obsolescence includes continual research and reporting of semiconductor vendor end-of-life (EOL) schedules. This ensures the timely purchase and banking of EOL'ed components, and greatly reduces a program's logistical burden.

In combating obsolescence, COTS vendors must be committed to preventing counterfeit electronic parts from entering the supply chain. A COTS vendor that operates its own manufacturing facilities has an advantage regarding visibility and control over the materials used in the fabrication of its products.

By sourcing materials directly from the component manufacturer, authorized aftermarket support, or franchised distributors, COTS vendors can ensure that components

have supporting documentation that proves an auditable pedigree.

Curtiss-Wright adheres to AS5553-compliant practices when using independent distributors. Our "Trusted COTS" initiative manages the supply chain by maintaining an approved vendors list, and all suppliers are subject to audits and must be able to comply with quality clauses in every purchase order.

In addition, we recently launched our PLUS Services which ensure that raw materials are purchased only from franchised distribution or original equipment manufacturers (OEMs) unless specifically authorized by the customer.

One example of the approaches to mitigate obsolescence developed by COTS suppliers is seen in how we tackle the challenge of long life support for graphic processing units (GPUs), a device type known for its typically short lifecycle. To ensure that our new XMC-715 and VPX3-716 graphics display cards are supported for the full length of military programs, Curtiss-Wright partners with CoreAVI and AMD to guarantee 15- and 20-year supply of AMD's Radeon GPUs through use of a suite of CoreAVI software drivers supported with 20-year component supply program.

Another important weapon in the COTS arsenal is the use of modified COTS (MCOTS) design. In one recent example of how MCOTS helps ensure longevity of support, the U.S. Navy had a system based on an obsolete processor from a company that was no longer in business. We were able to modify one of our standard Power Architecture-based VME single-board computers to meet the needs of the system, making it possible to replace only the obsolete processor rather than replacing the entire system. The result was significant cost and schedule savings for the Navy.

> "To win the fight against obsolescence while delivering the full performance and economic benefits of COTS electronics requires a comprehensive product life cycle management plan."

Too frequently though, industry critics focus on aspects of system hardware and miss sight of the critical role that software plays in the defense and aerospace market. Finding or training a software engineer to keep a legacy military system based on an older software language such as Ada, MIL-STD-1750, or CMS-2 up and running can be a great burden and challenge.

Designing rugged COTS solutions with the contemporary electronics components that provide the underlying platform for today's most popular programming languages provides system developers with access to that large pool of software engineers fluent with the latest software tools and languages required to build next-generation system solutions.

We applaud Mr. Keller's proposed remedy to help mitigate the potential confusion caused by the broad reach of the term COTS. He suggests that industry adopt a new, more intelligent range of terms to delineate classes of COTS electronics to clearly differentiate components built with standard commercial products and those specially selected, packaged, and supported with long life cycle commitments from semiconductor vendors.

We agree that defining terminology to differentiate between classes of COTS electronics will be a helpful and progressive step, one that recognizes the degree of sophistication and the maturity achieved by today's COTS vendors.

As Mr. Keller puts it, the class of COTS vendor that delivers the COTS solutions needed today "meets military needs, often meets a fundamental set of military standards, and...has a long-term roadmap and plan to mitigate the ill effects of component obsolescence."

Establishing a set of new industry terms to clearly communicate the various levels of COTS hardware solutions will help military system designers identify those solutions providers who understand and address the daily and long term challenges of bringing the latest commercial technology to the harsh environments typical of defense and aerospace applications.

We look forward to working with *Military and Aerospace Electronics* and other industry participants to come up with a new hierarchy of terminology that helps system designers get COTS right. ←

L-3 boosts radar expertise for unmanned vehicles with Mustang acquisition

L-3 Communications in New York is boosting its radar technology for smart weapons, electronic warfare (EW), and unmanned vehicles with the acquisition of Mustang Technology Group in Plano, Texas. L-3 officials are renaming the company L-3 Mustang Technology, which will focus on radar-based sensors and systems used in precision-guided weapons, EW, unmanned systems, and other military applications. Mustang has expertise in radar systems engineering and signal processing, RF and digital electronics, systems engineering, hardware and software design, prototyping, guidance and control, simulation and analysis, ruggedized electronics, and data analysis.

FAA chooses six UAV research and test sites

The Federal Aviation Administration (FAA) chose six public entities to develop unmanned aerial vehicle (UAV) research and test sites in preparation for integrating UAVs into crowded civil airspace: the University of Alaska; state of Nevada; Griffiss International Airport in Rome, N.Y.; North Dakota Department of Commerce; Texas A&M University; and Virginia Polytechnic University. The FAA will help to set up safe testing areas and enforce strict safety standards.

Kongsberg Maritime offers MUNIN UUV for 24-hour offshore surveillance

BY **John Keller**

KONGSBERG, Norway—Unmanned systems experts at Kongsberg Maritime AS in Kongsberg, Norway, are introducing the MUNIN unmanned underwater vehicle (UUV) for offshore surveillance and survey.

The MUNIN UUV is designed to collect high-resolution sonar data geo-referenced by a survey grade positioning system. It has a modular structure that provides the ability to install extra batteries to extend operational scope for missions lasting to 24 hours at depths nearly to 5,000 feet.

The UUV is 10 to 14 feet long depending on configuration, 14 inches in diameter, and weighs 662 pounds in air. Company designers have combined their experience in developing and manufacturing both the HUGIN and REMUS UUVs.

MUNIN can carry a subsea sensor payload. Its rigid design integrates the navigation systems and acoustic payload sensors in one mechanical housing.

Its S-44 sensor payload includes a custom version of the EM2040 multibeam echo sounder operating at 200–400 kHz with a 1-by-1-degree beam width with a swath of 120 degrees. It also has an EdgeTech side scan sonar operating at 230/540 kHz and forward-looking sonar with advanced terrain following and collision avoidance.

Also included is an NBOS conductivity and temperature sensor with specifiable sub-bottom profiler and still image cameras. Communication is via Kongsberg Maritime's cNODE acoustic command and data link, Wi-Fi, and Iridium.

The Kongsberg Maritime NavP aided inertial navigation system (AINS) with Honeywell HG9900 inertial measurement unit (IMU) have within the navigation system alongside optional cNODE and HiPAP for acoustic positioning.

The Kongsberg MUNIN unmanned submersible, shown above, is for offshore persistent surveillance.

"The offshore survey industry has long sought a capable tool that can be operated from smaller vessels," explains Geir Schmidt, vice president of UUVs at Kongsberg Maritime.

In Norse mythology, MUNIN (Muninn) and HUGIN (Huginn) are a pair of ravens that fly around the world of Midgard, collecting information for the Norse God Odin.

FOR MORE INFORMATION visit **Kongsberg Maritime** online at *www.km.kongsberg.com*.

Navy looks to Teledyne Benthos for long-duration UUV sea glider persistent surveillance

BY **John Keller**

Navy researchers are counting on sea glider UUV technology for long-duration persistent surveillance of the ocean's depths.

ARLINGTON, Va.—U.S. Navy researchers are working with unmanned underwater vehicle (UUV) experts at Teledyne Benthos Inc. in Fall River, Mass., to develop long-range and long-duration UUV technology that can harvest energy from the difference of ocean temperatures at different depths.

Officials of the Office of Naval Research (ONR) in Arlington, Va., are awarding a $203,731 contract to Teledyne Benthos for a project called Long Endurance, Transoceanic Gliders Harvesting All Energy From The Ocean Thermocline.

For this project, Teledyne Benthos experts will investigate technologies that could enable UUVs to conduct long-duration persistent surveillance of the ocean in different regions and different depths.

The ability to sample ocean water at different depths could help Navy experts calibrate sonar for efficient anti-submarine warfare (ASW), as well as detect quiet nuclear or diesel-electric submarines or hidden minefields. Data gathered by long-duration UUVs also could help Navy scientists with weapons and sensor research.

For this project, Teledyne Benthos will use sea glider technology. Sea gliders are long-endurance UUVs that control forward motion with differences in buoyancy.

Sea gliders can rise to the surface and stick an antenna out of the water to communicate with controllers or with GPS satellites. Then the UUVs make themselves heavier to sink themselves. As the craft descend, control surfaces propel it forward, similar to the way glider aircraft maneuver without power. Sea gliders are among the most power-efficient unmanned subsea vehicles.

Teledyne Benthos has designed the Slocum Glider, which can be powered by batteries or by a thermal engine. The thermal glider version of the Slocum Glider offers long range and endurance using environmental energy via a thermal engine.

A thermal engine, or "heat engine," converts thermal energy into mechanical energy to power the sea glider's control surfaces, buoyancy system, and communications. The thermal engine exploits changes in temperature in the ocean's depths to generate power.

The Teledyne Benthos thermal glider can be deployed in the ocean for as long as five years, operating anywhere from the surface to depths of nearly 4,000 feet. It has a range of nearly 25,000 miles.

Teledyne Benthos also designs an electric version of the Slocum Glider that runs on alkaline batteries. It can deploy for 15 to 30 days and has a range of nearly 1,000 miles.

FOR MORE INFORMATION visit **Teledyne Benthos** online at *www.benthos.com*, or the **Office of Naval Research** at *www.onr.navy.mil*.

ELECTRO OPTICS watch

Raytheon moves toward full production of multispectral avionics targeting sensor

Engineers at Raytheon Co. are taking another step toward full-scale production of an upgraded avionics sensor system that provides visible-light, infrared, laser designation, and laser illumination capabilities integrated in one sensor package. The Raytheon Co. Space and Airborne Systems segment in McKinney, Texas, won a $9.1 million order from the U.S. Air Force to enable Raytheon to achieve full-rate production readiness for the Multispectral Targeting System (MTS)-B High Definition/Target Location Accuracy (HDTLA) system—an upgraded version of the Raytheon MTS-B. This common sensor payload for unmanned aerial vehicles (UAVs) and manned aircraft will provide day and nighttime capability. The UAV sensor payload will offer the ability to collect and display continuous high-definition imagery as well as to designate targets of interest for attack by laser-guided precision weapons.

Lockheed Martin logs order for Marine attack helicopter electro-optical avionics

The Lockheed Martin Missiles and Fire Control segment in Orlando, Fla., won another contract to provide a multi-sensor electro-optical/infrared (EO/IR) fire-control system for the U.S. Marine Corps Bell Cobra attack helicopter avionics. The Naval Surface Warfare Center in Crane, Ind., announced a $34 million contract to Lockheed Martin to build AN/AAQ-30(A) Target Sight Systems (TSS) for the Marine Corps AH-1Z Cobra attack helicopter as part of the Marine Corps H-1 upgrade program converting the Marine Corps fleet of AH-1W attack helicopters into AH-1Zs. ←

Army considers upgrades to night-vision sensors with dual-band IR imaging

BY **John Keller**

FORT BELVOIR, Va.—U.S. Army electro-optics experts say they plan to develop dual-band, mid-wave and long-wave infrared sensors and electronic modules to replace the Army's existing second-generation forward looking infrared (FLIR) sensor assemblies used in a wide variety of sensor applications.

Army researchers are showing interest in dual-band sensors that combine mid-wave and long-wave infrared detectors.

Officials of the Army Contracting Command-Aberdeen Proving Ground-Belvoir Division (ACC-APG-Belvoir) are looking around industry for experience in developing dual-band, medium-wave infrared (MWIR) and long-wave infrared (LWIR) technologies, or with the capability to do so.

The specific technology that Army night-vision experts would like to replace involves the Horizontal Technology Integration (HTI) Second Generation Forward Looking Infrared (HTI 2GF) B-Kit sub-assemblies and electronic modules.

Army experts doing the research and shopping industry for new ideas and technologies are in the office of the Army's project manager, terrestrial sensor (PM TS), manager ground sensors (PdM GS) at Fort Belvoir, Va.

B-Kit sub-assemblies and electronic modules have four-field-of-view -afocal and imager optics able to take high-definition, dual-band MWIR/LWIR images with 720-by-1280-pixel focal plane arrays, and thermal reference sources.

B-Kits also have electronic cards and software for video processing, graphics/symbology, and vehicle interface controls, Army officials say.

Researchers also would like these kits to include image quality enhancements, such as scene-based non-uniformity correction (NUC); dual-band IR image fusion; and NUC mechanisms. ←

FOR MORE INFORMATION contact the **Army's Zun Lin** by e-mail at *zun.z.lin.civ@mail.mil*, or by phone at 703-704-0848.

U.S. military electro-optical spending to reach $13.5 billion over next 10 years

BY **John Keller**

NEWTOWN, Conn.—U.S. military forces will spend $13.5 billion on electro-optical systems and technology over the next decade, and buy nearly 300,000 electro-optical systems, say analysts at Forecast International in Newtown, Conn.

The U.S. military will spend an estimated $13.5 billion on electro-optical programs through 2022 on research, development, and production, say Forecast International analysts in a report, entitled "The Market for Land and Sea-Based Electro-Optical Systems."

Of the major electro-optical systems covered in the report, 296,036 units will be produced over the next 10 years. From 2013 through 2017, 156,561 units will be produced, and 139,475 units will be built between 2018 and 2022, analysts say.

"Despite the drawdown of troops in Iraq and the reduction of forces in Afghanistan, high demand for electro-optical systems will see only a slight decline over the next few years," says Andrew Dardine, senior defense analysts at Forecast International.

The next several years should see steady production of the Raytheon-produced VAS-5 driver's vision enhancer (DVE), analysts say. This production will be spread among other services in the U.S. military, including the Navy, Marine Corps, Air Force, and Special Operations Command. Raytheon also is at work completing a $25.4 million contract for the foreign military sale of the DVE to the Saudi Arabian national guard. Work under the contract should be finished by this spring.

U.S. military spending for electro-optical systems should reach $13.5 billion over the next decade.

Night-vision devices will see high demand in the years ahead, driven by U.S. Army demand for advanced surveillance systems, analysts say. The PSQ-20 enhanced night-vision goggle (ENVG) will be produced in relatively steady numbers through the rest of the decade. The Army in May 2013 awarded prime contractor Exelis a $48 million contract for the system.

The U.S. military will spend $1.1 billion on night-vision devices through 2018, analysts say. Developers of sea-based, electro-optical systems over the next several years, meanwhile, will shift their focus to surveillance and targeting of small sea-based threats.

L-3 KEO in Northampton, Mass., for example, in August 2013 won a $9.7 million order to upgrade and refurbish the Mk 46 optical sight system and the Mk 20 electro-optical sensor components and subcomponents, Forecast International analysts point out.

FOR MORE INFORMATION visit **Forecast International** online at *www.forecastinternational.com*.

PRODUCT applications

RF AND MICROWAVE

Air Force chooses crystal oscillators from Syntonic Microwave for B-1B bomber EW system

U.S. Air Force airborne electronic warfare (EW) experts needed crystal oscillators as spare parts for the Exelis ALQ-161A integrated radio-frequency (RF) electronic countermeasures system aboard the Air Force Boeing B-1B Lancer supersonic jet bomber. They found their solution from Syntonic Microwave in Campbell, Calif.

Officials of the Air Force Materiel Command at Robins Air Force Base, Ga., announced plans to order a variety of crystal oscillators as spare parts for the ALQ-161A.

The AN/ALQ-161A is designed to detect and counter radar-based weapon systems and also provides a tail warning function to detect and counter incoming missiles coming in from behind the B-1 bomber.

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency to stabilize frequencies for radio transmitters and receivers.

Syntonic Microwave specializes in custom and customizable microwave components and subsystems with proprietary digital synthesis technology and traditional microwave skills.

The company has a reputation for meeting difficult design challenges, officials say.

The AN/ALQ-161A defensive EW system provides 360-degree simultaneous receive and jamming coverage against a large number of radar-guided missiles and other threats to the Lancer bomber. The electronic countermeasures system sorts threats by priority and responds to them automatically while allowing for man-in-the-loop intervention, Exelis officials say.

FOR MORE INFORMATION visit **Syntonic Microwave** online at *www.syntonicmicrowave.com*, and the **Air Force Materiel Command at Robins Air Force Base at www.robins.af.mil.**

ANTENNAS

InterTronic wins U.S. Navy competition to replace radio telescope antenna at Kauai, Hawaii

U.S. Navy space researchers needed a 12-meter, high-precision radio telescope antenna for high-accuracy measurement of the positions of planets and stars. They found their solution from the InterTronic Antennas segment of InterTronic Solutions Inc. in Vaudreuil-Dorion, Québec.

Officials of the Naval Supply Systems Command Fleet Logistics Center Norfolk office in Philadelphia are awarding a $2.1 million contract to InterTronic Antennas to build and install a VLBI2010-style radio antenna at Kokee Park Geophysical Observatory (KPGO) on the island of Kauai, Hawaii, in support of the U.S. Naval Observatory in Washington.

InterTronic designs full-motion, high-accuracy, pedestal-mount antennas ranging in size from 2 to 12 meters in diameter that have typical pointing and tracking accuracies of better than 0.01 degrees. The precise motor-driven antennas are rigid structures and suitable for windy environments.

The U.S. Naval Observatory uses radio telescope data obtained by observing distant astronomical sources for determination of Earth orientation parameters (EOP) and for maintenance of the Celestial Reference Frame (CRF). Such observations are

made by combining data from two or more widely separated radio telescopes with a technique known as Very Long Baseline Interferometry (VLBI), Navy.

The VLBI2010 radio antenna is 12 meters in diameter and has a slew speed of 720 degrees per minute, a System Equivalent Flux Density (SEFD) sensitivity of 2,500, a frequency band of 2 to 18 GHz, and a recording rate of 2 to 16 gigabits per second. These antennas replace ageing antennas that are as large and cumbersome as 100 feet in diameter, and have nowhere near the frequency and data bandwidth.

The new antenna will replace a 20-meter VLBI telescope at KPGO that provides data for the Navy and NASA. The existing antenna is nearing the end of its operational life and is in need of replacement with a VLBI2010-type radio antenna.

FOR MORE INFORMATION visit **InterTronic Solutions** online at *www.intertronicsolutions.com*.

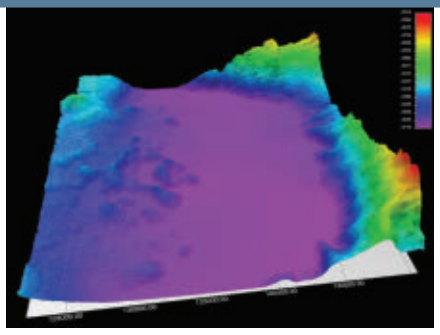
UNDERWATER SENSORS

Ocean researchers at China's SOA choose multibeam echo sounder from Atlas Hydrographic

Ocean researchers at the State Oceanographic Administration (SOA) in Xiamen, China, needed a multibeam echo sounder to conduct hydrographic surveying in oceans deeper than 6,000 feet. They found their solution from Atlas Hydrographic GmbH in Bremen, Germany.

Officials of the 3rd Institute of Oceanography of the SOA has awarded Atlas Hydrographic a contract to supply an Atlas Hydrosweep multibeam echo sounder for hydrographic surveying from mid 2014.

The Atlas Hydrosweep multibeam



echo sounder can take a Bathymetric data sample of an area as large as nearly 20 square miles to an average water depth of about 12,000 feet.

Besides its standard functions of recording Bathymetric data of the seafloor structure and the ability of recording as many as 10,000 side scan values in parallel, the Hydrosweep MD/50 comes with a 4x multiping feature. This operation mode enables the system to generate as many as four swaths simultaneously per ping using frequency modulation to increase the data density along track. As a result, the new multibeam echo sounder maintains gapless coverage at high survey speed enabling SOA fulfilling its tasks more efficiently in shorter time.

Delivery of the system is scheduled for March 2014 and the sea acceptance trials will be conducted soon after. The MD/50 for SOA will be the third Hydrosweep Multibeam echo sounder in China.

FOR MORE INFORMATION visit **Atlas Hydrographic** online at *www.atlashydro.atlas-elektronik.com*.

RUGGED COMPUTERS

Raytheon chooses Octagon Systems to supply FLEET rugged computers for LPD-17 shipboard electronics

Shipboard electronics integrators from the Raytheon Co. Integrated Defense Systems segment in Tewksbury, Mass., needed rugged computers for the U.S. Navy amphibious transport dock USS Somerset (LPD 25). They found their solution from Octagon Systems in Westminster, Colo.

Octagon officials received an additional delivery order from Raytheon to provide the Octagon rugged FLEET computers for the Somerset, as well as for several other of the Navy's San Antonio-class amphibious transport dock surface warships. The Naval and Maritime Solutions segment of Raytheon Integrated Defense Systems is the ship electronics systems integrator for all San Antonio-class amphibious warfare ships and prime contractor for lifecycle engineering and support of Raytheon-designed

and developed equipment.

The Octagon open-architecture FLEET rugged computers are based on the 1.6 GHz Intel Atom N270 microprocessor. The Octagon Hedgehog power supply provides protection from the severe transients common in mobile power systems. The high density extrusion becomes the heat sink for the CPU and other heat producing components.

Octagon designed FLEET rugged computers for fanless operation over temperatures from -25 to 70 degrees Celsius. The computers accept Mini PCI, Mini PCI Express, and PC/104 Plus modules, as well as automotive hard drives or solid-state disks.

FOR MORE INFORMATION visit **Octagon Systems** online at *www.octagonsystems.com*.

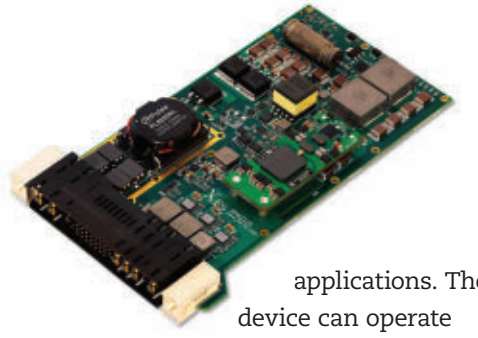
new PRODUCTS

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

DATABUSES AND NETWORKING

Extended-temperature MIL-STD-1553 encoder/decoder for military uses offered by Holt

Holt Integrated Circuits Inc. in Mission Viejo, Calif., is introducing an extended-temperature version of the company's HI-15530 MIL-STD-1553 encoder/decoder for military platforms and down-hole drilling



applications. The device can operate in the temperature range -55 to 200 degrees Celsius, and also is a drop-in replacement for the Intersil HD-15530. The HI-15530CDH is designed to meet the requirements of MIL-STD-1553 and similar Manchester II-encoded time division multiplexed serial data protocols. The HI-15530 contains an encoder and decoder, which operate independently and are compatible with either 5- or 3.3-volt logic and transceivers.

FOR MORE INFORMATION visit **Holt Integrated Circuits** online at *www.holtic.com*.

EMBEDDED POWER

3U VPX embedded computing power supply for aerospace and defense introduced by X-ES

Extreme Engineering Solutions Inc. (X-ES) in Middleton, Wis., is introducing the XPm2220 3U VPX-REDI (VITA 62) embedded computing power supply for aerospace and defense applications. The XPm2220 power supply can help systems designers reduce size, weight, and power (SWaP), as well as the cost and complexity of VPX-based systems, X-ES officials say. The power electronics module offers output power and efficiency. It also provides internal EMI filtering, direct support for a wide input voltage range, and fits within one 0.8-inch or 1-inch pitch 3U VPX slot. The XPm2220 provides as much as 300 watts of total combined output power at 90 percent efficiency, and it can be paired with another XPm2220 for load sharing and redundancy.

FOR MORE INFORMATION visit **X-ES** online at *www.xes-inc.com*.

FPGAS

Small, power-efficient FPGAs for context-aware mobile devices offered by Lattice Semiconductor

Lattice Semiconductor Corp. in Hillsboro, Ore., is introducing the ultra-low-density iCE40 field-programmable gate arrays (FPGAs) for context-aware, ultra-low power mobile devices. The iCE40 FPGA family comes in packages as small as 1.4 by 1.48 by 0.45 millimeters. With hard IP for strobe generators, I2C and SPI interfaces, the iCE40LM FPGAs deliver near-zero latency for context-aware systems with the real-time capturing of user and environmental inputs with minimal delay or error. The small size of the iCE40 FPGAs enables integration of advanced functions such as IrDA, barcode emulation, and service LED in one chip

with available logic for additional customer-defined functions.

FOR MORE INFORMATION visit **Lattice Semiconductor** online at *www.latticesemi.com*.

IMAGE PROCESSING

4-Channel PCI Express video and audio frame grabber for surveillance introduced by Sensoray

Sensoray in Tigard, Ore., is introducing the model 810, PCI Express 4-Channel frame grabber with audio capture for video surveillance, law enforcement, and broadcast-grade video/audio capturing. The low-latency and real-time video solution simultaneously captures four channels of analog NTSC/PAL video and four channels of stereo audio. It captures raw video frames from each channel to full frame rate, resulting in an aggregate frame capture rate as fast as 120 frames per second for NTSC and 100 frames per second for PAL. The high frame capture rate through a one-lane x1 PCI Express interface complements four BNC connectors available on the board's mounting bracket for

connecting external composite video sources.

FOR MORE INFORMATION visit **Sensoray** online at *www.sensoray.com*.

DATA CONVERSION

FPGA-based data converter XMC module for radar and communications introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing the Onyx model 71730 high-speed data converter XMC field-programmable gate array (FPGA) embedded computing modules for radar, communications, or general data acquisition applications. The Onyx model 71730 is a one-channel, 1 GHz 12-bit A/D, 1 GHz 16-bit D/A module based on the high-density Xilinx Virtex-7 FPGA. It is for air-cooled, conduction-cooled, and rugged operating environments. The board can receive and transmit at the same sampling rate, supporting signal bandwidths to 400 MHz. Architectural enhancements in the Onyx family include a doubling of the DDR3 memory in size and speed to 4 gigabytes and 1600 MHz, respectively. The PCI Express interface has been upgraded to Gen 3, delivering peak transfer rates to 8 gigabytes per second.

FOR MORE INFORMATION visit **Pentek** online at *www.pentek.com*.

CHASSIS AND ENCLOSURES

6U 6-slot ATCA embedded computing shelf with integrated switch cards introduced by VadaTech

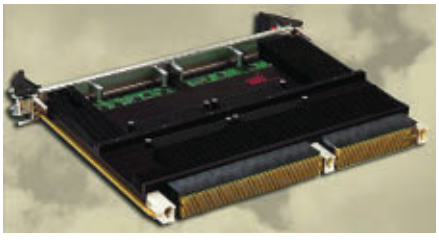
VadaTech in Henderson, Nev., is introducing the VT830 6U 6-slot ATCA embedded computing shelf with integrated boards that combine the functionality of switch cards and shelf managers. The VT830 locates switching shelf managers (SSMs) below the card cage to free-up those slots to be used as payload slots, providing six slots instead of the usual four, company officials say. The 19-inch rackmount 6U shelf offers redundancy for field replaceable units (FRUs). The chassis has a push-pull cooling configuration, providing as much as 375 watts per slot of thermal management. The VT030 SSMs in the 6U ATCA chassis provide layer 2/10 Gigabit Ethernet as well as layer 3/10/40 Gigabit Ethernet switching.

FOR MORE INFORMATION visit **VadaTech** online at *www.vadatech.com*.

EMBEDDED COMPUTING

6U OpenVPX DSP board for sense-and-response applications introduced by Curtiss-Wright

Curtiss-Wright Controls Defense Solutions in Ashburn, Va., is introducing the CHAMP-WB family of Xilinx Virtex-7 6U OpenVPX digital signal processing (DSP) board for sense-and-response applications that require high bandwidth and minimal latency. In addition, Curtiss-Wright is introducing the TADF-4300 6U OpenVPX embedded computing board with the Tektronix Component Solutions 12-gigasample-per-second analog-to-digital and digital-to-analog converters. These two modules are for wideband digital radio frequency memory (DRFM) processing for defense and aerospace embedded computing applications. The rugged CHAMP-WB-DRFM card set is optimized for electronic warfare (EW), while the TADF-4300 enables designers to develop powerful embedded DRFM solutions with 3x the performance of existing CMOS-based offerings when coupled with the CHAMP-WB's on-board Virtex 7 FPGA and high-speed, wideband interfaces.



FOR MORE INFORMATION visit **Curtiss-Wright Controls Defense Solutions** online at *www.cwcdefense.com*.

WEARABLE COMPUTING

Battlefield wearable computer to manage military communications introduced by Crystal Group

Crystal Group Inc. in Hiawatha, Iowa, is introducing the TAC-V integrated military communications

system designed to provide mobile computing capability in a small, lightweight system for infantry and vetronics applications. The TAC-V is a modular wearable computer system with enough ports to connect to many types of radios, company officials say. These radios range from narrowband or wideband to software-defined or legacy, allowing for connectivity on the battlefield. This system weighs less than nine pounds and can exceed 10 hours of mission support. The TAC-V includes a RD1107 display, RE0911 micro-computer, IOH-05 I/O hub, battery pack, and global positioning system (GPS). The TAC-V system can be purchased as modular components. These components can be integrated into combat vehicles, helicopters, and unmanned vehicles.

FOR MORE INFORMATION visit **Crystal Group** online at *www.crystalrugged.com*.

POWER ELECTRONICS

DIN rail power supplies for low-power industrial, automation, and process control offered by TDK Lambda

TDK-Lambda Americas Inc. in San Diego is introducing the DRB series of DIN rail power supplies for low-power industrial, building automation, and process control applications that require little space on the mounting rail. The DRB series DIN rail power supplies offers efficiency of as much as 91 percent, with no-load power consumption between 0.3 and 0.5 watts, depending on the model type. Housed in a plastic case, the DRB series offers a narrow design, ranging from 18 to 45 millimeters. All DRB models will mount on either a TS35/7.5 or TS35/15 DIN rail, and are tested for shock and vibration while mounted onto the rail. The supplies operate from a universal input of 85 to 264 volts AC, have EN61000-3-2 compliance, and can withstand input voltage surges of

300 volts AC for 5 seconds.

FOR MORE INFORMATION visit **TDK-Lambda** online at *www.tdk-lambda.com*.

RUGGED COMPUTERS

Waterproof computer for ship, aircraft, and land-based applications introduced by Crystal

Crystal Group Inc. in Hiawatha, Iowa, is introducing the SE16 sealed embedded computer for high-performance computing applications in military and other environments where performance, ruggedness, and reliability are imperative. The SE16 has immersion protection rated to IP67, allowing it to operate while submerged in water to one meter. Weighing 23 pounds, the SE16 Sealed Embedded's ruggedness and performance makes it desirable

for shipboard, airborne, and land-based applications. The rugged computer has an updated MINI-ITX Intel i7 mobile processor and X9SPV Supermicro motherboard for increased computing power, graphics performance, power saving, and server long-term availability. The SE16 sealed embedded computer offers an all-aluminum construction with custom EMI gasketing to seal the chassis. It is designed as convection-cooled which enables the unit to operate in extended temperature ranges of -40 to 55 degrees Celsius. Cold-plate mounting also is available for higher-temperature environments.

FOR MORE INFORMATION visit **Crystal Group** visit at *www.crystalrugged.com*.

DATA RECORDING

Rugged portable and high-speed turnkey hot-swappable data recorders introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing the model RTR 2728 rugged portable and the model RTR 2748 high-speed turnkey data recording systems for hot-swappable applications for removal and exchange during or after a mission to

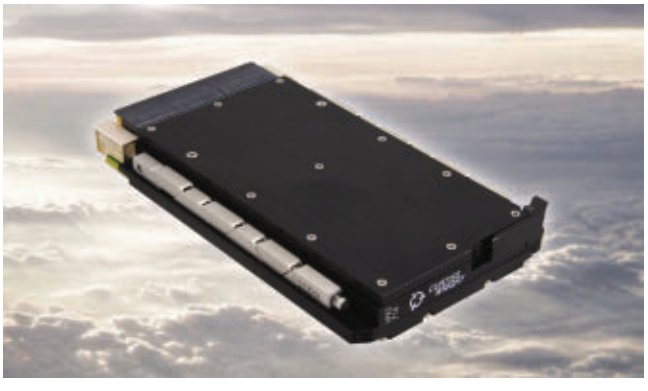
retrieve recorded data. The model RTR 2728 is a rugged portable data recorder, and the model RTR 2748 is a rugged rackmount recorder. The devices use state-of-the-art solid state drive (SSD) storage technology to achieve aggregate recording and playback rates to 4 gigabytes per second. These recorders are for recording and reproducing wideband IF signals at sample rates to 1 gigasample per second. Systems are built on a Windows 7 Professional workstation with an Intel Core I7 processor and provide a graphical user interface (GUI) and application programmer's interface (API) to control the system.

FOR MORE INFORMATION visit **Pentek** online at *www.pentek.com*.

GRAPHICS PROCESSING

3U OpenVPX graphics display card for aircraft and ground vehicles offered by Curtiss-Wright

Curtiss-Wright Controls Defense Solutions in Ashburn, Va., is introducing the VPX3-716 3U OpenVPX six-head graphics display card for demanding graphics-rich applications in aircraft and ground vehicles that require extensive video processing and display capabilities. The module is based on the AMD next-generation embedded Radeon Adelaar graphics processing unit (GPU), and



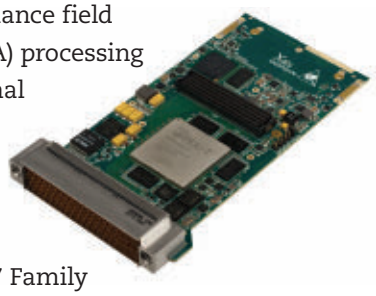
meets the long-lifecycle availability required for military programs through use of a suite of CoreAVI software drivers supported with 20-year component supply program. The VPX3-716 is suited for embedded training, moving maps, geographic information systems (GIS), 360-degree situational awareness, diminished vision enhancement (DVE), and other graphics and video-intensive applications.

FOR MORE INFORMATION visit **Curtiss-Wright Controls Defense Solutions** online at *www.cwcdefense.com*.

SIGNAL PROCESSING

3U VPX and XMC FPGA modules for digital radio and signal processing introduced by X-ES

Extreme Engineering Solutions Inc. (X-ES) in Middleton, Wis., is introducing the XPedite2470 3U VPX and XPedite2400 XMC high-performance field programmable gate array (FPGA) processing modules for demanding RF signal acquisition, software-defined radio (SDR), and digital signal processing (DSP) applications. The embedded computing modules use the Xilinx Virtex-7 Family of FPGAs to merge high throughput, configurable I/O, and DSP-level processing with thermal efficiency and high-speed analog-to-digital or digital-to-analog conversion. These modules can use the VITA 49 VITA Radio Transport (VRT) protocol to format the data of a digitized IF stream. This enables interoperability and simplifies system integration, as VRT data can be carried over Gigabit Ethernet, 10 Gigabit Ethernet, PCI Express, Aurora, Serial RapidIO (SRIO), and Serial Front Panel Data Port (S-FPDP).



FOR MORE INFORMATION visit **X-ES** online at *www.xes-inc.com*.

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Mitch Snyder

The Bell Boeing V-22 Osprey continues to draw an international crowd.

The U.S. is increasingly investing in the V-22, with a five-year, $6 billion contract for 99 tiltrotor aircraft. Is international interest growing?
We are hearing from militaries worldwide excited about the V-22 Osprey and its capabilities. Bell Helicopter has an active presence in the Middle East and Asia-Pacific—that's where the biggest interest is and it is why we put offices there. International customers are proactively coming to us, asking specifically about vertical lift capabilities and aircraft availability.

The V-22 Osprey has proven itself capable in various missions, such as search and rescue, correct?
The V-22 has been instrumental in disaster relief missions. The U.S. military used V-22 to provide relief in Haiti after the earthquake in 2010 and, most recently, in the Philippines following Typhoon Haiyan.

We are seeing a growing need for vertical lift aircraft, a need for what you are seeing the V-22 do in the Philippines and what the Osprey did in Haiti. In addition to the protection of country, we're seeing lots of search and rescue (SAR) performed now with the V-22 and helicopters.

The V-22 can immediately take off and go help when there is a disaster.

Why is the V-22 well suited to SAR?
In the past, militaries would have to use large, fixed-wing aircraft to bring supplies; but, in areas such as Asia-Pacific, there aren't too many places to land. When lacking a sufficient runway, militaries and others would often fly helicopters, but you have to get them there; they often can't make it over long ranges. The V-22 Osprey tiltrotor can go by itself. You don't need ships to bring them in. The V-22 can self-deploy.

Even when the military has used a C-130 fixed-wing aircraft to search, when they find them, they need a V-22, or a helicopter if within range, to get them. With the V-22, you can search AND rescue; search and then go get them without a prepared landing surface. The V-22 is adept at setting down in remote areas. It doesn't matter that there's no runway.

So a tiltrotor delivers the best of both worlds—the speed and range of a fixed-wing aircraft and vertical lift functionality of a helicopter?
The V-22 can get there as fast as a turboprop, and its vertical lift capabilities take it anywhere people need help. Usually within 24 hours, V-22s are there. It's amazing to see. The U.S. Marine Corps responded within a 24-hour window, with four V-22s (and ultimately 12 V-22s) traveling more than 1,000 miles.

When runways are down amidst lots of damage, the V-22 can get there fast, land virtually anywhere, deliver much-needed supplies and relief workers, and transport people who are hurt. If someone is hurt, the V-22 goes so fast that it can get there and back within the "golden hour" to save lives. I think of it as delivering hope. When people are in desperate need of help and see the military tiltrotors coming, they're delivering hope. ←

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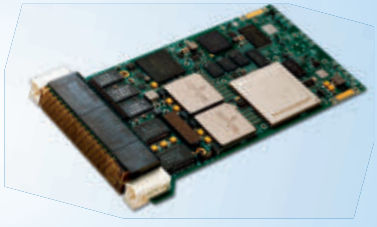

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