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Nov/Dec 2015 | Volume 11 | Number 8

SECURING MILITARY GPS

P 18

P 14

An interview with John Bryant, Senior Vice President, Defense Programs at Oshkosh Defense

Power management for military systems

P 26

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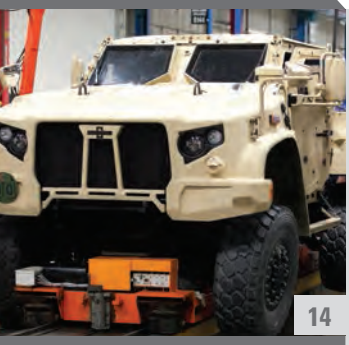

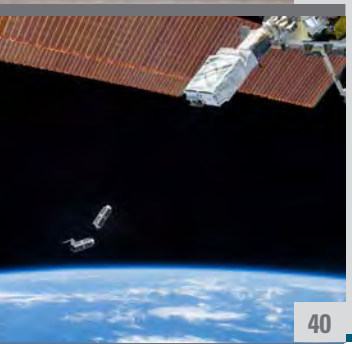

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Executive Interview

SPECIAL REPORT

Navigation/GPS Technology for Military Applications

MIL TECH TRENDS

Military Power Supplies

INDUSTRY SPOTLIGHT

VITA & PICMG Standards for Embedded Military Systems

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EVENTS

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ON THE COVER:

Top image: Air Force Airman 1st Class David Denesha enters coordinates into a Defense Advanced GPS Receiver (DAGR) while a UH-60 Black Hawk helicopter provides overwatch during training at Fort Dix, N.J. The DAGR is produced by Rockwell Collins.

Bottom image: Aviation Electronics Technician 1st Class Caleb Gilcrease supplies power to an MH-60R Sea Hawk helicopter prior to launch aboard the Ticonderoga-class guided-missile cruiser USS Mobile Bay (CG 53). (U.S. Navy photo by Mass Communication Specialist 2nd Class Armando Gonzales/Released).

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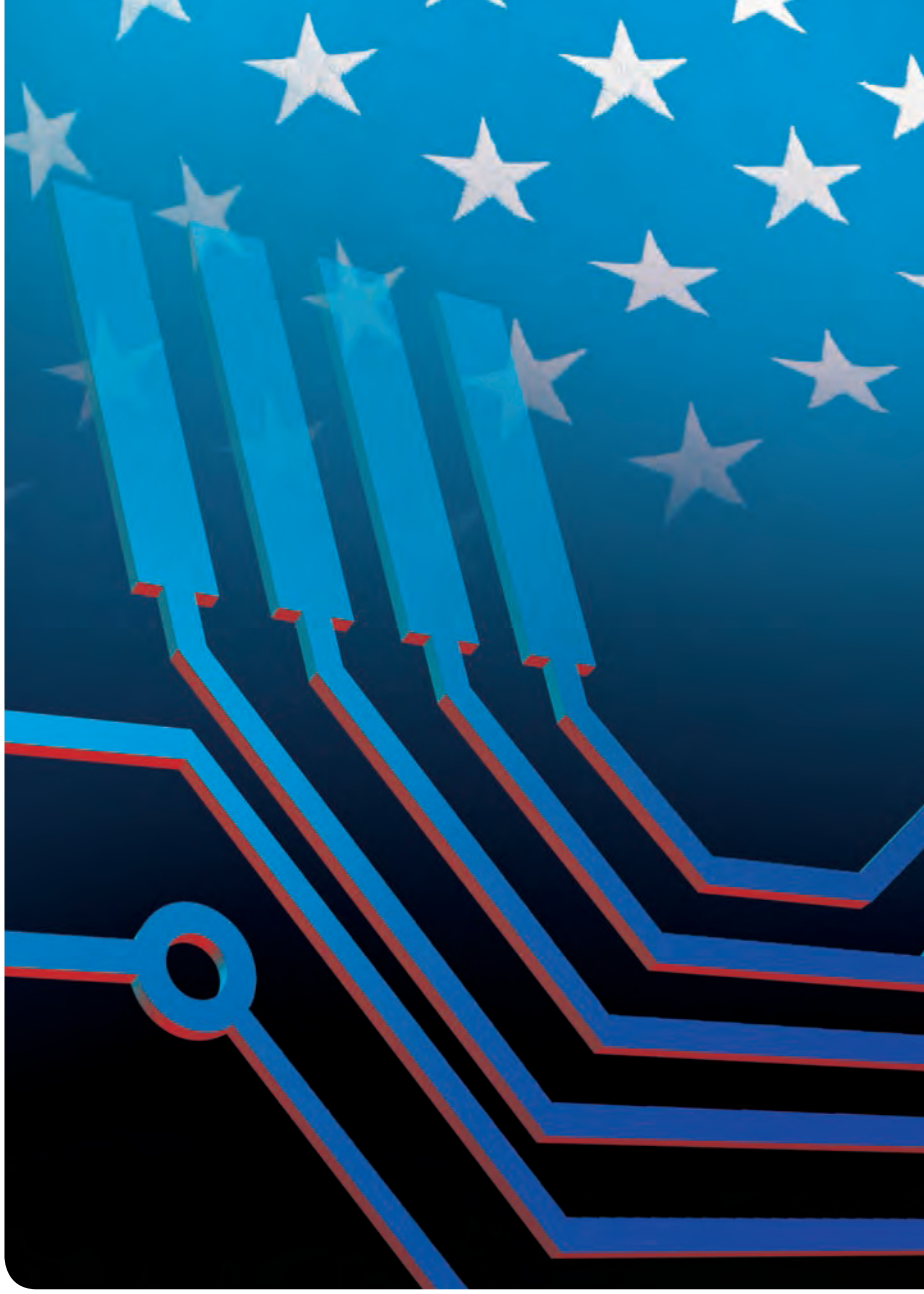

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Happy birthday, OpenVPX

By John McHale, Editorial Director

A little more than five years ago, OpenVPX/VITA 65 was ratified as an ANSI standard – ANSI/VITA 65-2010 (R:2012) – while just over six years ago, the OpenVPX Industry Working Group was founded by VITA member Mercury Systems. Mercury initially solicited other VITA members such as GE Intelligent Platforms and Aitech to put together the consortium and help lead it.

To mark the anniversary of OpenVPX, I interviewed experts from each company, as well as VITA leadership and Curtiss-Wright Defense Solutions, on the impact of OpenVPX technology and the lessons learned from what started out as a somewhat controversial process. The original ran in our COTS Confidential Roundtable discussion in the October McHale Report; what follows are some highlights from the roundtable. To read it in full, visit http://bitly.com/1QYAR1C.

Controversial start

When the OpenVPX working group was founded, it was initially set up outside the boundaries of VITA, which caused a bit of controversy at first. This structure proved successful in the long run, providing some lessons to those involved in the standards development process.

"Sometimes it's possible for inertia to set in when a standard is governed by many entities, and the very nature of standards bodies means that they may not make progress as quickly as the marketplace, customers, and technology demand," says Richard Kirk, director of core computing at GE Intelligent Platforms. "Occasionally, a disruptive force is required to break the cycle and get things on track; you might describe it as a 'wake-up call.' It probably should not be the model in all cases, but on occasion it can be effective. One lesson is, therefore, that the VITA Standards Organization (VSO) should be prepared to move faster."

Ian Dunn, vice president and general manager, and Robert Grochmal, OpenRFM program director, both from Mercury Systems – the company that led the "wake-up call" – say "attempting to infuse a consensus-driven environment with a sense of urgency can often conflict with the increasing demand for timely solutions. Sometimes 'out-of-band' efforts, where a team of domain experts generate a solid draft specification, which is then further refined by an expanded panel of experts, can be the quickest path to a solution. We also found that having committed customers on board early as a sponsor – in this case, The Boeing Co. – is critical so the standards team can stay focused on providing a relevant specification."

Not everyone was happy with how the OpenVPX Working Group process was started, believing that some bumps could have been avoided along the way.

"The original intent was to bypass the perceived 'bureaucracy' within VITA, but the exclusion of some companies from the process is not in the best interest of the industry," says Steve Edwards, director of product management, and Mike Slonosky, product marketing manager, power architecture SBCs, at Curtiss-Wright Defense Solutions. "The primary lesson learned is that we need to be able to operate quickly at times to get a spec to a releasable state in less than 12 months. That can happen within the VITA community, but only if clear ground rules are set up front and member companies dedicate resources to accomplishing this for the good of the industry. OpenVPX was successful because the companies involved dedicated resources to this effort, and continue to do so in order to keep the specification relevant as technology moves forward."

VITA's executive director, Jerry Gipper, agrees that valuable lessons were learned during launch. "Since then, the members have been much better at stepping back and taking a full-system point of view with an added emphasis on interoperability, hence the launch of the VITA 80 working group focused on developing methodologies for testing interoperability among VPX modules," he says.

VPX's next move?

What is next for VPX technology? A third revision of the specification is expected to be out in the first half of 2016, but other developments are happening, such as SpaceVPX and optical backplanes. I asked the panelists to predict the future.

"Programs are driven by humans, and generally all humans resist change," says Doug Patterson, vice president for Military and Aerospace Business at Aitech Defense Systems. "The same 'homily' applies to aerospace and defense programs. As component obsolescence takes its death grip on the older silicon used to make VME and CompactPCI systems, the natural progression will be toward VPX, or similar high-speed serial standards. However, there will come a time where high-speed serial copper-based backplane interconnects are not fast enough to implement the next generation of supercomputers, and options for solutions like fiber optics will be sought."

"Many people argued that VPX was too open, that it would fail like Futurebus," Gipper says. "I think the VPX pioneers had a bigger picture in mind for VPX; they weren't 100 percent sure what would work best for them but they did not want to be overly restrictive, leaving room for innovation. Since it is a living technology, it is adapting quickly to situations where it can rise above to be the best solution possible. More OpenVPX profiles will emerge; some will become widely accepted within the industry, while others will not survive. Fortunately, nothing in the technology or specifications prohibits creative application of VPX."

Choosing a processor a balancing act

By Charlotte Adams

A GE Intelligent Platforms perspective on embedded military electronics trends

How does a designer choose a processor for a single-board computer? The answer depends on many factors besides a chip's number-crunching prowess, including "macro" issues that arise from the outside environment, "micro" issues that are created by the chip itself, and intermediate issues relating to the board, box, and subsystem in which the device will function. Designers have to balance these factors and the interplay between them to select the best fit.

At the highest level the designer considers the likely physical and security challenges to the circuit. For example, can the chip be soldered to the host board to resist vibration and acceleration forces? Can it reject tampering and malware attacks? At the next level the designer considers factors such as the host board's function, power budget, and size constraints. Will the board require graphics capability and can that capability be integrated into the processing chip? In some cases a chip's versatility may trump its raw throughput. At the micro level the designer will consider factors such as throughput, power consumption, heat dissipation, and size.

Measuring performance

Perhaps the most important considerations in chip selection are comparisons of size, weight, power, and cooling (SWaP-C) versus performance tradeoffs at chip and board levels.

Compute performance is the primary requirement for a central processing unit (CPU), but performance is not an end in itself. More important is performance per watt: Is the CPU's performance affordable in terms of electrical power consumed and heat dissipated? Is it electrically and thermally viable for a given application? Despite its sparkling benchmarks, would the chip have to be run at a much lower-than-advertised clock speed to maximize reliability?

Thermal-management issues are a major cause of electronics failures, and heat removal is the highest bar to performance growth in embedded applications. Board manufacturers are deploying cooling solutions involving miniaturized heat pipes, piezoelectrics, and specialized materials. Integrated circuits must also cooperate, however.

Figure 1 | GE's SBC328 rugged 3U VPX single-board computer is based on sixth-generation Intel core technology ("Skylake").

Since most of the power they consume turns into waste heat, chips must provide the best possible processing rate per watt, as measured in GigaFLOPS or MIPS.

Embedded boards typically employ chips designed for the mobile or workstation market, depending on SWaP-C tradeoffs. Embedded computing often avoids server-class CPUs because they are big and hot and are usually socketed to the host boards. These traits, though acceptable in a data center, are anathema in a rugged environment, where size, heat dissipation, and vibration resistance are critical concerns.

Then there is the question of performance vs. flexibility. Do you go for conventional instruction throughput or parallel processing power? Or, within the constraints of embedded applications, do you want a combination of the two; that is, a chip with both conventional and graphics capabilities? Versatility is becoming increasingly important in applications such as electronic warfare, radar and sonar, command and control, intelligence/surveillance/reconnaissance (ISR), and signal processing.

Opportunity calls

Chipmakers, smelling an opportunity, have devised variations of high-end CPUs that maximize throughput but minimize die footprint, power consumption, and heat dissipation. New variants are solderable, thermally viable in embedded applications, and available in a range of configurations, allowing additional functions such as integrated graphics processing.

This convergence of supply and demand allows board designers to architect widely different products using a single family of chips, a fact which could translate to quicker time to market, faster upgrades, and longer lifecycles with lower costs to customers over time.

A product that considers performance per watt, thermal viability, and versatility is the GE Intelligent Platforms SBC328, a rugged 3U VPX single-board computer employing Intel's Xeon E3-1505M v5 server-class CPU with integrated graphics processing, antitamper and information assurance features, and a vapor chamber-style cooling system. The board can process 358 GigaFLOPS at less than 50 W (Figure 1).

Choosing the right processor for an SBC involves juggling multiple factors such as compute performance, throughput per watt, and thermal viability, all in the context of larger concerns. Thorough analysis of these factors results in the optimal processor choice, most effective board design, best fit with the intended application, and lowest cost to the customer over time.

www.gedefense.com

M-Code brings next-gen GPS to SWaP-constrained ground vehicles

By Mike Southworth

An industry perspective from Curtiss-Wright Defense Solutions

The combination of today's latest commercial off-the-shelf (COTS) hardware and command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) modernization initiatives – such as the U.S. Army's VICTORY standard – provides a common infrastructure for integrating new capabilities into ground vehicles while improving size, weight, power, and cost (SWaP-C) by eliminating redundant components. The VICTORY – the U.S. Army's Vehicle Integration for C4ISR/Electronic Warfare Interoperability – initiative fosters the use of open network interfaces, open data formats, and open protocols to enable the integration and sharing of networking, processing, display resources, and military position navigation timing (PNT) services. While not intended to define how line-replaceable units (LRUs) are built, the VICTORY open architecture standard does define how LRUs can intercommunicate and share data and resources. One of the objectives of VICTORY is to decrease the SWaP for the myriad C4ISR subsystems that threaten to overcrowd the crew areas inside a vehicle. At the same time, VICTORY integration delivers increased situational awareness while reducing the warfighter's operational burden by enabling the sharing of data between formerly stovepiped subsystems.

In a complementary effort, running in parallel to the VICTORY enterprise, the U.S. Army is advancing an Assured PNT program that will enable warfighters to transition from using less capable legacy military GPS user equipment (MGUE) such as Precision Lightweight GPS Receiver (PLGR) and Defense Advanced GPS Receiver (DAGR) SAASM (Selective Availability Anti-Spoofing Module)-based GPS devices. Assured PNT adds support for networkable GPS devices based on a new military signal called M-Code (Military Code). To speed the deployment of this GPS technology, the U.S. Congress has directed military acquisition managers to buy only M-Code-capable devices starting in fiscal year 2018.

PNT technologies provide an example of the challenges and opportunities that efforts like VICTORY were initiated to address: Today, when program managers add a proprietary or duplicative GPS receiver to their platform, they increase the weight and price of the system. Also helping to drive the transition to newer, networkable PNT technologies is the fact that in addition to not typically supporting network connectivity, PLGR and DAGR are unable to operate at the latest PNT data-assurance levels. Lack of network support and its effect on ground vehicles is highlighted by one Stryker vehicle variant that today carries nine separate DAGRs, each with its own antenna, and each of which operates completely independent of the others.

"... M-Code receivers feature advanced security aimed at preventing unauthorized access or exploitation by adversaries."

Compared to PLGR and DAGR, M-Code gives users access to a higher-power signal that is more resistant to jamming and interference, along with improved message formats and signal modulation techniques that make it both faster and more accurate. In addition to improving military GPS signals, M-Code hub devices support Ethernet networking and address the need for scalable distribution of PNT data. Moreover, M-Code receivers feature advanced security aimed at preventing unauthorized access or exploitation by adversaries.

Historically, tactical ground vehicles have been burdened by large "bolt-on" C4ISR electronics packages equipped with proprietary, stovepiped communication interfaces that were coupled with numerous independent GPS peripheral devices. This approach taxed the technology acquisition, upgrade cost, and interoperability of vetronics subsystems for vehicle programs. The crowded vehicles also had less physical space allotted for people, ammunition, and supplies. Initiatives like VICTORY are helping to mitigate these SWaP burdens. Since every device plugged into a VICTORY network backbone will be able to use a single GPS system, only one such device will be required in a vehicle. The end result, transparent to the warfighter, will be a roomier vehicle cabin and more efficient data sharing. For the ground-vehicle program manager, the benefits will include a greatly reduced overall lifecycle cost for maintaining the platform.

Figure 1 | The DuraDBH-672 Digital Beachhead Gigabit Ethernet switch and vetronics computer subsystem addresses the U.S. Army's ground-vehicle GPS modernization efforts.

A COTS solution now available for integrating M-Code GPS into ground vehicles is Curtiss-Wright's second-generation DuraDBH-672 Digital Beachhead Gigabit Ethernet switch and vetronics computer subsystem. This VICTORY appliance supports an integrated M-Code Ground-Based GPS Receiver Applications Module (GB-GRAM-M) and addresses the U.S. Army's GPS modernization programs (Figure 1).

Mike Southworth
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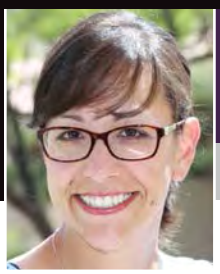

DEFENSE TECH WIRE

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By Mariana Iriarte, Associate Editor

NEWS

RadioMap spectrum management program reaches final phase

The Defense Advanced Research Projects Agency (DARPA) advanced RF mapping program – RadioMap – has reached its final phase as DARPA officials have selected Lockheed Martin engineers to further develop technology from the first two phases into a full system that can be transitioned to military services.

RadioMap seeks to provide real-time awareness of radio spectrum use across frequency, geography, and time. Program engineers are developing technology that visually overlays spectrum information on a map. It uses real-time visualization of actual spectrum that can help users detect the unused frequency. The RadioMap Phase 3 base period is scheduled through summer of 2016. Further operational testing could occur in early 2017 if the test is successful with the Marine Corps.

Figure 1 | Program aims to provide real-time RF map to help troops use and manage available spectrum in tactical operations. Photo courtesy of DARPA.

U.S. Air Force's GPS IIF-11 satellite launches to join GPS network

Officials at United Launch Alliance have announced the launch of the Global Positioning System (GPS) IIF-11 satellite for the U.S. Air Force. It joins the GPS worldwide timing and navigation system, using 24 satellites in six different planes, with a minimum of four satellites per plane positioned in orbit approximately 11,000 nautical miles above the Earth's surface.

ULA's Atlas V Evolved Expendable Launch Vehicle (EELV) 401 configuration vehicle carried the load to space. The EELV program – established by the U.S. Air Force – provides access to space for the Department of Defense and other government payloads.

Unmanned aircraft registration requirement announced by FAA

Transportation officials have announced the creation of a task force aimed at developing recommendations for a registration process for unmanned aircraft systems (UASs).

Transportation secretary Anthony Foxx and Federal Aviation Administrator (FAA) administrator Michael Huerta made the announcement. "Registering unmanned aircraft will help build a culture of accountability and responsibility, especially with new users who have no experience operating in the U.S. aviation system," Foxx says.

The task force will be composed of 25 to 30 representatives from the UAS and manned aviation industries, the federal government, and others. The group will advise the Transportation Department on which aircraft should be exempt from registration due to a low safety risk, including toys and certain other small UASs. They will also look at options for a streamlined system that would enable easier registration of commercial UAS operators and make additional safety recommendations.

U.S. Army procures APKWS laser-guided rockets for AH-64 Apache Helicopter

For ongoing operations in Iraq and Afghanistan, the U.S. Army has procured an initial quantity of BAE Systems' Advanced Precision Kill Weapon System (APKWS) laser-guided rockets from the Navy's inventory to be deployed in AH-64 Apache helicopters. The services are also working together to secure additional rockets to meet ongoing demands.

According to officials, this marks the first time the U.S. Army will use the laser-guided rockets. The APKWS system is a U.S. Navy program of record and has been deployed with the Marines.

Figure 2 | AH-64 Apache helicopter shoots rocket during test. Photo courtesy of BAE Systems.

Long Range Strike Bomber contract won by Northrop Grumman

Department of Defense and Air Force officials announced that Northrop Grumman Corp. won the Engineering and Manufacturing Development (EMD) and early production contract for the Long Range Strike Bomber (LRS-B).

Air Force officials say that the bomber will leverage open architectures in its design to enable integration of new technology. The LRS-B is to replace the Air Force's aging fleets of bombers with a bomber that can penetrate and operate in tomorrow's anti-access/area-denial environment.

The contract is made up of two parts: First is the EMD phase, which is a cost-reimbursable-type contract with cost and performance incentives estimated at $21.4 billion in 2010 dollars. The second portion comprises options for the first five production lots, consisting of 21 aircraft out of the total fleet of 100; they are fixed-price options with incentives for cost. Based on current LRS-B independent cost estimates, the Air Force projects that the average procurement unit cost for the program will be approximately one-third of the previous B-2 stealth aircraft.

Figure 3 | Secretary of Defense Ashton Carter introduced Secretary of the Air Force Deborah Lee James and Air Force Chief of Staff Gen. Mark A. Welsh III during the press briefing announcing the LRS-B award in the Pentagon. Photo courtesy of U.S. Air Force.

Explosive detection system for Army to be developed by Cobham

U.S. Army officials have tasked engineers at Cobham to develop next-generation technologies that can detect land mines and other explosive hazards that are hidden in the ground.

The $4.17 million development contract will last three years to produce an end result of a highly specialized handheld technology demonstrator created to provide the Army with a system that has increased capability beyond what similar systems can provide today.

Work performed under this contract will occur at Cobham Antenna Systems' business unit locations at Marlow and Leatherhead, England, at the direction of the Army's Communications – Electronic Research Development and Engineering Command.

Kuwait wants Sniper Advanced Targeting Pods under foreign military sale

U.S. State Department officials made a determination approving a potential foreign military sale (FMS) to the government of Kuwait for 14 Sniper Advanced Targeting Pods (ATPs) and associated equipment, parts, and logistical support. Lockheed Martin Missiles and Fire Control in Orlando, Florida, is the principal contractor.

Non-major defense equipment (MDE) items also in this request include associated equipment, spares, accessories, and airworthiness certification. The sale will have the system integration on the purchaser's F/A-18 aircraft, along with improvements to the onboard mission computer software suites. Operational support for these modifications will be made through upgrades.

Also included in this request are software development /integration, systems integration and testing, support equipment, maintenance and pilot training, test sets, spares, repair parts, publications and technical documents, U.S. government and contractor technical assistance, and other related elements of logistics, engineering, and program support. The MDE cost is estimated at $50 million, with the total cost estimated at $115 million.

Army Patriot radar processor upgrade contract won by Raytheon

U.S. Army officials are acquiring radar digital processor (RDP) upgrade kits from Raytheon to enhance the Patriot Integrated Air and Missile Defense system's ability to detect and destroy threats, reduce operational cost, and improve reliability.

The contract modification will enable the U.S. Army to complete the upgrade of their entire inventory of Patriots. The U.S. Army began phasing the upgrade kits into its Patriot fleet in 2013. The contract is not to exceed $86.2 million.

"When one country develops an upgrade or improvement to the Patriot, that capability is made available to the entire 13-nation partnership," says Ralph Acaba, vice president of Integrated Air and Missile Defense at Raytheon. "With more than 220 Patriot fire units owned by 13 countries, countries whose industrial bases participate in manufacturing Patriot have a very large potential export market."

Figure 4 | Raytheon's upgrade kits will enhance the Patriot Integrated Air and Missile Defense system. Photo by Raytheon.

JLTV from Oshkosh leverages C4ISR tech, open architectures

By John McHale, Editorial Director

An Oshkosh Defense technician puts the finishing touches on the company's Joint Light Tactical Vehicle (JLTV). Photo courtesy of Oshkosh Defense.

In this Q&A with John Bryant, Senior Vice President, Defense Programs at Oshkosh Defense in Oshkosh, Wisconsin, he discusses his company's win of the Joint Light Tactical Vehicle (JLTV) contract from the U.S. Army. He also details the C4ISR capability of the JLTV, explains how the vehicle leverages open architectures to help deal with obsolescence, talks about how the JLTV win is affecting the local Oshkosh community, and briefly addresses the current protest of the JLTV sole source selection.

MIL-EMBEDDED: ***Please provide a brief description of your responsibility within Oshkosh and your group's role within the company.***

BRYANT: I am the Senior Vice President of defense programs for Oshkosh Defense, a business division within Oshkosh Corporation. I lead the development, production, and sustainment of all vehicle and product platforms for Oshkosh Defense.

MIL-EMBEDDED: ***The Joint Light Tactical Vehicle (JLTV) award to Oshkosh is currently under protest by Lockheed Martin, with a decision reportedly expected by the end of this calendar year. Do you have any comments on the protest?***

BRYANT: While I cannot comment on specifics of the JLTV source selection due to it being under protest, I can share my view of the process based on my experience as a program manager and also on having run the program manager course at the Defense Executive University. From that perspective, I believe the Army efforts on the JLTV contract process and sole source selection were thorough and sound through and through, and the contract is very quantifiable. As it was such a robust process, I believe it would be difficult for the JLTV source selection to be successfully protested. Now, while I didn't get to see the bids of the competitors, I did see our debrief, which was very detailed and thorough. The Army's debrief also provided absolute clarity that the Oshkosh JLTV was the best vehicle for the warfighter and the best value for the taxpayer.

MIL-EMBEDDED: ***Please describe the JLTV development and its survivability features?***

BRYANT: We had an advantage in developing JLTV that we already had the Oshkosh MRAP-All Terrain Vehicle (M-ATV), which is really the only vehicle performing with a JLTV mission profile in-theater. It is saving lives right now. So, if you look at the M-ATV and the JLTV capsule, you will see that the JLTV very much resembles the M-ATV capsule; that is not by accident, as we leveraged our experience with those vehicles in theater and combat. We used our CORE1080

protection system and optimized it for the JLTV, providing the M-ATV's level of survivability in a platform that is one-third lighter than the M-ATV.

That experience in-theater and the more deliberate nature of JLTV program enabled us to design every component and piece of equipment – from the seats to the drive train – for survivability. Everything on the JLTV contributes positively to crew survivability. The survivability is not provided through sheer mass of armor, either. A good analogy would be with NASCAR vehicles that are not encumbered by levels of thick armor: When these vehicles crash into a wall or are hit by another vehicle, the driver more often than not hops out and is fine. This is because NASCAR vehicles surround the driver with equipment and components individually designed for survivability.

The JLTV is also a third the weight of the M-ATV and has increased its extreme-off-road mobility by 70 percent compared to the M-ATV.

MIL-EMBEDDED: ***How will the Marine Corps JLTV variant differ from that of the Army and vice versa?***

BRYANT: There is not a unique Marine Corps variant. The JLTV is built on a common set of requirements that meet the needs of the Army and Marine Corps. Differentiation occurs on how the services configure the JLTV based on mission requirements. The platform is designed for that plug-and-play configuration and are not just for the Army or Marine use, but for multiple configurations.

Through the converged set of requirements, the JLTV satisfied the needs of both the Marine Corps and the Army while meeting cost targets. I think it is a model that someday will be taught in defense-acquisition courses.

MIL-EMBEDDED: ***What types of Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) equipment will be leveraged in the JLTV?***

BRYANT: The Oshkosh JLTV is essentially a mobile command center. It is wired for current and future C4 systems to [with scalability] accommodate the installation of expansion packages as the infrastructure is already there. We can't get into specific details about the C4 systems on board, but the JLTV can carry or support all current radios and electronic equipment. C4ISR capability on the JLTV includes electronic-warfare devices and counter-radio electronic-warfare systems as well as GPS technology. It also has HF, VHF, UHF, SATCOM, and vehicle intercoms for communication. For on-the-move operations, it has situational-awareness systems such as shot detection, long-range surveillance, and silent watch power systems as well as visible light and infrared camera systems.

[While] many of today's vehicles simply get configured and delivered, making it difficult to modify them for a specific mission, the JLTV – in contrast – is flexible; C4ISR subsystems can be installed at the field level, enabling users to perform missions and reconfigure the vehicle for individual mission set requirements.

Additionally, the JLTV's integrated network means that the equipment and systems within the vehicle can be used independently or are interoperable with one another, providing a common sight picture. The network and vehicle enable users to display the vehicle configurations. For example, the driver has the capability to pass control to someone in the back seat if necessary. The network system also enables users to share information.

MIL-EMBEDDED: ***Will the JLTV's vehicle electronics (vetronics) leverage the VICTORY (Vehicle Integration for C4ISR /EW Interoperability) architecture and what will the VICTORY architecture bring to the platform?***

BRYANT: A VICTORY-compliant architecture is integrated through smart displays and centralized computers. Any combination of radios and C4ISR equipment can be added with a capability to handle larger requirements in the future.

MIL-EMBEDDED: ***How does the JLTV enable power management through its various systems, especially with all the C4ISR technology?***

BRYANT: We provide ten kilowatts of power to handle a wide variety of C4ISR configurations and we also provide growth capacity, as our onboard digital architecture allows integration of a wide variety of C4ISR suites tailored to commanders' needs.

MIL-EMBEDDED: ***Will the JLTV make use of commercial off-the-shelf (COTS) and open architectures to leverage high-performance commercial technology and also manage obsolescence issues?***

BRYANT: Many of the CORE1080 components today are COTS; however, items such as vehicle displays are fully ruggedized to meet military environmental specifications. These are not desktop systems by any means.

Regarding obsolescence, the JLTV design absolutely reduces life cycle costs. A key factor in JLTV development was enabling scalability to perform upgrades cost effectively. Components on the Oshkosh JLTV themselves are not high cost, so if

they break there are not large operations and support cost burdens. We also designed high reliability at the system level so those low-cost components don't break very often. Lastly, we provided superior fuel economy to help drive down operational costs.

Many of the design team at Oshkosh served as mechanics to ensure that the final JLTV platform will be maintainable for cost and protection. It also designed so that maintenance of the vehicle does not result in excessive downtime. Nobody wants an available vehicle part that takes 48 hours to get. Downtime will be minimal so the JLTV can get right back to the fight.

MIL-EMBEDDED: ***What types of human-factor feedback have you received from vehicle operators that you have integrated into the JLTV design?***

BRYANT: Small things that make operators' lives easier are typically what get suggested. For example, we added cup holders to our seats so they have a place to put their drinks, and we redesigned the seats so that an operator wearing a CamelBak may sit without it pressing into his back. It helps that we have many ex-military and current military personnel working for us and also advising us on the design. The JLTV capsule has more room for the occupant, as a result of that operator and former operator input.

MIL-EMBEDDED: ***When is the first JLTV expected to be deployed?***

BRYANT: The current plan the government has published will see a full-rate production decision in 2018, followed by the Army first unit equipped in 2018, with Marine Corps initial operating capability reached in 2018 as well.

MIL-EMBEDDED: ***The JLTV award is a positive boost to the military vehicle market, which has been flat for a few years as the U.S. military pulled back its global footprint. That said, how do you view the military vetronics over the next five years – growing, shrinking, or flat? Why?***

BRYANT: We've seen a decline in the defense budget, but actually Oshkosh received significant awards for their family of heavy tactical vehicles through Army recapitalization contracts. The JLTV will offer stability as those medium and heavy programs start to drop off in the coming years. As JLTV ramps up to full-rate production, it will provide stability for our workforce. We also expect international sales to increase.

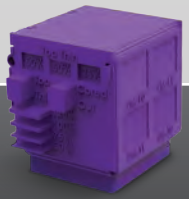
MIL-EMBEDDED: ***Large contracts like the JLTV and others before it have been shown to have positive long-term impacts on the winning company's local community. How will this contract impact Oshkosh, Wisconsin?***

BRYANT: It has had a positive impact already in the Oshkosh community and a large portion of the supply base in Wisconsin and significantly in Oshkosh. When we win a program like JLTV or receive orders for the M-ATV, the positive economic impact extends well beyond Oshkosh Defense to the entire local and state community. Its local economic impact goes well beyond Oshkosh Defense. **MES**

__John Bryant__ is the senior vice president of Defense Programs for Oshkosh Defense where he leads the development, production, and sustainment of all vehicle and product platforms and programs for Oshkosh Defense, Integrated Product Support (IPS), and contract administration. He previously served as vice president and general manager of Joint and Marine Corps Programs for Oshkosh Defense. As a retired colonel, Bryant brings a 28-year history of service with the Marine Corps to his role at Oshkosh. Prior to joining Oshkosh, he was a professor of program management at the Defense Acquisition University. Bryant holds a bachelor's degree in political science from Marquette University. He also received Level III certification in program management from the Defense Acquisition University.

Refuse to Let Design Fall Flat

Proto Labs is the world's fastest manufacturer of prototypes and low-volume parts. To help illustrate the design challenges encountered with injection molding, we created the Design Cube. See thin and thick sections, good and bad bosses, knit lines, sink and other elements that impact the moldability of parts.



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Securing military GPS from spoofing and jamming vulnerabilities

By Sally Cole, Senior Editor

The military community is in the midst of navigating a transition from selective-availability anti-spoofing module (SAASM) to modernized M-code encryption and adjusting to the major shift to international satellite constellations; the military is also on a quest for better methods to secure the Global Positioning System (GPS) from spoofing and jamming threats.

Air Force Airman 1st Class David Denesha enters coordinates into a Defense Advanced GPS Receiver (DAGR) while a UH-60 Black Hawk helicopter provides overwatch during training at Fort Dix, N.J. The DAGR is produced by Rockwell Collins.

The U.S. NAVSTAR GPS and global navigation satellite system (GNSS) are essential to military navigation, but how secure is military GPS to spoofing and jamming threats?

The short answer is that there are numerous changes underway to make military GPS more robust to these threats, as well as efforts to develop supplemental technology capable of operating even within GPS-denied environments.

Within the military realm, secure GPS has traditionally been defined as "encrypted GPS, military GPS, or SAASM GPS," says Al Simon, marketing manager for Rockwell Collins in Cedar Rapids, Iowa. "While there are a number of terms associated with it, it all has to do with the military code being used. We generally describe 'secure GPS' as military-encrypted GPS that uses military P(Y) code."

New terminology is starting to emerge from within the military community. "The U.S. Department of Defense (DoD) is now talking about assured position, navigation, and timing (PNT)," Simon adds. "This introduces other elements of security, even though they don't call it 'secure GPS.' Instead, it's usually referred to as 'assured PNT,' and uses the latest encrypted GPS technology or M-Code, as well as high levels of anti-jam or cyber resiliency … and eventually other sensors will be used to protect the PNT. So we're starting to move the navigation conversation beyond just GPS."

PNT approaches to provide backup coverage, such as inertial navigation systems (INS), are appealing options. "These systems use inertial measurement units (IMUs), a collection of precise accelerometers and gyroscopes that measure movement without any outside reference and are immune to jamming," says John Fischer, chief technical officer for Spectracom in Rochester, New York. IMUs tend not to be used as a standalone approach, however, because, Fischer says, they "drift over time and become inaccurate quickly."

GPS vulnerabilities: spoofing and jamming

Military GPS must be capable of withstanding or working around vulnerabilities to fend off spoofing and jamming attacks, which are both increasing.

Jamming is the intentional or unintentional interference of the signal that prevents it from being received, which is relatively simple to do.

Spoofing, on the other hand, is more challenging. "It requires simulating the GPS accurately and capturing the user's receiver away from the true signal to steer it off course," Fischer says. "Doing this requires some very complex signal-generation equipment to track the vehicle first to exactly match its trajectory before you can start spoofing. So if you're engaging an enemy vehicle and have acquired it and are tracking it, there are simpler ways of engaging – like shooting it down – than spoofing."

How secure is military GPS?

Military receivers use encrypted GPS signals to ensure that they are receiving an authentic signal – so these are secure in that they can't be spoofed, Fischer points out.

A common misconception, however, is that a secure military GPS receiver is immune to jamming. "It's easy to jam even the encrypted signal," he adds. "Signals from satellites are so weak that even a one-watt to 10-watt jammer can deny GPS coverage for a large area of both military and civilian signals."

The U.S. military is in the midst of transitioning from the current SAASM technology to a newer encryption technology known as M-code. "This offers a few measures

to be more jam resistant, but with high jammer-to-signal ratios so easy to implement by the enemy, M-code won't alleviate the problem with jamming," Fischer says. (Figure 1.)

While points of vulnerability always exist, the industry is designing systems to provide the maximum protection possible. "One of the reasons the U.S. government is spending a lot of money on the GPS modernized M-code system is because it provides a substantial increase in the level of protection from an encryption and security standpoint," Simon says.

When dealing with cyberthreats and spoofing, it's essential to put solid protection in place and use levels of redundancies to prevent and identify attacks. "Even if one level of protection falters, redundancies or crosschecks need to be built into systems to ensure that you catch these attacks – even if your system is shut down for one reason or another – so that it's not taken off the air completely and you can restore it yourself," Simon says. "It's analogous to any national infrastructure trying to protect itself from the whole cyberenvironment."

Rockwell Collins is a forerunner within the anti-jam realm because the initial need for anti-jamming was driven by the weapons community. "The weapons community requires high-precision anti-jamming and the ability to maintain it until an end target is hit," Simon points out. "I think the highest levels of the DoD would say that as long as there are satellites in the sky, we've got the level of anti-jam that's going to keep forces protected where needed."

However, there is always the potential issue of a satellite that stops working or is taken out for one reason or another. "So, within the past several years, there's been a lot of discussion about GPS being 'denied' or 'challenged' … there's a need to ensure some sort of backup capability to sustain temporary GPS or GNSS outages," Simon says.

Eventually, "the Holy Grail will be an alternative navigation system that can do everything and is as widespread as

Figure 1 | The SecureSync from Spectracom is a SAASM GPS receiver in a GPS time server with a backup atomic clock in case of GPS disruption.

GPS is today," Simon adds. "Those systems don't exist yet, but for several years down the road, the military community will be seeking to develop them."

GPS "smart" antenna tech advances

A conventional antenna has full hemispherical coverage so it can see the entire sky and listen to as many as 12 satellites at once to determine the best navigation solution. "A 'smart' antenna is capable of focusing multiple narrow beams directly at the satellites and tracking them as they pass overhead, while pointing nulls – regions where the antenna doesn't receive a signal – at any interference," Fischer explains. "These devices drastically improve GPS reception within the presence of jamming, but are expensive and larger than conventional antennas."

Electrically steerable directional antennas are "the best bet to combat jamming," according to Fischer. These are also known as controlled-reception pattern antennas (CRPAs) or "smart" antennas.

In the past, fixed-reception pattern antennas (FRPAs) were used, but now "users are migrating to multi-element CRPAs," Simon says. "For several years, we've operated with FRPAs and four-element CRPAs but some of the more sophisticated systems are beginning to operate with more elements. This means more flexibility or degrees of freedom to deal with the signal environment, which has to do with the number of signals being tracked or jammers you're trying to reject."

As the level of multi-element CRPA antennas in the world increases, it is "enhancing interoperation with the more sophisticated GPS receivers with advanced anti-jam capabilities that can track more channels," Simon adds.

Another area of antenna advances has to do with size, weight, and power (SWaP). "In some cases, we're seeing the potential integration of antennas and antenna electronics," Simon says. "It used to be that the more sophisticated antenna electronics were either placed on a GPS card or on standalone antenna electronics units. In isolated cases, we're even seeing antenna electronics integrated with the antenna. So there's a slight shift in flexibility in terms of how any particular integrator or user can now start integrating all of this capability."

Future of navigation

GPS is currently undergoing changes on several fronts, including the introduction of international satellite constellations, the transition from SAASM to M-code, and a search for technologies capable of augmenting GPS.

So, what does the future of navigation hold? With the shift to GNSS, "there's value to be gained by looking at other constellations' signals, in terms of signal availability, cross-checking, and using these added signals to ensure system robustness," Simon asserts.

The shift from SAASM to M-code is well underway – nearing the final stages of development – and the weapons community is busy trying out figure out how to get M-code into their systems to make the transition by fiscal year 2018.

In terms of the future of navigation systems, expect to see supplemental technologies used as backup, depending on the user and platform. "There will be definite levels of GPS and GNSS assistance, which may involve going to other constellations or the highest level of navigation-grade inertials," Simon says. "Or it could involve very enhanced timing capabilities … there are a number of different levels of protection and assistance that different users' systems may need, depending on who the user is and exactly what they're using GPS for."

Whether used exclusively for navigation, positioning, targeting, sensor support, or timing support – or all of the above – these factors "will likely dictate a different set of sensors and capabilities," Simon points out. "But the common denominator is GPS."

Nearly everything that moves will have a GPS receiver in it in the future, according to Fischer. "The signal covers the globe, receivers are cheap, and the accuracy is superior to anything else. Its two biggest drawbacks are the weak signal that's easy to jam and its unavailability indoors," he adds.

Fischer says he also envisions the future of navigation as a hybrid blend of GPS and other alternatives. "Micro-electromechanical systems (MEMS) technology is greatly improving inertial measurement unit (IMU) accuracy at a fraction of the cost of conventional components and is revolutionizing INS systems," he points out. "And graphical processing, led by the gaming sector, is growing at a rapid pace, making vision-recognition systems practical."

Radar and lidar systems "are advancing with millimeter-band RF semiconductor and electro-optic advances being fueled by the driver-assisted and driverless car industry," Fischer says. "'Crowdsourced' navigation – in which a device on a network that doesn't know its position can infer it by communicating with many other nodes that might know theirs, and then measuring the proximity distance to them by radio transmission delay – is an emerging technology ideal for smartphones."

Spectracom is working with all of these technologies to create a comprehensive navigation system. "Our mission is to simplify the integration of PNT technology into our customers' systems, so we'll bring all of these technologies – not just GPS – to the solution," Fischer notes. **MES**

Navigation warfare: GNSS denied – threat and mitigation

By Neil Gerein and Peter Soar

Bombardier Suddes and Master Bombardier Wiseman, from Y Battery Royal Canadian Horse Artillery (RCHA), plan their target engagements to support the trial of a GPS anti-jammer antenna. Photo courtesy of Defence Research and Development Canada.

Deliberate jamming of Global Navigation Satellite Systems (GNSS) – including the U.S. GPS, Russia's GLONASS, China's BeiDou, and Europe's Galileo systems – is a fact. It's a problem because the best accuracy, availability, and global coverage of position, navigation, and time (PNT) data is from GNSS. Emerging technologies show promise for the future, but the good news is that techniques and solutions already exist to ensure that "friendly forces" can have reliable, robust PNT. That robustness may be achieved by multiconstellation/frequency GNSS, multisensor navigation, and anti-jam antenna systems.

Navigation warfare (NAVWAR) threat

Deliberate, intentional jamming is occurring with increasing regularity and should now be expected as a routine aspect of operations to disrupt and deceive. As with other aspects of electronic warfare (EW), attacks on PNT capabilities are often made before any "kinetic" fighting. Examples of effective jamming include recent incidents in Korea and Ukraine. Repeated jamming against GPS, allegedly from North Korea, was experienced in South Korea between August 2010 and May 2013 when many ships and aircraft reported disruptions to the received GPS signal. More recently, the Organisation for Security and Cooperation in Europe (OSCE) has reported "military-grade" GPS jamming directed against the unmanned aerial vehicles (UAVs) of its Special Monitoring Mission (SMM) in Ukraine.

Low-level, but nonetheless insidious and illegal, jamming is pervasive. So-called "personal protection devices" (PPD) are being used to disable vehicle-tracking devices to mask the use of company-owned vehicles for private purposes, or similarly to incapacitate covert trackers that a person feels may be attached to their vehicle. Worse, GNSS jammers are now being used as part of vehicle-hijacking attacks to stop an emergency report of position being made, as reported by the FBI: "… GPS tracking devices have been jammed by criminals engaged in nefarious activity including cargo theft and illicit shipping of goods." In 2014, the UK's SENTINEL Project investigated mission-critical or safety-critical services, which need to be able to "trust" GNSS signals. It found that some key sites were reporting five to ten jamming incidents daily, and that the problem is growing.

Despite some PPD publicity statements like "This product has low operating power and little working radius to prevent interfering with other cars or important city systems which rely on GPS navigation," some of these devices are surprisingly powerful. (Note: Readers of *Military Embedded Systems* will be familiar with the incidents in 2012 that produced harmful interference to the Ground Based Augmentation System (GBAS) at Newark Liberty International Airport.)

Spoofing is the attack method that seeks to supplant good GNSS satellite data with false signals, either by rebroadcast or by signal generation, in order to have the receiver give out incorrect position or time data. The consequences of a successful spoofing attack could be severe; consider false targeting information or the effect of taking advantage of a timing offset in high-speed financial trading. Fortunately, spoofing is much harder to achieve than the jamming discussed above if simple protection measures are used. Authorized users can take advantage of the U.S.-controlled encrypted GPS signals by using the Selective Availability Anti-Spoofing Module (SAASM) and the upcoming M-Code. The ease of capturing a normal unprotected civil receiver where its velocity is known has been demonstrated, notably by a team from the University of Texas at Austin. However, creating the same effect on a number of

receivers at the same time is much harder and becomes impossible with larger numbers.

NAVWAR mitigation measures

Preventing the jamming signal from reaching the GNSS receiver is vital to interference mitigation. To this end, Controlled Reception Pattern Antenna (CRPA) anti-jam systems have proven highly effective. The CRPA and accompanying electronics dynamically change the apparent antenna gain pattern to create nulls in the direction of interference signals. This shift effectively reduces the level of interfering signal imparted on the GNSS receiver electronics. The adversary can continue to increase the jammer power until even the anti-jam antenna electronics are saturated; however, higher power jammers expose themselves to detection and geolocation techniques.

While low-power GNSS signals are susceptible to jamming, other navigation sensors can provide NAVWAR protection. Inertial sensors at present lack the long-term stability of GNSS, but they are immune to jamming and spoofing since they do not rely on radio frequency signals. Inertial sensors can be used as a consistency check against the GNSS sensor during times of attempted spoofing. They can also be relied upon during extended GNSS outages, as long as attention is given to the drift components of the inertial solution. Adding additional measurements from wheel sensors further increases resilience to jamming and spoofing.

Figure 1 | OEM6 receivers feature scalable positioning options and low latency positioning with high data rates. They support all current and upcoming GPS, GLONASS, Galileo, and BeiDou satellite signals.

Multifrequency GNSS receivers provide jamming protection through frequency diversity, although intentional jamming often covers all GNSS frequencies. Substantial spoofing protection is achieved by having a multifrequency/multiconstellation GNSS receiver, as simultaneous spoofing attacks against GPS, GLONASS, BeiDou, and Galileo is difficult and expensive. For authorized users, there is also the excellent option of using a SAASM-enabled receiver, which can access the encrypted signals from GPS. (Figure 1.)

"GNSS denied"

Designers, staff, and users are alert to the NAVWAR threat. As a result, the requirement for new equipment to operate in "GPS/GNSS denied" conditions is now becoming normal. It is worth drilling down beyond that statement as the denial of GNSS signals, both accidental and deliberate, can be due to a variety of reasons and the mitigation may be different for each. Therefore, it is helpful to describe the requirement. It is important to detail of the cause of the denial (e.g., blockage, jamming, spoofing), and explain the accuracy that must be maintained by the PNT system or the jamming power that it should be able to resist.

The tight coupling of GNSS + Inertial Navigation System (INS), as in NovAtel's SPAN technology, also increases system robustness against jamming and spoofing. Systems such as NovAtel's GAJT anti-jam antenna (Figure 2) protect against jamming and add to the robustness of the PNT system. Protection from the effects of spoofing is best provided by the use of SAASM (for authorized users) although multiconstellation/frequency GNSS and anti-jam antennas also help.

The key point is that heterogeneous sensors, multiconstellation/frequency, and anti-jam protection can be used in combinations to ensure robust PNT. The correct choice of technology needs to be informed by well-defined requirements. **MES**

Figure 2 | The NovAtel GAJT anti-jam antenna is a single-unit GPS antenna for use on military land vehicles.

Neil Gerein *is the product manager, defense, for NovAtel. He joined the firm as a GPS software engineer in 2001, focusing on satellite navigation signals. In 2009 he became the defense product manager and since 2015 has been NovAtel's segment manager for defense and NAVWAR. He is responsible for the NAVWAR product lines, including the GAJT GPS anti-jam antenna and OEM625S SAASM receiver used in unmanned vehicle systems. In this role, he interacts with a wide international range of NAVWAR specialists, including Defence Research and Development Canada (DRDC). His early career was as an engineer at Vecima Networks and Navsys Corp., where he worked on beamforming GPS receivers. Neil earned an M.Sc. in Electrical Engineering at the University of Saskatchewan. Readers may reach Neil at neil.gerein@novatel.com.*

Peter Soar *is the business development manager, military and defense, for NovAtel. He was commissioned as an officer in the Royal Artillery of the British Army in 1976 and was sent to the University of Surrey to read an Honours Degree in Engineering. After graduation he rejoined his regiment and served in a variety of appointments at home and abroad including field artillery, air defense, antiterrorist, and ceremonial. Upon leaving the army in 1994, he assumed a series of roles in the City of London and subsequently joined QinetiQ as a principal project manager for Indirect Fire Rockets and Navigation Warfare (NAVWAR); he took on sales roles for NAVWAR, Autonomy, and Global Navigation Satellite Systems business lines. Peter joined NovAtel in 2012, is based in England, and reports to the corporate headquarters in Calgary, Alberta. Readers can reach Peter at peter.soar@novatel.com.*

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More efficient power supplies using health monitoring

By Mariana Iriarte, Associate Editor

Intelligent power supplies for military applications are providing users with the ability to monitor faults, often in real time, thereby allowing warfighters to make quick decisions during critical missions. Meanwhile, standardization and commercial-off-the-shelf (COTS) technology are enabling flexibility.

Sailor supplies power to Sea Hawk helicopter prior to launch. Photo courtesy of the U.S. Navy/ Mass Communication Specialist 2nd Class Armando Gonzales.

Power is always a primary concern in military systems: Designers constantly balance size, weight, power, and cost (SWaP-C) requirements in order to boost efficiency. While each application may be different, power supplies that share information with the operator enable better understanding of what is wrong with the system. Monitored power supplies reduce troubleshooting and down time for the system, as well as enable smarter decision-making during evolving battlefield situations.

"Customers who in the past have typically resisted 'intelligent power supply units' (PSUs) are now warming to the benefits that improved built-in-test (BIT) signaling and overall control of the power supply provided by microcontrollers," says Graham Jefferies, managing director of XCEL Power System, Ltd., a U.K. business unit of Data Device Corp. "Many requirements now call for a PSU that can perform self-diagnostic tests, to ensure that it is within its own parameters and to constantly pass the information via the aircraft or vehicle data bus, to the relevant systems, commonly referred to as health monitoring."

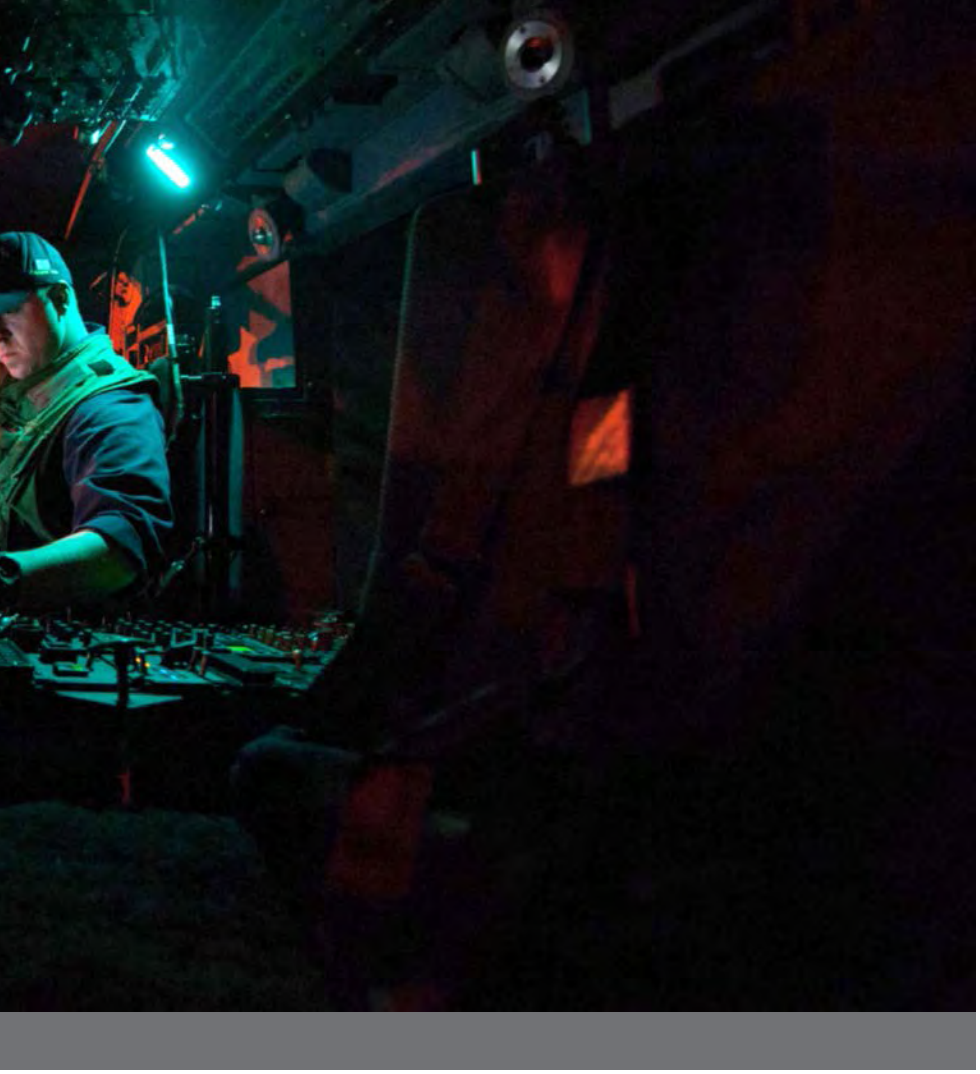
"Fault reporting is a common requirement," states Vito D'Erasmo, engineering manager of North Atlantic Industries, Inc. (NAI) Power Products in Bohemia, New York. A lot of what [customers] are requesting is part of the standard, things like input/output and temperature monitoring," he says.

The basics of power management are there and are driving better efficiency in all military platforms. These trends are leading to "higher density, higher efficiency, and more communication type features. Continuous BIT test, power on BIT testing, so basically a lot of telemetry with power supply in terms of health status," according to Lou Garofolo, product manager of NAI Power Products.

"Power supplies can share, sense, and monitor. Customers are looking more for intelligence, or power supplies that can gather information from the entire system," says Jerry Hovdestad, director of COTS engineering, Behlman Electronics in Hauppauge, New York. "In the past when you had four cards, it was difficult to determine which one was misbehaving, now a complete check can tell you which one is not working."

As the efficiency of each system rises, warfighters have the option of not taking the system offline for testing. Military applications such as unmanned systems, airborne electronic warfare (EW), and land-based platforms performing critical missions can opt to continue running if the issue is minor.

While it could be a minor issue, the software would tell the user that taking the equipment offline is necessary, thereby making the decision process faster and easier, says Christopher J. Stabile, marketing communications manager at Data Device Corp. in Bohemia, New York. With older systems, troubleshooting could take hours; with newer system-health monitoring devices, it only takes seconds, he adds.



"Digitized power supplies mean that diagnostic data is continuously available to the operator, enabling them to know the power status of all active system loads, and to know in advance if any are experiencing issues that may lead to a power failure," Stabile says. "Prior to the availability of health and diagnostics data, vehicles and other equipment were required to have regularly scheduled – often costly – maintenance programs that required significant downtime to replace parts, whether they needed to be replaced or not, based on the parts' theoretical life cycle. With vehicle health and diagnostic data, the operator is now provided with a real-time understanding of the whole power system, enabling them to make informed mission-critical decisions as needed, utilize the full operating capacity of the system, and potentially experience less time out of the field. Maintenance costs are lower, as well."

Decisions made easier through fault monitoring

"If the systems have the performance information relating to the PSU, a decision can be made to prioritize the critical functions supported by the unit," Jefferies says. "If the functions are mission-critical, ongoing operation would be allowed regardless of the effect on the PSU. Circuit-health monitoring avoids users having to take the unit out of service and test it on a bench; aside from the financial implications and system down time, continuous monitoring is a more valid way of testing, often giving more insight into the failure modes and interaction with the rest of the system.

"This tends to be found more with custom power supplies, rather than standard power supplies, because it is a specific feature," he continues. "That capability generally needs to be tailored into a certain application."

Standardization paves the way for flexibility

Standardization is not completely out of the picture, however. Manufacturers are still following the SWaP requirements set by the Department of Defense (DoD). For example, the VITA 62 standard still acts as a guideline for power supplies that support the VITA 62 slot on VPX backplanes and brings COTS components into power-supply modules. The perk about setting a standard is that engineers are able to not worry about the basics.

"We have been seeing a lot of airborne applications – both fixed-wing and rotary helicopter – going toward the newer VPX platforms," D'Erasmo notes. "We are part of the VITA 62 committee; we finished updating the first specification for the VITA 62 specification. We see a lot of requirements from military customers asking for VPX products."

There's the addition to the VITA requirements which outlines communications – many customers want those capabilities of the VITA extension," Garofolo adds.

"Everything we do is COTS. Our VPX is COTS. We repackage our designs into various custom form factors. Our customers are looking for high reliability," Hovdestad says. "I'm part of the VITA 62 committee, where we are attempting to make an open standard, so anyone can buy, plug it into a system, and play."

However, "our customers are looking for flexibility, to be able to change this and that and enhance what they like," he continues. "They want standard, but they also want flexibility." Engineers at Behlman Electronics have developed the VPXtra 100CD-IQ, which is designed to power Open VPX modules and is also VITA 62-compliant (Figure 1).

Figure 1 | VPXtra 1000CD-IQ gathers input/output voltage/current. Photo courtesy of Behlman Electronics.

Behlman's VPXtra 1000CD-IQ has the capability to monitor all input and output voltages as well as input/output current. "It gathers information from the entire system. If it has a temp issue or input problem, it collects and reports that information," Hovdestad says.

NAI's VPX57-31, a 3U DC/DC VPX product, includes remote error sensing, current share, and a built-in EMI filter.

Engineers designed it to have VITA 62-compatible outputs, signaling, user programmability, inter-integrated circuit (I²C) communication, and temperature monitor (Figure 2).

"The 3U VPX power supply has a 270 volt DC (VDC) input," D'Erasmo says. "The 270 VDC is used by aircraft. They take the AC and rectify right down to 270 DC. They'll have an AC distribution system where they can put 270 into the power supply and we'll make the voltage as they need for the rest of the system. The input and the features that we put in this power supply – programmability, BIT, temperature monitor, current share, higher efficiency – all come in a small package that's 400 to 500 watts."

NAI designs are also 100 percent discrete component designs, which "gives us a lot more flexibility to address special needs because we are not confined to a certain footprint of a brick. We can lay things out, we can reuse proven parts of a circuitry, and we can add new features a lot easier. We do nothing with prepackaged bricks," he adds.

Figure 2 | The VPX57-31 is suited for use in rugged military and commercial aerospace applications. Photo courtesy of North Atlantic Industries

Testing challenges come with software

While the software that monitors power supplies' faults benefits the users, giving them the ability to know exactly what is wrong, it can bring additional testing requirements in systems that are deemed safety-critical by the government.

As of right now, "Software has been mainly restricted to fault reporting and simple ON/OFF control and sequencing; this may change, however," Jefferies says.

Installed software will be different from every manufacturer. "Customers need a standard," Hovdestad explains. "The software from the manufacturer may be different, and so we need software standardization."

Unlike with VITA 62, there are no set guidelines for software in power supplies. Engineers can innovate and take it to the next level, but within the boundaries the DoD has set, it could prove difficult. "We haven't observed requirements for software control over PSUs in terms of altering output voltages on the fly," Jefferies notes.

"In the military environment, introducing software and firmware triggers additional design hurdles and the requirement for testing becomes onerous," he continues. "Once you start to build software into these units, you start to get into a vicious cycle: You bring digital control, which then brings the complication of certifying this software, which is a requirement all its own." **MES**

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Wide-range DC-DC converters power military electronics

By Steve Butler

Advanced power-conversion topologies achieve both wide input voltage range and high efficiency, enabling modular DC-DC converters to satisfy military power bus requirements and simplify power electronic-system design.

Modular DC-DC converters can satisfy military power bus requirements and simplify power electronic-system design in all types of military vehicles and aircraft. Senior Airman Thomas Thornburg of the 163rd Reconnaissance Wing marshals the MQ-1 Predator safely home after a training flight at Southern California Logistics Airport. (U.S. Air National Guard photo by Master Sgt. Julie Avey.)

Modern military vehicles and aircraft are packed with sensitive electronics. The electrical power in a vehicle is usually 24 Volts DC (VDC) taken from the vehicle's battery, while in an aircraft it could be 28 VDC, 270 VDC, or even 115 Volts AC (VAC), but this power bus is unregulated, noisy, and subject to voltage transients. An isolated power supply is necessary to convert and regulate the many voltages required by the discrete electrical components, such as FPGAs, memories, and displays, which make up every piece of electronic equipment. Schedule and cost pressures have driven the move toward modular power solutions using off-the-shelf DC-DC converters. As the trend continues toward smaller and more efficient yet higher performance electronics, integrating voltage transient capability directly into the DC-DC converter modules can simplify power system design and improve overall system performance in terms of efficiency, size, and weight.

The noisy power bus

MIL-STD-1275, currently revision E, governs 24 VDC military-vehicle power. Even though the voltage is taken from the vehicle's battery, it is not a simple DC voltage. MIL-STD-1275 calls out various transient conditions, which must be considered for a reliable system design. During engine startup, the voltage can dip sharply to 12 V during the initial engagement surge, and then remain at a cranking level of 16 V for as long as 30 seconds. Revision D calls out a more severe initial engagement surge to 6 V. Short-duration, limited-energy voltage spikes up to +/-250 V peak can result from switched loads and are usually due to wiring inductance. These spikes can usually be clamped or filtered. Longer duration and much higher energy voltage surges can be caused by larger switched loads or by step loads on the alternator. An alternator load dump is a typical example, where a large load such as the battery is suddenly disconnected. The alternator cannot reduce its output quickly and instead puts the energy that was going to charge the battery into the 28 VDC bus, causing a large voltage surge. This type of surge cannot be clamped or filtered. It must be blocked, for example, with a series pass device such as a metal-oxide-semiconductor field-effect transistor (MOSFET); more preferably, it must fall within the input range of the downstream electronics.

Military aircraft power is governed by MIL-STD-704, currently at revision F. While voltages of 270 VDC and 115 V, 400 Hz AC are common, the voltage usually encountered when powering embedded electronics is 28 VDC. The MIL standard details normal, abnormal, and emergency operation as well as electric starting. Each mode contains a steady-state voltage range and possible transients. The maximum transient in revision F is 50 V; however, revision A, with which some equipment must

still comply, includes an 80 V transient. Abnormal operation includes a seven-second dropout, although since uninterrupted operation through this dropout requires bulk energy storage, such as a holdup capacitor bank or a battery, some equipment is allowed to turn off and restart.

The various modes of operation and associated voltage levels from MIL-STD-1275 and MIL-STD-704 are shown in Table 1 and Table 2. Every application may not need to operate through every condition, but combining the worst-case values, the total voltage variation can be as much as 6 V to 100 V for military vehicles or 12 V to 80 V for aircraft. This is a wide voltage range for a DC-DC converter to operate. Commercial and telecom DC-DC converter modules usually have an input range of only 18 V to 36 V. Even some military targeted modules extend that range only slightly, yet still do not plug directly into the military power buses. The usual solution has been to add additional input transient protection in the form of discrete circuitry or a separate module. This added complexity is contrary to the goal of shrinking electronics. The ideal solution is for the DC-DC converter to handle these transient voltages directly.

"AS THE TREND CONTINUES TOWARD SMALLER AND MORE EFFICIENT YET HIGHER PERFORMANCE ELECTRONICS, INTEGRATING VOLTAGE TRANSIENT CAPABILITY DIRECTLY INTO THE DC-DC CONVERTER MODULES CAN SIMPLIFY POWER SYSTEM DESIGN AND IMPROVE OVERALL SYSTEM PERFORMANCE IN TERMS OF EFFICIENCY, SIZE, AND WEIGHT."

The topology choice

Most DC-DC converter modules use a buck-derived topology, such as the forward, push-pull, half-bridge, or full-bridge. These topologies are well understood and have good efficiency. However, they tend to work inadequately with wide input voltage ranges, primarily due to limited conversion ratio and high-voltage stresses on the switches.

A simple alternative is the flyback topology. The flyback is the simplest isolated topology, with one primary switch, one secondary switch, and a single magnetic for both isolation and energy storage. Its conversion ratio is n•D/(1-D) where n is the transformer and D is the duty cycle. It has a practical range of 0.1n to 3n. This is

Condition	Level
Steady State	20 V to 33 V
Starting disturbance	12 V for 1 sec
Cranking surge	16 V for 30 sec
Voltage surge	100 V, 50 ms, 60 J
Revision D Starting	6 V for 1 sec
Total Range	6 V to 100 V

Table 1 | MIL-STD-1275E

Condition	Level
Normal	
Steady state	22 V to 29 V
Transients	18 V, 15 ms
	50 ms, 60 J
Abnormal	
Steady state	20 V to 31.5 V
Overvoltage	50 V, 50 ms
Undervoltage	0 V, 7 sec
Emergency	16 V to 29 V
Electric starting	12 V to 29 V
Revision A surge	80 V, 50ms
Total Range	12 V to 80 V

Table 2 | MIL-STD-704F

much wider than the conversion ratio of a buck-derived topology, which is n•D with a practical range of 0.1n to 0.9n or less. The flyback also maintains low voltage stresses on both its primary and secondary switches.

While the flyback excels in wide range applications, it is often dismissed as a low power or low efficiency topology. The main reason is that it has both pulsating input and output current. This causes high rms current in the output capacitor and therefore high output ripple. It also causes high peak and rms currents in the primary switch and output rectifier, which contribute to lower efficiency. The benefits of the flyback topology can be realized once these drawbacks are solved.

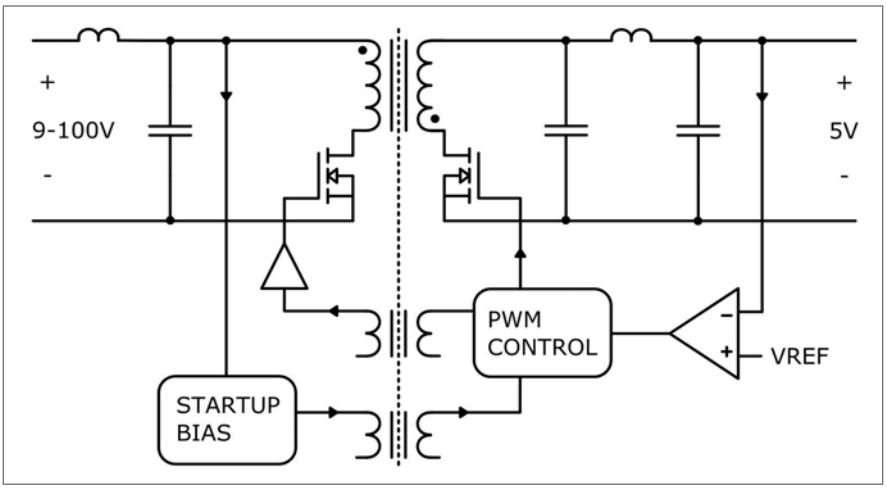

Figure 1 | Flyback topology with secondary side pulse-width modulation (PWM) and control-driven synchronous rectifiers for optimum efficiency.

Fixing the flyback

Pulsating output current is troublesome as power increases, but ultralow equivalent series resistor (ESR) capacitors, either multilayer ceramic or solid tantalum, are good choices for the output. These capacitors can handle high rms current reliably and provide low voltage ripple. A second-stage L-C filter further reduces the output ripple.

High losses in the output rectifier are remedied by using synchronous rectification. The output rectifier diode is replaced with a low on-resistance, low gate-charge MOSFET. The MOSFET is then switched synchronously out of phase with the primary switch. The voltage drop and hence the power loss on the MOSFET can be lower than that of a

Figure 2 | The VXR100-2800S from VPT Inc. is aimed at use in applications such as military ground vehicles, commercial and military aircraft, and unmanned aerial and ground systems.

Schottky rectifier. The trick is timing the gate of the MOSFET to minimize power loss. Self-drive schemes – where the gate is driven from a transformer – and integrated solutions tend not to work well in flyback converters at high frequency. Driving both the primary and the synchronous MOSFETs from the pulse-width modulation (PWM) controller allows precise timing, which is the key to minimizing power loss. (Figure 1.) The necessary gate drive signal can be transmitted digitally across the isolation boundary.

At higher power levels, the flyback topology is still a good option. Instead of beefing up the components, multiple power stages are added in parallel. The stages are then operated out of phase, enabling input and output current ripple cancellation. The cancellation effect is significant, greatly reducing the rms current in the capacitors. It also increases the ripple frequency, further reducing filter size.

Size, weight, and power concerns

Improving power conversion efficiency not only saves energy, but by reducing power dissipated as heat, simplifying thermal design, and even reducing wiring sizes, the technique saves weight. Power conversion efficiency can often be increased by increasing size, but a clever design achieves both smaller size and higher efficiency. Integrating full input voltage transient compliance directly into the DC-DC converter enables a reduction in size and complexity which ultimately improves reliability.

Examples of these wide-range isolated DC-DC converters can be seen in the VXR series from VPT Inc., which have an input voltage range of 9 V to 60 V, can handle transients up to 100 V, and achieve an efficiency rate of as much as 90 percent. (Figure 2.) **MES**

Steve Butler *is director of advanced product development for VPT in Blacksburg, Virginia. He has been with VPT since 1996, and is one of the principal designers of VPT's hybrid DC-DC converter product line. He has since led the development of VPT's Hi-Rel COTS and standard space products, as well as numerous custom projects. Steve is currently focusing his efforts on high temperature power conversion. Steve holds Bachelor of Science and Master of Science degrees from Virginia Tech, both in electrical engineering, and has published numerous technical articles and videos. He can be reached at sbutler@vptpower.com.*

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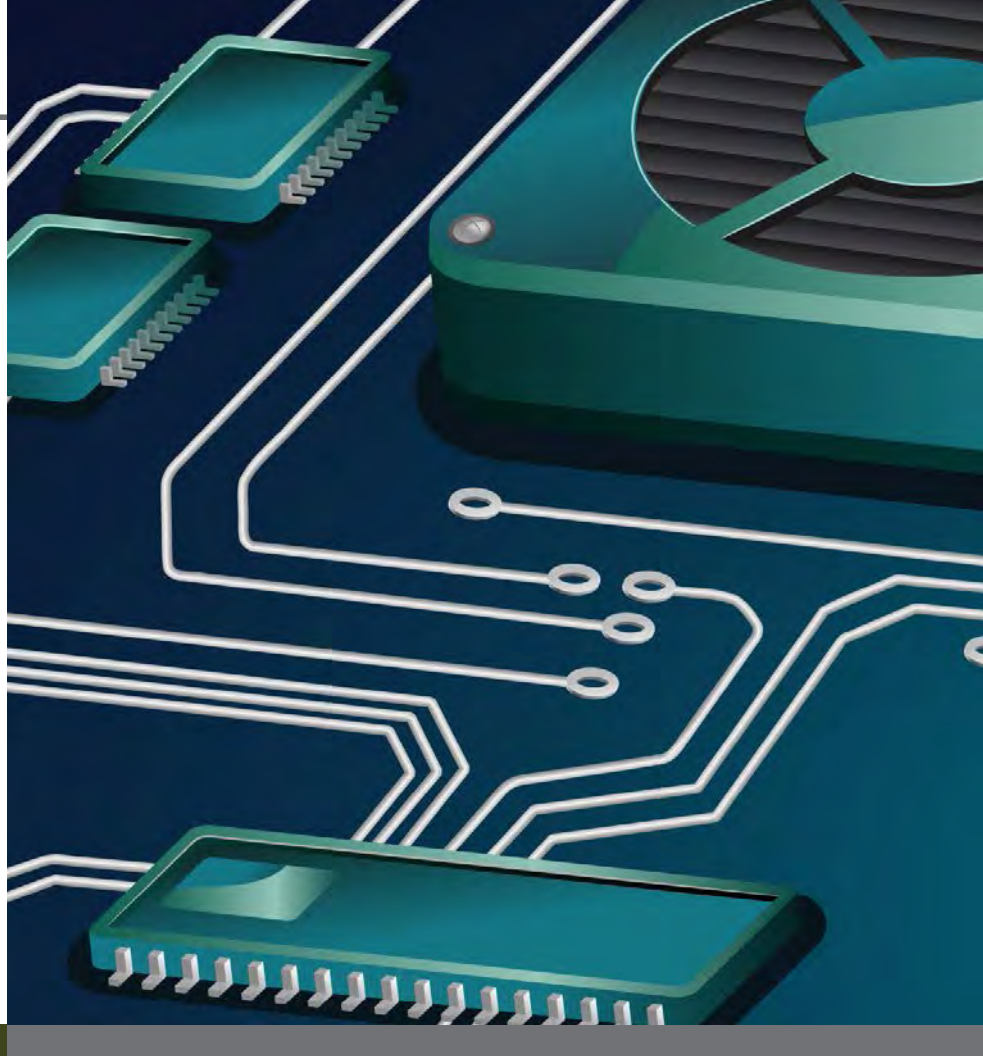
Battling the heat in military CPUs

By Tim Fleury

Demand for higher functionalities in defense electronics has led to conflicting demands for more heat management, more sensitive signals, shorter design cycles, and higher test coverage, all within ever-tighter budgets. Heat is the primary enemy of reliability in central processing units (CPUs).



Military reconnaissance and surveillance platforms rely on CPUs in intensive signal processing systems to handle real-time radar, video, and signals intelligence data. Hardware for these applications often must meet size, weight, and power (SWaP) constraints for use in aircraft, unmanned aerial vehicles (UAVs), ships, and other platforms.

With advancing technological developments, the power levels for CPU modules and mezzanine buses used in military electronics has increased dramatically. Devices such as microprocessors and field-programmable gate arrays (FPGAs) have been running ever faster while their size has been constantly shrinking, which has in turn increased heat densities and threatened product reliability.

This demand for higher and higher functionalities in defense electronics has led to conflicting demands for more heat management, more sensitive signals, shorter design cycles, and higher test coverage, all within ever-tighter defense budgets. Moreover, these products have to be highly reliable with years of operational run time in a wide range of harsh environments. These demands make designing new printed circuit boards (PCBs) and enclosures challenging for test engineers, signal-integrity engineers, and mechanical engineers. Many of today's high-powered modules cannot be cooled using legacy cooling approaches.

Three different types of CPU modules include air-cooled (A/C), conduction-cooled (C/C), and what can be called air flow-by (AFB) modules. Each type or technique has a different cooling efficiency.

Challenge: Cooling computing systems in a rugged environment

Air-cooling provides easy access to module debug connectors, front panel I/O, and mezzanine modules. This combination simplifies system development and configurability while the system is in its greatest state of flux and all requirements are not yet identified. A major drawback is that air-cooled modules are not typically designed to be deployed in rugged environments. Conduction cooling has been the preferred method of cooling for deployed systems for many years.

The modules are designed to handle the rugged shock and vibration levels, while the systems seal the modules away from harmful elements. A major challenge with conduction cooling, however, is that it is heavier than air-cooled and thermally challenged with higher power modules. Air flow-by delivers the best of both worlds. It provides the efficient point-source cooling of an air-cooled module with the rugged deployment capabilities of conduction-cooling.

Analysis on the thermal design of one of Mercury's air-cooled products (Figure 1) was performed, using a standards-based approach to bring heat from the mezzanine modules to the carrier module's heatsink.

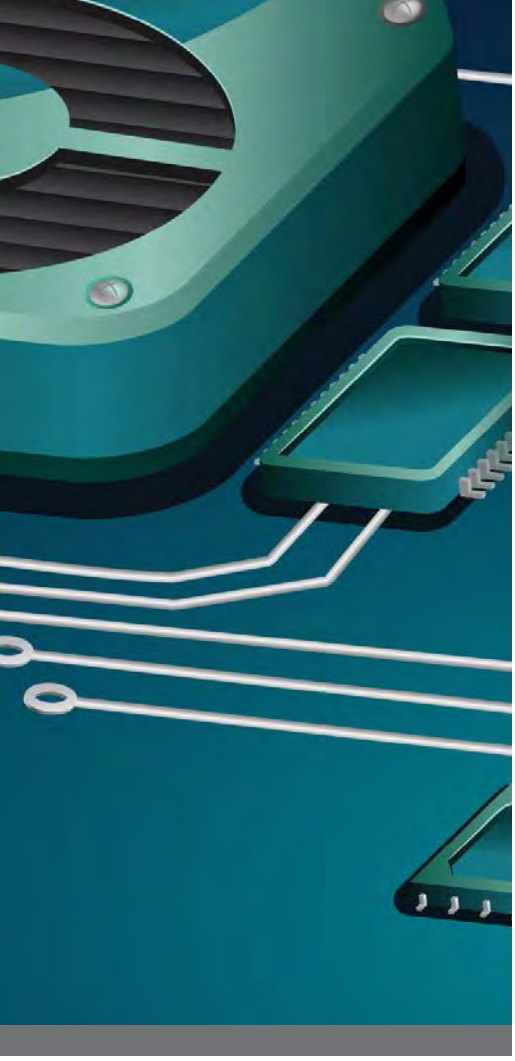


Figure 1 | Cooling system developed after analyzing with CFD, using thermal bridge hooks.

Designers discovered in the computational fluid dynamics (CFD) simulation (performed with the Mentor Graphics FloTHERM 3D thermal simulation software) that this was possible by adding "hooks" for a thermal bridge between the carrier module heatsink and the mezzanine module heatsink. The net effect was a thermal solution that complied with standards and allowed for a wide range of mezzanine modules to be placed on a host, while limiting any potential changes to a single component. This method was also found to lower the cooling by half, to a 5 °C processor thermal reduction. It also had a significant effect on mean time between failures (MTBF).

These new thermal-management solutions are capable of dissipating tremendous amounts of thermal energy, while still meeting the same or smaller size, weight, and power requirements for the overall solution. By understanding the thermal profile for each specific component that makes up a system using CFD, it is possible to innovate methods for the mass transfer of thermal energy that work at the individual component, module, and subsystem level. **MES**

Tim Fleury *manages the Thermal Analysis and Environmental Test department at Mercury Systems. Before joining Mercury, he was director of engineering services at Harvard Thermal and a principal engineer at Raytheon with 20 years as a thermal analyst. He holds a master's degree in thermofluids from Northeastern University and a bachelor's degree in mechanical engineering from the University of Rhode Island.*

Mercury Systems
www.mrcy.com

The purpose of standards in building a thriving technology community

By Steve Gudknecht

The path to development of a standard is most successful when key experts in that industry are intimately involved in its development.

Electronics manufacturers are expected to possess a certain level of design competency and level of industry knowledge, serving as a resource to their customers. If you aren't prepared to deliver products using the latest standards within your customers' industries, you're at a large disadvantage.

Have you ever thought about the purpose standards serve? They create a known set of expectations. Whether it's in the name of workplace safety, public health, or technology innovation, there's a certain code written into the fabric of developing and adhering to an industry standard that enables everyone that it affects to move forward in the same direction and with a common purpose.

What if there was no common language for computers to display a web page? Would we be as far along as we are in the world of the Internet if there were disparate systems that only worked with certain types of code?

A standard doesn't just happen on its own; it's driven by customer needs, especially in the technology and computing markets. Before the 1980s, the only entities dictating the development of standards were the military and the government, with the main purpose of product procurement. The technology revolution changed the model.

Taking a page from the established military specifications, companies realized that this new level of compatibility among products still involved mechanical requirements – the importance of form, fit, and function remained – but now the products needed to know how to talk to one another and work together.

Open standards enabled not only this communication element to take place, but also paved a whole new pathway to innovation as different companies, and even competitors, began collaborating and sharing knowledge to deliver a robust set of products that worked well together in customers' systems.

As standards began to be developed, a certain level of competence and an expected degree of cooperation was being demanded of manufacturers, driven by their customer base. Once the standards train started rolling, the benefits to developing a unified roadmap for computing technologies became very evident.

Taking the lead

Think first about Everett M. Rogers' Diffusion of Innovations theory: In short, that early innovators are typically the market leaders. Being involved in the development of a standard gives a company an inside look at what is to come as well as the ability to participate as the technology becomes available. Such companies become influencers, helping to map the strategy that the rest of the industry will follow.

Companies that are involved in a standard's creation are able to develop products more quickly, saving on research and design costs and the often-costly costly trial and error associated with proprietary designs. While there will always be industries that require custom-tailored solutions, most have adopted a standards-based approach for economic, global, and technological-innovation reasons.

Preparing the next generation

The engineering workforce is aging, with a younger, less experienced talent pool coming on board. This trend is as clear as is it inevitable. Standards give those newer to an industry a clear set of guidelines, regulations and design parameters, so they can get up to speed quicker.

THOSE INVOLVED IN THE DEVELOPMENT OF STANDARDS ELEVATE THEIR KNOWLEDGE BASE TENFOLD – IDEAS ARE SHARED, PROBLEMS ARE DISCUSSED, AND THOUGHTS ARE BUILT UPON IN AN ATMOSPHERE OF COLLABORATION.

A company's involvement in standards development draws in the innovators as well. Smart engineers realize that if they are to contribute to the development of standards, they need a company that shares the global vision of making the market a better place.

It takes committed time and resources, typically in the form of an engineer's involvement in the planning, evaluation, and discussions surrounding the creation of a standard. The short-sighted vision some companies have is that this time is best spent working solely on projects for existing customers, rather than preparing for future projects.

The longer-term vision is one of growth. Those involved in the development of standards elevate their knowledge base tenfold – ideas are shared, problems are discussed, and thoughts are built upon in an atmosphere of collaboration. This collective knowledge is then brought back into the company and can be applied towards other projects.

Using a holistic approach, whereby a shared knowledge base is contributed to and accessible by all, the working groups and committees involved with a standard's development consist of highly skilled, interested individuals, whose collective voice can be heard louder than if they had to blaze a trail in an industry alone.

Some companies may be worried about competition or trade secrets, but the disadvantages of not sharing in this collective community is far worse. A standards committee gives members the opportunity to hash out theories, share views and insights, and make a positive contribution to a system that will be in place for many years to come. The early access to this information better prepares a company to adopt a standard during its product-development cycle and inform the sales team about specific information pertaining to the standard.

Additionally, since committee members drive the discussions on how the standard would be implemented into different industries and the potential challenges associated with those markets, the entire team is in a much better position to engage with customers about how they can successfully use the standard.

Involvement in creation of standards also gives engineers the freedom to innovate and be a part of something bigger, which can increase job satisfaction as well as productivity. Have you ever met an engineer that didn't want to solve a problem? Being immersed in such a project offers a chance to make a difference in an area they enjoy, all while they address challenging issues in the process.

Market viability, opportunity, and growth

Participating in a standard's development enables companies to map products around the strategy laid out by the standard at a much faster pace and with less design effort. By enabling technology reuse through standardized products, manufacturing costs are lessened as well. As more companies are able to produce compatible parts, end users gain buying confidence, since they know there is a competitive market surrounding the technology.

Take VME, for example, which has been in place for several decades, with a large installed base across a vast number of military applications; VME also has a standards committee that is continually moving forward. The results are seen in evolutions such as OpenVPX, enhancing the original VME, ensuring that this technology platform will stay viable for several decades to come. (Figure 1.)

From a market perspective, standards grow and strengthen the ecosystem, giving users a stable of products tied to a specific set of principles based on interoperability. This is not only what customers expect, it's what they demand.

A standard does not operate in a vacuum; it is a living thing. It is the community that surrounds it that truly drives it forward, first by setting the objectives, then by examining it with critical questions, and ultimately by creating products that meet the vision that has been set out. The companies that work together towards a standard's common goal foster a better community for the end user; in today's high-visibility world, this will not go unnoticed.

Managing globalization through standardization

Standards also enable a broader market base by allowing companies to deliver products to multiple regions around the world, and in today's global economy this is a key advantage.

Many customers install systems across their global presence, not only in one facility located in a certain country. The systems themselves need to talk to one another as well. Suppliers may be different across borders, so having a defined set of interoperability and performance expectations allows businesses to buy products on a global scale with confidence.

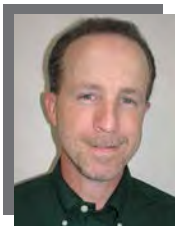
It also evens the playing field for manufacturers big and small. Standards give companies with more limited resources or product lines the opportunity to provide solutions to a wider range of customers.

Figure 1 | Being part of the OpenVPX steering and marketing committees has enabled Elma to offer deeper resources, such as these backplane profiles that assist users in the development of OpenVPX-based systems.

Involvement is the key to growth

The question is not why do we need standards, but how can companies best be part of the team that sets the strategy for our industries through standards. Involvement in a standard's creation offers a collaborative community, where each member can contribute and learn from the experience of the rest of the group.

Modern business also dictates a standards-based approach in terms of the expectation of products on the market. Being a part of the development team gives deeper insights as to the hows and whys of a standard. When applied to product development, this knowledge provides companies with a significant business advantage over those who merely implement a standard. **MES**



Steve Gudknecht *is product marketing manager at Elma Electronic. He has held positions in field applications and marketing in high-technology industries for nearly three decades. Steve's responsibilities include product development, product marketing, training, and sales support. Readers may reach Steve at steven.gudknecht@elma.com.*

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Is space in the future for VNX?

By Bill Ripley and Wayne McGee

VPX technology was fine-tuned for use in space by the SpaceVPX (VITA-78) Working Group. Now the lessons learned from this exercise are being applied to VNX, the small form factor variant of VPX.

SpaceVNX systems can be used in constellations of small satellites. CubeSats being placed into low earth orbit from ISS. Photo courtesy of Nanoracks and NASA.

What is the problem with simply using legacy space electronics?

Why would anyone want to try to use commercial off-the-shelf (COTS) hardware for a space electronics application? Everybody knows that legacy space systems are point solutions, designed for a one-off mission funded by a big checkbook and a pen able to write lots of zeroes. Reuse has never been a priority. All the interfaces are proprietary and application-specific. Modules are not designed to be either hardware- or software-interoperable. Large space systems are complicated and expensive. The market is small and captive to a handful of relatively large integrators. Why would anyone want to invest valuable resources to develop a technology that can be only narrowly applied?

These are all seemingly good arguments, except for the fact that they are not completely accurate anymore. Enter CubeSats, SmallSats, MicroSats, and other cute little satellites that hitchhike to space in leftover real estate on delivery vehicles that drop them off into a low earth orbit (LEO). Obviously, that is a bit oversimplified, but there is a growing market for low-cost satellites that are intended to do common or mundane tasks that are indeed suitable for a COTS solution. Figure 1 shows a group of CubeSats being prepared for launch.

VNX SWaP profile well-suited for space

With the VNX (VITA-74) specification in its final year of trial usage before becoming an ANSI specification, there are several "dot specs" that have been proposed by interested users and integrators to further expand the usage base for VITA-74.0 technology. One such proposal is to create an analog of the VITA-78 SpaceVPX specification, except in a small form factor. Let us review what makes VNX a good candidate for SpaceVNX, what some of the additional requirements are needed to achieve the goal, and how the technology might be used for conventional terrestrial applications as well.

VNX extends the VPX bus technology into a smaller form factor by defining two module sizes. The length and width are the same but differ in depth (or "pitch"). The two depths are defined as 12.5 mm and 19 mm. The 12.5 mm module utilizes a 200-pin connector and can currently dissipate as much as 15 W. The 19 mm module utilizes a 400-pin connector and has been shown to be able to dissipate as much as 30 W. VNX modules are designed to be inherently conduction-cooled and quite rugged. VNX-based systems are also substantially smaller and less expensive than 3U or 6U VPX systems. The size, weight, and power (SWaP) proposition make VNX an ideal candidate for LEO applications where payload delivery cost is directly related to SWaP. The delivery cost sometimes dwarfs the equipment cost, so every gram is money.

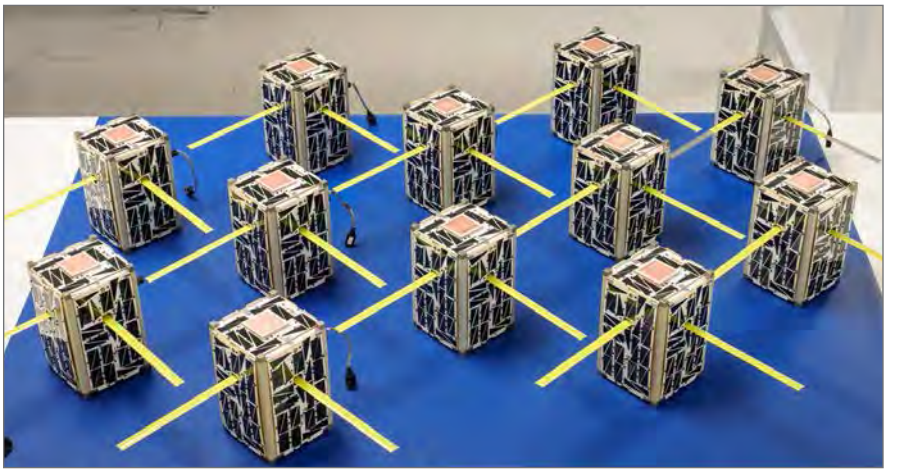

Figure 1 | A group of CubeSats, prelaunch.

LEO applications, depending upon the actual application type, do not require the same level of radiation hardening as is mandated for equipment in the much harsher environments found in higher earth orbits. This requirement greatly simplifies adoption of COTS hardware into this type of application. At the same time, system reliability is absolutely required, as there are no service calls in space. Therefore, the addition of redundancy requirements and elimination of single points of failure will be prominent in the technical committee's deliberations. A number of interested companies have already joined the effort, as well as the Air Force Research Laboratory.

Likely issues the committee will address

VITA 74.0 specifically defines the module dimensions, connectors, and pin-out structure. SpaceVNX will explore the system-level implementation of these modules to create mission computers with reliability suitable for space. As seen in SpaceVPX, a set of backplanes must be defined in order to facilitate redundant compute operations. Topologies for this requirement would either be a mesh data backplane providing redundant data paths to duplicate computers or a switched star/redundant star backplane that provides a similar capability. Other architectures, such as a self-healing ring topology, will be studied.

A typical SpaceVNX system will also require redundant system controllers and control switch modules. Since VNX was derived from VPX, the definitions for these functions should convert in a straightforward manner.

"VITA 74.0 SPECIFICALLY DEFINES THE MODULE DIMENSIONS, CONNECTORS, AND PIN-OUT STRUCTURE. SPACEVNX WILL EXPLORE THE SYSTEM-LEVEL IMPLEMENTATION OF THESE MODULES TO CREATE MISSION COMPUTERS WITH RELIABILITY SUITABLE FOR SPACE."

Slot and module profile definitions were not a part of VITA 74.0 base specification, but will likely be a large part of the SpaceVNX committee work.

SpaceVNX use cases

Obvious use cases for SpaceVNX include single standalone 1U CubeSat satellites requiring high performance data collection and analysis at a lower cost. A larger variant with networked high-performance computers with a scalable data-collection and processing capability is possible by expanding the card cage to a 1.5U or 2U configuration. The small satellites may also be used as a disaggregated cluster of networked satellites designed for a variety of data collection and analysis applications with a single sensor. The next step would be to use the same network of LEO satellites with multiple sensors, where the networked cluster fuses the data from all active sensors. Figure 2 shows an example of an existing rugged VNX system.

Adaptation of VNX for space use

Since VNX is a module standard, the package that holds and buses the modules together can be in whatever size and shape it needs to be in. The resemblance between a 1U CubeSat and the VNX Reference Chassis is remarkable. All the technology is available in other

Figure 2 | The ROCK-3 mission computer, a rugged VNX system from CES.

specifications just waiting to be integrated into a nice tidy package that looks like it can be utilized to save size, weight, power, and cost (SWaP-C). The same technology can be used to make small space and terrestrial systems more resilient and fault-tolerant, improve the networking and interoperability of related subsystems, and provide a new solution to an evolving LEO small-satellite marketplace. **MES**

Wayne McGee *is the Vice President of Sales and General Manager for North American Operations for Creative Electronic Systems (CES). Wayne has served in various senior management positions in his career and has more than 30 years of experience in the VME, CompactPCI, ATCA, and VPX markets. He is also the chairperson for the VNX VITA-74 Marketing Alliance. Before joining CES, Wayne worked for companies such as Motorola Computer Group, VMIC, SBS Technologies, and GE Intelligent Platforms. He holds a BSEE from the University of South Carolina. Wayne can be reached at wayne.mcgee@ces-noam.com.*

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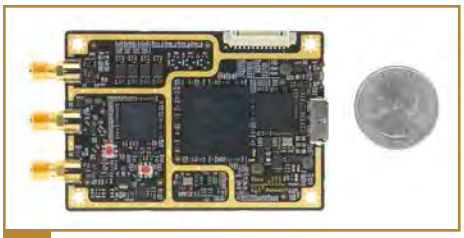


USRP B200mini device with continuous RF coverage

The Universal Software Radio Peripheral (USRP) B200mini series from Ettus Research, a National Instruments company, essentially enables software-defined radio (SDR)/cognitive radio capability in a business-card size. The device is targeted at functions such as wireless signal discovery and analysis and its compact form factor makes it useful for integration into larger systems for research and deployment. It features a programmable Xilinx Spartan-6 XC6SLX75 FPGA with RF coverage ranging from 70 MHz to 6 GHz. The RF front end uses the Analog Devices AD9364 RFIC to provide a transceiver with 56 MHz of bandwidth powered by a USB 3.0 connection for streaming data to the host computer.

The product family has three versions: the USRP B200mini – commercial-grade Xilinx Spartan-6 XC6SLX75; the USRP B200mini-i – industrial-grade Xilinx Spartan-6 XC6SLX75 FPGA; and the USRP B205mini-i – industrial-grade Xilinx Spartan-6 XC6SLX150 FPGA.

The B200mini also includes connectors for GPIO, JTAG, and synchronization with a PPS trigger or 10 MHz reference input signal. The USRP Hardware Driver (UHD) software API supports all USRP products and enables users to develop applications and then transition designs between platforms as requirements expand. Other features include synchronization with 10 MHz reference or PPS trigger, 2.0-inch by 3.3-inch (5.0 cm by 8.4 cm) form factor, and GNU radio support.

Ettus Research | www.ettus.com | www.mil-embedded.com/p373150

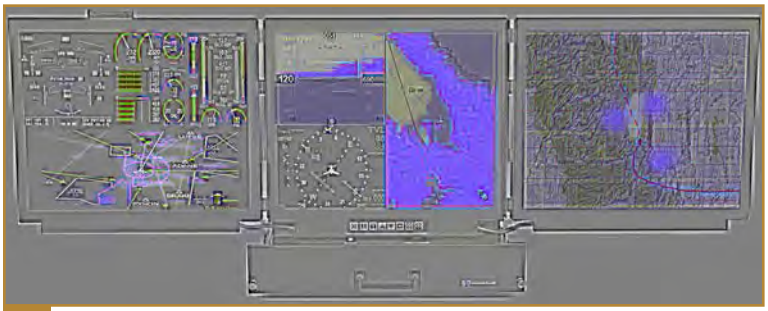
NDR308 converts VHF/UHF spectrum to digital IF

CyberRadio Solutions offers the NDR308, a standalone 8-channel wideband digital tuner that converts the VHF/UHF spectrum to digital intermediate frequency (IF) data over 10 Gigabit Ethernet interfaces. It includes eight independent tuners that cover the 20 to 3,000 MHz frequency range with 40 MHz bandwidth. Each channel can tune independently or the tuners can operate phase-coherently.

The NDR308 includes an FPGA-based digital processor board that receives eight channels of wideband data, performs narrowband filter and decimation, forms time-stamped digital IF data packets, and transmits streaming data over the two 10 Gigabit Ethernet output ports; the dual output ports support 8 by 40 MHz bandwidth data streaming.

To enable geolocation applications, the NDR308 includes an embedded GPS receiver, an external 1 PPS input, and time-tagged digital IF data formatted based on the VITA-49 standard. The NDR308 can be grouped together with additional units to support 16-, 24-, or 32-channel low size, weight, and power (SWaP) phase coherent systems. The unit is packaged in a ruggedized aluminum chassis providing RF shielding, thermal management, and physical protection. It is powered via an external +12 Volt DC power supply and controlled via a 10/100 Ethernet interface.

CyberRadio Solutions | www.cyberradiosolutions.com | www.mil-embedded.com/p373151



Rugged military display features three LCD panels

With a series of panels, the TFX1-19 from Chassis Plans is a rugged military-grade 2U rackmount LCD panel display. It features three 19-inch TFT LCD displays with per-panel resolution of 1,280 by 1,024. Chassis Plans officials offer display options that include a bonded anti-reflective glass cover and a bonded ITO EMI filter.

The system has been tested or designed to meet the MIL-STD-810G specifications. The LCD standard display temperature ranges from 0 to 50 °C while the high temperature display ranges from -20 to +70° C while operational. Electrical systems are specified for long-term reliability and multiyear program availability.

It also features RGV(VGA), DVI-D, and HDMI inputs. The body is made of 5052-H32 aluminum alloys with milled front panel, while the enclosure is stainless-steel hardware with self-locking fasteners. The TFX1-19 is manufactured in the USA.

Chassis Plans | www.chassis-plans.com | www.mil-embedded.com/p373157

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CONNECTING WITH MIL EMBEDDED

By Mil-Embedded.com Editorial Staff

CHARITY

Hire Heroes USA

Each month in this section the editorial staff of *Military Embedded Systems* will highlight a different charity that benefits military veterans and their families. We are honored to cover the technology that protects those who protect us every day. To back that up, our parent company – OpenSystems Media – will make a donation to every charity we showcase on this page.

This month we're featuring Hire Heroes USA, which helps transitioning military members, veterans, and their spouses to succeed in the civilian workforce by sponsoring workshops, providing personalized career coaching, and paying for employment-preparation counseling. The 501(c)(3) nonprofit organization – funded by donations and grants from corporations and individual donors – provides these services at no cost to the recipients.

Headquartered in Alpharetta, Georgia – with additional offices in Torrance, California; San Diego, California; Auburn, Washington; Colorado Springs, Colorado; Plano, Texas; and Raleigh, North Carolina – works nationally helping veterans find jobs; according to the organization, more than 60 veterans are confirmed hired every week. Veterans are individually partnered with a specially-trained Veteran Transition Specialist who works collaboratively with the veteran and families to create a tailored civilian resume that highlights skills and achievements and translates military experience into civilian terminology. Those in the program also learn effective job-search and interviewing techniques and are able to network with companies who want to hire veterans.

Hire Heroes USA team members work with military members and veterans stationed across the U.S., Washington, D.C., Puerto Rico, and six foreign countries (Belgium, Germany, Italy, Kyrgyzstan, Norway, and the U.K.) who are looking for full-time or part-time work, internships, or training opportunities. Once the job seeker has completed the self-marketing workshops and pre-employment preparation, members of the Veteran Outreach team will offer continued support until the veteran gets a job.

For more information, visit www.hireheroesusa.org.

WHITE PAPER

SWaP-C and why your component partner matters

By Sparton NavEx

When size, weight, power, and cost (SWaP-C) is important to your project, working with the right contract manufacturer is critical to the project's success. From knowing the unique demands of military requirements to possessing the capabilities to ensure top-notch component functionality, having the right partner for the project can help the build team balance the project's SWaP-C.

This white paper will help designers select the right manufacturing partner and ensure maximum SWaP-C benefit with minimal fuss. It details why SWaP-C matters, the challenges involved in working to military spec, and ways to choose the right manufacturer.

Read the white paper: http://mil-embedded.com/white-papers/white-swap-c-why-component-partner-matters/

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