JULY 2014

Military & Aerospace Electronics

ENABLING TECHNOLOGIES FOR NATIONAL DEFENSE

Rugged mobile devices

Mobile computing and communications devices come into their own for defense environments and applications. PAGE 14

Military microprocessors

Microprocessors divide into two camps: big and high performance, and small and efficient. PAGE 20

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Unmanned aerial vehicles

UAVs are considered for agriculture, law enforcement, and even package delivery. PAGE 6

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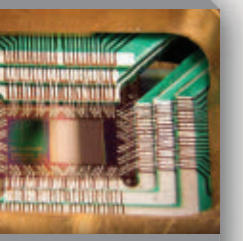

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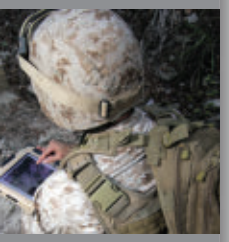

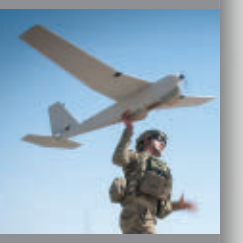

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BY **JOHN KELLER**, EDITOR IN CHIEF

Crumbling Iraq feels like fall of Saigon

Events in Iraq are starting to make that country look a lot like South Vietnam did in spring 1975, and the circumstances of the turmoil in both places is eerily similar.

Islamic militants calling themselves the Islamic State in Iraq and Syria (ISIS) have captured Mosul in Northern Iraq, the nation's second-largest city, as well as Tikrit, the former home town of Saddam Hussein.

Now these fighters who are backed by al-Qaida—except reportedly meaner and more extreme—are marching on the capital of Baghdad. It's as if a decade of U.S. military presence in that country—not to mention 4,487 American soldiers killed and 32,226 wounded in Iraq between 2003 and 2012—never even happened.

Here's the biggest irony. U.S. forces invaded Iraq in 2003 presumably to punish Saddam Hussein and his regime for their suspected support of the al-Qaida terrorist attacks on the Twin Towers in New York on 9/11. Now the al-Qaida-backed ISIS rebels are poised to take control of all Iraq.

Remind me again why the U.S. government spent thousands of American lives and billions of dollars over a decade fighting in Iraq. At this stage it seems like such a waste, and American military personnel who served in that country must be heartily disgusted. For historians and for those of us who lived through the 1960s and '70s, there is a growing sense of bitter deja vu.

On 10 March 1975, the North Vietnamese army and Viet Cong fighters launched a spring offensive. While U.S. intelligence suggested that South Vietnam forces could hold out at least for the season and for as long as a year, Hue and Da Nang fell to the attackers before the end of that month.

U.S. military forces had pulled out of Vietnam two years earlier after more than 10 years of warfare in which 2.59 million U.S. military personnel served, 58,169 were killed, and 304,000 wounded. Without direct U.S. military support, the South Vietnam military couldn't hold off the attackers.

After Hue and Da Nang fell, floods of refugees fled from the fighting, as South Vietnam military resistance quickly disintegrated. By 9 April, the attackers had reached the South Vietnam capital of Saigon. The city fell on 30 April 1975 after a frantic helicopter evacuation of U.S. South Vietnamese citizens.

During the Saigon evacuation called Operation Frequent Wind, many of those 2.59 million U.S. servicemen who had been in Vietnam must have felt a lot like Iraq veterans must feel today: What was it all for?

Should we have been in Vietnam and Iraq at all? Those questions are best addressed elsewhere. What we see today is a monumental amount of American blood and treasure wasted over the last 50 years. We've seen military interventions begun with optimism and ending with defeat and disgrace.

My heart goes out today to the U.S. veterans who served in Iraq, and in Vietnam before them. They gave so much, sometimes even their lives, and the tolls on individuals and families are immeasurable.

As U.S. forces entered Iraq in 2003 and for a good while afterward there was a spirit that U.S. military leaders and warfighters, this time, wouldn't let another Vietnam happen. Well, here we are.

Perhaps it's too early to start talking about the lessons learned from Iraq. Here are a few observations.

First, the U.S. government is really, really bad at nation building. I'm hoping the debacles of Vietnam and Iraq have cured us of that permanently.

Second, you can't win the hearts and minds of people who don't want their hearts and minds changed. Contrary to our best intentions, democracy isn't always a cure for the ills of nations. American values are worth fighting for, but the fighting should stop short of imposing our values on others. Worthy as the task might seem, the last 50 years have shown us that it simply doesn't work.

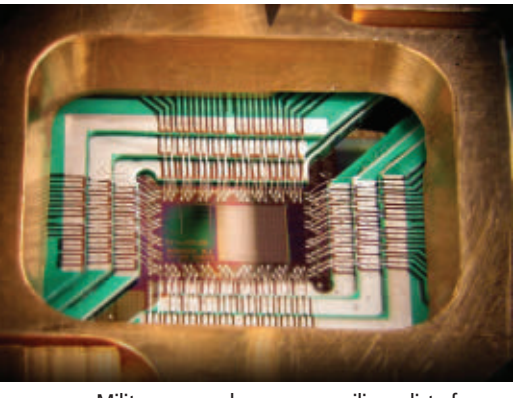
Let's all take a deep breath, and resolve that we'll learn some meaningful lessons from these experiences.

news

Researchers eye leap-ahead technologies in high-performance embedded computing

BY JOHN KELLER

FORT BELVOIR, Va.—U.S. military researchers are attempting major advances in military high-performance embedded computing (HPEC) by focusing on solutions to problems that are too difficult for today's technology as a way to refine the directions of future research.



Military researchers are compiling a list of computing tasks too difficult for today's most advanced embedded computing technologies.

Officials of the Army Contracting Command at Fort Belvoir, Va., issued a request for information (W909MY14QSEAK) for the Suite of Embedded Applications and Kernels (SEAK) program, which will identify embedded applications and kernels that represent the most difficult embedded computing challenge of interest to the military.

Researchers from the U.S. Army Research, Development and Engineering Command (RDECOM) Communications-Electronics Research, Development, and Engineering Center (CERDEC) Night Vision and Electronic Sensors Directorate (NVESD) at Fort Belvoir, Va., the Pacific Northwest National Laboratory (PNNL) in Richland, Wash., and the U.S. Defense Advanced Research Projects Agency (DARPA) Microsystems Technology Office (MTO) in Arlington, Va., are involved in the SEAK HPEC program.

SEAK's goal is to produce a suite of embedded computing applications and software kernels that represent the most difficult HPEC challenges to the U.S. Department of Defense (DOD). These difficult problems are referred to as "critical resource-constrained processing domains of interest."

The program also will try to formulate a process for assessing and evaluating potential solutions to these critical resource-constrained processing domains of interest.

To do this, military researchers are asking industry to identify the processing workloads that even today's most advanced embedded computing technology cannot handle, due to computational, I/O, or bandwidth complexity. Military researchers then would like to distribute these computational workload problems to the research community for potential solutions.

Part of the SEAK program is to

CONTINUED ON PAGE 5 ➔

IN BRIEF

U.S. Army officials select Lockheed Martin to maintain military cyber warfare range

Cyber security experts at the Lockheed Martin Corp. Mission Systems and Training segment in Orlando, Fla., will maintain a key U.S. military training range in place to test and validate cyber warfare technologies and systems under terms of a sole-source contract. Officials of the U.S. Army Program Executive Office for Simulation, Training, and Instrumentation in Orlando, Fla., are awarding a $14.2 million contract to Lockheed Martin to operate and sustain the National Cyber Range (NCR), which helps with test and measurement of offensive and defensive technologies involving computer malware, viruses, and other cyber warfare aspects. The NCR is designed to allow potentially virulent code to be introduced and studied on the range without compromising the range itself. The NCR is a self-contained facility for advanced cyber research and testing, using hardware and software automation tools that enable a range to be configured rapidly to emulate complex, large-scale heterogeneous networks. ←

Raytheon and Northrop Grumman to attack costs and complexity of AESA radar

BY JOHN KELLER

WRIGHT-PATTERSON AFB, Ohio—Two of the nation's leading military radar houses are trying to develop new manufacturing processes for active phased array military radar to increase system reliability while reducing development time and costs.

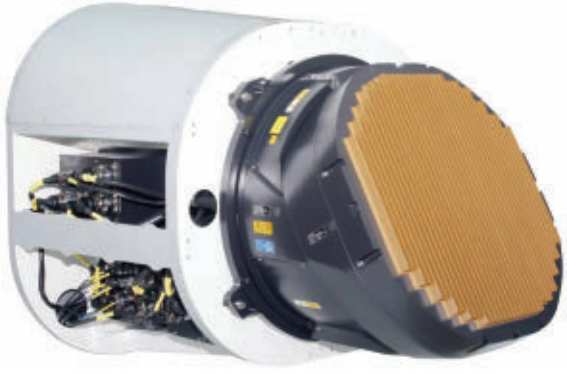
Radar experts at the Raytheon Co. Space and Airborne Systems segment in El Segundo, Calif., and the Northrop Grumman Corp. Electronic Systems segment in Linthicum Heights, Md., received contracts for the Affordable Radio Frequency Multifunction Sensors (ARMS) program.

Awarding the contracts were officials of the Air Force Research Laboratory's Materials and Manufacturing Directorate at Wright-Patterson Air Force Base, Ohio. Raytheon won a $7.1 million ARMS contract and Northrop Grumman won a $3.8 million ARMS contract.

The ARMS program centers on developing new manufacturing processes to enable an increase in reliability and a decrease in cycle time and costs for active electronically scanned array (AESA) radar sensors.

AESA radar uses transmitters and receivers that are composed of many small solid-state transmit and receive modules. AESA radars aim their beams by emitting radio waves from each module in different phases to focus radar energy in different directions.

This kind of radar particularly lends itself to digital processing, and enables radar steering without a traditional rotating antenna. Omitting moving parts from the system increases reliability and reduces the need for constant maintenance.



Raytheon and Northrop Grumman are trying to reduce the cost and complexity of advanced AESA radar systems like the one shown above.

As useful as these kinds of radar systems are, they are increasingly expensive and time-consuming to develop and manufacture, Air Force officials say. Next-generation aircraft must provide the warfighter with increased situational awareness in highly integrated airspace. This places a heavy burden on AESA radar systems, which must have increasing bandwidth, capability, functionality, and performance for new generations of high-performance military aircraft.

AESA sensors must be thin and lightweight which forces the design to be highly integrated, Air Force researchers say. The size and performance requirements for these systems drive the array architecture to be very difficult to manufacture, test, and expensive to build.

Raytheon and Northrop Grumman engineers are aiming to change all that. The contracts to Raytheon and Northrop Grumman are for the two-year first phase of the ARMS program, which calls for Raytheon and Northrop Grumman to identify the primary challenges of developing new AESA radar manufacturing processes, as well as establish key performance parameters.

Near the end of the ARMS program's first phase, Air Force experts will determine whether or not they will pursue a two-year second phase. If they do, the program's second phase would continue development to bring ARMS technology to a level of maturity sufficient to demonstrate the technology's viability.

The goal of the ARMS program ultimately is to focus on reducing cycle time, part count, labor, costs of AESA sensors for next-generation aircraft.

Raytheon will perform the work on the ARMS program in El Segundo, Calif., while Northrop Grumman will do the work in Linthicum Heights, Md. Both companies should be finished by March 2016. ←

FOR MORE INFORMATION
contact **Raytheon Space and Airborne Systems** online at *www.raytheon.com*, and **Northrop Grumman Electronic Systems** at *www.northropgrumman.com*.

HPEC CONTINUED FROM PAGE 3

rank a set of difficult embedded processing challenges in terms of performance, power, and reliability, researchers say. For this request for information, researchers are asking industry for detailed information on representative HPEC computational workloads relevant to the program.

The DARPA Microsystems Technology Office has overall responsibility for the SEAK project. The Pacific Northwest National Lab is handling the SEAK technical effort, while the Army RDECOM CERDEC NVESD has an advisory role.

From industry, researchers want information to characterize HPEC workloads such that experts at the Pacific Northwest National Lab can identify key algorithms and kernels and develop sample computational workloads for distribution to the research community.

Technical areas of interest center on data flows; sensor and data bandwidths; size, weight, and power (SWaP) constraints; communications traffic; tasking; and other workload requirements unique to DOD high-performance embedded computing. The SEAK program will distill these workloads into a publicly releasable format suitable for wide distribution.

Those interested in participating should email suggestions to the Pacific Northwest National Lab's Adolfy Hoisie at Adolfy.Hoisie@pnnl.gov; the NVESD's John Hodapp at john.d.hodapp2.civ@mail.mil; or DARPA's Joseph Cross at seak.rfi@darpa.mil. Phone the Army's Michelle Hodges at 703-704-0846 with questions. The SEAK program response template is online at http://hpc.pnnl.gov/projects/SEAK.

The future of military unmanned aircraft

Military unmanned aerial vehicles (UAVs) have come a long way since the first Persian Gulf War in 1991, and today are competing with a broad range of future civil and commercial UAVs for agriculture, law enforcement, and even package delivery.

BY **J.R. Wilson**

The types, sizes, missions, and capabilities of unmanned aerial vehicles (UAVs) have expanded at increasing speed since the 9/11 terrorist attacks on the Twin Towers. Today UAVs are becoming one of the most vital weapons in the military's arsenal. At the same time, the number of civil and commercial UAV applications also is growing.

The result, combined with dwindling U.S. defense budgets, has brought about new technology requirements for next-generation UAVs. Not only must Pentagon UAV experts do more with less, but rule makers in the U.S. Federal Aviation Administration (FAA) in Washington and other aviation authorities around the world also are feeling pressure to permit at least limited non-military UAV operations in civilian airspace.

"The FAA is concerned for a reason—making sure the software is fully tested and the devices have sufficient structural integrity—all of which have to be figured out before they get into the national air space [NAS]," says Carl Johnson, vice president for Advanced Mission and systems development at Northrop Grumman Corp.

"Another major requirement for air space integration includes sense-and-avoid for obstacles in the UAV's path, but the real issue for commercial will be cost," Johnson continues. "You can do very small UAVs, such as quadcopters, at a reasonably low cost, but once you go to fixed wing, costs begin to escalate.

"We see much higher levels of automation in the future, which means we will need high-speed data processing onboard the aircraft, with orders-of-magnitude higher throughput and memory," Johnson says. "By Moore's Law, that's coming, so I don't think it will be as big a problem as some think. In addition, some of the very small UAVs are developing sensor capability. As all those are integrated onto smaller platforms, cooling becomes a big issue, so finding more efficient sensors that project less heat will be very important to all classes of UAVs."

So, experts see a changing military market, growing use of UAVs for civil law enforcement, and a fast-growing commercial market that experts say one day either could dwarf the military or fail to materialize at all, at least for the foreseeable future in the U.S. With these factors in mind, industry experts see several UAV technology trends on the horizon, including:

This MQ-9 UAV with added electronic warfare pods was demonstrated for the U.S. Marine Corps.

- better batteries with longer endurance for smaller electric UAVs;
- better fuel efficiencies—along with longer endurance—for larger platforms;
- stealth technologies for military UAVs intended to penetrate contested airspace;
- sense-and-avoid systems not only to enable military UAVs to operate alongside manned aircraft in a congested battlespace, but also to enable civil and commercial UAVs to do the same in civilian airspace;
- smaller, lighter, more efficient and capable sensors;
- greatly increased onboard computing power to process enormous volumes of raw data before transmitting smaller packets of useful information into an overloaded bandwidth spectrum;
- lower manufacturing, acquisition and lifecycle operations and maintenance costs;
- multi-mission capabilities utilizing swappable or reprogrammable sensors to get more utility from each platform; and
- common ground systems—including U.S. Department of Defense (DOD) inter-service and joint coalition—to reduce the number of installations and operators and make joint operations easier.

"Another key feature for the next generations of military UAVs is survivability, which means lots of things to different people—stealthy, standoff, longer-range weapons, longer-range communications," says Chris Pehrson, director of strategic development at General Atomics Aeronautical Systems in Poway, Calif.

"That will vary by size of platform. Medium to large may need stealth and electronic countermeasures, where small UAVs could use swarming so some will survive any denial effort. And in GPS-denied environments, we will need the right decision algorithms on the aircraft," Pehrson says.

"Another change requiring new technologies is the integration of UAVs with other platforms," Pehrson continues. "For example, the Army Gray Eagle is tightly linked with the Apache helicopter, whose crew can take control of and direct the UAV. We will see more such link-ups between UAVs and manned aircraft to extend the sensor web—situational awareness. What any kind of automation does is enhance productivity, which an autonomous UAV does on the battlefield because UAVs are very cost-effective compared to manned aircraft."

Getting those capabilities in small aircraft also is a military goal for future generations—and one likely to translate to civil and commercial applications. "It's about who can take a [MQ-9] Reaper-type system and get that capability out of a [RQ-7] Shadow, or Shadow capability out of a [RQ-11] Raven, always pushing the technology further and further down until you are putting a lot of capabilities into platforms you can carry in your pocket," says Larry Dickerson, unmanned systems analyst at market researcher Forecast International in Newtown, Conn. "It's always a power-to-weight question, because they more you put on it, the bigger it has to be."

Less weight and more onboard processing with less heat are two most challenging future requirements for UAVs, says Ian Dunn, vice president and general manager of embedded products at embedded computing specialist Mercury Systems in Chelmsford, Mass. Mercury designers have found that increasing numbers of sensors on small UAVs quickly can overwhelm the aircraft's structure, leading to sensors driving future payload requirements, he says.

"For a subsystems provider like Mercury, it's not that the technologies we have are not useful in those scenarios, but there is no open-architecture or modular product strategy that will work. When you introduce the concept of a system-of-systems, it's hard to make that small, so in a tightly integrated form factor package, we may offer custom devices," Dunn says. "If the platform is so small an antenna may have to be incorporated into the shell of the aircraft, the UAV becomes less of an airplane and more of a flying sensor, in which case everything has to be treated as a custom package.

"In the small UAV categories, the military already has the assets they need to get the job done," Dunn continues. "What they don't have, but need, is a fast global strike capability, perhaps a one-way mission UAV, which is something we haven't dealt with before."

That altitude and speed combination also is under consideration as an expanded requirement for medium-altitude, long-endurance (MALE and high-altitude, long-endurance (HALE) UAVs, Dunn points out. The kind of computing power necessary for those types of UAVs require increased weight, size, power consumption, and heat signature, which are among the contributing factors to increasingly stringent UAV technology requirements.

In the 1970s, the computing industry spent a lot of money developing and standardizing electrical architectures; in the following two decades, the focus was on standard mechanics so computers could be scaled up and down to better meet both commercial and military needs. Both now are largely commodisized, Dunn says, but are relevant to current efforts to develop a common thermal architecture.

"In the 1980s, thermal was an afterthought of the mechanics—and if you really got lucky, it didn't cost you anything extra," Dunn says. "That is not true today, where the average modular mechanical architecture can no longer cool the average device because the form factor was not designed to seamlessly handle thermals," he says. The first incarnation of that effort is air flow-by cooling, and making a device's slot mechanics and thermal architecture a compound, unified design.

"Air flow-by is about getting air closer to the hot components in a finely managed fashion, with the minimal gradient between inlet air temperature and the device's temperature," Dunn explains. "That may require big fans or more power to get the air you need or you may have a stealth asset that limits what you can do. We're looking at new

The Northrop Grumman MQ-8B Fire Scout prepares to land on the littoral combat ship USS Freedom (LCS 1), marking the first time a littoral combat ship, an MQ-8B Fire Scout unmanned helicopter, and an SH-60R Sea Hawk helicopter conducted integrated training.

system-level ways to incorporate a thermal arch into the subsystem—liquid, air, hybrids. As part of that, we're also looking at new materials for better thermal conductivity."

The Association for Unmanned Vehicle Systems International (AUVSI) is a non-profit trade association in Arlington, Va., that represents the aerospace industry, primarily with DOD. "AUVSI has been the incubator for a lot of technology that, once matured, takes off and flourishes in civil and commercial markets," says Ben Gielow, the AUVSI general counsel and senior government relations manager. "One of our goals is to open the commercial market for small, limited UAV operations. The frustration is the FAA has been saying no to everybody, regardless of size, weight, area of operations, or whatever. That is especially bad for new companies that have never been in the military market but were created to feed the civil and commercial markets; right now, they are having to look overseas for sales.

"The only [non-DOD] market that exists today is for public entities, so if you are a sensor or platform manufacturer, your U.S. market is limited to the U.S. government, from DOD to NASA and NOAA," Gielow says. "Universities can get an authorization waiver to fly, but those are the only existing markets for medium and small UAVs. Commercial is where the UAV industry will go, from a crawl-walk-run perspective, but there is enough need today that we should not punish everyone with a one-size-fits-all 'no'."

As law enforcement interest grows, UAV designers and operators must determine what types of UAVs and sensors will provide more cost-effective capability than what they have been using—and how growing UAV availability will change both civil and criminal operations.

"Police will have to buy new radar

The General Atomics Predator C Avenger unmanned combat aerial vehicle, shown above, is jet powered, and is a candidate for the U.S. Navy's planned fleet of carrier-based fighting UAVs.

and sensor technologies to know when UAVs are in use—for whatever application—and counter-UAV technologies also will increase, especially as people are able to buy more and more technology and capability off the shelf," says John Miley, business drones analyst for The Kiplinger Letter, a financial publication based in Washington. "If you have an approved FAA system, you might have an auto system that will send it home if something goes wrong or if police send out a broadcast ordering all UAVs out of a crime scene area.

"In another 10 years, we see a $10 billion a year industry, combining manufacturing, sales, jobs, etc., in the U.S.," Miley says. "In the next year or two, we expect the FAA to finally set privacy rules for small UAVs, responding to a lot more pressure from manufacturers and from state and local governments, who see it as a jobs issue. By 2025, you're looking at bigger UAVs, delivering pesticides for agriculture, maybe packages for Amazon and others, which means going from almost nothing today to a multi-billion dollar industry in a decade or less."

Before the first Persian Gulf War in 1991, UAVs had a rocky history, appearing on the scene, then vanishing for lack of military interest, then reappearing again, sometimes all within a single decade. Israel was the first nation to commit to unmanned intelligence, surveillance and reconnaissance (ISR) missions, deeming it far better to lose a small unmanned aircraft than a large manned one—and, especially, the man on board.

With their experience and technology as a launchpad and the success of what now are considered extremely primitive UAVs in the Gulf War, American manufacturers and the military services began serious development programs. Those kicked into ultra-high gear after 9/11, especially when UAVs—in a wide range of sizes and capabilities—became critical to combating insurgents and terrorists in Iraq and Afghanistan.

Each year since 2001 has seen new technologies provide the U.S. unmanned fleet with enhanced sensors, longer endurance, better communications and even precision weapons. By the time of the withdrawal of U.S. combat troops from Iraq—and the subsequent "surge" in Afghanistan—UAVs played the dominant aerial role in Southwest Asia's uncontested airspace, from ISR to air strikes.

Now, however, the U.S. continues drawing down combat forces in Afghanistan, and the need to meet constantly changing and urgent combat demands is being replaced with the need to consider how the next generations of UAVs will fit into a much smaller U.S. military, with increasingly tighter budgets for research, development, test, and evaluation and new acquisitions. Plus the not inconsiderable differences between the past 15 years of largely desert warfare and the ongoing "Pacific pivot".

The growing civil and prospective commercial markets—the latter already beginning to show its potential in Europe and Asia—also will play a major role in defining what new technologies are needed.

"The U.S. is by no means a leader in commercial UAVs; there are at least a dozen countries—including Canada, Australia, England, Germany, France—that allow some level of commercial UAV operations. Even more so in countries where the airspace is controlled by the military," says the AUVSI's Gielow. "A lot of those take a risk-based approach, weighing the size, scope and use of a UAV and demonstrations by the operators that they have mitigated those risks and so deciding to let those fly.

Wild West of UAVs

"We would like to see the FAA do the same, but they are sticking with their 'one-size-fits-all' rejection," Gielow says. "Even with the FAA's own calendar on developing rules for small UAVs, they will be four years late to market—probably the second quarter 2016 for flying even small UAVs commercially in the USA. That is unacceptable and industry won't wait; people are out there flying UAVs commercially

with little FAA reaction. The more that happens, the more others will see only one FAA action against a small UAV operator—which they lost—and probably move ahead."

The FAA is considering some one-off exemptions for small UAV operators, such as the movie industry, and recently allowed survey flights over the Alaskan North Slope. But AUVSI maintains the agency does not have the money or manpower for the effective regulation of an entire industry of UAVs that weigh four pounds or less. As a result, Gielow maintains, operators will continue to fly those platforms illegally until the FAA comes up with real regulations. Which puts the growing number of small U.S. companies hoping to become major suppliers to the commercial market, as well as established UAV manufacturers looking to replace declining military sales with civil and commercial customers, in a difficult position.

To meet the requirements of those new markets, they must invest in new technologies, but a market comprising largely illegal—if not prosecuted—users is unlikely to be large enough to cover that investment. It also could open them up to legal action should the FAA take a more aggressive stance, but go after UAV manufacturers rather than illegal operators.

Barring the FAA quickly issuing new regulations to open up a legal market in the U.S., the only other route for U.S. manufacturers is to sell to overseas operators. But there, too, they face restrictions designed to keep superior U.S. technology away from potential adversaries and competitors that instead could prove devastating to the nation's current lead in UAV design, development and production.

"Some folks make the analogy to the U.S. satellite industry in the 1980s, where efforts to protect our technology led to a lot of that going overseas and eventually losing our lead," says the AUVSI's Gielow says. "The fear is we're doing the same in UAV technologies. The U.S. military probably will continue to be the largest spender and developer in UAVs for military use, but eventually the Israelis, Chinese and others

will catch up and surpass us.

"Where DOD makes cost savings is when the commercial industry takes military developments, further advances them for other markets, then sells the upgraded technology back to the military at lower cost," Gielow says. "A number of people in Congress realize the need to keep the U.S. on top of this new industry, but we still need to do a lot of education on what these systems are and what they are not for commercial applications."

All of which means next-generation and beyond enabling technologies will be driven, not by urgent combat requirements, but by significantly different military environments, the nature of civil (border security, law enforcement, etc.) and commercial (agriculture, energy, news, real estate, etc.) applications, tight budgets, technology transfer restrictions and increasing competition, at home and abroad.

This artist's rendering of a future Predator B ER (Enhanced Endurance) UAV shows a potential version with fuel pods.

Some technologies needed by the military also will be useful to non-combat platforms, which, depending in large part on when and what rules the FAA publishes, could mitigate development costs, but all three markets also have unique requirements.

SWaP

A major DOD concern from the beginning also will be at the top of civil and commercial UAV interests—SWaP-C2 (size, weight, power, cooling, and cost).

Frost and Sullivan Aerospace and Defense Senior Industry Analyst Michael Blades says the military has a lot of decisions to make before they can move beyond the current UAV fleet returning from combat and deal with the potential for near-peer engagements and the first contested airspace since Vietnam.

"The first point of order will be to consider how we will operate in a contested airspace, which we're not ready to do. Which is why the debate about the UCLASS [U.S. Navy Unmanned Carrier-Launched Airborne Surveillance and Strike], including whether to incorporate stealth," Blades says. "Then you have air-refueling of UAVs for even longer endurance and manned/unmanned teaming, using UAVs as force multipliers.

"Our autonomous capabilities must be way more advanced. From a big picture look at how war is changing, we won't have a big land occupation, but small special ops units operating against insurgents and terrorists, which is why the Marines have a program of record with the Blackjack and the ability to operate their own reconnaissance UAVs. In the future, they also will arm everything that can be armed."

Another issue for UAVs operating in a contested battlespace is dealing with the loss of communications, between platforms in swarming or manned/unmanned operations or command and control stations, so they will be able to adjust tactics to changing situations. That will require a level of autonomy beyond what is currently in place for them to execute their missions.

Large UAVs, from the Predator/Reaper to Global Hawk, are the exclusive domain of the U.S. Air Force. The difficulty in assessing their plans and requirements for next- and next-after-next-generation UAVs, however, is the Air Force has moved nearly all of that into its black budget.

"They probably have two or more black programs going on right now and we don't know if they're in development or production," says Steven Zaloga, senior analysts at market researcher The Teal Group in Fairfax, Va. "My suspicion is they have one program to do the role of the F-117 for suppression of enemy air defenses and probably a penetrating ISR platform. Obviously they still have ongoing acquisitions, but their black programs, with higher survivability, are probably their long-term focus now. The Navy has defined its UCLASS requirements, but we don't know the details—stealth versus less expensive, for example. There also is the whole field of non-carrier ship-based, such as current work with the Fire Scout. That is a big field and potentially a significant area in terms of the number of platforms and what they will be able to do. The Navy's land-based Triton surveillance platform is similar to Global Hawk."

The U.S. appears to have a lead

in developing naval vertical take-off UAV systems, he added, and if it can field them quickly, those also may be an attractive export item, depending on International Traffic in Arms Regulations (ITAR).

The Army is looking for new applications for the Gray Warrior and upgrades to its inventory of Shadows, but so far as new funding is concerned, that is likely to be focused on redefining small unit UAVs, such as the quadcopter.

"The issue with those is endurance. The current battery-powered endurance is about 30 minutes and the Army would like more battery endurance, so that is the pivotal technology there," says Teal's Zaloga. "The Marines piggy-back on the other services, such as the Navy Blackjack and Army Shadow, so I don't see them being at the cutting edge of enabling technologies for next-generation UAVs, although they have been enthusiastic users."

Overall, Zaloga contends UAV technologies, even for next-generation applications, are not radically different from those developed for other uses. The key is how to combine such technologies in ways that meet short- and long-term SWaP-C2 limitations and a host of new missions, from military long endurance/deep penetration in contested airspace to civil and commercial applications in civilian airspace.

"On the large end, satellite communications antennas are important for operations at very long distances in a complex network of communications components," Zaloga continues. "Earlier attempts for long-endurance UAVs stumbled because they had to use line-of-sight communications or some form of relay. Uplink capabilities and infrastructure have been very important. It will be interesting to see if that blends down below the largest platforms. With carrier landings, you also have extended issues for naval UAVs where enabling technologies are starting to be demonstrated, but their development is still ongoing.

"Airborne Sense-and-Avoid [ABSAA] will be a critical issue for military, civil and commercial users, probably starting out on big platforms because the easiest to begin with is an active radar," Zaloga says. "In the long-term, ABSAA probably will be a family of systems, based on size and including off-board systems, such as Blue Tracking on medium size UAVs. There may be nothing for the smallest, just keeping them away from high-traffic areas. It will be significant to basing Global Hawk in Japan to monitor the South China Sea, which is full of commercial aviation. And without ABSAA, the FAA will be hesitant to allow UAV operations in the NAS."

When trying to identify the enabling technologies for next-generation and later UAVs, then, the issues are far more complex than they have been since 9/11. In the coming decades, nearly every nation, friend and foe, will field its own UAVs, with goals of self-manufacturing and export. Civil and commercial markets are expected to make the military a minor player overall, adding a new level of speed and focus to technology evolution, just as happened with computers, lasers, cell phones, etc.

ITAR restrictions intended to protect the U.S. technology lead may prevent the export volumes need to pay for future research to maintain that lead—or even fall behind other nations. FAA restrictions on commercial operations may do the same. Tight budgets could combine with poor geopolitical forecasting to leave the U.S. with UAVs unsuited to future mission requirements, from ISR to combat. And many of the developments need to meet those requirements, such as increased bandwidth, are more an issue of available funds than technological advances.

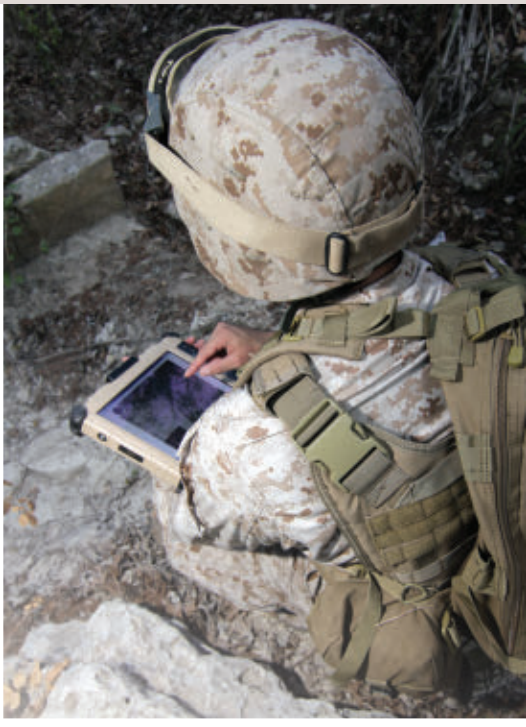
"Today, the U.S. is head and shoulders above the rest of the world, providing something like 70 percent of all research in the past decade," says Teal's Zaloga. "Israel [is second], having spent a lot of money on exportable tactical UAVs while ITAR restrictions have kept the U.S. from being anywhere close to the exporter it could be. China is trying to become a peer competitor and throwing a lot of money into UAVs. Everybody else talks the game, but really hasn't put the money into it."

The U.S. as a leader of the UAV industry, however, may be coming to a close. "I don't think the U.S. will retain that dominant position, even though both the U.S. Air Force and Navy see UAVs as an important technology for future conflicts, both low- and high-intensity," Zaloga says. "China thinks the same. As does Europe, but they haven't the money nor unified technology development to compete with the U.S. or China, which is the most likely competitor for high-end HALE and UCAV systems. UAVs are still a relatively new and evolving technology, so it's hard to pin it down, but 10 years from now, UAVs will look very different from what we have today."

Rugged and reliable mobile devices

Industry delivers a wealth of mobile computing and communications devices capable of withstanding extreme aerospace and defense environments and applications.

BY **Courtney E. Howard**



The Xplore Technologies RangerX and RangerX Pro rugged tablets offer sunlight readability and glove touch capability.

A majority of professionals rely on mobile devices in their everyday lives. Yet, those on aerospace and defense, homeland-security, and public-safety missions require electronic devices that are not only portable, but also robust, reliable, and rugged.

Cost calculation

Consumer devices operating in harsh, demanding environments often fail because of drops, extreme temperatures, and other hazards of taking electronics out on the field," explains John Costello, vice president of marketing at Xplore Technologies in Austin, Texas. "Those in any industry, including military and government officials, can certainly reap the benefits of switching their troops and officers to rugged devices.

"The hardest part of making the move from consumer to rugged devices often is the initial sticker shock," Costello adds. "With sturdy outer casing, durable parts, and tough design, rugged devices are more expensive, but can outlast three to four consumer devices." Proving that last point, Xplore partnered with VDC Research to develop a tool for companies to see the benefits and cost savings possible with rugged devices.

The Total Cost of Ownership (TCO) Calculator is designed to help operations determine the true cost of deploying rugged versus consumer devices. The free calculator provides a cost analysis, comparing the financial benefits rugged devices can bring to the workplace against deploying consumer devices. The free tool is available on Xplore's website at http://xplt.ch/1mwM7EO.

"When the decision comes to purchase or upgrade devices, it can be difficult to justify a more expensive rugged tablet, even if you know it will last three to four times longer than standard consumer tablets," says Mark Holleran, president and chief operating officer of Xplore Technologies. "The TCO Calculator takes much of the guesswork out of the equation, and makes it easier to decide if a consumer or rugged tablet is best for your business. We anticipate many companies will find that although rugged tablets may have a higher upfront cost, consumer tablets will be more expensive to deploy in the long term."

The tool is designed to provide guidance to organizations making mobile investment decisions, while "acknowledging that all deployments are unique," says David Krebs, vice president of enterprise mobility and connected devices at VDC Research.

Today's market bears a wealth of rugged, mobile computing options, with features nearly as varied as the applications for which they are deployed. Aerospace and defense organizations and individuals generally seek a set of key features.

Serious security

Security is a key concern, and among the top requirements of a mobile device for aerospace and defense applications. Several technology firms, including hardware and software

vendors, are innovating to infuse mobile devices with enhanced security to meet current and future needs.

"Our top customer need in military and aerospace is security," says Costello. Xplore tablets are designed with security features such as common access card and fingerprint readers to block access to unauthorized users. "They are also compatible with night-vision and other military-grade applications to help keep troops safe and in constant communication on the battlefield, as well as designed to provide easy access to vital storage components, so they can be quickly removed in instances where time is of the essence and protecting critical data is high priority."

Engineers at Panasonic System Communications Europe (PSCEU) in London and ViaSat in Carlsbad, Calif., have teamed to provide Top Secret-level security encryption on the rugged Toughpad FZ-G1 tablet via an optional ViaSat Eclypt encrypted hard drive, designed to ensure premium data protection.

"This collaboration with ViaSat ensures the Toughpad FZ-G1 is perfectly equipped for the defense industry and other security-conscious markets," says Kevin Tristram, general manager at Panasonic Toughbook UK and Ireland.

ViaSat tested the mobile device using Microsoft Windows 7 and 8 operating systems with its full range of Core drives, and confirms protection from FIPs (IL2) up to Enhanced (IL6). This level of secure data protection, combined with the portability and power of the Panasonic's FZ-G1 tablet, means secure mobility is now a reality, company officials say.

"With ever-increasing demands on accessing sensitive data 24/7, securing mobile platforms to the highest level is becoming increasingly significant. ViaSat's Eclypt technology ensures that data is secure by default even if lost or stolen," says ViaSat CEO Chris McIntosh. "Combining Eclypt technology with the Panasonic FZ-G1 tablet provides a mobile platform that can be deployed within the high-threat government, military, and critical infrastructure protection environments. That provides a totally reliable, secure, and powerful portable system."

Small size

Size, weight, and power (SWaP) are always among the top considerations when selecting virtually any aerospace and defense system. It is especially true of choosing the optimal mobile device. Engineers at Panasonic last month announced a smaller and tougher Toughpad product line, including five-inch handheld tablets that are submersible and able to withstand 10-foot drops.

The rugged, 5-inch Toughpad FZ-E1, powered by Windows Embedded 8.1 Handheld, and the Toughpad FZ-X1, running the Android 4.2.2 operating system, are enterprise-class handheld tablets designed for mission-critical mobile workers. The Toughpad devices are purpose-built with 14-hour, hot-swappable batteries, FIPS 140-2 Level 1 security, and sunlight-readable HD touchscreens that work with gloves to improve efficiency and productivity of such mobile professionals as first responders and military service members.

"An always-connected workforce is only as strong as its weakest link, and this is true whether on the shop floor or the battlefield," says Rance Poehler, president of Panasonic Systems Communications Company of North America. "Our Toughpad FZ-E1 and Toughpad FZ-X1 build on the legacy of nearly two decades of rugged devices from Panasonic to accomplish the mission of keeping professionals in the most demanding work environments connected to the data they need to do their jobs, to one another and to the customers they are supporting."

The new rugged, mobile devices provide resistance to drops of up to 10 feet to concrete, going beyond MIL-STD-810G specifications to assure in-field reliability, officials say. Both devices are sealed against dust and are submersible in up to five feet of water for up to 30 minutes, meeting IP65 and IP68 certification requirements. The devices carry an operating temperature range of -4 to 140 degrees Fahrenheit thanks to a built-in heater, and are tested for resistance to impact, shock, vibration, altitude, and extreme humidity.

Crystal Group has unveiled its first wearable computer, the TAC-V Integrated Tactical Communications System.

These Toughpad systems are compliant with FIPS 140-2 Level 1 and boast OS-based enhanced security features, rear and front cameras, and sunlight-readable, anti-reflective HD (1280x720) 10-point capacitive multitouch screens with a rain-sensing feature enabling single touch use even in pouring rain.

Rugged SFF

Aerospace and defense engineers and managers continue to invest in small-form-factor (SFF) solutions able to withstand extreme applications and environments.

Stealth Computer, a provider of rugged small form factor computing, has released its LPC-681 extreme-performance, mini PC measuring roughly 6.5 x 6 x 2 inches in size and powered by an Intel 4th Generation Core i7-4800MQ mobile processor.

The Stealth PC is equipped with Intel HD Graphics 4600 with 3-video ports for driving up to three 1080p HD displays or a single 4K ultra HD display for high-end graphics capability. The LPC-681 operates from an external 19 volts DC (VDC) power adapter or via an external DC source of 12 to 20 VDC for mobile and in-vehicle applications.

Wearable wares

Success in mission-critical situations is dramatically improved when personnel have accurate and timely intelligence, say officials of rugged computer specialist Crystal Group in Hiawatha, Iowa. To help enable critical information sharing, Crystal Group expanded its portfolio of rugged commercial off-the-shelf (COTS) computers with the TAC-V integrated tactical communications system.

"The TAC-V system is a concerted effort to provide the needed computing horsepower and comms capability to the edge of the battle space without asking a soldier to carry a laptop," says Jim Shaw, executive vice president of engineering at Crystal Group. "This system is lighter and more capable as well as integrated into the ballistic vest. Laptops are for Road Warriors, TAC-V is designed specifically for the soldier."

The TAC-V provides ultra-mobile computing capability in a small, lightweight, engagement-ready system for dismounted users and hard-mounted

applications. The modular communications system provides ports sufficient for connecting to any type of radio, from narrowband or wideband to software-defined or legacy, enabling connectivity on any battlefield, officials say. In fact, the TAC-V system can be purchased as modular components for integration into combat vehicles, helicopters, unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), and other applications in which SWaP is critical to mission success.

The system weighs less than 9 pounds, can exceed 10 hours of mission support, and includes a display, micro-computer, I/O hub, battery pack, and global positioning system (GPS). It meets MIL-STD-810 for shock, vibration, and thermal performance, the sealed micro-computer runs Linux and Windows operating systems, and the touchscreen display works with cold weather gear.

Google with gloves

Aerospace and defense end users increasingly demand touchscreen devices that support the use of gloves, no matter if bulky or heavy. Xplore Technologies engineered the RangerX rugged, multi-touch tablet and RangerX Pro with glove touch capability to help improve safety and usability in the field.

"The updates for the RangerX put more opportunities in our customers' hands," says Philip S. Sassower, chairman and CEO at Xplore Technologies. "Our team is always working to provide the most advanced rugged computing experience possible, and now our users have access to glove touch capability to help them stay safe, efficient, and productive on the job."

By increasing the sensitivity of the RangerX's capacitive screen and using a finely tuned touchscreen software, the tablet can detect electrical impulses on the skin even if obstructed by a glove. "We're sensitive to the needs of the mobile workforce, and many of our customers operate in field environments where gloves are required for safety reasons or freezing temperatures," says Costello of for Xplore Technologies. "Removing gloves to work with their tablet slows down field workers' operations

and raises potential compliance concerns. We're eliminating that worry with the glove touch feature."

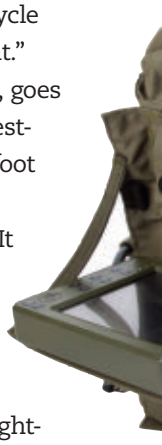
Xplore Technologies' RangerX is certified rugged, holding IP65 and MIL-STD 810G ratings. The tablet has a battery life of up to 10 hours to maximize time in the field and boost productivity, allowing for a full working shift on one charge. In addition, the tablet's outdoor viewable, multi-touch display enables a seamless transition from indoors to outdoors.

Extreme environments

Aerospace and defense applications vary in the level of ruggedness or ruggedization required. A wealth of technology firms are endeavoring to deliver an unsurpassed level of durability in a mobile format. Xplore Technologies, for example, unveiled its iX104 ultra-rugged tablet series, boasting high performance speeds, increased sunlight-readability, rugged, multi-touch display, and Windows 8.1 or Windows 7 Pro.

The iX104 ultra-rugged product line includes: the XC6 DMSR with 4G LTE capabilities and a dual-mode sunlight readable display for demanding outdoor environments; the XC6 M2, which is 461F certified for operation on military front lines and in fixed-wing aircraft, and FIPS 140-2 compliant for military and government applications; and the XC6 DM/DML for less resource-intensive applications and ambient outdoor or indoor light conditions.

"The XC6 is the toughest and highest performance product Xplore has ever developed. It will perform very well in environments where device failure is not an option," says Costello. "No matter if it's the middle of the desert or in freezing rain, this tablet is going to excel in extreme conditions, resulting in a longer life cycle and higher return on investment."



The XC6 is third-party tested, goes beyond MIL-STD-810G rugged testing requirements with a seven-foot drop rating, and is certified water and dust proof, officials say. It is equipped with a 4th Generation Intel Core i5 processor, 4G LTE communications, configurable solid-state storage, and a 1300-NIT direct sunlight-readable screen. Xplore's Analog Matrix Resistive multi-touch screen facilitates tablet use while wearing gloves or in soaking wet conditions. The XC6 is also designed for in-field upgrades, delivering flexibility with minimal downtime and reduced cost.

Ultra-rugged upgrade

Computing technology companies, like the aerospace and defense professionals that use their products, seldom rest on their laurels, upgrading systems in the field and on the production floor. Getac Inc., a manufacturer of rugged computers that meet the demands of field-based applications in Irvine, Calif., has upgraded its X500 ultra-rugged notebook and X500 rugged mobile server.

The Getac X500 employs 4th Generation Intel Core processors to increase CPU performance by 55 percent over the previous model, an enormous benefit to the technologically advanced military customers who rely on speed and efficiency when working in some of the world's harshest and most demanding work environments. The X500 is certified to MIL-STD-810G, MIL-STD-461F, IP65, and ANSI; can be deployed in dangerous environments with flammable gasses and tempera-

The Crystal Group TAC-V Integrated Tactical Communications System can be purchased as modular components, or integrated onto a tactical vest or backpack.

tures from -20 to 55 degrees Celsius, can withstand drops and shocks, and is dust and water resistant.

The new X500 Rugged Mobile Server is designed to deliver outdoor data storage and rapid server deployment for public safety, military, research, and exploration applications.

"With 4th generation Intel Core processors, Nvidia GeForce 745M discrete VGA option, 15.6-inch HD display, and a maximum RAM capacity of 16GB, the next-generation X500 is the most powerful ultra-rugged we've ever designed," says Rowina Lee, president of Getac. "This update overhauls the inside to maximize the benefits of new technologies while maintaining its ultra-rugged exterior to withstand the harshest working conditions and environments."

Future functionality

"The market continues demanding smaller, thinner, lighter, more portable, and longer battery life. Militaries want rugged devices that can perform in any environment, so tablets need to work the same on the battlefield as they do in the boardroom," Costello admits, noting that devices need to "come with the necessary ratings and certifications to withstand desert dust storms and Arctic weather without downtime to keep the military running and the missions successful." ←

FOR A MORE-COMPREHENSIVE version of this article, visit *www.militaryaerospace.com*.

Microprocessors dividing into two camps: big and high performance, and small and efficient

BY **John Keller**

Microprocessors for modern military and aerospace applications are diverging into two distinct classes—high-end microprocessors for demanding applications like radar processing, signals intelligence (SIGINT), and electronic warfare (EW), and highly integrated chips without the performance of their high-end brethren, but with small size, weight, and power consumption (SWaP).

While high-end processors are dominated by the latest Intel, Freescale, and AMD processors for graphics-intensive and parallel processing applications, the lower end is lining up with the ARM processor and the new Intel Quark processor for aerospace and defense applications like wearable computers, networked weapon sights, handheld communications, and computing appliances.

"There are two areas I see in processing capabilities," explains Ajit Patel, marketing manager for the Intel Corp. Internet of Things Solutions group in Chandler, Ariz. "On the high end, I see many-core processors—something that can provide 60 to 80 cores like our Xeon Phi microprocessor. These are not merely multicore devices, but many core." These high-end processors, which also would include the Intel Core architecture, are for radar, sonar, and similar kinds of processing that demand the highest performance.

"At the lowest end is demand for systems on a chip," Patel says. These have more integration and the lowest possible power consumption for applications like wearable computing. Intel is covering the waterfront, he says, with the Xeon Phi at the high end, and the company's new Quark architecture at the lower end.

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is a prime example of an embedded computing company that makes broad use of microprocessors on both ends of the spectrum.

"At the higher end we need a data manager, and we need big data pipes," says Gregory Sikkens, product marketing manager for the Curtiss-Wright C4 Solutions business. "Microprocessors are keeping up with trends in I/O performance, and well-sized pipes, so we can move data around efficiently now. It used to be a bottleneck, and now it is a non-concern."

The need for massively parallel processing, as well as advanced graphics processing, drives many of

COMPANY INFO

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amd.com

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ajile.com

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altera.com

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apm.com

Atmel Corp.
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Zilog
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Curtiss-Wright's needs for high-end microprocessors. "At the high end you look at a microprocessor connected to a general-purpose graphics processing unit (GPGPU) to get data out and fire it somewhere else," Sikkens explains. "That takes a lot of bandwidth. We need graphics rendering and compute for work where you are doing a lot of displays for a mission, and some of the displays are demanding in frameser-second updates for applications like digital moving maps."

Microprocessor specialist Advanced Micro Devices (AMD) in Sunnyvale, Calif., attacks the military market primarily on the high end, where systems integrators require data visualization and parallel processing. "Whether it is more displays in the cockpit or in an operations room, visual data and visualization is becoming very important," says Kamal Khouri, director of product management and marketing at the AMD Embedded Business Unit in Austin, Texas.

AMD designers are addressing this challenge by combining advanced microprocessing and GPGPU capability on the same device. This also is a design emphasis at Intel for high-end processors.

"We are being asked to provide the operator with more and more information that is being processed through smart algorithms," Khouri says. "Parallel processing is becoming a big deal for radar and satellite applications." Blending microprocessor and GPGPU capability on the same chip can address both challenges, as the GPGPU inherently is a strong parallel processing engine, as well as a graphics processor.

Blending those two capabilities, however, presents its own challenges. "With that comes a huge investment in software," says AMD's Khouri. "We need tools to enable aerospace and military customers to develop code efficiently, because the hardware and software have to be out in the field for a very long time."

To provide the right software for aerospace and defense designers, AMD partners with Core Avionics & Industrial (CoreAVI) in Tampa, Fla. For AMD processors "we do ground-up development, and safety-critical Open CL drivers" for GPGPU applications, says Dan Joncas, vice president of sales and marketing at CoreAVI. "We develop software on real-time operating systems and develop certification packages" for customers such as Boeing and Lockheed Martin.

From the perspective of microprocessors specifiers, each microprocessor supplier has its own strengths, says Sikkens. "In our market, we are supplying the [Freescale] Power Architecture and ARM. Many customers perceive the Power Architecture as being the most deterministic, but some customers are becoming comfortable with Intel, which has a large ecosystem with a lot of low-cost or no-cost driver support available.

"ARM is for some customers who don't want Intel," Sikkens continues. "It has the largest ecosystem, but the negative perception is that it's for tablet computers, but that is changing for the better. Arm is now at a competitive performance level." ←

Nevada UAV test site to help link unmanned aircraft systems with air traffic control

Federal Aviation Administration (FAA) officials announced that the State of Nevada's unmanned aircraft systems test site is ready to conduct research vital to integrating UAS into the nation's airspace. The FAA granted the State of Nevada team a two-year Certificate of Waiver or Authorization (COA) to use an Insitu ScanEagle at the Desert Rock Airport located in Mercury, Nev. Desert Rock Airport, owned and operated by the U.S. Department of Energy, is a private airport and not for general use. The ScanEagle from Insitu, a Boeing company in Bingen, Wash., will fly at or below 3,000 feet, monitored by a visual observer and mission commander. Initial flights will verify that a UAS can operate safely at the airport. Nevada's research will concentrate on UAS standards and operations as well as operator standards and certification requirements. The site's activities will also include a look at how air traffic control procedures will evolve with the introduction of UAS into the civil environment and how these aircraft will integrate with NextGen, the modernized national airspace management system.

Special Operations Command asks industry for EO/IR cameras for 14-pound, hand-launched UAV

MacDILL AIR FORCE BASE, Fla.—U.S. Special Operations experts are asking industry to supply an electro-optical and infrared (EO/IR) camera with laser pointer for a 14-pound hand-launch unmanned aerial vehicle (UAV) in surveillance and reconnaissance applications.

Officials of the U.S. Special Operations Command (SOCOM) at MacDill Air Force Base, Fla., issued a presolicitation (H92222-14-R-0023) to supply EO/IR UAV cameras with laser pointer for the RQ-20A Puma small UAV from AeroVironment in Monrovia, Calif. These cameras, which SOCOM officials may buy from several different companies, must have stabilized gimbals for steady focus on targets as far away as 1,000 feet. The camera also should have adjustable black-and-white contrasting infrared imaging.

The laser pointer accuracy should be 65 microns, with target position tracking and movement estimation. the camera should be waterproof, operate from existing Puma UAV power and data linking, and have image resolution of 10 to 20 megapixels at 1.67-micron pixel size in 1080 by 720-pixel images.

The camera should be able to download streaming digital video at 30 frames per second, and should be able to help intelligence experts recognize personnel on the ground by their uniforms and clothing from as far away as one mile.

U.S. Special Forces are looking for tiny electro-optical sensor payloads for hand-launched unmanned aerial vehicles.

The camera also should have shortwave infrared (SWIR) imaging capability able to help analysts recognize personnel through windows and shaded areas in daylight and at night. The device should weigh between 19 and 24 ounces.

The AeroVironment Puma UAV is 4.6 feet long, weighs 13.5 pounds, and has a wing span of 9.2 feet. It can fly for as long as 3.5 hours at speeds from 20 to 45 knots, at altitudes to 500 feet above the ground. It has a range of nearly 10 miles. It can navigate with GPS via the AeroVironment common ground control system.

SOCOM officials say at least some proposers may demonstrate and test their cameras on the Puma before a down selection to one successful offeror. Officials plan a six-month base period and one three-year ordering period.

To express interest, or to ask questions, e-mail Contracting Officer Christine Johnson at johnsc1@socom.mil, or Jennifer Metty at jennifer.metty@socom.mil.

Navy chooses RDRTec to develop sense-and-avoid radar for Fire Scout and Triton UAVs

BY **John Keller**

LAKEHURST, N.J.—U.S. Navy avionics experts are overseeing a program to create a radar system to enable unmanned aerial vehicles (UAVs) to sense and avoid nearby aircraft to avoid mid-air collisions and other difficulties caused by airborne close encounters.

Officials of the Naval Air Warfare Center Aircraft Division-Lakehurst in Lakehurst, N.J., are asking radar experts at RDRTec in Dallas to design a sense-and-avoid radar system for the MQ-8 Fire Scout unmanned helicopter and the MQ-4C Triton unmanned reconnaissance aircraft under terms of a $3 million contract. RDRTec experts will evolve and transition the Radar Autonomous Collisions Avoidance System (RACAS) Sense and Avoid (SAA) radar technology into the Common RACAS (C-RACAS). The goal of the project is to enhance efficiency in airspace integration.

The Fire Scout and Triton UAVs are manufactured by the Northrop Grumman Corp. Aerospace Systems segment in Rancho Bernardo, Calif.

The Fire Scout unmanned autonomous helicopter provides reconnaissance, situational awareness, aerial fire support, and precision targeting support for ground, air, and sea forces. The initial RQ-8A version was based on the Schweizer 330; the enhanced MQ-8B was derived from the Schweizer 333; and the MQ-8C variant is based on the Bell 407 helicopter.

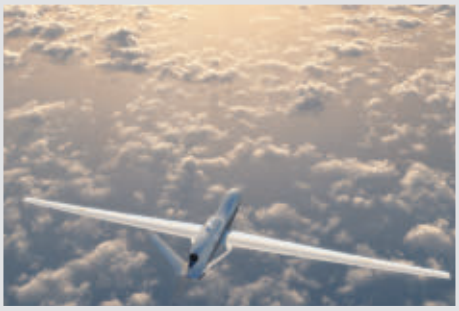
The Triton is a version of the Northrop Grumman RQ-4C Global Hawk long-range high-altitude reconnaissance UAV adapted for maritime patrol in a support role to the Navy P-8 Poseidon manned maritime patrol jet. The Triton was developed under the Broad Area Maritime Surveillance (BAMS) program.

The Triton will provide real-time missions over vast ocean and coastal regions, continuous maritime surveillance, as well as search and rescue missions. The UAV will be able to descend through cloud layers to gain close views of ships and other targets at sea when needed. It will track ships and submarines over time by gathering information on their speed, location, and classification.

The contract to RDRTec is part of a Rapid Innovation Fund (RIF) program of the Office of Naval Research (ONR) in Arlington, Va. RDRTec specializes in solutions to difficult radar problems involving active electronically scanned arrays (AESA); airborne early warning; anti-submarine warfare; anti-surface warfare; intelligence, surveillance, and reconnaissance; and missile systems. The company has expertise in low, medium and high pulsed-Doppler, synthetic aperture radar, ground moving target indicator, inverse synthetic aperture radar, and detection and tracking of small maritime targets.

In a separate Navy project, RDRTec experts developed radar sense-and-avoid technologies for the Fire Scout UAV using advanced AESA technology and proprietary signal processing to provide actionable collision warning information with lead times longer than 30 seconds involving non-cooperative aircraft moving as fast as 400 knots. When it comes to AESA radar, RDRTec Inc. is developing adaptive multi-channel phased array manifold radar technology that reconfigures by radar mode for optimum performance.

Company experts are focusing on multi-mode X or C-band radars with phased arrays that support modes with high and low bandwidth requirements. High-bandwidth modes include synthetic aperture radar (SAR), inverse synthetic aperture radar (ISAR), and high range resolution (HRR). Relatively low-bandwidth modes include ground moving target indicator (GMTI), maritime moving target indicator (MMTI), air-to-air (AA) and sense and avoid (SAA).



The Navy is overseeing a program to develop sense-and-avoid radar to enable UAVs like the Triton maritime patrol craft, shown above, to operate safely alongside manned and unmanned aircraft.

RDRTec experts have developed these kinds of technologies and capabilities for the Fire Scout UAV, yet are moving the technologies to other future Navy ISR radars, such as that on the Triton UAV. ←

Rockwell Collins and Elbit to provide night-vision head-up displays

U.S. Navy combat aircraft experts needed night-vision capability for helmet-mounted, head-up displays for high-performance fighter-bomber aircraft. They found their solution at Rockwell Collins-ESA Vision Systems, formed by Rockwell Collins and Elbit Systems of America. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., plan to negotiate a sole-source contract with Rockwell Collins-ESA for Night Vision Cueing and Display (NVCD) Systems that are compatible with different versions of the Navy's Boeing F/A-18 Hornet strike fighter.

FOR MORE INFORMATION contact at *www.rockwellcollins.com* or *www.elbitsystems-us.com*.

Navy takes page from optical cable industry for ocean surveillance

U.S. Navy undersea warfare experts are investigating the commercial undersea cable industry to find technologies that might be useful in maritime surveillance systems. Officials of the Space and Naval Warfare Systems Command in San Diego issued a sources-sought notice for the Undersea Cable System and Sonar System Technology Advances program, which seeks to capitalize on commercial ocean cable technology for maritime surveillance.

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

Creative Microsystems pursues next-generation, night-vision technology

WASHINGTON—U.S. Navy researchers are moving forward with a program to shrink the size and increase the capabilities of the next-generation military night-vision goggles, while drastically reducing the cost of manufacturing these night-vision devices.

Officials of the Naval Research Laboratory (NRL) in Washington plan to award a sole-source research contract to Creative Microsystems Corp. (CMC) in Waitsfield, Vt., for the Micro Optic Low Light Imager (MOLLI) project to design next-generation lightweight high-performance military night-vision goggles.

CMC electro-optics experts will measure the size and performance of their new night-vision goggles design against the current-generation AN/PVS-31 night-vision binocular. The new design at first should weigh no more than 17.65 ounces, and ultimately should weigh no more than seven ounces and as little as 3.5 ounces, Navy researchers say. The AN/PVS-31, by contrast, weighs nearly 21 ounces.

The new design will be a low-light-amplification system with a spectral response in the visible, near infrared (NIR), and shortwave infrared (SWIR) light bands. Navy officials want the new night-vision goggles design within five years, with a plan that ultimately would cost 75 to 90 percent less than current models to manufacture in high volumes.

CMC experts are being asked to design an imaging array that gives the new binocular night-vision goggles design a wide field of view. Company engineers will develop an application-specific integrated circuit (ASIC) that supports a hybrid-electro-optic imaging approach.

U.S. Navy researchers are among U.S. military authorities trying to develop the next generation of night-vision technology.

The hybrid design will combine scene elements from the imaging array and amplifier pair into one high-resolution image. High-performance optics will produce a reduced form factor emissive near-to-eye display that provides the viewer with 20/20 acuity, Navy researchers say.

The estimated value of the two-year contract is $2.7 million. CMC holds the proprietary intellectual property necessary to design the kind of night-vision goggles the Navy wants, officials say, and is the only qualified source able to do the work at an affordable cost.

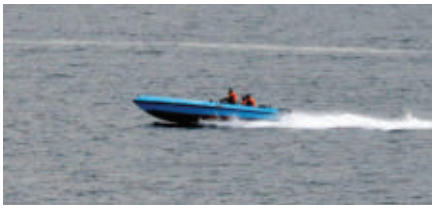
More information on the MOLLI project is online at https://www.fbo.gov/spg/DON/ONR/N00173/N00173-14-C-2010/listing.html.

FOR ADDITIONAL INFORMATION contact **Creative Microsystems Corp.** online at *www.creativemicro.com*.

Navy eyes 360-degree multispectral persistent surveillance for ship defense

CRANE, Ind.—U.S. Navy shipboard electronics experts are looking for companies interested in developing an electro-optical sensor that provides 360-degree multispectral persistent surveillance capability.

The Naval Surface Warfare Center (NSWC) in Crane, Ind., issued a request for information for components for a 360 Degree Electro-Optical/Infrared (EO/IR) Persistent Surveillance System under the U.S. Navy Ships program. This capability would give Navy ships the ability to gather high-resolution video and images all around the vessel in daylight, at night, and in bad weather. This capability could enhance shipboard defenses against fast maneuverable missile boats attacking with swarm tactics, and similar threats.



Fast attack boats are the focus of multispectral sensor development for surface ship defense.

Long-range day/night/all-weather surveillance holds the potential to slave 360-degree electro-optical sensors to advanced shipboard systems like laser weapons to help defend surface warships from swarm tactics. The 360 Degree Electro-Optical/Infrared (EO/IR) Persistent Surveillance System for U.S. Navy Ships program is still in its infancy, and Navy officials warn that they do not yet have the funding to release formal solicitations and award contracts.

Navy surface warfare experts are contemplating industry-day briefings to industry on their plans for the program sometime in September or October 2014. Industry briefings could include the best industry ideas gathered from this RFI, officials say.

E-mail technical questions to Matthew Thurner at matthew.thurner@navy.mil. The contracting point of contact is Michael Allen (michael.t.allen1@navy.mil).

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

PRODUCT applications

SHIPBOARD ELECTRONICS

Navy chooses shipboard IFF interrogators from BAE Systems

U.S. Navy aviation experts needed identification-friend-or-foe (IFF) interrogators for surface ships and land installations to help identify friendly and potentially hostile aircraft. They found their solution from the BAE Systems Electronic Systems segment in Greenlawn, N.Y.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., awarded a $6.7 million contract to BAE Systems for 16 AN/UPX-41 digital interrogators for ships and land sites. For this order, 14 are for the Navy and two are for the government of Japan.

A digital IFF interrogator looks at signals from the transponders of nearby aircraft to identify them on air traffic control radar, and to determine if the aircraft are friendly or potential threats.

This contract also includes 45 Mode 5 IFF field change kits — 33 for the Navy and 12 for Japan. These field change kits help upgrade fielded AN/UPX-41 interrogators with Mode 5 transponder capability. Mode 5 is a military feature that reads cryptographically secured transponder signals from aircraft, and helps sort out friendlies from potential enemies.

The AN/UPX-41 digital IFF interrogator is the U.S. Navy's standard mode 5 level 1 and level 2 interrogator. The U.S. Marine Corps and Air Force also use it for several applications. The interrogator handles Mark XII and Mark XIIA IFF processing, including mode 5, with growth to mode S.

The unit conforms to U.S. Department of Defense (DOD), NATO, International Civil Aviation Organization (ICAO), and U.S. FAA requirements. Its design represents an upgrade to the AN/UPX-37, which replaces all AN/UPX-27 IFF interrogators in the fleet, BAE Systems officials say.

The AN/UPX-41 modular and digital architecture enables users to customize different configurations, and to optimize the unit for applications such as air defense, weapon systems, air traffic control, and range instrumentation.

The unit can provide digital target reports in addition to wideband video for subsequent passive and active decoding. The digital interrogator also provides amplitude monopulse for enhanced azimuth accuracy, and can operate autonomously or together with a host radar.

FOR MORE INFORMATION contact **BAE Systems Electronic Systems** online at *www.baesystems.com*, or **Naval Air Systems Command** at *www.navair.navy.mil*.

RF AND MICROWAVE

Air National Guard chooses RF amplifiers from AR Modular for C-130 aircraft

Communications experts at the U.S. Air National Guard in Washington needed RF and microwave equipment for an upgrade to Air Guard EC-130 Commando Solo special operations aircraft. They found their solution from AR Modular RF in Bothell, Wash.

AR Modular officials are providing the company's AR-75 RF amplifier for upgrading a fleet of C-130 Air Guard onboard aircraft communication systems.

The Air Guard's EC-130 aircraft to receive the communications upgrades is a modified C-130J Hercules four-engine turboprop that conducts psychological operations and civil affairs broadcast missions in the standard AM, FM, HF, TV, and military communications bands.

The AR-75 tactical booster amplifier enhances the communications capabilities of the C-130 by providing the ability to broadcast at altitudes necessary to reach the desired target audiences, AR Modular officials say. The AR-75 tactical booster amplifier exceeds requirements of MIL-STD 461F and 810G safety flight certification testing, company

officials say. The lightweight booster amplifier exceeds shock and vibration requirements even when directly mounted to the airframe.

The Commando Solo is operated by the Air National Guard's 193rd Special Operations Wing, a unit of the Pennsylvania Air National Guard based at the Harrisburg Air National Guard Base at Harrisburg International Airport in Middletown, Pa.

The 75-watt AR-75 operates with VHF/UHF tactical radio equipment on military bands from 30 MHz to 512 MHz. It can work with legacy, proprietary, and emerging waveforms. The amplifier uses six high-speed auto switching filters for harmonic suppression and is SINCGARS, HAVEQUICK, HPW, DAMA, IW, WNW, SRW, and ANW2 compatible.

The amplifier includes power supply voltage spike suppression, a DC-DC converter for wide DC input range, RF sensing, transmit/receive switching, automatic level control, six automatically switched harmonic filter bands (DAMA capable), and protection against antenna mismatch, over-temperature, and accidental polarity reversal.

FOR MORE INFORMATION contact **AR Modular RF** online at *www.arww-modularrf.com*.

DIGITAL SIGNAL PROCESSING

3 Phoenix to provide data-fusion sonar signal processing for submarines and ships

U.S. Navy sonar experts needed data-fusion technology to blend information from several different towed-array sensors to improve target detection and tracking. They found their solution from 3 Phoenix Inc. in Chantilly, Va.

Officials of the Naval Sea Systems Command in Washington awarded 3 Phoenix a $7.3 million contract modification for two TB-29A submarine sonar inverted Passive Electrical Network (iPEN) towed array production-representative units, spare parts, and test equipment.

The iPEN is a low-power, open-architecture data fusion system that distributes, merges, and totals sonar information on a tactical network

while maintaining close synchronization. The iPEN system capitalizes on technology that 3 Phoenix developed as part of a small business innovation research contract the company won in May 2013 called Real-time Data Fusion and Visualization Interface for Environmental Research Data.

For this contract, 3 Phoenix engineers will develop deployable iPEN systems. The TB-29 submarine thinline towed array is for fast-attack submarines and works with the AN/BQQ-5E sonar and Combat Control System (CCS) Mk 2. It is a coaxial wire that trails behind submarines for as long as 1.6 miles. Telemetry data from the iPEN system acts as a data fusion point for integrating sonar data from towed arrays on Navy submarines and surface ships. Navy experts say iPEN technology will reliability and operational availability of TB-29A towed arrays.

The iPEN system accepts inputs from independent analog, digital, or smart sensors, synchronizes the data to a common time standard, combines the signals, compresses the data, and shares the information with data analysts over radio channels or on Internet protocol-based networks.

FOR MORE INFORMATION contact **3 Phoenix** online at *http://3phoenix.com*.

RUGGED COMPUTERS

Curtiss-Wright to provide Ethernet switches for Atlas and Delta launch

Rocket scientists at the United Launch Alliance (ULA) in Centennial, Colo., needed rugged Ethernet switches for the Atlas V and Delta IV launch vehicles. They found their solution from the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va.

ULA officials awarded a $2 million contract to Curtiss-Wright for Parvus DuraNET 3000 rugged commercial off-the-shelf Ethernet switches for ULA's work in the U.S. Air Force Evolved Expendable Launch Vehicle (EELV) program.

The Parvus DuraNET 3000, an R-COTS version of the Cisco Systems IE-3000 industrial Ethernet switch, is hardened for demanding military and civil IP networking applications. The Parvus DuraNET 3000 Ethernet switches will contribute to a redundant on-vehicle local area network (LAN) used prelaunch to communicate with the flight control computer transferring pre-flight information to launch control, officials say. The switch routes compressed digital video off the launch vehicle. The Ethernet switch is part of ULA's common avionics initiative that seeks to use the same avionics design on Atlas and Delta rockets, which boost satellites into various Earth orbits.

FOR MORE INFORMATION contact *www.parvus.com*.

new PRODUCTS

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

HPEC

Software engineering tool for multicore HPEC unveiled by GE

GE Intelligent Platforms announced Advanced Multiprocessor Integrated Software (AXIS) development environment 6.0 for aerospace and defense software applications. The AXIS 6.0 software engineering tool provides support for the latest fourth generation Intel Core i7 processors as well as for the most recent multicore processors from Freescale and Nvidia. AXIS is designed to speed the development, debugging, optimization, testing and deployment of size, weight, and power (SWaP)-sensitive multiprocessor high-performance embedded computing (HPEC) systems. AXISPro supports Open MPI to enable developers to run MPI and AXISFlow applications concurrently. AXIS provides for application portability and scaling across several processor cores, CPUs, and multi-board systems. The AXISView GUI provides a user interface to create, configure, build, load, run, scale, visualize, and tune several processes across distributed multi-threaded, multi-core, multi-node platforms.

FOR MORE INFORMATION contact **GE Intelligent Platforms** online at *http://defense.ge-ip.com*.

EMBEDDED COMPUTING

GSM channelizer 3U VPX module introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing model 52663 full spectrum GSM channelizer 3U VPX module for military, homeland security, and other government embedded computing applications. The 52663 uses an optimized IP core for the Xilinx Virtex-6 field-programmable gate array (FPGA) for mobile monitoring systems that must capture some or all of the 1100 uplink and downlink signals in upper and lower GSM bands. The model 52663 accepts four analog inputs from an external analog RF tuner where the GSM RF bands are down converted to an IF frequency. Four A/D converters then digitize these IF signals and route them to four channelizer banks, which perform digital down conversion. Two of the banks handle 175 channels for the lower GSM transmit/receive bands and two banks handle 375 channels for the upper bands. The DDC channels within each bank are equally spaced at 200 kHz.

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

RF AND MICROWAVE

Low-noise amplifiers introduced by Pasternack

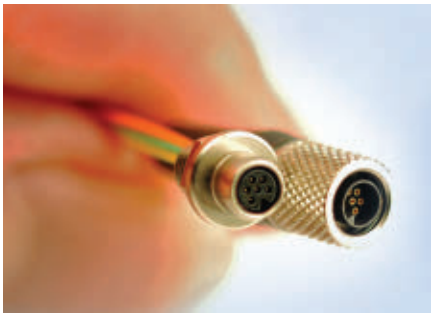
Pasternack Enterprises Inc. in Irvine, Calif., is introducing a family of 14 low-noise amplifiers (LNAs) for military and commercial RF and microwave applications. The LNAs offer high gain and broadband performance between 9 KHz and 18 GHz. These LNAs have a choice of noise figures, gain levels, frequency ranges, and power outputs. The LNA category exhibits broadband performance from 9 KHz to 18 GHz, noise figures between 0.8 dB to 3 dB, gain levels from 25 dB to 50 dB, gain flatness from plus-or-minus 0.75 dB to plus-or-minus 1.25 dB, and power output levels (P1dB or Psat) between 10 dBm and 18 dBm. The performance of these LNAs relies on a hybrid microwave integrated circuit design and advanced GaAs PHEMT technology. The LNAs from Pasternack are connectorized SMA modules that are stable and include built-in voltage regulation, bias sequencing, and reverse bias protection for added reliability.

FOR MORE INFORMATION contact **Pasternack** online at *www.pasternack.com*.

CONNECTORS

Rugged metal nano-connectors introduced by Omnetics

Omnetics Connector Corp. is introducing the Metal Nano-Connectors high-density, multi-position connectors made with break-away or threaded metal housings for unmanned aerial vehicles (UAVs) and other mission-critical aerospace and defense applications. The Metal Nano-Connectors offer positive lock and environmental seal, and are built to meet or exceed military specifications. The UAV applications of these connectors include circuits, cameras, and other instruments that require cable and interconnects that are extremely small and lightweight, yet



that can withstand high shock and vibrations while maintaining electrical integrity. The Omnetics line of Metal Nano-Connectors can survive ruggedness tests beyond military specifications. Temperature ranges exceed 200 degrees Celsius and locking screws hold connections together securely even during tough landings.

FOR MORE INFORMATION contact **Omnetics Connector** at *www.omnetics.com*.

POWER ELECTRONICS

Synchro booster amplifier for shipboard electronics introduced by DDC

Data Device Corp. (DDC) in Bohemia, N.Y., is introducing the SBA-3500X synchro booster amplifier for shipboard electronics applications. The

1.2-pound factor synchro booster amplifier has a 25-volt ampere output drive to amplify synchro or resolver signals to 90-volt synchro signals for control transformer, control differential transmitter, and torque receiver loads. The power electronics devices are suitable for training simulators, remote indicators, gunfire control, and retransmission systems. The SBA-3500X offers output of 90-volt synchro 60 Hz or 400 Hz to 25-volt amperes; input of 90-volt synchro or 6.8-volt, 5-volt, and 2-volt resolver 60/400 Hz; reduced heat dissipation; power disable features; short circuit, overload, load transient, and over temperature protection; enhanced electromagnetic interference protection; and operating temperatures of -40 to 85 degrees Celsius.

FOR MORE INFORMATION contact **DDC** online at *www.ddc-web.com*.

EMBEDDED COMPUTING

Rugged 3U VPX ARM-based processor modules introduced by Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the VPX3-1701 3U VPX embedded computing module based on a CPU that has dual 1 GHz ARM processors for demanding C4ISR applications such as video, radar, and sonar data processing. The low-power, small-form-factor, rugged ARM processor is rated at less than 15 watts maximum power dissipation. The VPX3-1701 delivers the benefits of ARM technology while providing a path to technology insertion with pin-compatible, higher-performance Curtiss-Wright ARM single-board computers to follow. The VPX3-1701's high-speed backplane and XMC connectivity enable multi- gigabytes per second data flows from board-to-

board through the backplane interface and from the backplane to its on-board XMC site to support the acquisition, processing, and distribution of sensor data.

FOR MORE INFORMATION contact **Curtiss-Wright** at *www.cwcdefense.com*.

CHASSIS AND ENCLOSURES

Pentair offers rugged SFF enclosures

Pentair in Warwick, R.I., is introducing the Schroff Interscale M range of enclosures for small-form-factor (SFF)

printed circuit boards. The embedded computing enclosures provide a flexible platform for protecting SFF electronics, including single-board computers, computer-on-module, nanoETXexpress, Mini-ITX, and Nano-ITX. Users may configure the enclosures, which range from 5.25-inch designs to standard 19-inch racks.

FOR MORE INFORMATION contact **Pentair** online at *www.schroff.biz*.

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Andrew Dunn

Industry executive discusses the value of airborne electronic warfare (EW).

What is prompting EW investment?

The biggest changes in the world are the pivot to the Pacific and reacting to anti-access/area-denial (A2AD) strategies. We are now out of Iraq, winding down in Afghanistan, and looking to a different part of the world, Asia-Pacific. The entire threat scenario is radically changed, so there's significant investment to address the new environment in this new area of operations. As the Department of Defense talks about the hard problems the U.S. and allies are facing, EW has a significant role in solving those problems.

What else has changed?

The whole mindset of the U.S. has changed. We have had unfettered access to the areas in which we operated in the past. When we went to send up unmanned aircraft, we essentially had free reign in both the electromagnetic and physical spectrums. We were able to fly where we wanted to, get to where we needed to be, and had access to areas in which we were operating. That has all changed now. We may not have that access in the future, and we may not be in uncontested battle spaces. It's a whole different mindset, and different scenarios future warfighters will be seeing. The other is the air-sea battle. The geographic area, the battlefield, has changed significantly. Now we're going from the air-land battle to the air-sea battle.

Are other regions investing in EW?

It's not only the U.S., Australia has purchased 24 Super Hornets and are preparing a significant number of F-18G Growlers that are very focused on A2AD and air-sea battles. All the challenges associated with the contested sea lanes [e.g., in the South China Sea] have caused a lot of concern among allies in that area and they're increasing investments in capabilities to address the geopolitical realities appearing in the region.

How are you winning contracts?

Customer intimacy is part of portfolio and part of our success, making sure we have products that customers are looking for, anticipating their hard problems, and investing in those technologies that are going to support/help them.

We knew the Joint Strike Fighter (JSF) was coming—and it is one of the most beautifully cancel-proof programs ever made, with so many countries involved that the U.S. is in no way going to be able to back away from that platform because of the political ramifications. We knew there was going to be an availability of F-16s around the world. One of the capability gaps in the F-16s is EW.

We invested a number of years ago to be able to provide to F-16 users an upgraded EW that could be relatively easily integrated. We were able to anticipate the need and develop the technology. It's an example of trying to understand customer needs and investing in those technologies and capabilities that they will need. When they say they have this gap, we are able to provide the technology quickly. ←

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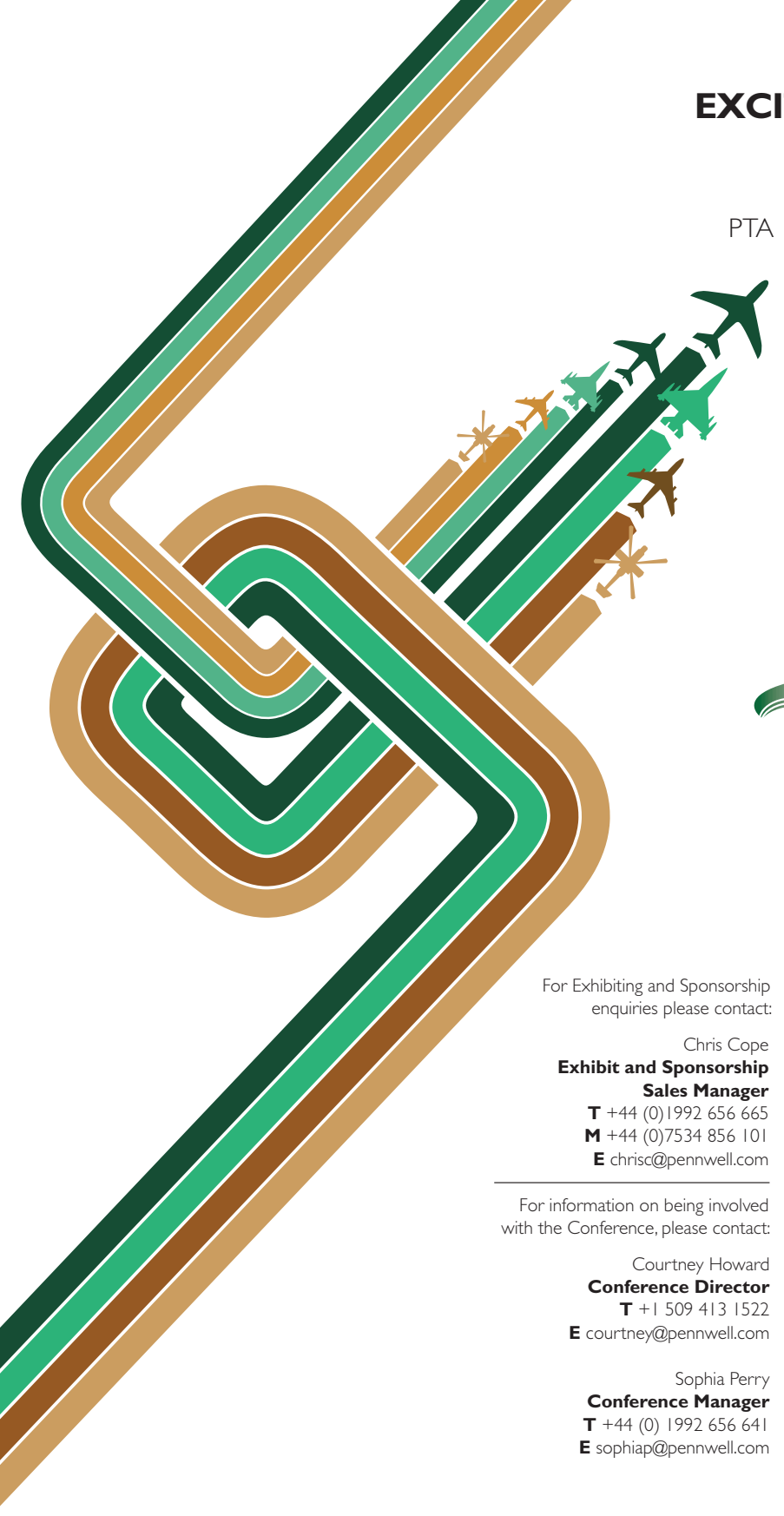

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The conference will ultimately look at how these technology elements are transferable, complimentary and integrate with one another.

With these technologies transforming virtually all phases of air travel and transport, Intelligent Aerospace provides a new and vital platform for the most senior key decision makers to view products, network, and be part of an exciting conference program, all under one roof.

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