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Networking combat vehicles

The drive to render military vehicles as network nodes on the digital battlefield forces electronics consolidation.

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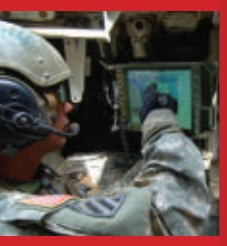

COVER STORY

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BY **JOHN KELLER**, EDITOR IN CHIEF

With robots like these, who needs humans?

U.S. military researchers are enjoying reasonable success in designing robotic technology that enables unmanned aircraft, ships, and land vehicles to operate autonomously. Today's technology can enable autonomous vehicles to assess their own operating conditions independently of human operators and make rudimentary decisions about the best ways to proceed with their missions.

Now researchers are ready to take the next step by developing technology that enables autonomous vehicles to work not only with other autonomous craft, but also as participating members of teams of autonomous vehicles and human operators.

Military researchers have announced a couple of upcoming projects to enhance machine autonomy such that unmanned vehicles could work together as teams with or without input from human operators.

The Air Force Research Lab in Dayton, Ohio, announced the Formal Mission Specification and Synthesis Techniques program to develop standardized frameworks for developing autonomous systems for military applications, as well as to find ways to help humans collaborate with autonomous systems on complicated missions involving several different tasks. DARPA also launched the Collaborative Operations in Denied Environment (CODE) program to enable surveillance and attack unmanned aerial vehicles (UAVs) to work together on missions involving electronic jamming, degraded communications, and other difficult operating conditions that could separate autonomous vehicles from human operators. The program aims to enable UAVs to work together in teams and take advantage of the relative strengths of each aircraft.

DARPA already has demonstrated technology that enables UAVs to refuel one another in mid-air with little or no intervention from human operators. Put all this together and military leaders will have some formidable technology.

It also sounds a bit like technological democracy. By that I mean that in the future humans might not be the undisputed masters of unmanned vehicles in all circumstances. In dangerous situations or emergencies humans could take charge, of course, but in routine operations it sounds like human operators simply would be team members.

Done right, it could help bring together the best strengths of autonomous systems and their human operators. The kinds of capabilities this might bring to the table are limited only by the imagination.

Launch a long-endurance UAV on a persistent-surveillance mission, for example. This autonomous aircraft might be able to make judgments and alter its own operating areas based on where it's finding the most interesting action.

This might free human operators to respond only to the most dire and immediate military or terrorist threats, rather than managing surveillance assets and second-guessing sensor-processing algorithms.

It's a far leap to get there, however. Machines that make their own decisions today are difficult for humans to trust—particularly where lives are on the line. Increasing machine intelligence might put the shoe on the other foot. Imagine a smart UAV that didn't believe its human operator, or thought him a fool.

The Air Force Formal Mission Specification and Synthesis Techniques program is trying to take man/machine trust into account. It won't solve all the issues of man/machine trust, but it's a start.

I know we've all seen our share of science-fiction movies that depict machine intelligence gone wrong. But what if we can actually make it go right? Maybe human couples in the future won't be the only ones who occasionally need relationship therapy.

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Could Navy fighters carry UAVs and UUVs in place of auxiliary fuel tanks?

BY JOHN KELLER

ARLINGTON, Va.—U.S. military unmanned vehicle experts have developed innovative ways to send drones on their missions. Unmanned vehicles can launch from runways and deploy from ships and submarines. But how about launching from the undercarriage of a jet fighter?

The Navy F/A-18E/F fighter bomber has room for five auxiliary fuel tanks. DARPA wants to know if some of those spots could carry UAVs and UUVs.

Scientists at the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., are asking engineers at the Raytheon Co. Missile Systems segment in Tucson, Ariz., to come up with a preliminary design for launching unmanned aerial vehicles (UAVs) and unmanned underwater vehicles (UUVs) from the Navy carrier-based F/A-18 Hornet fighter-bomber.

The idea is to use attachments on the underside of the F/A-18 where auxiliary fuel tanks normally go. This approach, if successful, would give Navy commanders a fast and long-range capability to deploy unmanned surveillance aircraft and submersibles when time is of the essence.

DARPA awarded a $284,640 study contract to Raytheon Missile Systems to focus on a preliminary design for a base station for UAVs and UUVs on an F/A-18 fuel tank underwing hard point. DARPA researchers want Raytheon to evaluate enabling technologies for deploying UAVs and UUVs from F/A-18 combat jets in variable seas, define potential mission profile for UAV and UUV deployment from jet fighters, and consider power, communications, and surveillance payloads for fighter-deployed drones.

DARPA is trying to help Navy commanders find new ways to provide long-range persistent surveillance in forward deployed maritime areas. This concept capitalizes on the speed and responsiveness of aircraft with the persistence of a maritime platform, officials say.

If successful, air delivery will enable the drone payloads to survive the force of entering the water from a relatively high-speed aircraft like the F/A-18.

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IN BRIEF

China prepares to take lead in UAV development

The global market for unmanned aerial vehicles (UAVs) will more than double over the next decade, rising from $942 million this year to $2.3 billion 2023, predict analysts at market researcher Forecast International in Newtown, Conn. The Aviation Industry Corporation of China (AVIC) in Beijing is expected to be the biggest UAV manufacturer in the world over the next decade, with an anticipated $5.76 billion worth of UAVs to be manufactured, nearly all earmarked for Chinese consumption, analysts say. Drone manufacturers worldwide will build about 1,000 UAVs of all types in 2014.

Air Force considers upgrades to AWACS aircraft computers

U.S. Air Force surveillance experts are surveying industry for enabling technologies that would improve the airborne moving target indication (AMTI) capabilities of the E-3 Airborne Warning & Control Systems (AWACS) aircraft. Air Force researchers seek enabling technologies to improve the AMTI and battle management/command and control capabilities to help AWACS perform missions at lower cost and risk, and with improved capabilities. ←

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Seven companies and $100 million take aim at reinventing the RF phased-array antenna

BY JOHN KELLER

ARLINGTON, Va.—U.S. military researchers plan to spend more than $100 million, involve at least seven defense companies, and award at least nine contracts in a landmark project to speed development of electronic RF phased-array antennas for communications, signals intelligence (SIGINT), radar, and electronic warfare (EW).

Military researchers are attempting fundamentally to reinvent the RF phased-array antenna to cut costs and speed development.

The Arrays at Commercial Timescales (ACT) program, sponsored by the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., seeks to do nothing less than re-invent how the military develops RF and microwave technology for a broad variety of applications that include advanced radar, electronic warfare, communications, and electronic intelligence.

The list of companies involved in the DARPA ACT program reads like a who's who of the nation's most prominent prime defense integrators and top research institutions. Among the ACT contractors are Raytheon, Northrop Grumman, Lockheed Martin, Boeing, Rockwell Collins, HRL Laboratories, and Georgia Tech Applied Research.

Together these organizations are trying to move beyond the traditional specialized and time-consuming array design process and focus on new ways of developing RF phased-array antenna transmit and receive modules.

RF phased arrays use numerous small antennas to steer RF beams without mechanical movement. Their lack of moving parts enables them to look in several directions

at once. Still, this technology is extremely expensive and can take many years to engineer and build.

The problem revolves around the need to start engineering RF arrays from scratch. The ACT program aims at creating shared hardware for future military phased arrays. ACT technologies could save the Pentagon billions of dollars and require years less research and development time for new systems, DARPA officials say.

The program has three thrusts: a common building block for RF arrays; a reconfigurable electromagnetic interface; and over-the-air coherent array aggregation.

DARPA awarded the first ACT contracts late last year. The Raytheon Co. Space and Airborne Systems segment in El Segundo, Calif., won a $19.5 million ACT contract on 17 Dec. 2013. The Northrop Grumman Electronic Systems segment in Linthicum Heights, Md., followed the next day with a $21.9 million ACT contract, and the Lockheed Martin Corp. Mission Systems and Training segment in Moorestown, N.J., won an $18.5 million ACT contract on 19 Dec. 2013.

The new year brought another participant to the program. On 14 Jan. 2014, Rockwell Collins in Cedar Rapids, Iowa, won an $11.5 million contract, followed by a $5.9 million ACT contract to the Raytheon Integrated Defense Systems segment in Tewksbury, Mass., on 26 Feb.

Four more DARPA ACT contracts came later, beginning on 24 March with a $7.4 million contract to HRL Laboratories LLC in Malibu, Calif.; a $4.6 million contract to the Boeing Co. in Seattle on 26 March; a $5.5 million contract to Georgia Tech Applied Research Corp. in Atlanta on 27 March; and a $5.5 million to Raytheon Integrated Defense in Tewksbury, Mass., on 28 March. In all, Raytheon scooped up three separate DARPA ACT research contracts.

Today's RF and microwave systems increasingly use antenna arrays for multiple beam forming and electronic steering, yet these arrays are expensive and time-consuming to develop and upgrade in the field. While the commercial market has set the pace of how electronic systems evolve, military electronics development lags be-

hind, researchers say. A fielded military system based on decade-old electronics, for example, has a small fraction of the capabilities of a system based on modern components, and the performance gap is widening between RF components and digital electronics.

As a result, a system with static RF or analog features cannot capitalize on advancements of the underlying digital electronics. The ACT contractors will help DARPA define a path toward shorter design cycles and infield updates. The DARPA ACT contractors will try to push past the traditional barriers that lead to 10-year array development cycles, 20-to-30-year static life cycles, and costly service life extension programs by developing new technology for custom arrays that takes advantage of constantly evolving digital components.

Specifically, experts from Raytheon Integrated Defense Systems (IDS) in one contract will concentrate on developing a common hardware module applicable to many different array functions, as well as combining arrays on separate platforms into a larger aperture with precise timing and localization. Rockwell Collins also is working on this first thrust of the DARPA ACT program.

In a second separate contract, Raytheon IDS experts will focus on developing a reconfigurable electromagnetic interface for different polarizations, frequencies, and bandwidths by creating a customizable electromagnetic interface to a common module. Boeing, Georgia Tech, and HRL Laboratories also are working on this second thrust of the DARPA ACT program.

Georgia Tech researchers have proposed a reconfigurable electromagnetic interface (REI) with an integrated reconfigurable ground plane that can be optimized in-situ for frequency, bandwidth, beam pattern, steering, null placement, polarization, and input impedance. They plan to capitalize on the gain of the array to match the gain of the standard array, but with added ability to reconfigure for different missions, to train to its environment, and to require a lower feed density and lower common module density than a traditional array.

Boeing, meanwhile, has proposed a novel RF phased array antenna (PAA) composed of reconfigurable wideband elements. Boeing researchers will scale the device for configurability within the 2-to-12-GHz frequency range but this technique could be scaled to other frequency bands as well. The recon-

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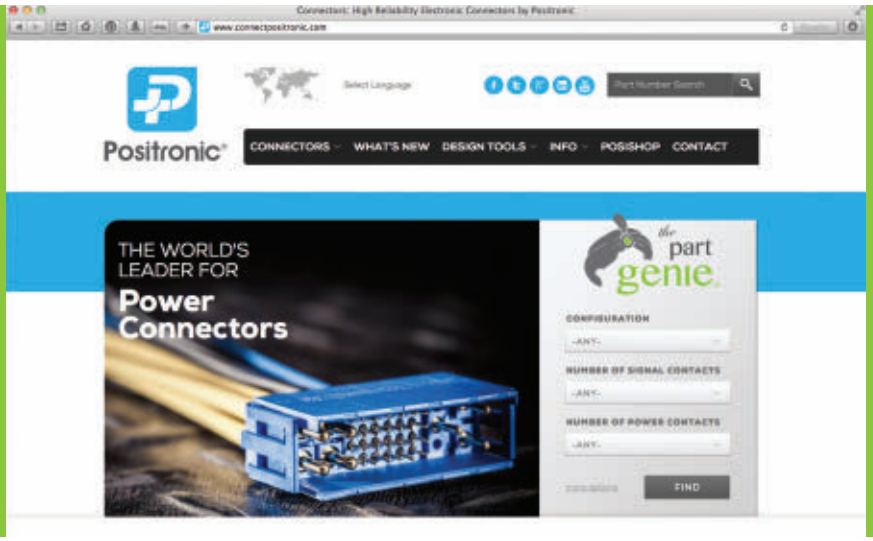

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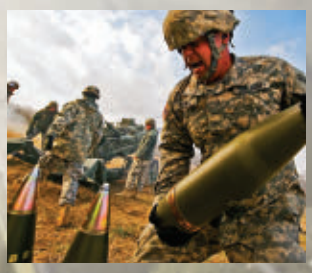


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RF CONTINUED FROM PAGE 8

figurable Boeing array should be modifiable in the field to support common module changes or emergent mission requirements. Reconfigurable arrays have persistent challenges in four main technological categories: array element performance; low-loss switches; controlling switches without hurting array performance; and fabricating interconnect structures.

The DARPA ACT program also seeks to combine arrays on separate platforms into a larger aperture with precise timing and localization. The goal is to create electromagnetic interface arrays that can be fielded at a rate to match that of commercially developed electronic components.

NAVY CONTINUED FROM PAGE 4

Raytheon has expertise in designing missiles and other munitions for delivery from high-performance military jets. The company's Integrated Defense Systems segment in Keyport, Wash., also produces the Navy's MK 54 MAKO Lightweight Torpedo, which can be launched from aircraft.

The F/A-18F Super Hornet can fly at nearly twice the speed of sound, and has a combat radius of 630 miles. The jet can carry a variety of bombs and missiles, including the Boeing Standoff Land Attack Missile Expanded Response (SLAM-ER). The SLAM-ER missile is 14.3 feet long, 13 inches in diameter, and weighs 1,487 pounds. The MK 54 torpedo, by contrast, is nine feet long, 12.75 inches in diameter, and weighs 608 pounds.

The Boeing F/A-18E/F Super Hornet is a twin-engine, carrier-based multirole fighter aircraft with an internal 20-millimeter M61 rotary cannon and the ability to carry air-to-air missiles and air-to-surface weapons. Additionally, the F/A-18E/F can carry fuel in as many as five external fuel tanks and the aircraft can be configured as an airborne tanker by adding an external air refueling system.

FOR MORE INFORMATION visit **Raytheon Missile Systems** online at *www.raytheon.com*, or **DARPA** at *www.darpa.mil*.

Consolidated networking for military combat vehicles

Today's armored vehicle crews use a wide variety of sophisticated vetronics displays and subsystems.

Adding a wide variety of electronics to military ground vehicles over the past decade is putting the squeeze on tight spaces, and pressing the need for networking and consolidation.

BY **J.R. Wilson**

When U.S. forces entered Afghanistan and Iraq after 9/11, the topic of vetronics rarely was mentioned. Today, however, the technology explosion of the past 14 years has made it possible to insert advanced electronics into ground vehicles of every type to add to their capabilities. That enhanced capability comes at a price, however. New electronics can take up space designed for warfighter operations and add to weight, power, cost, complexity, and maintenance demands.

Worse yet, the new systems added over the past 14 years have been heavily stovepiped, often with proprietary elements that complicate communications between them within a vehicle. Communications with other vehicles or with command units was even more rare.

The Army sought to address this with a set of common standards for all future vetronics systems called the Vehicle Integration for C4ISR/EW Interoperability (VICTORY) initiative. Developed by a government-industry standards body, VICTORY uses an adopt-adapt-author approach independent of specific hardware or software.

The VICTORY databus uses standards-compliant Ethernet protocols in the IEEE 802.3 family, with copper and fiber Ethernet interfaces allowed. Copper requires support for 10BASE-T and 100BASE-TX interfaces, with a recommendation for 1000BASE-T; 10-gigabit copper Ethernet standards optionally are supported, as well. Selected fiber optic

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links provide transmission rate options from 10 megabits per second to 10 gigabits per second.

"We've come out with a new approach for the future of C4ISR applications for the Army, for all platforms, including the soldier," says Paul Zablocky, head of the Space & Terrestrial Communications Directorate at the Army Communications-Electronics Research, Development & Engineering Center (CERDEC). "Our approach is not to field boxes, but to field an electronics package, onto a vehicle, that can deliver a variety of capabilities, from communications to electronic warfare to PNT [position, navigation, timing] and some higher-end capabilities, such as SIGINT [signals intelligence]."

VICTORY is a whole-systems design method. "The approach is to start with VICTORY to network within the vehicle, build on it by asking the vehicle program managers, during initial builds or upgrades, to install not only the next generation of VICTORY, but also electronics backplanes, working with TARDEC [Army Tank Automotive Research, Development & Engineering Center] so they come up with the available sizes, cooling, shock mount for these electronic chasses—and there should be more than one per vehicle, for reliability, linked by VICTORY," Zablocky says.

VICTORY standards

The Army's program executive office-ground combat systems (PEO-GCS) is the managing partner for VICTORY standards development among the four PEOs assigned to that task, which also include command, control, communications-tactical (PEO-C3T), combat support & combat systems support (PEO-CSCSS), and intelligence, electronic warfare & sensors (PEO-IEW&S).

The Army has yet to approve an official roadmap for VICTORY compliance timelines, points out Fasi Sharafi, acting assistant program executive officer-systems engineering & integration within PEO-GCS.

"VICTORY-compliant really depends on each platform and each platform's needs. Across all the VICTORY specifications, you need to pick and choose those that would apply to a given platform," Zablocky says. "I believe the first platform that would be close to a VICTORY-compliant implementation would be Stryker, probably around 2018."

VICTORY is not a single tool to create modern vetronics for the networked battlespace, Zablocky adds. Instead, it relies on elements, some of which must be in place for others to evolve later. The bottom line is placing the necessary new infrastructure—an Ethernet-based databus—within vehicles first.

"Beyond that, VICTORY has its own specific specifications across multiple component ties to define how an interface to that databus is implemented," Sharafi says. "Across the multiple vehicles that belong to PEO-GCS, that databus infrastructure must be implemented before we can start implementing VICTORY. In some instances, existing platforms do support Ethernet, but as part of [ongoing] change proposals, they are migrating from 10/100 to gigabit Ethernet, which would more than satisfy the implementation of VICTORY. As a starting point, we are already on our way to accomplishing that."

Kay Griffith-Boyle, director of the VICTORY Standards Support Office (VSSO) under PEO-GCS, agreed, saying moving toward that implementation roadmap—by clarifying the technologies and standards involved—is part of VSSO's mandate. "The science and technology community has been working on specifications development and interfaces

The M2 Bradley Fighting Vehicle, shown above, is a candidate for add-on inter- and intra-vehicle networking upgrades

that can handle future technology. While a lot of equipment already out there will be there for a long time and we can adapt it to those, these interfaces also have to work for new technologies," she says. "They're also looking at fiber as well as 1- and 10-gigabit Ethernet.

"We have some things in the experimental stage and our job is to get those to a proposed stage of maturity, building against the VICTORY specifications," Griffith-Boyle says. "The motivation for the S&T community is that technology insertion in the past has been a barrier; these open specs facilitate that kind of integration." Those dealing with integrating vetronics components "sometimes tripped over parts requirements," she adds, leading PMs to be motivated by specific requirements.

Open architectures

"VICTORY is really more about open architecture and systems engineering, so typically you won't see how it will be applied in the documents. However, it is commonly recognized an open architecture will enable a lot of savings across the community, so the four PEOs have written policies for their PMs to implement VICTORY," Griffith-Boyle explains.

"VICTORY-compliance is measured against particular component types. Within the architecture, we've identified a number of interfaces to be standardized and have broken those down into categories, which is how we measure

Legacy fighting vehicles are filling up rapidly with add-on electronics, which leaves little room for warfighters.

compliance. We have a compliance test suite, a test plan tool to verify compliance."

In short, VICTORY involves taking what systems now exist and how they provide information, then providing the interface to allow different components to tap into that information.

"We don't touch anybody's equipment or boxes; it's really all about the interface to enable networking," Griffith-Boyle says. "That could be an adapter or a new bus; we just work on that interface and standardize it. Shared services and hardware are big elements. In the past, we had vehicles with a lot of antennas and systems that didn't talk to each other. It's also about managing central functions in a common way to look at status and system management. And there are a lot of logistics implications.

"The objective is to reduce SWaP [size, weight, and power], in terms of sharing computing devices, displays, keyboards, cables, and GPS," Griffith-Boyle continues. "Another key feature is recognizing that all the systems on a platform convey data in some format and standardizing how they do that, which would reduce cycle time in development, testing, troubleshooting. When it comes to integration management and control functions, it is an enabler for single sign-on. Today, if you have a lot of different systems on a vehicle, the user may have to sign off one in order to sign onto another. If you can enable them to just sign on once and get access to everything to which they are entitled access, it makes things easier."

After more than a decade of stuffing increasingly more new systems into existing platforms not designed with the space, power or cooling capabilities to handle them, the Army—and Marine Corps—have found they often have no room for new warfighting enhancements, which can compromise the

efficiency of warfighters. A new key to VICTORY involves finding ways to consolidate technologies and systems, share common databuses and components, facilitate intra- and inter-vehicle communications, and reduce SWaP while increasing platform and warfighter capabilities.

"This effort started around 2007 and the 2009 Stryker demonstration gave us the momentum to kick off the standards body in 2010," Griffith-Boyle says. "This is the year you will see PMs start to develop plans to incorporate and field VICTORY. Because the timelines for vehicles can be lengthy, I would say you will see increasing numbers of specifications for VICTORY compliance called out in new documents. I know the Army has tried several times in the past to address this issue, but never got over the hump. And that is the question a lot of people have about VICTORY—will we get over the hump?" Griffith-Boyle says.

"For me, the question is 'if not now, when?' I think those folks who have been around the block for a while are really starting to get behind it because it makes sense and we have to do it. I know there are components now in acquisition, so we should see something happening sooner rather than later, but full implementation may be later rather than sooner. It's all a question of programmatics, which includes cost-schedule-risk. And, really, what we are doing is the foundation step to enable capabilities to the soldier," Griffith-Boyle says.

Flexible design

Wayne Plucker, analyst and director of aerospace and defense research at market researcher Frost &

Sullivan, generally agrees, but does not see VICTORY moving quite so quickly—nor even being a "carved-in-stone" standard.

"Fundamentally, the goal of VICTORY is to establish a single distributed, IP-based set of networks," Plucker says. "Ultimately, everything is supposed to leverage that, with part of that driving us to more embedded computing and less on-frame computing, a lot of coordinating systems, etc. That's the real key.

Vetronics displays enable combat vehicle crews to see outside the vehicle using signals from networked sensors.

"Revision A to VICTORY talked a lot about approaches to components and services, but each user segment defines their own, based on the initial set," Plucker says. "So VICTORY is really a top-level view and everything subsequent to that is someone refining that, using it as the standard stepping stone to bolt on whatever they need to do."

Industry, of course, tends to view VICTORY and the Army's goals from the perspective of their particular product lines and capabilities.

For TE Connectivity in Berwyn, Pa., the main focus is bandwidth and providing a VICTORY-compliant backbone to address the current stovepipes caused by different vehicles implementing different connectivity schemes for things like maintenance, logistics, fleet management, and real-time diagnostics. Even as those vehicles have become more sophisticated, the primary military initiative to network the battlespace while extending the lives of costly ground vehicles has led to a desire to see each new vehicle come off the assembly line with a VICTORY-compliant backbone and router pre-installed.

For some users, vetronics—short for vehicle electronics—means actuation and motor controls, connecting those so the commander knows what is happening, notes Gregory Powers, TE's business development manager. But others may want something more sophisticated—and bandwidth-hungry—such as radios and ISR gear.

"With that comes evolutions in connections, from megabit Ethernet to gigabit Ethernet to 10-gigabit Ethernet. That same evolution is occurring inside the boxes. Some can get by with basic VME connectors, but others—such as vision or listening or jamming systems—need the sophistication of a VPX architecture," Powers says. "When you then look at SWaP, you enter another realm. As functional density increases, size decreases, but weight remains a constant challenge to come up with efficient systems that can shed heat through conductive- or liquid-cooled systems. That also becomes part of the weight issue.

"Much of the VICTORY hardware already exists, it's just a matter of commonality and LRU interfaces compatible with VICTORY software. We're ruggedizing Ethernet, baselined to gigabit Ethernet, and offering our own composite formulations for chasses and structures, so we can make them lighter or stronger, depending on customer requirements. We also have connectors and cables that are 10Gb compatible and offer the same installation characteristics, assuring longevity and future-proofing and eliminating the need to upgrade the infrastructure down the line," Powers explains.

Commercial technology

GE Intelligent Platforms in Huntsville, Ala., sees the military following a path similar to that blazed by commercial telecom systems in the last decade.

"We've seen temporary solutions

coming in to bridge all the old technology to Internet and IP [Internet protocols], but now going to direct connections over IP," says Rubin Dhillon, GE-IP's senior business development manager for military networking & communications. "So you have this connected battlefield, with all the systems on a vehicle—the System-of-Systems [SoS]—all connected with an increasingly complex network and the systems themselves connected across a backplane.

"GE's role in the internet-of-things is the industrial side and making things like aircraft engines, wind turbines, mining rigs, etc., intelligent and interconnected—they can talk to each other and save money or optimize," Dhillon says. "We refer to the connected battlefield as a straight line to what we're doing in the Industrial Internet. The defense forces are still in the process of connecting everything, but once they do that and have all this data collected, that's where the Industrial Internet and the connected battlefield will join up—and once everything is connected, it will be about leveraging all that data from the connected things."

What frustrates Dhillon most, however, is the military's failure to accept the virtualization of some capabilities, which would reduce the hardware required and significantly improve SWaP cooling.

"We have a small rugged box in our lab that essentially replaces three boxes—the network router firewall, the mission computer, and some mission or video processing. All virtualized. But the way the certification and qualification process is set up in the military, they need to see physically separate boxes," Dhillon says. "The technology is being used in the commercial world and we have shown military customers we can do it for them, adding the functionality they want using virtualized switches and such.

"Every day I talk to a customer with a platform—UAV, weapons system, etc.—on which everything is connected by IP that has never been connected before," Dhillon continues. "Now, they say, the requirement is to get a router into a very small, space-constrained platform which has no room for it. We then start talking about virtual technology, which they agree will solve the problem—but say we'll never get it certified."

General Dynamics Canada in Ottawa is concentrating on technologies such as high-speed encrypted wireless to deal with desperate devices, says Andrew Shepherd, GD Canada's Land & joint solutions product manager.

"It's easy to talk about networking when you are talking about a new vehicle, but a lot of programs today are about keeping legacy fleets alive longer," Shepherd says. "So you're looking at what is there and can be done on Abrams and Bradley. As we integrate new features and capabilities on those platforms, it is partly about enabling them to get where they want to go in moving toward VICTORY, but also about all the existing systems and

how to communicate with different buses, some over legacy 1553 devices. While I would prefer to have everyone move toward Ethernet standards, I still have to support legacy systems," he says.

"So we have to look at how to use existing infrastructure to provide different capabilities in different locations, such as muxing in a video solution over power buses—and sometimes using new infrastructure, such as Ethernet, not only to do data but to call up whatever is needed over a common bus. Where I can't use high-speed encrypted wireless, I have to use 100BASE [100Mbps] Ethernet, using legacy products to mesh data to create a reliable low bandwidth capability. So the current state-of-the-art [in vetronics] can be enabling any capability on legacy systems or doing encrypted high-speed wireless," Shepherd says.

At the Curtiss-Wright Corp. Defense Solutions segment in Ashburn, Va., the key to achieving VICTORY is seen in a Digital Beachhead that includes all the basics needed to establish a VICTORY-compliant databus on a vehicle.

Add-on networking

Curtiss-Wright describes its Digital Beachhead as a rugged, VICTORY-compliant networking backbone for new and legacy military ground vehicles, combining a 16-port gigabit Ethernet network switch with a high-performance Vehicle Management Computer.

"With its advanced Vehicle Management Framework software simplifying vehicle management and pre-integrated VICTORY services software, Digital Beachhead is the industry's first low-cost, rugged COTS solution for modernizing ground vehicles to comply with the U.S. Army's VICTORY initiative for interoperable digital network services," according to a company statement. "Housed in a compact and lightweight enclosure, Digital Beachhead is designed to deliver optimal performance in SWaP-C-constrained vehicles deployed in harsh military environments."

The Digital Beachhead system from Curtiss-Wright offers add-on networking for legacy combat vehicles.

A large part of that effort will involve Curtiss-Wright's recent acquisition of Parvus, now a Curtiss-Wright product line with extensive experience with Cisco routing technology. A lot of VICTORY standards were developed around such commercially available products.

"When you look at the SWaP challenges as we try to reduce the electronics footprint, the lower level, less processor- and user interface-intensive systems are where the Digital Beachhead provides a great benefit. When you go into higher-end signals processing or target recognition or video processing, that's where you get into the higher end blade, VTX-type architectures in a ground vehicle," says David Jedynak, chief technology officer at Curtiss-Wright.

"Right now, the U.S. Army is pushing forward on ground combat systems—Bradley and Abrams and Stryker—all pulling in VICTORY requirements and adopting VICTORY as they upgrade," Jedynak says. "The JLTV [Joint Light Tactical Vehicle] has some VICTORY requirements in the current phase of production, but the expectation—although not actually in writing—is the LRIP [low-rate initial production] phase will see more VICTORY elements. The current Armored Multi-Purpose Vehicle [AMPV], which is out right now for bid, calls out VICTORY requirements, which also are seen in various other tactical vehicle programs."

While some in industry and government appear confident VICTORY will see the first network-compliant platforms—probably Stryker—ready for deployment as soon as 2018, others predict it will take as long as 10 years beyond that, with full capability (albeit possibly not the current VICTORY standards) not fielded before the 2030s. In the meantime, the military is seen turning to even greater reliance on fast-developing commercial technologies as military research budgets decline.

Frost & Sullivan's Plucker, who spent a lot of time on avionics

upgrades in the Air Force, including with the B-1B Special Projects Office, says they encountered many of the same stumbling blocks now facing vetronics.

"Every day things come out of Silicon Valley that are light years ahead of where the current considered architectures are in the military. And I look for that trend to continue. As we start dialing back expenses, we have to consider the COTS models more and more, so I think we'll see architectures that are, in general, more standardized, more non-proprietary, that then can absorb relatively plug-n-play insertion," Plucker says. "That gives the military the ability to tweak it, add new layers of security and differentiation and better leverage software-defined radios, for example, as part of the network environment.

"To be perfectly blunt, [VICTORY] is a mixed bag," Plucker says. As we see wholesale changes being made to vehicles during major modifications—new series, if you will, under retrofit—that tends to follow the VICTORY architecture better; I won't say well, but better. With smaller mods, realistically, it's cheaper to just do a patch for software accommodations rather than taking it back to the frame architecture. It's in the new forward fit we will see closer adherence. Although, if you read through the contracts published the last couple of years, you hardly find the word VICTORY mentioned. There is more mention in some of the documentation accompanying the RFP, but they don't use it in the actual contracts."

Cost pressures

That, Plucker explains, is because the contracts make allowances for

the winner, based on cost, to come up with a cheaper, quick fix that doesn't really address the basic VICTORY architecture.

"In today's contracting environment, cheaper almost always wins. From a long-term point-of-view, the Army would be smart to insist they follow the standards, because then modifications down the road become more plug-n-play. But we've always been penny-wise and pound-foolish in contracting," Plucker says. "Certainly the systems being fielded specific to the heavy brigade combat team [including the AMPV] have VICTORY as an underlying architecture. And if you look at the requirements against the new series—JLTV and GCV [ground combat vehicle]—you will find that. To some degree, the latest WIN-T [Warfighter Information Network-Tactical] contract modification leaned heavily that way.

"The software-defined radios we have now exist on proprietary waveforms. There has been some contracting to make that fit better, but those kinds of proprietary architectures keep us a good distance away from plug-n-play, which is where the Army ultimately is headed with VICTORY," Plucker says. "To use an open architecture system with COTS pieces ultimately will work to their benefit. But until you get away from the proprietary nature of communications and network computers, it means patch after patch, which slows down the system, makes it more expensive to deal with and ultimately harder to retrofit."

At this stage, Plucker adds, "the budget realities just scream that you can't get there from here in the near-term. The winners now are not the lead integrators—Boeing, Lockheed, General Dynamics—but more the Curtiss-Wrights and Wind Rivers, who can swing whatever way the winds finally blow.

The Stryker combat vehicle, shown above, stands to benefit from VICTORY-compliant add-on vetronics networking.

"Some current standards speak to the ability to migrate commercial products in; if we can make the equipment compatible with those kinds of standards, then we can migrate a lot of stuff. More importantly, we can do that with our NATO allies and others," Plucker says. "The U.K. has a pretty similar system going on now [Generic Vehicle Architecture or GVA], but with the same sorts of challenges in meeting compliance across a broad spectrum. And, again, going from many proprietary architectures that never worked well together to a common commercial architecture will be a bit of a challenge," Plucker says.

"I think we've already seen, in the commercial world, the standards that will be used for the next 15 years in next-generation military hardware—open standards like VME and VPX—which are counter to current military standards. The trick is, except within an LRU, most of that is not really conveniently retrofitable. If you're going to pretty much pull everything out and replace it, that's all right. But you really need to wait for new builds—and we know the story there: Is it coming, will the bucks be there, will the political environment allow it?" Plucker says.

A genuinely new architecture such as VICTORY espouses could solve nearly all the SWaP-C, interoperability, cost, and complexity problems now impacting ground combat platforms, Plucker concludes, especially if it allowed better leveraging of commercial products—what he calls "mostly-off-the-shelf" due to ruggedization and other military requirements. Enabling commonality in displays, routers, databuses, etc., also would eliminate the need to crowd components together in a vehicle,

The DuraNET is a ruggedized version of the Cisco 2955T-12 Ethernet switch for data, video and voice services for vetronics and other rugged military applications

instead allowing internal multiple-use systems or remote wireless connections.

Technology insertion

In addition, plug-n-play would enable quick, simple upgrades or mission reconfigurations, ending current methods that are "horribly time-consuming, require some kind of unique can-opener, if you will, and are horribly expensive... Right now we have a lot of boxes that would have to run through some kind of translator or software filter or switches to use whatever architecture they plug into. The Army needs to get LRU providers to sign on to the system; even if most of the vehicles aren't VICTORY compliant, the new hardware needs to be," Plucker explains.

Although Plucker says he believes much of the technology for VICTORY already exists and some progress will be made, driven by the dynamics of the battlefield, he doubts full VICTORY compliance is possible by 2020 or even 2025.

"I think we will see something partially reworked, something closer, so long as they keep the standards, but I don't expect to see the true net-centric battlefield by then. Still, we will have gained at least some traction toward that—a higher level for connectivity. But as to what the average regimental commander would like to see—I think we'll still be short in that goal," Plucker says, adding the same is likely true of all the other nations working on similar projects—with the possible exception of Israel, the only one he thinks may be ahead of the U.S. in this arena.

"The reality is the whole modularity concept makes sense and will take off whether VICTORY becomes ubiquitous or not," Dhillon predicted. "There is a common infrastructure and there will be a network because it makes sense, with one screen connected to multiple systems rather than one screen per system in the vehicle, which will, by nature, reduce SWaP. And, over time, we absolutely will solve the virtual issue and start seeing virtual rather than physical appliances being deployed, which will reduce SWaP even further."

Advanced technologies for enhancing public safety

Homeland security and first-response personnel seek an advanced, interconnected network of sensor, information, and communications devices to help save lives.

BY **Courtney E. Howard**

"History, despite its wrenching pain, cannot be unlived, but if faced with courage, need not be lived again," Maya Angelou has famously written. The global aerospace and defense community historically has faced challenging events with courage, translating lessons learned into advanced technologies. Much innovation has been achieved during challenging times, solving pressing or even life-threatening challenges.

Tragic and even catastrophic events of the past, be they the result of natural or manmade causes, have made evident the urgent need for a reliable, interoperable, and far-reaching communications and information network. Time has taught us the importance of communication, of the dissemination of critical information, and today's technology firms are working to deliver such networks into the hands of awaiting homeland security, first response, and other public safety professionals.

Filling a need

Homeland security and first-response professionals seek a communications network with several key features. "Any communications system for first responders in emergency or disaster situations needs to be deployable at a moment's notice, mobile on location, and user-friendly to the extent that it does not require an engineer for operation or deployment," says retired U.S. Marine Corps Col. Harry Jensen, senior director of aerospace and defense operations at Radisys in Hillsboro, Ore.

"New solutions must be able to provide global positioning system (GPS) [information] for situational awareness, distribute high-definition video imagery, support multi-casting, and have transmission capability greater than that of Wi-Fi [wireless fidelity] or Land Mobile Radio Systems [LMRS]," Jensen adds. "In emergency situations, the option to transmit video—as opposed to still imagery—can be paramount to situational awareness and, thus, the outcome."

Similarly, "next-generation communications technology must be able to support the control of robotic vehicles and their sensors in inhospitable environments, such as through walls in collapsed buildings, in dense terrain with trees down, or in inclement weather environments," Jensen says.

Flexible and future-proof solutions

Flexibility, interoperability, and longevity are key characteristics of networked communications for homeland security and public safety applications.

"To maintain close coordination within their team and across adjacent and higher operating units, first responders will need multi-cast user equipment supported by the network; point-to-point is just not

The Mobile Surveillance Capability vehicle uses FLIR ground surveillance sensors.

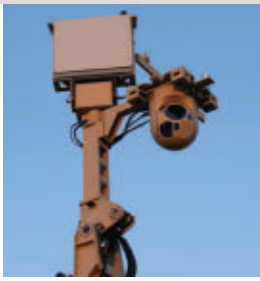
sufficient anymore," Jensen says. "To amortize system costs, a system entering widely deployed public service utility will need to have a long service life. Moreover, it will need to feature an open architecture that aligns easily with full life-cycle support, including technology refresh capability based on hardware and software upgrades and backward and forward compatibility."

Many engineers are opting to implement commercially available technologies to access these features.

COTS communications

First responders will need the capabilities offered by commercial off-the-shelf (COTS) broadband technology, such as 4G/LTE (Long Term Evolution), rather than legacy Wi-Fi or LMRS, Jensen says.

"Unlike the proprietary development approach taken to develop LMRS currently in use, future public-safety private networks can reduce time-to-market, as well as provide significant cost-savings, by relying more heavily on COTS developments," Jensen explains. "One key advantage for end-users of a



The U.S. Customs and Border Protection MSC program uses stabilized ground surveillance sensors from FLIR to capture full high-definition video from the infrared, visible, and low-light spectrums.

COTS system is being able to rapidly understand how the system operates. The more a system looks and feels like contemporary 3G and 4G/LTE systems and applications, the easier it will be to introduce it into widespread service."

Mobile, ruggedized, private 4G/LTE broadband "networks-in-a-box" with Evolved Packet Core (EPC) and small cell functionality is the hottest technology available to the public-safety market now, Jensen says. "Today, these complete network solutions can fit in a shoebox, can be battery-powered, and can conveniently be carried in a backpack or vehicle-mounted in the trunk of a police cruiser."

A national team of geotechnical engineers attached imaging equipment to the wing of a lightweight Cessna plane to collect data related to the recent Oso, Wa., mudslide.

Radisys supplies COTS-based, end-to-end LTE network solutions, such as mobile, ruggedized, private broadband networks-in-a-box for first responders and homeland security professionals. The company's small-form-factor COM Express modules with 4th Generation Intel Core i7 processors are designed to save size, weight, and power usage in operation, while providing the processing power to run the virtual machines required in a mobile Evolved Packet Core (EPC). Radisys Trillium TOTALeNodeB 2.0 small cell software enables mobile operators to deploy LTE-FDD and LTE-TDD small cells to add needed bandwidth and coverage for subscribers, while maximizing spectrum efficiency.

Advanced infrastructure

Network equipment deployment will need to rely exclusively on its own infrastructure; be mobile, durable, and user-friendly; and require hybrid backhaul as an emergency situation becomes stabilized, Jensen explains.

"After the first responders have succeeded in their initial response to an emergency," Jensen says. "Engineers will need to be able to rapidly transition to moving data across broadband and proprietary mobile network infrastructures that may already have been in place. This will allow local inhabitants, in addition to first responders, to communicate as needed. These network infrastructure solutions could include substituting cell towers initially with aerostats or unmanned aircraft orbiting overhead with a networks-in-a-box; on-board."

Unmanned aerial vehicles (UAVs), public-safety broadband (FirstNet), and push-to-talk over LTE are among the hottest emerging trends in communications and sensors for homeland security and first responders, says Brad Kay, general manager of North America at Exelis C4i in McLean, Va. Yet, he admits, the ability to interoperate and share information across various radio and network technologies is still a challenge for homeland security and public safety organizations.

Exelis C4i engineers are focused on networked voice communications for radio/telephone and intercom using voice over Internet Protocol (VoIP) and radio over Internet Protocol (RoIP). "The use of IP-based systems allows for more collaboration, remote access, flexibility of installation, and ease in sharing of data for specific incidents," Kay says. "Additionally, these systems lower maintenance costs. It is critical to adopt industry standards, rather than proprietary systems because it allows the integration of third-party devices, as well as other functions into a single system to enhance efficiencies."

Exelis C4i staff "understand the crucial nature of communications in the public-safety environment and the need for system reliability, rapid response time, and ultimate

interoperability," Kay notes. Exelis C4i engineers designed the company's interoperable communications system to streamline standard operating procedures, be compatible with legacy technologies, automate alarm monitoring and crisis response, and provide inter-service communications, "saving those extra few moments it takes to initiate deployment or activate emergency procedures that could mean the difference between life and death," he says.

In the future, Kay predicts, first responders and homeland security personnel will be able to use a single small device for voice, video, and data communications, and will be able to use the same device in a secure manner over commercial networks and secure, private government networks. "This migration will take time, be expensive, and require careful planning to ensure interoperability between agencies," he says. "As with the migration from analog radio to P25 and other digital technologies, there will be a need for organizations that can provide solutions that integrate legacy systems with digital and that also deliver local and regional interoperability in a cost-effective manner."

U.S. public-safety network

The Nationwide Public Safety Broadband Network (NPSBN) will harness 4G LTE technology to provide a dedicated wireless broadband network to the public-safety community in the United States. The NPSBN is generating a great deal of excitement and anticipation, says James Teel, director of business development at Harris Public Safety and Professional Communications (PSPC) in Melbourne, Fla. The Middle Class Tax Relief and Job Creation Act of 2012 created the First Responder Network Authority (FirstNet), the governing body that is responsible for the design, build, and operation of the NPSBN.

"The NPSBN holds great promise for public safety, in that it will greatly improve the way first responders communicate with data by expanding the use of applications like broadband video, location-based services, voice and text communications, and much more, for better emergency response," Teel says. "Coupled with existing Land Mobile Radio (LMR) network technology for voice communications, the NPSBN will give first responders capabilities that were previously thought to be impossible."

The NPSBN is not without its challenges, however, such as providing nationwide coverage within the budget constraints, Teel adds. "Bring the network with you" deployable solutions will be required to address these coverage requirements, he says. "Such deployable solutions must operate in unison with the fixed terrestrial network, when deployed in an overlap area. In addition, the NPSBN should provide converged services with existing LMR networks, enabling public-safety agencies to leverage their significant LMR investments." Harris provides solutions to address these challenges and for the NPSBN in general, including network-management and end-user devices.

"With LTE, the future holds a lot of promise," Teel explains. Enhanced situational awareness via voice, video, and data delivered not only to the emergency operations/dispatch center, but also to first responders in the field will become more commonplace, he predicts. "Additional innovative applications down the road could include real-time capabilities for biometrics, telemedicine, border protection, intelligent transportation systems, data analytics, crowd tracking, and chemical/biological/explosive sensor networks."

More mission success

The ability of deployed resources to share imagery and information in real time enables dramatically improved mission success, says Andrew Saxton, director of marketing–surveillance at FLIR Systems in Wilsonville, Ore. "Great effort is expended to get the right people in the right places with the right technology to perform their duties day or night, such as thermal imaging, which is a game changer in the homeland security realm," he says. "In order to reap the full security benefits of these resources, however, information must be available to all involved. For teams to effectively coordinate coverage and responses, each element must not only know where the others are, but what they are seeing."

U.S. Customs and Border Protection (CBP) officials selected FLIR technology for the organization's Mobile Surveillance Capability (MSC) program. FLIR has delivered an integrated solution comprised of a ruggedized vehicle well suited for the rough border environment housing stabilized ground surveillance sensors able to capture full high-definition video from the infrared, visible, and low-light spectrums, Saxton describes. It features ground

surveillance radar, standalone back-up power supply, climate-controlled cabin workstation, and command and control system.

FLIR's MSC truck is designed to deliver outstanding thermal, visible, and lowlight sensor performance from the TacFLIR 380HD; precise target detection and tracking from ground surveillance radar; and integrated command and control to fuse the data into actionable intelligence and distribute it to fixed and mobile assets around the area of operations, Saxton says.

"This integrated solution allows the Customs and Border Protection teams to deploy a full surveillance capability anywhere they need it on short notice, and delivers unmatched coverage and connectivity," Saxton explains. "FLIR has provided numerous thermal imaging systems to the Coast Guard for both helicopter and ship-borne use. These multi-sensor gimbals feature advance technology to stabilize the system against the harsh operating environment at sea and deliver valuable video imagery in support of search and rescue, counter-narcotics, and maritime patrol operations.

"The challenges to networked communications are varied, from frequency allocations to bandwidth and many more," Saxton adds. "The ultimate key to resolution is a clearly defined end state from the beginning of a project so all participants are on the same page. With the expanding types of data being shared back and forth, maintaining commonality across multiple platforms and end users becomes more challenging. With early adoption of common standards and practices however, overall project risk can be lowered."

A vast amount of imagery and data is being collected at any given time, Saxton says. "We are all working to find ways of making this information more valuable, and not overloading the operators. Future sensor and networked communication technologies must not simply add information on top of existing data, but synthesize information to enable faster assessment and response."

Smart motion control speeds design and integration of motor-actuated equipment

BY **John Keller**

An effective military has a lot of moving parts—literally—with an almost unlimited scope. They range from rotating gun turrets, to steerable sensor pods on unmanned aerial vehicles, to actuators and control surfaces on aircraft. Motors increasingly drive these moving parts, often replacing maintenance-intensive hydraulics, yet these motors require precise control to keep guns and sensors aimed in the right direction.

At the heart of many of these precision motors are smart motor-control devices with digital signal processing (DSP) capability. Digital motor control gives the designer access to a wide range of advanced digital technology, including microcontrollers, application-specific integrated circuits (ASICs) and field-programmable gate arrays (FPGAs) to lend precision to anything moved by a motor. In addition to digital control, systems designers employing smart motion control have access to a broad range of software design and development tools to ease integration, debugging, maintenance, and upgrades.

Tapping into digital technology "makes it easy to design motor controllers, and makes them low cost," says Mike Glass, product line manager of motor control at Data Device Corp. (DDC) in Bohemia, N.Y.

Digital motor control and readily available software design and development tools also offer a revolutionary step in the speed at which designers can get their subsystems up and running. In fact, these tools can cut the time it takes to fine-tune specific applications from months to just hours, says Don Laskay, product sales manager of motor control products at DDC.

Digital motor control also opens up many different systems-integration options involving digital data buses. Today's systems designer wants to place sensors and control as close to the subsystem as possible to reduce size, weight, and power (SWaP), and reduce loading on data buses.

On a helicopter, for example, "pitch control for the rotor blade is in one area, and the rudder section is in a different area," explains Amir Shafy, product and applications engineering manager at North Atlantic Industries (NAI) in Bohemia, N.Y.

Smart motion control enables helicopter designers to locate rudder- and rotor-control devices close to where they are needed, "rather than placing a huge box near the mission computer," Shafy says.

Some systems designers prefer smart motion control based on microcontrollers, others based on ASICs, and a growing number of designers are using FPGAs for smart motion control.

DDC designers prefer microcontrollers that are designed and optimized for motor-control applications, Glass says. "Microcontrollers are lower-cost generally than FPGAs," Glass says. In addition, the relative simplicity of microcontrollers offers time-to-market advantages not available to FPGA users. "An FPGA or an ASIC is a big cost-to-market factor," Glass says.

Designers at NAI, however, say FPGAs are growing in popularity with their customers due to their potential for fine control. "We are seeing a lot of people who want more control than what a microcontroller can achieve," Shafy says. "They want raw positional data, and want to be able to write their own algorithms." NAI offers motion control based on the Altera Cyclone V FPGA, with ARM microprocessor capability built in to the FPGA.

"You have the ability to run your own programs, for setting brakes, and checking for door-open and door-closed, in addition to the motor control," Shafy explains. "Being able to write your own control code, not just for the motion control but also for these ancillary tasks can be better because there is one box that

COMPANY INFO

Alizem
Levis, Quebec
shop.alizem.com

Altera Corp.
San Jose, Calif.
altera.com

Data Device Corp.
Bohemia, N.Y.
ddc-web.com

Fairchild Semiconductor Corp.
San Jose, Calif.
fairchildsemi.com

Galil Motion Control
Rocklin, Calif.
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Hansen Corp.
Princeton, Ind.
hansen-motor.com

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Golden Valley, Minn.
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North Hollywood, Calif.
meggitt.com

Microchip Technology Inc.
Chandler, Ariz.
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Moog Animatics
Milpitas, Calif.
animatics.com

National Instruments
Austin, Texas
ni.com/motion

North Atlantic Industries
Bohemia, N.Y.
naii.com

Performance Motion Devices Inc.
Boxborough, Mass.
pmdcorp.com

Rockwell Automation
Milwaukee, Wis.
rockwellautomation.com

Texas Instruments
Dallas
ti.com

Xilinx Inc.
San Jose, Calif.
xilinx.com

can handle the whole portion."

The choice of microcontroller vs. FPGA vs. ASIC often depends on the application and on the customer, Shafy affirms. "Both are viable methods; we also have a motion-control modular based on a microcontroller."

Modular motor control also has been an attractive feature for NAI customers. "Since we are a modular design, our customers get what they need," Shafy says. "And with the ARM processing there is no operating system overhead. We give them all the pieces and they can adjust the gains and filtering that they need, and can close the loop on the measurement side and the driving side for the sensors." ←

Raytheon to provide multi-spectral sensors for Navy helicopters

Officials of the Naval Surface Warfare Center Crane Division in Crane, Ind., issued a $17.7 million contract to the Raytheon Co. Space and Airborne Systems segment in McKinney, Texas, for 19 Multi-Spectral Targeting (MTS) systems for U.S. Navy MH-60R/S helicopters. The Raytheon MTS airborne, electro-optic, forward-looking infrared, turreted sensor package provides long-range surveillance, high-altitude target acquisition, tracking, range-finding, and laser designation for tri-service and NATO laser guided munitions. Raytheon won two contracts in March from the Naval Surface Warfare Center-Crane worth a collective $22.9 million to provide MTS systems for the U.S. Navy Sikorsky MH-60 helicopter and for the U.S. Air Force HC/MC-130J four-engine turboprop aircraft.

Navy to buy L-3 KEO sensor mast systems

U.S. Navy undersea warfare experts needed non-penetrating sensor masts for the fleet of Virginia-class fast-attack submarines. They found their solution from L-3 KEO (formerly Kollmorgen Electro-Optical) in Northampton, Mass. Officials of the Naval Sea Systems Command in Washington announced a $15 million contract to L-3 KEO to provide 16 Universal Modular Mast (UMM) systems for the Navy's Virginia-class submarine fleet. The Virginia-class is one of the first submarines without a traditional optical periscope.

Navy announces plan to deploy laser weapon aboard amphibious assault ship late this summer

BY **John Keller**

ARLINGTON, Va.—U.S. Navy leaders plan to deploy the service's first laser weapon aboard a surface warship later this summer, say officials of the Office of Naval Research (ONR) in Arlington, Va.

The prototype laser weapon—an improved version of the Laser Weapon System (LaWS)—will deploy on the amphibious transport dock USS Ponce for at-sea testing in the Persian Gulf against so-called "asymmetric threats" like unmanned and light aircraft and small attack boats.

High-energy lasers offer an affordable and safe way to target these threats at the speed of light with extreme precision and an unlimited magazine, experts say.

"This is a revolutionary capability," says Rear Adm. Matthew Klunder, the chief of naval research. "It's absolutely critical that we get this out to sea with our sailors for these trials, because this very affordable technology is going to change the way we fight and save lives."

Laser weapons cost about a dollar a shot, never run out of ammunition, and offer an alternative to costly missiles, artillery shells, bullets, and other munitions, Klunder says.

The Navy demonstrated the effectiveness of lasers at sea—particularly in a 2011 demonstration to defeat several small boat threats from a destroyer. In 2012, LaWS shot down several unmanned aerial vehicles.

Over the past several months scientists have upgraded LaWS, and proved that targets tracked with a Phalanx close-in weapon system (CIWS) can hand off to the laser's targeting and tracking system.

The result will be a laser weapon aboard the Ponce with one control console manned by a surface warfare weapons officer who can operate all functions of the laser weapon system. Operators will be able to manage the laser's power to disable or destroy targets.

An improved version of the Laser Weapon System (LaWS), shown above, will deploy on a Navy warship this summer for several months of real-world testing.

Data regarding accuracy, lethality, and other factors from the Ponce deployment will guide the development of even more capable weapons under ONR's Solid-State Laser-Technology Maturation program. The program calls for industry teams led by Northrop Grumman, BAE Systems, and Raytheon to develop cost-effective, combat-ready laser prototypes for guided-missile destroyers, the Littoral Combat Ship, and other surface combatants in 2016.

FOR MORE INFORMATION visit the **Office of Naval Research** online at *www.onr.navy.mil*.

Air Force chooses fast mirrors from Optics In Motion for weapons test

BY **John Keller**

EGLIN AIR FORCE BASE, Fla.—U.S. Air force weapons experts needed fast-steering mirrors for the Guided Weapons Evaluation Facility (GWEF) at Eglin Air Force Base, Fla. They found their electro-optical solution from Optics In Motion LLC in Long Beach, Calif.

Officials of the Air Force Materiel Command at Eglin plan to award a sole-source contract to Optics In Motion for two 3-inch-diameter clear aperture fast-steering mirrors and two 3.5-inch-diameter diffusing aperture fast steering mirrors. The value of the contract has yet to be negotiated.

Weapons test experts at the Air Force 96th Test Wing at Eglin will configure the Optics In Motion mirrors with a diffusing aperture substrate mirror at Eglin's Guided Weapons Evaluation Facility as part of the GWEF's infrared jammer simulation used for test & measurement of infrared countermeasures capabilities.

The 96th Test Wing is the test and evaluation center for Air Force air-delivered weapons, navigation and guidance systems, command and control systems, and Air Force Special Operations Command systems. The wing performs developmental test and evaluation for Air Force systems program offices, the Air Force Research Laboratory, logistics and product centers; major commands; other U.S. Department of Defense services and U.S. government agencies; foreign military sales; and private industry.

The Optics In Motion fast-steering mirrors are critical elements in the GWEF infrared jammer simulator, and without these mirrors experts cannot be prepared for testing guided weapons and their responses to various countermeasures, officials say.

These fast-steering mirrors enable technicians to build an exact replica of the existing simulators for testing new hardware compatibility. Two of the mirrors from Optics In Motion will have a clear aperture diameter of 3 inches, have extremely flat surfaces, will have gold coatings for maximum reflection in the necessary spectral region, have high pointing accuracy, allow for at least 30 Hz frequency of operation at full amplitude operation, and allow for circular angular range of motion of at least five degrees.

The other two mirrors will have diameters of 3.5 inches and high precision pointing accuracy. Optics In Motion is the only company able to meet all the Air Force's requirements, officials say.

The Guided Weapons Evaluation Facility, operated by the 96th Test Wing at Eglin, is the only facility of its kind in the world. The GWEF can evaluate the millimeter wave, laser, infrared, radio frequency, and visible light spectra of munitions seekers and inertial and GPS systems. The GWEF helps certify missiles before they are deployed in combat.

The facility provides real-time hardware-in-the-loop (HIL) tests of weapon systems to help the military evaluate performance by simulating environmental conditions and determining how weapons would respond during actual flights.

FOR MORE INFORMATION visit **Optics In Motion** online at *www.opticsinmotion.net*, or the **Air Force's 96th Test Wing** at *www.eglin.af.mil*.

Coast Guard on lookout for unmanned ocean vehicles

U.S. Coast Guard ocean surveillance experts are shopping for mature unmanned marine vehicles to handle persistent-surveillance missions at sea. Officials of the Coast Guard Research and Development Center in New London, Conn., issued a sources-sought notice (HSCG32-14-I-R00012) for the Coast Guard Persistent Unmanned Marine Vehicle Market Research program to survey industry for ready-to-deploy long-endurance unmanned oceangoing craft, such as unmanned surface vehicles, unmanned underwater vehicles, or hybrid unmanned vehicles to handle Coast Guard surveillance missions offshore.

FAA to establish UAS research center

U.S. aviation authorities will create a center of excellence for unmanned aircraft within the next year, consisting of representatives from government, academia, and industry to conduct unmanned aircraft research, education, and training. FAA officials will conduct a competition to determine the organization that runs the Center of Excellence (COE) for Unmanned Aerial Systems (UAS). The FAA's W.J. Hughes Tech Center released a presolicitation (13-C-UAS-PRESOL) to establish the COE for UAS.

Navy to start official competition to build carrier-based combat UAV

BY **John Keller**

PATUXENT RIVER NAS Md.—Four U.S. designers of unmanned aerial vehicles (UAVs) are set to square-off in a do-or-die competition to build the first deployable carrier-based combat UAV. U.S. Navy officials have signaled the imminent release of a solicitation to design the Unmanned Carrier Launched Airborne Surveillance and Strike (UCLASS) aircraft.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., issued a presolicitation (N00019-14-R-0029) that announces plans to release an initial draft solicitation and subsequently a final solicitation for the UCLASS aircraft.

The upcoming competition will be limited to four of the nation's leading UAV designers: the Boeing Co. Defense, Space & Security segment in St. Louis; Lockheed Martin Corp. Skunk Works in Palmdale, Calif.; General Atomics Aeronautical Systems in Poway, Calif.; and the Northrop Grumman Corp. Aerospace Systems segment in Redondo Beach, Calif. All four companies have built prototypes of unmanned combat aircraft. Boeing has the X-45N; Lockheed Martin has a variant of its RQ-170 Sentinel; General Atomics has the Avenger; and Northrop Grumman has its carrier-proven X-47B. The formal UCLASS solicitation will be issued only to these companies.

The Navy's UCLASS aircraft will provide a persistent, aircraft carrier-based intelligence, surveillance, reconnaissance, targeting, and strike capability to support carrier air wing operations, Navy officials say.

The Lockheed Martin unmanned combat vehicle, depicted above, is one of four competitors for the upcoming Navy UCLASS carrier-based drone competition.

In addition to the aircraft, the UCLASS program involves a control system and connectivity segment and a carrier segment. The government will function as lead system integrator for the UCLASS system.

The UCLASS program will make the most of existing technology to launch and control the unmanned carrier-based aircraft, transfer data, and support persistent surveillance and precision strike operations, Navy officials say.

Plans call for release of the formal UCLASS request for proposal (RFP) no later than this fall, and contract award in the last half of 2015.

FOR MORE INFORMATION visit **Boeing** online at *www.boeing.com/boeing/bds*, **Lockheed Martin** at *www.lockheedmartin.com/us/products/uclass*, **General Atomics** at *www.ga-asi.com*, and **Northrop Grumman** at *www.northropgrumman.com*.

PRODUCT applications

DISPLAYS

Tobyhanna Army Depot to buy display processors from Jupiter Systems for vision collaboration

U.S. Army electronics repair and upgrade specialists at Tobyhanna Army Depot in Tobyhanna, Pa., needed display processors for a variety of collaborative visualization applications. They found their solution from Jupiter Systems in Hayward, Calif.

Officials of the Army Contracting Command Aberdeen Proving Ground (ACC-APG), Tobyhanna Division (TYAD), announced plans to award a sole-source contract to Jupiter Systems for 36 Vizion Plus II display wall processors.

The VizionPlus II, designed for military applications in collaborative visualization, uses second-generation PCI Express technology that delivers bandwidth as fast as 40 gigabits per second, Jupiter officials say.

A VizionPlus II display wall processor blends visual data sources from military operations centers and displays them in moveable, scalable windows on a virtual display composed of several output devices such as LCD flat panels, plasma panels, projectors, or projection cubes.

The VizionPlus II's 40-gigabit-per-second bandwidth can carry several high-resolution video signals at 60 frames per second, drive high-resolution monitors at 32 bits per pixel, and support many configurations.

The VizionPlus II also is a PC, with an Intel Core 2 Duo microprocessor, 8 gigabytes of RAM, and a 500-gigabyte hard drive that enables users to run mission-critical applications, access data through the network, engage the information, and collaborate on a wall-sized desktop, Jupiter officials say.

Data sources for the VizionPlus II can include local applications, remote network applications, remote network RGB streams, IP video streams, directly connected SD and HD video, VGA, and DVI inputs. Users access data sources from a software interface that controls the virtual display surface.

FOR MORE INFORMATION visit **Jupiter Systems** online at *www.jupiter.com*, and the **Army Contracting Command at Tobyhanna Army Depot** online at *www.tobyhanna.army.mil/organization/contracting*.

SAFETY EQUIPMENT

Navy chooses man-overboard warning systems from BriarTek

U.S. Navy shipboard safety experts needed automatic warning systems to alert authorities if sailors fall overboard during operations aboard Navy surface warships. They found the solution at BriarTek in Alexandria, Va.

Officials of the Naval Surface Warfare Center Carderock Division's Ship System Engineering Station in Philadelphia are awarding an $8.1 million contract to BriarTek for the Man-Overboard Indicator (MOBI) Ship Installation Support System. The MOBI system consists of BriarTek's ORCA transmitters, receivers, and direction finders, and enables the immediate, rapid recovery of a sailor or marine who has fallen overboard. The Navy's MOBI program seeks to outfit each ship with an alert system so the crew can start a search and rescue as quickly as possible.

After being immersed for 3–5 seconds, the water-activated ORCA transmitters begin sending radio signals back to the ship that a crew member is in the water. ORCA receivers aboard the bridges of surface ships receive signals from activated ORCA transmitters. Receivers announce man-overboard events by audible alarms that a survivor is in the water and in need of recovery.

FOR MORE INFORMATION visit **BriarTek** online at *www.briartek.com*.

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

DATA STORAGE

High-speed controller and storage module from Elma

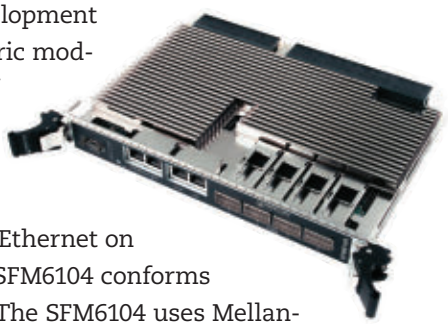
Elma Electronic Inc. in Fremont, Calif., is introducing its model 5335/6 high-speed controller and storage embedded computing module for defense and industrial applications ranging from ground, ship- and airborne systems to signals intelligence, engine and automation control, and mission critical information systems. The data storage device supports as many as eight SATA III ports and more than 2 terabytes of onboard capacity in one 3U VPX slot. The board is an expansion to Elma's 533x 3U VPX storage family. The model 5335/6 is seen as a PCI Express Gen2-by-8 connection to the host as it provides the link to a storage array where capacities exceed 8 terabytes across four slots and where data bandwidth exceeds 1 gigabytes per second.

FOR MORE INFORMATION visit **Elma Electronic** online at *www.elma.com*.

HIGH-SPEED SWITCH FABRICS

40 Gigabit Ethernet switch-fabric module from Mercury

Mercury Systems Inc. in Chelmsford, Mass., is introducing the Ensemble SFM6104 embedded computing switch-fabric module for complex sensor processing. The module comes with InfiniBand and 40 Gigabit Ethernet capability. Designed for Mercury's I/O, processing, and OpenVPX development chassis, the switch-fabric module supports SDR/DDR/QDR/FDR-10 InfiniBand or 10/40 Gigabit Ethernet across the data plane and Gigabit Ethernet on the control plane. The SFM6104 conforms to VITA 65 (OpenVPX). The SFM6104 uses Mellanox's SwitchX-2 technology to perform complex InfiniBand and Ethernet fabric switching. The SFM6104 is a key system building block within the company's Xeon server-class OpenVPX ecosystem.



FOR MORE INFORMATION visit **Mercury Systems** online at *www.mrcy.com*.

CHASSIS AND ENCLOSURES

Rugged OpenVPX air-flow-through chassis for SIGINT and radar from Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the Hybricon AFT16 rugged commercial off-the-shelf (R-COTS) OpenVPX air-flow-through embedded computing chassis for dense, high-performance systems, such as SIGINT, ELINT, COMINT, and radar processing. This chassis is designed to provide cooling for high-performance modules like Xilinx Virtex-7 FPGA, multicore Intel Core i7, and GPGPU-based VPX single-board computers and DSP engines that can dissipate heat in the 120-to-200-watt range. Capitalizing

on Curtiss-Wright's air-flow-through subsystem technology, the AFT16 supports the ANSI/VITA 48.5 air-flow-through standard with the Northrop Grumman patented air-flow-through technology. The 16-slot chassis supports 16 ANSI/VITA 48.5 6U air-flow-through slots with 13 slots of 1.5-inch pitch for air-flow-through OpenVPX cards and three slots for power supplies for to 2,370 Watts of power.

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

DATA CONVERSION

Rad-hard 10-bit A/D converter from DATEL

The DATEL Business Unit of Murata Power Solutions in Mansfield, Mass., is introducing the ADS-1011 series analog-to-digital (A/D) converters in hermetically sealed ceramic packages for aerospace and defense applications. The A/D converters offer 10-bit resolution, serial output, low power, and the ability not only to withstand as much as 30 kilorads of total-dose radiation, but also operate in military temperature ranges. Each unit features guaranteed no missing codes and is 100 percent tested for performance across one of three standard temperature ranges: 0 to 70 degrees Celsius, -40 to 100 C, and -55 to 125 C. The ADS-1011 can run from power supplies ranging from 2.7 volts to 5.5 volts.

FOR MORE INFORMATION visit **DATEL** online at *www.datel.com*.

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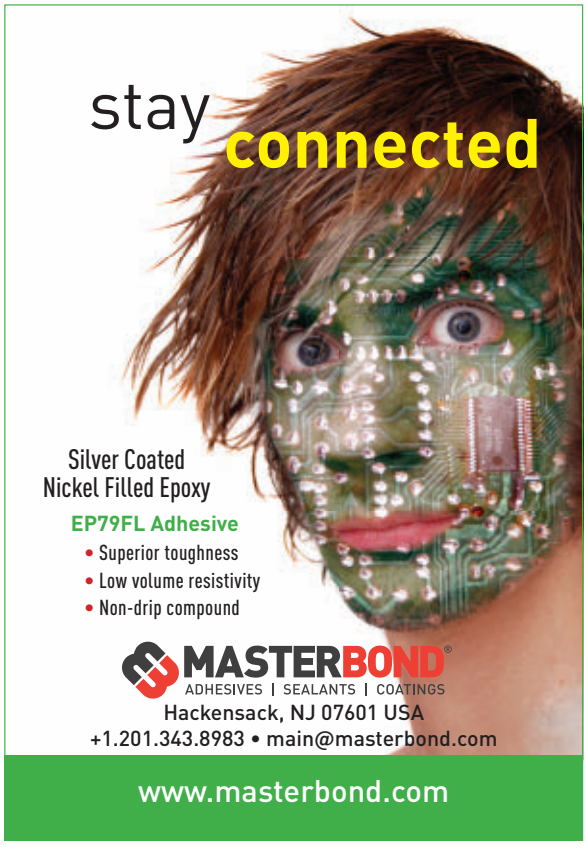

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Glenn Reese

DigitalGlobe, which merged with GeoEye, provides geospatial imagery and advanced analysis tools for defense, homeland security, public safety, and search and rescue efforts.

What role does satellite imagery play in public safety and security?

Effective emergency planning and response requires quick and easy access to accurate, up-to-date information, which is often a challenge for homeland security and first responders to acquire. DigitalGlobe's satellite imagery can provide a way to gauge the damage from disasters through comparisons of before, during, and after images that geospatial analysts can use to provide answers.

DigitalGlobe's FirstLook service relies on its satellite constellation and ground infrastructure to collect and deliver fresh, up-to-date imagery of an event to customers in as little as four hours. In many instances, like the ongoing conflict in Ukraine, satellite images can often be the only way to immediately see and understand the full scope of what's happening on the ground.

How have DigitalGlobe's products and services been used?

In 2013, the FirstLook crisis team monitored 169 natural disasters, manmade crises, political instabilities, and human interest events, including wildfires, floods, and earthquakes. On 7 Nov. 2013, several hours before Typhoon Haiyan made landfall, DigitalGlobe activated its FirstLook service; in the first few days following the initial devastation, DigitalGlobe's satellites collected and delivered more than 19,000 square kilometers of imagery in the hardest hit areas, including Tacloban City and the surrounding areas.

Since the scale of the storm's destruction was so massive, DigitalGlobe immediately asked volunteers to help map the devastation through DigitalGlobe's crowdsourcing platform, Tomnod. Within the first few hours, DigitalGlobe had more than 27,000 map views and 35,000 tags from volunteers. Ultimately, DigitalGlobe's imagery and analysis helped rescue workers and relief personnel quickly understand the most affected areas and how to route first responders and relief supplies.

What will the future hold?

Commercial satellite imaging capabilities are moving toward higher resolution, higher accuracy, and greater spectral diversity, [resulting in] larger volumes of data which require increasingly sophisticated analytic tools and techniques to extract insight. With our WorldView-3 satellite launching this summer, DigitalGlobe will be able to offer imagery that holds even more potential for homeland security and first responders. WorldView-3 has the ability to image the earth in both the visible and infrared parts of the spectrum. Its atmospheric instrument will monitor the atmosphere and provide correction data to improve imagery when areas of interest are obscured by haze, soot, dust, or other particulates. This capability will be particularly useful after natural disasters, such as hurricanes, typhoons, and wildfires. ←

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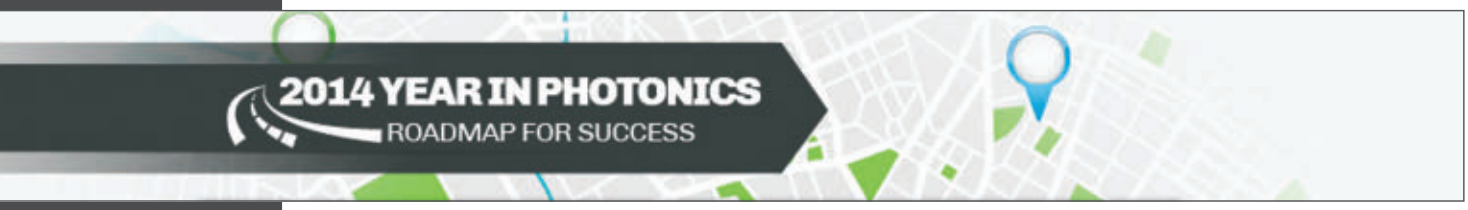

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