OCTOBER 2015

# Military & Aerospace Electronics

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## Modernizing the B-52

Equipping the venerable B-52 bomber for network-centric warfare. PAGE 5

## Small-form-factor embedded computing

Small size, weight, and power consumption are only the beginning of the SFF era. PAGE 16

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# Data comms and situational awareness

*Information networking, sensor fusion, and data security help keep warfighters on top of their game.* PAGE 6

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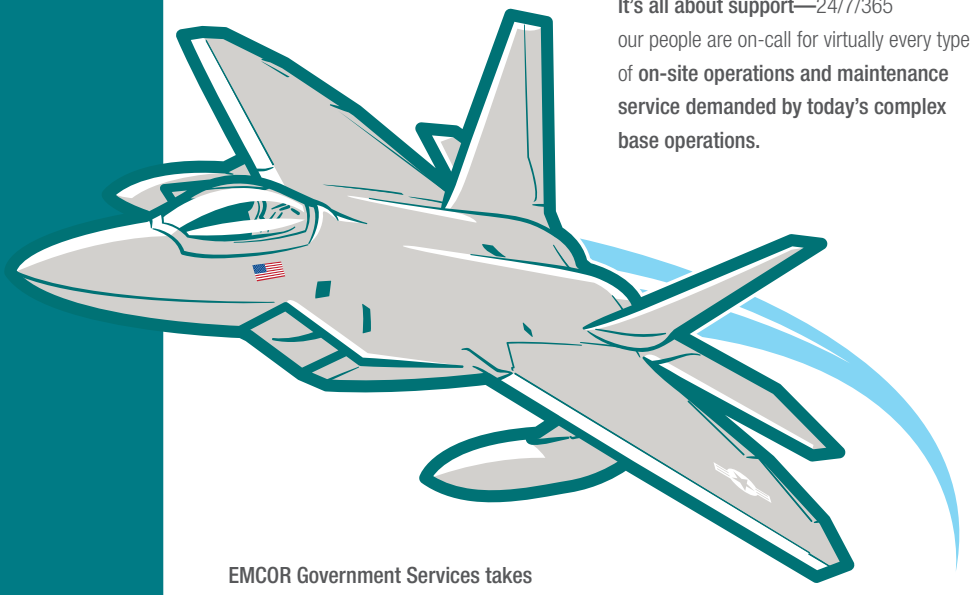

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COVER STORY





BY **JOHN KELLER**, EDITOR IN CHIEF

# Military eyes swarms of drones working as teams to overwhelm the enemy

Working as a team is a core component of modern military doctrine, yet what usually comes to mind first when we ponder the role of unmanned vehicles is the lone wolf, not members of a team.

Consider the unmanned aerial vehicle (UAV) and most likely you'll think of a single reconnaissance drone tracking terrorists or enemy military forces, or the armed UAV slipping through enemy defenses quickly and quietly for a surgical hit-and-run attack.

All that could be changing, because of research initiatives like the Gremlins program of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va. The Gremlins program, announced in September, envisions swarms of semi-expendable reconnaissance and electronic warfare (EW) UAVs falling quickly on an unsuspecting enemy to overwhelm opposition by suppressing missile defenses, cutting off communications, spoofing internal security, and perhaps even infecting enemy data networks with computer viruses.

This is all without exposing even one human aircraft pilot to danger. Manned aircraft would launch the drones from platforms like the C-130 utility turboprop or similar military planes at safe distances outside the ranges of enemy air defenses and unleash an onslaught of drones on the enemy.

The swarming drones envisioned in the DARPA Gremlins program would be relatively inexpensive, so their losses wouldn't jeopardize missions or impose crippling costs. Still, Gremlins drones would be sophisticated enough to do real damage to the enemy, and then be recovered should they survive the mission.

Host C-130 aircraft would be fitted with special equipment to capture returning drones so they could fight another day. In fact, the Gremlins drones could be used several more times — but are not envisioned for anything other than limited life cycles. Maybe they could last as long as 20 missions before being retired. Think of reusable target drones, and you have the idea for Gremlins UAVs.

Simply swarming an enemy with UAVs will be harder than it sounds. Not only will these drone swarms overwhelm an enemy, but they must work together to do it. For capabilities like this, technological challenges remain to be overcome. Perhaps the most important is devising effective and secure ad-hoc wireless networks that would enable UAVs to communicate and coordinate their actions.

The contractors chosen to participate in the Gremlins program will confront just such a challenge. These wireless networks must be adaptable and self-healing so that when one drone fails, gets shot down, or crashes unexpectedly, then others automatically can assume its responsibilities. No medics will be necessary.

As attrition were to factor in to Gremlins-like missions, the remaining drones would continue on with surveillance duties, electronic jamming, communications eavesdropping, cyber warfare, or other assigned tasks. After completing the mission, surviving drones would rendezvous at a pre-determined location and be recovered by the host C-130 aircraft. Sneak in, swarm and overwhelm the enemy, and then leave. That's the objective.

DARPA isn't alone in pursuing swarming drone technologies; a variety of military agencies are trying to develop the ability to swarm the enemy with UAVs. There's the Office of Naval Research's LOCUST (Low-Cost UAV Swarming Technology) program. DARPA is doing similar cooperative UAV work in its Collaborative Operations in Denied Environment (CODE) program. The DARPA Gremlins program is one of the latest initiatives, and will help give depth and focus to military drone swarming research. DARPA wants Gremlins program proposals by November.

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# GE sale of embedded computing unit to make company nimbler, more agile

**BY JOHN KELLER**

**NEW YORK** — The New York-based private equity firm Veritas Capital is acquiring the embedded computing business of General Electric Co., which has been part of the GE Intelligent Platforms business unit based in Huntsville, Ala.

The GE embedded systems business specializes in open-architecture electronic systems for aerospace, defense, and industrial applications. The company offers rugged products designed to withstand harsh environments, such as extreme temperature and high vibration, and has about 700 employees worldwide.

GE Intelligent Platforms has been part of the GE Energy Management segment. Veritas Capital invests in companies that provide products and services to government and commercial companies worldwide.

Terms of the transaction, announced on 22 Sept., were not disclosed, and the acquisition is expected to close by later this year. After closing, GE's embedded systems business will be renamed and operate as an independent company at its current headquarters in Huntsville, Ala., Veritas officials say.

The change of ownership will enable the GE embedded business unit to be nimbler, faster, more agile, more responsive, and more flexible, company officials say.

Bernie Anger, currently General Manager of GE's Intelligent Platforms business, will continue to lead the embedded computing business for Veritas, says Mark Begor, president and CEO of GE Energy Management.

"Veritas brings deep experience investing in the defense market, a vast network of relationships in the government and commercial markets, and a track record of adding significant value to its portfolio companies," Anger says.

"Acquiring GE's Embedded Systems business is an exciting opportunity to partner with a leading provider of mission-critical technology solutions to both government and commercial markets," says Hugh Evans, a managing partner of Veritas.

The embedded systems business has been part of GE largely since 2006, when GE acquired leading embedded computing companies Radstone Technology PLC and SBS Technologies. Earlier GE had acquired embedded computing companies VMIC in 2001 and RAMiX in 2003.

**FOR MORE INFORMATION** visit **GE Intelligent Platforms** online at *www.geautomation.com*, or **Veritas Capital** at *www.veritascapital.com*.

## IN BRIEF

### 16 research organizations to share $800 million for expeditionary warfare

Sixteen U.S. defense technology research organizations will share as much as $800 million over the next five years to develop, test, and demonstrate new technologies related to expeditionary warfare. The Army Contracting Command at Research Triangle Park, N.C., named the 16 companies last month to participate in the Advanced Expeditionary Warfare Development (AEWD) program. The 16 companies are BAE Systems Technology Solutions & Services Inc. in Rockville, Md.; Battelle Memorial Institute in Columbus, Ohio; Booz Allen Hamilton Inc. in McLean, Va.; Bowhead System Management LLC in Alexandria, Va.; By Light Professional IT Services Inc. in Arlington, Va.; Charles Stark Draper Laboratory Inc. in Cambridge, Mass.; Envistacom LLC in Atlanta; Exelis Inc. in Herndon, Va.; Georgia Tech Applied Research Corp. in Atlanta; Hickory Ground Solutions LLC in Heathsville, Va.; Ideal Innovation Inc. in Arlington, Va.; Janus Research Group Inc. in Appling, Ga.; K2 Solutions Inc. in Southern Pines, N.C.; Leidos Inc. in Reston, Va.; STS International Inc. in Berkeley Springs, W. Va.; and WinTec Arrowmaker Inc. in Fort Washington, Md.

# Air Force to upgrade B-52 bombers for network-centric warfare

**BY JOHN KELLER**

**WRIGHT-PATTERSON AFB, Ohio —** U.S. Air Force avionics experts are preparing to upgrade 28 Boeing B-52 eight-engine strategic jet bombers to enable the venerable aircraft to log-in to the network-centric battlefield.

Officials of the Air Force Lifecycle Management Center at Wright-Patterson Air Force Base in Ohio have announced a $46.7 million contract to the Boeing Co. Defense, Space & Security segment in Oklahoma City, Okla., for seven full-rate-production Combat Network Communication Technology (CONECT) upgrade kits for the B-52 bomber.

The CONECT upgrades provide the B-52H with digital display screens, computer network servers, and real-time beyond line of sight communication links to enable crews to stay connected to the world throughout their missions.

The contract also calls for Boeing to provide 21 retrofit kits to convert previously purchased B-52 CONECT kits from a low-rate initial production configuration to the full-rate production configuration.

Another facet of CONECT is the addition of networking devices to the aircraft to act as a digital framework, for easy incorporation of new technologies in the future.

Included in the CONECT modification kits are six units of peculiar support equipment; 14 CONECT mission support system ground stations; 114 removable storage devices; and technical support for installation of the CONECT system on the B-52H aircraft — including parts and components expected to go obsolete and depot maintenance during the program.

The Air Force and Boeing are upgrading communications links on the 1950s vintage B-52 bomber for network-centric warfare capability.

The B-52 CONECT program involves new computers and color displays, key data links, an advanced wideband satellite terminal, and tie-ins to existing Air Force systems to enable B-52s to receive new missions and re-target weapons during flight.

The Air Force operates 76 B-52s primarily out of Barksdale Air Force Base, La.; Minot Air Force Base, N.D.; and Andersen Air Base, Guam.

These upgrades to the B-52 are designed to improve the aircraft's utility in the modern battlespace and to keep the 50-year-old aircraft capable and lethal until at least 2040, Air Force officials say.

The machine-to-machine interfacing introduced by CONECT also allows for rapid re-tasking and re-targeting while eliminating potential human error. This enables the B-52H to conduct digitally aided close-support missions in coordination with tactical air controllers on the ground.

A combined air and space operations center provides the aircraft with constantly updated threat and targeting data, rather than requiring the crew and mission to depend solely on information that was available only at take-off.

Air Force and Boeing technicians install the CONECT kits aboard each B-52 as it comes in every four years for periodic depot maintenance (PDM) at Tinker Air Force Base in Oklahoma City, Okla. Because CONECT requires making such extensive modifications to the aircraft, the upgrades only can be performed during PDM visits at Tinker Air Force Base.

Equipping a B-52H with CONECT requires nearly 7,000 man-hours to complete, or approximately nine months per aircraft. The Oklahoma City Air Logistics Complex at Tinker has the capacity to perform as many as 17 of these refits per year. Upgrades to the B-52H aircraft are scheduled to be complete by 2020.

On this sole-source contract, Boeing will do the work in Oklahoma City, Okla., and should be finished by May 2017.

**FOR MORE INFORMATION** visit **Boeing Defense, Space & Security** online at *www.boeing.com/defense*, or the **Air Force Lifecycle Management Center** at *www.wpafb.af.mil/aflcmc*.

# Situational awareness

## relies on data communications and networking

*Throughout the history of human conflict — from the outcome of minor battles to the fate of major empires — the results largely have come from one simple concept: situational awareness.*

BY **J.R. Wilson**

**U.S. 173rd Airborne Brigade Combat Team soldiers review a tactical operations center map during an exercise at the Joint Multinational Readiness Center in Hohenfels, Germany.**

In the 21st century, military situational awareness relies on rugged, reliable, hack-resistant voice and data communications; advanced, multifunction sensors with data fusion and secure, comprehensive networking data links throughout the now-digitized battlespace, from National Command down to the individual warfighter.

Situational awareness, generally seen as a localized defensive measure, far pre-dates the digital age and also has been used to great effect as a mass impact offensive weapon.

One of the most successful users of offensive situational awareness were the Mongols, who employed it in building the largest land

empire of all time with an astonishingly small number of warriors on horseback. Combining a fierce reputation for victory through slaughter, psychological warfare and mass deception, the Mongols created in their enemies a carefully crafted — and often false — "situational awareness" with only one option: Submit to the Great Khan or face extinction.

Another example is the World War II U.S. atomic bombings of Hiroshima and Nagasaki, Japan. Offensive situational awareness, however, also can backfire, revealing weak defensive situational awareness, as was the case with al-Qaida's 9/11 attacks on the United States and the subsequent devastating U.S. military response.


The Curtiss-Wright DuraNET 20-11 low-SWaP networking switch delivers managed Gigabit Ethernet connectivity in a miniaturized form factor of only 30 cubic inches and 0.50 pounds.

An ongoing technology revolution has greatly altered the scope and nature of both offensive and defensive situational awareness during nearly 15 years of hybrid warfare in Southwest Asia, where the enemy — while never being remotely close to the U.S.-led coalition in technology — ranged at various times from nation-states and transnational terrorists to warlord, tribal and religious insurgencies to something not seen in more than one thousand years — a caliphate, as ISIS often calls itself.

**Not your father's situational awareness**

The 21st Century has seen situational awareness evolve from a simple concept into a complex and comprehensive network of electronic components acquiring, analyzing, and moving more raw data in a single

day than all the armies of World War II combined.

"Sun Tzu said to know the terrain, the ground you will be moving your army across, as a key to victory. What we have in the world today is an incredibly complex terrain, not just ground but what is out there electronically and situational awareness at all levels — the 21st Century version of 'knowing the terrain'," says Tom Roberts, product marketing specialist for COTS board products at the Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va.

The tactical operations center (TOC) like the one shown above is where distributed sensing, signal processing, battlefield networking, and high-definition displays combine into situational awareness.

"Today's forces don't know what terrain they may face next week or next month or to what part of the world they may go. What we in the defense industry must do is provide equipment rugged enough to go anywhere with interfaces to whatever kinds of sensors are needed to accurately describe that terrain, then the networking infrastructure — also rugged — to get it to whoever needs that view of the terrain, of the situation," Roberts says.

So far, the U.S. has maintained what has seemed an insurmountable lead in situational awareness technologies. Still, the extensive use of COTS components and the likelihood of future confrontations with far more sophisticated adversaries — including near-peer militaries — will make retaining that edge increasingly difficult.

"All communications will be contested in a peer- or near-peer engagement and ensuring we have the technology edge will be even more important in the future," warns Paul Quintana, director of defense & security vertical marketing at Microsemi Corp. in Aliso Viejo, Calif. "Wireless networking, including soldier-based, will be very important, maintaining connectivity in any communications environment will be extremely important, and the side with the greatest resilience and ability to recover will have the edge. The ability to be adaptable to other people's networks will be important, beginning with NATO, but also all systems available, regardless of ownership.

"It's also important to know what the regional actors — South Korea, Malaysia, etc. — are doing, which includes a lot of focus on HF [high-frequency radio communications]," Quintana continues. "The U.S. hasn't done a lot of work in HF for a while, concentrating instead on satellite-linked communications. But to ensure reliable and resilient comms, we have to start looking across all parts of the spectrum. I think everybody agrees that is critical for all future warfare. DOD isn't all that different from the trends we see in the commercial world — big data solutions that require moving a lot of data back and forth and the only way to do that is resiliency."

Companies such as Cisco, Microsemi, Curtiss-Wright, Extreme Engineering Solutions (X-ES), MilSource, LGS Innovations, and TE Connectivity Aerospace, Defense and Marine provide the systems and components required to maintain and evolve America's lead in combat data communications, networking data links and situational awareness into the next generation and beyond.

**Enabling technologies**

Core technologies and processes to advance those capabilities — especially battlespace situational awareness — include applied research and development on cyber security; secure wireless communications; photonics; cellular, using standard commercial techniques combined with tactical solutions; new and upgraded network infrastructure; a quantum leap in controlling SWaP-C (size, weight, power, and cost); on-platform data fusion and analysis; major improvements in the use of spectrum and mission-attached services to help warfighters and battlefield commanders make sense of the vast quantities of data collected in the modern battlespace.

The U.S. Department of Defense (DOD) "needs things that are very secure, robust, physically survivable, and able to deal with cyber threats," says Kevin L. Kelly, CEO of network specialist LGS Innovations in Herndon, Va. "Most commercial equipment is not built to go

into UAVs [unmanned aerial vehicles] or other battlefield platforms, which must be able to go anywhere. Another requirement is portability. The commercial world generally doesn't worry about weight or power requirements, but in the military environment, you don't have the luxury of always having lots of power and typically need to be manpackable, which requires re-engineering.

Ryan Straughan, hardware product engineer on the LGS Innovations research and development team, uses a thermal imagining camera to troubleshoot a custom-designed board for situational awareness processing.

"When you're dealing with commercial communications, you usually have available several choices for data backhaul, but DOD must be able to deploy anywhere and can't assume there will be good communications capabilities, so many of our solutions must be able to work without any physical medium, such as transmitting through the air using laser technology in a very secure and high speed way that just doesn't manifest in the commercial world at all," Kelly says. That includes a push away from proprietary, serial, or USB-based communications to standardized IP-based systems and from vehicle- or program-specific products to COTS-based systems and components that can be integrated into platforms at a lower cost, faster rate and with greater reliability and interoperability.

"You now have comms on every warfighter in the field; when they are in urban situations, line-of-sight is very difficult and there is no signal connectivity. We've seen UAVs deployed as large antennas, providing the warfighter direct connection to the sky, so we do see routing at the UAV level,

Remote, rapidly deployable tactical operations centers are used in the battle theater to obtain situational awareness and help commanders make tactical decisions. (Photo Courtesy of Fort Hood, U.S. Army III Corps.)

with data packets flowing from the warfighter to the UAV, then down to others on the ground, such as a TOC [tactical operations center]," says Ronen Isaac, general manager of rugged networking specialist MilSource in El Segundo, Calif.

"There are two modes of communications for individual soldiers, such as USB, and we have rugged USB hubs that do that connectivity," Isaac says. "We can take HUDs, GPS devices, tactical radios, group them all together and allow for the radio to route that off the soldier to the UAV then down to the ground. The same idea theoretically could be put into a vetronics application, with mobile base stations where communications from the individual warfighter go to a local Humvee that connects to a UAV."

**Ubiquitous IP**

"The underlying technology that is the common thread through everything is Ethernet and its ubiquitous nature has brought it to the front line for being deployed for situational awareness because it is robust, well known, and commonly available. So from LANs to WANs, Ethernet is being leveraged to handle the transmission of data, including video, over a network that can be shared quickly, affordably, and with technologies that are understood," says Mike Southworth, product marketing manager for small-form-factor systems at Curtiss-Wright Defense Solutions in Ashburn, Va.

"In many of our mission processor systems, we often are finding requirements for more and more Ethernet interfaces to be integrated within the computer itself, some card switches, some ports connecting to a streaming device with a video encoder, which we now often integrate with the processor as an I/O module," Southworth says. "In a vehicle or aircraft that has sensors, especially cameras, either analog or digital, video can be quickly shared to local displays inside the vehicle or transmitted outside and shared with whomever needs to analyze it."

The key to future combat networking is reliably and transparently moving multiple large data packets around the battlespace and, eventually, to a final destination in real time. Due to the level of complexity involved, however, that is not necessarily something the individual warfighter will carry. At the same time, placing limited capability on the warfighter, linked to more advanced vehicle-based systems, will improve situational awareness and platform and human health.

"Vehicles have many different sensors on them, from engine temperature and oil levels to tactical devices, such as cameras, GPS, radar-jamming. Those are all being brought into IP, whether natively IP or using an adapter. They can all be aggregated into a Layer 2 switch, at which point we can take all that data and send it off the vehicle in

U.S. Northern Command used a tactical operations center to consolidate intelligence information in support border-security operations in Northern Arizona.

a single link. So you can remotely monitor everything from vehicle status to sensors," explains MilSource's Isaac.

"Some of those sensors are at the bleeding edge and we have submitted our devices into, for example, special ops requirements to make the next generation of warfighter safer, stronger, etc. There is a lot of talk about body sensors that can keep an eye on temperature, blood pressure, etc., then analyze and route to a higher command," Isaac continues. "The router for that might be built into an individual or squad radio or it might be in a UAV flying overhead — it just depends on how the integrator wants to design the network."

Situational awareness systems designers have starting to move from Ethernet switches to Layer 3 router ports, with the next generation seeing a requirement for 10-gigabit ports, says Bret Farnum, vice president of sales at Extreme Engineering Solutions (X-ES) in Middleton, Wis.

"One can assume 10-gigabit will become the de-facto standard, but Gigabit Ethernet only recently became the standard, so it could take up to 10 years for 10-gigabit to reach that point," Farnum adds. "The other thing playing into the router space is most military customers require FIPS 140-2 certification and/or Common Criteria certification. Those certifications are key. I see that as an ongoing requirement for any router or switch that will be deployed by the military in the future.

"Most available routers in the field today are 10/100 and now we're talking about going to 10/1000, which is a 10-fold increase in speed, on the most simplistic basis," Farnum continues. "And the number of available ports is increasing, which means more soldiers, vehicles, and connection points can be supported. The bottom line is greater knowledge. If you are in an airplane, are you landing in a friend or foe area and where is the foe? If you are a soldier on the ground, what hazards are around you? And every major mil/aero company today has information assurance groups whose job is to prevent any hacking of these systems."

For DOD, in a period of tight budgets, industry officials say future decisions will have to balance a wide range of combat requirements against what is available off-the-shelf, taking advantage of commercial demands for more speed and capability, reduced power, smaller size, less weight, more ruggedization, higher reliability, economies-of-scale, etc. The expectation is the government will focus on what is truly COTS, enabling comparatively low-cost systems to be deployed in only a few weeks rather than spending millions of dollars and months or even years to field something built from scratch to specific military standards.

"The ability to link multiple data sources and associated intelligence that comes from those sources — not just clandestine, but the wireless spectrum, troop movements, supply chain, etc. — is ever-increasing with the move to cloud computing as a centralized repository and even processing architecture, which allows us to 'home run' all this data to a central place," explains Kelly of LGS Innovations. "That gives the warrior and the mission planners more real-time access to data to make intelligent, efficient decisions."

**Convergence**

"The challenge, of course, is information overload, where you base decisions on a subset of all that data and you may not have chosen the correct subsets. Creating the proper hierarchical structure so you don't overload inputs is necessary to avoid what is called 'analysis paralysis'," Kelly continues.

"The secondary challenge is the network itself," Kelly says. "There's only so much spectrum, so many connection points to the GIG [Global Information Grid], which means prioritizing traffic and slimming it down to the absolute essential for data transmission. Today's network is overloaded with data and the ability to transport it is the limiting factor; a lot of innovative work is being done to make full use of the spectrum that has been allocated."

While many of today's combat products are capable of megabits of

performance, sufficient for voice and low data rates, achieving gigabits for throughput across the network and multiple features per processor and device will be a significant challenge.

"It's not new or unique to routers, but the trend is convergence," says Curtiss-Wright's Southworth. "In the past, different types of data — voice, datalink or sensor data — might have had different systems, each with its own encryption and waveform and box. The trend is to get all that onto one network, which is what already exists in the commercial world using IP. In the military vehicle space, the VICTORY standards enable getting EW, ISR, communications and other data onto the same network so they all can be managed essentially by COTS switches and routers using Ethernet IP.

"That's really pushing the requirements so the router, which is putting all those services on one big, multi-service datalink, requires a lot of Intel in that device to manage all those different kinds of traffic, which may have different security classifications, throughput rates, real-time requirements," Southworth says. "That's really what we've already seen in enterprise networks; now putting voice and video data all on the same IP backbone is starting to happen on tactical networks."

Industry is seeing an evolution of universal requirements, enabling the adoption and incorporation of commercial standards into military communications and situational awareness solutions.

In the closing decades of the last century, communications architectures and protocols were custom designed to meet military applications for which there were no corollary markets in the commercial world. The dawn of the Internet led to vastly expanded and growing civilian content and the related need for more broadband.

"That became possible through the development of more commercial standards, such as a global set of standards for 4G networking and IPv6 [Internet Protocol version 6] and data encryption. There was a mil-standards for everything back then and the one unifying requirement now is making use of universal tools, of standards, even


The Combat Operations Center, or COC, assists military commanders consolidate information from many different sources to create a situational-awareness report.

componentry, because it is less expensive and much faster to deploy," Kelly explains.

"From a customization standpoint for these commercial systems — 4G networking as a ubiquitous standard, for example — what is challenging is most 4G systems were built for very large deployments," Kelly says. "And while we think of the military as a big user, they are not [compared to civilian cell phones], so a 4G networking structure for a Navy ship reaches only a few thousand users rather than several million subscribers."

Downsizing very-large-capacity systems to meet the needs of a few hundred or even a few dozen users, while simultaneously controlling SWaP-C to make them light, affordable and energy efficient, is DOD's leading customization requirement. That is further complicated by the need to make those systems and components appear to operate the same way as commercial systems.

Accompanying the revolution in data comms, networking and situational awareness in recent years have been a growing demand for and use

Situational awareness aboard U.S. Navy warships comes into focus in the combat information center, better-known as the CIC.

of Special Operations forces (SOF). And as SOF has seen increased and diverse global missions and deployments, it has developed its own specialized requirements for situational awareness and related technologies. But despite being less of a target for budget cuts and force reductions, the U.S. Special Operations Command (SOCOM), its four service components, and SOF in militaries throughout the world also have limited research and acquisition money.

"Conventional forces usually can rely on some fixed communications point, a hub-and-spoke type architecture, transporting data back from the field to a home base where you can do data storage and analysis and presentation. Even when they deploy in an expeditionary fashion, there is a hierarchical infrastructure for conventional forces, from fixed bases to smaller bases that move every few weeks to expeditionary forces that may move daily," Kelly says.

"SOF just doesn't work that way. They may deploy from fixed assets, such as a surface ship, then land ashore and set up a temporary encampment before joining a larger group in a more permanent structure," Kelly adds. "How do you plan for that? We rely on satellites, which give the best coverage, but that also gives up stealthiness and using high power RF systems can reveal your position. So figuring out how to do that without a fixed network architecture is a very different challenge that must be incorporated into the mission plan, which changes with each mission. There are solutions, but not those used for conventional forces."

"The goal, when we start to get networks of networks and dynamically bring in UAV imaging systems, whether video or an E/O sensor, is to make everything available back to the TOC — but also to the boots on the ground — in a real-time, dynamic way," Roberts says. "That requires a powerful way to route things through the network, to flexibly bring all different kinds of imagery down to the field commander or even to the Bradley or Abrams. You can't overwhelm them with everything that comes from those

systems, so there has to be some system intelligence to get the right information to the right place.

"The ability to effectively upgrade over time also is important," Roberts continues. "As new camera technologies come out, our customers want to be able to bring those to bear to get greater resolution, faster input into situational awareness, but they have to be able to easily tie it in without having to rip out a whole subsystem just for the camera. That's another case where the adoption of industry standards such as PCI Express goes a long way toward moving forward for technology refresh and enhancements."

Increasing network centricity to the warfighter involves a lot of technology advances, with cost central to the equation.

"COTS vendors can bring the state-of-the-art — and you can't get more state of the art than Cisco. Curtiss-Wright, for example, is a Solutions Technology Integrator partner with Cisco. So it's not just taking the commercial versions, but ruggedizing them from the ground up to support the military requirement," Southworth says. "Networking evolves at a pace and we're able to deliver our solutions at the pace of commercial evolution without any lagging. That is part of America's competitive advantage over our adversaries — we reduce the time to deployment of the most advanced technologies."

While Cisco's technology — hardware and software — is central to this move toward universal standards, Consulting System Engineer Darrel Beach sees a similar future for all those developing components for the next generation network-centric battlespace.

"If you look at the Internet of Things or Everything, the commercial marketplace is developing into a number of vertical markets — oil and gas, connected cities — interconnecting a vast array of sensors and vehicles, etc. Cisco has developed products relatively specific to those markets, but if you look at those carefully, they are very similar to what DOD needs," Beach says.

"We will be able to adopt the technologies being developed for those commercial markets back to DOD, which will not need to develop a specialized processor but can adopt a commercial processor," Beach adds. "I think that will be how we get these new technologies into the military in an era of shrinking budgets."

# The design advantages of small form factors


The N1U1A small-form-factor embedded computer from North Atlantic Industries is about the size of a TV remote control, and has applications in unmanned vehicles and vehicle-management systems.

*Small-form-factor embedded computing offers small size, weight, and power consumption (SWaP), as well as the ability to distribute high-performance computing and avoid single-points of failure and thermal hot spots.*

BY **John Keller**

When we think of small-form-factor (SFF) embedded computing, the first thing to mind usually is small size. SFF design approaches are at the forefront of today's embedded computing architectures that drastically can reduce system size, weight, and power consumption (SWaP). Still, SFF embedded computing involves much more than small size.

The collection of design approaches that represent what we know as SFF embedded computing is ushering in fundamentally new ways to create digital signal processing, display processors, data concentrators, digital maps, data reducers, and a wide variety of other computer systems.

Not only does SFF represent much smaller embedded computing architectures than ever before, but it also enables systems designers to distribute networked processing nodes where they fit best, place signal processing closely to sensors to reduce data flow bottlenecks, and create processing networks with built-in redundancy that can eliminate single-point-of failure issues of larger centralized embedded computing.

Small form factors also offer the next generation of readily upgradable embedded computing systems because they give designers the choice of upgrading installed computer boxes, or simply adding more boxes on a network; it no longer has to involve tearing into centralized embedded computing enclosures to swap out different boards.

"Right now is an interesting time for small-form-factor computing in that the proliferation of the system on chip in a variety of different architectures and processor types allows us to put a lot of processing power in a very small envelope," says Bill Ripley, director of business development for Creative Electronic Systems (CES) in Geneva, Switzerland.

### The SFF lineup

Small-form-factor embedded computing today covers a broad waterfront. It includes 3U VPX and CompactPCI, which represent traditional backplane databus and single-board computer architectures. The SFF lineup also encompasses designs that blend standard and custom components, COM Express, the PC/104 family, and emerging standards like VITA 74 VNX.

Essentially small form factors represent a transition from computer boards about the size of tablet computers to architectures with boards the sizes of credit cards or even match books that go into computer enclosures no larger than a deck of cards. The applications of SFF embedded computing are limited only by the imagination, and include powerful sensor systems on unmanned vehicles, wearable computers, embedded navigation and guidance, built-in test, and applications that haven't even been thought of yet.

### 3U embedded systems

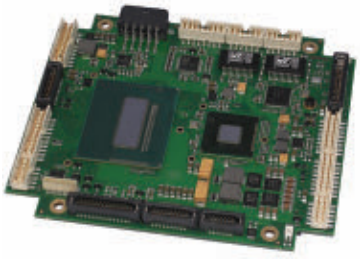
At the top of the performance scale in SFF embedded computing are the latest generations of 3U VPX and 3U CompactPCI. These are the heavy iron of the SFF world and are for demanding applications like radar


signal processing, electronic warfare (EW), software-defined radio, and signals intelligence (SIGINT).

3U VPX and CompactPCI — physically the largest of the SFF versions — are offering the opportunity for systems designers to reduce the sizes f what had been 6U centralized embedded systems, as well as to add power and functionality. "We are seeing a lot of quotes for retrofits to replace legacy hardware that was in the 6U VME form factor," says Jason Shields, product marketing manager of 3U VPX and switch boxes at Curtiss-Wright Defense Solutions in Ashburn, Va.

3U VPX also is enabling designers to consolidate into one embedded computing box the functionality that had been in several 6U VME systems, Shields says. In addition, 3U VPX offers level-2 maintenance and the ability to upgrade embedded computing by replacing circuit cards in enclosures, rather than computer boxes in integrated systems, he says.

3U VPX also offers the power and cooling capability for high-performance processors like the Intel Xeon D and Core i7, while smaller architectures might not be able to handle these high demands. "We just released our Xeon D version in 3U VPX. That is getting a lot more core processing, more virtualization, and more memory," says R.J. McLaren, product manager at Kontron in Poway, Calif.



The ADLQM87PC small-form-factor embedded computer from ADL Embedded Solutions is based on the PCI Express/104 form factor and supports the Intel Core family of microprocessors.

3U VPX also offers advantages in I/O-intensive systems that smaller technologies might not be able to offer. "We can put in more interfaces to sensors, from MIL-STD-1553 or analog sensors for radar and video," McLaren says. "We can put more of that in as XMC cards or legacy PMC cards, and leverage the higher processing boards to aggregate data that can go out over Ethernet or 10-Gigabit Ethernet."

For high-performance embedded computing that requires SFF, there's nothing else like 3U VPX, says Bret Farnum, vice president of sales and marketing at Extreme Engineering Solutions Inc. (X-ES) in Middleton, Wis. "3U VPX is a tremendous solution for our military customers who want to cram more electronics into smaller spaces. It's a SWaP champion," Farnum says.



## PC/104

Outside of traditional bus-and-board architectures like 3U VPX and CompactPCI, embedded computing designers look to stackable architectures like PC/104 and COM Express that stack boards like a sandwich, rather than plug them into backplanes. Perhaps the best-known stackable SFF embedded computing approach is PC/104, which includes a high-performance design based on PCI Express called PCI Express/104 (PCIe/104).

"PC/104 started out as a rugged small stackable form factor," explains J.C. Ramirez, director of engineering and product management at PC/104 specialist ADL Embedded Solutions in San Diego. "Everything about it is rugged. The stackability part of it allows spacing of 0.6 inches, so in the space of three inches you have five slots, and the footprint is in the neighborhood of 4 by 4 inches; the rest is cabling. We can come up with some very small form factors."

Among the advantages of PC/104 is systems designers know it works, Ramirez says. "Its roots are 20-plus years old, and the PCI Express stackable connector is well known." High-end embedded computing designers can use the PC/104 approach in systems that require 10-Gigabit Ethernet, he says.

"The advantage of PC/104 has everything to do with SWaP," Ramirez says. The real challenge always comes back to thermal management and where you are mounting it. "We can design the smallest box we can," he says. Another advantage is thermal management, he says. In an aircraft application, for example, "we can do conduction cooling directly to the airframe."

PC/104 and other stackable approaches like COM Express typically cannot accommodate the top-performing microprocessors like the Intel Xeon D, yet represent an attractive alternative for capable processors like the Intel Atom and Corei5, says George Hilliard, sales and marketing manager at WinSystems Inc. in Arlington, Texas, which specializes in PC/104 and COM Express SFF embedded computing.

"We are oriented to industrial-format embedded computing, so with these lower-power processing units we can get into applications without any active cooling that we haven't been able to play in before," Hilliard says. "The ARM processor proliferates into a growing number of applications, and from our perspective, that is what

we are seeing." These small embedded computing formats are helping WinSystems with design wins involving unmanned forklifts for factory floor use, as well as unmanned medicine carts for hospitals, he says.

**COM Express**

Another small form factor growing in popularity is the COM Express — short for computer on module. This architecture typically uses custom or semi-custom motherboards, and stacks standard COM Express boards on top. COM Express boards, about the size of standard credit cards, can make for extremely small designs.

X-ES's Farnum describes the COM Express architecture as a "Dagwood Bumstead sandwich," referring to the massive sandwiches favored by the well-known character from the comic strip *Blondie*. One of the biggest advantages of COM Express is thermal management, Farnum says. "COM Express brings the processor out to the edge of the enclosure; everything else is generally I/O, and the processor typically is the hottest component."

Like PC/104, COM Express architectures can draw heat out through the enclosure directly to a cold plate, which could be the airframe of an aircraft, the body of a land vehicle, or the superstructure of a ship.

"It's a tight fit to keep it as small as possible, and everything has to be packed very efficiently for heat dissipation," Farnum says. "You don't want free space with COM Express; it doesn't do you any good. We can dissipate 60 to 90 watts of power in a small form factor like this."

Computers on module, or COMs, come in a variety of sizes — all of them small enough to be considered

Small-form-factor embedded computing can be packaged in a wide variety of enclosures to meet specific system needs for size, weight, and power consumption.

small form factor. Among these are the COM Express Mini, and the Smart Mobility Architecture, otherwise known as SMARC.

"Using computer-on-module architectures resonates with customers," says Mike Southworth, product marketing manager for small-form-factor systems at Curtiss-Wright Defense Solutions. "You can go from one design from one generation of CPU to another because the connectors and pinouts are similar from one generation to the next. You can look at architectures from the perspective of longevity."



**VNX**

There are several industry-standard small form factors, and among those is the VITA 74 VNX standard of the VITA Open Standards, Open Markets trade association (formerly the VME Industry Trade Association) in Fountain Hills, Ariz. Although slow to catch on broadly across the embedded computing industry, a few companies are pursuing it with enthusiasm, among them is CES.

"VNX is 3U VPX shrunk into a smaller form factor," explains CES's Ripley. "We use the same electrical topology and signaling as 3U VPX, and can take a VPX design and port it to VNX in a short period of time."

Essentially VNX uses a COM Express Mini mezzanine card with VNX carriers that enable designers to place a COM Express Mini single-board computer on a VNX module, Ripley says. One of the best things about VNX is its adherence to established industry standards.

"VNX is something that is in the standard space, and that is the reason we support it so heavily," Ripley says. "We are trying to stay with the standard because the market is fairly small, and time to production is so large that it is hard to get in a real market to get the cost down — unless you take advantage of technology designed originally for another part of the mass market."

VNX is not a substitute for 3U VPX, which is for higher-end systems, Ripley cautions. "We are investing in 3U VPX and consider it to be part of our small-form-factor offerings. Still, VPX can help make a seamless transition from VPX to VNX."

**Mixing standard and custom**

The small-form-factor embedded computing industry remains somewhat fragmented today, which makes it difficult for the industry to coalesce around any one small-form-factor standard. It is for this reason that designers are moving toward architectures that mix custom and standard approaches.

North Atlantic Industries in Bohemia, N.Y., has pioneered an approach called Custom-On-Standard Architecture (COSA). This approach combines industry-standard modules for I/O, measurement and simulation, communications, single-board computers, and power supplies in custom enclosures designed to be as small and thermally efficient as possible, says Lino Massafra,

vice president of sales and marketing at North Atlantic Industries.

One product that North Atlantic based on the COSA design is the N1U1A one-module, one-function box, which measures 6.5 by 1.5 by 1.5 inches, not including the connectors. "It's not a board; it's homegrown to be as small as possible," Massafra says. "It gives a 28-volt MIL-STD-704 power supply input with single-board computer capability and

The Parvus DuraCOR 80-41 from Curtiss-Wright Defense Solutions is a small-form-factor tactical mission computer based on a quad-core, high performance 4th generation Intel Core i7 processor, PCI Express Mini card I/O slots, and stackable PCI Express/104 bus architecture.

dual-Ethernet. It's about the size of a TV remote control. We're passing a lot of stuff in a very small volume."

The N1U1A is a full-custom system that uses industry standards, most of North Atlantic's COSA offerings are based either on standard CompactPCI, VPX, or VME modules.

**Distributed architectures**

The most notable advantage of SFF other than its obvious small size, is the ability to distribute embedded computing capability throughout a system where space is available, which can facilitate designing for specific applications, as well as for

CONTINUED ON PAGE 29 ➔

## DISA selects Inmarsat SATCOM services

Inmarsat Government in Reston, Va., will provide satellite communications (SATCOM) to the U.S. military. The Defense Information Technology Contracting Organization, on behalf of the U.S. Defense Information Systems Agency, is asking Inmarsat Government to provide telecommunications services including SATCOM capacity in C-, Ku-, Ka-, and X-Band for mobile and fixed satellite transceivers on military ships, aircraft, ground vehicles, and fixed sites. The contract is worth up to $450 million, and consists of a one-year base and four one-year options.

## Radiation monitors introduced by Thermo Fisher Scientific

Thermo Fisher Scientific in Oakwood Village, Ohio, is introducing two area radiation monitors for military teams, security personnel, and first responders. The Thermo Scientific RadHalo rapid deployment probe (RDP) and fixed monitor (FM) offer hands-free test and measurement technology to monitor dose rate and identify radiation on location or from miles away via five different reachback options. The RadHalo RDP and the RadHalo FM are designed to deliver high sensitivity and accuracy across a range of low to extremely high radiation dose rate levels. ←

# Microwave Applications phase shifters chosen for passive electronically scanned array radar

BY **John Keller**

**LAKEHURST, N.J.** — U.S. Navy researchers needed ferrite phase shifter modules for advanced radar development work. They found their solution from Microwave Applications Group Inc. in Santa Maria, Calif.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., announced a $10.2 million contract to Microwave Applications for 1,800 ferrite phase shifter RF and microwave modules, which researchers will use to develop a closed-loop passive electronically scanned array radar system.

The ferrite phase shifter modules from Microwave Applications, as well as the closed-loop passive electronically scanned array radar system under development, are for the Naval Air Systems Command's Test Readiness Management Center's Closed Loop Passive Electronically Scanned Array Project Office, Navy officials say.

A passive electronically scanned array, also called a passive phased array, is a phased array radar with one central radio frequency source, which sends energy into several phase-shift modules. These modules then send energy into the individual emitting elements in the front of the antenna. The passive electronically scanned array design approach is different from active electronically scanned array (AESA) devices, which are common aboard advanced military jet fighter aircraft.

RF phase shifters are a key enabling technology for passive electronically scanned array radar systems.

AESA radar systems use a separate radio-frequency source for each phase shifter and emitting element; a passive electronically scanned array radar is simpler to build than an AESA radar.

Phase shifter modules like those from Microwave Applications provide a controllable phase shift of the RF signal in phased array radar applications.

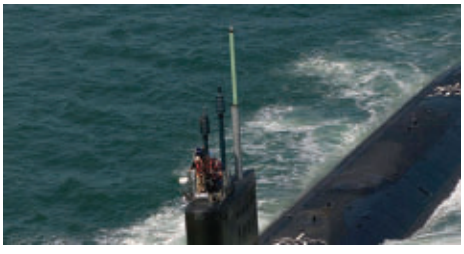
On this contract Microwave Applications will do the work in Santa Maria, Calif., and should be finished by November 2016. ←

**FOR MORE INFORMATION** visit **Microwave Applications Group** online at *www.magsmx.com*, or the **Naval Air Warfare Center Aircraft Division-Lakehurst** at *www.navair.navy.mil/nawcad/lakehurst*.

# Lockheed Martin to upgrade multi-band communications submarine antenna

BY **John Keller**

**SAN DIEGO** — U.S. Navy undersea warfare experts are asking engineers at the Sippican/GSM Submarine Antenna joint venture in Marion, Mass., to make upgrades to wideband antenna that enables submarine communications on a wide variety of radio frequencies.



Lockheed Martin is upgrading an antenna to enable Navy submarines to communicate on a wide variety of radio frequencies.

Officials of the Space and Naval Warfare Systems Command (SPAWAR) in San Diego announced a $30.9 million contract to Sippican/GSM Submarine Antenna to develop an OE-538B antenna upgrade, as well as to provide OE-538 and OE-538A antennas for Navy submarines.

The OE-538 antenna system is a submarine mast-mounted, multifunction antenna that enables submarines to communicate on radio frequencies ranging from very low frequency (VLF) to ultra-high frequency (UHF), as well as provide identification, friend or foe and global positioning system (GPS) capabilities.

The contract provides for existing and upgraded capabilities to the OE-538 antenna system, which is applicable to all submarine classes.

Sippican/GSM Submarine Antenna operates as a subsidiary of Lockheed Martin Sippican Inc.

The OE-538A antenna system is a modified OE-538 antenna system with added capabilities to support Mobile Users Objective Systems Tactical Data Link via Link 16 and iridium capabilities. The OE-538B antenna will be a modified OE-538A antenna with added capabilities for anti-jam and GPS military-coded capabilities.

The OE-538/BRC is a mast-mounted communication and navigation antenna for new submarines, or as a replacement upgrade for antennas on existing submarines.

It supports VLF/LF receive (10 to 170 kHz), MF/HF transceive (2 to 30 MHz), VHF line-of-sight transceive (30 to 174 MHz), VHF/UHF transceive (225 to 400 MHz), VHF/UHF SATCOM transceive (240 to 400 MHz), IFF transpond, and GPS receive.

When used for satellite communications, the antenna is capable of full duplex UHF Demand Assigned Multiple Access (DAMA) communications with UFO and MILSTAR (LDR) satellites.

The contract has options that could bring its value to $68.9 million. Sippican/GSM Submarine Antenna will do the work in Marion, Mass., and should be finished by August 2018.

**FOR MORE INFORMATION** visit **Lockheed Martin Sippican** online at *www.sippican.com*, or **SPAWAR** at *www.spawar.navy.mil*.

## Counter-drone system can detect and commandeer intruding UAVs

An English defense electronics company is touting a perimeter-security counter-drone system to defeat unmanned aerial vehicles (UAVs) that may be on terrorist or spy missions by forcing the UAVs to land before they can do damage. Selex ES Ltd., a Finmeccania company in Basildon, Essex, is unveiling the Falcon Shield electronic warfare system, which enables its operator to detect, locate, identify, and defeat the security threat posed by low, slow, and small drones. Falcon shield relies on an electronic warfare subsystem that enables its operator to take control of intruding remotely piloted drones and land them safely, Selex ES officials say. Its primary applications are to defend sensitive installations like airports, power plants, military bases, and sports stadiums.

## Northrop Grumman tests sonar for undersea imaging

Sonar experts at the Northrop Grumman Undersea Systems segment in Annapolis, Md., demonstrated the company's AQS-24B mine-hunting system and sonar signal processing. The Navy can detect, classify, and localize modern-day mine threats through the AQS-24B's enhanced mine-hunting sonar. During a U.S. Navy field test in the Persian Gulf off of Bahrain, the AQS-24B finished 12 for 12 in missions.

# Sikorsky and Aurora move to next phase of DARPA aircraft automation project

BY **John Keller**

**ARLINGTON, Va.** — Avionics designers at two U.S. military aviation companies are moving forward with a U.S. defense research program to develop and insert new aircraft automation into existing planes and helicopters to enable operation with reduced onboard crew.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., are looking to Aurora Flight Sciences Corp. in Manassas, Va., and Sikorsky Aircraft Corp. in Stratford, Conn., to begin the second phase of the Aircrew Labor In-Cockpit Automation System (ALIAS) program.

DARPA awarded contract modifications to the two companies in late August. Aurora Flight Sciences is working under a $15.4 million contract modification, and Sikorsky is working under a $9.8 million contract modification.

Sikorsky won an initial $8 million phase-one DARPA ALIAS contract last March. Lockheed Martin Corp. announced plans in July to acquire Sikorsky for $9 billion. Aurora Flight Sciences won an initial $6 million phase-one DARPA ALIAS contract in December 2014.

For the second phase of the ALIAS program, Sikorsky engineers will conduct flight demonstrations of the Autonomous Crew Enhancement System (ACES) cargo-resupply mission on the UH-60L helicopter, as well as demonstrate the ACES system on a fixed-wing aircraft.

Two defense contractors are developing flight-automation technologies to enable helicopters to fly with reduced crews, or no crews at all.

For ALIAS phase-one, Aurora worked with the National Robotics Engineering Center in Pittsburgh and the Duke Engineering Research Institute in Durham, N.C., to develop an automated assistant able to operate an aircraft from takeoff to landing. The assistant automatically executes flight and mission activities, checklists, and procedures, while detecting and responding to contingencies and informing the human pilot.

In the second phase of ALIAS, Aurora engineers will focus on refining the overall system, reducing risks, demonstrating rapid installation time, and conducting additional demonstrations. Aurora also will refine subsystems and demonstrate the overall system on a Sikorsky UH-60 military helicopter.

The ALIAS phase-two objectives are to enhance and mature the phase-one system to support flight tests, enhance the usability and robustness of the human interface, and demonstrate system portability on the ground.

# Researchers consider overwhelming enemy with swarms of recon and EW drones

BY **John Keller**

**ARLINGTON, Va.** — U.S. military researchers want to develop the ability to use C-130 aircraft to launch drone swarms of networked and cooperating unmanned aircraft for electronic attack and reconnaissance missions from standoff ranges, and then use other C-130 utility aircraft to recover as many of these drones as possible.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., released a broad agency announcement (DARPA-BAA-15-59) for the Gremlins program, which relies on relatively inexpensive unmanned aerial vehicles (UAVs) in volley quantities to saturate enemy defenses.

The Gremlins approach would launch swarms of UAVs with a variety of surveillance and electronic warfare (EW) payloads from aircraft beyond enemy air defenses, and then recover surviving UAVs when they have completed their missions. The idea is to design UAVs that are inexpensive enough that occasional losses would not compromise the overall mission. The drones would communicate and cooperate with one another, so surviving drones could assume the roles of those unmanned aircraft lost during the mission.

DARPA researchers want to develop affordable UAVs that could be reused as many as 20 times for dangerous missions in contested air space like pre-attack reconnaissance and surveillance, as well as electronic attack to destroy or disable enemy communications, missile defenses, and battlefield networks. These drones would be fitted with diverse payloads in volley quantities, and would have the attributes of small vehicle size, reusability, and limited vehicle design life.

Key enabling technologies include: aerial launch and aerial recovery techniques, equipment, and aircraft integration concepts; low-cost, attritable airframe designs; design for limited life; automated wave off strategy; precision digital flight control and navigation; aerial refueling techniques; efficient small turbine engines; automated fuel tank inerting and engine shutoff; small distributed payload integration; and precision station keeping.

DARPA is pursuing the Gremlins program in three phases: system and technology design; preliminary design; and prototype flight demonstration. This solicitation concerns only the first phase, will involve several different contractors, and spends about $15.8 million.

Ultimately, DARPA wants a Gremlins flight demonstration by early 2020 to show the feasibility and potential of air-launched, recoverable unmanned aircraft. Only phase-one contractors will be eligible to participate in the program's second and third phases.

The program seeks to make a fundamental shift in the notion of aerial attack. Instead of using conventional, monolithic systems to conduct missions in denied environments, DARPA wants to use several platforms with coordinated and distributed warfighting functions to saturate adversary defenses.

DARPA envisions using C-130 aircraft to launch swarms of reconnaissance and electronic warfare drones to overwhelm enemy defenses.

The idea is to use conventional aircraft hosts to transport and launch a volley of gremlins from stand-off ranges. Researchers want to scale-up the number of UAVs such that a loss of any individual drone is reduced as a result of the collaboration between vehicles.

Not only does the program have the potential to enable enhanced mission effectiveness in contested environments, but it also explores an approach to reduce the cost of operations dramatically.

DARPA officials envision the primary focus of the Gremlins program to be on the technical challenges of aerial launch and recovery of volley quantities of air drones. Ideally, the host C-130-based aircraft equipment would be roll-on, interfacing with standard air vehicle interfaces to reduce integration and airworthiness effort, turnaround time, and costs.

Companies interested in participating in the DARPA Gremlins program should submit full proposals no later than 17 Nov. 2015. ←

**MORE INFORMATION IS** online at *http://1.usa.gov/1FDK8LF.*

## Navy orders night-vision helmet-mounted displays

Rockwell Collins-ESA Vision Systems in Fort Worth, Texas, will provide the U.S. military with head-up, helmet-mounted displays for fighter-bomber aircraft under a $20.9 million order. The U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking Rockwell Collins-ESA Vision Systems, a partnership of Rockwell Collins and Elbit Systems, to provide 120 Joint Helmet Mounted Cueing System Night Vision Cueing and Display (NVCD) systems, 30 helmet mounted display test sets, and 120 interim spares. The NVCD is part of the Joint Helmet Mounted Cueing System (JHMCS), which projects symbology and imagery onto the helmet-mounted visor to help with the workload of operating the aircraft; detecting, tracking, and engaging targets; and dealing with emergency situations. It also allows near daytime tactics at night, displays data over the eye, and records the pilot's viewpoint.

## Rugged display introduced by Curtiss-Wright

Curtiss-Wright Defense Solutions in Ashburn, Va., is introducing the 10.4-inch PVDU2600 LCD rugged display for fixed-wing aircraft, helicopters, and tactical ground vehicles. The touchscreen display combines high brightness and rugged construction with options for the Intel Atom E3800, Core i3-4010U, Core i5-4300U, or Core i7-4650U processors. It has NVIS-compatible, dual-LED backlighting to ensure viewability in all light conditions.

# DARPA launches WIRED program for affordable wafer-scale IR sensors

BY **John Keller**

**ARLINGTON, Va.** — U.S. military researchers are asking industry to develop infrared sensors and cameras for low-cost, large-format, and high-performance imaging in the short-wave infrared (SWIR), medium-wave infrared (MWIR), and long-wave infrared (LWIR) spectral bands.

These infrared detectors must be able to be fabricated directly on silicon-based readout integrated circuit (ROIC) substrates at the wafer scale.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a broad-agency announcement (DARPA-BAA-15-57) for the Wafer Scale Infrared Detectors (WIRED) program.

DARPA researchers would like the ability to manufacture high-quality miniature SWIR, MWIR, and LWIR detectors as affordably as the industry makes high-quality visible-light digital cameras for cell phones and other small handheld devices.

Infrared focal plane arrays that respond in the SWIR and MWIR spectral bands today are manufactured using complex and time-consuming processes that typically involve several manual processing steps, including single-die processes, DARPA researchers explain. The cost of individual cameras is prohibitive for many applications.

Cooling MWIR and LWIR detectors with reasonable power con-

Military researchers are trying to make the manufacture of infrared sensors as affordable as cell phone cameras.

# Esterline to deliver displays for British Army Scout armored combat vehicle

BY **John Keller**

**BELLEVUE, Wash. —** Vetronics designers at General Dynamics UK Ltd. in Blackwood, England, needed rugged displays and video-processing units for the Scout Specialist Vehicle (SV) that General Dynamics is designing for the British Army. They found their solution from Esterline Corp. in Bellevue, Wash.

Esterline officials announced that General Dynamics UK are choosing the Esterline Codis turret crew-station displays, triple-head driver's displays, and specialized video-processing hardware for a total contract value of $21 million over seven years.

Scout SV will be an agile, tracked, medium-weight armored fighting vehicle with an open-systems architecture of sensors networked on Gigabit Ethernet open architecture for intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) applications.

The scout's onboard networked sensors and computers will enable the vehicle to capture, analyze, manipulate, store, and share more than 6 terabytes of intelligence data, including still images and video. Scout SV crews will provide commanders with decision-making support now available only from manned and unmanned ISTAR aircraft.

Esterline will provide the Codis TX-335S turret crew-station displays to present Scout gunners and commanders with logistics, mission-system and gun-control information; the Codis TX-321S triple-head driver's displays to render a near-seamless 120-degree image of the route with selectable front or rear view in day or night vision; and Codis VPU-101 video-processing units to receive and interpret data from several vehicle-mounted sensors, then process, reformat, and distribute it to displays.

Esterline Corp. is providing the rugged vetronics displays for the British Army Scout Specialist Vehicle (SV).

Hardware deliveries will begin in 2016. Esterline will manufacture the hardware in Kortrijk, Belgium. General Dynamics UK won a contract in 2010 to design the Scout SV, and won another contract in September 2014 to build the 589 Scout SV variants for the British Army.

**FOR MORE INFORMATION** visit **Esterline** online at *www.esterline.com*.

**DARPA** CONTINUED FROM PAGE 26

sumption, moreover, typically requires a cryogenic cooler, which adds size, weight, and power consumption, and cost (SWaP-C). SWIR generally doesn't require cryogenic coolers, but focal plane array costs are still high because of complex processing.

SWIR imagers are not widely available with formats greater than 2 megapixels because the size of the die as well as the resulting optics become prohibitively large and expensive.

Fast optics frequently are used for SWIR imaging, and scaling to smaller pixel pitch could enable larger array formats and higher resolution with the same optics. Alternatively, system SWaP could be reduced if the same imager format was achieved with smaller pixels.

The WIRED program focuses on three technical areas: SWIR, MWIR, and LWIR detectors.

SWIR detector research zeroes-in on appropriate materials and wafer-scale processing techniques to produce focal plane arrays with 3-micron pixel pitch without the need for cryogenic cooling or hybrid bump bonding.

MWIR detector research concerns materials and wafer-scale processing techniques for 10-micron focal plane arrays without cryogenic cooling or hybrid bump bonding. LWIR work, meanwhile, focuses on 12-micron focal plane arrays without cryogenic cooling or hybrid bump bonding.

The ultimate goal is to develop and demonstrate prototype SWIR, MWIR, and LWIR cameras that can be field tested under controlled conditions. The DARPA WIRED program should be worth as much as $40 million, and several contract awards are expected.

**MORE INFORMATION IS** online at *https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-BAA-15-57/listing.html*.

# PRODUCT applications

MISSION COMPUTERS

## Curtiss-Wright to provide mission embedded computing for Turkish unmanned aircraft

Signal processor experts at Sierra Nevada Corp. in Sparks, Nev., needed small-form-factor embedded computing for a Turkish unmanned aerial vehicle. They found their solution from the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va.


Sierra Nevada awarded a contract to Curtiss-Wright to supply the Parvus DuraCOR 820 small-form-factor mission computer for use in the Turkish Aerospace Industries (TAI) ANKA medium-altitude long endurance unmanned aerial vehicle (UAV).

The Curtiss-Wright Parvus DuraCOR 820 mission computer provides processing capabilities for the ANKA UAV's automatic take-off and landing system. The ANKA provides the Turkish Armed Forces with tactical surveillance, reconnaissance, and combat missions.

The Parvus DuraCOR 820 is a rugged tactical mission processor subsystem designed for military aircraft, ground vehicles, and fixed-site applications that require small size, weight, and power consumption (SWaP).

The DuraCOR 820 complies with MIL-STD-810G environmental conditions for high altitude, extreme temperature, water, shock, vibration, and humidity). The mission computer also meets MIL-STD-461E EMI/EMC levels, and 28-volt DC avionics power supply standards per MIL-STD-704F.

Curtiss-Wright is doing the work on this contract in Salt Lake City.

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

RADIO COMMUNICATIONS

## General Dynamics to provide radios for surface warships and submarines

U.S. Navy shipboard communications experts are placing a $29 million order with General Dynamics Corp. to provide 56 AN/USC-61 (C) digital modular shipboard radios for Navy surface warships and submarines.

Officials of the Space and Naval Warfare Systems Command (SPAWAR) in San Diego, announced a contract modification to the General Dynamics Mission Systems segment in Scottsdale, Ariz., for the continued production of AN/USC-61(C) digital modular radios (DMRs), initial sparing components, and related supplies and services.

The General Dynamics AN/USC-61(C) radio enables surface ships and submarines to communicate over high frequency (HF), ultra-high frequency (UHF) line of sight, UHF satellite communications (SATCOM), and very high frequency (VHF) frequencies.

This order exercises option five on a contract awarded to General Dynamics in 2010. This contract includes options that could bring the total value of the contract to $300 million.

The AN/USC-61(C) is a maritime software-defined radio (SDR) that has become standard for the U.S. Military. The compact, multi-channel DMR provides several different

waveforms and multi-level information security for voice and data communications.

Software-defined radio waveforms are computer programs that enable SDR-enable radios to operate on different frequency bands with different encryption and cyber security functions. The AN/USC-61(C) operates on Navy surface ships, submarines, and other military platforms using frequencies from 2 MHz to 2 GHz.

General Dynamics has certified the DMR to pass secure voice and data at multiple independent levels of security (MILS) over HF, VHF, UHF, and SATCOM channels, and to withstand the effects of electromagnetic interference and other harsh operating conditions.

**FOR MORE INFORMATION** visit **General Dynamics Mission Systems** online at *www.gdc4s.com*, or **SPAWAR** at *www.spawar.navy.mil*.

**AVIONICS COMPUTERS**

## Northrop Grumman to provide flight computers for Marine Corps helicopters

Avionics computer experts at the Northrop Grumman Corp. are delivering the company's next-generation mission flight computers for lot 12 of the Marine Corps' H-1 helicopter upgrade program.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Northrop Grumman Electronic Systems segment in Woodland Hills, Calif., to provide the company's FlightPro Gen III mission computers for the Marine Corps UH-1Y utility helicopter and AH-1Z attack helicopter-the aircraft involved in the H-1 helicopter upgrade program.

The FlightPro Gen III mission computers incorporates a ruggedized 6U VME PowerPC-based single board computer. FlightPro interfaces include Fast Ethernet, four serial ports, parallel I/O, and built-in-test. FlightPro has a standard, partitioned real-time operating system with ARINC 653 and POSIX support. The lot 12 contract runs from October 2016 through October 2017.

The lightweight FlightPro Gen III mission computer integrates advanced mission, weapons, and video processing capabilities into a conduction-cooled, high-performance airborne computer capable of driving four independent, multifunction displays.

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

FlightPro is capable of Required Navigation Performance/Area Navigation (RNP/RNAV) in all flight regimes, including departure, en route, terminal and non-precision approach using GPS as the sole navigation source. The flight computer software is RTCA DO-178C compliant, has ARINC-653 partitioning for safety and security, and complies with the Modular Open Systems Architecture (MOSA) standard.

**FOR MORE INFORMATION** visit **Northrop Grumman Electronic Systems** online at *www.northropgrumman.com*, or **Naval Air Systems Command** at *www.navair.navy.mil*.

TECHNOLOGY FOCUS

**DESIGN** CONTINUED FROM PAGE 21

technology insertion in the future.

"That enabling technology is taking the large, expensive, centralized computer out of the vehicle and taking away that one central point of failure," says Doug Patterson, vice president of marketing and business development at Aitech Defense Systems Inc. in Chatsworth, Calif. "It's hot, heavy, expensive, and difficult to cool when you put that much power in one space."

Systems integrators appreciate the flexibility that SFF offers, Patterson says. "The smaller form factors are allowing the customer base to be more flexible and imaginative in the way they are solving their problems. They are taking away that large centralized computer and distributing the processing over the platform and out to the sensors." In addition, the systems designer doesn't have to concern himself with the internal box architecture, Patterson says. "He doesn't care what's in that box, as long as it talks to his other boxes, and can distribute the intelligence out as he defines the architecture."

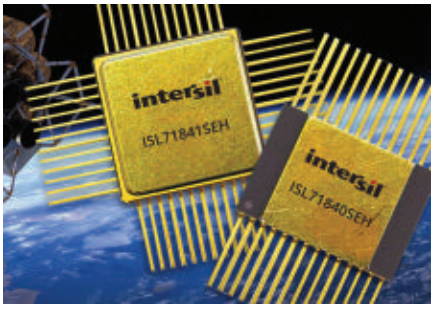
# new PRODUCTS

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

RAD-HARD ELECTRONICS

## Radiation-hardened multiplexers for spacecraft introduced by Intersil

Intersil Corp. in Milpitas, Calif., is introducing the ISL71840SEH and ISL71841SEH radiation-hardened multiplexers for manned spacecraft and satellites. The multiplexer power electronics devices offer solid electrostatic discharge (ESD) protection and signal chain accuracy and timing performance. The ISL71840SEH 30-volt, 16-channel multiplexer is a drop-in replacement for Intersil's HS9-1840ARH, which has been aboard satellite and space exploration missions like the NASA Orion spacecraft flight test. For applications with form factor constraints, the ISL71841SEH 30-volt, 32-channel multiplexer offers high-performance and 41 percent reduced board space compared with an ISL71840SEH two-chip solution. The ISL71840SEH and ISL71841SEH rad-hard multiplexers capitalize on Intersil's proprietary silicon-on-insulator process, which provides single event latch-up (SEL) robustness in heavy ion environments. The enhanced 8-kilovolt ESD protection eliminates the need for external protection diodes on the input pins.




**FOR MORE INFORMATION** visit **Intersil** online at *www.intersil.com*.

BOARD PRODUCTS

## Xeon-D 3U VPX board for battlefield computing introduced by Kontron

Kontron in Poway, Calif., is introducing the VX3058 3U VPX single-board computer based on the eight-core version of the Intel Xeon-D embedded computing processor architecture for demanding military server and other high-performance embedded computing (HPEC) applications. The VX3058 brings server-class computing capabilities to the battlefield with its Dual-10 Gigabit Ethernet, high-bandwidth PCI Express 3.0, and high-speed DDR4 memory. The embedded computing board is ruggedized for harsh environments that require small size, weight, power, and cost (SWaP-C). The VX3058 provides digital signal processing (DSP) performance to demanding uses like virtual machine architectures that can take advantage of the extensive capital and operational efficiencies provided by isolated workloads configured to share common resources dynamically.

**FOR MORE INFORMATION** visit **Kontron** online at *www.kontron.com*.

DISPLAYS

## Rugged display for avionics and vehicles introduced by Curtiss-Wright

Curtiss-Wright Defense Solutions in Ashburn, Va., is introducing the 10.4-inch PVDU2600 low-cost LCD rugged display for SWaP-C constrained fixed-wing aircraft, helicopters, and tactical ground vehicles. The touchscreen display combines high brightness and rugged construction with options for the Intel Atom E3800, Core i3-4010U, Core i5-4300U, or Core i7-4650U embedded computing processors. The display measures 9.6 by 7.9 by 3.2 inches, weighs 8.8 pounds, and offers 1024-by-768-pixel resolution for applications that require small size, weight, power consumption, and cost (SWaP-C). Built for performance in harsh environments, the non-ITAR PVDU2600 is designed to meet DO-160 and MIL-STD-810/461 testing requirements. The unit is built to AS9100 quality-certified manufacturing services in a UK MoD Design Approval Organisation Scheme (DAOS) certified facility.

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

RUGGED COMPUTERS

## 5U rugged computer servers introduced by Crystal Group

Crystal Group Inc. in Hiawatha, Iowa, is introducing the RS549 and RS5718L24 5U rugged computer servers for military, security, and other applications. The RS549 rugged server has an Intel Quad

E5-4600-class processor, four PCI Express X16 (double-width) slots, and 32 1024-gigabyte registered DDR3 with ECC memory. It measures 17.5 by 8.72 by 20 inches. The rugged computer has four options on external bay configurations. The first is nine removable SATA or SAS 2.5- or 3.5-inch hard disk drives. The second is eighteen 2.5-inch SATA or SAS hard disk drives. The third option is three drive packs and eight removable SATA or SAS 2.5-inch hard drives. The fourth is one CD/DVD/BD (R/W) drive. The RS5718L24 rugged server, meanwhile, measures 17.5 by 8.75 by 23.75 inches, and has three CPU options: Sandy Bridge or Ivy Bridge LGA2011, X9DRL-IF; Sandy Bridge or Ivy Bridge LGA1155, X9SAE-V; or Haswell LGA2011, X10SRL-F or X10DRL-I.

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

**TEST AND MEASUREMENT**

## Compact DC power supplies for testing introduced by Keysight

Keysight Technologies in Santa Rosa, Calif., is introducing the E36100 series of compact DC power supplies that offer LAN and USB interfaces and power for test and measurement testing and validating designs. The series adds five models with as much as 100-volt or 5-amp output. Design and validation engineers need to power their devices under test (DUTs) safely and easily during manual tests or automated


sequences. They frequently are under pressure to perform tests quickly, and their test benches are often crowded, Keysight officials say. The E36100 series 2U ¼-rack form factor saves space on the bench or in a rack, and standard LAN (LXI Core) and USB interfaces connect the power supplies to a computer. An on-screen menu system makes helps engineers perform manual tasks quickly, and overvoltage.

**FOR MORE INFORMATION** visit **Keysight** online at *www.keysight.com*.

**POWER ELECTRONICS**

## 3U rugged 3U VPX DC-DC power supply introduced by NAI

North Atlantic Industries (NAI) in Bohemia, N.Y., is introducing the VPX57-31 3U rugged VPX power supply for rugged military and commercial aerospace applications. The VPX57-31 power electronics product provides as much as 400 watts of power (CC4 temperature range, full load) with six outputs and is compliant with MIL-STD-704F. Other features include current share, remote error sensing, and a built-in EMI filter compliant with MIL-STD-461, CE-102

in a one-slot package. The VPX57-31 is designed to meet standard 3U VPX mechanical requirements and has VITA 62 compatible outputs & signaling, user programmability, I2C communication, and a programmable over-temperature monitor.

**FOR MORE INFORMATION** visit **North Atlantic Industries** at *www.naii.com*.

**RF AND MICROWAVE**

## Rugged RF and microwave bandpass filter introduced by Anatech

Anatech Electronics Inc. in Garfield, N.J., is introducing the AB915B656 rugged indoor and outdoor GSM-band RF and microwave cavity bandpass filter for defense and commercial wireless applications. The bandpass filter combines high rejection, low return loss, and the ability to remove nearby RF interference. The AB915B656 has a passband of 910 to 920 MHz, insertion loss of 1.5 dB, return loss greater than 16 dB, and out-of-band rejection of 75 dB

from 850 to 894 MHz and 929 to 950 MHz. It can handle 20 watts at continuous wave (CW) and uses Type-N female connectors. Other kinds of connectors are available. The filter measures 140 by 80 by 53 millimeters, and operates in temperatures from -45 to 85 degrees Celsius.

**FOR MORE INFORMATION** visit **Anatech Electronics** online at *www.anatechelectronics.com*.

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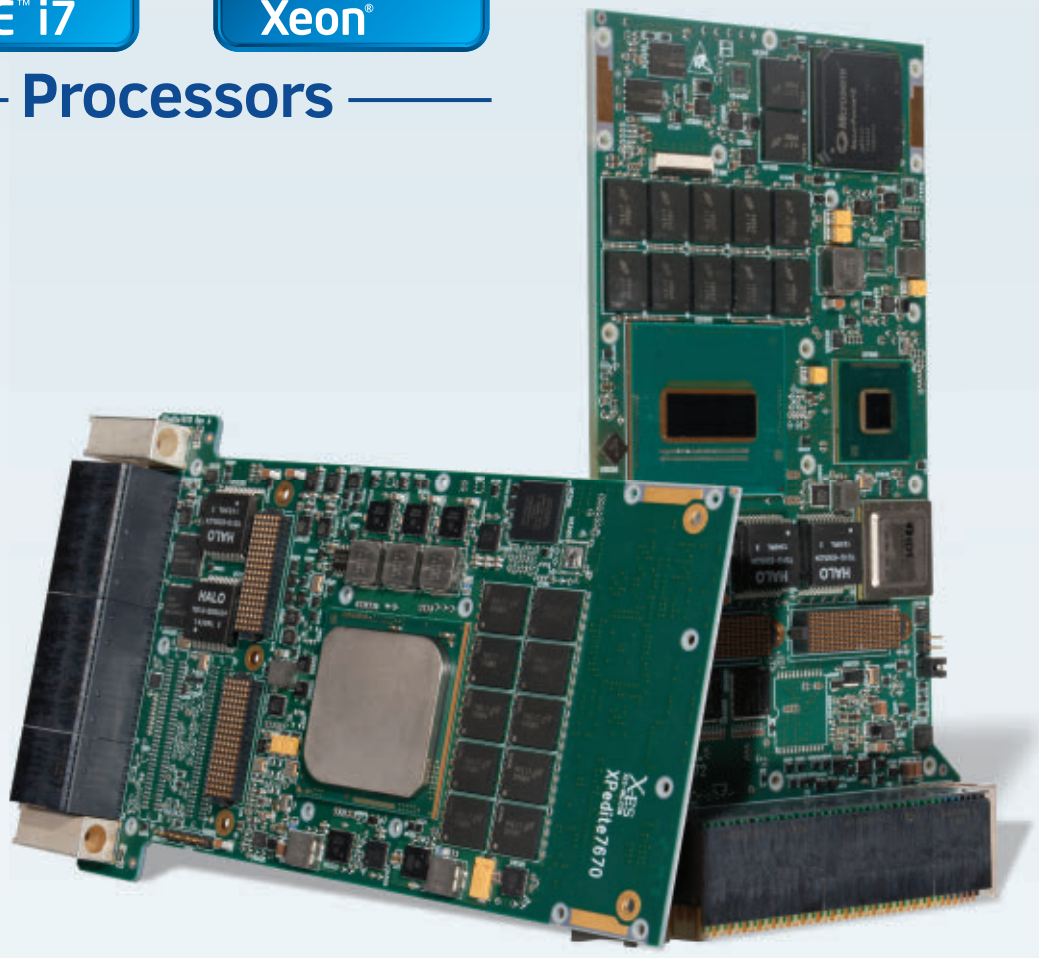


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