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JULY/AUGUST 2011

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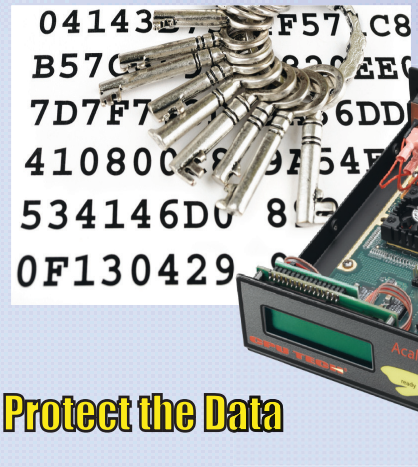

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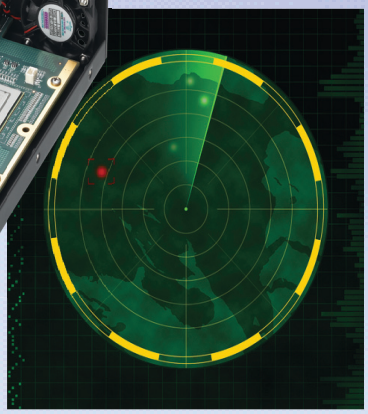

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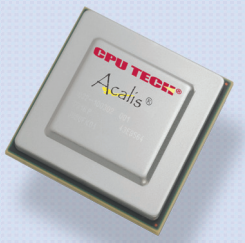

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July/August 2011 Volume 7 Number 5

COLUMNS

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ON THE COVER:
Bullet casings gather at a Marine's feet as the 11th MEU is deployed right at the tip of the spear. Out there, the terrain is rugged, the opponent lethal, and the environment is hell on electronics, especially those powered by batteries when dismounted from a vehicle. We've assembled a collection of articles – and our first Rugged Power Directory – to highlight this crucial topic of power conversion and energy storage. Check out all the articles, as listed here on the Table of Contents. (Photo by Gunnery Sgt. Scott Dunn, courtesy U.S. Marines Corps)

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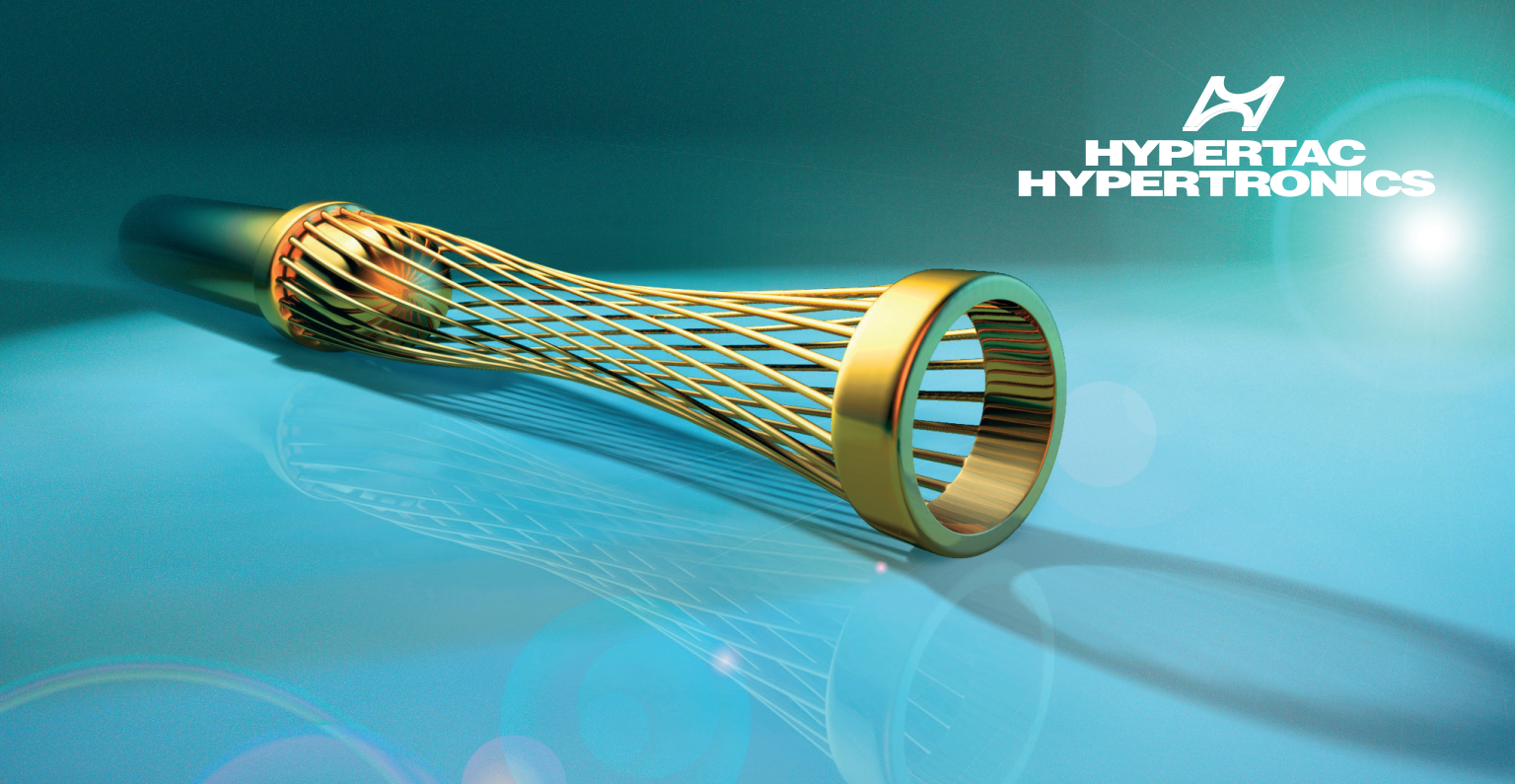

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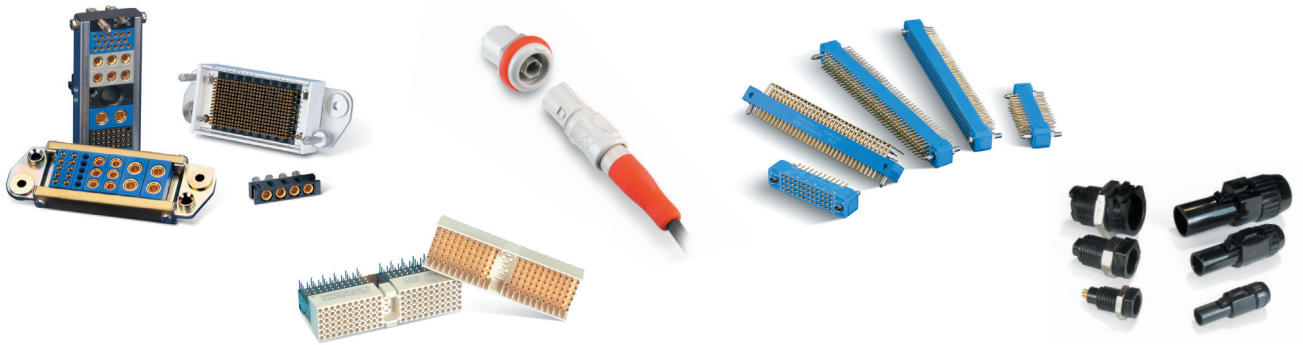

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Supercomputers drive high-performance embedded multiprocessing

By Duncan Young

Many of today's supercomputers or High-Performance Computing (HPC) systems are based on vast clusters and arrays of the twin industry standards of Intel's multicore processors and NVIDIA's General Purpose Graphics Processing Units (GPGPUs). Processors and GPGPUs are scaled to many thousands of compute nodes over InfiniBand with additional connectivity via 10 and 40 GbE, providing low latency and high data throughput to support applications from scientific research, engineering, and meteorological forecasting to financial trading floors and government information processing. These systems share key architectural concepts that are supported by mainstream operating systems such as Windows and Linux plus a wealth of off-the-shelf middleware, drivers, and libraries.

Switched-fabric dilemma

Unlike the almost universal use of PCI Express for host to end-point connectivity, the choice of Interprocessor Communication (IPC) switched fabric for embedded multicomputing remains fragmented. Serial RapidIO is currently popular in the signal-processing arena, being well supported with switches and integrated processor devices by manufacturers such as Freescale Semiconductor and Integrated Device Technology (IDT). However, 10 GbE for connectivity and InfiniBand for low-latency, high-throughput IPC are the preferred technologies for commercial HPC systems. InfiniBand's market size sustains a large ecosystem of off-the-shelf product and service suppliers. It uses 2.5 GHz signaling on bidirectional links. Data is 8B/10B encoded, giving a theoretical maximum data rate of 8/10ths of the signaling rate, plus links can be aggregated, for example, X4 or X12 for higher throughput.

Single, dual, and quad data rates are also available while fiber-optic interconnect options give even higher signaling rates with greater transmission distance. Designed for very low latency and efficient data packing, the InfiniBand specification does not define any higher levels of protocol. For HPC and general computing applications, these protocols are provided by Remote Direct Memory Access (RDMA), a unified open source, optimized software stack that operates under Windows or Linux for both InfiniBand and 10 GbE. RDMA is supported and maintained by the Open Fabrics Alliance (www.openfabrics.org), a broadly based industry alliance that has become the *de facto* data movement standard for HPC systems.

Compute nodes

Intel's AVX-equipped, multicore Xeon and NVIDIA's Tesla 20 series of GPGPU are key elements of HPC nodes, configured in massive numbers, as needed by the types of application to be supported. A GPGPU has arrays of many Single Instruction Multiple Data (SIMD) processor cores ideally suited to complex, parallel multithreaded applications; meanwhile, the latest Xeon platforms offer high-performance floating-point vector processing with one 256-bit AVX unit per processor core. Computing nodes can be mixed while the performance of the system is scaled to the application by creating fabric topologies and data pipe sizes, plus clusters and arrays of processing nodes to suit.

Deployable military applications

The development and deployment of advanced radar, sonar, electro-optical sensor processing, and situational awareness systems appear set to benefit from the rapid evolution of widely adopted HPC technologies. Embeddable, low-power versions of the compute nodes and other key semiconductor devices are available, able to meet the vital Size, Weight, and Power (SWaP) requirements of military platforms without performance compromise. Thus, products can now be realized in rugged formats, such as 6U VPX (VITA 46), able to survive the harshest military environments. When combined with off-the-shelf Linux, Windows, fabrics, drivers, and libraries, project development risk and timescales will be significantly reduced because of their wider commercial market usage. Additionally, future upgrade and performance enhancement paths are assured and can be brought to maturity much earlier in the technology cycle. Fully compatible with mainstream HPC concepts, the new DSP280 6U VPX multicomputer from GE Intelligent Platforms depicted in Figure 1 uses two quad-core, second-generation Core i7 devices with AVX, plus InfiniBand and 10 GbE RDMA data plane ports.

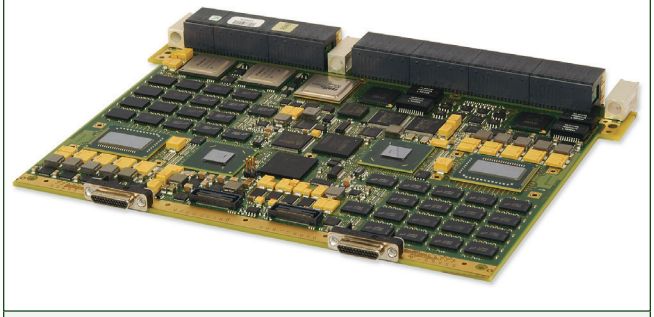

Figure 1 | A DSP280 6U VPX multicomputer offered by GE Intelligent Platforms

The levels of performance and broad-ranging industry support for open standards, such as RDMA, plus the availability of rugged Core i7 and GPGPU products are bringing high-performance, multicomputing architectural capability in military and aerospace ever closer to its commercial HPC equivalent. The potential advantages of other fabrics or computing technologies will be offset by rapid technology evolution (perhaps also revolution) and time-to-market of new products, driven by the strength of the growing HPC market.

To learn more, e-mail Duncan at duncan_young1@sky.com.

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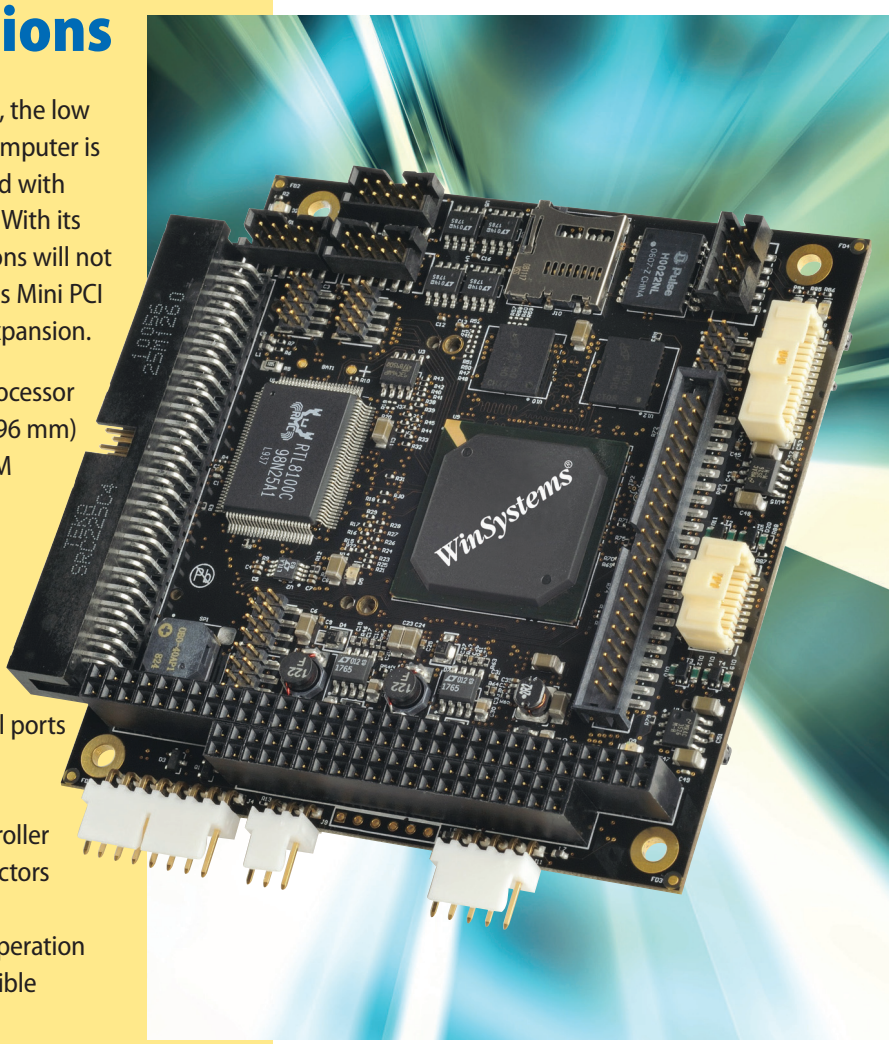




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Mil Tech Insider

Understanding FMC interoperability

By Steve Edwards

New generations of FPGAs present developers with a level of processing performance and potential I/O bandwidth that cannot easily be matched by conventional CPU configurations. The FPGA Mezzanine Card (FMC) (ANSI/VITA 57.1) directly addresses the challenges of FPGA I/O by solving the dual problem of how to maximize I/O bandwidth while still being able to change the I/O functionality. FMCs offer an elegant, simple solution because they only host I/O devices, such as ADCs, DACs, or transceivers.

Advantages of FMC

FMC modules have no onboard processors or bus interfaces, such as PCI-X. Instead, FMC modules take advantage of the intrinsic I/O capability of FPGAs to separate the physical I/O functionality on the module from the FPGA board design of the host of the module, while maintaining direct connectivity between the FPGA and the I/O interface. In comparison, PMC/XMC mezzanine modules implement a fairly generic interface, usually using PCI (PMC) or PCI Express (XMC). Their electrical interfaces are well defined so that the host can deal with all hardware in a common manner. For PMC/XMC modules, the main reliance is on the software driver for determining how this interface is controlled on the other side of the PCI or PCI Express interface.

Because the PMC/XMC interface is generic and abstract, there is a good chance that a PMC with, for example, a VxWorks 6.5 driver for a Power Architecture-based host card will work on any VxWorks 6.5 Power Architecture host (with a PMC site) with little or no modification. On the other hand, FMCs are different. FMCs operate at a very low level, and the probability of direct interoperability between host cards with no code changes is low. However, the advantages of FMCs for high-performance applications are considerable: high-bandwidth, low-latency interfaces; lower power; and more I/O real estate.

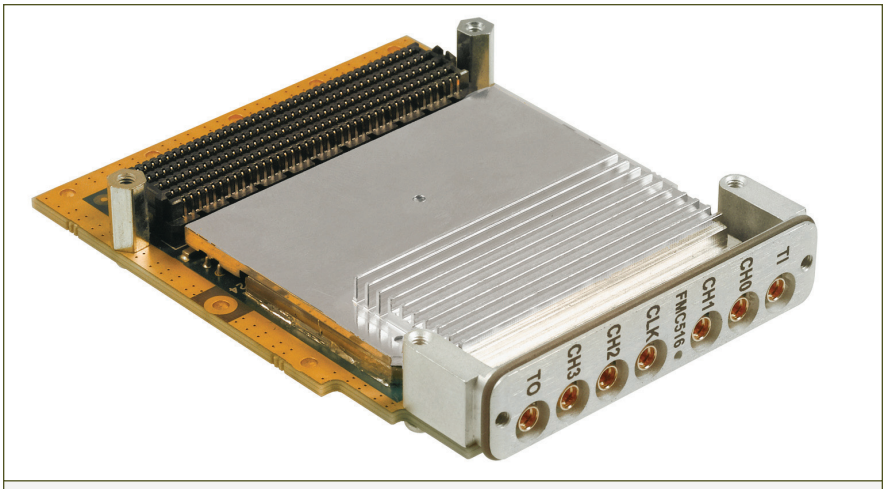

Figure 1 | An FMC-516 quad-channel, 250 MSps, 16-bit analog input card from Curtiss-Wright Controls Embedded Computing

The FMC specification does not define a generic interface. Instead, it defines a *maximum* number of FPGA connections. Thus, the FMC's I/O devices are very intimately connected to the host card's FPGA. There are no buses such as PCI to contend with. But this flexibility requires more direct control. The exact FPGA connectivity – for example, which pins are utilized and FPGA type – needs to be considered. All FPGA hosts will be different, even within a family such as a Xilinx Virtex-5 SX95T and a Xilinx Virtex-5 SX240T.

LPC and HPC defined

The FPGA tools environment is also critical. When a single vendor supplies both the host processor and the FMC card, it will be easier to supply software/HDL optimized for the low-level connectivity of the host and its environment. Sometimes, though, it is preferable to use an FMC and a host card from different vendors. FMC allows for two sizes of connector, Low Pin Count (LPC) and High Pin Count (HPC), each offering different (maximum) levels of connectivity, analogous to how some PMC boards have a 32-bit interface while others have a 64-bit interface by using an additional connector. The LPC offers up to 68 differential pairs while HPC offers up to 80 differential pairs. Curtiss-Wright Controls Embedded Computing's (CWCEC's) FMC-516 (Figure 1) is a quad-channel, 250 MSps, 16-bit analog input card that enables I/O devices to be directly coupled to a host FPGA. By providing direct ADC connection to the host FPGA, this card ensures maximum throughput and enables multiple channels and boards to be synchronized.

FMCs with HPC connectors cannot usually be used on LPC FMC hosts. The LPC is a subset of HPC and so some combinations yield reduced functionality. But HPC FMCs will typically not work on LPC host boards. Also, not all HPC FMCs can be used on every HPC FMC host. And there are FMCs with more connectivity requirements than some hosts can provide, even if the host is identified as an "HPC FMC" host. As FMCs continue to increase in popularity, thanks to their high-bandwidth, low-latency interfaces, lower power, and increased I/O real estate, it is important to be familiar with the differences between different classes of FMC cards so that interoperability can be maximized and the benefits of these flexible, compact I/O cards are optimized.

To learn more, e-mail Steve at Steve.Edwards@curtisswright.com.

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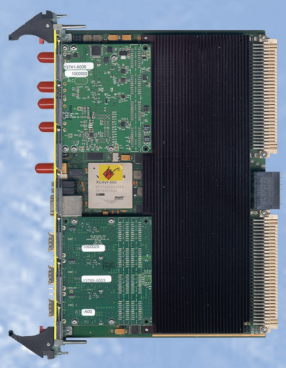

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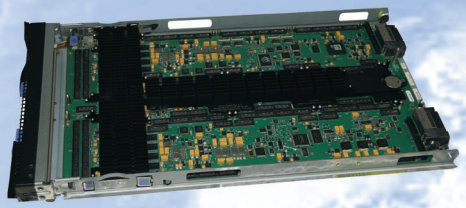

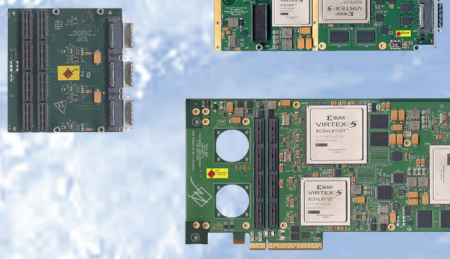

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Legacy Software Migration

By David Stewart

Mitigating the multicore factor

Soon most hardware processing platforms will be based on multicore architectures. But what does this mean for legacy software applications?

Multicore platforms are capable of delivering higher performance, lower power consumption, a smaller physical footprint, and even a lower bill of material costs as compared to single-core platforms. However, none of those benefits will come unless legacy single-core optimized software applications are successfully moved onto multicore architectures. This does not necessarily mean that lots of software refactoring work needs to be done. But it does mean that developers need to have the right knowledge and tools to assess their options and select the right one.

The consolidation play

The most straightforward approach to legacy software migration is to consider the multicore platform as the same collection of single-core processing engines in use today, except that the cores are now all in one physical package. In other words, for each processor, developers will select the appropriate OS and application to run on it. Virtualization is a popular method to achieve this and is sometimes seen as the first step in the multicore journey. This approach consolidates discrete processing functionality onto a multicore platform and requires limited new knowledge and software refactoring, although it will only deliver a fraction of the performance, power, size, and cost benefits mentioned earlier because it does not utilize the inherent parallel processing available.

Balance, optimization, and opportunity

Most developers know that the way to exploit the fundamental benefits of multicore platforms is to unlock whatever concurrency exists in their software applications so that a reasonably balanced loading can be achieved across the available processors. The challenge is that some new concepts, such as threading, data dependencies, and data races, need to be understood to implement an efficient migration to a multicore platform. The military systems market, while having its own idiosyncrasies, is certainly also governed by one of the fundamental rules of business: Companies that master a new technique or technology faster than their competition give themselves a real differentiating edge.

> “Programming multicore systems is not a brand new science; it is a question of adding a few new ideas and techniques to existing and well-established skills.”

Afraid to jump?

To become a multicore-ready software development organization, a few things need to be added to the armory of skills, methods, and tools available to engineers. These are imperative in satisfying the fundamental question at the heart of all multicore migration projects: How much concurrency is there in the applications, and how easy is it to unlock it? Traditionally, the answer to this question has been hard to find. Usually it is necessary to do all the trial-and-error engineering work to answer it. Therefore, it is not surprising that many development teams resist taking this step. This reluctance is because they do not know how to evaluate the benefits of multicore adoption and they do not know how to implement such a concurrency analysis project. Therefore, they do nothing.

Guidance through the darkness

In recent years, CriticalBlue has helped many different types of organizations to migrate towards and optimize their use of multicore platforms. The Prism tool was developed after extensive consultations with experienced multicore software developers to establish the capabilities needed to address the aforementioned challenges. One small example of the output of those discussions is that CriticalBlue’s Prism has a *what-if* exploration capability that allows developers, without first having to modify their code, to investigate the impact of different parallelization approaches, multicore platforms, and data dependency management methods. The tool, coupled with a range of training courses and methodology services, provides a framework to help developers migrate legacy systems efficiently and effectively.

Putting the right foot forward

Mitigating performance, power, size, and cost constraints while delivering leading-edge functionality based on existing legacy software is the key to profitable embedded systems. While multicore hardware is rapidly becoming the norm, knowledge of how to best utilize such platforms while running legacy application software is limited. Programming multicore systems is not a brand new science; it is a question of adding a few new ideas and techniques to existing and well-established skills. Therefore, managing the complexity of migrating legacy software onto multicore platforms can be turned into a real business differentiator. So why not get there ahead of the competition?

David Stewart *is the cofounder and CEO of CriticalBlue. He has 30 years’ experience in the software and silicon industries and is also the chairman of the Multicore Association’s working group on Multicore Programming Best Practices. He can be contacted at david.stewart@criticalblue.com.*

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USAF launch-vehicle program gets a boost

The USAF has extended a whopping $1.1 billion contract to United Launch Services for program management, engineering support, launch capability, mission integration, launch and range site activities, and mission-specific design for the Evolved Expendable Launch Vehicle (EELV) program. EELV aims to cut costs and boost reliability for U.S. launches. Specifically, EELV provides that existing launch systems get replaced by two launch vehicle families utilizing a common infrastructure and components: The Atlas V and the Delta IV (Figure 1). Meanwhile, the contract's work is slated for completion at Cape Canaveral Air Force Station, FL and Littleton, CO. by September 2012.

Figure 1 | United Launch Services and the USAF just put pen to paper, signing a $1.1 billion contract for the former to provide the latter with program management, engineering support, launch capability, and mission integration for the Evolved Expendable Launch Vehicle (EELV) program. Delta IV photo courtesy of Boeing

L-3 contract supports airborne sensors program

Airborne sensors operators and Command and Control are sure to benefit somewhere down the pike, thanks to the Missile Defense Agency's recent $537 million Airborne Sensors Program IDIQ contract with L-3 Communications Integrated Systems. Specifically, L-3 will render sustainment, operations, and mission support for the Wide-body Airborne Sensor Platform and the High Altitude Observatory I, II, and III. The contract comprises a five-year base, in addition to five options spanning one year each. If all five options are activated, contract completion is expected in June 2021.

CompactPCI helps with MoD ISR in Afghanistan

When Manchester, England's Brimar Limited received an urgent order of 200 Foxhound patrol vehicles for the UK's Ministry of Defence (MoD), it turned to COTS to minimize risk. Accordingly, Thales is supplying the electronic architecture, which utilizes GE Intelligent Platforms' 6U CompactPCI SBC, rugged style. The computer includes an Intel Core i7-610E processor speeding along as fast as 2.53 GHz, and offers support for a duo of either x8 PCI Express XMCs or PCI-X PMCs. The Thales electronic architecture's end goal is to make it possible for vehicle-mounted cameras to deliver ISR video information to Foxhound Light Protected Patrol Vehicle (LPPV) crew. Foxhound, a 7.5t mine-protected vehicle, will be used in Afghanistan for patrol purposes. Foxhound is a spinoff of Force Protection Europe's Ocelot vehicle.

Raytheon helps guide U.S. Navy via GPS

GPS is everywhere. It's in most consumers' cell phones and will once again become part of the U.S. Navy's arsenal, per a recent contract between the Space and Naval Warfare Command and Raytheon Integrated Defense Systems. The $32 million contract specifies that Raytheon will design, develop, and test the Global Positioning System Based Positioning, Navigation, and Timing Service (GPNTS). GPNTS will report for Positioning, Navigation, and Timing (PNT) duty for navigation, combat, weapons, and C4I systems where real-time, mission critical PNT is necessary (Figure 2). Contract completion is anticipated by June 2015 if all options are activated, raising the contract's total value to about $77 million. Raytheon's San Diego, CA and Fairfax, VA locales will fulfill the contract.

Figure 2 | Raytheon Integrated Defense Systems will design, develop, and test the U.S. Navy's Global Positioning System Based Positioning, Navigation, and Timing Service (GPNTS). U.S. Army photo by Spc. Kristina Gupton

50-year-old T-38 educates USAF pilots

With the Air Education and Training command as the U.S. Air Force T-38 Talon's primary user, the supersonic Mach 1 jet trainer's 50-year lifespan has largely been dedicated to training military pilots (Figure 3). And that mission is slated to continue, per a recent contract between the Air Combat Command AMIC/PKCA and MI Support Services. The $13 million contract provides that MI Support Services renders intermediate maintenance services, organizational services, and program management for the T-38s enlisted in the Companion Trainer program. The contract's performance will occur at Langley AFB, VA; Holloman AFB, NM; Tyndall AFB, FL; Beale AFB, CA; and Whiteman AFB, MO. Meanwhile, T-38Cs are used to prep pilots to fly bomber and front-line fighter aircraft including the F-22 Raptor, F-16 Fighting Falcon, F-15C Eagle, F-15E Strike Eagle, and A-10 Thunderbolt, among others.

Figure 3 | MI Support Services will render intermediate maintenance services, organizational services, and program management for the USAF T-38s enlisted in the Companion Trainer program. U.S. Air Force photo by Master Sgt. Lance Cheung

Mergers and acquisitions take it easy

This time of year every year, nearly everyone is taking lengthy vacations. And the merger and acquisition arena seems to be following suit. Accordingly, there is only one acquisition to report: **Eurotech**, a "pervasive computing device" and embedded tech supplier announced that the $1.9 million cash "share capital" acquisition of VPX, VME, and CompactPCI board supplier **Dynatem Inc.** has been finalized. The international Eurotech has its headquarters in Italy and subsidiaries and offices in Asia, North America, and Europe. The company specializes in delivering miniaturized computers and computers fitted with High Performance Computing (HPC) capability. Target markets include defense, medical, and industrial, among others.

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Figure 4 | General Dynamics recently received a $60 million contract modification from the Naval Sea Systems Command for long-lead-time materials for MLP. U.S. Navy photo

General Dynamics eases U.S. port anxiety

General Dynamics continues to make the seas a less risky place for the U.S. DoD Maritime Prepositioning Force (Future), thanks to a recent $60 million contract modification from the Naval Sea Systems Command. The previously awarded contract stipulates that General Dynamics renders long-lead-time materials for the Navy's Mobile Landing Platform (MLP). Said materials include integrated propulsion components, diesel generator engine components, pumps, the emergency generator, and more. MLP is designed to facilitate successful at-sea, military-vehicle transfers between ships, eliminating U.S. foreign port dependency (Figure 4). MLP's features include a self-deploying sideport platform and a self-deploying ramp system. Work continues in various Canada, U.S., and Germany locations and is anticipated for completion by December 2014.

COTS focus for Lockheed Martin sub upgrades

Relevant to the U.S. Navy's Technology Insertion Hardware program, Lockheed Martin recently received an IDIQ contract with a maximum $758 million value to provide COTS hardware- and software-based submarine sonar and combat systems. Accordingly, Lockheed Martin will utilize commercial switches, displays, and servers and ruggedize them for military environments in fulfillment of the contract. Meanwhile, the Technology Insertion Hardware program affects subs such as those in the Virginia Class, in addition to SSGN, Seawolf (Figure 5), 688/688i, and future subs.

Figure 5 | Lockheed Martin will spruce up U.S. Navy Virginia Class, SSGN, Seawolf (pictured), 688/688i, and future subs with COTS-based sonar and combat systems. U.S. Navy photo by Mass Communication Specialist 3rd Class Timothy Aguirre

Open standards ease Multi-Level Security (MLS) systems integration

By Edwin de Jong, PhD

When sharing mission-critical information across networks, enforcing security policies can be surprisingly complex. Using a standards-based platform to manage secure communication channels helps overcome the technical challenges.

The use of advanced computer systems and networks as tools in all aspects of modern warfare continues to grow. Situational awareness and timely access to mission-critical information are increasingly the difference between mission success and failure. Providing mission-critical information often involves making data at different security classification levels widely available, often to systems on the battlefield.

Increasing Multi-Level Security or *MLS* requirements are being met by a new generation of operating systems. General-purpose and embedded operating systems like SELinux, VxWorks MILS, INTEGRITY-178B, and LynxSecure are available. However, the connected and distributed nature of modern systems dictates that a single operating system and set of applications is not sufficient. Secure communication links enable the extension of individual nodes into a distributed system that can collectively process data at multiple security levels.

The following discussion examines some of the challenges involved in architecting and integrating distributed MLS systems – and how these challenges are best addressed by adopting a standards-based integration platform.

Architecting MLS systems

Enforcing security policies in a distributed MLS system can be surprisingly complex. The goal of MLS is to maintain security classification levels throughout distributed systems. The rules are seemingly straightforward and operate on sensitivity (for example, Secret or Top Secret) and a set of categories (for example, red, blue, and green). Data is labeled with sensitivity and one or more categories. Processes, acting on behalf of a user, should only access data at the same or lower sensitivity and only if that process is authorized for that particular set of categories.

The root of the problem lies in the fallibility of computer software. Even the best software inevitably contains flaws. Because even the tiniest flaw can be exploited, it is not possible to rely on the majority of software to enforce security policies.

The question then becomes how to architect software and systems to make it possible to process multiple security levels of data without having to rely on the majority of the software in the system, particularly application software.

Multiple Independent Levels of Security (MILS) architecture, for example, employs operating systems that separate security domains using very small and highly assured kernels. Within each separated environment or *partition,* applications or virtualized operating systems are run.

Most MILS systems also provide communication mechanisms that allow for controlled sharing of data between partitions. This can be used to allow many of the communication patterns found in a Bell-LaPadula architecture, for example, such as Read Down (read from lower classification level components or storage).

A MILS separation kernel allows applications that require high-assurance to run on the same system with medium- or low-security applications.

The problem of controlled information sharing

At the core of distributed MLS systems is the controlled sharing of information across networks. This often requires a guaranteed one-way flow of information that is different from most network or interprocess communication standards.

The one-way nature of these communication channels is a constant challenge when architecting MLS systems. Most communication mechanisms, even when only transferring data one way, have a mechanism for a reader to communicate back to the writer. This channel is used, for example, for reliability traffic, like positive and negative acknowledgement of packets in a reliability protocol. Without this backchannel, most existing software, including network protocols, will not work unmodified.

Some implementations have a limited backchannel that is controlled by a trusted component. For example, consider two processes communicating using a System V Message Queue on a Linux system. In this scenario, the operating system kernel provides limited information back to the writer, such as when the queue is full, allowing the transfer of status information without allowing the reader to communicate back arbitrary data. Arbitrary data communication paths, called *overt channels,* are the largest risk to the controlled sharing of information because they are intentionally enabled, high-bandwidth communication paths.

Even when overt information flows are removed in a communication channel, it is possible that unintentional (from the point of view of the system designer) information flows are still present. These flows, called *covert channels,* are typically present when the reader can influence reliability data provided to the writer. In the aforementioned example, the indication of queue status to the writer can be exploited to communicate a substantial amount of information over time.

Standards-based information sharing

Addressing the challenges of controlled information sharing in distributed MLS systems requires a standards-based approach that enforces security policies across different platforms (Figure 1). The Data Distribution Service for Real-time Systems (DDS) standard from the Object Management Group (OMG) is a compelling choice for managing distributed MLS communication channels. Its peer-to-peer, brokerless architecture directly supports MLS systems without compromising security controls or introducing special security components that must be trusted to maintain data separation.

The DDS standard provides anonymous publish/subscribe communication. To an application, DDS provides an interface for sending and receiving data while providing QoS such as reliable data transfer, sending historical data, and hot fail-over. In addition, the standard offers specific mechanisms that help implement controlled information sharing in MLS systems.

Domain separation

The most fundamental requirement of a distributed MLS system is that of ensuring the separation of data from different security levels across the network. The DDS standard provides a mechanism, called *Domains,* that effectively supports the separation requirement of these systems and gives system designers a powerful tool to meet this particular constraint. DDS Domains represent logical, isolated, communication networks. Multiple applications running on the same set of hosts in different DDS Domains are isolated from each other (even if they are on the same machine). Application processes belonging to different DDS Domains will never exchange data, including both user and meta-data. Because this method is for systems with no cross-domain requirements, backchannel traffic is not an issue.

Low-to-high communication

For distributed MLS systems, providing mission-critical information often involves making data at different security classification levels available on the network across security domains. The DDS standard provides a QoS model that enables system developers to control the behavior of communication protocols. If backchannel traffic is not allowed, the developer can configure DDS to use a best-effort delivery protocol, which does not return acknowledgements. This way, the system accommodates one-way, low-to-high data flow that would allow for the implementation of Read/Write at level capabilities as well as Read Down/Write Up capabilities.

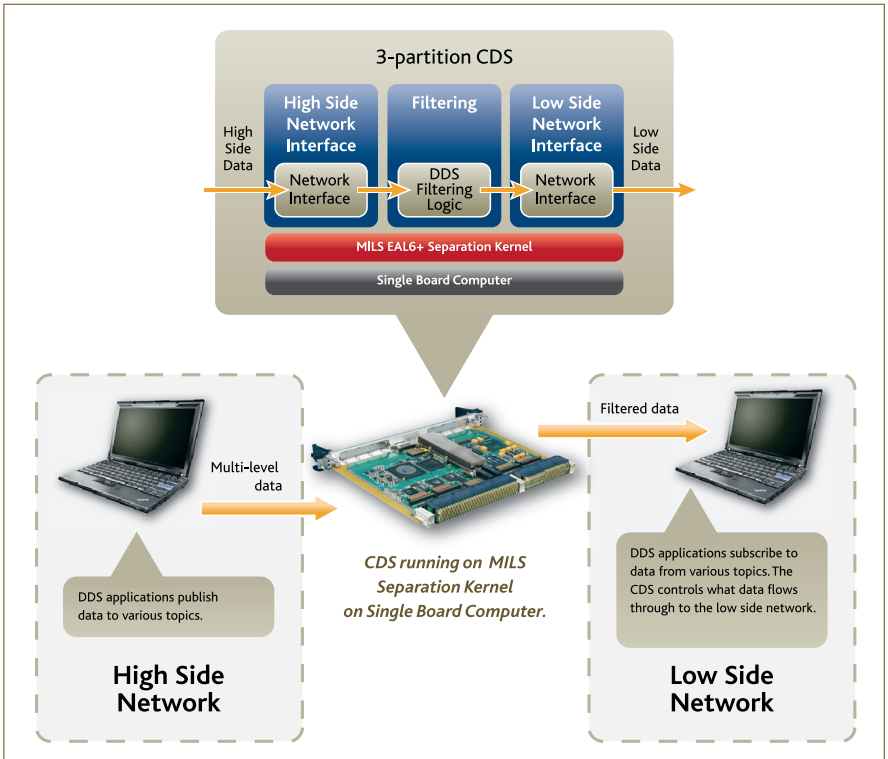

Figure 1 | Addressing the challenges of controlled information sharing in distributed MLS systems requires a standards-based approach that enforces security policies across different platforms.

Secure bidirectional information sharing

In distributed MLS systems, fully bidirectional transfer of information between security levels often involves the use of a Cross Domain Solution (CDS). A CDS can run in one of two modes:

- Low-to-high reliable transport – transfer of user data from the lower security level to the higher security level with a transfer of only reliability-protocol traffic, including positive and negative acknowledgement messages, from high-to-low
- Bidirectional transport – transfer of user and reliability-protocol data from both low-to-high and high-to-low

The CDS can be a separate hardware solution with two or more network interfaces or a software component that runs in a MILS OS partition. In either scenario, the CDS can bridge several network levels, providing bidirectional traffic between any pair of levels as allowed by the security policy of the CDS.

High-to-low transfer using a DDS-based CDS

A fundamental requirement for any CDS is that all traffic flowing through the CDS can be inspected and potentially filtered according to the active security policies. This requirement is directly supported by the DDS standard through its type system. DDS provides type information for all data flowing through the system. The CDS can use the type information to dynamically inspect the contents of each packet that passed through. The data inspection can inspect all data fields and, potentially, allow for the modification or redaction of fields according to a security policy. The DDS standard provides an architectural opportunity to perform deep inspection of content to preserve data confidentiality (for high-to-low transfers of user data) and protect differing levels from malicious code or data. Since DDS exchanges type information once (when it sets up a communication channel), the data inspection capability takes minimal network bandwidth.

These are a few examples of how a standards-based platform helps implement secure sharing of mission-critical data across networks. Some system integrators have already adopted a standard-based approach and are well positioned to respond to the increasing MLS requirements.

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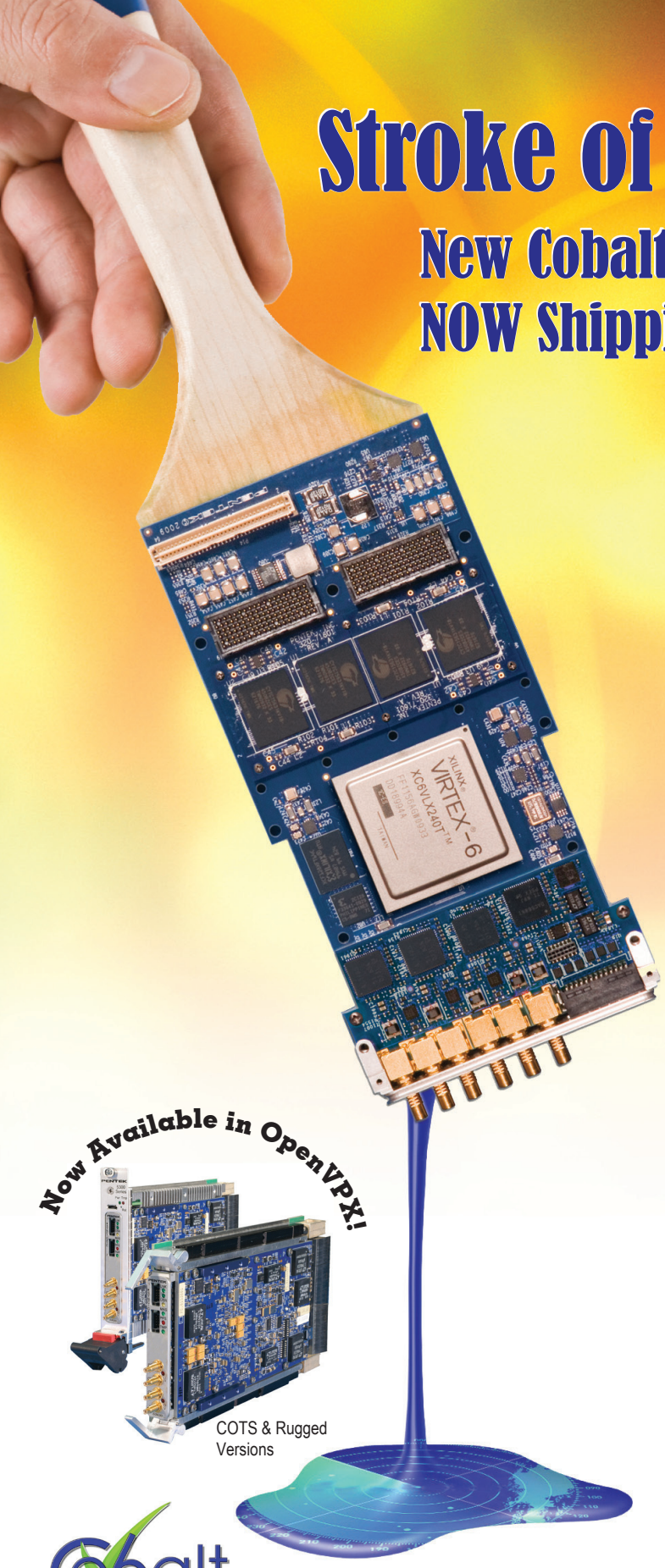

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A new chapter in secure "Data at Rest" using cryptography

By Tom Bohman

Cryptography has evolved over many years to prevent unauthorized access to communications, whether the information was transported by courier, teletype, radio waves, or the Internet. Its use in protecting information on computer storage devices is a relatively new and rapidly evolving cryptographic technology.

U.S. Air Force photo by Airman 1st Class Samuel W. Goodman

Communications Security (COMSEC) has always been a critical issue in defense systems, and its importance has greatly increased as a result of the military engagements the U.S. has found itself in after 9/11. Data and COMS security have taken on renewed and urgent importance because of the readily available technology that enables adversaries to easily intercept and exploit communications or Data in Transit (also called *Data in Motion*), as well as gain access to restricted data retained on storage devices (Data at Rest). Security for Data at Rest is a relatively new and increasingly critical problem driven by the explosive growth of low-cost, high-capacity storage devices and the many forms of digital data. It's important to understand how Data at Rest differs from communication security, and the unique security definitions, issues, and technologies available to protect Data at Rest.

Data at Rest versus Data in Motion

Cryptography was invented to protect *communications,* which is essentially information transmitted between two end points. Historically, this Data in Transit comprised voice or text transmitted over radio frequency channels. Today, both voice and digital data are transmitted over digital networks using Internet Protocol (IP). The National Security Agency (NSA) approved encryption device for Data in Transit over IP networks is called *High Assurance Internet Protocol Encryptor* (HAIPE).

With HAIPE, the communication end points coordinate keys at the beginning of each transmission, and these keys are destroyed when that unique transmission is complete. The keys are ephemeral in nature and are constantly being refreshed so that even if a key were to be compromised, the amount of information compromised would be small, and therefore, the damage would be minimal.

In contrast to Data in Motion, Data at Rest is data that is recorded to a storage device such as a computer hard drive, and can remain valuable for very long periods of time measured in days, months, and sometimes longer. For many years, the data recorded to storage devices was not encrypted, but was instead stored in clear text while the storage device itself was physically secured from theft or compromise. Over time, as nonvolatile flash storage became less expensive, its utility and value in the military for storing both unclassified and classified programs became apparent. A problem, though, was that securing the storage device itself was not always possible. To help solve the problem, suppliers of flash storage devices began to build in

Information Assurance (IA) methods that enabled users to quickly erase, clear, purge, sanitize, and zeroize the contents of the storage device. It is useful to understand the definition of these various Information Assurance terms and how Data at Rest physical device security has evolved to support cryptography.

ERASE or CLEAR:
Data piracy is an issue

ERASE, or CLEAR, is the process of performing data elimination by sending a single erase or clear instruction to each physical location or address of the non-volatile memory. This is done in such a way that the data cannot be reconstructed using normal system functions such as binary block reads or file recovery software. It's not a perfect method. By observing the data remnants effects that remain in the device, the data can be restored by an adversary using special laboratory techniques. While ERASE/CLEAR function can be completed in a few seconds, it provides minimal security for the Data at Rest problem.

PURGE/SANITIZE: Fast enough?

PURGE/SANITIZE is the process of performing data and data remnants elimination so that the data cannot be recovered by any known laboratory technique. PURGE/SANITIZE requires multiple memory erase and overwrite cycles and in some cases partial or complete verification as specified by various government agency PURGE standards. These standards include NSA 9-12, Navy NAVSO P-5239-26, Army AR380-19, Air Force AFSSI-5020, DoD 5220.22-M, and IRIG 106-09 Ch 10.

PURGE/SANITIZE algorithms that overwrite and verify memory contents several times work well, but only for a few gigabytes of either volatile or non-volatile memory because of the time required for each memory access. Today's storage devices typically have a capacity of several hundred gigabytes, and can often be as large as several terabytes. For large capacity storage, PURGE/SANITIZE algorithms can take hours to complete, which is unacceptable for the emergency PURGE of sensitive data in a hostile environment.

Another major issue associated with PURGE is that today's nonvolatile flash storage usually consists of COTS Solid

State Drives (SSDs). Figure 1 is a 3U VPX SSD. Such SSDs have multiple flash controllers located between the host interface and the actual flash memory chips. These flash controllers perform many tasks, such as wear leveling and bad block management, independent of and transparent to the host computer. As a result, in modern SSDs the flash controllers may reserve and make inaccessible to the host more than 20 percent of the flash memory cells. Because of this SSD feature, the PURGE algorithms must be implemented by the drive manufacturer; in lower-cost drives,

Figure 1 | A 3U VPX SSD

PURGE algorithms are not implemented at all. Recently, as this problem has become better understood, it has become clear that PURGE/SANITIZE of the entire storage device is both impractical and unacceptable for security of Data at Rest in military systems.

> "Because of the relatively small amount of data that must be PURGED, the ZEROIZE process can be extremely short, often one second or less."

ZEROIZE:
The new cryptography frontier

Emphasis in cryptography applied to Data at Rest has increased dramatically. Today, nearly all military programs include stringent IA requirements that focus on detailed *ZEROIZE* specifications.

ZEROIZING a storage device's memory is the process of PURGING all sensitive cryptographic parameters from the cryptographic module, especially the keys. Once the ZEROIZE mechanism has been initiated, an adversary will have no way to decrypt the information on the storage device without first obtaining the sensitive parameters, including encryption keys, from some other source. Because of the relatively small amount of data that must be PURGED, the ZEROIZE process can be extremely short, often one second or less. This is very effective for emergency ZEROIZING of Data at Rest on devices of virtually unlimited capacity on the battlefield, whether megabytes, gigabytes, terabytes, or even petabytes of data.

It is worthwhile to note that the cryptographic key used to encrypt the data is also essential for anyone attempting to decrypt the data, including the data owner. Unlike COMSEC, the Data at

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Rest encryption key must exist as long as the encrypted data needs to be made available. That means that cryptographic key management becomes as important as protecting the unencrypted data.

Data at Rest security is only as strong as the encryption algorithm and the key management architecture being used. If the algorithm is strong but the key management is weak, the data is still not sufficiently protected. While the key management strategy must be strong, it must also be operationally simple so as not to impede the mission.

For ZEROIZING to be effective, the encryption module must be positioned "inline" between the host processor and the flash controller to ensure that all information stored to the flash gets encrypted and everything read from the flash gets decrypted. All of the Data at Rest on the flash always remains encrypted. Therefore, not only is the data protected but the entire File Allocation Table (FAT), directory, bad block, and wear-leveled data are also protected and are not available to the host unless decrypted.

Figure 2 shows the architecture of the Curtiss-Wright Controls Electronic Systems 3U VPX SATA Flash Storage Module (FSM) with onboard encryption. Note that this module has four flash banks, each with a SATA flash controller for wear leveling and bad-block management, and an inline SATA-to-SATA AES-25 encryption module. Also onboard is a microcontroller that performs key management, ZEROIZING, and BIT. The key management architecture is designed to be flexible and easily programmable to mesh smoothly with the end user Concept of Operations, often referred to as *CONOPS*.

Implementation: More to the story

Implementing Data at Rest encryption differs from Data in Transit encryption and is new to most military programs. Implementing Data at Rest encryption can be complicated and confusing, especially in light of the many choices for IA: ERASE or CLEAR, PURGE/SANITIZE, and ZEROIZE. The world of military security entails a veritable cryptic alphabet soup of acronyms and terms, including NSA, NIST, CDE, CNSS, CCI, NIAP, CCEVS, FIPS 140-2, Type 1, Suite A, Suite B, and CSPP, that need to be understood and navigated as well.

In addition, a variety of government agency validations and certifications may be required for components and products that store ever-increasing sensitive data from clear text to Top Secret and beyond. The NSA and National Institute of Standards and Technology (NIST) are the two U.S. government organizations that evaluate, validate, and certify cryptographic equipment for various levels of security.

Editor's note: *Curtiss-Wright Controls has two separate and distinct divisions working on embedded technologies. This article was written by Curtiss-Wright Controls Electronic Systems.*

Tom Bohman *is a Sr. Product Manager for Rugged Storage at Curtiss-Wright Controls Electronic Systems. He has more than 30 years of experience in the design of real-time embedded systems for man and hardware-in-the-loop simulations, high-speed data acquisition, DSP systems, and rugged storage products. Tom holds a BSEE degree from the University of Dayton and an Associate Degree in Tool & Die design. He can be contacted at tbohman@curtisswright.com.*

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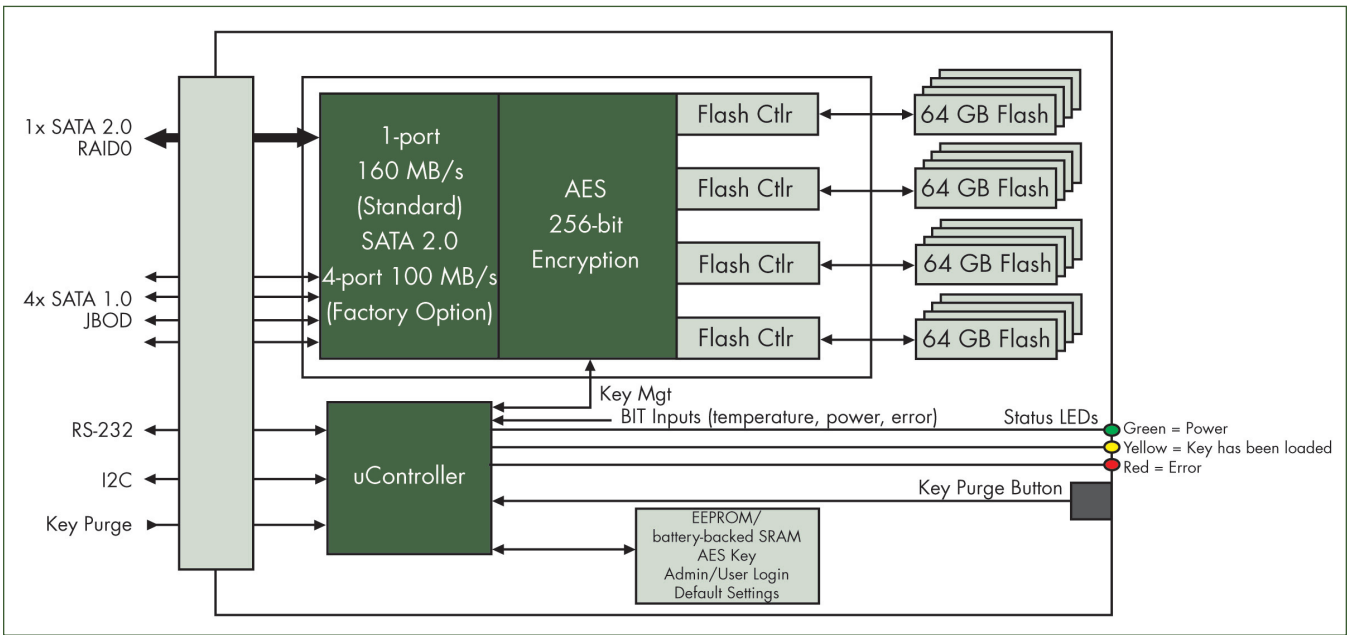

Figure 2 | The architecture of the Curtiss-Wright Controls Electronic Systems 3U VPX SATA Flash Storage Module (FSM) with onboard encryption.

Revolutionary lithium batteries might solve military's power problems

An interview with Contour Energy's Dr. Simon Jones, Vice President, Technology

EDITOR'S NOTE

With all the buzz about electric cars, it's no wonder that universities and COTS companies are investing heavily in research to develop next-generation batteries. The problem they're trying to solve? More, with less. More stored energy, less weight, at lower cost. This boils down to energy density, or amp-hours/kg/$. Funded originally by academia and private money, southern California-based Contour Energy Systems recently partnered with MIT to "dramatically improve the power capability of lithium-ion batteries." Their innovation? Using carbon nanotubes for battery electrodes. Licensed from MIT, the sheets of pure carbon atoms rolled up into tiny tubes allow huge numbers of lithium atoms to congregate at the positive end of the battery, or cathode. As well, the lithium storage reaction at the cathode is very fast – enabling more electron migration per unit time, equaling more power. Batteries can be tuned for weight, power, or both. Editor Chris Ciufo interviewed Contour's director of research and development, Dr. Simon Jones, and discussed this nanotube technology and Contour's throw-away (primary cell) batteries. Edited excerpts follow.

MIL EMBEDDED: ***What's the mission of Contour Energy?***

JONES: Our company was founded from a collaboration between the CNRS [the French National Center for Scientific Research] and Caltech in 2007.

MIL EMBEDDED: ***What's the nature of Contour's relationship with MIT?***

JONES: Contour has established an exclusive technology licensing agreement with Massachusetts Institute of Technology. We've acquired a breakthrough carbon nanotube technology that can dramatically improve the energy capacity of lithium-ion batteries.

MIL EMBEDDED: ***So what is this carbon nanotube breakthrough based on?***

JONES: Well, early findings from researchers at MIT confirm that using carbon nanotubes for battery electrodes can produce up to a tenfold increase in the amount of power than can be delivered from a given weight of material when compared to a conventional lithium-ion battery.

MIL EMBEDDED: ***What exactly is new in the battery electrode being developed by Contour and MIT?***

JONES: First of all, it's important to understand the concept of a carbon nanotube and how they are assembled into our electrodes. These nanotubes are sheets of pure carbon atoms rolled up into tiny tubes, and we use "self assembly" through a controlled deposition process that is driven by electrostatic interactions to make the electrodes. This creates a tightly bound structure that is porous at the nanometer scale. We're talking about billionths of a meter. These carbon nanotubes contain numerous functional groups on their surfaces. So what's the big deal? The functional groups allow the nanotubes to store a large number of lithium ions per unit mass. For the first time, carbon nanotubes can serve as the cathode in lithium-ion batteries, instead of in their traditional role as the anode in such systems. Our mission is to be a world leader in developing and commercializing next-generation battery solutions for a cleaner planet.

MIL EMBEDDED: ***So what does this mean for lithium-ion battery performance?***

JONES: It means this new material can produce very high power outputs in short bursts and steady lower power for long periods of time. Think of it this way: The energy output for a given weight of this new electrode material is five times greater than conventional electrochemical capacitors while the total power delivery rate approaches 10 times that of lithium-ion batteries.

MIL EMBEDDED: ***Are there other advantages beyond high power output?***

JONES: In a word, "stability." We've found that after 1,000 cycles of charging and discharging a test cell, there has been no detectable change in the material's performance.

MIL EMBEDDED: ***Shifting gears, tell us about your currently available lithium primary cells.***

JONES: This is the major technology that we have market ready at the moment. You can buy button cells commercially, and we are developing cylindrical cells for military and other applications. Our primary battery technology is based on lithium as the anode material, but here our innovation is a new type of carbon fluoride cathode material that enables extremely long runtimes and very high power capability. This is an advance from a chemistry originally developed in the '70s for very low-drain, long-runtime applications. Now we can use this new carbon fluoride material in high-power applications.

If you think about, for example, a soldier battery – a battery needs to power radios and various other communications equipment in the field, which would require both an extremely long runtime and high-power capabilities to run all of these

instruments at once. Traditional solutions employ lower energy-density systems because previous carbon fluoride technologies could not be used in these applications. We've made the breakthrough that allows us to use new carbon fluoride materials, so we can really lighten the mass of batteries required for a mission and significantly increase their runtime.

MIL EMBEDDED: ***Energy density in this context is the amount of energy per-unit size or per-unit weight?***

JONES: We can define specific energy as per-unit mass and energy density per-unit volume. For our primary cells with a long runtime, the delivered voltage can be anywhere between 2.5 to 3 volts per cell. It's a somewhat sloping discharge, which can be used as a state-of-charge indicator.

MIL EMBEDDED: ***How does your cathode work?***

JONES: Our innovation is the cathode material, which we call *Fluorinetic* technology. We take carbon nanomaterials, nanotubes, fibers, and other types of materials and turn them into a fluorinated form of that carbon to make a very high-energy density cathode system. Lithium metal is the anode, and that's standard for all lithium primary cells. The lithium dissolves at the anode and reacts with the carbon fluoride to make lithium fluoride and carbon at the cathode.

Carbon fluoride has a very high energy density because carbon and fluorine are both very light, but the traditional carbon fluorides do not work well at high drain rates. Graphite [carbon] is electrically conducting, but as you turn that carbon material into carbon fluoride, you lose the electrical conductivity. Our Fluorinetic breakthrough is to retain some of that electrical conductivity in the system, while keeping the significant energy density of carbon fluoride. And we are also able to [provide] power capability using nanomaterials and different reaction conditions to make Fluorinetic materials with high power capabilities.

MIL EMBEDDED: ***When you say "power," you're talking about the ability to move a lot of current through the material?***

JONES: Exactly, to extract the energy fast and efficiently. Without the Fluorinetic breakthrough, the carbon material loses its conductivity as part of the normal fluorination reaction.

Our Fluorinetic material is much less resistive in performance; therefore, it provides much higher power capability in a battery. This is our major market-ready technology that we're currently manufacturing in the USA. And we build and assemble parts here in California for OEMs and commercial, industrial, and military customers.

MIL EMBEDDED: ***Let's dig deeper. What is your specific innovation that enables magic at the cathode?***

JONES: If you think about a traditional cathode of carbon fluoride material with low power, the ratio between carbon and fluorine in the system is approximately 1:1. Our Fluorinetic innovation reduces the amount of fluorine in the system. Instead of having a carbon and fluorine ratio of 1:1 we have 1:0.8, for example. This leaves up to 20 percent of the sp^2 (graphite-like) structure in the system,

which allows us to retain some of the electronic conductivity that was originally present in graphite. Also, instead of just graphite, we can take nanotubes, nanofibers, other kinds of nano-sized materials too – layered, disc-shaped, or spherical materials – and apply that subfluorination process to them. So we end up with a much greater power capability.

MIL EMBEDDED: ***Very interesting. So can the levels be adjusted?***

JONES: Yes, we need to carefully control the fluorination conditions to make sure that we are introducing just the right amount of fluorine. Also, depending on what the temperature is, we can retain more or less of the sp^2 characteristics. There are other reaction pathways, which give you all sorts of different fluorination products, too. You need to be able to understand quite how to do that retention of sp^2 structure in the carbon material, and that's where our intellectual property is strong.

MIL EMBEDDED: ***How production-ready are these batteries?***

JONES: Currently we are manufacturing coin cells for consumer applications in the 2032, 2025, 2016, and 2450 varieties. They are well-suited for different applications in consumer electronics, such as 3D television glasses, LED lights, and smart key fobs.

All four form factors will be on the market soon. But you can certainly buy two form factors today if you go to Amazon.com and search for our 2032s and our 2025s.

MIL EMBEDDED: ***What's the advantage of your battery?***

JONES: The energy stored in the system is related to the amount of fluorine present because you're breaking the carbon-fluorine bond. The advantage of our system is delivered capacity at higher rates. So if you're draining extremely slowly at a 1 micro-amp discharge, you'll end up with essentially the same delivered capacity as traditional systems. But as you go to a 1, 10, 100 milli-amp discharge rate, the relative delivered capacity will scale proportionately, so you end up with around twice the delivered capacity at 1 milli-amp or four times the delivered capacity at 4 milli-amps and so on.

MIL EMBEDDED: ***How does this relate to defense applications or power cells that Marines and soldiers carry?***

JONES: If you think about the energy density of the materials in the current soldier battery, there's a sulfur dioxide system, which is the BA5590 and there's a manganese dioxide system, which is the BA5390. The specific energy of a sulfur dioxide battery is somewhere around half that for a Fluorinetic system. The specific energy of the manganese dioxide system is somewhere around two-thirds of the Fluorinetic system. So an xx90 equivalent system made from our Fluorinetic material requires about half the amount of batteries that other systems do for a comparable amount of energy, or we can approximately double the amount of energy in the same form factor. So, double the runtime is possible.

MIL EMBEDDED: ***What are the power requirements on these military xx90 style batteries, and what's your production status?***

JONES: Typically the standard test is a 2-amp discharge. Regarding status, we're developing samples at the moment. We are intending to have them out towards the end of the year.

MIL EMBEDDED: ***Wow, totally COTS. How do prices compare with existing off-the-shelf competition?***

JONES: The amount of material going into a button battery is very small, so that's something well suited for the consumer market. The amount of material in these larger batteries is obviously significant, but we manufacture our powder ourselves. Other large battery companies typically source their cathode material, and the unit cost of the material is significantly more if they were to use, for example, traditional carbon fluoride. This is because the price is driven by the cost of fluorine. As we manufacture our Fluorinetic material ourselves, the cost of fluorine is reduced significantly at scale. At smaller scales, carbon fluoride may be twice the cost of MnO_2 but can deliver twice the performance on a price per-kilowatt hour. So we're approximately equivalent, and the cost of Fluorinetic material will decrease significantly as we increase production capability.

MIL EMBEDDED: ***Have you considered using these technologies for other military applications?***

JONES: Yes, both the primary and carbon nanotube-based rechargeable systems are useful in micro and unmanned aerial vehicles. This is something that we've been working with the Air Force to demonstrate – are you familiar with soldier-launched drones?

MIL EMBEDDED: ***Absolutely, Dragon Eye and others.***

JONES: Yes. We had a program at the Air Force [Research Laboratory at Wright-Patterson] to demonstrate our Lithium CFX Primary as a power source. The program was titled "New Power Source for Aerial Vehicles." These types of applications are in our "sweet spot" in the sense that they require a long runtime and a high-power capability. That's because of the need for power to perform takeoff and climb and then, for example, make altitude adjustments while running sensors and other electronic instruments. You don't want to only be able to take 10-15 minutes of surveillance data and then come back. What we did was take a spec that originally allowed the plane to run for 30 minutes: 15 minutes out and 15 minutes back. Throughout the program, we were able to extend that runtime to 45 minutes there and back, thus tripling the total runtime from 30 to 90 minutes.

Dr. Simon Jones *is Vice President, Technology at Contour Energy, where he oversees the R&D effort in both Lithium primary and advanced rechargeable technologies. In addition, he works closely with partners such as universities, national laboratories, and other institutions for the licensing and development of other advanced battery technologies and platforms. He received a D. Phil in Chemistry from the University of Oxford, UK, and is the author of more than 30 scientific publications. He has more than 10 years of experience in materials research for emerging technologies, including electrochemistry, organic electronics, and nanotechnology.*

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This is how the Army builds a quiet hybrid vehicle: from the battery up

An exclusive interview with John Battaglini, VP of Business Development at International Battery

EDITOR'S NOTE

When I read the press release from International Battery and the Army about the Silent Watch program, it read like a Clancy novel describing covert night operations. But that's exactly what the Army's TARDEC wants: the ability to operate truckloads of equipment using only battery power. As the following interview with John Battaglini, International Battery's VP of Business Development reveals, drop-in replacement has about 10x the number of discharge cycles compared to traditional lead-acid types, can cut auxiliary generator use by 50 percent to save fuel and noise, and has enough juice to run equipment without running a vehicle's engine. And, it's made in America. Edited excerpts follow. – Chris A. Ciufo

MIL EMBEDDED: ***OK. Tell me about the press release I received from International Battery entitled, "International Battery Receives TARDEC Contract to Develop Advanced Energy Storage Systems for the U.S. Army Silent Watch," which I think is a combination of iron phosphate cells and ultra-capacitors.***

BATTAGLINI: This was an award that we received from TARDEC, which does research for the tank [armored vehicle] division of the U.S. Army. We've been working with them for many years on Silent Watch. This latest contract was for a 12-volt battery that is a lead acid replacement. And, as you mentioned, it's a lithium ion battery that is combined with ultra-capacitors to replace what is called the *NATO 6T* battery, a lead acid battery used in many military vehicles for Silent Watch Operations. This program is originated out of TARDEC in Michigan.

MIL EMBEDDED: ***You just said lithium ion, but the press release says lithium iron phosphate cells. Is that correct?***

BATTAGLINI: Lithium iron is a subset of lithium ion, so both are correct. Lithium iron phosphate is the cathode chemistry we are using for this particular battery cell. This is a secondary cell, so this combination makes it a hybrid concept.

MIL EMBEDDED: ***Tell me more about Silent Watch Operations.***

BATTAGLINI: Silent Watch is a military program, and its main objective is to enable longer runtimes when Humvees, Stryker vehicles, or other military vehicles are out on silent watch. Obviously you want to be as quiet as possible for as long as possible – no heat signature, no audible signature. Runtime has been a big concern: How long can Silent Watch happen? Right now they're limited to [a couple of] hours of operation, and they really want to extend that to 8-10 hours. The battery technology is an important part of that.

MIL EMBEDDED: ***This battery we're talking about – does it start the engine, or is it for the vehicle's auxiliary equipment?***

BATTAGLINI: It's a combination. Basically, it will be used to start the vehicle, which is where the capacitors come into play to provide the high power needed for starting operations. We also want to be able to power all of the electronics on the vehicle and used during Silent Watch, such as sensors and night vision and laser designators and communications equipment.

MIL EMBEDDED: ***What is the starting power in this case, and what is the typical power drain when the engine is not running during Silent Watch?***

BATTAGLINI: For starting power, these are rated as 130 amp hour cells. You're going to get two or three times that current to start the vehicle. As far as the auxiliary load, it [can be around] 100 amps. To really increase the runtime, you'll need several of these battery cells, but a continuous power draw is probably about 50-100 amps.

MIL EMBEDDED: ***This cell itself – the iron phosphate battery coupled with an ultra-capacitor – is this all in a self-contained unit? Or are these two physical pieces that work together?***

BATTAGLINI: It's in a self-contained enclosure. They are different technologies, both of which we will manufacture in our facility. They will work together, but they will be in one rugged enclosure.

MIL EMBEDDED: ***Give me an idea of how lead acid compares with lithium.***

BATTAGLINI: You're going to get double the energy in the same space for lithium versus lead acid. That's significant for these vehicles where space is very limited inside a vehicle. The military has tried different technologies, and lithium is the most advanced battery technology to help solve this problem. So, you're going to get very good energy density, as I mentioned, and you're going to get very good cycle life performance versus lead acid. We're projecting greater than 4,000 cycles for the lithium iron phosphate, whereas with lead acid you're going to be limited to probably 300-500 cycles.

And another thing – these are very high-temperature environments where lithium ion does very well. Lithium iron phosphate

in particular is able to get very big performance across a wide temperature range, whereas lead acid has problems in [military-style] environments and its life will be shortened.

MIL EMBEDDED: ***Any other factors?***

BATTAGLINI: Case safety is another important factor. With the lithium iron phosphate, you're getting a very abuse-tolerant chemistry that's excellent for DoD applications. We've done considerable testing in iron phosphate, including shooting it with live ground fire, and there are no catastrophic events. It fails very gracefully even under those extreme conditions, which is very important. Overcharge it up to 20 volts and nothing will happen, no fires or anything like that. With other lithium chemistries under live round fire – you're talking explosions and some very nasty things happening.

MIL EMBEDDED: ***What's different about this lithium chemistry besides the lithium iron on the cathode? What about the battery's electrolyte?***

BATTAGLINI: The electrolyte is the same, but the cathode material is the biggest determinant for that, so it's the chemistry of the materials. So that's the long and short of the contract. The contract included the development of this new NATO 6T drop-in lead acid replacement in addition to an extension of work we were doing for what we call the *NPS-1160* battery for TARDEC and Silent Watch. NPS-1160 is just a pure lithium battery, no ultra-capacitor. But that is a ruggedized module that's been through various MIL-SPEC testing and various safety testing.

MIL EMBEDDED: ***What the about cost differential between military battery versions available today and your battery that offers 4x the performance?***

BATTAGLINI: Really, the correct way to look at that is: What is the total life-cycle cost? There will be less maintenance and more cycles with a lithium battery, as I mentioned – greater than 4,000 versus 300-500 with a lead acid battery. That means less replacement and virtually no maintenance with a lithium battery. Up front, out of the gate, yes lead acid is cheaper. But you have to look at the total cost of ownership over a number of years.

And, our battery is a drop-in replacement; it fits in the same footprint as an existing battery.

MIL EMBEDDED: ***Let's talk about charging these batteries. Do you just wire one into the same application with the alternator on the vehicle or auxiliary generator?***

BATTAGLINI: There are control electronics that come with our battery that will interface to the engine compartment and make sure it's getting the right current and the right voltage. Typically, we can get the full charge in two hours. For lead acid, you're looking at six hours.

MIL EMBEDDED: ***Do you have plans to market your battery civilian-wise at some point? I've got a friend with a pleasure yacht…***

BATTAGLINI: Absolutely. There are different types of recreational vehicles, heavy-duty industrial vehicles that could benefit from more technology, so it's certainly a dual-use type of program.

MIL EMBEDDED: ***Besides what we've already talked about, what differentiates International Battery in the market?***

BATTAGLINI: We use an environmentally friendly, water-based process rather than solvents to manufacture the mixing and the coating of our batteries. It's good for the environment, and eventually gets into a lower cost point in the industry. Something else that makes us different as a company is we make the

large-format cells, and we make them here in the United States.

MIL EMBEDDED: ***Who are your competitors in this market?***

BATTAGLINI: I would say some of our biggest competitors are A123 and SAFT, which have worked with TARDEC and other military divisions, and they're both public companies.

MIL EMBEDDED: ***OK. Let's move on to technology in general. Which other technologies is the military needing?***

BATTAGLINI: We're seeing a tremendous amount of interest from the Marines and the Army for using lithium iron in micro-grid applications and forward-based operating camps, for example, rolling out equipment to do a shelter that might have solar with it. Typically in the past, it might have used generators or lead acid batteries, but now they're looking toward lithium to be a lighter-weight solution. So, combining renewable [energy] such as solar together with lithium batteries and even with the generator can optimize the use of all three – to get the use of fuel and make an easier solution for the soldiers in the field.

A trend for forward-operating missions is to operate their own microgrid. Forward-operating missions are where in theater some of the bigger operating camps could generate all their power independently, with reduced use of generators. That's a big thing – to reduce the use of fuel in theater. Lithium ion batteries are a big part of that reduction.

The military wants to cut down on the use of generators so they want to hybridize the generator with the battery and solar, so you can run the generator a lot less. But when you do run the generator, run it at full efficiency, and whatever power you're not using, dump into the battery. Then use the solar to do the same thing to continuously charge the battery from solar.

MIL EMBEDDED: ***So you might cut down the generator's duty cycle within 24 hours by "x" percent?***

BATTAGLINI: Yeah, it's cut by more than 50 percent.

MIL EMBEDDED: ***But if you replace a generator with a battery, voltage issues arise?***

BATTAGLINI: I don't think you're ever going to completely eliminate the generator, but it will be hybridized by using inverters to charge the battery/energy storage component to run on, creating a generator with much greater efficiency, using fuel for shorter periods of time.

John Battaglini *is Vice President of Business Development at International Battery. He has more than 20 years of experience in high-technology companies. He holds an MBA from Villanova University, an MS in Electrical Engineering from Clemson University, and a BS in Electrical Engineering from Drexel University.*

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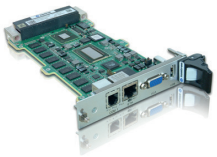

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Hermetic power packaging vs. PEMs for mil electronics? No power issues here

Q&A with Shane O'Donnell, Hi-Rel Plastic Devices Program Manager at Microsemi

In the midst of the debate over hermetic packaging versus Plastic Encapsulated Microcircuits (PEMs) in mil electronics, Microsemi quietly yet confidently recently announced a full line of new and re-released military-level-upscreened PEMs incarnated (or reincarnated) as TVSs, MOSFETs, IGBTs, and rectifiers. Editor Sharon Hess recently caught up with Shane O'Donnell, Microsemi's Hi-Rel Plastic Devices Program Manager, to find out why the company is focusing on PEMs rather than their rival, hermetic packaging.

Remind us about Microsemi – its technology focus and areas of expertise, locations, number of employees, and goal in the industry.

O'DONNELL: Microsemi is focused on providing technologies where power matters, security is non-negotiable, and reliability is vital. Our key markets are defense and security, aerospace, enterprise and commercial, and industrial and alternative energy. Our solutions focus on differentiation in power, security, reliability, and performance and include high-performance, high-reliability analog and RF devices, mixed-signal and RF integrated circuits, configurable SoCs, FPGAs, and complete subsystems. Microsemi headquarters are located in Irvine, Calif., and [the company] has approximately 2,800 employees in the U.S., Asia, Europe, and India.

Microsemi recently announced a new line of plastic upscreened Plastic Encapsulated Microcircuits (PEMs). Which types of products are we talking about?

O'DONNELL: The new products and packages available for upscreening include MOSFETs, IGBTs, and rectifiers in D3Pak, TO-220, TO-247, TO-264, and SOT-227 packages. For some of the transient voltage protection (TVS) products, this could be considered a re-release because of die and assembly location requalifications.

What was the impetus?

O'DONNELL: Upscreened PEMs will provide the industry with a broader selection of products than is currently available strictly from hermetic packages. For example, when used in a transient voltage protection application, PEMs are available with large exposed copper bottoms and top clip technology that can be soldered directly to a heat sink. During multisurge incidents, getting the heat out of the package is imperative. So these features provide ultra-low thermal resistance (< 0.2 degree C/W) junction to case, and products in this package can handle surge currents in the 15-30 kilowatt range. Through-hole hermetic packages offering the same power rating have much higher thermal resistance, in the range of ~ 20 degrees C/W junction to lead.

Another example is MOSFETs. Hermetic MOSFETs are typically offered in a Breakdown Voltage Drain to Source (BVDSS) range of 100 to 500 V. However, these new upscreened PEMs are offered in the 800 to 1,200 V range. In addition, generally speaking, PEMs can offer smaller X-Y footprints, a lower profile, lighter weight, and other extended parametric ranges as compared to hermetic packages. Favorable pricing is always a factor, but that's dependent on the amount of screening performed.

That's quite a difference. Can you explain technically what the 5 types of upscreening tests on this new line entail?

O'DONNELL: The type of tests performed to the upscreened devices target various quality levels that utilize military testing techniques based off of MIL-PRF-19500. Table 1 provides an example of a standard transient voltage protection device (SMBJ36CA) upgraded to four reliability levels. To change the screening level, you change the prefix. By adding an "M" prefix, you obtain a device that includes process control. By adding an "MA," you obtain avionic grade screening along with process control, and so on. The tests conducted for each level are shown in Table 2 as well.

The *M* prefix in the TVS product range represents a controlled process, where all aspects of the device production and test are controlled by Microsemi. Customers are informed of any change in this process even if the form, fit, or function is not changed. Lot-norming ensures all parts are within a close distribution of the average, and 100 percent surge testing verifies the clamping voltage specifications in the datasheet are adhered to.

MA products provide the optimum COTS+ offering with minimal device mortality levels. The MA upscreening flow offers ten -55 °C to +150 °C temperature cycles followed by three surge tests, 24 hours of high-temperature reverse-bias testing, three-sigma lot-norm screening performed on standby current, and final electrical tests.

The *MXL* TVS devices undergo more temperature cycles, surge tests, and a longer reverse-bias test.

Description	Part Number	Military Equivalent
Commercial Standard	SMBJ36CA	
HiRel Standard	MSMBJ36CA	Standard product with traceability of wafer lot and assembly
HiRel "MA" Upscreened	MASMBJ36CA	Traceability with avionics grade screening
HiRel "MXL" Upscreened	MXLSMBJ36CA	Traceability with "Lite" military grade screening
HiRel "MX" Upscreened	MXSMBJ36CA0	Traceability with military grade screening

Table 1 | Upscreening data relative to part numbers and military equivalents

The parts also receive PDA evaluation and delta calculations with conformance inspection based on MIL-PRF-19500 Group A. *MX* devices receive all of these tests in addition to Groups B and C conformance inspection based on MIL-PRF-19500 specifications. The *MXL* MOSFET, IGBT, and rectifier devices get a 24-hour stabilization bake followed by various temperature cycling and high-temperature tests depending on the part type. Final electrical tests are always performed prior to dispatch, ensuring the parts have remained within specification.

Plastic parts are known for moisture ingress. How does your upscreening processes thwart this specific danger?

O'DONNELL: For harsh environments, hermetic packages will always have a place in high-reliability applications. A hermetic package in the context of microelectronics implies an airtight seal that will keep moisture and other harmful gases from penetrating the sealed package. For PEMs, steps can be taken to reduce moisture ingress and tests can be added to ensure the barrier of the package. Defect-free passivation of the surface of the silicon die effectively blocks moisture access to microchip devices. Designing the lead frame for epoxy adhesion and lock minimizes the effects of moisture. Choosing the right epoxy can enhance the resistance to moisture penetration. Moisture penetration tests are performed to establish the Moisture Sensitivity Level (MSL) of each type of PEM. Standard qualification tests performed on upscreened PEMs include testing at 85 percent humidity/85 degree Celsius (85/85) and autoclave or pressure pot testing. Moisture measurements are then taken after testing to ensure package integrity.

What percentage of military-specific products does Microsemi test?

O'DONNELL: PEM screening includes the same rigorous 100 percent testing as is applied to our hermetic package devices.

For which types of military applications/systems might this new upscreened product line be suited? Why?

O'DONNELL: PEMs are used where size, weight, performance, and various grades of reliability are needed. Two big users are Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Vehicles (UGVs). Missile systems are another example where size and weight play a critical role

SCREENING OPTIONS

Description	Transient Voltage Suppressors				MOSFETs, IGBTs & Rectifiers
Process, Screen or Test Description	Product Assurance Level Requirement				
Plastic Part Prefix:	M	MA	MXL	MX	MXL
Stabilization Bake					24 hours
100% DC Electrical Test, Go/No-Go	R	R	R	R	R
3 Sigma lot norm – key parameters	R	R	R	R	R
Temperature Cycling		10 Cycles	20 Cycles	20 Cycles	20 Cycles[3]
Surge Test (TVS diodes)	1x	3x	10x	10x	
Initial Electrical Test, Read & Record			R	R	
Interim Electrical Test, R & R			R	R	
HTGB					48 hours[4]
HTRB		24 hours[1]	96 hours[2]	96 hours[2]	168 hours
Final Electrical Test, R & R	Go/no-go	Go/no-go	R	R	Go/no-go
Delta Calculations			R	R	Go/no-go
PDA Evaluation			R	R	
Group A Conformance Inspection			R	R	
Group B Conformance Inspection				R	
Group C Conformance Inspection				R	

R - Required and performed based on military test conditions and limits
1 – 24 hours for unidirectional. 24 hours each side for bidirectional.
2 – 96 hours for unidirectional. 48 hours each side for bidirectional.
3 – Not for ISOTOPs
4 – Not for Diodes

Table 2 | Screening options for Transient Voltage Suppressors (TVSs) and MOSFETs, IGBTs, and rectifiers

in the design. These vehicles and systems may be unmanned, but a malfunction at the wrong time can cost lives. Other applications include ground-based military systems such as radar, vehicle, and telecom systems.

Where and when will the new and re-released upscreened military-suitable PEMS be manufactured and upscreened?

O'DONNELL: Die fabrication and package assembly will be performed at onshore and offshore locations utilizing Microsemi Corporation facilities and contract manufacturing facilities. Screening locations are at the Microsemi facilities in Ennis, Ireland and Bend, Oregon. These products are available now.

Looking toward the future, what are some of the military-appropriate PEM technology trends immediately on the horizon, and why are they needed, technically speaking?

O'DONNELL: For a given device footprint on a circuit card, the engineering community continues to seek better performance, smaller size, and less cost. Discrete MOSFETs, TVSs, IGBTs, and rectifiers are used in power systems; to handle power for a given footprint, new surface-mount packages are being introduced such as the Plastic Large Area Device (PLAD) package. Until recently, only through-hole-type packages with multistacked die were available for high-surge applications. PLAD-type devices offer large die and an exposed copper bottom pad, contributing to an incredibly low package thermal resistance (< 0.2 degree C/W), which dissipates package heat without expensive cooling techniques. A smaller form of the PLAD-type package is currently under qualification at Microsemi.

OK, so wrapping up, which technologies will be needed in your sector of the defense arena in the next 5 to 10 years, and why?

O'DONNELL: With the cost of energy continuing to rise, saving power will continue to be important. The development of wide band gap materials such as SiC and GaN for diode and FET switching applications will be the emerging, maybe even disruptive technologies of the future replacing silicon sockets. Wide band gap materials offer near zero conduction losses in switching applications. For example, we took measurements on a 40 W point-of-load converter with a 3.3 V output using GaN MOSFET switches and did a comparison against silicon MOSFET switches in the same circuit. We found an 8.5 percent improvement in overall circuit efficiency when using the GaN MOSFET switches. Both SiC and GaN base material costs are expensive today; but as more applications emerge, cost will come down, allowing for greater industry adoption.

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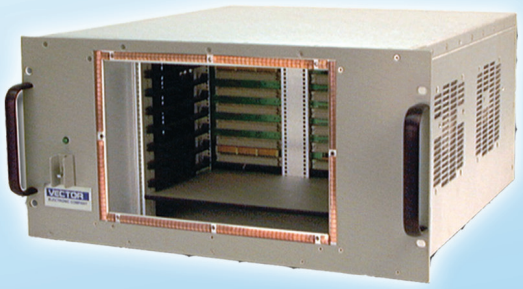
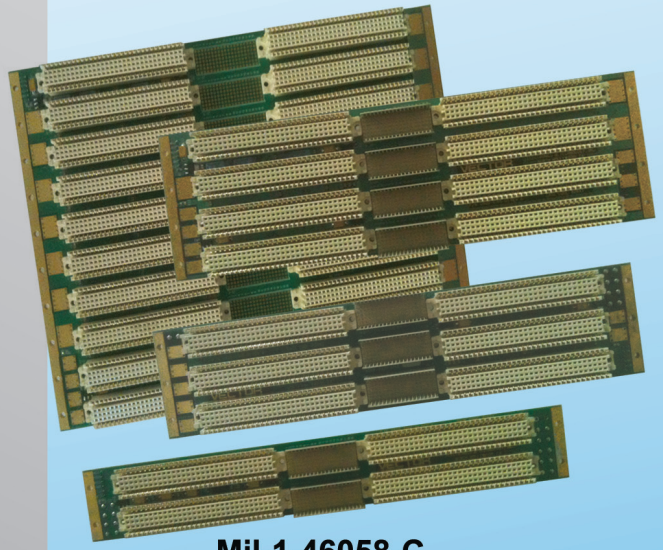


790 Chassis

792 Chassis



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Rugged Power Directory

Converters	Power Supplies	Batteries	Company/URL	Model Number	Summary	Physical Size/Form Factor
	✓		**Advanced Power Components (APC)** www.apc-plc.com	MIL-PRF-49470 SMPS Series	Military-approved switch mode power supply capacitors	Available in case codes 3, 4, & 5, capsulated or unencapsulated
	✓		**Advantech eAutomation Group** www.advantech.com/eautomation	EKI-2528PAI	A ruggedized 8-port, unmanaged industrial PoE switch	48.6 mm x 140 mm x 95 mm
	✓		**Aitech Defense Systems** www.rugged.com	P230	A rugged, 3U, conduction-cooled, high-efficiency power supply that operates over a continuous input voltage range of 18 VDC to 36 VDC	3U, suitable for VME, CompactPCI, and VPX systems: 100 mm x 168 mm x 29 mm
		✓	**City Labs, Inc.** www.citylabs.net	EOL20KY15	A tritium-based betavoltaic battery	Surface Mount
		✓	**City Labs, Inc.** www.citylabs.net	P100 NanoTritium Battery	A tritium-based battery	DIP
	✓		**Dawn VME Products, Inc.** www.dawnvme.com	PSC-6629 3U 400W Plug-in Power Supply	3U 400 watt 6-channel plug-in or bulkhead mounted power supply for air or conduction-cooled OpenVPX systems	P47 power connector pinouts mapped to PICMG 2.11 CompactPCI; 3U air- or conduction-cooled models available on 0.8" or 1" form factor
✓	✓		**Emerson Network Power** www.emersonnetworkpower.com	µMP4	A configurable AC/DC power supply for medical, industrial, process automation, robotics, and telecommunications	Low-profile 1U (44.45 mm)
	✓		**Emerson Network Power – Embedded Power** www.powerconversion.com	iVS Power Supplies	An intelligent VS (iVS) AC/DC power supply for industrial, military, and medical instrumentation applications	
	✓		**Emerson Network Power – Embedded Power** www.powerconversion.com	LCC250	Fully enclosed conduction-cooled 250 watt AC/DC power supplies providing full useable power at elevated temperatures	177.6 mm L x 101.4 mm W x 27.9 mm
	✓		**Eurotech** www.eurotech.com	ACS-5125	A new MIL-rated PC/104-*Plus* power supply designed to meet the system requirements of military vehicle, aircraft, machine, or vessel installations	PC/104-*Plus* – 90 mm x 96 mm (3.6" x 3.8")
	✓		**Extreme Engineering Solutions** www.xes-inc.com	XPm2000	MIL-STD-704 28 V input ± 12 V, 5 V, and 3.3 V output 3U power supply with integrated MIL-STD-461E filtering	3U VPX or CompactPCI
	✓		**Falcon Electric** www.falconups.com	SSG Series	A UL-listed industrial-grade Uninterruptible Power Supply (UPS)	88 mm x 482.6 mm x 540 mm
✓			**HDL Research Lab** www.hdlresearchlab.com	3U DC-DC Converter	A DC/DC converter that uses proven low-risk circuits that can easily be modified for other applications	6.57" (L) x 3.937" (W) x 0.97" (H)
✓			**Lineage Power** www.lineagepower.com	ProLynx DC-DC converters	A family of DC/DC converters for applications requiring a wide input voltage tolerance	20.3 mm x 11.4 mm x 8.5 mm
✓			**Linear Technology Corporation** www.linear.com	LCC250	Dual-output synchronous DC/DC controller draws only 170 µA in battery-powered systems	
	✓		**Linear Technology Corporation** www.linear.com	LT3082	A programmable 200 mA linear regulator	Three packages: (0.75 mm) 8-lead DFN (3 mm x 3 mm), 8-pin SOT-23, and 3-pin SOT-223
		✓	**Linear Technology Corporation** www.linear.com	LT3652	A solar-power-directed monolithic buck battery charger IC for modern battery chemistries	Low-profile (0.75 mm) 12-pin 3 mm x 3 mm DFN package
		✓	**Linear Technology Corporation** www.linear.com	LT3652HV	A monolithic step-down battery charger that operates over a 4.95 V to 34 V input range	Thermally enhanced packages: a low-profile (0.75 mm) 12-pin 3 mm x 3 mm DFN package, and a 12-lead MSOP package
✓			**Linear Technology Corporation** www.linear.com	LT3690	A 1.5 MHz synchronous step-down DC/DC converter	4 mm x 6 mm QFN Package
✓			**Linear Technology Corporation** www.linear.com	LT3692	2.25 MHz step-down DC/DC converter	5 mm x 5 mm 32-Pin Exposed Pad QFN Package
✓			**Linear Technology Corporation** www.linear.com	LT3757	The H- and MP-grade versions of the LT3757 wide input range DC/DC controllers for boost, flyback, SEPIC, and inverting power supply applications	10-lead DFN (3 mm x 3 mm) and thermally enhanced 10-pin MSOP packages
✓			**Linear Technology Corporation** www.linear.com	LT3758	Wide input range, current mode, DC/DC controller capable of generating either positive or negative output voltages	10-lead DFN (3 mm x 3 mm) and MSOPE packages
	✓		**Linear Technology Corporation** www.linear.com	LT3980	A 2A, 58 Vin step-down switching regulator with burst mode operation to maintain quiescent current under 85 uA	3 mm x 4 mm DFN-16 package (or thermally enhanced MSOP-16E)
✓			**Linear Technology Corporation** www.linear.com	LT4180	A DC/DC controller that eliminates the remote sense wires required to compensate for the voltage drop in cables, wires, and circuit board trace runs	24-pin SSOP package
✓			**Linear Technology Corporation** www.linear.com	LTC2383-16	16-bit, 1Msps, low power SAR ADC with serial interface	16-pin MSOP and 4 mm x 3 mm DFN packages
	✓		**Linear Technology Corporation** www.linear.com	LTC2939 and LTC2938	A four- or six-channel supply monitor with processor supervisory functions that can be configured for low-voltage applications down to 1.2 V	LTC2938: 12-lead 4 mm x 3 mm DFN or 12-lead MSOP; LTC2939: 16-lead MSOP package
✓			**Linear Technology Corporation** www.linear.com	LTC3112	15 V, 2.5 A synchronous buck-boost regulator	16-lead (4mm x 5mm x 0.75mm) DFN package
✓			**Linear Technology Corporation** www.linear.com	LTC3113	A synchronous buck-boost converter that delivers 3 A of output current from a nominal 3.3 V power source	Thermally Enhanced 16-Lead (4mm x 5mm x 0.75mm) DFN Package or 20-Lead TSSOP Package

Temperature Range	Input/Output Voltage	Over/Undervoltage Protection	Power Efficiency	Notes
-55 °C to +125 °C	Input: dielectric in from 50 VDC ≤ 500 VDC			MIL-PRF-49470/1 and MIL-PRF-49470/2 unencapsulated and encapsulated ceramic dielectric, switch mode power supply capacitors
-40 °C to +75 °C	Input: 24 VDC/48 VDC	4,000 VDC Ethernet ESD and reverse-polarity protection		Ruggedized for demanding applications with redundant power inputs
-40 °C to +71 °C	Input: 18 VDC to 36 VDC; Output: 5 V/20 A, 3.3 V/10 A, 12 V/9 A, -12 V/1 A	Short-circuit, overvoltage, and overcurrent protection	≥ 85%	4 ms holdup time (50 ms with optional capacitor bank module)
-40 °C to +80 °C	Input: 3 V; Output: Year 00: 50.0 microWatts, Year 12: 25.0 microWatts, Year 15: 21.5 microWatts, Year 20: 16.2 microWatts			20-year lifespan; Technology Readiness Level (TRL): 4
-40 °C to +80 °C	Input: 0.75 Volts; Output: Year 00: 75.0 nanoWatts, Year 12: 37.5 nanoWatts, Year 15: 32.1 nanoWatts, Year 20 24.3 nanoWatts			20-year lifespan; Technology Readiness Level (TRL): 6
-40 °C to +85 °C	Input: 18 to 36 VDC, 36 to 75 VDC	Overvoltage, overcurrent, and overtemperature protection		Six-channel design provides full OpenVPX support; I^2C interface for status and control
-40 °C to +70 °C	Input: 85 VAC to 264 VAC; Output: 0.9 V to 60 V	Reverse-voltage protection	≤ 91%	Precertified with a host of safety specifications – including UL, CSA, VDE, BABT, BSMI, CB, and CE certifications; meets EMI Class B and EN61000 standards for conducted noise and RoHS directives
-40 °C to +70 °C	Input: 85 VDC to 264 VDC or 120 VDC to 300 VDC; Output: 24 different choices from 2 V to 60 V	Overvoltage protection: single output module: 2 V to 5.5 V 122 - 134%, 6V to 60 V 110 - 120%; Dual output module: 2 V to 6 V 122 - 134% or 8 V to 28 V 110 - 120%	≤ 85%	Digitally configurable single and dual output power supply modules available in 6 power ratings
-40 °C to +85 °C	Input: 90 VAC to 264 VAC, 47-63 Hz; Output: 12 VDC adjustable by ±10 percent	IP64 ingress protection	89%	ITE 60950-1 2nd edition and Medical 60601-1 1st edition compliance
-40 °C to +85 °C (-55 °C to +100 °C)	Input: +15.5 VDC to +40 VDC (50 VDC for 1s); Output: single +5 V, power outputs without derating: +5 V/5 A	Overload protection and reverse voltage protection ≤ -60 VDC	83%	Complies with MIL-STD-810F, MIL-STD-704, MIL-STD-1275A/B/C, and MIL-STD-461E
-55 °C to +65 °C (-55 °C to +85 °C)	Input: ±12 V, 5 V; Output: 3.3 V		≤ 90%	PICMG 2.11 standard 47 position connector (modified pinout)
-20 °C to +55 °C	Input: 120 VAC; Output: 100, 110, 115, or 120 VAC	Extended brownout, surge, and transient protection	≥ 87%	Remote output receptacle control is an option to REPO, allowing the load segment outlets to be remotely controlled using a wire connected, remote switch
-54 °C to +85 °C	Output: 5 V, 3.3 V, ±12 V			Meets MIL-STD-461 and MIL-STD-704
-40 °C to +85 °C	Input: 9 V to 36 V; Output: 3.0 to 18 VDC	Overcurrent and overtemperature protection	> 91%	
-40 °C to +85 °C	Input: 90 VAC to 264 VAC; Output:500 VAC	Autorecovery overcurrent, overtemperature, and latching-mode overvoltage protection	≤ 95%	Selectable burst mode operation, pulse skipping, or continuous operation
-40 °C to +125 °C (-55 °C to +125 °C)	Input:1.2 V to 40 V; Output: adjustable to 0 V	Reverse-battery and reverse-current protection		Quiescent current of 170 µAs with one output active and 300 µAs with both outputs active
-40 °C to +125 °C	Input: 4.95 V to 32 V (40 V absolute maximum rated)			Multichemistry: resistor programmable float voltage ≤ 14.4 V accommodates Li-Ion/Polymer, LiFePO4, SLA, and NiMH/NiCd chemistries
-40 °C to +125 °C	Input: 4.95 V to 34 V (Float voltage ≤ 18 V)	Thermal-foldback protection		Charges 1 to 4 Li-Ion / Polymer cells in series, 1 to 5 LiFePO4 (Lithium Iron Phosphate) cells in series and sealed lead acid (SLA) batteries ≤ 18V. Applications include solar-powered systems, 12V to 24V automotive equipment and battery chargers
-40 °C to +125 °C	Input: 3.9 V to 36 V; Output: 0.8 V to 20 V	Overvoltage lockout protection through 60 V transients	≤ 93%	Programmable & synchronizable oscillator (170 KHz to 1.5 MHz)
-40 °C to +125 °C	Input: 3V to 36 V; Output: 1.23 V	Under/overvoltage lockout and enhanced short-circuit protection	≤ 95%	Adjustable/synchronizable fixed frequency operation from 250 KHz to 2.25 MHz with synchronized clock output
-40 °C to +150 °C (-55 °C to +125 °C)	Input: 2.9 V to 40 V; Output: ± voltages with single feedback pin	Output overvoltage and overcurrent protection		Low side external N-channel power MOSFET from an internal regulated 7.2 V supply
-40 °C to +125 °C (-55 °C to +150 °C)	Input: 5.5 V to 100 V; Output: wide range of ± voltages	Undervoltage lockout with hysteresis, overvoltage, and overcurrent protection	≤ 96%	Internal 7.2 V low dropout voltage regulator
-40 °C to +125 °C (-40 °C to +150 °C)	Input: 3.6 V to 58 V	Overvoltage lockout protection	88%	Switching frequency is user programmable from 100 KHz to 2.4 MHz, enabling the designer to maximize efficiency while avoiding critical noise-sensitive frequency bands
-40 °C to +85 °C (-55 °C to +125 °C)	Input: 3 V to 50 V	Undervoltage and overvoltage protection		User-programmable dither frequency and optional spread-spectrum dither
-40 °C to +125 °C	Input: +2.5 V differential, 2.5 V external reference	ESD protection		92 dB SNR (typ) at fIN = 20 KHz
-40 °C to +125 °C	16 user-selectable combinations of 5 V, 3.3 V, 2.5 V, 1.8 V, 1.5 V, 1.2 V and/or ± adjustable voltage thresholds	ESD protection		Power supply glitch immunity guaranteed/RST for VCC >1 V
-40 °C to +125 °C	Input: 2.7 V to 15 V; Output: 2.5 V to 14 V	Overvoltage protection	≤ 95%	750 KHz switching frequency, synchronizable between 300kHz and 1.5 MHz; Internal N-Channel MOSFETs; Selectable burst mode operation, IQ = 50 u
-40 °C to +125 °C	Input: 1.8 V to 5.5 V; Output: 1.8 V to 5.5 V	< 1µA shutdown current, integrated soft-start, short-circuit, current limit, and thermal overload protection	≤ 96%	Selectable burst mode operation

Rugged Power Directory

Converters	Power Supplies	Batteries	Company/URL	Model Number	Summary	Physical Size/Form Factor
✓			**Linear Technology Corporation** www.linear.com	LTC3632	A 50 V input-capable synchronous buck converter that delivers up to 20 mA of continuous output current from a 3 mm x 3 mm (or MSOP8-E) package	3 mm x 3 mm (or MSOP8-E) package
✓			**Linear Technology Corporation** www.linear.com	LTC3803H-3	The rugged H-grade version of the LTC3803-3, a current mode flyback DC/DC controller	Low-profile (1 mm) ThinSOT package
✓			**Linear Technology Corporation** www.linear.com	LTC3857/-1	A dual-output, high-efficiency synchronous DC/DC controller that draws only 50 µA in battery-powered systems	SSOP packaging
✓			**Linear Technology Corporation** www.linear.com	LTC3858/-1	Dual-output synchronous DC/DC controller draws only 170 µA in battery-powered systems	4 mm x 5 mm QFN and narrow SSOP packages
✓			**Linear Technology Corporation** www.linear.com	LTC3872H	The H-grade version of the LTC3872, a small footprint 550 KHz fixed frequency step-up DC/DC controller that is specified over a -40 °C to +150 °C junction temperature range	Thermally enhanced 2 mm x 3 mm DFN-8 package and 8-lead ThinSOT package
		✓	**Martek Power** www.martekpower.com	200UFR series	DC/DC converter solution for low-power, battery-operated, portable, mixed signal, or Unmanned Aerial System (UAS) platforms	0.86" x 0.36" x 0.49"
✓			**Martek Power** www.martekpower.com	CB150D	A 150 W dual output DC/DC power supply	2.28" x 2.90" x .0.50" (57.9 mm x 73.7 mm x 12.7 mm)
✓			**National Semiconductor** www.national.com	DAC161S055	A precision 16-bit digital-to-analog converter (DAC) with a buffered voltage output	0.86" x 0.36" x 0.49"
✓			**North Atlantic Industries** www.naii.com	55MQ2	Rugged 150 watt 3U, CompactPCI DC/DC converter	3U CompactPCI or VPX
	✓		**Parvus Corporation** www.parvus.com	ACS-5180	A PC/104-*Plus* 80 watt isolated DC/DC MIL-704/1275 power supply	Small form factor (3.550" x 3.775") card
	✓		**Phoenix Contact** www.phoenixcontact.com	QUINT-PS/ 1AC/12DC/20	Primary-switched power supply with Selective Fuse Breaking (SFB) technology	90 mm x 130 mm x 125 mm
✓			**Picor Corporation** www.vicr.com/cms/home/ products/picor	PI3101	Cool-power DC/DC converters	Power-System-in-Package (PSiP) package; .87" (L) x .65" (W) x .27" (H)
✓			**Power Sources Unlimited Inc.** www.psui.com	EC2SBW	The new EC2SB(W) Series single and dual DC/DC converters in a 1" x 1" package size	1" x 1" package
	✓		**Power Sources Unlimited Inc.** www.psui.com	NXT-400 Series	Compact 1U 400 W AC/DC power supplies	1U, 3.9" x 8.0" x 1.5"
✓	✓		**Power Sources Unlimited Inc.** www.psui.com	TOP-60 Series	New TOP-60 Series 60 watt, open-frame, high-efficiency, AC/DC power supplies	2.0" x 4.0" (50.8 mm x 101.6 mm) footprint
	✓		**Power Sources Unlimited Inc.** www.psui.com	TOP-100 Series	100 W AC/DC power supplies in a 2" x 4" footprint	2.0" x 4.0" (50.8 mm x 101.6 mm) footprint
	✓		**Rantec Power Systems Inc.** www.rantec.com	VME28M	A 28 V input, MIL-STD-704A-F and MIL-STD-1275A compliant avionics and vetronics power supply	6U x 160 mm single-slot conduction-cooled or two-slot convection-cooled configurations
✓			**RECOM Power Laboratory** www.recom-international.com	PowerlinePlus Series	A 20 W to 50 W power range DC/DC converter series	Compact 40.6 x 25.4 x 11.7 mm package
✓			**RECOM Power Laboratory** www.recom-international.com	RAC04-Family	AC/DC converter guarantees high reliability: MTBF reaches 350.000 hours, or 40 years continuous operation	36.5 mm (L) x 27.0 mm (W) x 17.1 mm (H)
✓			**Schaefer** www.schaeferpower.com	C4500HV Series	High output voltage power converters	6U pluggable module for 19" subrack
✓			**Schaefer** www.schaeferpower.com	C5100 Series	A series of 5,000 W, 3U and 5U plug-in DC/DC and AC/DC converter modules	3U x 40TE x 538 mm rack module; can be rotated for 5U mounting
✓			**Schaefer** www.schaeferpower.com	C5800HV Series	A series of high-output voltage power converters	6U or 9U rack module or a wall-mount module, with optional custom designs
✓	✓	✓	**Schaefer** www.schaeferpower.com	C/B5800 Series	A series of 12,000 W DC/DC converter, AC/DC power supply, and battery charging products	6U or 9U rack module or a wall-mount module
✓			**Schaefer** www.schaeferpower.com	Subsea Power Converter	A rugged power converter for subsea environments	6U
		✓	**Tadiran** www.tadiranbat.com	TLM 1550-HP	High-power lithium batteries currently employed in UAV applications and suitable for rockets and missiles, smart ammunition, mines, and jammers	Standard in AA size; custom and smaller cells, including sub-1/2 AA and 2/3 AA sizes
		✓	**Tadiran** www.tadiranbat.com	TLM Military Grade Batteries	A family of rugged, high-energy lithium metal oxide batteries developed specifically for military and aerospace applications	Available in a variety cylindrical configurations and can easily be assembled into custom battery packs to meet virtually any requirement
✓			**Vicor** www.vicr.com	MIL-COTS Bus Converter Modules	Vicor's MIL-COTS Bus Converter Modules are designed to run voltage around airframes	1.28" x 0.87" x 0.265"
✓			**VPT Inc.** www.vpt-inc.com	VPT100+ 2800 Series	Open circuit voltage of 4 V, discharge capacity of 500 mAh (20 µA at 2.8V RT), handles 5 A continuous pulses and 15 A maximum high-current pulses	2.28" x 1.45" x 0.5" (quarter brick size)

Temperature Range	Input/Output Voltage	Over/Undervoltage Protection	Power Efficiency	Notes
-40° C to +125 °C	Input: 4.5 V to 50 V; Output: adjustable down to 0.8 V	Overvoltage protection	≤ 93%	Utilizes internal high side/synchronous power switches that draw 12 µAs at no load while maintaining output voltage regulation; suitable for always-on battery-powered applications
-40 °C to +150 °C	Input: 9 V to 75 V; Output: dependent on external components			Start-up current of only 40 µAs; low 240 µAs quiescent current
-40 °C to +85 °C	Input: 4 V to 38 V; Output: 0.8 V to 24 V	Output overvoltage and overcurrent-foldback protection	≤ 95%	Low quiescent current of 50 µAs with one output active and 80 µAs with both outputs active
-40 °C to +85 °C	Input: 4 V to 38 V; Ouput: 0.8 V to 24 V	Output overvoltage and overcurrent latch-off protection	≤ 95%	Quiescent current of 170 µA with one output active and 300 µA with both outputs active
-40 °C to +150 °C	Input: 2.5 V to 9.8 V; Output: ≤ 60 V	Undervoltage lockout protection and internal soft start	90%	Well suited for automotive, heavy equipment, and industrial control applications
-40 °C to +85 °C	Input: 12 VDC, 24 VDC, or 48 VDC; Output: 3.3 V, 5 V, 12 V, 15 V, +5 V, +12 V, and +15 V	Short-circuit and overcurrent protection	≤ 80%	MTBF per MIL-HBD-217F is at least 1 million hours (25 °C, ground benign)
-55 °C to +100 °C	Input: 16 VDC to 40 VDC; Ouptut: 75 W	Overvoltage protection	≤ 84%	Startup current of only 40 µAs; low 240 µAs quiescent current
-40 °C to +105 °C	Input: 2.7 V to 5.25 V (separate I/O supply pin operates down to 1.7 V); Output: 10 µA			Wide voltage reference range of +2.5 V to VA
-55 °C to +85 °C	Output: 150 W (+5 VDC, +3.3 VDC, and ±12 VDC)	Overvoltage protection	80%	Designed and manufactured to NAVSO P3641 component derating guidelines
-40 °C to +85 °C	Input: 18 VDC to 33 VDC; Output: +5,+3,+12 VDC	Reverse-polarity, voltage transient, surge, spike, overcurrent, filtered output, and current fold-back protection	≥ 90%	MIL-STD-704E and MIL-STD-1275D compliance
-25 °C to +70 °C	Input: 100 VAC to 240 VAC; Output: 12 VDC ±1%	Electronic short-circuit	≥ 90%	High degree of operational safety due to high MTBF > 500,000 h, long mains buffering times > 20 ms, high dielectric strength ≤ 300 VAC
-40 °C to +125 °C	Input: 36 V to 75 VDC; Output: 3.3 V / 18 A / 60 W output current	Under/overvoltage lockout and dual current limit threshold protection	≤ 87%	Programmable features such as soft-start capability, temperature monitoring, and ±10 percent output voltage trimming
-40 °C to +85 °C (to +71 °C with derating)	Input: 2:1 and 4:1; Output: trim function ±10%	Overcurrent and input undervoltage protection	≤ 86%	Remote ON/OFF control
0 °C to + 70 °C	Inputs: 85 VAC to 264 VAC, 120 VDC to 370 VDC; Outputs: 2.5 VDC to 48 VDC	Overvoltage protection latching and overpower protection	85%	EN60950-1 and EN60601-1 safety certification
-25 °C to +50 °C	Input: 90 VAC to 132 VAC/187 VAC to 264 VAC	Low-leakage current and overvoltage protection	> 90%	Compliance with EN 61000-3-2
-25 °C to +50 °C	Input: 90 VAC to 132VAC/187 VAC to 264 VAC	Low-leakage current and overvoltage protection	≥ 90%	Compliance with EN 61000-3-2
-55 °C to +65 °C (-55 °C to +85 °C)	Input: 28 VDC; Output: 3.3, 5.0, and ±12 VDC are provided	Overcurrent protection	70% minimum	All power supplies meet MIL-STD-461 EMI, MIL-STD-810F environmental, and MIL-STD-901C shock requirements
-45 °C to +120 °C	Input: 9 VDC to 75 VDC; Output: 15 watts to 20 watts	Overload, short circuit, overvoltage protection	> 90%	Built-in FCC/EN55022 Class B EMC filter (no external components required)
-40 °C to +70 °C	Input: 90 VAC to 264 VAC at 47 Hz to 440 Hz; Output: 3.3 V, 5 V, 9 V, 12 V, 15 V, or 24 V	Short-circuit, overload, and overvoltage protection	80%	MTBF reaches 350,000 hours, or 40 years of continuous operation
-20 °C to +75 °C (-40 °C to +75 °C)	Input: 10 VDC to 800 VDC; Output: 9 VDC to 400 VDC	Overvoltage and short-circuit protection	≤ 90%	Parallel/redundant operation, mechanical ruggedization, inhibit, power-OK/DC-OK alarms, and system reset
-20 °C to +75 °C (-40 °C to +75 °C)	Input: 3 ranges from 320 VDC to 800 VDC, 3Æ AC voltages of 3 x 400 VAC (320-460) and 3 x 480 VAC (400-530); Output: 6 ranges from 23 VDC to 200 VDC	Overvoltage and current-limit protection	≤ 95%	Applications include railway controls and communications equipment (onboard and trackside), military applications, transportation, telecommunication systems, process control systems, and power stations
-20 °C to +75 °C (-40 °C to +75 °C)	Input: 80 VDC to 800 VDC; Output: 12 VDC to 3,000 VDC, adjustable and fully regulated to 0.2% or better (load) and 0.1% (line)	Protection circuitry inherent throughout design	≤ 95%	Provides output voltages ≤ 3,000 VDC, while generating ≤ 12 kW of output power
-20 °C to +75 °C (-40 °C to +75 °C)	Input: 5 DC input voltages from 80 VDC to 800 VDC; Output: 12 VDC to 400 VDC	Overvoltage protection	≤ 95%	All outputs are adjustable and fully regulated to 0.2% or better (load) and 0.1% (line); DC/DC and AC/DC models have remote sense capability
-20 °C to +75 °C	Input: Up to 5,000 VDC; Output: 24 VDC	Overvoltage, short-circuit, and overload protection		Seawater can be used as the input return path
-40 °C to +85 °C	Open circuit voltage of 4.0 V, capable of handling pulses of ≤ 15 A and 5 A maximum continuous current at 3.2 V			Provides ≤ 20 years of service life and can be periodically tested without having to fully discharge the battery, no squibs needed to start the battery, no thermal insulation required
-40 °C to +85 °C	Open circuit voltage of 4 V, with a discharge capacity of 500 mAh (20 µA at 2.8V RT), capable of handling 5 A continuous pulses and 15 A maximum high-current pulses			Complies with MIL-STD-810G specs for vibration, shock, temperature shock, salt, fog, altitude, acceleration (50,000 gn), and spinning (30,000 rpm)
-55 °C to +125 °C	Input: 240 V to 330 V	Undervoltage/overvoltage lockout, overcurrent, short-circuit, and overtemperature protection	> 96%	MIL-STD-704E/F-compliant
-55 °C to +100 °C	Input: 16 V to 40 V; Output: 3.3 V, 5 V, 7 V, 12 V, 15 V, and 28 V or dual outputs of ±12 V and ±15 V	Current limit protection, indefinite short-circuit protection	≤ 91%	Meets MIL-STD-461C/D/E conducted emissions requirements when used with a VPTF Series EMI filter

Power Conversion Product Spotlights

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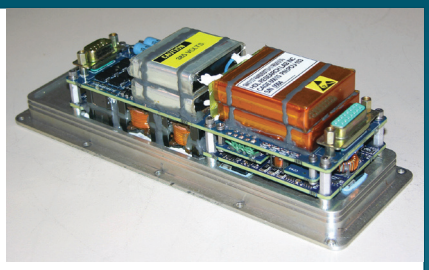

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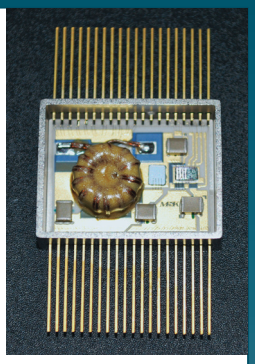
Power Conversion Product Spotlights

New Radiation Hardened POL Regulator offers up to 4.5 Amps Output Current



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Power Conversion Product Spotlights

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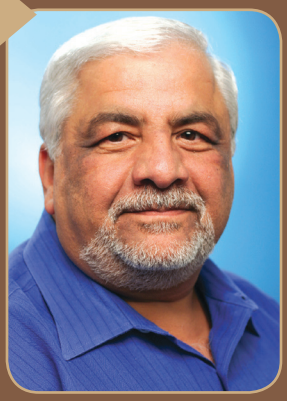
Power.org keeps the wheels turning and evolution churning on everything "Power Architecture"

Q&A with Fawzi Behmann, Director of Marketing and Strategic Advisor at Power.org



Most of us in the embedded design realm have probably tucked a PowerPC, PowerQUICC, or some other Power Architecture incarnation into an application or system in our time. But where, oh where has Power Architecture ended up? While Intel ramps up and delivers its high-profile industry vision, Power.org is steadily and more quietly (for now) putting its pedal to the mettle to sustain and grow the Power Architecture road map. Editor Chris Ciufo recently sat down with Fawzi Behmann, Director of Marketing and Strategic Advisor at Power.org, to get an inside look at the organization: past, present, and future.

> How did Power.org get started?

BEHMANN: As suppliers such as Motorola, Apple, and IBM were carrying out the goal of Power Architecture or PowerPC, the notion of Power.org arose, so that it would carry the ball in Power ISA. The focus would be conserving the Power Architecture and instruction set for both the embedded and the compute [markets]. Power.org would generate technical committees to develop various specifications that aid development by member companies. The organization would also encourage opportunities to promote the Power Architecture ecosystem. So Power.org came onto the scene back in 2005, with IBM and Freescale as founding members. And we recently celebrated Power.org's 20th anniversary.

> How is Power.org doing in market share these days?

BEHMANN: The 2009 Processors market size for 32- and 64-bit processors was $63 billion. Then the Power Architecture market share [according to IMS research] is $4.4 billion of that (broken down by these segments):

- #1: 32-bit MPU
- #2: 64-bit CPU
- #2: 32-bit MCU
- #1: 32-bit FPGA
- #3: 64-bit MPU
- #3: ASIC and ASSP

> Who are the members of Power.org?

BEHMANN: We have three levels: founder, sponsor, and participant. They could be on the silicon supplier level or they could be at the SoC level; they could be at the OS or they could be in the middle layer or in the higher-end or applicational solutions. We also collaborate with a variety of communities, like the Linux community, and with other standards development organizations.

We additionally consult with customers and with market researchers in terms of opportunities. But our technical committees try to focus on three things: 1) What would the road map look like? 2) How do we go about what matters in terms of software? and 3) What matters in terms of platform and ecosystem? So we try to work with the core members and ecosystem partners and developers. We have about 2,500 developers working with Power Architecture.

> What is the biggest market that Power Architecture products find themselves in?

BEHMANN: I would say communications, networking, and enterprise servers. We are also strong in wireless infrastructure, strong on automation in terms of the application. Also, we have quite a presence in military, aerospace, and medical imaging. And certainly the automotive, industrial, and consumer markets are also strong for us.

> What really drives Power Architecture behind the scenes?

BEHMANN: What drives Power Architecture more than anything is really the *Power ISA* or the *Power Instruction Set Architecture* because it's 64-bit and 32-bit, addressable, and provides capabilities for developers to build an architecture that is scalable from a very low end to a high end. Today we're deploying processors all the way from 60 MHz to 5 GHz. But with that, there's a progression in terms of which capabilities we need to have in the instruction set.

> Tell me more about the Power ISA progression you've mentioned.

BEHMANN: We've had a series of evolution in terms of Power ISA standards – 2.03 all the way to 2.06 – since the inception of Power.org. The 2.04, 5, and 6 address specific areas dealing with multicore virtualization, hypervisors, and energy management – which are really what future systems are pulling for now because they're getting more complicated, more complex, more scalable, more multicore, utilizing multithreading, and so on.

> When you say "Power Architecture," what does that encompass exactly?

BEHMANN: The Power Brand is an umbrella brand that covers any emerging power product road map made by member companies. So Power7 was introduced last year to come on the Power Architecture, also Power EN [Edge of Network], PowerPC, QorIQ, PowerQUICC, and so on.

Not only that, the Power.org 2011 road map continues to demonstrate a great level of investment by member companies. From a timeline perspective, it covers processor product lines by silicon vendor: history, current, and future. And certainly you see a whole lineup of product lines for the both the 32-bit to 64-bit, as well as the commercial and the commercial licensable core.

> What sort of specifications has Power.org released for Power ISA?

BEHMANN: One specification we have released is the *Common Debug Interface,* developed by member companies to help define different methods and impact the way of tracing and debugging based on embedded, as well as compute environments. Another specification is called *Embedded Hypervisor.* That defines the thin layer of the hypervisor that determines how to have multiple operating systems running over multiple cores and so on. We also have a specification called *Virtual Platform,* which enables software development before the availability of silicon.

These three areas and specifications tend to handle major achievements or core impact in terms of enablement, whereas things like our sPAPR specification have to do with rebooting devices. Also the ABI Documentation specification concerns the documentation related to the application binary interface. So sPAPR and ABI Documentation are more ancillary-type support and specifications.

> Let's talk trends. Android is everywhere these days. Is Power.org doing anything with Android?

BEHMANN: Yes, we had a showcase on Android activities and demonstrated that we had a special way of making it. Now we even have Android-based open source available to the developer community. We also have various initiatives in Android by Freescale [Android over MPC8536, Android over QorIQP1022, Android + MPC5521e, and Android + MPC5525] and IBM [Android over PowerPC460S, XGI (now SIS) Z11 graphics card, and AppliedMicro Canyonlands board] and third parties, which ported Android over Power Architecture.

> What about cloud computing? That's as much a water-cooler topic as Android these days.

BEHMANN: Yes, Power.org has also shown advancement in terms of a wireless network cloud system, through our research project based on [Software-Defined Radio]. That's progressing actually from IBM Research in China.

But something else your audience might be interested in is IBM's Watson computer, based on the Power7 processor within an optimized system running IBM DeepQA software developed by IBM. Watson, as you probably know, was featured on [the TV game show] "Jeopardy" and won the game, answering the questions in less than 3 seconds.

> Interesting. So what are some of the other Power.org technical developments, such as with QorIQ, for example?

BEHMANN: Freescale has generated the QorIQ Qonverge basestation-on-a-chip, comprising the metro microcell, macro basestation, enterprise pico/femto, and home/SMB femto. One example of this is the PSC9130/31, a femtocell SoC solution. There's also the PSC9132, a pico station. That solution is really an integration of not just Power Architecture, but also DSP, I/O, memory, switchback, and so on. And it provides a different type of scalability. Femto SoC accommodates 8-16 users, and pico and enterprise [products] accommodate up to 64 users.

> What's the different between pico and enterprise if they're both up to 64 users?

BEHMANN: It's a progression. For the enterprise, you could have a small enterprise, big enterprise, and so on. So you could have something 32, something 48, something 56, or whatever, all the way up to 64 users. So it's really a mix between a medium to a larger type of cell.

> Where do power considerations play into these basestations?

BEHMANN: In terms of pico versus macro, most of them are delivering lower cost and lower power – typically by almost 4x in both cases, except in macro the power is going down by 3x. The 3x and 4x comparison is for pico and macro versus discrete solutions. That's really quite an important achievement to have that consolidation of basestations on a chip.

> OK so wrapping up, any other achievements of Power.org?

BEHMANN: If you have watched the news lately, you probably know that in terms of high-performance computing, two of the Top 10 and five of the Top 20 most powerful computers are based on Power Architecture. Included in these are the BlueGene/Q and also the BlueWater, which will be installed next year.

The Blue Gene/Q [supercomputer] is characterized by a 16-core chip and high performance and high efficiency. And it is about to reach 20 petaflops, so that's really a great milestone. It was also ranked No. 1 from an energy management perspective [by Green500]. [**Editor's note:** Blue Gene/Q was also ranked No. 1 on the list of the world's fastest supercomputers for six years in a row (see www.top500.org)]. It uses Power7, which has policy-based energy management capabilities.

> What does the road map for Blue Gene look like, then?

BEHMANN: We have gone from 596 teraflops in 2004 [with Blue Gene/L] to 1 petaflop in 2008 with Blue Gene/P. And now with Blue Gene/Q, as I mentioned, we are reaching 20 petaflops. So we feel that Power.org has great potential for even more differentiation.

Fawzi Behmann *is Director of Marketing and Strategic Advisor for Power.org.*

Power.org
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www.power.org

Editor's Choice Products

Editor's note: Military Embedded Systems *is "hip" to the whole Web 2.0 social networking revolution. While we don't know which of today's buzzy trends will last, we're going to start including links to vendors' social networks, when provided. You can also reach us on Twitter, Facebook, and LinkedIn ... and that's just for this week. Next week there'll undoubtedly be more new sites.*

Tin/lead conversion thwarts tin whiskers

Whether we're talking the International Space Station, a C-17, or a Humvee, tin whiskers can throw a monkey wrench into system functionality – and even result in loss of life. However, AEM, Inc.'s tin/lead conversion process aims to stop tin whiskers in high-rel, surface-mount components originally terminated with tin-only solder. Moreover, AEM's tin/lead conversion process leaves even the most delicate electronics intact – as opposed to using all that hot soldering, which can damage sensitive components. Meanwhile, the tin/lead conversion process offers the assurance of at least 5 percent Pb in converted component terminations, as verified via XRF and SEM/EDS inspections.

The AEM tin/lead conversion process works most effectively on chip-scale, passive, multilayer components such as inductors, ferrite chip beads, resistor arrays, capacitors, bead arrays, and active surface mount components or molded body passive components. And that's not all (literally): Other components outside the chip-style realm might be appropriately armed against tin whiskers with the AEM tin/lead conversion process; just ask them, and the company's AS9100/MIL-STD-202 compliant lab can pre-evaluate any other component type you might want to run through the process.

AEM, Inc. • www.mil-embedded.com/p52914 • www.aem-usa.com

Simulation and training platform preps soldiers

Since simulation and training are supposed to be realistic, how realistic is it for soldiers to have to learn commands and actions specific to operating the simulation device – actions that would never be used in combat? Quantum3D's CG² subsidiary is thwarting this potential challenge – plus many others – with its ExpeditionDI fully immersive, wearable training and simulation platform (sans the need for soldiers to learn simulation-only commands). Specifically, while the system trains soldiers to act as individuals in combat, it also maintains coordination and communication needed for team functionality. Accordingly, ExpeditionDI is being integrated into the Joint Forces Command-sponsored Future Immersive Training Environment Joint Capabilities Technology Demonstration (FITE-JCTD). So clearly, Expedition DI's got some great credentials (many more than we can list here), but what else makes this training and simulation system so compelling?

For starters, ExpeditionDI has a single-package hot-swappable battery, powering a ruggedized, wearable computer powered by an Intel Core 2 Duo CPU and NVIDIA FX880M GPU. Additionally, the training and simulation system features a Head Mounted Display (HMD) at a 1,280 x 1,024 resolution to realistically render the sights and sounds of the battlefield. The HMD coupled with a head tracker afford a 360-degree field of regard, and a hand-grip controller serves as an intuitive interface. Meanwhile, posture sensors help the trainee by reinforcing effective tactical behaviors and giving stance information. The open-architecture ExpeditionDI runs a plethora of simulation software such as RealWorld from DARPA and Total Immersion, SVS from Advanced Interactive Systems, and VBS2 from Bohemia Interactive. The company also says "any software can be integrated with ExpeditionDI SDK."

CG², a subsidiary of Quantum3D • www.mil-embedded.com/p52839 • www.cg2.com

Rugged, compact computer meets the multi-mission challenge

Attention, military designers: It just might be time to scrap your plans to swap in a display and bussed ATR when that critical system goes "kerplunk." Now there's a viable alternative: The smaller, sleeker, more flexible S822-D Armor computer system by General Micro Systems, Inc. Indeed, the field-reconfigurable, Core Duo Penryn (up to 2.26 GHz) based Armor is a multimission savvy, 30 W alternative. The S822-D measures 8.5" x 13.25" x 2.75", and the computer features up to 8 GB 1,066 MHz DDR3 memory, 6 MB L2 cache, and two 512 MB removable solid state drives. Flexibility enters the picture when customers pick and choose WiFi, ARINC 429, Ethernet, 1553, graphics, video, and GPS options – available in addition to standard Armor accoutrements such as four RS-232/422/485 ports, five USB 2.0 ports, x1 XMC, x16 XMC, and three Express Mini sites, to name just a few. Data encryption and secure erase are also proffered on the drives, in addition to the software-attack thwarting Trusted Execution Techology (TXT).

Then there's the "rugged" – so much so that the company describes Armor as "boot kickable." (Anyone want to try it?) Aside from resisting impact (apparently), the computer is also watertight and the display comes with optical transmission greater than 97 percent, thanks to the slathered-on Direct Dry Film rendering avionics-grade viewability. Sunlight readable and night vision- and blackout ops-savvy, Armor is easy to use with its backlit keys and eight-wire touch screen, operable even when gloves are worn.

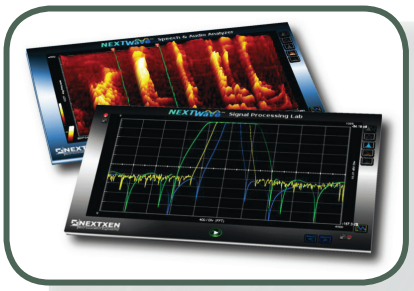
General Micro Systems, Inc. • www.mil-embedded.com/p52489 • www.gms4sbc.com

Nighttime is the right time for this IR night-vision spotlight

It would be so convenient if military adversaries only struck when the sun was up … OK, dream on. But for those times when warfighters need to identify details of faces or must observe information pertaining to buildings, targets, or tactical surveys after the sun's gone down, Magnalight's RL-85-10W1-IR Infrared handheld night-vision spotlight just might come in handy. While some IR spotlights provide short-range visibility, the RL-85-10W1-IR proffers an IR light beam measuring up to 1,800 feet. And worrying about failure doesn't need to be an option: The 50,000-hour-service-life spotlight is powered by 3 W Lithium ion batteries that afford 17 hours of runtime on just a mere 2-hour charge. And if partial charges or inconsistent charging sessions occur, the spotlight's batteries will not degrade as a result.

Not only that, the RL-85-10W1-IR LED spotlight weighs only 14 ounces, perfect for preventing further load-carrying fatigue for troops. And resistance to chemicals, UV, impact, and water are built-in, as is an ergonomic pistol grip. And two versions of the IR night-vision spotlight are available: a cutting-edge, 4th generation night vision 940 nm configuration or a model sporting an 850 nm IR wavelength suited to the night vision wares most commonly used these days.

Magnalight • www.mil-embedded.com/p52916 • www.magnalight.com



DSP software eliminates signal-analysis headaches

Digital Signal Processing is as integral to the military embedded scene as butter is to bread. However, applying DSP data analysis is a bit more challenging. That's why NEXTXEN's NEXTWave SPL software caught our eye. Its mission: To proffer data analysis and signal processing via a signal environment that is 3D, interactive, and programmable. And the software is designed to execute "as-is" waveform data analysis. Additionally, A/D data acquisition in real-time, such as from USB, can be molded into new signals and introduced into the analysis, or standard data files can be used to import any existing signals into NEXTWave SPL for analysis.

NEXTWave SPL features a graphical programmable interface and an extensive signal-processing function library covering capabilities like frequency transforms and digital filtering. An open software architecture, extensive algorithm library, and file exporting with ease are some other obvious plusses. Then there's the bottom line: how the software's results are displayed. Options include depiction in 360-degree rotation spectograms and topographical data markers. And if you don't see exactly what you expected, gesture-based manipulation and panning of the waveforms are also possible with this software. Sounds like a good deal to us.

NEXTXEN • www.mil-embedded.com/p52446 • www.nextxen.com

PrivateEye could protect U.S. DoD privacy

Could U.S. DoD workers using laptops outside (or even inside) the office use a PrivateEye? We think so – if that PrivateEye is the security software incarnated by Oculis Labs, anyway. Able to find its home on Panasonic Solutions Company's rugged MIL-STD-810G-compliant Toughbook 31, C1 convertible tablet, and 53 semi-rugged notebook models – among other computers – PrivateEye works to thwart the attempts of "visual eavesdroppers" looking over someone's shoulder at a computer screen on which they aren't authorized to view information. Specifically, the software uses facial recognition of authorized computer user(s). When the authorized user looks away from the screen or leaves the computer, the on-screen data is instantly blurred and thereby rendered unreadable; when the user returns to their desk or turns back toward the screen, the text on the screen becomes legible again. Also, if the software detects a visual eavesdropper at any time, the screen blurs instantly and an alert is sent in one of three ways: 1) A video showing the eavesdropper appears on the computer screen; 2) an audible alarm is sounded; or 3) a balloon popup occurs on a system tray.

The good news is all that's needed is a compatible laptop or computer that has a webcam. And simple GUI control makes it easy to change settings. For instance, the user or IT staff can choose security settings such as "high security" and "normal use" – or customize their own. Taskbar control also makes it easy for users to resume or pause PrivateEye, and an Auto Start option enables PrivateEye to boot up when the system does. And there's not much to lose – Oculis Labs even offers a free trial download.

Oculis Labs • www.mil-embedded.com/p52915 • www.oculislabs.com

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Empire Challenge 2011 pours on the power ... and not always in a good way

By Chris A. Ciufo, Editor

2,000 participants, 9 nations, and 12 U.S. agencies reach many conclusions in this year's Empire Challenge 2011. One of them is that low power, portability, and mission objectives rely on handhelds. Lower power means longer runtime.

Batteries, low-power devices, and energy conservation. What do these have to do with this year's Empire Challenge (EC11)? EC11 is all about showing our coalition military strength and power, but like my January/February edition's column "*For want of a nail, the shoe was lost*" (www.mil-embedded.com/articles/id/?5049) mentions, it turns out the DoD is still desperate for lower-power solutions.

The test range at Fort Huachuca began humming with activity, EMI, and electronics cooling fans on May 1, as nine nations including the United States, Canada, Australia, and Great Britain began setting up for this year's Empire Challenge. Focusing on C4ISR capabilities and coalition operations, the USJFCOM assumed the leadership role while relying on the Distributed Common Ground/Surface System (DCGS) Enterprise, the Joint Intelligence Operations Center (JIOC), the Distributed Development & Test Enterprise (DDTE), and too many other joint and coalition network backbones to mention here on one page.

The goals of EC11? 1. DCGS/DI2E (Defense Intelligence Information Enterprise) interoperability; 2. Support to coalition interoperability; and 3. Support to emerging sensor/system interoperability. In a nutshell: Make sure our C4ISR stuff all works as planned so we can gather actionable intelligence and conduct precision strike operations wherever we want to, anywhere on the planet. And we have to play nicely with our allies because this go-it-alone nonsense started by President Bush ain't gonna get funding for much longer. I was privileged to be one of a small group of journalists to be briefed on and participate in a roundtable discussion with the brass running EC11.

I had five COTS- and technology-related questions lined up, and when the discussion turned to "new ISR technologies and lessons learned," I asked: "What technology do you most need that you didn't have?" The answer surprised me. That's because EC11 uses dozens and dozens of assets, from the U-2 Dragon Lady, A-10 Thunderbolt II, E-8 JSTARS, EC-130H Compass Call, F-16C, Firebird, RQ-4 Global Hawk, and on and on. Not to mention the network infrastructure, distributed databases, UAS ground stations, foreign platforms, and so on.

> "... The typical DoD-style handheld device like GD's GD300 wrist computer gets eight hours of runtime; that's not much different from my iPhone when I lean heavily on the Wi-Fi. But I'm not in the field, behind enemy lines."

I expected to hear how better technology was required for any one of these platforms.

Nope. Instead, the EC11 program manager disclosed how important to the future were the Army's handheld devices, based upon IP smartphones as part of the Land ISR Net. The Relevant ISR to the Edge (RITE) program brings soldier handheld devices to the battlefield, much like the ones I recently saw at demonstrated at Black Diamond and General Dynamics C4 Systems in Phoenix. These devices provide localized INTEL that's essential for modern urban, asymmetric warfare. Turns out without that kind of on-the-ground info, all the other assets are less effective.

The challenges with portable, wearable devices, of course, are performance and power consumption, metrics that probably came to light during live fire operations at EC11. In fact, the typical DoD-style handheld device like GD's GD300 wrist computer gets eight hours of runtime; that's not much different from my iPhone when I lean heavily on the Wi-Fi. But I'm not in the field, behind enemy lines.

Accordingly, this issue of *Military Embedded Systems* is all about power. You could thumb over to our four-page Rugged Power Directory on power solutions starting on page 40, read up on how "Revolutionary lithium batteries might solve military's power problems" (page 28), peruse the interview "This is how the Army builds a quiet hybrid vehicle: from the battery up" (page 32), and finally ponder the differences between "Hermetic power packaging vs. PEMs for mil electronics? No power issues here" (page 36).

The subject of power, power conversion, and batteries is so important that I'm talking about it here again. And the DoD seems to agree with me, since it came out as a key answer to my question about technology from EC11. To help you stay up on this topic, the editors at *Military Embedded Systems* have also placed the Rugged Power Directory online at http://products.opensystemsmedia.com/guide/power and will be adding to it and expanding the capability to do product comparisons. This should be your "go to" source for rugged power products.

Chris A. Ciufo, Editor

GE
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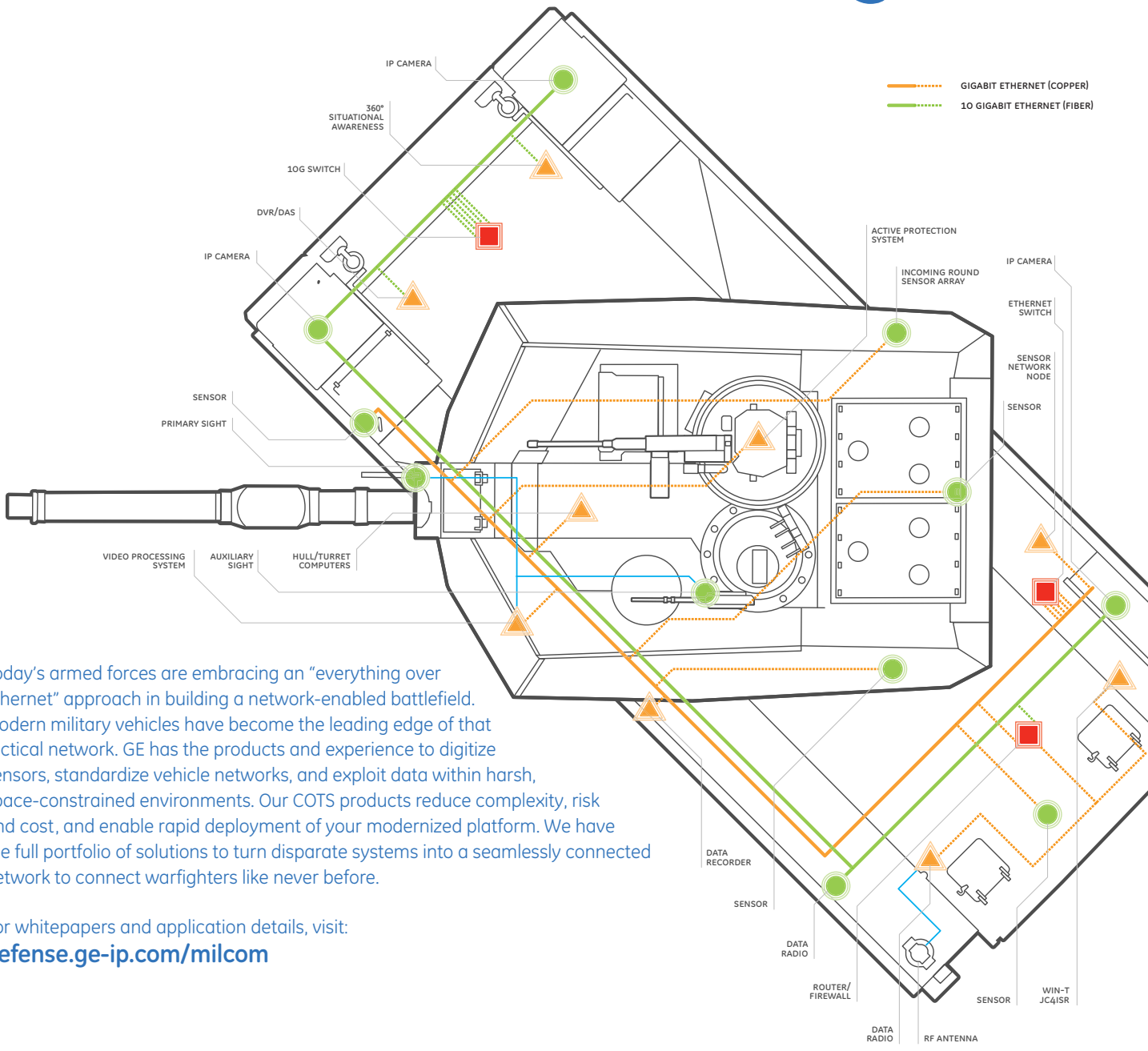

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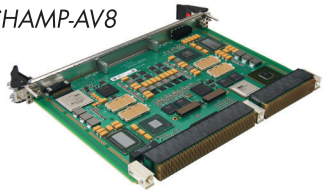

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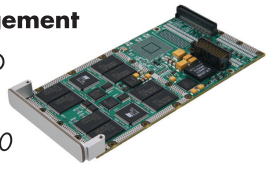

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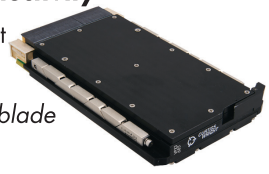

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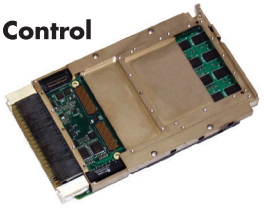

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