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Distributed computer designs

Small-form-factor embedded computing opens up a new horizon in aerospace and defense systems. PAGE 2

Small-form-factor embedded computing

The new frontier of small form factors isn't just about small size, weight, power consumption, and cost. PAGE 18

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How aerospace and military systems designers borrow crucial technologies from the commercial market. PAGE 8

Commercial technology in aerospace

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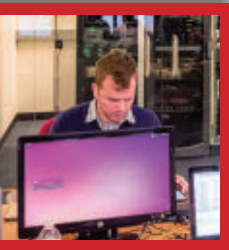

COVER STORY

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BY **JOHN KELLER**, EDITOR IN CHIEF

Small form factors: a new embedded computing design paradigm

The notion of relatively small size, weight, and power consumption (SWaP) in aerospace and defense electronics generally suggests the ability to place more computing power in a smaller space. That's true, but it's only half the story. SWaP-constrained electronics technologies like small-form-factor (SFF) embedded computing does enable big power in small spaces, but the ever-shrinking size of today's electronics is helping systems designers think of space in a whole new way.

Small-form-factors for embedded computing — like COM Express, PCI/104 Express, the Smart Mobility ARChitecture (SMARC), and Mini Embedded Technology eXtended (Mini-ETX) — are shaking up the embedded computing design paradigm by helping designers consider new kinds of distributed embedded computing architectures, above and beyond traditional board-and-backplane designs.

Small form factors can help systems designers think about placing computer components where they make sense, rather than consolidating computing in board-and-backplane boxes. When it comes to digital signal processing (DSP), for example, designers often talk about placing computing components as closely to antennas and sensors as possible. Small-form-factor embedded computing may offer just the ticket.

Using a distributed embedded computing architecture based on small form factors can help designers place analog-to-digital (A/D) and digital-to-analog (D/A) converters with some field-programmable gate array (FPGA) pre-processing in a small package next to antennas and sensors, and then route this data over high-speed optical fiber interconnects to more powerful processors conveniently placed elsewhere in the system where size and weight are not critical issues. Moreover, small-form-factor embedded computing can help designers place components where they fit best, rather than worry about finding a space big enough to accommodate a traditional computer box.

Potential benefits of distributed embedded computing architectures don't end there. The whole idea of dividing computers into separate parts may offer advantages in thermal management, controlling electronic emissions, and graceful degradation when things go wrong.

A distributed computing system might tolerate overheating, power surges, or battle damage better than a centralized board-and-backplane computer box. If the worst happens and the computer box goes down, the mission might be over. Bring down a preprocessor memory packaged in small form factors and the mission might be able to continue, but with degraded performance.

Distributed architectures enable designers to spread out not only relatively small components over a larger system, but also waste heat over a larger area. Hot processors could be located near potential cooling sources like flowing air; components susceptible to electromagnetic interference (EMI) could be physically separated from EMI sources; and relatively cool-operating components like memory and controllers could go near the center of the system where heat is not a big challenge.

Serial networking becomes a central concern for distributed architectures, and confronts designers with crucial decisions on whether to use optical fiber, copper wire, or even wireless networking. Fast Ethernet and other advanced network architectures are making these decisions easier than they used to be.

Small-form-factor embedded computing is on the verge of introducing a deep new design paradigm for aerospace and defense applications. Possibilities are limited only by the imagination.

You can read more about the latest trends in small-form-factor embedded computing in the Technology Focus feature, entitled "The new frontier of small-form-factor embedded computing" on page 18.

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IN BRIEF

NASA wants radiation-hardened data recorders for future WFIRST spacecraft

U.S. space observation experts are surveying industry to find space-qualified, radiation-hardened, solid-state data recorders for the future Wide Field Infrared Survey Telescope (WFIRST). Officials of the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center in Greenbelt, Md., issued a source-sought notice (NASA-GSFC-RFI-WFIRST-SOLID-STATE-RECORDER) for the WFIRST Solid-State Recorder project. The WFIRST spacecraft, set for launch in 2024, will be an orbiting observatory for wide-field imaging and surveys of the near infrared sky. The spacecraft will operate for six to 10 years and will operate in the orbit about the Sun-Earth second Lagrange point (L2), which is about 930,000 miles from Earth. Companies interested should e-mail NASA's Scott Pursley at Scott.R.Pursley@nasa.gov. For questions or concerns, contact NASA's Julie Anne Janus by e-mail at julie.a.janus@nasa.gov, or by phone at 301-286-4931.

MORE INFORMATION IS ONLINE
at *https://www.fbo.gov/spg/NASA/GSFC/OPDC20220/NASA-GSFC-RFI-WFIRST-SOLID-STATE-RECORDER/listing.html.*

Navy boosting C4ISR, multi-sensor intelligence capabilities of P-8A aircraft

BY JOHN KELLER

PATUXENT RIVER NAS, Md. — U.S. Navy surveillance and reconnaissance experts are moving forward with upgrades to the Boeing P-8A Poseidon maritime-patrol C4ISR and ASW aircraft to enhance the plane's profile as a long-range, multi-sensor, intelligence-gathering platform.

The U.S. Navy P-8A Poseidon aircraft isn't just for anti-submarine warfare anymore. Experts are finding new ways to enhance the plane's capabilities in strategic reconnaissance and surveillance.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $60.8 million contract modification to the Boeing Co. Defense, Space & Security segment in Seattle for several enhancements to the P-8A aircraft command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) capabilities.

The modification is to mature C4ISR technologies aboard the Poseidon Increment 3 Block 2 aircraft. The order involves Minotaur; Multi-Static Active Coherent (MAC) enhancements; wide-band satellite communications (SATCOM); a new computing and security architecture; automated digital network system common data link upgrades; anti-surface warfare signals intelligence (SIGINT); combat system architecture improvements; and communication capability upgrades.

Minotaur most likely involves an integrated sensors, signal processing, and communications system to enable P-8A aircrews to gather and process surveillance information for transmission to other shore and surface operators.

The U.S. Coast Guard reportedly has been installing a system called Minotaur from the L-3 Communications Platform Integration segment in Waco, Texas, aboard Coast Guard C-130J long-range surveillance aircraft.

The Coast Guard's Minotaur project is developing a new standardized mission system with next-generation mission control processor to incorporate the HC-130 aircraft's radar, sensors, and other C4ISR equipment.

At nearly the same time, the U.S. Air Force Research CONTINUED ON PAGE 6

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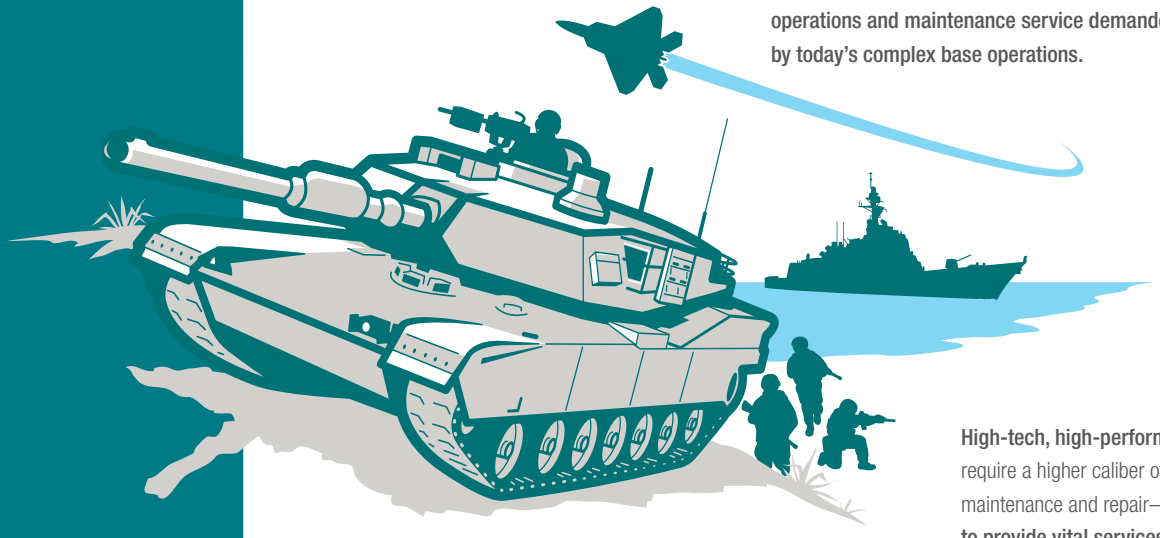

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C4ISR CONTINUED FROM PAGE 4

Laboratory's Information Directorate in Rome, N.Y., is working with industry on the Multi-INt Operations Technologies and Unification Research (MINOTAUR) project. This research initiative seeks to incrementally deliver a suite of tools and technologies to enhance open-architecture intelligence information systems from the sensor through the analyst, chain of command, and out to the operational units.

The Air Force MINOTAUR project seeks to integrate several intelligence sources and improve the fusion, processing, and exploitation of raw source data from the battlefield to actionable mission criteria through assured and adaptable technologies.

These tools and technologies will be able to share information securely and integrate new sensors and sources of data to modernize intelligence-gathering systems; integrate new sensors and data sources into existing systems; develop new tools for processing raw intelligence data; and speed access to intelligence.

The Multi-Static Active Coherent (MAC) project is an anti-submarine warfare (ASW) system that seeks to detect, locate, and identify enemy submarines using sonar emitters and receivers in separate locations on separate platforms, such as submarines, surface ships, ASW sonobuoys, and helicopter dipping sonar. MAC brings coherent acoustic source technology and improved signal processing to the P-8A, P-3C Anti-Surface Warfare Improvement Program (AIP), and other Navy ASW aircraft.

This order also involves wideband satellite communications (SATCOM); a new computing and security architecture; automated digital network system common data link upgrades; anti-surface warfare signals intelligence (SIGINT); combat system architecture improvements; and communication capability upgrades.

On this contract modification Boeing will do the work in Puget Sound, Wash; Patuxent River Naval Air Station, Md.; Huntington Beach, Calif.; Dallas; and St. Louis, and should be finished by February 2019.

FOR MORE INFORMATION visit **Boeing Defense, Space & Security** online at *www.boeing.com/defense*, or **Naval Air Systems Command** at *www.navair.navy.mil*.

Air Force asks industry for ideas on reinvigorating nuclear weapons command and control

BY JOHN KELLER

ROME, N.Y. — U.S. Air Force researchers are reaching out to industry in a potential $8 million project to reinvigorate and expand how the service can command and control the nation's nuclear weapons forces.

Officials of the Air Force Research Laboratory's Information Directorate in Rome, N.Y., have issued a presolicitation for the Nuclear Command, Control, and Communications project, which seeks to incorporate new platforms and communications systems into the nation's nuclear weapons battle management.

Researchers are asking for industry's help in defining a new nuclear command, control, and communications architecture by defining what's possible in future nuclear battle-management technologies, including new ways to maintain communications during a nuclear war, as well as defining cyber security approaches to safeguard the nation's arsenal of nuclear weapons.

Air Force researchers are soliciting industry white papers on new ways advance the state of the art of the Air Force's nuclear command, control, and communications capabilities. Experts chiefly are interested in two technical areas: survivable and enduring beyond-line-of-sight communications; and modeling, simulation, and emulation of nuclear command and control architectures and systems.

U.S. Air Force strategic weapons experts are taking a fresh new look at command and control of the nation's nuclear missiles and jet bombers.

Researchers are looking for industry ideas in areas such as network operation amid electromagnetic

IN BRIEF

Lockheed Martin to install missile-defense equipment in Poland

U.S. missile-defense experts are starting to install electronic equipment at a new anti-ballistic-missile site in northern Poland near the Baltic coast. Officials of the U.S. Missile Defense Agency (MDA) in Dahlgren, Va., announced a $36.4 million contract to the Lockheed Martin Corp. Mission Systems and Training segment in Moorestown, N.J., to install Aegis Ashore equipment at the missile-defense site in Redzikowo, Poland. Aegis Ashore is the land-based component of the Aegis ballistic missile defense (BMD) system developed originally for deployment at sea aboard specially equipped U.S. Navy Arleigh Burke-class guided missile destroyers. The land-based Aegis Ashore system uses the same AN/SPY-1 radar; command, control, communications, computers, and intelligence (C4I) systems; Vertical Launch System; computer processors; display system; power supplies; and water coolers that are used onboard the Navy's new construction Aegis BMD destroyers.

pulse (EMP) and nuclear scintillation; network monitoring and control in a nuclear environment; agile network radio control in nuclear-electronic warfare (EW)- and cyber warfare-contested environments; airborne communications in nuclear environments; real-time atmospheric sensing to enhance airborne communications; secure airborne transmissions that can resist nuclear scintillation and high-altitude EMP; and network connectivity and situation awareness to manage nuclear communications.

Other areas of interest involve modeling, simulation, and emulation of nuclear command and control architectures; nuclear command and control functions; survivable communications; and communication across several different frequency bands.

Air Force researchers expect to spend about $960,000 on this project in 2017, $1.8 million in 2018, $2.4 million in 2019, and $2.9 million in 2020.

Companies interested should e-mail white papers to the Air Force's Paul Gilgallon at paul.gilgallon@us.af.mil. The Air Force will accept white papers until 30 Sept. 2020.

For technical questions or concerns, contact Paul Gilgallon by e-mail at paul.gilgallon@us.af.mil, or by phone at 315-330-4409. Direct contracting questions to Gail Marsh by e-mail at Gail.Marsh@us.af.mil, or by phone at 315-330-7518.

MORE INFORMATION IS ONLINE at *https://www.fbo.gov/spg/USAF/AFMC/AFRLRRS/BAA-AFRL-RIK-2016-0011/listing.html*.

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How military harvests technology from commercial industry

Commercial and military satellite communications are prime examples of how the U.S. military continues to adapt commercial technologies to military applications.

BY **J.R. Wilson**

The clash between an antiquated and time-consuming military research and acquisition process and the rapid evolution of important commercial technologies is nowhere more obvious than in advanced communications systems. Today's cutting-edge communications technologies also represent a showcase for the most serious drawbacks of applying commercial off-the-shelf (COTS) technology to military designs.

The growing adoption of commercial technologies for military communications systems is a balancing act: lower development and acquisition costs for the U.S. Department of Defense (DOD), but those same technologies available, without control, to everyone — from antagonistic nations to non-state enemies such as al-Qaida and ISIS. On the one hand COTS can lead to faster fielding with less training required, but on the other hand it can led to increased vulnerability.

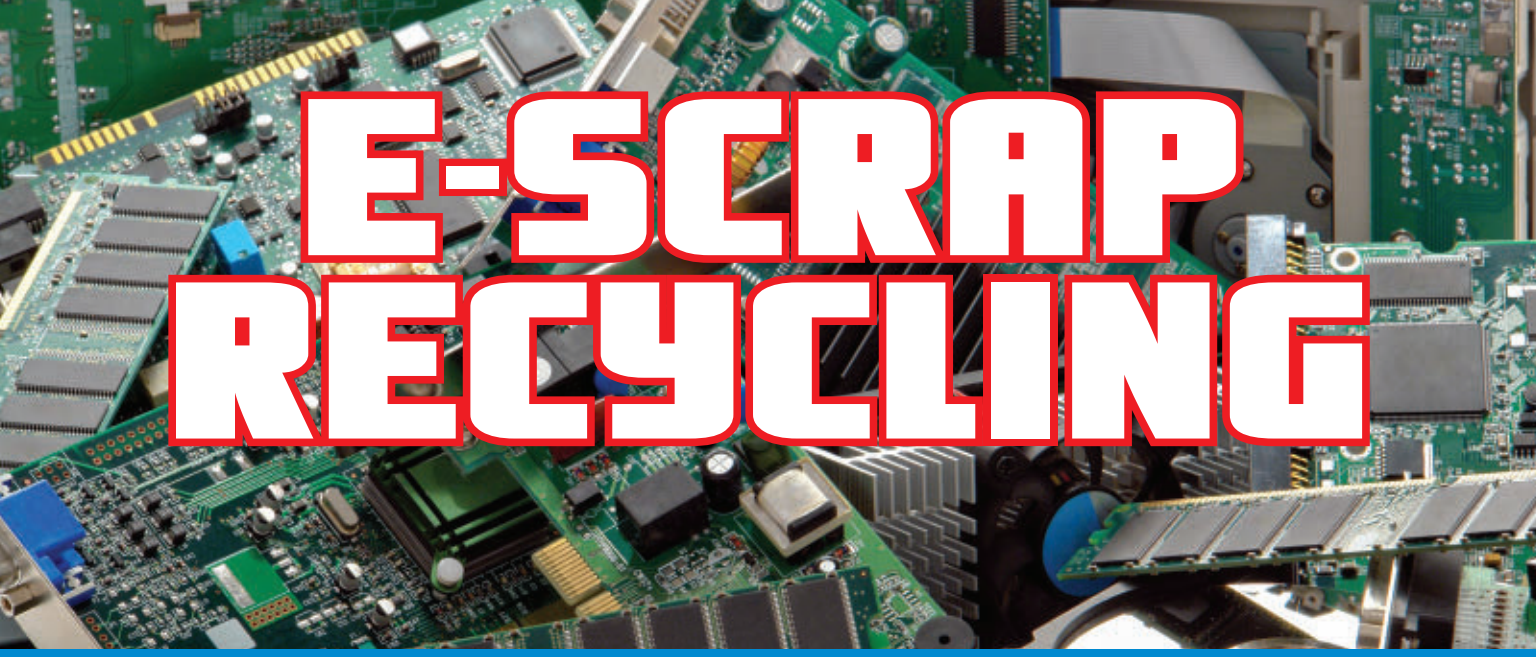
Despite today's fast merging of commercial and military communications technologies, the two markets still do call for differences in design. "Currently, we have to design military to be robust and security has to be higher, with a push to never use a well-deployed technology because those become less secure," says Jim Aralis, chief technology officer of Microsemi Corp. in Aliso Viejo, Calif.

"Robustness, both physical and logical, is the biggest difference," Aralis explains, referring to operating temperature extremes, radiation hardeness, operation in shock and vibration, as well as in harsh environments like dust, rain, and salt spray, not to mention the military's elevated needs for data and cyber security.

"From a security perspective, the U.S. has been willing to spend the money for very-high-processing elements, but soon those will be available to everyone in the world, so that is a concern," Aralis says, pointing out that security remains a complication not fully addressed by either DOD or commercial manufacturers.

"In some ways, the commercial communications arena is kind of the Wild West," says Kevin Kelly, CEO of networking

The military is capitalizing on commercially developed IP telephones, such as these from Cisco Systems.



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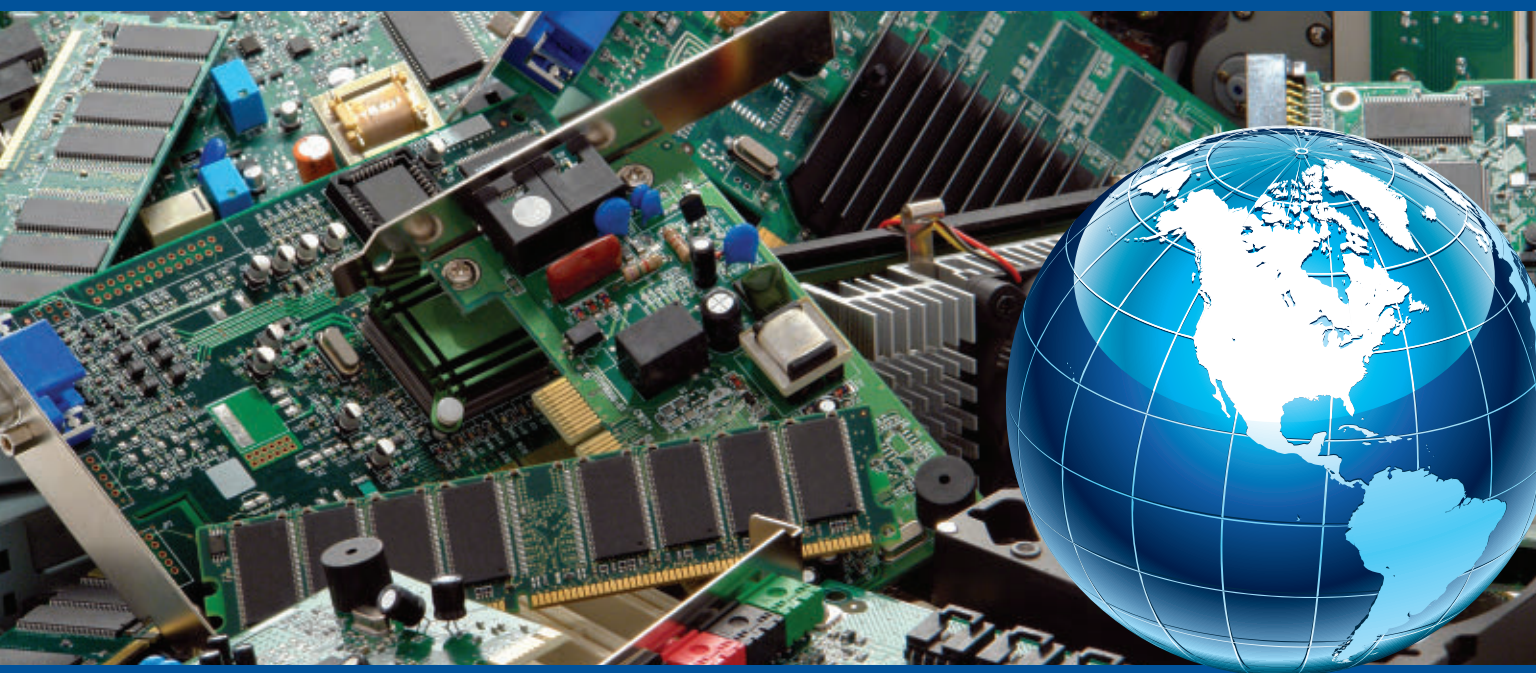

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expert LGS Innovations LLC in Dulles, Va. "When high-ranking global telecom executives are asked how they are dealing with information-assurance issues, the service providers said they assume it's not safe and wrap themselves up in intrusion and virus detection systems, pattern mapping, etc. — pretty much what the government is doing, trying to monitor everything.

"In terms of information assurance, there's no great difference between milcom and commercial," LGS's Kelly continues. "When it comes to determining mission needs, there is a big difference, not the least of which is ensuring solutions have certain features to make them interoperable. Some vendors build those into their communications products, others ignore it. So when the military is looking for tech solutions, they may find something that meets their needs, but isn't secure."

The LGS Innovations Information Security group uses open-source and commercial communications technology to develop custom networking solutions for the military.

Security in the field

The growing use of personal communications devices by individual warfighters and small units not only has raised the bar on security, but has led to major innovations in security technologies and practices, as well.

"For warfighter communications and personal body networks being developed for the military, vulnerability is extremely important," Microsemi's Aralis explains. "Because most of those are being built from scratch, we are allowed to do more to secure them, but the objective for an adversary to break into them is very great. So there are opportunities to make it a lot better, but the complication of having autonomous communications is exacerbating the problem."

To beef-up defenses, systems designers may have to take a close look at the tactical battlefield networks themselves. "We can do bio monitoring of the soldier to make sure it is not being used by someone else, but connections into the broader network still need a lot of work," Aralis says. "The systems will be maybe two orders of magnitude better than the largely ad-hoc systems we now have, but making them nearly fault-proof will be difficult. They will observe the warfighter's movements and so learn who it is attached to so they can determine if the system is being used by someone else, leading to restrictions on their use until the questions are resolved."

Another area of concern is size, weight, and power (SWaP). As the military puts more and more communications on satellite-based platforms, it must adapt commercial technologies to operate in a space environment, where it is difficult to control temperatures and power requirements differ significantly from a terrestrial data center environment.

"So adapting commercial technology is much easier said than done," Aralis adds. "For example, as the military becomes more mobile, many systems have been based on putting base stations on mobile platforms. But when those were developed by the commercial industry, they weren't meant to move."

SWaP remains the primary driver for commercial technology development and the requirements of its military adopters. While faster and cheaper also remain major drivers, power is a top concern and an area of rapid development.

"The next generation is being driven by bit width and higher-speed conversion technologies," Aralis says, but adds some technologies are reaching the end of major improvement potential. "In a few years, a big problem for industry will be technology advancement, which we have always used to solve problems, but that will not continue. We can't go any further down than 5 nanometers, for example, without creating high unpredictability. Even moving to

seven nanometers, we must address predictability, chip degradation, and the ability to fix those and continue working. So while technology is driving the architecture, architecture is driving technology. It's also hard to fund building these technologies into military systems if we have to pay for it all from the DOD budget."

Digital transformation

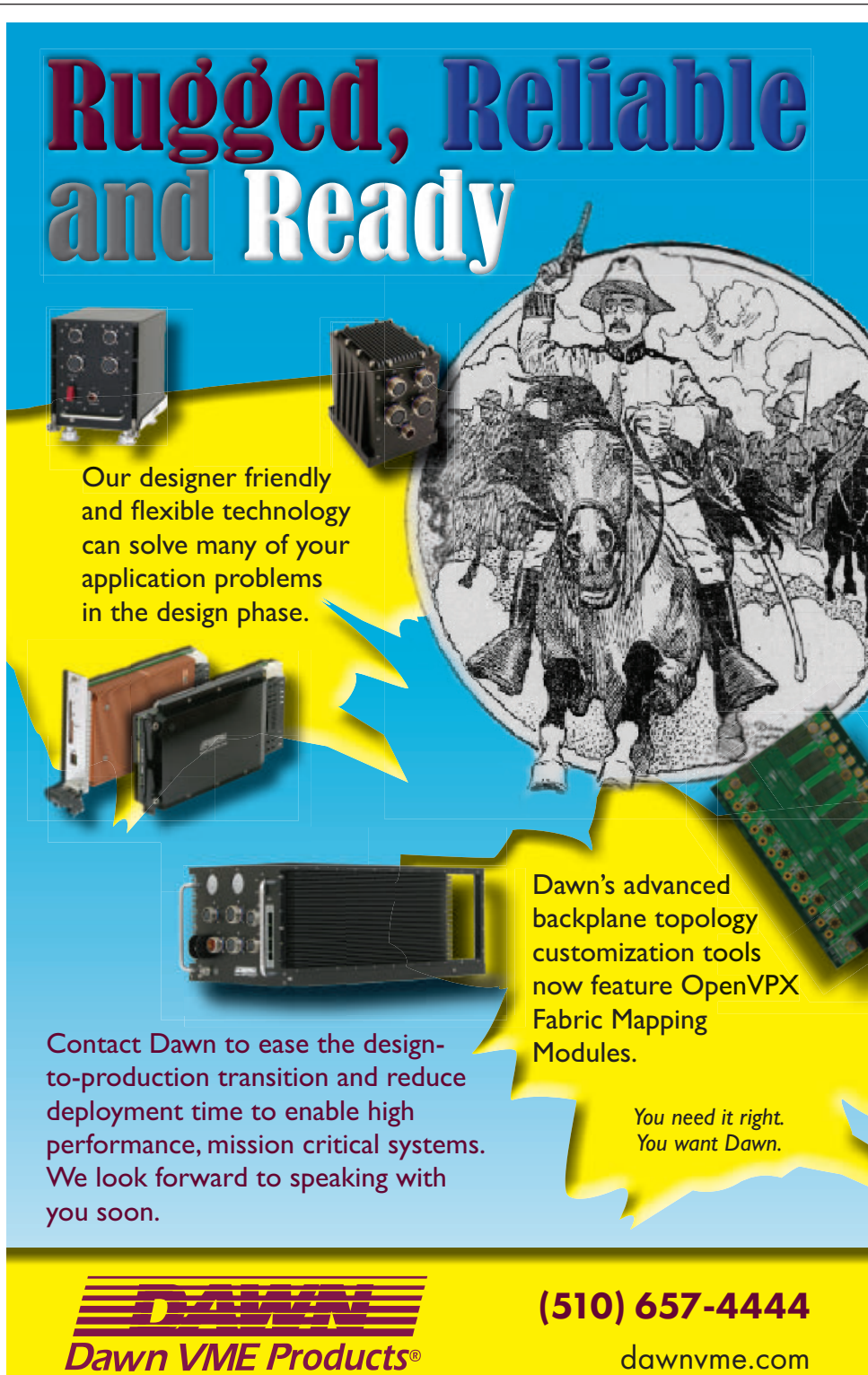
DOD's growing reliance on commercial communications technology is sustained, in part, by digital transformation on the commercial side, says Darrel Beach, consulting systems engineer at networking expert Cisco Systems Inc. in San Jose, Calif.

"That includes distributed analytics, where we may deploy hundreds or thousands of sensors in a mine or oil rig or stadium, where it is almost impossible to have enough bandwidth to collect all the data from all those sensors, bring it back to a central location, then send the results out," Beach says. "What we are seeing is only uploading specific anomalies or important themes — or analytics at the edge. Not every sensor feed needs to be sent back; system analytics at the source can monitor changes and notify central processing only when change happens, as defined by mission parameters or even geographics.

"Theoretically, you may have low-level analytics on individual handhelds, then unit-level analytics at the next level, then additional analytics on up the chain, distributing those around the network where it makes sense for what you are trying to do," Beach says. "In the commercial space, we are seeing analytics down to individual sensors, group analytics, groupings of hubs and nodes. The electrical grid system is an excellent example of that."

This digital transformation is in its infancy in the commercial marketplace, but the military needs to adopt it rapidly to get new capabilities into the hands of warfighters more quickly.

In June, the Army Program Executive Office for Command, Control, and Communications-Tactical (PEO C3T) hosted a mission command network industry forum at Aberdeen Proving Ground, Md., to update industry on the Army's network modernization plans. The develop-



ment and launch of a new generation of high-capacity communications satellites is a major part of what industry is doing.

Army experts want to take advantage of future throughput in gigabytes, rather than megabytes, of data, along with narrow, steerable spot beams that will be difficult for an enemy to jam. For DOD, a key advantage of moving more military communications to these new commercial satellites is relieving the federal budget of development costs for a major leap forward in communications technology and capability.

"Top commanders have rallied around proposals for a partnership with commercial SATCOM providers to pave the way for what we call 'SATCOM as a service,'" wrote Rebecca Cowen-Hirsch, senior vice president of government strategy and policy at SATCOM provider Inmarsat plc in London in a September 2015 blog. "With this, troops access satellite on-demand with seamless availability of transponders, equipment terminals, backhaul, capacity and features. It's about engaging with the government, understanding not just what the threats are, but what the responses need to be. It is a very dynamic environment."

Military SATCOM

Dedicated military satellites fall into two categories: radiation-hardened, which are highly protected Advanced EHF satellites designed to provide assured communications in the event

Cisco commercial Advanced Services Routers provide core IP network functions across many DOD networks.

of a nuclear war; and the Wideband Global SATCOM (WGS) constellation, which is less protected but still dedicated satellites providing U.S. forces with broadband communications during non-nuclear conflicts.

On the commercial side, companies such as Eutelsat in Paris, Intelsat General in McLean, Va., Inmarsat in London, and SES Government Solutions in Betzdorf, Luxembourg, have provided DOD with communications assets under annual contracts since the turn of the century. As military requirements have outpaced military SATCOM capabilities, DOD and commercial SATCOM providers are looking for a more long-term partnership.

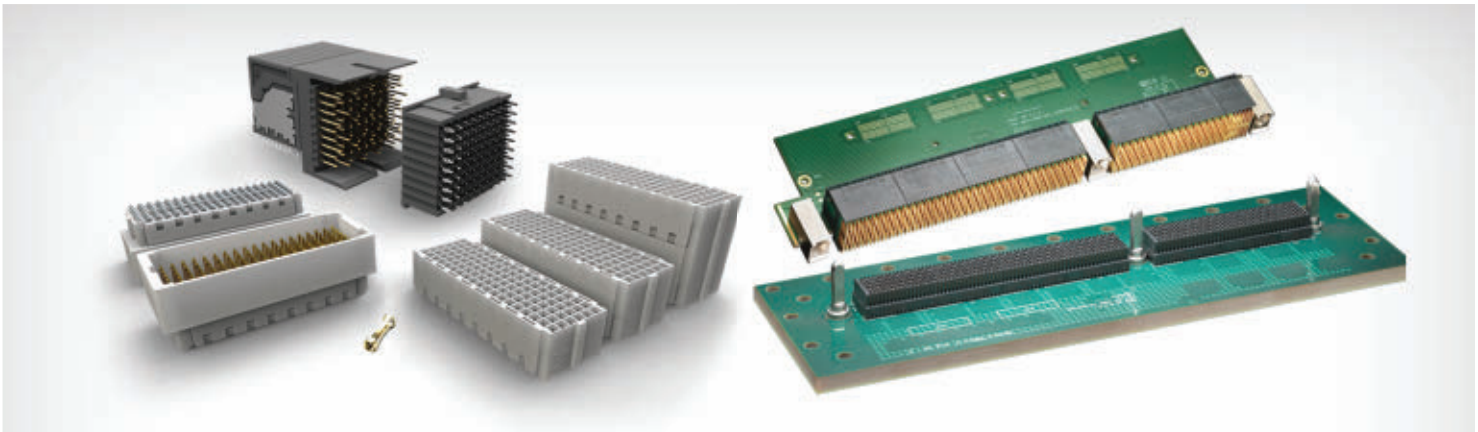
That was a major part of the discussion at a Space Business Round-

Microsemi Corp. specializes in providing radiation-hardened processors for commercial and military communications satellites.

table panel discussion in early 2016 in Washington by SATCOM providers and the military. "I think there is a real convergence on the technology side. The key is to get convergence on the policy side so we can operate more seamlessly," Air Force Undersecretary for Space Winston Beauchamp told the panel.

Several companies have proposed their next-generation satellites for such a convergence. The new SES O3b network of eight low-Earth orbit (LEO) high-capacity satellites constantly change position, compared to standard fixed-orbit geostationary (GEO) satellites. The lower orbit reduces signal latency, while using several moving satellites and far narrower spot beams to increase protection against enemy jamming.

"You used to point a dish at a satellite and you were on that satellite for months, maybe years. With O3b, you're on all eight of the satellites about four times per day," P. Glenn Smith, SES vice president of business development, told the conference, adding the existing use of steerable beams for at-sea communications for



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cruise ships can serve as a template for similar communications links for U.S. Navy battle groups.

Inmarsat's new Global Xpress constellation of high-throughput, flexible-beam satellites offers about 20 times the capacity of the company's earlier satellites and is compatible with any terminal that can connect with WGS satellites, says Cowen-Hirsch. In addition, a flexible beam enables the satellite to change beams quickly in the presence of interference, without an enemy realizing such a change has occurred.

Spot-beam SATCOM

Intelsat General's new Epic satellites will offer wide and spot beam coverage in the same bands, adding flexibility for mobile applications and small terminals covering commercial and government needs with six times the bandwidth of WGS satellites, notes company president Kay Sears.

"In the satellites we're launching in 2016, we have already seen a [leap] in technology in terms of throughput, power, and flexibility, and that will continue," Sears told government representatives at the conference, adding the military's space-based communications networks should incorporate industry's next-generation satellites on a permanent basis. "We don't get a lot of help understanding the requirements and the future direction [of military communications]," she added, even though industry can insert the latest technologies as they develop, far more quickly and less expensively than trying to upgrade Air Force program-of-record satellites.

Joe Vanderporten, director of the Air Force Space & Missile Systems Center's Pathfinder Office at Los Angeles Air Force Base, Calif., offered the panel some support for their arguments — but not at the level of commitment industry representatives were seeking. "Some analysis suggests that some of the newer satellites are near WGS capacity, [but] a purpose-built [military] satellite does more things," he said, adding how a future combination of commercial and government-owned systems may evolve is yet to be determined. "I think it will be a mix. How big of a mix remains to be seen."

Cisco's 829 Industrial Router is used in vehicle and transportation systems worldwide.

Robert Tarleton, director of the Air Force Military Satellite Communications Systems Directorate, says they have not yet given formal, in-depth consideration to such a combined architecture. However, a program review running through spring 2017 is looking at ways in which operation, control, and maintenance tasks could be shifted from the Air Force Satellite Control Network to private industry, with the military continuing to manage key command and control elements. A separate study is investigating possible new options for future communications satellite acquisitions.

One advantage to the government moving from an annual lease to part ownership of commercial satellites would be gaining some degree of influence over future designs to increase their utility for military applications. That essentially is a mirror image of industry's quest to be included in the design phase of future military communications architectures.

An important part of that, says LGS's Kelly, must be the creation of international standards for software and embedded systems assurance and agreement on what is "safe enough" with respect to countering ever-growing numbers of intrusions. "That's one area where the commercial industry is lacking direction, which needs to come from policymakers," he says. "But while industry says they will embrace such standards, they cannot be set by a specific vendor. The good news is the market tends to figure out economic ways to deliver solutions; it's up to regulators and buyers to insist on high quality and some form of built-in information assurance."

The role of VoIP

There have been limited instances of DOD-specific communications technology development that eventually found commercial applications, making the cost of future evolutions likely to be at least shared by the military and commercial markets. One example was the multi-level precedence and preemption features for military Voice-over-IP (VoIP) data sharing and video systems.

In the past year, forecast analysis firms Frost & Sullivan and Markets & Markets have predicted significant growth in demand for next-generation military communications capabilities and the utilization of com-

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mercial satellites to help meet those requirements. Markets & Markets predicts the global military communications market will nearly double in the next five years, from $23.02 billion in 2015 to $40.82 billion in 2020.

"Military communications system must integrate emerging technologies such as Ka-band, Advanced Extra High Frequency (AEHF) band satellite communication, IP-based networking, COTS-based products, and other technologies into a robust, standards-based, network-enabled environment to facilitate the delivery of the right information to the right location and at the right time in an actionable format," according to their "Military Communications Market Global Forecast to 2020" report.

Frost & Sullivan predicts an accelerated demand for COTS-based computing, data storage, security, networking, and collaboration tools for military command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) applications through 2020, despite a flat market for military C4ISR applications overall. "With C4ISR products and services likely to experience price and technology upgrade pressure from the commercial process control, imagery, IT, as well as energy and power industries, market participants must quickly revise their strategies for success," Aerospace & Defense Senior Industry Analyst Brad Curran reports. "Additionally, adequate emphasis on maintenance, spares, logistics, and training services will be essential for new sales."

An example of DOD letting industry pay the development costs on new commercial systems the military then adapts for its own purposes is the Marine Corps Hatch-Mounted Satellite Communication Antenna System (HMSCAS) from ViaSat Inc. in Carlsbad, Calif., that provides secure voice, tactical network access, chat, and streaming video between C-130 Hercules aircraft and commanders in the field, based on a commercial system developed for private executive jets. Managed by the Marine Air-Ground Task Force (MAGTF) Command, Control & Communications team at Marine Corps Systems Command in Quantico, Va., it is a substantial improvement over previous voice-only systems, enabling the aircraft to transmit globally while connected to all military networks and databases worldwide. By adapting an existing commercial system rather than building a military-specific application from scratch, the Corps was able to field the HMSCAS only four months after its initial funding.

The Cisco 6807 Ethernet switch is used in both shipboard and fixed-base installations to provide a high-speed network core.

At the individual warfighter level, the MAGTF Common Handheld program is looking at how commercial smartphones could be adapted — with special software from the U.S. National Security Agency (NSA) — to meet a dismounted infantry requirement for reference and tactical sharing in the field without the high cost of a military program-of-record. Initial fielding of the first Marine Corps common handhelds is scheduled for infantry squad leaders in 2019. Incorporated military software will include the Joint Battle Command-Platform application, which provides next-generation friendly force tracking, secure data encryption and advanced logistics capabilities.

Commercial research is key to providing military capabilities without the cost to taxpayers of military-specific programs. In many cases, that is a serendipitous result of purely commercial product development, but there remains an element of military-oriented independent research by companies serving both markets. Such efforts have two primary drivers, says LGS's Kelly.

"A company like LGS will spend north of $20 million a year, only some of which is recoverable. The war on terror is the biggest driver, creating a very dynamic battlefield environment that is far less predictable than past wars and difficult to predict where the battlefield will be six months from now. So mobility is key, which is where cellular communications and opticals come in. The second driver is the availability of spectrum, due to the mobile nature of the users. As we need more and more data on the move, with RF technology pervasive throughout the mission, finding effective ways to use the RF spectrum — which is tightly controlled inside the U.S. — is a major challenge. So we are building more and more efforts to monitor the RF spectrum as the amount of data we need to send over limited channels continues to grow."

Laser communications

Two areas in which commercial and military interests coincide are the development of 5G mobile telecomm standards and free-space optical communications, which uses advanced line-of-sight laser technology to enable secure communications.

"There is available spectrum that, if used creatively and doesn't create a cumulative jamming effect, will open a new band, which is really what 5G is all about. In commercial, they are estimating 5G deployments within 24 months, where the challenge is more economics than technical. You'll never have enough government users to pay for 5G, but cost isn't always the most important factor for the military when you need solutions for critical needs," Kelly explains. "We don't have any [DOD] requirements for 5G now, but we have to keep up with the technology for when that demand does arrive. Meanwhile, free-space optical communications is important to the military and commercial environments, which seem to be proceeding in unison at a very rapid pace."

The use of commercial technologies raises a number of questions, the two most important being: Can the U.S. maintain a technology edge if everyone has access to the same commercial developments and does foreign manufacture present serious vulnerabilities, such as "backdoor" access built into software or hardware?

"I often ask myself if we are winning or losing there," Kelly admits. "The U.S. utilizes communications to a greater degree than just about anybody — more bits per capita than any other nation on Earth — using technology largely coming out of Asia. We're way ahead in converting commercial communications technologies into military and while that also introduces more vulnerabilities, we've been sophisticated enough to eventually detect attacks."

Adoption of commercial technologies is not a simple matter; DOD has to certify systems for use on the military network.

"We reached the transition point about a decade ago, where all the technology being developed for the commercial sector simply makes if far more economical for the military to adopt rather than develop," says Microsemi's Aralis. "Maintaining our technology lead in military communications is critical. Communications is the most important thing you need to maintain military superiority. That investment will get bigger as the cost of not having the latest technology gets higher." ←

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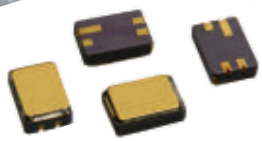

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The new frontier of small-form-factor embedded computing

It's not just about small size, weight, power consumption, and cost anymore, as efficient processors, fast data conversion, and optical interconnects help designers look at systems in a whole new way.

BY **John Keller**

Small form factors can free designers of board-and-backplane architectures to create some of today's smallest systems.

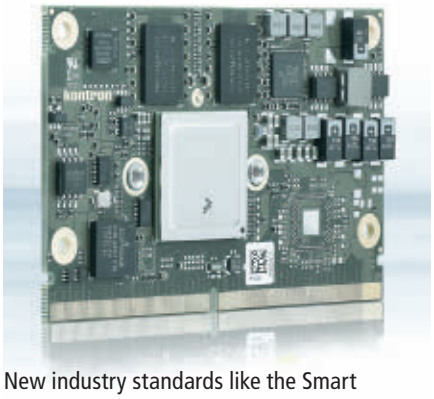
Military embedded computing systems perhaps are more susceptible than any other components to demands for small size, weight, power consumption, and cost — collectively known as SWaP-C. Standard board-and-backplane architectures like 3U VPX have tried to meet the SWaP-C demands of systems designers, but it's still not enough.

Enter small-form-factor embedded computing — SFF, for short. This embedded computing design approach involves board standards like COM Express and Mini COM Express, PCI/104 Express, the Smart Mobility ARChitecture (SMARC), and Mini Embedded Technology eXtended (Mini-ETX), as well as proprietary SFF form factors like those from Gumstix Inc. in Portola Valley, Calif.

These tiny embedded processors and peripherals rarely, if ever, depend on a backplane architecture, and can implement tiny systems as small as one board. The modules themselves often can be as small as a credit card, or even a stick of gum, which opens up a broad variety of embedded computing implementations in wearable systems, small unmanned aerial vehicles (UAVs), mobile communications systems, vehicle electronics (vetronics), and many other systems that require extremes in small size, weight, and power consumption.

The drive for SWaP

It's no secret that military systems designers want to pack as much computing power as they can into applications of virtually every size and shape. Moreover, designers are trying to shoehorn embedded computing into applications that never required it before for tasks like sensor processing, voice and data networking, graphics capabilities, and fast data recording.



New industry standards like the Smart Mobility ARChitecture (SMARC) are providing designers with new alternatives to reduce size, weight, power consumption, and cost.

They often can get all this with small-form-factor embedded computing. "Customers are looking at functionality, data storage, and processing requirements, and they are more keen on meeting requirements than they are on the board-level architecture within the system," says Mike Southworth, product manager at Curtiss-Wright Defense Solutions in Salt Lake City. "Minimizing size, weight, power, and cost is more important than the architecture."

This is particularly true in applications where traditional board-and-backplane architectures may be dif-

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ficult or impossible to use. "If you're designing a UAV, you are counting ounces as a budget for payload weight," explains Rodger Hosking, vice president of embedded computing specialist Pentek Inc. in Upper Saddle River, N.J. "You will be very interested in getting anything smaller and lighter. The cost of size and weight is at a premium."

Military land vehicles like the Humvee and future Joint Light Tactical Vehicle (JLTV) also are prime candidates for small-form-factor embedded computing. These used to be considered to be only for soldiers and Marines, weapons, and ammunition. Today they are much more.

The modern military land vehicle today is a communications node, sensor platform, battery charger, and mobile rugged computer server room, in addition to transporting warfighters and fire power. As land vehicles become smaller and lighter, and as their demand for computers and other electronics grows, military commanders are competing for on-board space to accommodate personnel as well as electronics.

Finding room for both is becoming a big challenge. "At one of the VICTORY meetings an Army general said, 'I need more room for my soldiers' feet to drive the vehicle," says Bret Farnum, vice president of sales at Extreme Engineering Solutions (X-ES) in Middleton, Wis. VICTORY describes a standard vetronics architecture and stands for Vehicle Integration for C4ISR/EW Interoperability.

Emphasis on standards

In these kinds of applications designers often find it worthwhile to place a higher priority on SWaP-C than on traditional embedded computing architectures like 6U and 3U VPX or PCI Express. "In military and aerospace applications we see that many systems integrators are becoming slightly less concerned with industry-standard form factors," says Stuart Heptonstall, product manager for graphics systems at Abaco Systems in Huntsville, Ala. "They are looking to get a specific computing job done in a small space where low SWaP is the aim of the game. If that means trading an industry standard to get the SWaP they need, they'll go right ahead."

Pentek is working on a new generation of data recorders and data-acquisition systems that make use of small form factors.

Engineers at Kontron America in Poway, Calif., used the small-form-factors approach when they designed a satellite modem for Hughes Communications in Germantown, Md., for use in a wide range of airborne applications. The modem is based on the fanless Kontron COBALT 901 rugged embedded computer with the Intel Core i7 dual-core microprocessor.

"The packaging was made possible by the COM Express board, which we now are qualifying for shock and vibration, temperature, and electronic emissions. It's a full Mil-810 system," says Mark Littlefield, vertical product manager for defense products at Kontron. "In the past we had a single-board computer and an array of peripherals, and built with a series of blades in a chassis. Small-form-factor offers an off-the-shelf module you can use on a COTS carrier, as well as the ability to add very compact peripherals like Mini PCI Express boards for ARINC 429 or 1553 data buses or solid-state drives. With standard COM-Express board and compact carrier card you can build very compact computing with a lot of options."

Using small sizes, weights, and levels of power consumption have been a design rule for quite some time in aerospace and defense applications. In some new systems, as well as in upgrades to small existing systems, designers simply cannot count on the availability of large spaces for traditional computer boxes. "In many cases, the end product itself is also a bespoke shape, so industry-standard SFF boards do not always fit the slot," Heptonstall adds.

Military land vehicles

Military land vehicles like the JLTV are a case in point, says X-ES's Farnum. "Take a larger 3U VPX system and compare it to our XPand6052 SFF system, which is one-third the size of a 3U system. It is only two inches tall and hosts COM Express, so designers can distribute and shoehorn them in different pockets on the vehicle."

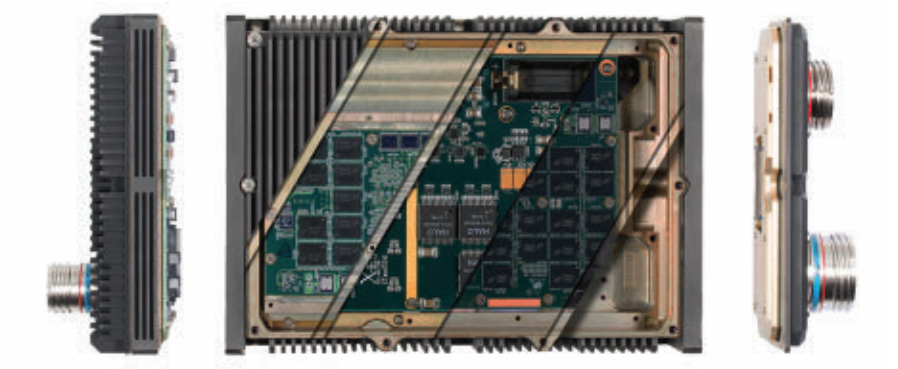
X-ES is focusing on land vehicles as a market opportunity for small form factors, as well as on small aircraft like UAVs, helicopters, and sensors packaged in airborne pods.

Designers at Curtiss-Wright relied on small-form-factor PC/104 to craft a miniature Ethernet switch for a constrained-payload application aboard a medium-sized UAV. "That box was considerably smaller than our competition, but was larger than what the customer could support," says Curtiss-Wright's Southworth. "They could accommodate half a pound of weight, and about the size of a pack of cigarettes. We adapted PC/104 to something even smaller, and the new box was about 10 cubic inches."

Similarly, Pentek is designing a new data recorder and new signals-acquisition system based on COM Express carrier cards that can accept field-programmable gate array (FPGA) processors packaged on Switched Mezzanine Card (XMC) or FPGA Mezzanine Card (FMC) modules. Such an architecture is not be limited to COM Express carrier cards, but also could accommodate PC/104, Mini PCI Express, or Mini ETX, Hosking says.

The new Pentek small-form-factor data recorders and data-acquisition systems feature FPGAs as their core technology, and high-speed wideband analog-to-digital (A/D) converters and digital-to-analog (D/A) converters to translate RF signals to digital data streams. One big enabling technology for these systems is the Zynq system-on-chip (SoC) from Xilinx Inc. in San Jose, Calif., Hosking explains. "It includes the multicore ARM processor and FPGA, all on the same silicon. Now we have a combination of resources for FPGA for high-speed DSP [digital signal processing], and a processing engine to manage all system control functions."

Today's small-form-factor embedded computing is providing designers with rugged computers that fit in the palm of the hand.



The lack of a backplane in small-form-factor embedded computing helps designers take a fresh look at how they put systems together.

Design tradeoffs

There are design tradeoffs involved with moving designs into the smallest realms possible. Where small form factors offer relatively small SWaP-C, using this approach gives up the reliability, established thermal management, extremely high computer power, broad industry support, and upgradeability of something like a 3U VPX board-and-backplane architecture.

Those who choose SFF embedded computing over modular board-and-backplane systems typically are looking at purpose-built systems with limited capacity for upgrades, experts say. "In small form factor, customers really are not as driven by the mandate for standards as they are for larger systems such as VPX," Hosking says.

Small form factors trade small size and low cost for a relative lack of upgradeability. "In small form factors you are looking more or less at a dedicated function that is unlikely to be upgraded," Hosking says. "The cost to replace it is not such a big hurdle, since its up-front cost is not as expensive as a VPX system."

It all boils down to the application, Hosking says. "The advantages of 3U VPX is a modular open-standard board system with replaceable modules that can be upgraded and configured, with a longer life cycle than a dedicated processor box. There is a place for both; it depends on the mission."

3U VPX and similar architectures have the advantage of a databus, says X-ES's Farnum. "Depending on what you put inside a VPX chassis, you can put two to six different types of boards in a half-ATR tray. That gives you two CPUs, switch and router, some custom I/O like MIL-STD-1553, or special Ethernet connectivity. You can fit everything in one box."

Although small form factors may not be able to accommodate the industry's most powerful processors, at least not yet, there are plenty of SWaP-constrained military applications in which processors that dissipate no more than 80 watts are more than good enough. "Sometimes you can get by with a smaller system and still have plenty of processing power," says Kontron's Littlefield.

All factors being equal, designers most likely will opt for a standard board-and-backplane architecture, says Abaco's Heptonstall. "If there is an industry-standard form factor product that meets the requirement, then that still would be generally preferable, as it has the potential lower time-to-market and risk."

The small form factors

Industry experts say there is no clear consensus on the right small form factors for military embedded computing. Still, companies do have their preferences. Designers prefer components that adhere to some sort of industry standard over custom-designed form factors — unless nothing standard can meet requirements.

"Customers prefer standards where they're available and will do the job, because they allow better leverage of development and procurement dollars as they span many vs. few applications without redesign," says Ben Daniel, general manager of the avionics business at Abaco Systems. "That said, we do still see custom versions, all the way down to core and component integration onto application-specific solutions."

Although it's too early to tell, COM Express may be emerging as the default for SFF embedded computing for a variety of reasons, including industry familiarity, a growing installed base, an inherent resistance to shock and vibration, and ability to keep the boards cool.

"COM Express is gaining significant sway in the military and aerospace area," says Curtiss-Wright's Southworth. Echoes Littlefield of Kontron, "I was surprised at how much interest there is in COM Express and other form factors in aerospace and defense applications."

Military applications especially may be suitable for COM Express integration because of the way the modules can be cooled, says X-ES's

Farnum. “The best thing about COM Express is when you mount a module, all the heat moves outward. It’s much superior in that it is easier to cool.”

COM Express also is proving itself to be a match for applications subject to physical abuse. “COM Express and its mounting and connector technology are much more stable than a PC/104 stack when subjected to shock, and vibration,” Farnum says.

That’s not to say that competing small form factors are losing out in aerospace and defense applications. “We have been doing PC/104 and PCI/104 for years, and still see both civil and military using those for small SWaP systems,” says Abaco’s Daniel.

Distributed systems

Perhaps one of the most exciting aspects of small-form-factor embedded computing is the technology’s ability to be distributed throughout a system or platform, enabling designers to locate components where they fit and where it makes the most sense.

Pentek’s Hosking points out that the convergence of small-form-factor embedded computing, powerful A/D and D/A converters, the growing availability of high-speed optical fiber interconnects, and the growing power of efficient microprocessors and FPGAs may help systems designers look at systems in a whole new way. He gives the example of RF antennas packed tightly together on the mast of a military ship. By blending small form factors and fast optical fiber interconnects, designers might consider placing A/D converters and pre-processor FPGAs as closely to the antennas as possible, and linking the signal via fiber to computer centers on the interior of the ship.

Optical fiber, Hosking says, is immune to RF noise and can help alleviate problems with shipboard co-site interference, where closely spaced transmit and receive antennas cause noise and distortion for one another.

Distributing embedded computing throughout a platform using small form factors also has its tradeoffs. Signal integrity and cybersecurity take on bigger roles with distributed systems, and secure networking can introduce technological complexity. Still, the potential payoffs may be well worth it. “A pool of processing resources you can retask to whatever tactical situation you might have is a real active dream,” says Kontron’s Littlefield. “If people aren’t doing distributed architectures today, then they are thinking about it.”

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Teledyne LeCroy in Chestnut Ridge, N.Y., is introducing the HDO9000 oscilloscope with HD1024 high-definition technology. HD1024 technology automatically optimizes vertical resolution under each measurement condition to deliver 10 bits of vertical resolution. The addition of HD1024 technology to a deep-analysis toolbox enables the HDO9000 to uncover difficult-to-find signal abnormalities. HDO9000 oscilloscopes offer 10-bit resolution, bandwidths of 1 GHz to 4 GHz, and sample rates of 40 gigasamples per second.

F-35 combat jets data-link targeting data to Navy shipboard weapons

Lockheed Martin Corp. experts were able to link the F-35 jet fighter-bomber with the Navy's Aegis shipboard combat system during a live-fire exercise, company officials report. The joint exercise between the company, the U.S. Navy, and the U.S. Marine Corps was the first live-fire missile test that demonstrated the integration of the F-35 and the Aegis weapon system to support naval integrated fire control and counter air. During the test, an unmodified Marine Corps F-35B acted as an elevated sensor and detected an over-the-horizon threat. The jet sent data through the aircraft's multifunction

Marine Corps orders nine G/ATOR radars to protect warfighters on attack beaches

BY **John Keller**

QUANTICO MARINE BASE, Va. — U.S. Marine Corps surveillance experts are ordering nine more versions of the new G/ATOR radar system designed to protect Marines on attack beaches from rockets, artillery, mortars, cruise missiles, unmanned aerial vehicles (UAVs), and other low observables.

Officials of the Marine Corps Systems Command at Quantico Marine Base, Va., announced a $375.6 million order to the Northrop Grumman Corp. Mission Systems segment in Linthicum Heights, Md., for nine low-rate initial production (LRIP) versions of the Ground/Air Task-Oriented Radar (G/ATOR).

G/ATOR is an expeditionary, three-dimensional, short-to-medium-range, multi-role radar system designed to detect low-observable targets with low radar cross sections such as rockets, artillery, mortars, cruise missiles, and UAVs. Marine Corps leaders are developing and fielding G/ATOR in three blocks for use by the Marine Air Ground Task Force across the range of military operations, officials say.

Northrop Grumman built G/ATOR for short-range air defense (SHORAD) and tactical air operations Center (TAOC) air surveillance missions, including identification friend-or-foe (IFF). The increment I design was to provide for growth to all following increments without equipment re-design and provide an open architecture to enable upgrades with following increments.

The Northrop Grumman G/ATOR radar is designed to protect deployed Marines on invasion beaches from rockets, artillery, mortars, cruise missiles, and UAVs.

The G/ATOR program was to showcase new component technologies, including the then-new VPX embedded computing fast switch-fabric interconnect. As part of the G/ATOR program's first increment, Northrop Grumman awarded a $4.3 million contract in 2008 to Curtiss-Wright Corp. for VPX-based embedded computers for radar signal processing, to be delivered by 2010.

The Ground Weapons Locating Radar (GWLR) portion of G/ATOR uses active electronically scanned array (AESA) radar technology to provide several different radar missions and adapt automatically to changing battlefield conditions.

FOR MORE INFORMATION contact **Northrop Grumman Mission Systems** online at *www.northropgrumman.com*.

advanced data link to a ground station connected to Aegis on the land-based USS Desert Ship. The target then was attacked with a Standard Missile 6. The test reflects how the 5th-generation fighter can be a force multiplier and this capability can increase situational awareness using Aegis and the F-35 together to better understand the maritime operational environment, experts say.

Navy orders shipboard torpedo defense systems

Argon ST Inc. in Smithfield, Pa., are building nine additional shipboard electronics systems for the U.S. Navy that use torpedo-spoofing decoys to lure enemy torpedoes away from U.S. and allied surface ships. Officials of the Naval Sea Systems Command in Washington announced a $10.2 million order to Argon ST, a wholly owned subsidiary of the Boeing Co., to provide nine AN/SLQ-25A/C countermeasure decoy systems. The AN/SLQ-25A/C is a digitally controlled modular electro-acoustic soft kill countermeasure decoy system that employs an underwater towed body acoustic projector deployed from the ship's stern on a fiber-optic tow cable to defend ships against wake-homing, acoustic homing, and wire-guided enemy torpedoes. The new order is to provide improved naval surface ship defense against modern advanced torpedoes in support of the Navy's Undersea Defensive Warfare Programs.

Textron to build test equipment for systems designed to detect and jam IEDs

BY **John Keller**

INDIAN HEAD, Md. — U.S. Navy bomb-disposal experts are looking to the Textron Systems Electronic Systems segment in Hunt Valley, Md., to provide test and measurement equipment to validate the performance of equipment designed to jam radio-frequency (RF) and microwave signals that detonate improvised explosive devices (IEDs).

Officials of the Naval Explosive Ordnance Disposal Technology Division in Indian Head, Md., announced a $7.4 million order to Textron Electronic Systems to produce the AN/GLM-11 universal test set for IED jamming systems. The contract also calls for Textron to provide AN/GLM-11 engineering services and program and configuration management.

The order is for the second option for universal test set production. Two years ago, Textron won $27.3 million to produce versions 1 and 2 of the AN/GLM-11 universal test set.

The AN/GLM-11 is a portable, battery-powered, programmable, ruggedized RF test system designed to validate IED jamming equipment. The unit provides in-field testing for warfighters employing IED jammers prior to departure, Textron officials say.

The AN/GLM-11 system executes preprogrammed test sequences that replicate threats and measures expected jammer responses. These measurements use the build emitter, build measurement, and build sequence applications of the AN/GLM-11. An operator display on the AN/GLM-11 automatically provides the operator with go/no-go test results. Under a password option, advanced users also can call up a spectral display of the jammer response.

The Textron AN/GLM-11 universal test set ensures that IED-detection equipment is functioning properly before operators take the field.

The AN/GLM-11 can test many communications and communications-jamming systems deployed worldwide, and has a frequency range sufficient for current and future counter-radio-controlled IED electronic warfare (CREW) jammers. The unit's stimulus modulation can provide continuous wave; AM and FM; amplitude-shift keying; phase-shift keying; frequency-shift keying; minimum-shift keying; and Gaussian minimum-shift keying waveforms, and can modulate the carrier signal with dual-tone, multi-frequency, tone, digital code, and arbitrary waveform.

Textron will do the work in Hunt Valley, Md., and should be finished by September 2017.

FOR MORE INFORMATION visit **Textron Electronic Systems** online at *www.textronsystems.com*.

Unmanned ocean vessels may help optimize use of cargo ships, cut fuel use, and reduce labor costs

Commercial surface ship designers, operators, and regulators are gearing up for a future in which cargo vessels sail the oceans with minimal or even no crew. Ship operators say they believe more automation and unmanned surface vessels (USVs) will enable them to optimize ship use, including reducing fuel consumption. "The benefit of automation is as an enabler of further efficiency across the 630 vessels we operate," says Palle Laursen, head of Maersk Line Ship Management, a unit of cargo-ship giant A.P. Moeller-Maersk A/S. A future unmanned ship could resemble some of the most advanced combat drones, using infrared detectors, high-resolution cameras, and laser sensors to monitor its surroundings. The vast troves of data would be transmitted to command centers where staff do little more than monitor progress and ensure ships are operating at optimum speeds. We've been hearing a lot about unmanned aircraft and land vehicles like trucks and cars, but the world's vast oceans may open up big opportunities for networked sensors and big-data applications with the potential to automate the world's merchant ship fleet.

General Atomics to build four more Gray Eagle long-endurance attack drones

The U.S. Army is ordering four more MQ-1C Gray Eagle UAVs for long-range surveillance and attack missions.

BY **John Keller**

REDSTONE ARSENAL, Ala. — U.S. Army aviation experts are ordering four MQ-1C Gray Eagle reconnaissance and attack drones, as well as four unmanned aerial vehicle (UAV) satellite control stations.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced a $25.3 million contract modification to General Atomics Aeronautical Systems Inc. in Poway, Calif., for Gray Eagle attack drones and satellite communications air data terminals.

The General Atomics MQ-1C Gray Eagle attack drone medium altitude long endurance (MALE) unmanned aircraft is an upgraded MQ-1 Predator as an extended-range multi-purpose UAV. The aircraft can be fitted with the AGM-114 Hellfire missile or GBU-44/B Viper Strike guided bomb for attack missions.

The Gray Eagle UAV has a synthetic aperture radar/ground moving target indicator (SAR-GMTI) system, and targeting capability from an AN/AAS-52 multi-spectral targeting system (MTS) under the nose. The aircraft can carry a payload as heavy as 800 pounds.

The MQ-1C Gray Eagle provides reconnaissance, surveillance, and target acquisition; command and control; communications relay; signals intelligence; electronic warfare; attack; detection of weapons of mass destruction; battle damage assessment; and manned and unmanned teaming capabilities.

Compared with its MQ-1 Predator predecessor, the Gray Eagle has an increased wingspan, and a Thielert Centurion 1.7 heavy-fuel engine (HFE) able to burn jet and diesel fuel. The UAV can fly for as long as 36 hours at altitudes to 25,000 feet. It has an operating range of 200 nautical miles.

Army commanders deploy the Gray Eagle UAV in platoons, each with four aircraft, support equipment, and payloads like electro-optical/infrared/laser range finder/laser designator; communications relay; and as many as four hellfire missiles. The common sensor payload and synthetic aperture radar ground moving target indicator are one per aircraft. Ground equipment per platoon includes two universal ground control stations; three universal ground data terminals; one satellite communication ground data terminal; and one mobile ground control station per company.

General Atomics will build the UAVs in Poway, Calif., and should be finished by December 2017.

FOR MORE INFORMATION visit **General Atomics Aeronautical Systems** online at *www.ga-asi.com*.

Military wants to track unmanned aircraft flying over cities

U.S. military researchers are surveying industry for technologies to provide persistent wide-area surveillance of unmanned aircraft operating not more than 1,000 feet above the ground in large cities. There is no good way to track unmanned aerial vehicles (UAVs) in the sky. Drones, especially commercial or hobbyist drones, are small enough to appear like birds on radar and there isn't yet a system requiring them to broadcast their location to traffic control. The Defense Advanced Research Projects Agency (DARPA) wants to change that. The DARPA Aerial Dragnet project seeks to map all drones in the sky, especially unknown and hostile drones in war zones. NASA, which has a project for tracking drones, wants a way for drones to comply with each other and laws in friendly skies.

Raytheon to retrofit F-16 aircraft center display units

Raytheon avionics engineers will retrofit 130 center display units (CDUs) for Lockheed Martin F-16 jet fighters under terms of an $8.7 million U.S. Air Force contract. F-16 CDUs are large, rectangular liquid crystal displays (LCDs) that provide high-resolution sensor imaging, situational awareness, and real-time processing and imaging of flight safety information. The CDUs are part of a glass-cockpit design for the F-16 that replaces analog gauges and preserves flight safety. The center displays offer crisp imaging during the day, as well as at night with night-vision goggles.

UES to develop new electro-optical materials for sensors and communications

BY **John Keller**

The Air Force is working with industry to create a new generation of materials for electro-optical sensors and communications equipment.

WRIGHT-PATTERSON AFB, Ohio — Electronics materials experts at UES Inc. in Dayton, Ohio, are developing new electro-optical, electronic, and magnetic materials for advanced military infrared sensors, radar, and communications.

Officials of the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have announced a $42 million research contract to UES for the Nanoelectronics Materials Optimization (NEMO) program.

UES engineers will work to develop new electronic and electro-optical materials for digital, radio-frequency, microwave, infrared detector, opto-electronic, secure communications, power generation, sensing, and control applications. Of primary interest are new semiconductor materials, magnetic materials, optical and electro-optical materials, dielectric materials, and their heterostructures. UES may study lifetime and failure physics to understand these kinds of new devices and materials.

UES will design, synthesize, grow material, fabricate devices and processing methods, and evaluate new and modified materials and laboratory testing for new materials and device performance.

Air Force researchers say they believe this research could lead to:

- new solutions for frequency-agile operation over the broad electromagnetic spectrum;
- improved detection of day and nighttime events with high resolution or large coverage areas;
- sensors able to operate in high temperatures with low noise, high power density in electronic materials use;
- keeping device size, weight, and power consumption (SWaP) to a minimum; and
- affordable conformal, flexible, and shock-resistant electronic materials.

The overall goal of the NEMO program is to develop nanoscale materials and processing methodologies that are vital to create advanced materials and devices for future Air Force systems, researchers say.

UES probably won't be the only company involved; Air Force researchers say they expect to award one other contract for the NEMO program. The two contractors each will

pursue the goals of two separate task orders. The first task order involves nanoscale transport electronic materials and processes, and the second task order involves quantum semiconductor and magnetic materials and processes.

Nanoscale transport electronic materials and processes will involve nanoscale electrical and thermal transport to develop improved materials and processes for high-frequency RF transistors; frequency-agile RF devices; high-bandwidth transmit/receive elements; analog-to-digital converters for electronic warfare (EW); and thermal management of electronic and electro-optic devices.

Quantum semiconductor and magnetic materials and processes, meanwhile, involves new materials based on quantum confinement of electrons and holes in nanostructured materials in III-V and II-VI semiconductors, diamond and silicon carbide nanocrystals, graphene, and multiferroic oxides.

These nanostructured materials may be superlattices, quantum dots, ultrathin films, or layered heterostructures with new electronic, magnetic, and optical properties. The goal is to discover new materials and improved processes for future electronic, magnetic, and optical devices for Air Force applications for infrared detection; tunable radar and communication devices; spintronics; and quantum encryption and information devices.

On this contract, UES will do the work at Wright-Patterson Air Force Base in Dayton, Ohio, and should be finished by September 2022. ←

FOR MORE INFORMATION visit **UES Inc.** online at *www.ues.com*.

Raytheon to upgrade fire-control systems in Marine M1A1 battle tanks

BY **John Keller**

QUANTICO, Va. — Marine Corps Systems Command officials at Quantico Marine Base, Va., issued a $12.6 million order to Raytheon Integrated Defense Systems in McKinney, Texas, for the Abrams Integrated Display and Targeting System (AIDATS) to upgrade U.S. Marine Corps General Dynamics M1A1 Abrams main battle tanks.

The AIDATS upgrade to 400 Marine Corps M1A1 tanks will improve situational awareness with an upgraded thermal sight, color day camera, and single stationary display. AIDATS is an enhancement to the current uncooled thermal sight module and display control module for the weapon station. It substitutes a color camera for the M1A1's black-and-white camera, and adds a daylight and nighttime thermal sight, simplified handling with one set of controls, and a slew-to-cue button that repositions the turret with one command.

The system is the primary interface between the tank commander and his weapon system, and consists of color day camera, uncooled thermal sight, system display and processor, power filter module, software and firmware, as well as related components. The system display, power filter module, and cabling are integrated into the interior of the M1A1 turret in front of the tank commander's position without interfering with simultaneous movement of the tank turret and tank commander cupola. The color day camera and thermal sight are mounted on the outside of the M1A1 and are attached to the stabilized commander's weapon station.

On this order Raytheon will do the work in McKinney, Texas, and should be finished by August 2017. ←

FOR MORE INFORMATION visit **Raytheon Integrated Defense Systems** online at *www.raytheon.com*.

The U.S. Marine Corps M1A1 main battle tank is set for a major electro-optical systems upgrade to enhance the tank's fire control.

PRODUCT applications

POWER ELECTRONICS

Marvin Land Systems to upgrade and redesign power units on MLRS vehicles

U.S. Army combat vehicles experts are asking engineers at the Marvin Group in Inglewood, Calif., to redesign and upgrade the auxiliary power units (APUs) in the vetronics of the Army's Multiple Launch Rocket System (MLRS) fire-support vehicle.

Officials of the Army Contracting Command in Warren, Mich., have issued a presolicitation (W56HZV-16-R-L171) asking the Marvin Group's Marvin Land Systems segment in Inglewood, Calif., for additional development of hydraulic and electric APUs for the Army's MLRS vehicle.

Marvin Land Systems provides the APU and environmental control unit for the MLRS vehicles deployed today. The M270 MLRS is an armored self-propelled rocket launcher able to fire salvos of guided and unguided rockets at targets nearly 200 miles away. It has been in service since 1983.

Army researchers are asking Marvin Land Systems to develop the MLRS APU further, as well as demonstrate an electric-only output APU that would fit on armored ground vehicles about the size of the M2 Bradley Fighting Vehicle.

A vehicle's auxiliary power unit provides electrical power to the MLRS vehicle — especially to enable its companion environmental control unit. The existing MLRS APU from Marvin weighs less than 330 pounds, and provides 8.5 kilowatts of power at 28 volts DC output, with voltage ripple independent of the engine speed or load at less than 100 millivolts of root mean square (RMS) power.

FOR MORE INFORMATION visit **Marvin Land Systems** online at *www.marvingroup.com/index.php/companies/mls*.

SIMULATION AND TRAINING

ZedaSoft chooses UEI for avionics interfaces to Army attack helicopter simulator

Aircraft simulation and training experts at ZedaSoft Inc. in Fort Worth, Texas, needed avionics interfaces for an AH-64D attack helicopter simulator. They found their solution at United Electronic Industries (UEI) in Walpole, Mass.

UEI will deliver its PowerDNA (Distributed Networked Automation) Cube and avionics interfaces to ZedaSoft, which is providing the AH-64D simulator to the U.S. Army's Distributed Test Control Center (DTCC) at Redstone Arsenal, Ala.

ZedaSoft's simulator is integrated with UEI hardware and I/O for Army aviation and communication system testing activities, UEI officials say.

ZedaSoft's Reconfigurable Cockpit System (RCS) will serve as the pilot's station, while the ZedaSoft Reconfigurable Desktop System (RDS) will serve as the co-pilot and gunner station. ZedaSoft's Experimenter Operator Station (EOS) will control system testing.

ZedaSoft designers customized the reconfigurable cockpit to an AH-64D configuration, which includes touchscreen, multifunction

displays, a five-channel image generator, a control loading system, a high-fidelity flight model, and 120-degree horizontal and 60-degree vertical out-the-window visual displays.

The system uses two UEI PowerDNA Cubes that will act as the simulator linkage I/O and avionics interface.

The UEI PowerDNA Cube is a 4-by-4.1-by-4-inch rugged Ethernet-based interface that enables the user to configure one or more cubes to match I/O requirements. The Cube is suited for aerospace, industrial, and laboratory data acquisition and control applications.

UEI's PowerDNA Cube offers a choice of I/O boards; full avionics support; and compatibility with Windows, Linux, and real-time operating systems. The UEI framework provides an API and supports common programming languages and software applications such as LabVIEW and MATLAB.

FOR MORE INFORMATION visit **UEI** online at *www.ueidaq.com*, and **ZedaSoft** at *www.zedasoft.com*.

CONTRACT MANUFACTURING

Connectec to provide contract manufacturing for Army mortar equipment

U.S. Army munitions experts needed contract manufacturing to produce electronic and non-electronic components and support equipment for 60-millimeter, 81-millimeter, and 120-millimeter mortar systems. They found their solution from Connectec Co. Inc. in Irvine, Calif.

Officials of the Army Contracting Command at Picatinny Arsenal, N.J., announced a $96.7 million five-year contract to Connectec to manufacture 60-millimeter mortar weapon components and 81-millimeter lightweight mortar weapon components.

The contract also asks Connected to manufacture 60-millimeter, 81-millimeter, and 120-millimeter support equipment to include mortar mounts, base plates, direct support tools, basic issue items, and additional authorized list items.

The Army uses mortars to fire explosive shells at low velocities, at high angles, and at short ranges in support of ground troops. These weapons use muzzle-loaded tubes to deliver explosives on targets at relatively short distances that are concealed behind cover.

Connectec is a prime contractor for the U.S. Defense Logistics Agency, Air Force, Army, Navy, Federal Aviation Administration (FAA), and National Aeronautics and Space Administration (NASA).

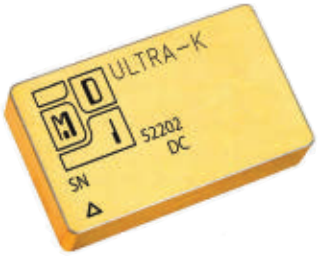
For this contract Connectec prevailed over five other companies who bid on this job. Connectec will do the work at locations to be determined with each order, and should be finished by August 2021.

FOR MORE INFORMATION visit **Connectec** online at *www.connectecco.com*, and the **Army Contracting Command** at Picatinny Arsenal at *www.pica.army.mil/Picatinny*.

RAD-HARD POWER

Radiation-hardened space power converters introduced by MDI

Modular Devices Inc. (MDI) in Shirley, N.Y., is introducing radiation-hardened space power converters for cryogenic temperature operation, particularly for spacecraft. MDI has developed a triple-wall Dewar system for characterizing the parameters of candidate active and passive components at temperatures as cold as 77 degrees Kelvin. A curve trac-



ing program using LabVIEW software is used for data collection. The parametric changes obtained from these measurements are then incorporated into relevant SPICE models, allowing predictions of circuit block performance. MDI has developed several power converter building blocks suitable for 77-degree-Kelvin power converters. Input voltages range from 5 volts DC from battery sources to 100 volts DC from satellite buses. Output voltages from these circuit blocks are available from 1.2 to 28 volts DC. Power levels can be from 1 to 100 watts. Also available are units that deliver 1 kilovolt or more, for propulsion or instrumentation.

FOR MORE INFORMATION visit **MDI** online at *www.mdipower.com*.

ANTENNAS

Body-worn antennas for tactical radios introduced by Southwest Antennas

Southwest Antennas in San Diego is introducing two S-band RHCP and LHCP patch body-worn antennas for multi-antenna MIMO/MANET radio applications such as handheld and small-form-factor body worn tactical radios. These antennas offer directional antenna performance, weigh 1.3 ounces, and are designed to be lightweight and worn and hidden in tactical clothing. The products are housed in a rugged, waterproof, UV-stable polycarbonate radome and are built to withstand abuse in harsh operating environments and active situations. The antennas are sealed to withstand immersion in 65 feet of saltwater for two hours when the RF connector is mated or sealed with protective end cap. The radome mea-

sures 0.51 inches thick, and 2.2 inches long and wide. A stainless steel SMA(f) RF connector helps prevent corrosion when the product is exposed to high salinity environments for extended periods of time.

FOR MORE INFORMATION visit **Southwest Antennas** online at *www.southwestantennas.com*.

EMBEDDED POWER

3U VPX 270-volt embedded power converter card offered by Aegis Power

Aegis Power Systems Inc. in Murphy, N.C., is introducing the 3U VPX 270-500 270-volt DC-DC embedded power converter card for military, aerospace, industrial, and commercial embedded computing applications. The lightweight 3U VPX embedded power unit is ruggedized; designed to meet portions of various military standards including Mil-Std-704, Mil-Std 461E, and Mil-Std-810F; and offers high power output, high efficiency, and a thin profile. The 270-volt DC VPX power supply units are suitable for VITA 62 standard rackmount chassis. The specifications of the VPX 270-500 power card exceed competitor models by yielding as much as 93 percent max efficiency, 500 watts total output power, and a small 4HP size. The conduction-cooled unit offers six output voltages, short-circuit protection with automatic recovery, option to parallel units, and a quick start-up time. Modifications may be available per customer request.

FOR MORE INFORMATION visit **Aegis Power Systems** online at *http://aegispower.com*.

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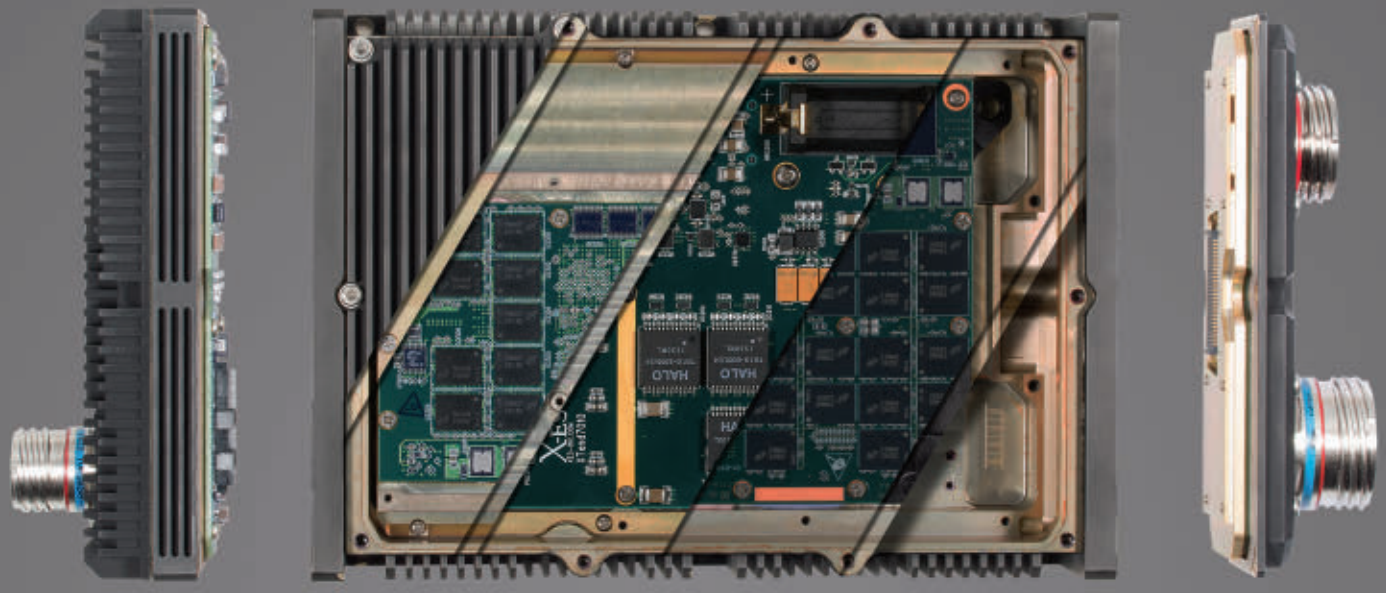

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