COTS JOURNAL

Tech Focus: PXI, VXI and LXI Boards

REAL-TIME DSP NEEDS IGNITE DATA RECORDING RETHINK

PLUS:

MicroTCA and AMC Gear Up for Defense Duty

Cooling Solutions Take System-Centric Path

Volume 10 Number 09 September 2008 www.cotsjournalonline.com

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Features

September 2008 Volume 10 Number 9

Special Feature

Data Recording System Architectures

Tech Recon

MicroTCA and AMC in Military Systems

System Development

Cooling Technology Update

Technology Focus

PXI, VXI and LXI Boards

COTS (kots), *n.* **1.** Commercial off-the-shelf. Terminology popularized in 1994 within U.S. DoD by SECDEF Wm. Perry's "Perry Memo" that changed military industry purchasing and design guidelines, making Mil-Specs acceptable only by waiver. COTS is generally defined for technology, goods and services as: a) using commercial business practices and specifications, b) not developed under government funding, c) offered for sale to the general market, d) still must meet the program ORD. **2.** Commercial business practices include the accepted practice of customer-paid minor modification to standard COTS products to meet the customer's unique requirements.

——**Ant.** When applied to the procurement of electronics for the U.S. Military, COTS is a procurement philosophy and does not imply commercial, office environment or any other durability grade. *E.g., rad-hard components designed and offered for sale to the general market are COTS if they were developed by the company and not under government funding.*

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The E-2D Advanced Hawkeye aircraft will be the U.S. Navy's next-generation airborne early warning and battle management system. The data recording and playback systems for the E-2D rely heavily on FPGA-based protocol engines to support application-specific processing in real time during record and playback. This past summer Northrop Grumman Corporation's E-2D Advanced Hawkeye Program achieved its 125th test flight milestone.

Photo courtesy of Northrop Grumman.

COTS JOURNAL

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COTS Journal

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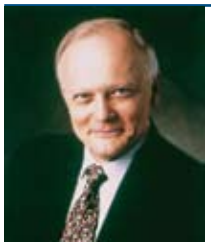

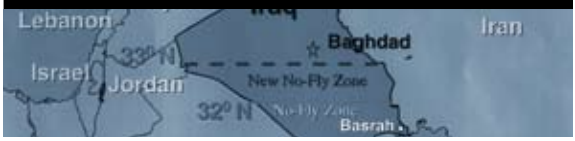

End of Summer Thoughts

COTS Journal is in its tenth year and next month we're planning to do some analysis of the market we serve. So this month in preparation I've been doing some retrospective thinking about that market. I've also been searching through many of the publications that serve the military market—from publications that focus on a single technology right through to the books that talk about deliverable systems to the military. The revelation that struck me the hardest is just how much COTS hardware—that's not advertised as COTS product—is out there targeting the military market. In fact, many suppliers of these products go out of their way to avoid implying that their product is a COTS product—doing things like promoting the Mil-Spec features of the item hoping that this will keep them from being labeled "COTS."

I have no intention of restating the proper definition of COTS, which we print in every issue on our table of contents page, but all those companies offering for sale standard military-capable power supplies, radios, handhelds, laptops and so on: they are COTS products. It's amusing to see how companies dance on both sides of the COTS fence. When it's politically beneficial to avoid the COTS designation, then companies avoid any association. But when necessary to comply with bid requirements or avoid cost accounting issues, the products are proudly designated COTS products.

As you read about the military systems that are being proposed or fielded today, it's clear to see how much of the most current commercial technology is being implemented—bringing the latest available technology to military systems. This is exactly what then Defense Secretary Perry intended when he ordered the military to change the way it procured systems back in 1994 and in doing so launched what we now commonly call "the COTS initiative." It's become more commonplace for a company to offer to take almost any of its products and adjust their durability level to meet the needs of the customer in severe environment markets such as military, law enforcement, medical, environmental and others. Meanwhile, there are still many companies that just don't want to cope with government proposals and contracts and avoid that market entirely.

All this retrospection motivated me to contact Dr. William Perry to convey my thoughts on where our segment of the COTS market has moved since he helped us when we started *COTS Journal* in 1998, and get an update on what he's been currently doing. We'll have more about that in next month's issue, but Bill has been very busy.

Back to what's happening now on the international scene. The Olympics have come to an end, providing not only great sports but also one of the greatest successful PR ventures by any country in history. Isn't it amazing how once every four years we're glued to the TV to watch volleyball, water polo, rhythmic gymnastics and a whole bunch of other things we wouldn't even acknowledge existed as a sport? Meanwhile, during the same time period Russia decided to show its muscle and tell one of its very small neighbors to fall back in line. In the process, Russia employed old equipment and ill-equipped soldiers against an adversary that was even more ill equipped, armed only with Russian cast-off equipment. Soon we will have to endure the political conventions and their version of "reality" TV until the first Tuesday in November. The nominees will promise us everything and anything we're willing to possibly accept. And they'll do so working on the premise that we'll vote for the one with the best promises. And all that out of hope that they can have a job that doesn't pay as much per year as a CEO of a half-way decent electronics company.

Closer to home, September will once again start the conference and show season. A lot of "Chicken Littles" are screaming that the economy is falling and people won't be going to shows. Personally, I don't see any major shifts in our marketplace—it always has its usual ups and downs. Those people or companies currently experiencing a downtrend, are just going through one of our normal occasional shifts we've seen over the past few years. It's difficult to buy into the pronouncements that there's a major general economic problem based on my visit to Disney World with my grandchildren a few weeks ago. The place was packed, and anyone who's been there knows how expensive a family trip there can be. If there was a real problem with the economy I wouldn't have felt like a sardine trapped in the middle of the school the whole time I was there.

I look forward to the conference season and go to many of the conferences. The big ones that currently provide me the most information are AUSA, MILCOM, I/ITSEC and ESC—and there are also a lot of smaller more specialized events that I find very useful including our company's own RTECC shows. It's important for me to get to do the touchy-feely thing. For me, it's a lot like going to a new car showroom and I'm sure I'm not alone. ▮▮

Pete Yeatman, Publisher
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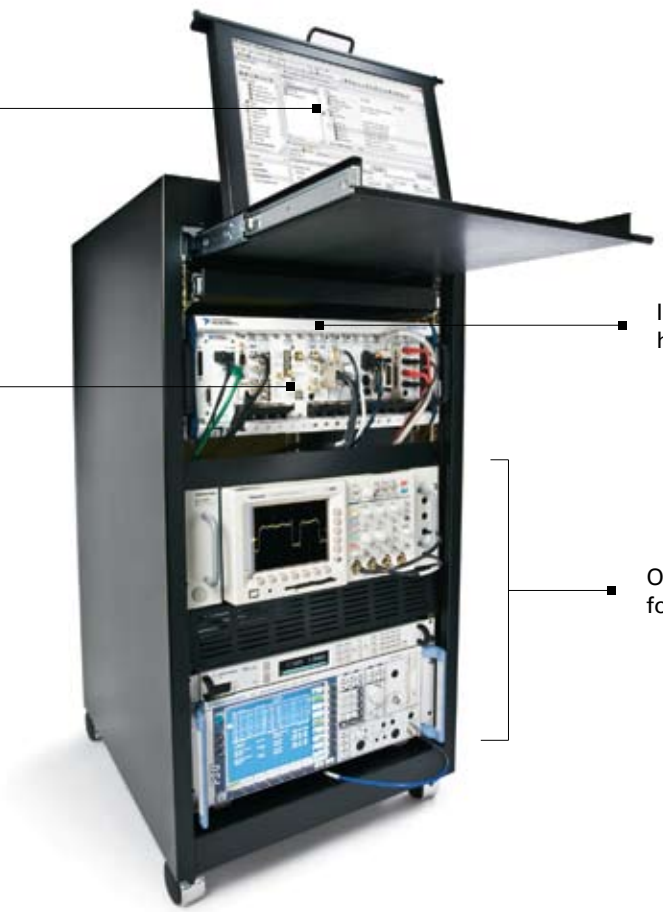

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The Inside Track

Wind River Tapped for X-47B Navy-UCAS Control/Mission System

Northrop Grumman Corporation has selected Wind River VxWorks 653 as the device software platform for its X-47B Navy-Unmanned Aerial Combat System (N-UCAS). The X-47B N-UCAS (Figure 1) is a carrier-capable, multi-mission, unmanned combat air vehicle. The U.S. Navy's program (Unmanned Combat Air System Carrier Demonstration, or UCAS-D) is designed to mature critical technologies and reduce the risk of carrier integration of a UCAS while providing the information necessary to support a potential follow-on acquisition milestone decision.

Wind River's VxWorks 653 offers a Certification Evidence DVD containing required documentation for the customer to deploy the VxWorks 653 real-time operating system in numerous safety-certified systems, with robust support for applications running at different safety levels on the same silicon. The platform also includes unique RTCA DO-178B-qualified development and verification tools that remove significant time, costs and risk for testing and deploying IMA systems.

Figure 1

The X-47B Navy-Unmanned Aerial Combat System (N-UCAS) is a carrier-capable, multi-mission combat UAV.

Wind River
Alameda, CA.
(510) 748-4100.
[www.windriver.com].

Curtiss-Wright Announces Offer to Acquire VMETRO

With intentions of acquiring VMETRO, Curtiss-Wright Controls has sent a letter to VMETRO stating that Curtiss-Wright Controls intends to make a voluntary offer for its outstanding shares. The launch of the offer is subject to completion of a limited due diligence and there being no material adverse change in the business and business assets of VMETRO before the launch of the Offer. According to VMETRO, the completion of the proposed offer will be conditional upon a 90% level of acceptance of the outstanding shares of VMETRO and obtaining regulatory approvals, including from relevant competition authorities.

Christian Jebsen, CEO of VMETRO, commented "Substantial synergies may be realized through a combination of the companies, among others through expansion of the market footprint and cross selling of products. I expect VMETRO to contribute significantly to Curtiss-Wright Controls Embedded Computing`s development through our broad and competitive product range and through our established and knowledgeable organization."

Curtiss-Wright Controls
Embedded Computing
Leesburg, VA.
(703) 779-7800.
[www.cwcembedded.com].

VMETRO
Houston, TX
(281) 584-0728.
[www.vmetro.com].

General Dynamics Awarded $41 Million for Marine Corps Combat Operations Centers

General Dynamics C4 Systems has been awarded a $41 million contract modification from the U.S. Marine Corps System Command for the production of nine capability set II Combat Operations Centers and 18 common modules. The capability sets and modules combine to become nine operations centers used by Marine Corps commanders. Used as the focal point of decision making for Marine Corps commanders and their staffs, Combat Operations Centers (Figure 2) are comprised of a network of workstations and servers supporting standard Tactical Data Systems and other mission-critical software, voice, data and Voice over Internet Protocol (VoIP) communications. Tents, trailers, radios, power generation and other tactical hardware integrate for a single-system command-and-control capability wherever Marines fight.

Figure 2

Combat Operations Centers house a network of workstations and servers supporting standard Tactical Data Systems and other mission-critical software, voice, data and Voice over Internet Protocol (VoIP) communications.

Deliveries will be completed by March 2010. The Marine Corps awarded the first contract for Combat Operations Centers to General Dynamics in 2002. Since then, more than 280 Combat Operations Centers have been ordered for Marine Corps command-and-control operations at the battalion, regiment, division and wing levels. This new order will equip the next-higher level of Marine Corps decision making, the major subordinate commands, with the same command-and-control capabilities.

General Dynamics C4 Systems
Scottsdale, AZ.
(480) 441-3033.
[www.gdc4s.com].

Northrop Grumman's Company-Owned MQ-8B Fire Scout Takes Flight

After conducting the first flight of its company-owned MQ-8B Fire Scout Vertical Unmanned Air System (VUAS) designated as "P6," Northrop Grumman prepares to move forward with selective demonstrations. The flight was conducted at the Webster Field Annex portion of Naval Air Station Patuxent River, Md. P6 (Figure 3) is part an on-going effort to expand upon the development capabilities of the MQ-8B Fire Scout.

The company's near-term plans include integration and flights with a maritime radar, a second electro-optical/infrared payload and various U.S. Army payloads. The P6 demonstration program will follow rigorous systems engineering processes to ensure success. Payload integration for all demonstrations will take place at Northrop Grumman's Unmanned Systems Development Center in San Diego. Demonstration flights will continue at Webster Field, Naval Air Station Patuxent River, MD and at Yuma Proving Ground, AZ. The 20-minute first flight of P6 followed Fire Scout's routine Fully Autonomous Functional

Figure 3

Northrop Grumman Corporation conducts the first flight of its company-owned MQ-8B Fire Scout Vertical Unmanned Air System (VUAS). The flight was conducted at the Webster Field Annex portion of Naval Air Station Patuxent River, MD.

Flight (FAFF) mission plan of vehicle start, takeoff, flight, landing and shutdown. The flight was commanded from a Tactical Control Station (TCS) with software produced by Raytheon Systems Corporation in Falls Church, VA.

Northrop Grumman Integrated Systems
El Segundo, CA.
(310) 332-1000.
[www.is.northropgrumman.com].

Robins Air Force Base Chooses DDC-I for AC-130U Support

U.S. Air Force Warner Robins Air Logistics Center has selected DDC-I to assist with the USAF's organic refresh and support effort for the C130's avionics software. The USAF will use DDC-I's Open Arbor products to replace legacy MIPS and 1750A Ada compilers. As part of the compiler evaluation, the USAF has migrated one of the avionics applications to DDC-I's OpenArbor development environment.

Starting with a clean slate enables the USAF software teams to look beyond the very basic tools that the original contractor used to developed and maintain the C130's avionics software. Now, instead of staying with rudimentary tools like command-line debuggers, Solaris/VAX servers, and weak profilers, the USAF teams can employ leading-edge IDEs and other tools.

DDC-I
Phoenix, AZ.
(602) 275-7172.
[www.ddci.com].

DataPath Awarded Contract to Support U.S. CENTCOM SatCom Hubs

DataPath has been awarded $1.9 million to continue providing field services for DataPath Deployable Ku Band Earth Terminals (DKETs) at a key communications hub in Iraq. The DKET systems were built and installed by DataPath and are used by the U.S. military as critical satellite communications (SATCOM) hubs that deliver high-bandwidth capabilities on the battlefield. DataPath technical experts have been based on-site to ensure optimum performance of the systems since they were installed in March 2005.

In addition to supporting the DKET network, DataPath field personnel specialize in designing, installing and managing other critical communications network programs such as the Defense Information Systems Agency's teleport network, the U.S. Army's Joint Network Node (JNN)/Warfighter Information Network-Tactical (WIN-T) program, and the U.S. Marine Corps' Support Wide Area Network (SWAN) program.

Datapath
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Polish Navy Selects Sabtech's Console Replacement Gear

Sabtech Industries has announced the completed installation of its Sabtech Military Equipment Replacement System (SMILES) on board two Polish Navy combatants. The Oliver Hazard Perry (ORP) class ships, Gen. K. Pulaski (F272) and ORP Gen. T. Kosciuszko (F273) (Figure 4), are Foreign Military Sales transfers from the United States Navy to Poland. The Polish Navy wanted to replace the OJ-172 Data Exchange Auxiliary Consoles (DEAC), which were difficult and expensive to maintain. The DEAC is the load device and operator console for the ship's mission-critical MK 92 Fire Control System.

Figure 4

The Oliver Hazard Perry (ORP) class ships Gen. T. Kosciuszko (F273) is a Foreign Military Sales transfer from the United States Navy to Poland.

The Polish Navy chose Sabtech's SMILES as the replacement for a number of legacy navy peripheral devices such as the DEAC. Since the system performs exactly like the equipment being replaced, no program changes are required on the host. It is configured with military connectors that mate with existing cables to further simplify the transition and save costs. Latter conversion of existing media to SMILES completely eliminates dependence on unsupportable hardware and obsolescent tape and disk media.

Sabtech Industries
Yorba Linda, CA.
(714) 692-3800.
[www.sabtech.com].

COTS Websites

www.sae.org

SAE Web Site Provides a Rich Set of Standards Info

Although its roots are in the automotive realm, the Society of Automotive Engineers (SAE) long ago expanded far beyond just automobiles. In fact, it's gone by just the name "SAE" for the past several years for exactly that reason. The SAE and its Web site are a one-stop resource for technical information and expertise used in designing, building, maintaining and operating self-propelled vehicles for use on land or sea, in air or space. They're responsible for creating numerous new avionic and ground vehicle standards as well as maintaining established ones like MIL-STD-1553.

SAE International has more than 90,000 members—engineers, business executives, educators and students from more than 97 countries—who share information and exchange ideas for advancing the engineering of mobility systems. The SAE's technical committees write more new aerospace and automotive engineering standards than any other standards-writing organization in the world. The SAE also publishes thousands of technical papers and books each year, along with leading-edge periodicals and Internet and CD-ROM products. The Web site boasts a vast online store from which visitors can purchase those items.

The SAE has cooperative research programs to help facilitate projects that benefit the mobility industry as a whole. Numerous meetings and exhibitions, such as the Department of Defense Maintenance Symposium and Exhibition, provide worldwide opportunities to network and share information. They also offer a full complement of professional development activities such as seminars, technical symposia and e-learning products.

SAE World Headquarters, Warrendale, PA. (724) 776-4841. [www.sae.org].

Special Feature

Data Recording System Architectures

Data Recording Systems Revamp to Suit New Signal Processing Demands

Wider, faster sensor inputs in military signal processing applications are driving a need for more sophisticated data recording system architectures. Advances in FPGAs, fabrics and storage media density are all helping ease the way.

Jeff Child
Editor-in-Chief

Choosing a data recording solution for an advanced signal processing military system might seem a straightforward task. But in reality it ranks among the more critical and challenging decisions engineers have to make. Consider the multitude of components found in modern sensor systems and the differing characteristics of those components. Pairing sensor acquisition/analysis subsystems with recording and storage subsystems requires consideration of interconnect pre-processing and reliability issues.

A recent example along those lines, earlier this year Lockheed Martin contracted VMETRO to supply Vortex Data Recording systems to support Lockheed Martin's work on the F-35 Lightning II test laboratory. The Data Recording systems are based on VMETRO's Vortex VME Open Data Recording platform. The Vortex system will be incorporated into Lockheed Martin's instrumentation and test plan for Lightning II. The Vortex family of real-time data recorder, playback and analysis systems for analog and digital applications offers sustained recording at rates up to 800 Mbytes/s. These recorders use Fibre Channel storage area network media in JBOD or RAID configurations. Available as targeted recorders or open custom recorders, the Vortex family easily integrates into any VXS (VITA-41), VME, CompactPCI or PC-based system.

Figure 1

TD3500 SATA disks with a total storage capacity of over 25 Terabytes form the recording system on NASA's WB-57 aircraft. The WB-57 is capable of operating for extended periods of time at altitudes ranging from sea level to greater than 60,000 feet.

Pushing the storage capacity curve, data recording system maker Conduant integrated 25 Terabytes of SATA storage into its Big River LTX2 High Speed Data Recorders. The recorders were developed to collect data on NASA's WB-57 aircraft (Figure 1), a mid-wing, long-range airplane capable of operating for extended periods of time at altitudes ranging from sea level to greater than 60,000 feet. Five recorders will each house 16 TD3500 SATA disks from solid-state disk vendor Formation for a total storage capacity of over 25 Terabytes.

Exemplifying the complex meld of sensor input processing and high-speed data recording is the E-2D Advanced Hawkeye program. The next-generation E-2D Advanced Hawkeye aircraft will be the U.S. Navy's next-generation airborne early warning and battle management system. The E-2D Advanced Hawkeye will be the latest version of the Hawkeye family of aircraft and will feature a new radar system along with other advanced capabilities. TEK Microsystems produced data recording and playback systems to support the next-generation radar system being developed for the E-2D Advanced Hawkeye. The data recording and playback systems for the E2-D will be based on TEK Micro's JazzStore family of data recording solutions. The Jazz Store family of data recording and playback systems includes several capabilities that were critical for the E-2D Advanced Hawkeye application. Among these were an ability to scale up to dozens of modular, heterogeneous input/output channels and FPGA-based protocol engines to support application-specific processing in real time during record and playback. ▮▮

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Special Feature

Data Recording System Architectures

DSP Propels Military Digital Data Recording into High Gear

Advances in sensor technology are complicating the job of today's military data recorders. FPGAs are easing the burden by increasing their pre-processing duties along the signal path.

Tom Bohman, VP of Business Development
VMETRO

Data recording used to be a fairly straightforward process—digitize the data and stream it to a storage subsystem fast enough to keep up in real time. Data analysis was done mostly offline, perhaps with some real-time display of channels during recording. But as sensors have gotten faster and more diverse, and requirements for data analysis have become real time, data recording has had to adapt. Recorders need to deal with data flowing in at different rates, in different formats and over multiple channels. Adding to that complexity is the synchronization required to correlate data on multiple channels to yield the needed results.

Coming to the rescue, as in many defense applications today, is advanced digital signal processing (DSP). With data now routinely digitized, more intelligence appearing in data recorders, and opportunities for better integration of data recording with the tactical system, data can be captured and processed into useful information quickly and accurately.

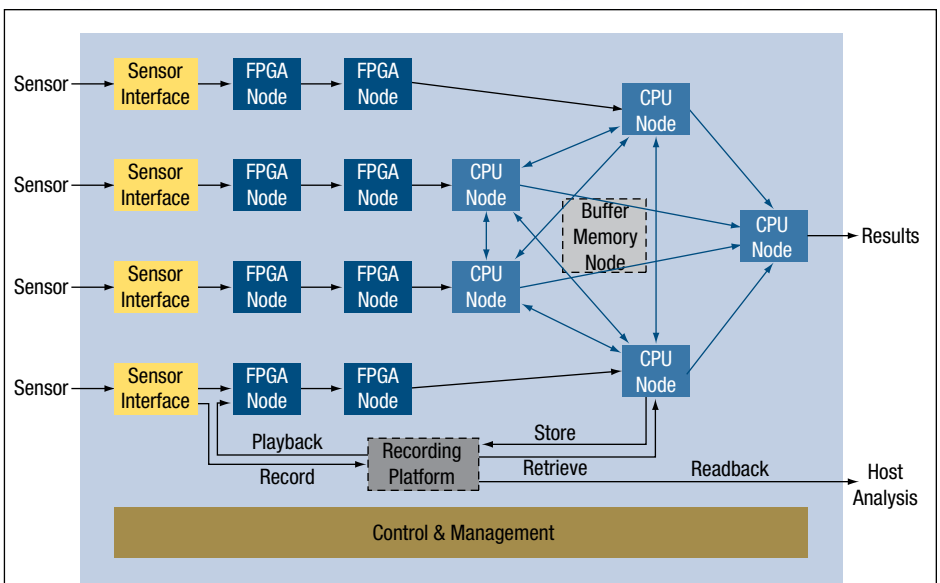

Figure 1

Depicted here is a hypothetical real-time DSP system with four channels of data each coming across an HSSI from four sensors. The FPGAs do some major front-end data processing before intermediate results are sent to an array of Distributed Multi-Processing (DMP) nodes for further processing and final output to other systems such displays or weapon targeting systems.

Signal Processing Elements

Sophisticated military electronic equipment, such as radars, electronic warfare (EW) systems, and Intelligence, Surveillance and Reconnaissance (ISR) systems, contains embedded computers that perform very sophisticated real-time DSP operations. The key elements in the data paths of these tactical systems include a maturing array of higher-speed sensor technologies, high-speed serial interconnects (HSSIs) and fabric technolo-

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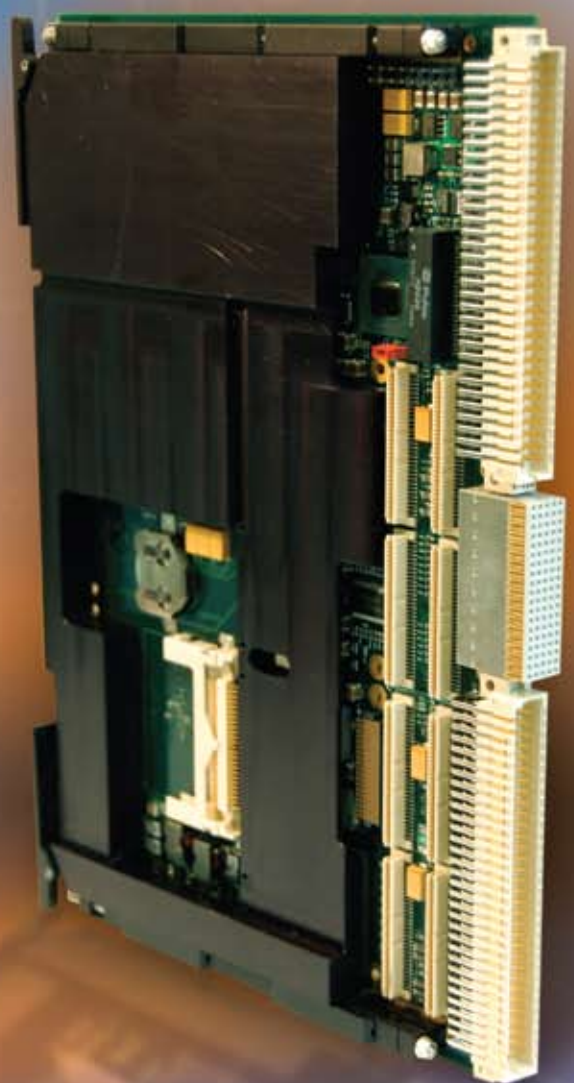

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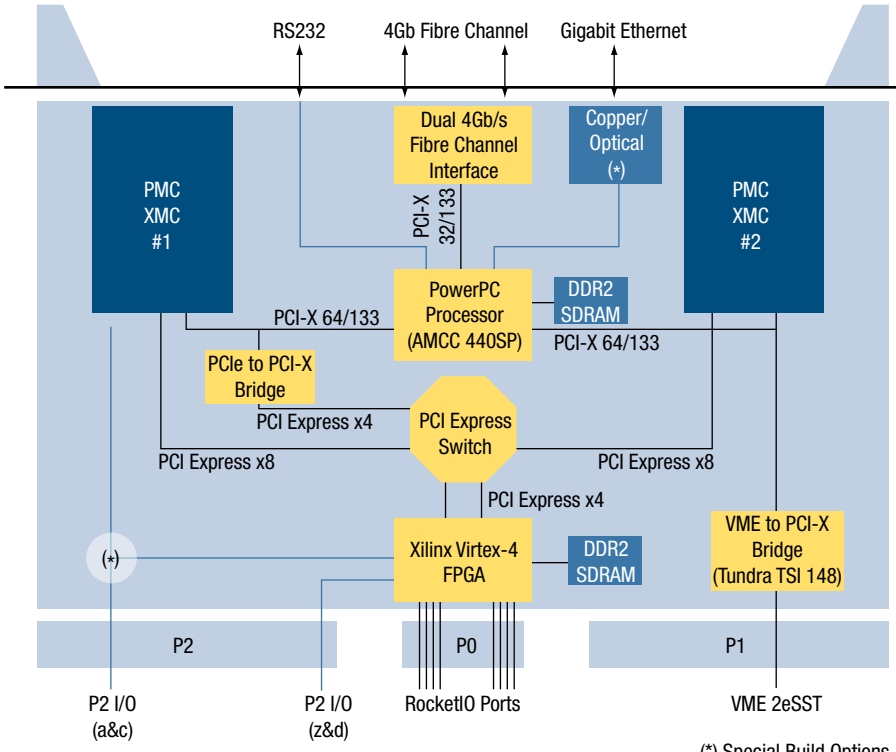

Figure 2

The architecture of this VXS-based real-time data recorder is a hybrid of FPGA technology and general-purpose processing. The FPGA technology allows integration with the HSSI and its protocol within the DSP system, and a general-purpose processor runs the data recorder software.

gies, very large FPGA devices and new multicore general-purpose processors.

A hypothetical embedded real-time DSP system is illustrated in Figure 1, showing components and interconnects in advanced DSP systems today. This hypothetical system shows four channels of data each coming across an HSSI from four sensors (via A/D converters). Significant layers of front-end data processing are done by FPGAs before intermediate results are sent to an array of Distributed Multi-Processing (DMP) nodes for further processing and final output to other systems such displays or weapon targeting systems.

From the sensors and between the FPGAs, the data flow is often unidirectional and routing is pre-determined and static. Here the system can utilize simple, low-overhead, point-to-point protocols such Serial FPDP from sensor to FPGA, and Aurora or RocketIO between FPGAs. Compared to switched fabric protocols, these lightweight protocols consume far

less FPGA resources preserving more gates for processing, and also have lower packet overhead preserving more link bandwidth for data.

Bringing in the Data Recorder

These same DSP architectural ideas used in tactical systems are poised to collect and crunch mind-boggling amounts of data at speeds barely imagined a few short years ago. Once the data is digitized, FPGAs can be used to grab and pre-process it, and general-purpose processors can finish the task. In fact, data recording systems designed with these ideas can be integrated with the tactical system, delivering significant benefits.

Figure 3

Shown here are the rugged air-cooled and conduction-cooled variations of the Vortex Recorder.

With many tactical systems now using HSSI links on a VXS or VPX backplane, a data recording system based on a VXS or VPX board can integrate into the same backplane and allow connection into one or more of the desired HSSI. Not only can data be recorded efficiently this way, the data also may be played back at the same point in the system. Data captured during an expensive real-world test can be played back into the system endlessly to improve and refine the system performance. The number of recording channels can be easily scaled to match the need for speed by scaling the number of data recorder boards.

Figure 2 illustrates a VXS real-time data recorder, the VMETRO Vortex hybrid recording engine. Such a data recorder must support a variety of protocols that might be used within the system, dictating that the architecture must be a hybrid of FPGA technology and general-purpose processing. The FPGA technology allows integration with the HSSI and its protocol within the DSP system, and a general-purpose processor runs the data recorder software.

In a system, the desired HSSI can be routed to eight HSSI links on the VXS P0 connector of the recording engine. Behind the VXS ports is a Xilinx Virtex-4 FPGA, where IP cores implement specific HSSI protocols and other functions such as headers, timing and processing algorithms. Attached to the FPGA is a

large block of high-speed SDRAM. This SDRAM can be used to stage and format data streams for recording, but its most important function is to supply ample elasticity buffering of very high burst rate data from the HSSI. Once captured, the high-rate data can then be drained to the recorder at much lower sustained data rates, reducing the sustained throughputs required from the rest of the recording system.

Keeping Pace with Data

Systems like these now include multiple HSSIs at up to 3.125 GHz each on the backplane, providing unprecedented opportunity to record and analyze enormous amounts of data. With A/D converters also now operating at 3 Gsamples/s and above, non-volatile capture of data streams has become a major challenge. The answer is to divide and conquer.

RAID0 striping of data across disk drives increases the throughput of disk storage to near the burst rate of the storage interface. On top of that, the storage interface links can also be striped in order to aggregate the speed of those connections. At the highest layer, the data recording engines themselves can be striped with data to linearly and infinitely scale the total throughput of a large recording system.

How does this work in practice? With Fibre Channel drives capable of storing data at 100 Mbytes/s sequentially across a drive, four of these drives can be combined on one 4 Gbit/s Fibre Channel loop to attain 400 Mbytes/s. Outfit the recording engine with two of these Fibre Channel ports and an aggregate rate of 800 Mbytes/s is theoretically possible. Then striping the sensor data across four recorders would allow 3.2 Gbytes/s or 100 percent capture of a 3 Gsample/s sensor stream.

While the example above is theoretically possible, in practical applications there are many elements that must be considered including inner track storage speeds, protocol overhead, protocol and bus conversion overheads, memory bandwidth, and the bursty nature of digital data as it flows through these many elements. Bandwidth is also required to allow various elasticity buffers to drain throughout the system while maintaining the specified sustained rate. The recorder shown previously is specified to record single or multiple streams at a sustained rate of 720 Mbytes/s. Next-generation recording engines are being developed that will more than double that rate in the not too distant future.

Storage of the End Results

To meet a broad spectrum of applications that spans from the relatively benign lab to the harshest operational and deployed environments, the ideal data recorder storage subsystem would be small, low power, fast, large capacity, removable,

rugged, high-altitude capable and the lowest possible cost.

Unfortunately, costs can increase dramatically as each of these characteristics increase. This is true for the least expensive 1 Terabyte SATA hard drive at less than $1 per Gbyte, to the sealed and shock isolated FC drive at $30 per Gbyte, to the most expensive extended temp solid-state drives at about $90 per Gbyte.

Recording engine hardware and software must embrace storage technology that includes an extremely broad spectrum of storage capabilities. Fibre Channel Storage Area Network (FC SAN) technology offers the right breadth, allowing most any FC equipped devices to be used for data storage. The spectrum includes anything from one or more SATA drives with FC interposer modules, to FC/SATA RAIDs, to almost unlimited rotating or solid-state FC devices on either an FC loop or switched topology.

Going Rugged When Required

Most programs begin with a proof-of-concept system in the lab connected to hardware-in-the-loop simulation systems. In this early development phase it is often a waste of program funds to utilize fully rugged conduction-cooled versions of the processing and recording products. When it is time to deploy, rugged versions with software and performance identical to the lab systems are critical.

The processing and data recording elements of the advanced DSP system as well as the data recorder engine must be available in commercial and rugged air-cooled as well as the most rugged conduction-cooled versions. Figure 3 shows the Vortex Recorder in both rugged air-cooled and conduction-cooled variations.

New advanced signal processing architectures have not only transformed tactical systems design, but created an opportunity for data recording to be seamlessly added to systems. Data recorder engines now employ hybrid FPGA and general-purpose processing techniques that allow new interconnect strategies, higher recording speeds, large variations in storage technologies, and a full spectrum of robustness and ruggedization levels. The near-term goals for real-time data recording using techniques described here reach into the range of 1500 Mbytes/s for a single recorder, and as technology continues to improve that target is expected to grow further. ▮▮

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Special Feature

Data Recording System Architectures

FPGAs Push Integrated Data Recorder Systems Beyond Number Crunching

The powerful processing capabilities of today's FPGAs provide the ideal building block for advanced military data recording system architectures. Blending signal processing with network interfaces and fabric endpoints makes for a flexible solution.

Andrew Reddig, President and CTO
TEK Microsystems

The use of Field Programmable Gate Arrays (FPGAs) for advanced military signal processing has become an obvious choice to achieve maximum performance within the limited size, weight and power constraints of high-performance embedded systems. However, the advantages of FPGA-based architectures are not limited to just raw number crunching performance. By taking advantage of the inherent flexibility of reconfigurable hardware, an FPGA-based system can tightly integrate signal processing with additional non-processing functionality such as network interfaces, fabric endpoints, or data recording and playback.

One of the challenges of data recording in embedded systems is that the requirement itself is usually only temporary. While the ability to record some or all of the raw input data is critical during the development and integration phases, it is not usually required once a system enters production. In an ideal world, developers would like to be able to add data recording to a system with no impact to the baseline configuration, and then install or remove it without changing hardware, firmware or software but also without tying up critical space, weight or power resources in the deployed system "just in case" the recorder is needed.

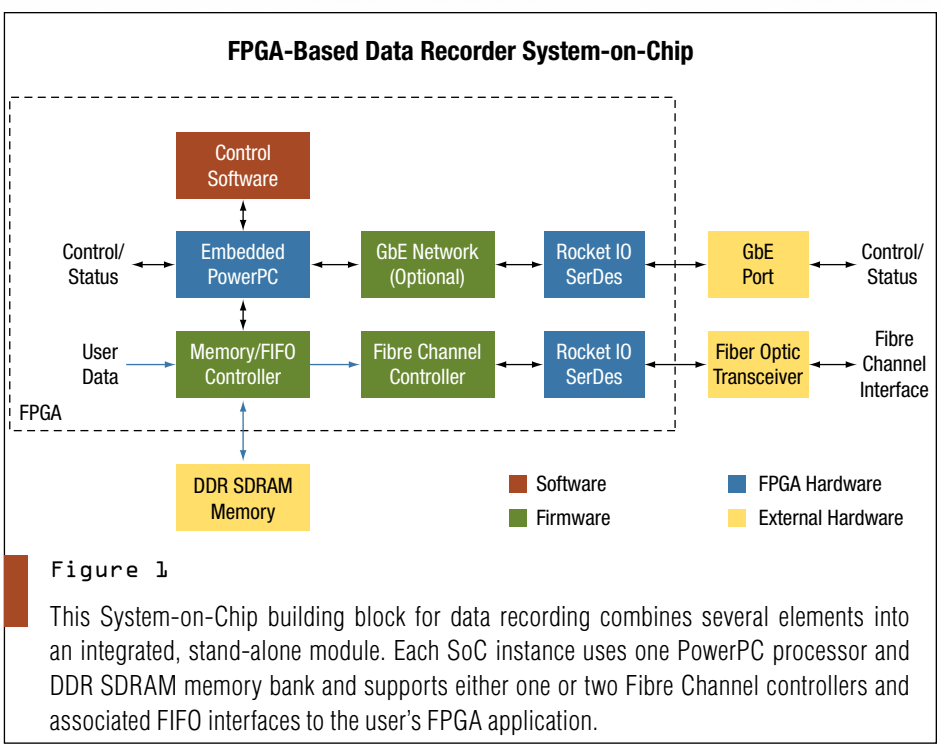
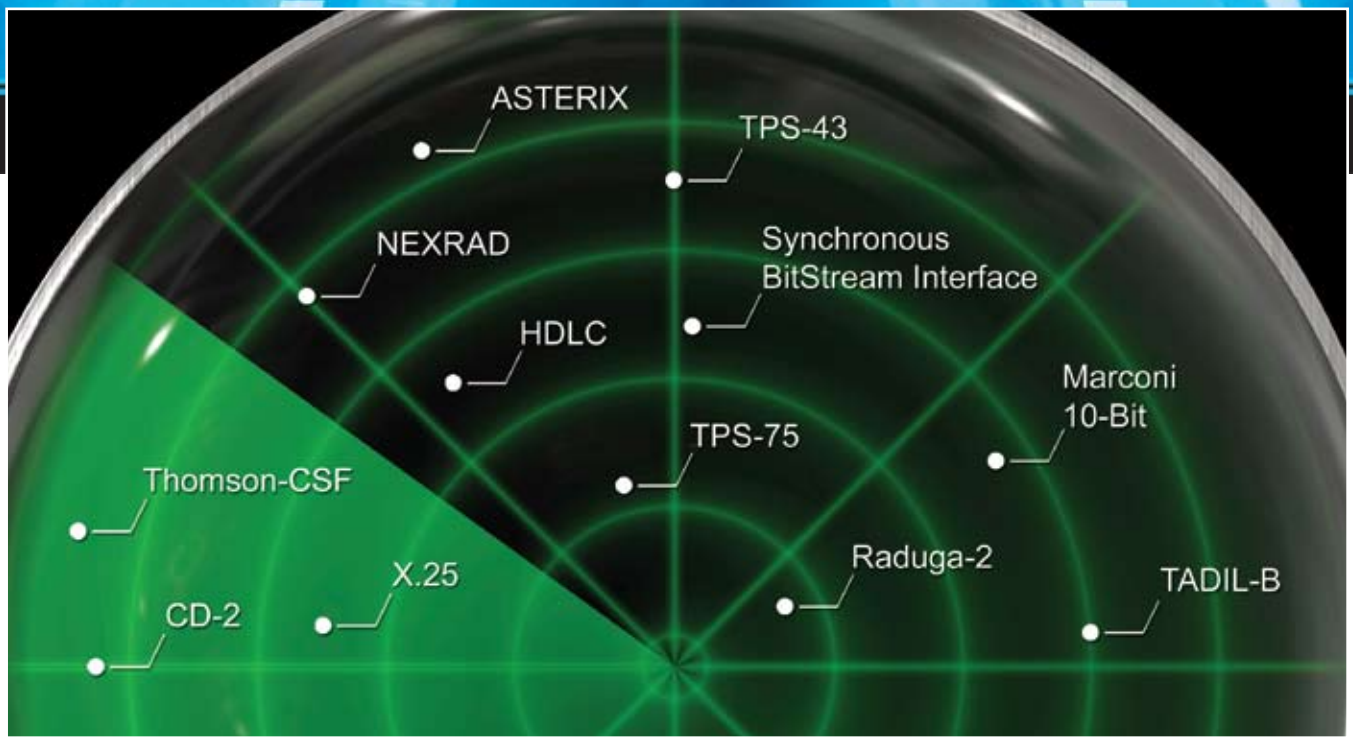


Figure 1

This System-on-Chip building block for data recording combines several elements into an integrated, stand-alone module. Each SoC instance uses one PowerPC processor and DDR SDRAM memory bank and supports either one or two Fibre Channel controllers and associated FIFO interfaces to the user's FPGA application.

Trade-Offs of Dedicated Solutions

Dedicated data recording products are typically based on a combination of general-purpose processors and ASIC-based storage controllers with interfaces such as Fibre Channel or Serial ATA. These stand-alone products typically require one or more slots in the backplane along with some way to get the data from the signal processing subsystem to the



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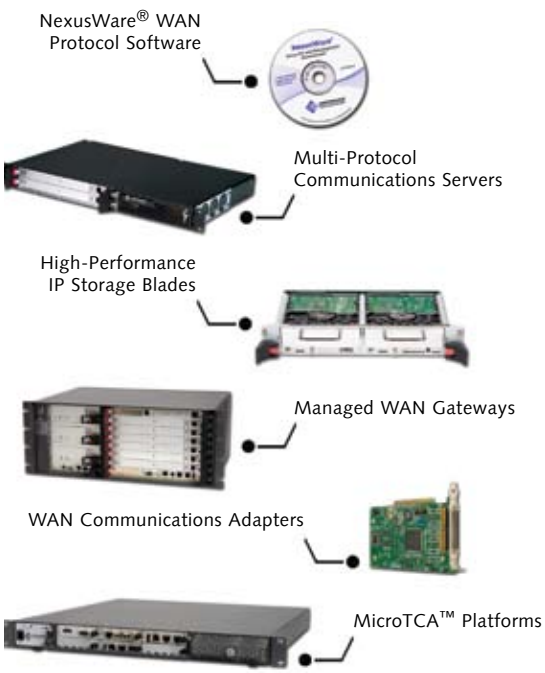

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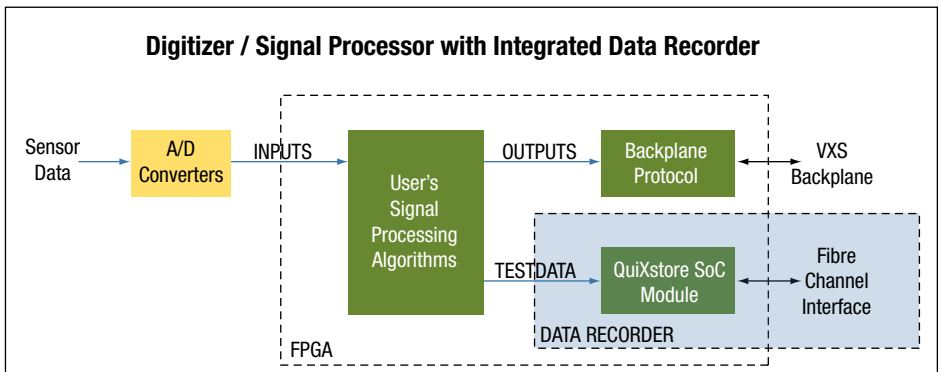


Figure 2

By integrating an SoC module into an FPGA-based digitizer card as shown here, the data recording function is integrated directly into the signal processing FPGA, making it straightforward for the user's signal processing module to select raw input data, intermediate results, or a combination of the two as test data to be recorded.

data recorder, resulting in a trade-off between the data recording requirement and other system requirements. In addition, because the data recorder is based on processor technology, it is usually difficult to scale up to a high channel count within a single card without running into processor, memory or backplane throughput bottlenecks, resulting in even more card slots for applications that scale beyond 1 Gbyte/s.

Two VXS System Examples

Consider, for example, two different examples of using FPGA technology to create highly integrated signal processing and recording solutions using off-the-shelf products based on the ANSI/VITA 41 VXS open standard. The first example uses FPGA resources to implement a "zero slot" recording solution as an integrated part of a high-speed digitizer and signal processing subsystem. The second example uses multiple FPGAs to create a high-density recorder engine in a single slot with 1.8 Gbytes/s of throughput using multiple JBOD or RAID arrays. Both examples reuse a common FPGA-based modular building block to implement a high-performance Fibre Channel controller with wirespeed data transfers between the user's signal processing functions and an attached JBOD or RAID array.

The foundation of the examples described here is an integrated System-on-Chip building block for data recording called QuiXstore SoC. This building block, shown in Figure 1, combines several elements into an integrated, standalone module:

- *Hardware*, including the FPGA with its RocketIO high-speed serial interface to the Fibre Channel device and onboard PowerPC core, along with one bank of attached DDR SDRAM for buffering.
- *Firmware*, including the Fibre Channel low-level protocol, memory interface, network interface if required, and support logic.
- *Software*, including the upper layer Fibre Channel protocol, SCSI protocol, real-time FAT32 file system and session control.

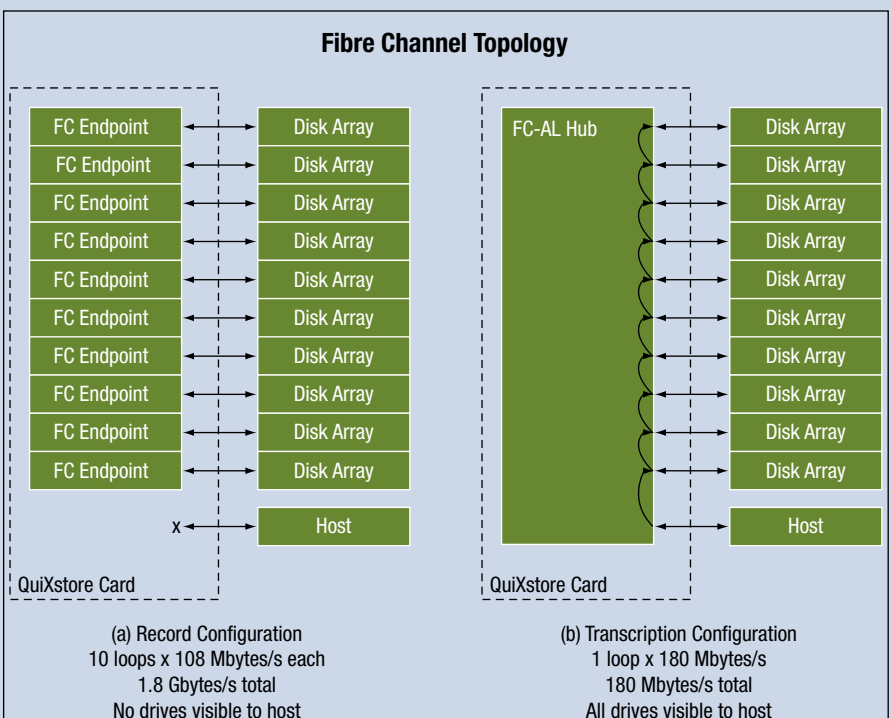
Each SoC instance uses one PowerPC processor and DDR SDRAM memory bank and supports either one or two Fibre Channel controllers and associated FIFO interfaces to the user's FPGA application. To record data, the user sets up the recording session and then simply streams data into the FIFO. The module manages the underlying control and data flow functions to manage the memory buffers, storage interface and file system semantics, resulting in FAT32 files on the Fibre Channel disk array.

In many applications, the post-mission analysis does not require all of the input data but can be performed with a well-defined subset of the input data.

Integrated Fibre Channel Hub Links FPGA Endpoints

One challenge with data recording systems, particularly very high throughput systems, is the need to efficiently transcribe the recorded data to offline storage. Typically, the RAID arrays that are used in the field stay in the field and the user transfers some or all of the data to a higher capacity portable RAID array, which is then moved to a laboratory for analysis and post-processing. With as many as 40 disk arrays in a large system, managing the connections for transferring data can be a challenge, particularly when the system needs to be quickly turned around and redeployed for the next data collection.

The use of FPGAs for the Fibre Channel endpoints creates some additional options for managing this problem. Because the FPGA is reconfigurable, each Fibre Channel endpoint can be configured through firmware to act as either an independent loop for high-speed data recording or as a node in an arbitrated loop for transcription (see figure).



(a) Record Configuration
10 loops x 108 Mbytes/s each
1.8 Gbytes/s total
No drives visible to host

(b) Transcription Configuration
1 loop x 180 Mbytes/s
180 Mbytes/s total
All drives visible to host

By using FPGAs for the Fibre Channel endpoints in this system, each Fibre Channel endpoint can be configured through firmware to act as either an independent loop for high-speed data recording or as a node in an arbitrated loop for transcription.

When configured for high-speed recording, each Fibre Channel connection is dedicated to a single disk array, supporting full wirespeed throughput for reading or writing on each of ten interfaces for aggregate throughput of 1.8 Gbytes/s. Once recording is completed, the FPGA endpoints are reconfigured to act as nodes in an arbitrated loop consisting of the ten disk interfaces and an eleventh host interface. This allows an external workstation to access all of the disk arrays for transcription without moving any cables or reconfiguring any of the disk arrays. Because the recording engines use a FAT32 file system, the workstation can simply "see" all of the recorded data as regular files in about 10 seconds per disk array after the end of a recording session.

Typically, this can be done by either windowing the input data to only record during specific time periods based on an external trigger or gate signal or by taking advantage of front-end signal processing to record only post-processed data. In addition to reducing the embedded system resource requirements, this approach also reduces the number of attached disk arrays and the time required for transcription and post-processing, all of which make the data recording problem simpler and easier.

For these applications, an FPGA-based data recording solution can be used to eliminate both the backplane slot and data flow impact of traditional data recording architectures. By integrating a QuiXstore SoC module into an FPGA-based digitizer card as shown in Figure 2, the data recording function is integrated directly into the signal processing FPGA, making it straightforward for the user's signal processing module to select raw input data, intermediate results, or a combination of the two as test data to be recorded for later analysis. The end result uses the memory and front panel inter-

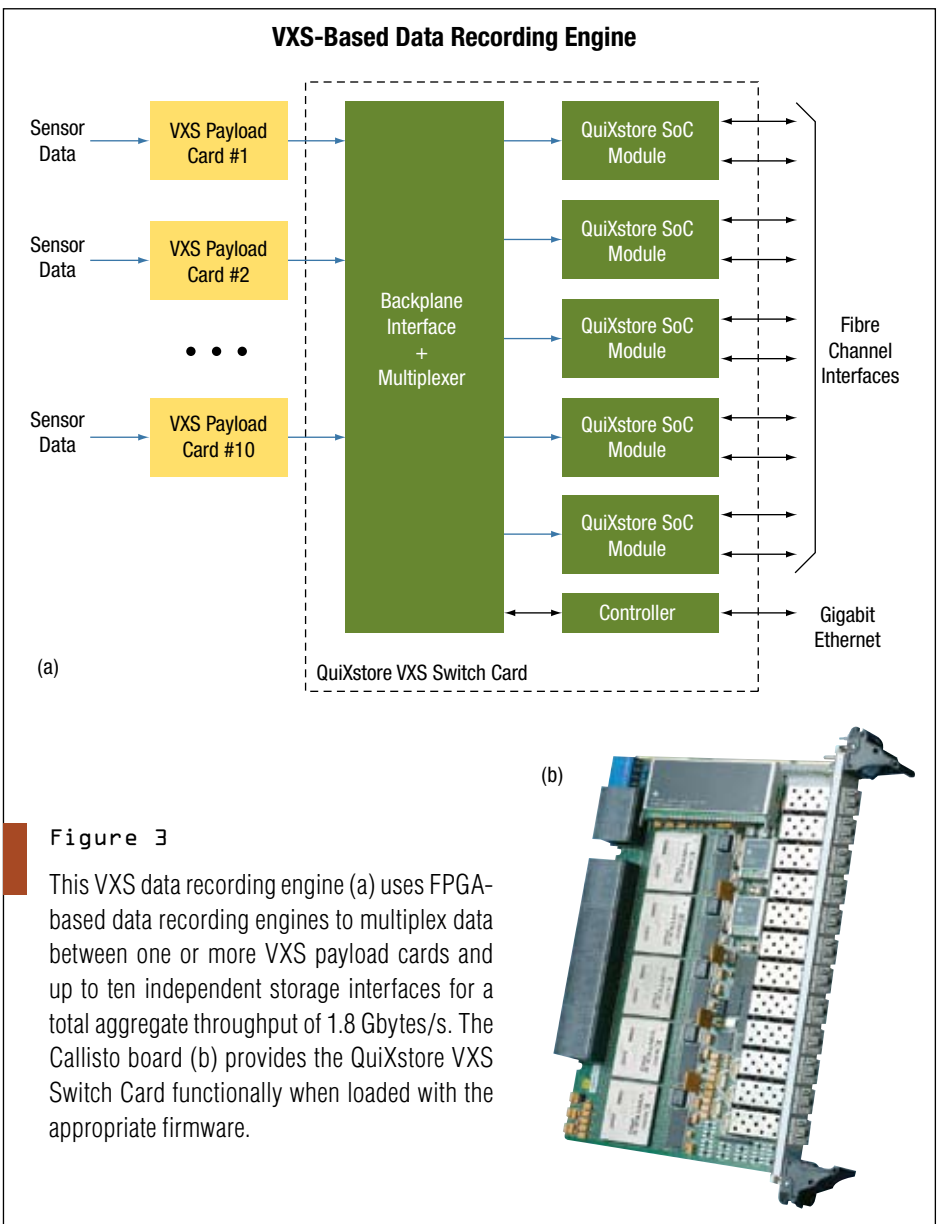


Figure 3

This VXS data recording engine (a) uses FPGA-based data recording engines to multiplex data between one or more VXS payload cards and up to ten independent storage interfaces for a total aggregate throughput of 1.8 Gbytes/s. The Callisto board (b) provides the QuiXstore VXS Switch Card functionally when loaded with the appropriate firmware.

face resources already available on the off-the-shelf card to add data recording functionality with "zero slot" impact.

One Slot, Maximum Density

While the "zero slot" solution is ideal for applications that can work within the constraints of a small number of storage interfaces, the advent of multi-gigasample-per-second A/D converters has created a need for data recorders in the 1+ Gbyte/s range requiring a large number of separate storage interfaces. Although these data rates cannot be supported with a "zero slot" approach, some of the same FPGA-based technology can be applied to use multiple FPGAs on a card to increase storage channel density and therefore meet these requirements with the minimum number of backplane slots.

The VXS data recording engine, shown in Figure 3, uses FPGA-based data recording engines to multiplex data between one or more VXS payload cards and up to ten independent storage interfaces for a total aggregate throughput of 1.8 Gbytes/s. By using the VXS switch slot form factor, each recording engine can access data from between 1 and 10 payload cards, supporting both ultra wideband applications with a small number of channels as well as more traditional 180 to 500 MHz applications with higher resolutions and channel counts.

The VXS standard supports backplanes with either one or two switch slots, and standard 19" rackmount enclosures can be implemented with either one or two VXS backplanes for a total of up to four data recording engines with total data recording throughput up to 7.2 Gbytes/s. Using high-density disk arrays, a data recording system with 7.2 Gbytes/s throughput and storage time in excess of one hour can be implemented in 30U (52.5 inches) of rack space including the front-end digitizers and associated signal processing FPGAs. While 40 storage interfaces can be challenging to manage, the FPGA-based architecture can be leveraged for post-mission transcription to allow host access to the disk arrays without moving cables (see sidebar).

Supporting Many Backplane Protocols

Because the data recording engine is FPGA-based, it is possible to support a wide range of backplane protocols through firmware. However, the data recording engine is designed to emulate a simple FIFO type interface to support maximum efficiency in speed, overhead and resources as well as low integration effort between the user FPGA on the payload card and the recording engine. The standard backplane interface uses the Xilinx Aurora protocol to implement a streaming FIFO interface with up to 8 serial lanes at a rate of 3.125 GBaud, resulting in throughput from each payload card of up to 2.5 Gbytes/s. The Aurora

protocol is being standardized for VXS through the VITA 41.5 working group and can easily be implemented on any FPGA-based payload card, allowing the board to be used as an off-the-shelf building block driven by a wide range of off-the-shelf digitizer and sensor interface cards from Tekmicro and other VITA 41.5 compatible vendors.

By using FPGA technology to implement a modular data recording engine, it is possible to solve low rate data recording requirements with no additional hardware and high data rate requirements with very high throughput/channel count solutions, all using off-the-shelf FPGA-based board-level products based on the VXS open standard. An example system requiring this level of FPGA processing is the data recording and playback systems developed for the E-2D Advanced Hawkeye (Figure 4).

Figure 4

An example system requiring sophisticated FPGA processing is the data recording and playback systems developed for the E-2D Advanced Hawkeye. The data recording and playback systems for the E-2D can scale up to dozens of modular, heterogeneous I/O channels and FPGA-based protocol engines to support the demands of the aircraft's next-generation radar system.

The data recording and playback systems for the E-2D can scale up to dozens of modular, heterogeneous input/output channels and FPGA-based protocol engines to support application-specific processing in real time during record and playback. As storage and FPGA technology improve over time, these approaches will continue to offer highly integrated data recording options with increasing throughput and storage capacity through reuse of the modular building blocks within an open standard framework. ▮▮

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Special Feature

Data Recording System Architectures

Video Distribution:
The Big Picture

As demand grows for more sophisticated military situational awareness and information sharing, digital video now ranks as a mission-critical function. As a result, understanding video distribution architecture and technology is now more important than ever.

Andrew Haylett, Head of Technology
Andrew Hipperson, Business Development Manager
Curtiss-Wright Controls Embedded Computing, UK

Today, video distribution in aerospace and defense applications—such as on ship—involves physically connected or wireless analog video signals. This is less than ideal because the quality loss, high bandwidth demands and costly switching infrastructure tend to limit flexibility. A far better approach is to distribute video digitally. Digital video distribution eliminates many of the problems associated with analog video at a lower cost. And digital video distribution has the added benefit that enables the use of a wider variety of transmission types than are supported by raw video and allows system integrators to leverage existing network infrastructures.

Digital video distribution is a critical function in a variety of defense applications including ship-wide naval distribution systems, local situational awareness systems, airborne distribution systems and simulation gear. An example along those lines is the Navy's Shipboard Protection System (SPS) (Figure 1), which provides a fully integrated and seamless sensor, analysis and response system with 360 degree situational awareness and engagement capability.

Figure 1

Engineers and crewmen review operation of the Shipboard Protection System (SPS) aboard USS Benfold (DDG 65) during a Feb. 22, 2008 testing event. A component of SPS is 360 degree situational awareness and engagement capability to counter asymmetric Anti-Terrorism/Force Protection threats. The Benfold, a Navy Arleigh Burke-class guided missile destroyer, is the first ship outfitted with SPS (Block 1 version).

To integrate a successful video distribution system requires a number of elements to be in place. An ideal video distribution solution would handle video resolutions from NTSC/PAL through high-resolution component video up to 2560 x 1600. It would support industry-standard video compression algorithms, network infrastructures and network protocols. Bandwidth is critical for high-resolution video. For example to distribute 1280 x 1024 60 Hz requires 1.89 Gbits/s, but with a 20:1 video compression the re-

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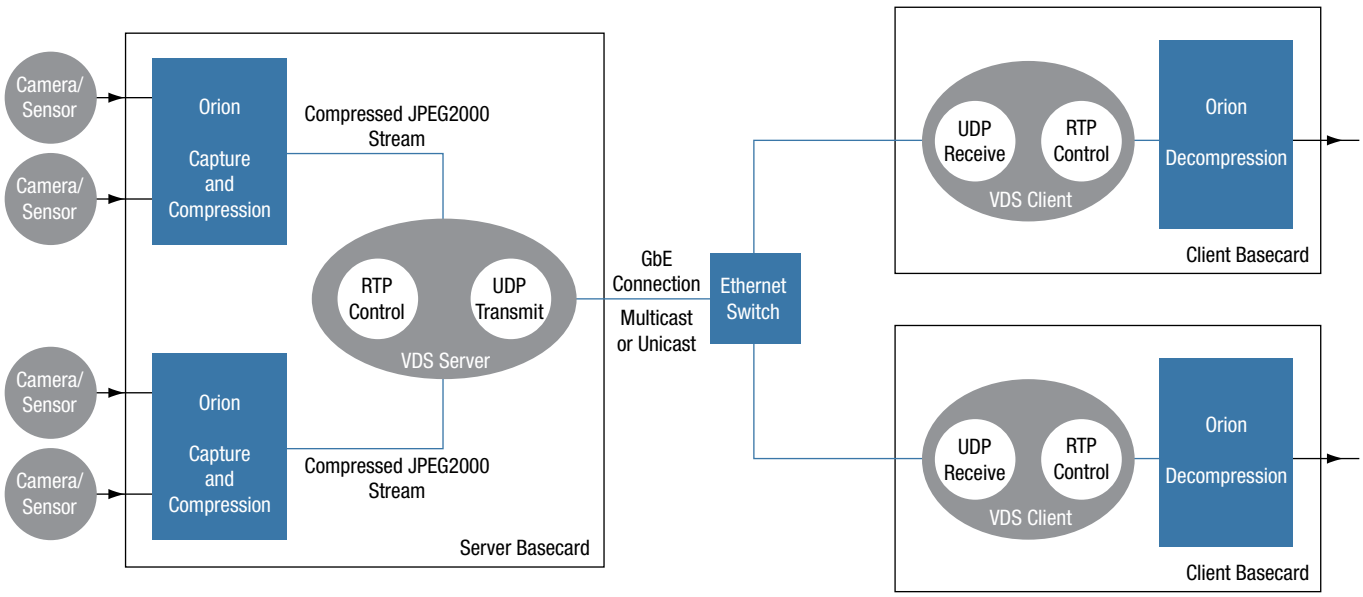

Figure 2

A typical video distribution system is comprised of Capture, Encoding and Decoding hardware linked to video processing, recording and display hardware—in other words, the monitors and processor arrays where the video streams are processed. Software provides the video distribution client/server framework that uses RTP (Real-Time Transport Protocol) for networking.

quired bandwidth can be reduced to 94 Mbits/s: the key is to ensure that this compressed video is of appropriate quality and delivered within an acceptable time.

The components of a digital video system include:

- the video source (for example, SAR image, FLIR, camera or computer display)
- a method for capturing and encoding this video
- a network over which the digitized video is transmitted
- a decoder and regeneration step to reconstruct the video
- a destination where the video will be used—this could be for display, storage or further processing.

Tried and True JPEG2000

JPEG2000 provides an optimal match of quality, robustness and compression and has been an industry standard since approval by the Joint Photographic Experts Group in 2000. In a deployed video distribution system there is a chance that bit errors may be induced between source and destination or that there may be an interruption in the video stream. It is in

these situations that JPEG2000 shows its great error resilience. Compared to JPEG, a bit error in a highly compressed frame of JPEG2000 causes little degradation.

A more extreme difference can be observed when comparing with MPEG2 and MPEG4: bit errors introduce "blocky" artifacts that can have a negative effect on following frames. It is the reliance on compression of sequences of frames in MPEG techniques that lead to their relatively poor performance when the video stream is interrupted—when the stream starts again a significant number of frames can pass before a reasonable image is obtained. In contrast, both JPEG and JPEG2000 are per-frame compression techniques so that an error in a frame affects only that particular frame—subsequent ones are unaffected.

The use of wavelet-based algorithms in JPEG2000 means that much higher compression ratios can be achieved for a given quality requirement; at very high ratios JPEG2000 images may appear blurry as opposed to MPEG and JPEG, which exhibit blocky artifacts. Conversely, when using lower ratios the compression can be virtually lossless—it is even possible to achieve mathematically lossless compression with JPEG2000 if a two-way integer wavelet transform is employed.

Wavelet-Based Approach

In contrast to the discrete cosine transforms employed in MPEG, JPEG2000's wavelet-based approach means it works equally well on frames consisting of continuous gradients as it does on two-tone images. Side channel spatial information is also supported thereby providing support for including transparency levels (if present). Within a typical video distribution system there may be multiple destinations for the video each of which may use video at a different resolution: JPEG2000 allows for progressively increased resolution and quality depending on the amount of the compressed video stream used in decompression.

Another aspect of JPEG2000 that may be of future benefit to systems that employ very high-resolution sensors is the ability to compress different areas of the screen at different rates—this means that the region of interest can be sent in very high quality with the rest of the frame transmitted in a more compressed form. It is also possible to divide a captured frame of video into strips that can be immediately processed: this means that low latencies can be achieved by starting transmission of the compressed frame before acquisition is complete. Even without this tiling technique, JPEG2000 offers lower latency than the MPEG alternatives because of its per-frame algorithm.

A typical video distribution system is comprised of three main elements (Figure 2). First there's the Capture, Encoding and Decoding hardware. To take advantage of the benefits of JPEG2000, it is necessary to use hardware acceleration of the compression and decompression as even modest resolution video can consume all of a modern CPU's processing power and still not meet full frame rate requirements. The Encoder captures and compresses input video, which it then formats and outputs as a network data stream. Meanwhile, the Decoder takes the network data stream and extracts the compressed video, which it then decompresses and re-generates either as uncompressed digital data or, via appropriate interface hardware, as native video.

Software Pieces to the Puzzle

The other two main elements of a video distribution system are the software and the video processing, recording and display hardware. The video processing, recording and display hardware includes monitors and processor arrays: these are where the video streams—either compressed or raw—are processed.

The software component of a video distribution system is made up a several pieces. A video distribution client/server framework provides a middleware layer that facilitates the integration of video distribution into arbitrarily complex architectures. Support is provided for nodes to publish their capabilities as services on the network and for users of the video to subscribe to these services. Quality of service (QoS) and error monitoring and control are required to ensure that video reaches its intended destinations within necessary time and quality parameters.

Also critical on the software side is RTP (Real-Time Transport Protocol), a

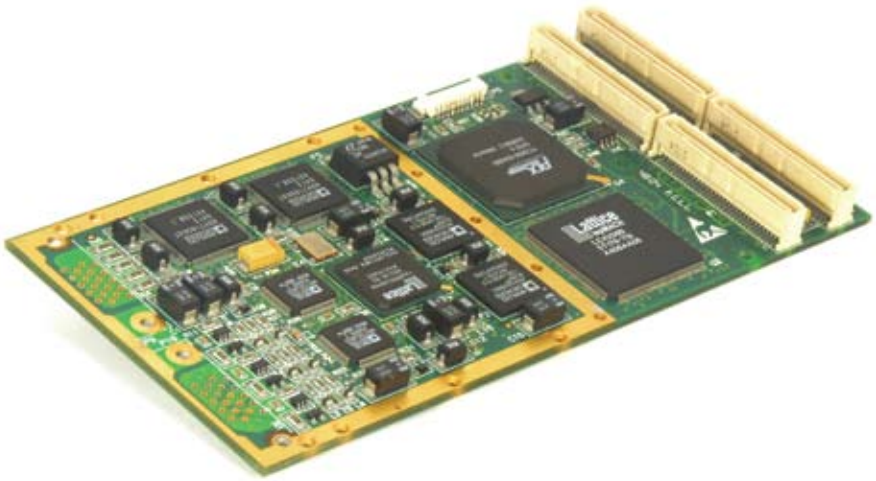

Figure 3

The Orion JPEG2000 PMC board can be used to provides lossless real-time video compression and decompression. JPEG2000 compression provides advantages in terms of latency.

real-time network specification that facilitates a standards-based implementation of several of the main capabilities of video distribution. Basic UDP over Ethernet is needed for relatively simple and lightweight implementations with more modest QoS requirements. Meanwhile, software-based sensor and Encoder/Decoder controls facilitate the integration of control-loops into our clients' applications. Software CODECs are included in video distribution for application areas where the real-time capabilities provided by hardware are not needed. For example, recording to disk might require software decoding of a compressed video stream. Smaller resolutions (such as NTSC) could also be processed by an optimized JPEG2000 software CODEC.

Video Distribution System Solution

An example of a complete video distribution system solution is Curtiss-Wright's VDS. It uses the JPEG2000 compression algorithm, and enables the transmission of multiple video streams over standard gigabit Ethernet or other suitable network connections in either lossless or lossy modes, thereby providing the flexibility to distribute video to match quality and bandwidth requirements. JPEG2000 compression provides advantages in terms of latency, making VDS ideal in applications where the minimum time from capture to display is critical. Curtiss-Wright's Orion JPEG2000 PMC board (Figure 3), for instance, can be used to provides lossless real-time video compression and decompression.

Video streams can be multicast or unicast using UDP protocol standards. VDS also supports the RTP (real-time protocol) standard used commonly for real-time video and audio distribution requirements. RTP controls the flow of video data to ensure optimized transmission over IP networks. The VDS software suite provides a Web or socket-based interface to allow simple configuration and set-up of a VDS system. A top-level API is also provided to allow a higher degree of customization if required. ▮▮

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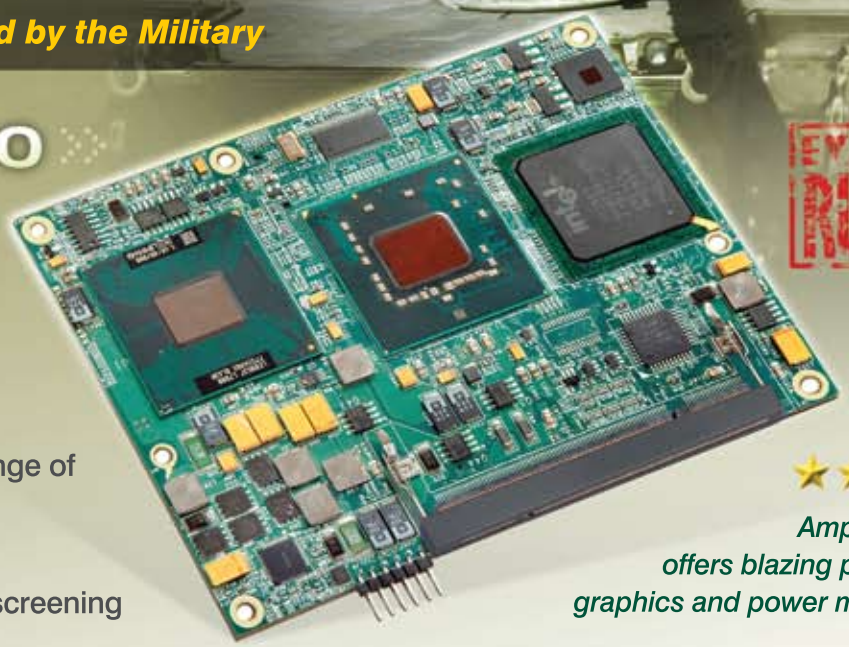

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Expansion Bus	PC/104 ISA Bus	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PCI-104 PCI Bus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
	PCI Bus Masters	4	4	4	4	4	4	4	4	4	4	4		4
	APIC (add'l PCI interrupts)	9	9	9	9	9	9	9	9	9	9	9		
CPU and BIOS	CPU Max Clock Rate (MHz)	1400	1400	1400	1400	1400	400	650	400	650	400	650	500	500
	L2 Cache (KB)	2048	2048	2048	2048	2048	256	256	256	256	256	256	128	128
	Intel SpeedStep Technology	✓	✓	✓	✓	✓								
	ACPI Power Mgmt	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0		
	Max Onboard DRAM (MB)	512	1024	1024	1024	1024	512	512	512	512	512	512	512	512
	RTD Enhanced Flash BIOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Nonvolatile Configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	RTD Quick Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peripherals	Watchdog Timer & RTC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ATA/IDE Disk Chip (MB)	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096
	Audio		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	Analog Video	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA
	Digital Video	LVDS	LVDS	LVDS	LVDS	LVDS			TTL	TTL	LVDS	LVDS	LVDS	
	AT Keyboard/Utility Port	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PS/2 Mouse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Mouse/Keyboard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
I/O	**RS-232/422/485 Ports**	4	4	2	4	2	2	2	2	2	2	2	2	2
	USB Ports	4	2	4	2	4	2	2	2	2	2	2	2	2
	10/100Base-T Ethernet	1	1	1	1	1	1	1	1	1	1	1	2	1
	ECP Parallel Port		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	aDIO (Advanced Digital I/O)	14	18	18	36	36	18	18	18	18	18	18	18	18
	multiPort (aDIO, ECP, FDC)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SW	ROM-DOS Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DOS, Windows, Linux	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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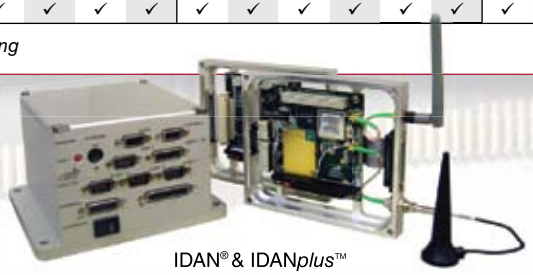

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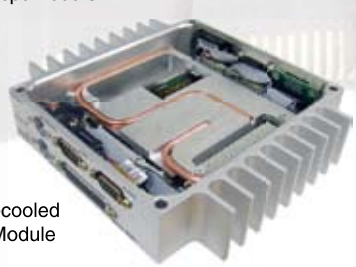

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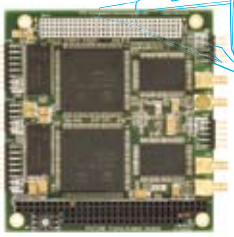

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Bus	Active Bus	PCI	PCI	ISA	ISA	PCI	PCI	PCI	PCIe	ISA	ISA	ISA	PCI	PCI	PCIe	PCI
	Passthrough Bus	ISA				ISA	ISA		PCI				ISA		PCI	ISA
	DMA or PCI Bus Master	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
	McBSP Serial Ports	✓	✓			✓	✓	✓	✓							
Analog Input	Single-Ended Inputs	16	16	16	16	16	16	16	16							
	Differential Inputs	8	8	8	8	8	8	8	8							
	Max Throughput (KHz)	1250	1250	500	100	1250	500	500	500							
	Resolution (bits)	12	12	12	16	12	16	16	16							
	Input Ranges/Gains	3/7	3/7	3/4	1/4	3/6	3/3	3/3	3/3							
	Autonomous Calibration	✓	✓													
	Data Marker Inputs	3	3	3		3										
Conversions	Channel-Gain Table	1K	1K	1K	1K	1K	1K	1K	1K							
	Scan/Burst/Multi-Burst	✓	✓	✓	✓	✓	✓	✓	✓							
	A/D FIFO Buffer	8K	8K	8K	8K	8K	8K	8K	8K							
	Sample Counter	✓	✓	✓	✓	✓	✓	✓	✓							
	SyncBus	✓	✓			✓	✓	✓	✓							
Digital I/O	Total Digital I/O	16	16	16	16	16	16	16	16	48	18/9	64	48	48	48	48
	Bit Programmable I/O	8	8	8	8	8	8	8	8	24	6/0		48	48	48	✓‡
	Advanced Interrupts	2	2	2	2	2	2	2	2	2			2	2	2	✓‡
	Input FIFO Buffer	8K	8K	8K	8K	8K	8K	8K	8K							
	Versatile Memory Buffer												4M	4M	4M	8MB
	Opto-Isolated Inputs											48				
	Opto-Isolated Outputs											16				
	User Timer/Counters	3	3	2	2	3	3	3	3	3	3		10	10	10	6
	External Trigger	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓‡
	Incr. Encoders/PWMs										3/9		4/8	4/8	4/8	✓‡
Analog Out	Analog Outputs	2	2	2	2	2	2	2	2							
	Max Throughput (KHz)	200	200	200	100	200	100	100	100							
	Resolution (bits)	12	12	12	16	12	16	16	16							
	Output Ranges	4	4	3	1	4	5	5	5							
	D/A FIFO Buffer	8K	8K			8K	8K	8K	8K							

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Tech Recon

MicroTCA and AMC in Military Systems

MicroTCA and AMC Team for Military Duties

Fitting in nicely with the military's quest of a compact, network-friendly embedded form factor, MicroTCA is gathering mindshare fast. Mechanical changes aimed at ruggedizing the MicroTCA spec could place it into the forefront of system architecture alternatives.

Robert C. Sullivan, VP of Technology
Hybricon
Clayton Tucker, Senior Marketing Manager,
Emerson Network Power

For the first time since the introduction of VME 25 years ago, an embedded computing architecture is emerging that is capable of serving a broad cross section of market segments: commercial, industrial, medical, telecommunications, and now military systems. This emergence of the MicroTCA architecture—originally developed for telecom and networking applications—coincides with a push underway in military and aerospace design to replace proprietary architectures with off-the-shelf embedded systems that can successfully integrate high-density, multicore processors and multi-compute nodes. Now, the MicroTCA architecture is evolving ruggedized construction specifications that can support operation in the harsh environments of military and aerospace systems.

Two trends are defining the next-generation military system designs: increasing complexity and data handling, and a move to off-the-shelf embedded computer technologies. To address the complexity and data requirements, system designers are turning to network-centric systems that simplify connection, coordination and high-speed data transfer among nodes. Previous generations of embedded networking equipment were developed for enterprise applications and lacked tolerance for the environmental hazards that face military systems, but the telecom industry's MicroTCA architecture is an exception. It's evolving to address ruggedization requirements and become the basis of next-generation military system designs.

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Net-Centric Requirements

Next-generation military systems will need to handle massive amounts of information traffic. The concept behind the Future Combat Systems (FCS) program (Figure 1), for example, calls for command and intelligence structures to become highly coordinated with the man in the field. Satellite information and video from unmanned autonomous vehicles (UAVs) in the air and on the ground will be sent directly to the troops that need the tactical support. Wearable computer-based health vests will continually update troop status to central command, and personal location devices will help coordinate air support with ground troops.

While all that sounds like science fiction, it lies within the range of current technology. The key to making it all work is to have systems designed to be part of a massive network for the exchange of information, including data, video and voice communications. The network must be easy to expand and maintain, exhibit high availability, and support the addition and removal of nodes without interruption of traffic. These various forms of information or data are the lifeblood of the theatre of operations. The optimal movement and use of that data across the networks will drive the real viability of future battlefield platforms. This communications backbone is the essential element of the integrated battlefield and is uniquely suited for a MicroTCA communication-based platform.

The Internet and the infrastructure it runs on is such a network, and its technology is widely available for military system developers to apply. But there are two main problems. First, the commercial-grade equipment of the Internet's underlying telecommunications network infrastructure is often proprietary in nature and is thus expensive, has limited availability, and is difficult to adapt to custom requirements. Sec-

ond, telecom networking equipment was designed for indoor operation and generally will not tolerate the shock, vibration and temperature conditions of field environments.

MicroTCA Addresses Rugged Needs

Those problems are rapidly evaporating, however, with the emergence of MicroTCA. The architecture arose specifically to solve the first problem: the high cost of developing and supporting proprietary networking equipment architectures. The PCI Industrial Computer Manufacturer's Group (PICMG) addressed the problem by creating open system, hardware and software specifications tackling the needs of telecommunications and networking equipment.

PICMG's initial effort resulted in the Advanced Telecommunications Computing Architecture (ATCA), which uses a modular design approach that plugs a variety of blades into a high-speed, protocol-agnostic, switched-serial backplane. The blades are also modular, configurable with I/O and computing functions on Advanced Mezzanine Card (AMC) modules, which are large enough to carry significant functionality but small enough to fit into a shoebox-sized housing, that plug onto the blade. The ATCA specifications define the entire base system; including cards, cage, power supply, cooling and system software for built-in test, fault monitoring and system management.

While ATCA targeted large-scale central-office installations, PICMG was tasked to address the need for smaller and less demanding designs. As a result, PICMG adapted the ATCA architecture to create MicroTCA. MicroTCA uses the same functional architecture, system management software and AMC modules as ATCA, allowing many system hardware and software elements created for ATCA to also serve in MicroTCA designs without modification. This commonality has the side benefit of increasing the applications base for AMC modules, fostering innovation and lowering their cost.

Figure 1

Exemplifying how next-generation military systems will need to handle massive amounts of information traffic, the Future Combat Systems program relies on a network capable of getting satellite information and video from unmanned autonomous vehicles (UAVs) in the air and on the ground and sending it directly to the troops that need the tactical information. Shown here a soldier reviews networked data during an FCS demonstration.

The primary difference between the two architectures is mechanical; with MicroTCA, AMC modules plug directly into a backplane rather than onto carrier cards as in ATCA. There is also a movement of some switching and control functions from ATCA carrier cards to an AMC-sized MicroTCA Carrier Hub (MCH) in MicroTCA. The AMC cards themselves, however, are identical in both systems.

One of the outcomes of this mechanical difference is considerable flexibility in physical configuration, as shown in Figure 2. Unlike the massive ATCA system design, a full MicroTCA system can be implemented with as few as two AMC modules, allowing extremely compact designs. MicroTCA systems can also be larger, with as many as 12 cards in a rack, where higher performance is required. This flexibility gives military system designers the freedom to implement systems in racks, cubes, or many other configurations and still conform to MicroTCA specifications, solving installation challenges while gaining access to MicroTCA's numerous off-the-shelf components.

Similarly, the protocol-agnostic nature of the MicroTCA's serial backplane provides flexibility in design choices without losing off-the-shelf benefits. Systems can be created with the Internet Protocol (IP) as the backplane's native format, or can just as easily be created to interface with another high-speed serial protocol unique to a military system's needs. The

backplane even supports the mixing of protocols to simplify bridging between disparate systems.

High Availability Built In

Telecom's need for high-availability system operation, which mirrors that of military systems, prompted PICMG to design AMC modules to support advanced features such as electronic keying and automatic fail-over in case of fault. Working in conjunction with the system management software, the modules allow remote power control for hot-swap operations, incorporate built-in test capability, and permit the system to automatically identify new modules and reconfigure appropriately. Together with the modularity inherent in the MicroTCA architecture, these AMC module and system management features also greatly simplify system maintenance, repair, modification and upgrade.

The AMC modules and other off-the-self components that are available for MicroTCA span the entire system structure. Cage mechanics, power and cooling subsystems, and backplane are all covered in the specifications and thus available from multiple vendors as interchangeable units. A wide range of interoperable AMC modules are likewise available with such functionality as high-performance CPUs, high-speed serial interfaces, mass storage systems, and other telecom system needs. Further, the market for MicroTCA system elements has been growing beyond telecom, adding to the diversity of functions available. The result is a hardware architecture with rich support of off-the-shelf equipment that addresses many of the functional needs of next-generation, network-centric military systems while providing enough flexibility to address specialized system needs, as well.

The embedded hardware support that MicroTCA provides has its match in embedded software support that can apply to military system needs. In addition to defining system hardware, the ATCA and MicroTCA specifications define a complete base system behavior including fully defined system management functionality. As a result, system management software for MicroTCA has become available as commercial products. Emerson Network Power's SpiderWareM3 middleware, for example, helps simplify the managing, monitoring and maintaining of MicroTCA systems. It gives an operator graphical access to and control of system behaviors such as module discovery and identification, environmental monitoring and alarm settings, fan speed and operation, and software loading.

Similarly, the open nature of the MicroTCA standard along with its built-in support for high-availability (HA) operation has allowed HA middleware to arise. Some of this is freely available. The Service Availability Forum—an industry-wide consortium—took advantage of features built into the MicroTCA specification to create open-source HA middleware that developers can adapt to their unique needs. For those that need full engineering support, commercial HA middleware is also available.

Such commercial software supports the ease of operation and maintenance essential for military systems by simplifying operations. It also provides an opportunity to implement system operation that is consistent across many platforms. Because it is standards-based, it is assured to be interoperable with specification-compliant system hardware regardless of application. This can greatly simplify military system software design by eliminating the system management design effort and allowing developers to concentrate on applications development, instead.

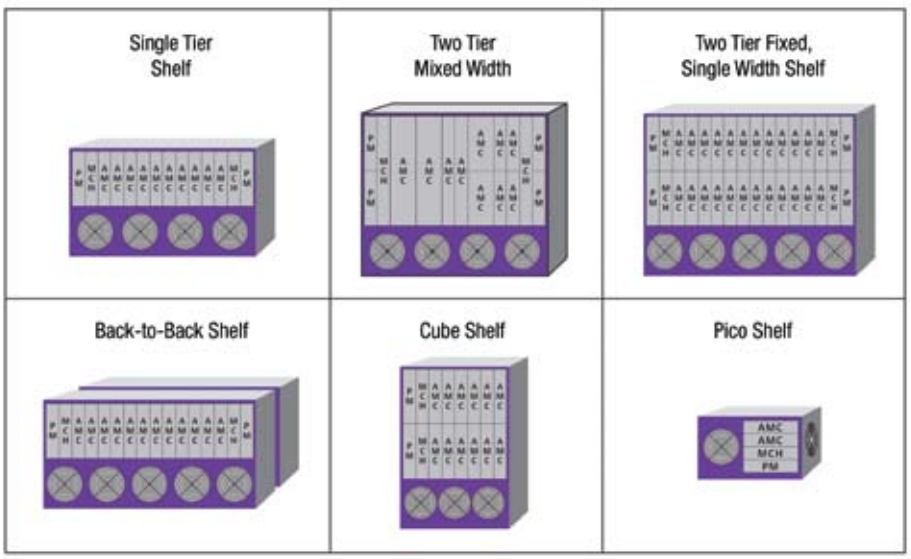

Figure 2

Design flexibility is a hallmark of the MicroTCA specification, as shown by the wide variety of system footprints the specification allows.

Addressing Rugged Environments

The cost, availability and development benefits of open-specification design solve the proprietary design problem and, together with the many attributes that support mission-critical operation, make MicroTCA a promising architecture for implementing network-centric military systems with off-the-shelf components. Recent efforts within the PICMG organization are now addressing the remaining weak area, the operating environment. The original PICMG specification—MicroTCA.0—targeted NEBS-grade environmental conditions of offices and outbuildings. The temperature range involved runs from -5° to +55°C ambient temperature range. Shock and vibration resistance are minimal, representing normal shipping and handling, installation activity, earthquakes, and the like.

Market interest in the MicroTCA architecture outside of telecommunications,

however, has prompted PICMG to extend its specifications to address harsher environment installations, including outdoor and industrial settings as well as vehicle mounting in trucks, trains and commercial aircraft. The organization's efforts are running in two phases. A ruggedized, air-cooled specification—MicroTCA.1—is up first, scheduled for release this year. A second extension, the MicroTCA.2 conduction-cooled system—MicroTCA.2—is also under active development but is at least a year away.

The goal in both of these efforts is to preserve cost and availability benefits of MicroTCA-compliant designs by keeping intact as much of the original design as possible. Part of the approach includes the use of component selection during board build to extend temperature tolerance. Another part is to augment, rather than change, mechanical designs to boost ruggedization. Such augmentation includes additional stiffeners and retention devices that can be applied to standard board designs. Extensive testing has proven that the current card-edge connector system can meet a 5G to 25G shock and 10G sinusoidal vibration immunity requirement with such augmentation.

Figure 3

This ruggedized MicroTCA system is a harbinger of conduction-cooled MicroTCA specifications currently under development within PICMG.

Air-Cooled or Conduction-Cooled

The target specifications for air-cooled MicroTCA.1 include several possible ambient operating temperature ranges, the broadest of which is -40° to +70°C. The conduction-cooled MicroTCA.2 specification aims at meeting many of the ANSI/VITA 47 environmental levels, including an operating temperature range of -40° to +85°C. Although the MicroTCA.2 specification has not yet been fully defined and approved, conduction-cooled MicroTCA units already available from companies such as Hybricon (Figure 3) point the way and prove the concept.

The jury is still out on the mechanical changes needed for MicroTCA.2, however. The use of wedge locks and conduction plates on the AMC modules to carry component heat to the frame is already clear, requiring changes to the card cage spacing and dimensions. The edge connector is the greater unknown as it is not clear that such a connector will withstand the most severe target shock and random vibration requirements of ANSI/VITA 47. Although preliminary testing indicates that some versions of the connectors will be acceptable for many applications, the committee plans extensive testing before making a final recommendation, in order to fully characterize the conditions for which a variety connector options have sufficient reliability.

PICMG's work is making MicroTCA an ever-more practical option for use in all but the most demanding military applications. It is a proven architecture, representing low risk to developers. It simplifies design because the system foundations along with a full range of system components are already fully defined and available. Yet, it provides the design flexibility needed to address unique application needs when suitable off-the-shelf elements are not available. The fully developed and thriving ecosystem of vendors developing MicroTCA products along with substantial interest in the architecture beyond telecom ensures that when the ruggedized specifications are in place, MicroTCA products covering a range of environmental options will quickly become available. MicroTCA will thus give military designers access to low-cost embedded computer system elements that match their functional and environmental requirements, allowing creation of network-centric systems for the next generation of military equipment. ▮▮

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System Development

Cooling Technology Update

Cooling Strategies Shift toward System-Level Approaches

As electronics continue up the power curve, system cooling becomes an ever greater problem. Chassis and system-level solutions are helping to tame those challenges.

Jeff Child
Editor-in-Chief

There's just no avoiding the trend toward processors and other key components ramping up in wattage. That ever increasing power means more challenges dissipating heat. Exotic techniques such as spray cooling and liquid cooling are all on the table as possible ways to attack the cooling challenge. As a result, military system designers are being compelled to weigh the complex risks and advantages involved in staying with evolutionary cooling approaches versus embracing newer, more exotic forms of controlling the thermal environments of their embedded systems. To keep pace, vendors of chassis and complete system-level solutions have begun to craft solutions designed from the ground up to use innovative cooling approaches.

At the board level, power increases are likewise expected to climb as military systems continue to crave greater compute density and shift to high-speed serial technologies via the emerging form factors like VPX (VITA 46). VITA 46 for its part allows up to 768 watts of power on a 6U x 160 mm board. That's a major increase over the 90-watt limit allowed on VME cards, but it poses a substantial cooling challenge to design engineers.

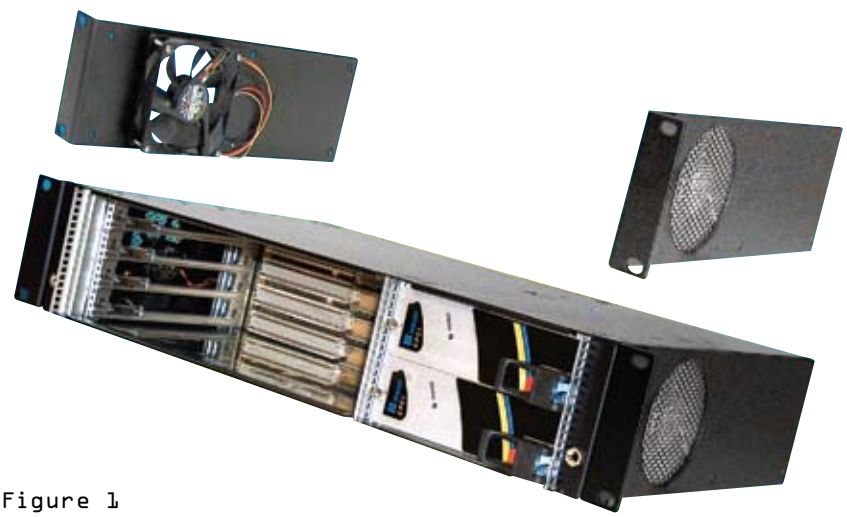

Figure 1

This 2U microchassis enclosure for military and aerospace harsh environment applications incorporates superior left to right cooling and maximum airflow between slots for protection against heat buildup all while supporting the weight of the unit in a 2U package size.

2U Chassis Solution

Rolling out a chassis solution, Triple E recently added a new 2U microchassis (Figure 1) to their line of enclosures for military and aerospace harsh environment applications. The rackmount unit features a flange that spans the entire depth of the unit, two fans and patented all-aluminum guide decks. This unique combination of features provides exceptional stability to protect boards from vibration damage, incorporates superior left to right cooling and maximum airflow between slots for protection against heat build up all while supporting the weight of the unit in a 2U package size.

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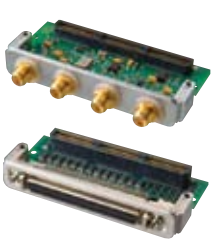

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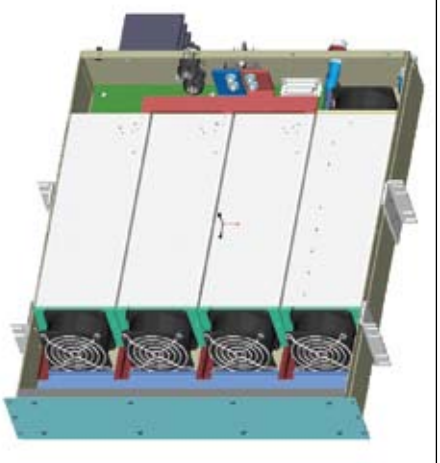

Figure 2

Liquid-cooling solution is designed to be part of a high-power DC system. Each 2U shelf is self-contained with an input AC connector and an output DC Terminal Block. Using the self-cooled rectifiers' fan to force the waste heat through the integral cooling element, the system releases very little heat outside of the shelf. Shelf cooling is completed via the internal Heat-Exchanger with an external coolant chiller.

Liquid-Cooling Systems

Liquid cooling—long considered too risky for military systems—has begun to gain mindshare in the defense realm. Liquid cooling relies on a naturally abundant medium, is environmentally friendly and enables the processing of massive amounts of energy. TDI Power's latest liquid-cooling solution is its Liquid Cooled Mercury Shelf (Figure 2). When combined with its standard fan-cooled Mercury rectifier modules, the shelf is designed to be part of a high-power DC system. Each 2U shelf is self-contained with an input AC connector and an output DC Terminal Block. The shelf also has inlet and outlet connectors for the cooling liquid and an alarm and control connector. Using the self-cooled rectifiers' fan to force the waste heat (from the rectifiers) through the integral cooling element, the system releases very little heat outside of the shelf. Shelf-cooling is completed via the internal Heat-Exchanger with an external coolant chiller.

(a)

(b)

Figure 3

Themis' CoolShell (a) is comprised of modular, sealed and self-cooled 1RU-high Field Replaceable Units (FRUs), which blind mate into a minimalist power and network backplane. All active components, including fans/blowers, are field replaceable from the front of the rack and all external interconnects, I/O and Power have front panel access. Cooling is front-to-back and all slots have independent, active airflow control. FRUs are provided in an "exoskeleton" clamshell (b) or truss plate, patent-protected Themis technology to ensure high shock and vibration resilience.

Where once relegated to a custom-only offering, system-level solutions geared specifically with cooling features have started to emerge as off-the-shelf products. Along just such lines is Themis' CoolShell product line (Figure 3). The CoolShell product line includes Slice, in liquid flow through and air-cooled configurations, and Slice-CT in its several height variants. This product family shares a common theme. This system offers modular, sealed and self-cooled 1RU-high Field Replaceable Units (FRUs), which blind mate into a minimalist power and network backplane. The product families each have passive subracks that house the constituent FRUs. All active components, including fans/blowers are field replaceable from the front of the rack and all external interconnects, I/O and Power have front panel access. Cooling is front-to-back and all slots have independent, active airflow control. FRUs utilize "exoskeleton" clamshell or truss plate, patent-protected Themis technology to ensure high shock and vibration resilience.

Figure 4

Aimed at SMT power semiconductor devices, Aavid Thermalloy's Slalom heat sink uses solderable "skis" that are staked to an aluminum body.

CoolShell standardizes on a backplane architecture with scalable links, including dual redundant 10 Gbit/s Ethernet, and dual redundant InfiniBand or PCI-e G2 links. The Backplane also provides out of band shelf and FRU management as well as KVM links. Backplanes and even the subrack are all replaceable from the front of the equipment rack. Re-

dundant switch modules are collocated with management units and are located within the Power Utility Shelf. PSUs are hot swappable and N+1 redundant.

Complete Environment Control

Another trend that touches on the cooling challenges facing today's military is the emergence of rugged box-level systems that offer complete environmental control including advanced cooling technologies. Exemplifying that idea is SprayCool's Multi-Platform Enclosure (MPE). The MPE chassis employs the company's patented two-phase cooling technology. The MPE's controlled operating environment enables it to accept a wide range of card types within the same chassis, simplifying the technology refresh cycle. It provides years of thermal headroom as it is capable of supporting sets of boards with almost twice the power and thermal load as those deployed today.

Advances in heat-sink technology occur on a more evolutionary pace compared to processor speed increases. But new ideas continue to emerge (Figure 4). An example is Aavid Thermalloy's recently released Slalom heat sink. Aimed at SMT power semiconductor devices in D2PAK packages, the Slalom uses solderable "skis" that are staked to an aluminum body. The heat sink together with the device to be cooled is soldered directly to a modified drain pad, creating a thermal transfer path from the device to the heat sink. The heat is removed indirectly without any contact between the heat sink and the device as is the case with traditional through-hole heat sinks. ■■

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System Development

Cooling Technology Update

Direct Spray Cooling Widens Choices in Harsh Airborne Environments

There are a myriad of advantages to using non-rugged boards in harsh environment military applications. The direct spray enclosure approach helps marry those diverse worlds.

Andy Finch, Product Manager
SprayCool

There's no doubt that demand is on the rise for ever more computing density. Military platforms such as radar and image processing, electronic warfare, signal processing, command and control, and mission processing are looking to multicore, multiprocessor architectures to meet such needs. But they bring with them integration challenges when those increased performance requirements drive higher heat loads inside pressurized compartments and ultimately force electronics out of the conditioned space. UAVs, for example, which are predominately unpressurized, challenge integrators to either ruggedize all the electronics or to isolate the more sensitive electronics from environmental extremes.

Exemplifying the compute density need, most Intelligence Surveillance and Reconnaissance (ISR) applications today relay critical information from the sensor on an airborne platform to the ground for compilation. They instead want to reduce dependence on those limited air-to-ground data link rates and do more processing in the air. That's driving system integrators to provide more performance with a smaller Size, Weight and Power (SWaP) budget, and boosting the challenge of cooling such systems.

Figure 1

When upgrading for improved sensor capabilities, developers of UAV platforms such as the MQ-1 Predator MQ-9 Reaper wanted to leverage existing air-cooled board sets, but the Predator has no air-conditioned space on board. Direct spray enclosure technology proved an ideal a solution to that problem.

A Variety of Board Cooling Choices

The spectrum of available embedded processing boards spans the gamut. For an ISR payload, typically what's required is some blend of off-the-shelf FPGA and DSP boards combined with custom or proprietary boards. Often the custom electronics were designed and qualified for conditioned environments. Meanwhile, off-the-shelf boards that target niche functions have either an air-cooled or conduction-cooled variant, but not always both. As a result, going with either an air-cooled or a conduction-cooled enclosure fails to accommodate the inevitable mix of cards. What's needed is a way to make less rugged electronics possible to use on unconditioned platforms. That entails a new approach to environmental isolation.

Deploying commercial-grade electronics in harsh environments brings a lot of advantages for military system integrators. These include reduced lifecycle costs, access to and faster sourcing of readily available technologies, and the

reliability that comes with high volume production. The difficult trick is to realize those benefits in harsh environment military applications.

Integrators resist deploying commercial-grade electronics in many military applications because they're not suited for severe environmental requirements such as temperature extremes, high altitude, vibration, shock, humidity, dust/sand, contamination and EMI. The problem can be addressed by using sealed, air-conditioned or pressurized compartments. The infrastructure required for that entails SWaP penalties at the platform level.

Platform Examples

There are a number of platform examples that were unable to provide sufficient conditioned space when it was time to upgrade their SIGINT payloads. These include both the U-2 Dragon Lady (ASIP program – Air Force Signals Intelligence Payload) and RQ-4 Global Hawk UAV. In both cases, alternative cooling solutions were needed to accommodate the upgrades. In contrast, other UAV platforms such as the MQ-1 Predator (Figure 1) and MQ-9 Reaper don't have any conditioned space, yet they had similar requirements for improved sensor capabilities and their designers likewise wished to leverage existing air-cooled board sets.

In another example along such lines, the UH-60 Blackhawk (Figure 2) recently had to place its Helicopter Autonomous Landing System (HALS)—consisting of commercial-grade cards—on the outside nose of the aircraft so the radar processing could be co-located with the sensors. The recently awarded spiral development of the Broad Area Maritime Surveillance (BAMS) aircraft includes requirements for an Electronic Support Measures (ESM) payload. That payload will likely employ sensitive RF cards coupled with processing boards that do not have readily available rugged off-the-shelf equivalents. With that in mind, it's helpful to use an enclosure with the flexibility to accept air-cooled and conduction-cooled electronics while at the same time providing isolation from extreme military environments.

Figure 2

A recent upgrade to the UH-60 Blackhawk called for placing its Helicopter Autonomous Landing System (HALS)—consisting of commercial-grade cards—on the outside nose of the aircraft so the radar processing could be co-located with the sensors.

Direct spray enclosures (Figure 3) are one way to attack the challenge of mixing all those types of boards. Direct spray enclosures provide a card cage for VME, CompactPCI, VXS, VPX or CompactPCI-Express boards and backplanes compatible with the IEEE 1101.1 Mechanical Core specifications. Although conduction-cooled boards in those form factors adhere to IEEE 1101.2, the boards mechanically fit in air-cooled card cages. The primary difference in geometry between the two specifications is the method of cooling that dictates specific hardware such as wedge locks.

With fluid as the heat transfer medium, direct spray card cages provide cooling independent of conduction hardware or standard air flow rates typically prescribed. Like conduction-cooled enclosures, direct spray enclosures protect card cages from EMI, dust, water, humidity, salt fog, and so on. The process for integrating boards into a direct spray enclosure involves thermal analysis, fluid compatibility and vibration analysis.

With few exceptions, boards are cooled from the card edges with atomizers directing dielectric fluid to heat-generating components. Typical heat transfer coefficients using perfluorocarbon fluids range from 0.1 to 2 W/cm^2 °C depending on board layout, component proximity to card edge and angle of spray relative to component surface. At the card level, per-slot cooling has been proven up to 500W on multiprocessor, multicore boards. The heat transfer rates of the fluid are not only effective for cooling but also for heating the cards at low ambient temperatures. In this way, sensitive boards can be isolated from environmental extremes.

Heat sinks for OEM air-cooled or conduction-cooled boards are designed to address thermal requirements of the card for its intended environment. Whenever possible, direct spray systems make use of the existing heat sinks. There are a number of common Thermal Interface Materials (TIM) used between heat sinks and high heat flux components that are fluid compatible. Because direct spray enclosures provide very efficient cooling system, designers have the option to use lower profile Integrated Heat Sinks (IHS). Such heat sinks enable a narrower board

pitch. In some cases, military system designers may decide to remove heat sinks altogether for weight savings or to help meet vibration requirements.

Mezzanine cards on carriers—common in VME/VPX/VXS and cPCI systems—present their own unique cooling challenges. Narrow gaps between baseboard and peripheral cards can reduce airflow and create challenges for conduction systems. By using direct spray enclosure systems, those same narrow gaps enable proper cooling by providing necessary geometries for thin film boiling. Even very small apertures such as 0.01 inches can enable capillary action generating very good heat transfer coefficients.

Fluid Compatibility

It's important to keep in mind that the cooling fluid isn't compatible with everything. Perfluorocarbon fluids such as 3M's Fluorinert have been used in the military for over 25 years for radar cooling on airborne platforms such as E-2C Hawkeye and E-3 Sentry (also known as AWACS). By definition, direct spray enclosures involve "direct/wet" fluid contact with electronics. In this instance, compatibility between the fluid and board components is particularly important. In general, anything that is gel-like, sticky, stinky, gooey, greasy, or pasty will not be compatible with fluids and can degrade cooling performance. RTV (Room Temperature Vulcanizing) adhesive is a good example of a material that should be avoided where possible. Other incompatibilities can be filtered without affecting the electronics or cooling system.

Conformal coating is common on embedded military electronics. Because direct spray enclosures are sealed environments, such coating is not required during operation. Often customers desire coatings for shipping, handling and storage irrespective of operational use cases. Fortunately, conformal coatings are compatible in varying degrees with cooling fluids and are generally acceptable for use with direct spray systems. Coatings do create a small thermal resistance between fluid and components but do not present an insurmountable cooling problem.

Vibration Profile for U-2 Dragon Lady

Operating Spectrum	
Frequency	Power Spectral Density
(Hz)	(G2/Hz)
10	0.004
29	0.004
40	0.004
57.5	0.004
61	0.004
500	0.004
800	0.00156
2000	0.00025

Table 1

A direct spray enclosure was held for two hours at high temperature while the enclosure was exposed to the U-2 vibration profile shown here for one hour per axis. Board functionality was monitored during the test.

Label materials vary between boards manufactures. Paper labels will degrade with exposure to fluid over time. More robust materials such as polyemide or vinyl withstand direct spray much better and are becoming more common on today's boards. When conformal coatings are applied, label material becomes irrelevant.

Vibration Issues

Military vehicles are notorious for high vibration. Ground-based vehicle profiles commonly range from 10 Hz to 500 Hz while airborne platforms often see vibration up to 2000 Hz. On any given vehicle, vibration profiles for every individual vehicle and every mounting location can differ greatly. The survivability of off-the-shelf commercial-grade electronics under vibration and shock depends on the profile and the card. To mitigate those issues, designers of rugged boards typically stiffen electronics to avoid the natural frequencies that coincide with low-frequency, high-amplitude inputs.

For sensitive electronics in direct spray enclosures, military system designers often opt to reduce the size of heat sinks or remove the heat sinks altogether. The natural frequency of a given board is proportional to the ratio of its stiffness to its mass. By removing a heat sink spanning an entire conduction board, the stiffness is less, but at the same time the mass is also reduced. The result is little or no impact on natural frequency. For heat sinks that do not span the length of the board found on air-cooled boards, the net effect can be a higher natural vibration frequency. If additional stiffness is required for commercial cards, stiffeners can be added often without board redesign.

Small surface mount components do very well under vibration while large through-hole components can create problems. For through-hole items like electrolytic capacitors, perpendicular-mounted memory modules or large pin-socket mated components, staking can be used to support the component on the board. As performance density of embedded computing increases, the trend toward stacked memory, integrated circuits, and tantalum and ceramic capacitors certainly helps commercial-grade electronics migrate into harsh environments.

A Board Test Example

Recently a board set from SKY Computers was integrated in a direct spray enclosure provided by SprayCool to illustrate the process of taking commercial-grade cards into extreme ambient conditions. The card set consisted of two FPGA boards and a single board computer. Based on the thermal analysis, the air-cooled heat sinks provided by the card manufactures were deemed sufficient for all testing. The fluid compatibility assessment identified thermal grease on the Themis SBC processor heat sink that was not an ideal material, but was used with adequate system-level filtration capacity. No other components or materials were identified for incompatibility.

Preparation on each card for vibration testing included Loctite and lock washers to ensure fasteners retained proper torque values. Board modifications consisted of staking several electrolytic capacitors to the baseboard of the SBC for reinforcement. The FPGA cards had heat sinks on the PowerPC processors held on by tape. The heat sinks were also staked to the baseboard. No other modifications were

Figure 3

Direct spray enclosures provide a card cage for standard boards and backplanes compatible with the IEEE 1101.1/1101.2 specifications. With fluid as the heat transfer medium, direct spray card cages provide cooling independent of conduction hardware or standard air flow rates.

made to test the commercial-grade cards exposed to vibration. With so few alterations to the electronics, integration and testing began just one week after identification of the board set.

Options on Airborne Platforms

On airborne platforms, the cooling fluid has many options for heat rejection. Among these include Ram air, ambient air, Ethylene Glycol and Water (EGW), fuel, aircraft skin, hull and PAO. In the SKY Computers example, the heat exchanger would be sized based on the board set, ambient conditions and ultimate heat sink. For the purposes of this test, a heat exchanger was located outside the chamber and was used to reject heat from the enclosure as the fluid was taken to a common high operational temperature of 70°C.

The enclosure was held for two hours at this high temperature while SKY successfully ran a high-performance application on both boards. The boards were monitored for continuous operation to ensure full functionality. The enclosure was exposed to the U-2 vibration profile shown in Table 1 for one hour per axis. Again, board functionality was monitored. The heat exchanger and hard drive were located adjacent to the vibration table to support operational tests.

The process of employing commercial-grade electronics in harsh environments isolated by direct spray enclosures has been successfully repeated on mobile military vehicles for the past decade. In SKY's case, they concluded that their particular board set comprised of commercial-grade electronics was able to fully operate at extreme temperatures and under vibration. As trends for enhanced processing on airborne platforms continue, alternative methods of environmental isolation for sensitive electronics will include direct spray enclosures. ■■

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System Development

Cooling Technology Update

Thermal Challenges Throw Curves onto the Path of Faster Processing

Getting that right mix of ruggedness and thermal performance isn't getting any easier these days as military programs push for ever greater levels of compute density. Clever board-level heatsinking is one way to help enable that mix.

Joe Eicher, Executive Director of VME Products
Kontron

Modern military applications continue to push the performance envelope while still demanding the lowest possible power dissipation. At the same time, the embedded computers in those systems must withstand severe shock and vibration elements in these harsh environments. Complicating matters further is the growing need for mobility in the military environment and the resulting push to reduce "Size, Weight and Power" (SWaP) to ensure reliable portability. That eliminates the option to increase the footprint to make room for more power or more performance. And all those challenges are now often under ever more severe time-to-deployment and budgetary constraints.

An example along those lines are the Signal Aperture Radar (SAR) systems aboard the Rafale fighter jet (Figure 1). Radar upgrades have an endless appetite for more powerful processing nodes and efficient data interfaces to sustain both the high throughput data flows delivered by the sensors and computing nodes. In airborne applications the constraints of minimum weight, high temperature of operation, as well as immunity to shocks and vibrations add to the challenge.

Figure 1

An example program wrestling with the need for compute performance and requirements of a rugged airborne platform is the Signal Aperture Radar (SAR) system aboard the Rafale fighter jet.

However, no matter how efficient the design, there are always additional design trade-offs that need to be considered. Addressing these early in the design cycle will help ensure the fastest time to market and the lowest possible investment. On a positive note, there are now technologies available to help maximize and control

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Balancing Ruggedness and Performance

Rugged military applications require advanced computing platforms capable of operating at extremes levels of thermal load, vibration, shock and other stresses. Often, these applications must be developed using commercial-grade platforms, until the rugged "equivalent" becomes available. This can force a trade-off between designs based on a lower performance product where rugged equivalents are available, and those based on the highest performer available on the market, with the anticipation that subsequent modifications will provide the needed hardening. Since the rugged product version is slightly different from the commercial-grade version, software compatibility issues can increase the complexity of the integration and qualification. Meanwhile, support for system software (OS, firmware, middleware) on rugged versions is more difficult since suppliers tend to deploy the rugged versions less frequently than commercial-grade versions.

Historically there have been a number of ruggedization methods to make computing boards and their components more resistant to shock and vibration in harsh environments. One common method is to alter the board's characteristics at the time of manufacture. These products are usually derived from a commercial design by screening the parts used in manufacturing, or by developing a re-layout of the original product for higher levels of ruggedness. Another way is to force air or liquid to cool the board (convection cooling) in order to support extended temperature ranges. In both cases, improvements in ruggedness incur higher costs, along with lower levels of performance and functionality.

An ideal solution would be a high-performance commercial design that could somehow offer the levels of ruggedness required for military use with little or no modifications. The reality is that most of the commercial components designed with the highest performance do not have a rugged or a MIL-grade equivalent.

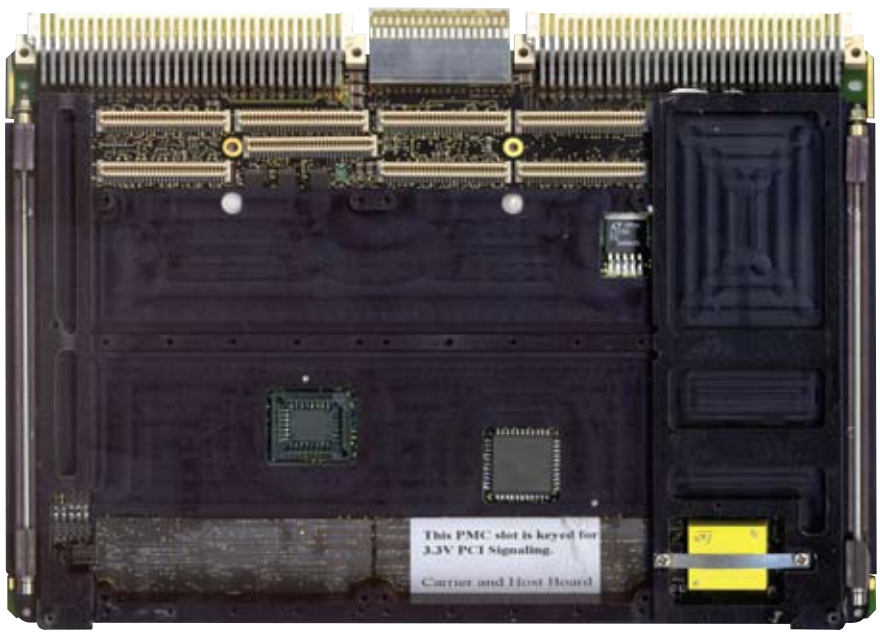


Figure 2

This ruggedized assembly fits into a standard 0.8-inch VME slot. This solution takes a standard commercial VME board and encloses it in a custom-sized milled aluminum plate that becomes the board-level heat sink. It is attached using existing mounting holes in the board, which enhances the mechanical properties of the final product.

Rugged Computing Considerations

Instead of starting from a strictly commercial-based design, most design teams would deem that the best alternative would be a rugged off-the-shelf product that would not compromise the original design. Although a number of newer embedded computing form factors have gained acceptance in the past decade, VME still holds a dominant position in established programs. In order to meet the needs of a large number of military programs, the specific objectives shown in Table 1 should be considered.

To be VME compliant, the ruggedized system must retain full compliance with VME specifications and retain its overall VME characteristics—especially with regard to occupying the same number of physical VME slots as a commercial-grade version. Having a commercial and industrial-grade product that needs little or no modifications allows designers to focus on their R&D efforts and allows systems integrators to deploy the most up-to-date technology with minimum design compromise or migration risk, and considerably reduces cost and time-to-deployment for the DoD program manager. In addition, an add-on or a removable kit for ruggedization enables developers to retain the full use of the base commercial-grade product. Plus, any add-on enhancement must be removable to ensure access for maintenance and repair.

Deployable System Cost Trade-Offs

To deploy the resulting rugged board in multiple programs, the ruggedized version must be manufacturable at low cost and high volume. This can only be achieved if standard manufacturing and support processes and practices are used. It is also important that the ruggediza-

tion technique must achieve substantial cost and schedule improvements over more traditional ruggedization methods. Lastly, the enhancement must extend the operational characteristics of the board, especially with regard to mechanical and thermal ranges of operation. Many rugged systems must also meet specifications for resistance to other environmental conditions such as to moisture, salt fog and so on.

An example solution satisfying the above considerations is the Kontron Ruggedizer (Figure 1), which is a specialized kit that can be added to standard commercial VME boards as an option at the end of the manufacturing process. The board's topside topology is captured in 3D in the CAD/CAM environment to fit with the components of the board. The resulting surface pattern is then reproduced, in negative form, as a milled aluminum plate that becomes the board-level heat sink. It is attached using existing mounting holes in the board, which enhances the mechanical properties of the final product. The technology can offer board-level products with three standard levels of ruggedization including Standard, Extended and convection-cooled Rugged. An additional fourth level of ruggedization is available through the individualized design of conduction-cooled Ruggedizer-equipped systems.

Thermal Management

Thermal management is at the top of design concerns for any rugged environment application. Although the general industry trend is toward air-convection-cooled systems, a number of military applications must still remain operational with limited cold airflow. In its standard convection-cooled version, the Kontron Ruggedizer adapts to all standard VME racks with no modification. The surface is optimized to provide maximum heat dissipation in the circulating air. In confined environments that prevent effective convection cooling, boards are cooled by conducting heat to a cold sink, typically the walls of the rack. However, because each conduction-cooled application has a specific set of space and other constraints related to confined environments, a more customized approach may be needed to adapt to the requirements of a specific application.

Computing Objectives for Harsh Environment VME-based Military Programs

√ Full compliance with VME specifications
√ Use of commercial and industrial-grade product with no (or very minor) modifications
√ Ruggedization capability as an add-on or removable kit
√ Compliance with standard commercial manufacturing practices
√ Enhanced resistance to harsh environments
√ Substantial cost and schedule improvements over more traditional ruggedization methods

Table 1

Listed here are the key objectives to be considered for meeting the embedded computing needs of a large number of VME-based military programs.

Depending on specific board characteristics, the gain in operational ambient temperature limits (compared with a non-ruggedized commercial-grade board) may be as much as 20°C (68°F). Since the board solution mentioned above also acts as a thermal equalizer, it lowers operating temperatures of the hottest points on the board by routing heat to cooler areas. In many cases, components that limit high-temperature operation of the board are not equipped with individual heat sinks in the original commercial-grade board design. As a consequence, the average temperature of the board, and all its components, is lower by 10° to 20°C (50° to 68°F), depending on the components. Since the components can now operate at a cooler temperature, the long-term reliability of the board increases significantly. On average, the benefit of a 10°C (50°F) reduction can increase the Mean Time Between Failure (MTBF) by 20% to 30%.

More Efficient Processors

At the processor level, power management can prove to be a vital tool to achieve optimized power performance. The power management for processors can be done over the whole processor, or in specific areas. With dynamic voltage scaling and dynamic frequency scaling, the CPU core voltage, clock rate, or both, can be altered to decrease power consumption at the price of slower performance.

For example, Intel SpeedStep technology is integrated into some of its processors to regulate processor voltage and core frequency, decreasing average power consumption and average heat. Enhanced SpeedStep technology allows the processor performance and power consumption levels to be modified while a system is functioning. This is accomplished via application software, which changes the bus-to-core frequency ratio and the processor core voltage. A variety of inputs such as system power source, processor thermal state, or operating system policy can be used to determine the proper operating state.

Technology advances in processors, buses and boards are all combining to provide designers of military and critical systems with cost reductions associated with shorter system development cycles, lower acquisition costs and higher performance in a smaller package. To further streamline rugged designs, cost-effective ruggedization via add-on options can now enable commercial-grade VME board products to be used in various harsh environments without compromising performance or reliability. ■■

Kontron America
Poway, CA.
(858) 677-0877.
[www.kontron.com].

Technology Focus

PXI, VXI and LXI Boards

PXI, VXI and LXI Boards Quench Military Instrumentation Needs

The rich ecosystems of PXI and VXI continue to serve military test and instrumentation needs. Meanwhile, the now entrenched LXI and PXI Express form factors offer a path to faster bandwidth.

Jeff Child,
Editor-in-Chief

Long gone are the days when it made sense to develop military and aerospace test systems from scratch. Today, such gear can be pieced together using standards-based instrumentation and embedded computer systems. Feeding such needs, two form factors have evolved—PXI and VXI—and each with its own entrenched ecosystem of board products and options. And more recently the LAN/Ethernet instrumentation architecture known as LXI (LAN eXtensions for Instrumentation) as entered the game too.

PXI (PCI eXtensions for Instrumentation), an open specification from the PXI Systems Alliance, defines a rugged, CompactPCI-based platform optimized for test, measurement and control. PXI products are compatible with the CompactPCI form factor and bus architecture. Currently, more than 56 companies worldwide are members of the PXI Systems Alliance, and more than 1,150 PXI products are available. In 2005 the PXI Express spec integrated PCI Express on CompactPCI technology into the PXI standard. PXI Express provides bandwidths up to 6 Gbytes/s per system while preserving compatibility with existing PXI products.

An example PXI application is the Airborne Data Acquisition and Recording System (ADARS) developed by the Royal Australian Airforce Aircraft Research and Development Unit (ARDU). ARDU engineers designed and developed using PXI boards and LabVIEW software to assist in flight test and data gathering exercises for the Australian Army's Black Hawk helicopters (Figure 1). The system was comprised of a Pentium class PXI-8156B controller and several data acquisition modules. The modular nature of PXI provided for the inclusion of a faster processor or alternative modules for future flight testing with specialized requirements.

PXI's older cousin, the VXIbus, was developed by enhancing the VME bus standard to better accommodate instruments. VXI extends VME by adding additional power supply voltages, analog and triggering buses. It also features complete power, cooling and EMC specification requirements for modules, and adds C and D-Size module sizes for larger circuit layout area. VXI also adds the twist of being able to accept PXI, VME and M-Module cards.

LXI, established now as the natural follow-on to PXI and VXI, is an instrumentation platform based on industry standard Ethernet technology. In particular, military designers are hungry for synthetic instruments that feature state-of-the-art microwave performance.

Figure 1

PXI boards were used to craft the Airborne Data Acquisition and Recording System (ADARS) developed to assist in flight test and data gathering exercises for the Australian Army's Black Hawk helicopters.

PXI and VXI implementations simply don't have the board space to create high-performance instruments, forcing integrators to use both card-cage and stand-alone architectures in their systems.

Introduced in 2005, the LXI Standard has been rapidly adopted by 46 companies, representing a who's who of the test-and-measurement industry. They recognize LXI as the natural successor to GPIB, and that it was time for instruments to go beyond GPIB to make it easier for test system designers and integrators to create faster, more efficient systems. To date, over 430 products have been certified as being compliant with the LXI Specification. Last fall the LXI Consortium approved the newest version of the Standard (Version 1.2). ▮▮

LXI Consortium
[www.lxistandard.org].

PXI Systems Alliance
[www.pxisa.org].

VXIbus Consortium
[www.vxibus.org].

Technology Focus:

PXI, VXI and LXI Boards Roundup

3U PXI Controllers Serve as Hybrid Testing System

The era of multifunction boards is upon us, and it's moved into the military test realm too. PXI, LXI, GPIB, USB and Serial instruments can now be controlled with the same controller hardware. With exactly that in mind, ADLINK Technology offers two 3U PXI controllers: the PXI-3920 (Pentium M 760) and PXI-3910 (Celeron M 760). Both the PXI-3920/3910 are designed to be the core of a hybrid testing

system: able to control bench-top instruments through different interfaces—including LXI, GPIB, USB and serial—by integrating multiple I/O interfaces.

The PXI-3920/3910 is the first 3U PXI controller to incorporate dual Gbit Ethernet ports. This feature allows the use of one port for LAN connectivity while the other port provides determinative bandwidth and latency for the connection with LXI instruments. The PXI-3920/3910 also provides a GPIB port, four USB 2.0 ports, and two serial ports for controlling instruments using these interfaces. The PXI-3920/3910 is designed to maximize stability and durability. The cable-free mechanical construction and onboard soldered CPU and memory chips, in conjunction with a solid-state disk drive, both enable the PXI-3920/3910 cards to withstand vibrations up to 6 Grms during operation and allow it to be used in harsh environments such as in vehicle and avionic applications.

ADLINK
Irvine, CA.
(949) 727-2077.
[www.adlinktech.com].

1U Power Meter is LXI-Compliant

LXI fits snuggly with the military's leaning toward networking and Ethernet connectivity. Agilent Technologies provides the first LXI-compliant power meter. This slim, compact power meter is just 1U high and supports LAN-based automated measurements of peak, peak-to-average ratio and average power. Its small size and ability to operate without shared power supplies, cardcages or system controllers enables a lower startup cost for an automated test system.

The Agilent N8262A P-Series is designed for seamless operation with widely used standards like Ethernet, Web browsers and IVI drivers, and integrates easily to work with existing test assets. With the convenience of LAN, users can perform remote access and control via a Web browser and bundled soft front panel GUI—virtually anytime, anywhere. The Agilent N8262A P-Series modular power meter is LXI Class C-compliant. It has a high sampling rate of 100 Msamples/s for fast, accurate and

repeatable power measurements. Besides power measurements, the N8262A also performs time and CCDF statistical measurements. The Agilent N8262A is code-compatible with the Agilent P-Series power meters, and backward compatible with the P-Series, E-Series (except E9320) and 8480 Series power sensors. The Agilent N8262A is priced at $11,474.

Agilent Technologies
Palo Alto, CA.
(650) 752-5000.
[www.agilent.com].

PXI Storage Unit Supports JBOD, RAID and SATA

Many aerospace and defense system developers need to capture and store vast amounts of data for high-speed data acquisition, digital signal processing, radar and sonar, telemetry and high-resolution video

recording. Conduant offers the Big River DM-425-3U Storage Unit—a compact subsystem that plugs directly into a PXI or CompactPCI chassis and provides up to one terabyte of disk storage capacity, in a very small enclosure. Configurations are available for both legacy PXI and CompactPCI as well as the new PCI Express-based versions. With the DM-425-3U, a broad range of high-speed storage applications may be designed around a standard PXI/CPCI chassis.

When ordered with the onboard PCI Express SATA controller, the DM-425-3U integrates with major operating systems to provide additional storage capacity in JBOD or software RAID configurations. When ordered with the external multilane SATA connector, the DM-425-3U can be used with the Conduant StreamStor PXI-808 Disk Controller Card for high-speed recording without requiring an external chassis to hold the disk drives. The DM-425-3U is designed for use in a PXI / CPCI 3U chassis with variations available for both PCI Express and legacy PCI-based architectures. The storage unit is also available with solid-state disk drives in capacities up to 512 Gbytes. Base pricing for the Big River DM-425-3U starts at $1,380.

Conduant
Longmont, CO.
(303) 485-2721.
[www.conduant.com].

3U and 6U PXI Chassis Feature Easy Interface Scheme

Complex military test systems are often plagued by an unwieldy nest of wiring and cables. Helping ease that burden, Geotest, a Marvin Group Company, added the GX7002A-MP and GX7302-MP products to its family of 3U and 6U chassis. The two chassis incorporate the MAC Panel SCOUT receivers, which offer a reliable and high-performance method to connect test system resources to a mass interconnect receiver, minimizing the need for cable assemblies. Because the MAC Panel is a PCB assembly it is more cost-effective, easier to maintain, and above all, more reliable.

The GX73x2-MP incorporates a 20-slot 3U PXI chassis that can accommodate up to 19 instruments as well as an embedded PXI controller or a PXI bus expander interface such as the GX7990 or MXI-4. The GX70x2A-MP incorporates a 20-slot 6U PXI chassis that can accommodate up to 19 instruments as well as a PXI controller or a PXI bus expander interface such as the GX7990 or MXI-4. Like all of Geotest's chassis, the GX7302-MP and

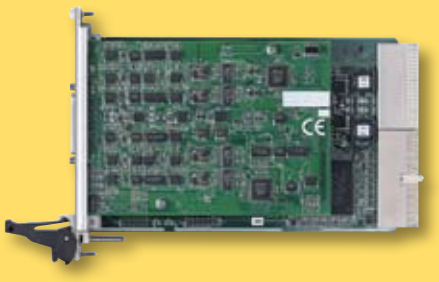
GX7002A-MP provide Smart features, which support the monitoring of slot temperatures and system power supply voltages as well provide the ability to program or map each PXI trigger line from one PCI segment to another.

Geotest-Marvin Test Systems
Irvine, CA.
(949) 263-2222.
[www.geotestinc.com].

PXI Boards Marry Analog I/O, Waveform Generation

What used to require a large rack-sized test instrumentation system is now possible on a single board. Exemplifying that trend, KineticSystems' P216/210/206/205 cards are simultaneous sampling multi-function PXI modules that provide four differential analog input channels, 14/16-bit A/D resolution, and up to 2 MS/s simultaneous sampling. They also provide two analog output channels with waveform generation capabilities to meet a wide range of application requirements.

By taking advantage of other KineticSystems



innovations such as its recently announced SoftView Soft Front Panel Application, users have a simple yet powerful tool that integrates KineticSystems' entire line of PXI/CompactPCI instruments into a single software package. Customers can quickly and easily construct fully integrated multi-instrument systems without any programming. KineticSystems PXI/CompactPCI product line consists of simultaneous data acquisition boards, multifunction analog I/O boards, digital I/O modules, PXI/cPCI chassis, counters and pulse output modules, multiplexers and high-speed digitizers. The P216/210/206/205 cards are available to order immediately and pricing starts at $1,495 or less than $375 per channel.

KineticSystems
Lockport, IL
(815) 838-0005.
[www.kscorp.com].

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Synchro/Resolver VXI Card Provides up to 0.005° Accuracy

VXI remains the proven choice for VME-compatible instrumentation work. Supporting that area, North Atlantic Industries (NAI) offers a high-density, DSP-based, single-slot VXI card whose modular design provides up to four synchro/resolver instrument-grade measurement channels and up to four synchro/resolver instrument-grade stimulus channels; or up to eight synchro/resolver embedded-grade stimulus channels; and up to six programmable reference supplies. The 65CS4 C-size VXI card performs most synchro/resolver evaluation, calibration and test functions. All functions are independent and user-programmable for either synchro or resolver format and can be formatted for

single- or multi-speed applications. Synchro/resolver measurement and instrument stimulus accuracy is to within 0.005°. Converter-grade stimulus accuracy is 0.015° loaded and 0.008° without load. Instrument stimulus and reference outputs provide 2.2 VA of drive and are programmable from 47 Hz to 4,000 Hz.

The 65CS4's stimulus channels can be programmed for continuous rotation up to 13.6 RPS or for specific start and stop angles. Measurement channels can track signals up to 4.68 RPS and provide both digital and DC angle-rate output signals. Operating temperature range is 0° to +50°C. The card provides a VXI data rate of 2 Mbytes/s, dynamic address configuration and 100 microsecond data processing. Power supply requirement is +5 VDC at 8A (no load). Pricing for 100 starts at $10,000.

North Atlantic Industries
Bohemia, NY.
(631) 567-1100.
[www.naii.com].

Scope Family Available in PXI and VXI Form Factors

Gone are the days when a slot card oscilloscope was a mere convenient but watered down version of a traditional bench top oscilloscope. ZTEC Instruments has closed that gap with its ZT4210 series of 300 MHz oscilloscopes in PXI, PCI and VXI form factors. These oscilloscopes provide the same powerful triggering, acquisition, math and analysis functions that are commonly found in today's bench top instruments and in ZTEC's

other M-Class oscilloscopes. In fact, the ZT4210 series is designed to replace bench top oscilloscopes in many ATE, aerospace, defense and portable test applications.

These powerful modular oscilloscopes are available with two channels (ZT4211 PXI, PCI and VXI) and with four channels (ZT4212 VXI only). Key specifications include 300 MHz analog bandwidth, up to 1 Gsample/s real-time sampling, and up to 256 Msamples record length. With its onboard processing, the ZT4210 series calculates over 40 waveform parameters related to a waveform's voltage, time and frequency characteristics. The ZT4210 accepts a wide range of voltage levels, handling up to +/- 300 V CAT II direct inputs. With input ranges from 1.25 mV/div to 40 V/div (10 vertical divisions), the ZT4210 covers an extremely wide range of voltage levels without the need for external signal conditioning. This is important in automated and remote test applications where it is difficult or impossible to quickly add/remove external conditioning. Prices for the ZT4210 series start at $4,450.

ZTEC Instruments
Albuquerque, NM.
(505) 342-0132.
[www.ztec-inc.com].

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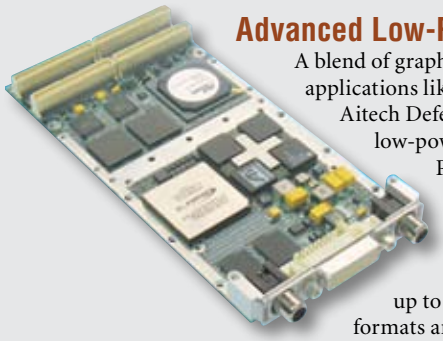


Advanced Low-Power PMC Supports Dual Graphics Heads

A blend of graphics and video performance is vital for advanced sensor fusion, image/frame capture and recording in applications like tactical, Red Force/Blue Force tracking and for avionics and tactical area moving map applications. Aitech Defense Systems offers a high-performance 3D graphics and imaging functionality available in a single, low-power PMC. Based on the ATI M9 graphics processor, the new M590 Multi-standard Graphics and Video PMC uses dual independent graphics heads to simultaneously output information from two separate data streams to two different monitors, whether analog or digital.

Designed for harsh environments, the PCI-X Rev. 1.0b and PCI Rev. 2.3-compliant M590 supports advanced 2D/3D video displays and image capture/frame grabbing with overlay and underlay for high-resolution man-machine interfaces with resolutions of up to 1536 x 2048 at 30 to 200 Hz refresh rates and up to 32 bits per pixel (Truecolor+). A host of channel-independent analog and digital video input and output formats are provided, including DVI, LVDS single/double link, progressive RGBHV/RGsB, RS-343 and composite/S-video supporting RS-170, NTSC and PAL, as well as internal or external sync. The M590 is available in commercial, rugged and military temperature ranges, and in either conduction-cooled or air-cooled versions. Pricing for an M590 starts at $3,440 in OEM quantities.

Aitech Defense Systems, Chatsworth, CA. (888) 248-3248. [www.rugged.com].

USB-to-Serial Adapters Is Software Configurable

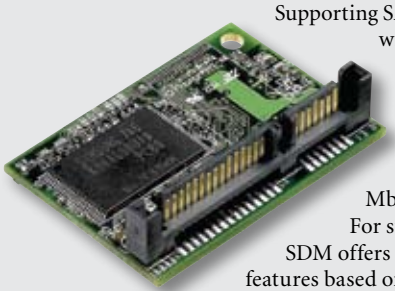
Embedded military applications are rapidly finding ways to use USB for functions once served by serial ports. Sealevel Systems announces two additions to the popular SeaLINK USB to serial product line, the SeaLINK.SC and SeaLINK+2.SC. Offering one or two serial ports that are software configurable for RS-232, RS-422, or RS-485, the adapters eliminate the need to open the enclosure to change jumper settings or dipswitches. The devices maintain their electrical interface settings locally, allowing the host computer to be repaired or upgraded without reconfiguring the serial ports.

The serial ports on each SeaLINK adapter appear as standard COM ports to the host computer enabling compatibility with legacy software. All Sealevel SeaLINK USB serial adapters use a state-machine architecture that greatly reduces the host computer's overhead when communicating over multiple serial ports simultaneously while supporting data rates to 921.6 Kbits/s. Status LEDs on the front of the enclosure indicate serial data activity, electrical interface and power. Standard operating temperature range for SeaLINK products is 0-70°C, and extended temperature range (-40° - +85°C) models are available. Both are available immediately from stock priced at $259 for the SeaLINK.SC (Item# 2123) and $309 for the SeaLINK+2.SC (Item# 2223).

Sealevel Systems, Liberty, SC. (864) 843-4343. [www.sealevel.com].

SATA Solid-State Drive Family Meets MIL-STD-810F

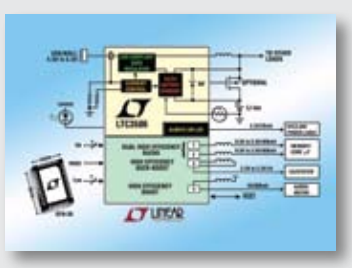
Flash-based solid-state drives are rapidly growing in capacity to where rotating disk solutions are now needed for only a shrinking niche of rugged military systems. Apacer Technology has introduced the SDM (SATA Disk Module) to meet an expanded range of SATA storage demand applications. The new SDM SSD (solid-state disk) series is available with a 7-pin or 22-pin connector that is oriented at 90 degrees or 180 degrees and is designed for a variety of housing configurations adopted in embedded computers.



Supporting SATA 1.5 Gbit/s and read and write speeds up to 35 Mbytes/s and 25 Mbytes/s respectively, the SDM offers outstanding reliability based on high-speed SLC (Single Level Cell) flash memory in capacities of 128 Mbytes to 4 Gbytes.

For strict rugged requirements, the SDM offers competitive and innovative features based on Apacer's advanced technology. Certified for MIL-STD-810F shock-resistance and anti-vibration, the SDM is suitable for harsh operating conditions in extended temperatures of -40° to 85°C, and includes industry-leading 8-bit ECC (Error Correcting Code) for high reliability. With less than 300 defective parts per million (DPPM), the SDM has undergone on-going reliability testing (ORT) to guarantee product dependability and longevity, with a mean time between failures (MTBF) of two million hours.

Apacer Memory America, Milpitas, CA. (408) 586-1291. [www.apacer.com].



Power Manager ICs Aim at Li-Ion/Polymer Battery Apps

Power management circuitry that used to require several components is now possible in one chip. That's a great benefit for space, weight and power constrained battery-power military gear. Linear Technology has announced the LTC3586, its most highly integrated PMIC in a family of multi-function, compact power management solutions for Li-Ion/Polymer battery applications. The LTC3586 integrates a switching PowerPath manager, a stand-alone battery charger, always-on LDO and four high-efficiency synchronous switching regulators: one buck-boost, one boost and two buck regulators, all in a compact, low-profile 4 mm x 6 mm QFN package.

The LTC3586's PowerPath control seamlessly manages power flow between multiple input sources such as a wall adapter or USB port and the Lithium battery while preferentially providing power to the system load. In addition, its "instant-ON" operation ensures system load power even with a dead battery. For fast charging, the LTC3586's switching input stage converts nearly all of the 2.5W available from the USB port to charging current, enabling up to 700 mA from a 500 mA limited USB supply or up to 1.5A when wall powered. The LTC3586 is available in a compact, low-profile (0.75 mm) 4 mm x 6 mm QFN-38 package. Pricing starts at $5.30 each for 1,000-piece quantities.

Linear Technology, Milpitas, CA. (408) 432-1900.[www.linear.com].

Slot-Card Disk Drive Offers New Media Options

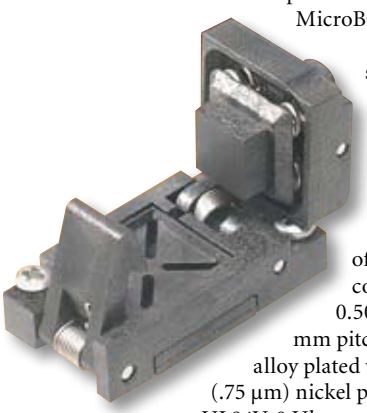
The rise in software-based functionality in military systems is driving demand for ever more programs and data storage. VMETRO has added new storage alternatives for its VMDRIVE. The VMDRIVE 6U VME/cPCI slot storage products now include rotating media options as well as several larger capacity solid-state storage options. The rotating media VMDRIVE offers 300 Gbytes or 450 Gbytes storage capacity. This dual-slot VME or cPCI alternative is available in commercial air-cooled models. The VMDRIVE rotating media version stores data at 100 Mbytes/s via dual channels of 2 Gbit/s Fibre Channel. For demanding applications that require solid-state storage, the VMDRIVE is available with dual channel 2 Gbit/s Fibre Channel interfaces using both high and low-density media.

The low-density VMDRIVE stores data at 60 Mbytes/s and is available with up to 256 Gbytes of storage capacity. The low-density models occupy a single VME or cPCI slot in air and conduction-cooled versions. High-density VMDRIVEs offer 146 Gbytes and 500 Gbytes storage capacity. Available as a dual-slot, air-cooled solution, the high-density solid-state stores data at 120 Mbytes/s.

VMETRO, Houston, TX. (281) 584-0728. [www.vmetro.com].

Test and Burn-In Socket Supports CSP/MicroBGA Devices

The squeeze on test and development costs has hit every industry and the military is not immune. The more you can combine more than one function in the same equipment the better. Aries Electronics has released its new CSP/MicroBGA test and burn-in socket that accommodates devices of up to 6.5 mm squared and is ideal for use with test and burn-in of CSP, MicroBGA, DSP, LGA, SRAM, DRAM and flash devices.



The socket offers solderless pressure mount compression spring probes, which can be accurately located by two molded plastic alignment pins and mounted with two stainless steel screws, which allow the sockets to be easily mounted to and removed from the burn-in-board (BIB). The socket accommodates up to 500,000 cycles and operates at a temperature of -55° to 150°C (-67° to 302°F). The sockets are comprised of spring probes with contact forces of 15g per contact on 0.30 mm to 0.35 mm pitches, 16g per contact on 0.40 mm to 0.45 mm pitches, 25g per contact on 0.50 mm to 0.75 mm pitches and 25g per contact on an 0.80 mm pitch or larger. Spring probes are heat-treated beryllium copper alloy plated with 30µ min. (.75µ) gold per Mil-G-45204 over 30µ min. (.75 µm) nickel per SAE-AMS-QQ-N-290. The socket's molded components are UL94V-0 Ultem and machined components are UL94V-0 PEEK or Torlon. All hardware is stainless steel. Pricing for a 100 lead socket starts at $200.

Aries Electronics, Bristol, PA. (215) 781-9956. [www.arieselec.com].

Digital Signal Conditioning System Is Network Centric

Programmable signal conditioning is vital in a broad range of testing applications including jet and rocket engine testing, vibration testing, acoustic chamber monitoring, wind tunnel testing and other challenging applications requiring high performance. GE Fanuc Intelligent Platforms has announced the DSC-2300 Series of high-performance signal conditioning systems. Developed to satisfy the growing customer requirement for powerful, modular signal conditioning solutions that are programmable and network-centric, the DSC-2300 is housed in a compact 3U, 16-slot rack-mountable chassis.

The DSC-2300 Series achieves its significant performance benefits through its ability to process the input from a wide range of sensors, supporting up to 32 sensor channels (2 channels per slot). Its high channel density keeps its cost per channel low, while its 3U form factor makes it compact and capable of being deployed in space-constrained environments. The DSC-2300 Series currently supports four plug-in signal conditioning modules that are fully configurable and programmable for gain, filter, cut-off frequencies and calibration. The DSC-2320 module is designed for static strain applications, and provides a two-channel voltage excitation bridge amplifier. The DSC-2325 module is used for dynamic strain applications, and features a two-channel current excitation bridge amplifier. The DSC-2330/31 module supports charge/ICP and voltage inputs.

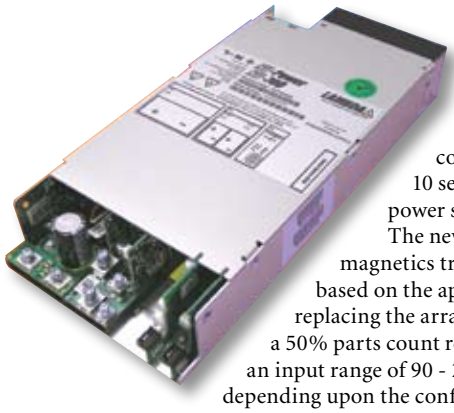
GE Fanuc Intelligent Platforms, Charlottesville, VA. (800) 368-2738. [www.gefanucembedded.com].

DC/DC Converters Provide Brown-Out Protection

Forward deployed military systems must wrestle with uncertain and unreliable power conditions. Serving that need, Calex has announced its Hold Up and Hold Up Light product offerings. The Hold Up modules are designed for use with Calex DC/DC Converters to protect against brown-out and temporary power loss conditions and provide a clean, uninterrupted source of power for downstream circuitry. The Hold Up model, part number HU-28, provides a complete turnkey solution for easy design integration. The Hold Up Light model, part number HUL-28, requires the use of an external capacitor bank in addition to the HUL module.

The HU-28 and HUL-28 have an input range of 15.5VDC to 36VDC. Both the HU-28 and HUL-28 offer user programmable hold-up trip voltage. Both modules have two modes of operation: "stand-by" and "tripped." During stand-by, the module charges the hold-up capacitors to 45V and maintains that voltage. When tripped, the module stops charging the hold-up capacitors and connects them to the Vout pins. The operating temperature range for both models is -40° to 100°C.

Calex, Concord, CA. (925) 687-4411. [www.calex.com].



Digital Power Supply Family Reduces Parts Count

Although power supplies are still primarily analog components, the addition of digital circuitry and interfaces offers significant benefits for military system designers—especially given the wide variation of power supply characteristics demanded across the military market. Lambda has introduced a new range of digitally controlled modules to its innovative NV-Power family of configurable AC-DC power supplies, enabling increased power output of up to 1450W peak rating for 10 seconds. The new modules enable Lambda to satisfy the increasing demand for low-profile configurable power solutions from 350W to above 1,000W.

The new digitally controlled modules incorporate many innovative design features including a new integrated magnetics transformer that allows for small size and increased efficiency. The digital control allows customizations based on the application's requirements. NV-Power employs an 8-bit microcontroller to handle housekeeping routines, replacing the array of comparators, op amps and other discrete components used in less integrated designs. This brings a 50% parts count reduction, which in turn allows 40% more board space for power components. All units operate with an input range of 90 - 264 VAC. The NV-Power series is available now with prices starting at $214 each in 100 piece quantities depending upon the configuration.

Lambda Americas, San Diego, CA. (619) 575-4400. [www.lambdapower.com].

Linux Board Support Package Rolls for Sidewinder SBC

Military system developers have found the Linux operating system a dependable choice to get started with. It lets them begin software development without committing to any one commercial embedded OS vendor. VersaLogic has announced the release of the DEV-CD-L5, a Linux quick-start Board Support Package (BSP) for their "Sidewinder," a VIA Eden-based single board computer. Using this BSP streamlines the hardware setup task by eliminating the need for Operating System (OS) configuration and driver installation. This allows embedded developers to create applications in a shorter time frame and reduce time-to-market.

The package is based on the popular Debian Linux 4.0 (etch/stable) product running Linux kernel 2.6.25-2. The bootable CD has been configured for easy installation and support of the Sidewinder's basic hardware features, including Ethernet, audio, video, USB and serial communications. Three stable images are provided to meet a range of functionality requirements. Additionally, an Advanced User Package (AUP) is available containing kernel sources, a customized config file, and driver patches for users who wish to run a Linux distribution other than Debian. The DEV-CD-L5 BSP is available immediately to qualified applicants for a nominal charge.

VersaLogic, Eugene, OR. (541) 485-8575. [www.VersaLogic.com].

Atom Processor Climbs Aboard Nano-ITX

Low-power systems and handheld mobile devices represents one of the most active areas of military design and development. Feeding those needs, American Portwell Technology has announced the NANO-8044. This is the first embedded board using the Nano-ITX form factor that is based on the Intel Atom processor Z510/Z530 and the Intel System Controller Hub US15W. At a mere 120 mm x 120 mm (4.72 x 4.72 inches), the compact NANO-8044 measures only 50 percent of the standard Mini-ITX. The NANO-8044 is specifically designed to operate at very low power consumption (less than 10 W at full loading) and low heat, so it can be a truly fanless configuration and battery operated.

It supports 1 Gbit Ethernet, audio, 6 USB and dual display by LVDS and SDVO connector. The NANO-8044 supports one 200-pin SO-DIMM memory slot for DDR2 SDRAM up to 1 Gbyte and comes with one IDE, one Type II CompactFlash socket, one SD card and one PCI-E expansion slot.

American Portwell Technology, Fremont, CA. (510) 403-3399. [www.portwell.com].

160 MHz FPGA-Based Digitizer Delivers 16-bit Resolution

Today's powerful FPGAs offer unprecented levels of embedded processing and serial transceiver capabilities. Defense system developers are applying them to all sorts of high-speed data acquisition and signal data recording applications. Satisfying those demands, Signatec has announced the PDA16 high-speed digitizer. Designed to meet demanding high-speed data acquisition, signal data recording and real-time FPGA processing applications, the PDA16 leverages the processing performance of Xilinx Virtex FPGAs with embedded PowerPC processors.

With 512 Mbytes of onboard memory configured as a large FIFO and a 64-bit PCI-X bus, Signatec's PDA16 can continuously sustain up to two channels recording at 160 Msamples/s per channel and transfer the digitized and/or processed data to PC disk storage at rates up to 640 Mbytes/s non-stop without any break in the analog record. The PDA16 comes with either a Virtex-4 FX20 (one immersed IBM PowerPC 405 processor) or an FX60 FPGA, (two immersed IBM PowerPC 405 processors). The PDA16 was designed to maximize the quality of captured signals in terms of signal-to-noise ratio (SNR) and spurious-free dynamic range (SFDR) over a very wide frequency range. Signatec's PDA16 is currently shipping.

Signatec, Newport Beach, CA. (949) 729-1084. [www.signatec.com].

PICMG 1.0 SBC Has Quad-Core CPU

Because of their long deployment cycles, military programs always gravitate toward the most advanced computing platforms possible because they'll inevitably get out-dated. Pushing the performance curve, ADLINK Technology has released the NuPRO-935A, a PICMG 1.0 full-size SBC powered by the next-generation Intel Core2 Quad/Duo processor on 45nm process.

Featuring a 1333 MHz front side bus and Intel Q35 Express chipset, the NuPRO-935A is specifically designed for high-performance computing. With processor speeds up to 3 GHz, the NuPRO-935A is designed to be a high-performance industrial computing solution. High-bandwidth dual-channel DDR2 800 MHz memory up to 4 Gbytes is supported, meeting high-speed data transfer requirements. The NuPRO-935A offers an ample range of I/O ports for data processing and storage. It provides up to five USB ports, two Serial ATA II storage ports, five USB 2.0 ports, two 10/100/1000 Mbit/s Ethernet ports, one RS-232 port, one RS-232/422/485 port and one parallel port. Other features include a PS/2 keyboard/mouse port, Watchdog timer and Hardware Monitor. Prices start in the mid $400s for the NuPRO 935A/LV and high $400s for the NuPRO 935A/DV in small quantities.

ADLINK, Irvine, CA. (949) 423-2354. [www.adlinktech.com].

3U VPX SBC Serves Up Dual-Core PowerPC

Designed with military needs in mind, VPX is the newest VITA embedded computing scheme. Curtiss-Wright Controls Embedded Computing has announced the VPX3-127, a new Power Architecture-based 3U VPX (VITA 46) SBC. The powerful, small form-factor VPX3-127 SBC is the latest addition to Curtiss-Wright's extensive family of rugged VPX SBC and DSP engines, and brings the high-bandwidth, serial switched fabric support and ESD protection benefits of the VPX board architecture to space and weight constrained 3U embedded applications.

The VPX3-127 is Curtiss-Wright's first 3U VPX SBC to feature Freescale's MPC864OD Power Architecture system-on-chip (SOC) platform processor. This high-performance dual core e600 Power Architecture processor operates at 1.0 GHz. The board offers up to 2 Gbytes of DDR2 memory with ECC at 500 MHz on dual memory controllers and 256 Mbytes of NOR flash and 1 Gbyte of NAND flash. The board supports one XMC/PMC site and two x4 lane fabrics offering either 2 x4 lane PCI Express ports, or a single x4 lane PCI Express port and a single x4 lane SRIO port. Two 10/100/1000 Ethernet ports, RS-232 and RS-422 Serial Channels, a USB 2.0 Host port and Discreet Digital I/O round out the board's I/O features. A VPX-REDI (VITA 48) version is available. Volume pricing for commercial and rugged versions of the VPX3-127 is available.

Curtiss-Wright Controls Embedded Computing, Leesburg, VA. (703) 779-7800. [www.cwcembedded.com].

Synchronous WAN Module Supports MicroTCA and ATCA

Advanced WAN-level communications gear plays a critical role in a variety of military systems. An intelligent synchronous four-port WAN, AdvancedMC module from Performance Technologies is designed for providing communications connectivity in a small form factor. The AMC335 can be easily integrated into MicroTCA offerings that include the company's 1U MicroTCA chassis, the MTC5070, and the highly integrated, ready-to-use Advanced Managed Platform, the AMP5070.

The AMC335 is a programmable communications subsystem that is capable of sustaining high data rates for a variety of protocols that are used in synchronous data communications. The architecture of the AMC335 capitalizes on the intelligence of the Freescale MPC8270 Quad Integrated Communications Controller (PowerQUICC II), which enables it to act as an optimized communications controller. The module is ideally suited for use in creating flexible and efficient radar gateways, radar recorders, protocol converters, serial gateways and front-end I/O elements as well as many other communications devices that require RS-232, RS-422 (RS-449/EIA530) and V.35 connectivity. The AMC335 is fully supported by NexusWare, the company's CGL 4.0 Registered Linux OS and development environment, as well as a complete set of installable WAN communications protocols.

Performance Technologies, Rochester, NY. (585) 256-0200. [www.pt.com].

Streamlined CANopen Configuration Tool Gets New Rev

CANopen, a communication protocol and device profile specification for embedded systems, is a power component in CAN-based military systems. The new version 1.6 of the IXXAT's CANopen ConfigurationStudio significantly simplifies the configuration of PDO messages within the "Visual Object Linker." PDO configuration is performed by simple drag & drop operations, so even users without an in-depth knowledge of fundamental CANopen mechanisms can operate the tool.

Further enhancements include a complete redesign of the CANopen Device Configuratior plug-in that enables the extensive configuration of CANopen Manager devices according to CiA 302. In addition, the configuration of node guarding and error behavior was simplified and a new front-end for LSS Master services was implemented. To access the CANopen bus an IXXAT CAN interface with VCI 3.1 driver installed is necessary. The CANopen ConfigurationStudio can be used on systems running Microsoft Windows 2000, Windows XP (32 and 64 bit) as well as Windows Vista (32 and 64 bit).

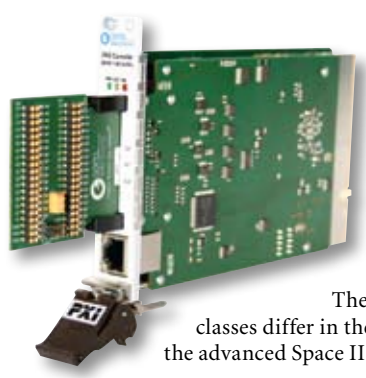
IXXAT, Bedford, NH. (603) 471-0800. [www.ixxat.com].

Mini-ITX Motherboard Targets Low-Power Apps

SWaP (Size, Weight and Power) has become the new watchword for many military apps like small UAVs, radio gear and unmanned ground vehicles. Feeding such needs, ITOX has introduced a Mini-ITX motherboard that uses the Mobile Intel 910GMLE Express chipset with Intel ICH6M I/O controller hub. The G5G100-L10C from ITOX comes equipped with a 1 GHz Intel Celeron M Ultra Low Voltage 373 processor with 512K cache, 400 MHz front-side bus, and integrated passive heatsink cooler. The low-cost G5G100-L10C embedded motherboard consumes less than 17W, making it suitable for applications with thermal or power restrictions.

The G5G100-L10C features one 184-pin DDR 333 SDRAM DIMM socket accepting memory modules with capacities up to 1 Gbyte. Additional features include one VGA port with integrated Intel GMA 900 graphics (2048 x 1536 at 75 Hz), two Serial ATA ports with speeds up to 1.5 Gbits/s, UltraDMA/100 IDE interface, eight USB 2.0/1.1 ports, four serial COM ports, and one Gigabit Ethernet controller/ Expansion is provided by one PCI slot, which accepts optional riser boards with 1, 2 or 3 slots for low-profile PCI cards. Pricing starts at $350 with OEM volume pricing available.

ITOX, East Brunswick, NJ. (732) 390-2815. [www.itox.com].



JTAG/Boundary Scan Platform Incorporates PXI Controllers

PXI holds a solid place in the mindshare of military test instrumentation developers. A new series of PXI-Bus-based controllers has been added for the Scanflex Boundary Scan hardware platform from Goepel Electronic. The new SFX/PXI1149/C4-FXT controllers incorporate the normally external Scanflex TAP transceivers into the 1 slot/3U unit, whereas the TAP interface cards (TIC) are linked externally. The TICs are active so complete signal conditioning is performed directly within the test fixture or environmental test chamber for HASS/HALT applications. Four different auto-identified TIC types are available to accommodate various applications. The differential signal interface ensures a secure transmission of the TAP signals, even through multiple interconnections and with over 4 meters of cable length, a TCK clock frequency of up to 80 MHz can be maintained.

The new controller series offers four truly parallel TAPs and is available in three performance classes A, B and C. The classes differ in their respective maximum TCK clock frequency of 20, 50 and 80 MHz as well as in the degree of implementation of the advanced Space II chipset for high-performance scan operations.

Goepel Electronic, Jena, Germany. +49 03641 6896-739. [www.goepel.com].

ATCA Blade Sports Quad-Core Processors

ATCA's acceptance in military applications has been mixed. But there's definitely a niche it's carving out, particularly in communications-centric defense programs. The ATCA-7350 processor blade from Emerson Network Power is a new ATCA blade that combines quad-core Intel Xeon processors with a wide range of memory options, plus redundant 10GbE support. The blade is based on two 2.13 GHz quad-core Intel Xeon processors and features a main memory capacity of up to 32 Gbytes. Dual hot-swappable and RAID-capable onboard disk drives can provide enterprise-class disk performance and storage capacity.

The PICMG 3.1-compliant fabric interface provides two 10 Gbit Ethernet interfaces for applications requiring higher network throughput in the backplane. Several rear transition module (RTM) configurations are available for external connectivity to suit application requirements, providing two or four optional 1 GbE interfaces, support for 10GbE, a USB 1.1 management interface and two optional 2 Gbit/s Fibre Channel interfaces. The ATCA-7350 will be available in the fourth quarter of 2008.

Emerson Network Power, Tempe, AZ. (800) 759-1107. [www.EmersonNetworkPower.com].

MPEG4 Codec Board Is Credit Card Sized

Small form factor boards are rapidly gaining in importance as the military looks for ways to add functionality like video to a variety of mobile platforms. Serving just such needs, the microMPEG4 from Advanced Micro Peripherals is a 4-channel MPEG4 Codec on a Mini PCI form factor that measures just 60 mm x 45 mm. This sub-credit-card-sized board is ideal for capturing and compressing up to 4 concurrent live analog video inputs to the MPEG4 standard. The microMPEG4 not only provides MPEG4 compression but can also decompress and play back recordings from storage to display.

Using the 32-bit PCI architecture, the microMPEG4 allows high-quality real-time video and audio capture and compression from 1, 2 or 4 concurrent PAL or NTSC video sources to disk while simultaneously providing an additional path for incoming video to be previewed on the host screen. Text overlay with time and date stamping is supported. The high-performance MPEG4 video data compression requires minimal CPU involvement. This plus the compact size, low heat dissipation and low power consumption makes the microMPEG4 ideal for space-constrained and deeply embedded video/audio recording applications. The microMPEG4 is supported by a suite of drivers for Windows-NT/2000/XP, Linux and QNX.

Advanced Micro Peripherals, Witchford, Cambridgeshire, UK. +44 1353 659 500. [www.ampltd.com].

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Low-Profile DC/DC Converters Boast High Efficiency

Distributed power architectures have become a fixture in military applications. Martek Power announced two new series of highly efficient DC/DC power converters, which are specially designed to address the application needs for data communication equipment, mobile battery-driven equipment and distributed power systems. The 200WFRs are fully isolated DC/DC converters in a low-profile SIP package. Measuring 0.86 x 0.36 x 0.44-inches, the 200WFRs feature a rated output power of 2W, precisely regulated single outputs of 3.3V, 5V and 12V and typical full-load efficiency up to 81 percent. Available in 5, 12, 24 and 48 VDC Inputs and 2:1 input range, the 200WFRs are priced at $8.70 per unit for volume orders.

The 200LFR series 2W single and dual power modules are designed to provide low output ripple and tight regulation in a low-profile 1.25 x 0.8 x 0.4-inch 24 pin DIP package. The series consists of 20 models with input voltages of 5V, 12V, 24V and 48V, and offers regulated output voltages of 3.3V, 5V, 12V, 15V, ±5V, ±12V and ±15V. The 200FRs are priced at $7.55 per unit for volume orders. All new models are available in RoHS-compliant versions.

Martek Power, Torrance, CA. (310) 202-8820. [www.martekpower.com].

Rugged Enclosure Family Features Lightweight Design

Enclosures rank high in the weight count of a system, and reducing weight ranks high in today's mobile and airborne military applications. With that in mind, the family of 12R1 enclosures from Elma Electronic is up to 20 percent lighter than the company's standard 12R2 line of rugged COTS chassis. The lighter units also help avionics and other applications meet weight constrictions. The system platforms are modular and come in various sizes and configurations. This includes 19" rackmount enclosures in 3U, 5U, 7U and 10U heights and 22 inches and 25 inches. The 12R1 line is also optionally Restriction of Hazardous Substances (RoHS) compliant. RoHS 5/6 versions are also available for military applications.

The 12R1 line has complete EMC shielding integrity with braided gasketing, honeycomb filtering and blind-riveting. The rugged chassis shell is made of aluminum frames and extruded profiles. Power supplies from 350W to over 1400W are available with both air-cooled and conduction-cooled options. The light 12R1 design withstands up to 15Gs of shock and vibration, while the heavy duty 12R2 version can handle up to 25Gs. Pricing for the 12R1 rugged chassis starts under $12,000 depending on size and configuration.

Elma Electronic, Fremont, CA. (510) 656-3400.[www.elma.com].

SBC Brings Low-Power Core 2 Duo to the VME

The multicore processor trend has hit the military embedded computing realm with the same force as it did the general computing market. A VME SBC, the TC2D64 from Themis Computer, is designed for a wide range of commercial and military applications in challenging environments—up to 30G shock 20ms. The TC2D64 is based on the low-power Intel Core 2 Duo processor clocked up to 2.16 GHz, and Intel's 7520 chipset used in high-performance Xeon servers.

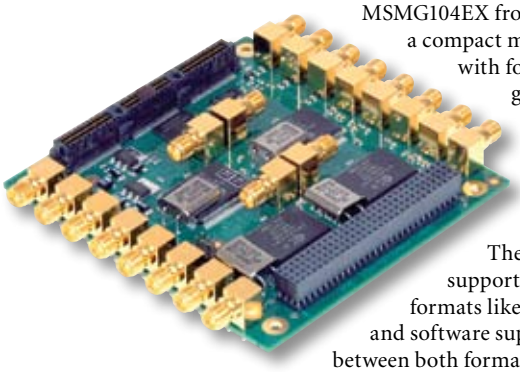
The Intel 7520 chipset includes an ECC memory controller to maintain the highest system integrity, and provides the bandwidth necessary to support high-performance I/O. TC2D64 memory is expandable to 4 Gbytes of DDRII-400 memory. TC2D64's memory modules feature a screw down design to withstand high shock and vibration.

The TC2D64 has extensive I/O including two Gbit Ethernet ports, a SATA port and two USB 2.0 ports. I/O expansion is provided by an onboard 64 bit/66 MHz PMC slot along with a PCI Express connector to a new, optional XMC expansion board with two XMC slots for either PMC modules or new PCI Express XMC modules, such as the latest cutting-edge graphics solutions.

Themis Computer, Fremont, CA. (510) 252-0870. [www.themis.com].

PC/104-Express Frame Grabber Boasts 16 Video Inputs

PC/104-Express marries the inherent compact size of PC/104 with the greater bandwidth of PCI Express. Digital-Logic's latest PC/104-Express offering is a video frame grabber that can connect up to 16 video cameras or one S-Video camera respectively. The MSMG104EX from Digital-Logic is a compact module equipped with four BT878 frame grabbers with 4-channel video multiplexer, a PCIe/PCI bridge and 16 TTL Inputs/Outputs. The frame grabber supports common image formats like PAL and NTSC, and software supports toggling between both formats. The bandwidth for PAL is 4x 25 frames/sec and for NTSC 4x 30 frames/sec. The maximum transfer rate is 133 Mbytes/s.



The video cameras are connected by SMA coaxial connectors, which guarantee a high mechanical robustness thanks to bolted connection. Standard pass-through connectors allow the board to be used either above or below other PC/104 modules. It is connected to the PCI Express bus via one lane. Included in delivery are drivers for Windows or Linux and optional demo software for display and storage of 16 video streams. The MSMG104EX has dimensions of 90 mm x 96 mm x 17 mm and a weight of 120 grams. It requires a 5V/3.3V power supply and operates within the standard temperature range of -25° to +50°C.

Digtal-Logic, Luterbach, Switzerland. +41 (0)32/ 681 58 40. [www.digitallogic.ch].

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Coming Next Month

- *Industry Analysts Plot Future of Electronics/Computers in the Military.* It looks likely that the overall DoD budget will shrink in coming months and years. But even as the political landscape changes, and forces within the government drive that budget down, the embedded computer component of the overall DoD budget is going to increase dramatically. In this special section, top analysts from Frost & Sullivan, Venture Development, Documental Solutions and *COTS Journal*'s own editorial staff will plot out the industry's future. This special technology and market analysis section will be something you'll save and use throughout the next 12 months to verify your system-architecture and business development choices.
- *Payloads for Small UAVs.* All branches of the DoD are investing heavily in UAV development and procurement. The Small UAV segment of that market faces unique challenges as system developers cope with size, weight and power trade-offs while attempting to cram more functionality and autonomy into Small UAV payload systems. Articles in this section examine the battery, small form factor SBC and radio technologies that are key to successful Small UAV development.
- *FPGAs and Configurable Computer Boards.* As the signal processing capabilites of FPGAs continue to climb, board-level configurable computing solutions have grown to become key enablers for waveform-intensive applications like sonar, radar, SIGINT and SDR. Such systems have an insatiable appetite for more digital signal processing muscle. This feature section delves into the solutions available in this area and explores how they're transforming military signal processing systems.
- *Data Acquisition Boards.* Driven by the twin trends toward higher sensor performance and the desire to tie more sensors together into wider arrays, makers of high-end data acquisition boards and subsystems are designing the latest A-D converters onto their board-level offerings. These board architectures are leveraging FPGAs as a means to efficiently channel digitized data. Articles in this section update readers on these trends and look at the latest crop of data acquisition boards in VME, VXS, cPCI, USB, PCI Express and PC/104 form factors.

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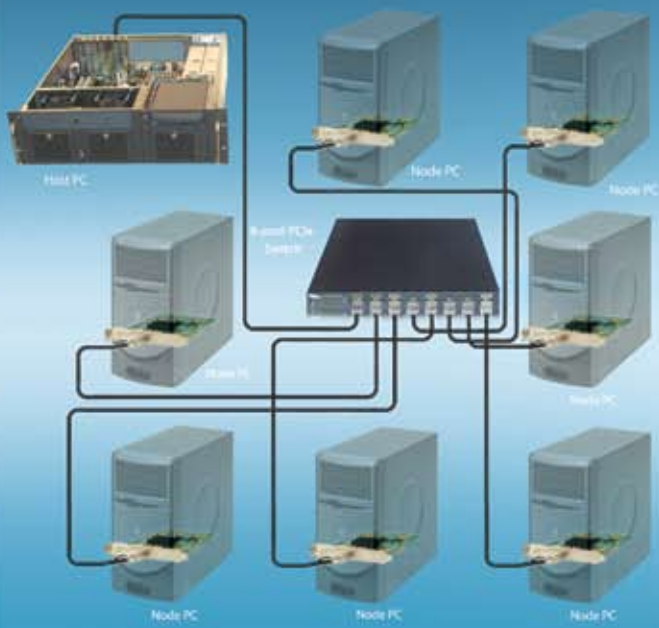

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COTS

Editorial

Jeff Child, Editor-in-Chief

As the summer winds down, thoughts about the "market" we cover are percolating to the top of my mind. For whatever reason, summer tends to be the time of year when I get the most invites to visit the offices of companies in our industry—particularly those in my corner of the country.

This year—perhaps more than ever—I'm finding that companies are starving for information about the market—the military electronics and embedded computing market—and where it's heading. And most are very eager to sit down with me and discuss the questions they're wrestling with about everything from embedded computing form factors to "macro" defense market and procurement trends. Questions like: Is this the year VPX will hit its

Trust, but Verify

stride? How are CompactPCI, VXS and COM Express positioned? Is MicroTCA destined for acceptance in the military? What effect will a change of Administration and budget changes have on the market? What impact will RoHS have? How will new reliability and security constraints dictate hardware and software designs?

Now, my crystal ball isn't without its cracks. But one of the great things about the job of an editor is that, after a string of meetings discussing the above questions with 10 different companies, I do indeed come away with a pretty good take on what the collective wisdom of our industry is on those topics. And by way, I don't care what anyone says about the merits of the Web, webcasts and videoconferencing. When you want to have a deep conversation with industry CEOs and CTOs about our market, there's no substitute for face-to-face—and for that matter, there's no substitute for meeting face-to-face on their home turf.

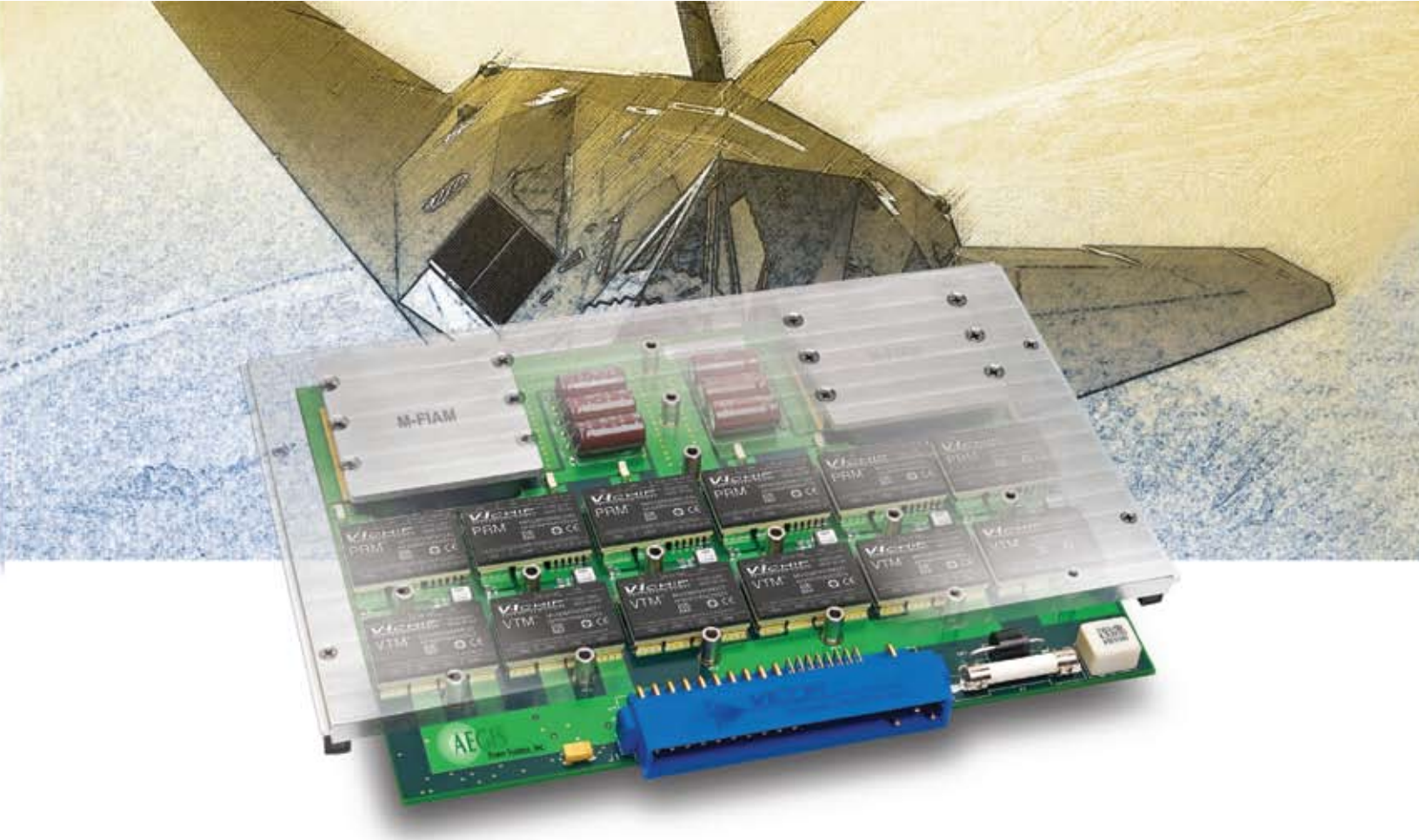
Perhaps one of the most compelling debates afoot these days is the question of MicroTCA's future as a trustworthy solution in defense applications. The architecture seems to boast the right mix of attributes defense applications need for integrating high-density systems with multicore processors and multi-compute nodes. Although designed originally for telecommunications, interest from other market segments inspired PICMG to extend its specifications to address harsher environment requirements—such as outdoor and industrial settings as well as vehicle mounting in trucks, trains and commercial aircraft. PICMG is doing that along two tracks. Scheduled for release this year, the ruggedized, air-cooled specification—MicroTCA.1—is up first. And then a second extension—expected a year or so from now—is the MicroTCA.2 conduction-cooled system.

MicroTCA employs AMC mezzanine cards as slot-cards. The broad and growing range of AMC and Processor AMC products also weighs in MicroTCA's favor. For me, a significant milestone along those lines happened this month with Data Device Corp.'s rollout of the first AMC product to sport military/avionics I/O. The card sports four MIL-STD-1553 channels, eight ARINC 429 receive channels and four ARINC 429 transmit channels.

Hardware/software security is another market topic that's been buzzing louder of late. I've been hearing rumors that prime contractors are starting to stress Trusted Computing technology in future military embedded computing designs. A couple years ago the Army began to mandate all Army computers to have a chip called the Trusted Platform Module (TPM) on their motherboards dedicated to performing security functions. The mandate was directed to desktops, laptops, servers and the like. That was followed up in July of last year with a DoD memorandum calling for "all new DoD enterprise computing assets to include a TPM version 1.2 or higher where such technology is available." But now there are signs that—within a few years—TPM may also become a requirement in embedded computers as well.

We'll share more of our analysis and predictions—about form factors, security and DoD budget shifts—in next month's issue of *COTS Journal*. For October we're putting together a special technology and market analysis section. The section will included insights and analysis from our friends at market research firms Frost & Sullivan, Venture Development and Documental Solutions, and from our own editorial staff. The section will exemplify, I think, what's so strong about magazines in general, and ours in particular. There's an overflowing mass of information about markets, the defense industry and technology. But magazines like ours play a unique role in shifting through the muck and presenting the information that's important, and including information from sources—like those analyst firms—that we've come to trust.

I remember at another publishing company I worked for years ago, I had a younger colleague come to me and ask me to help her make sense of a couple of market research reports she had from two different analysts. One she complained had numbers that didn't quite add up, while the other was meticulously annotated and precise in its numbers. I went over it with her and in the end advised her to put more trust in the first one. That's because I knew how that analyst had gathered his information. He went out and talked to the major movers and shakers in the industry. He didn't do what the other analyst had done, which was simply rely on "opinion surveys" for his forecast numbers. "His numbers don't always add up," I told her, "But his conclusions tend to be more correct than the other guy's." Hopefully the late President Reagan won't mind me borrowing his famous catchphrase and using it here, but when it comes to understanding the market "Trust, but verify" is what it's all about. ▮▮



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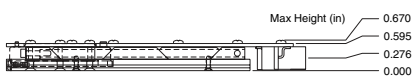

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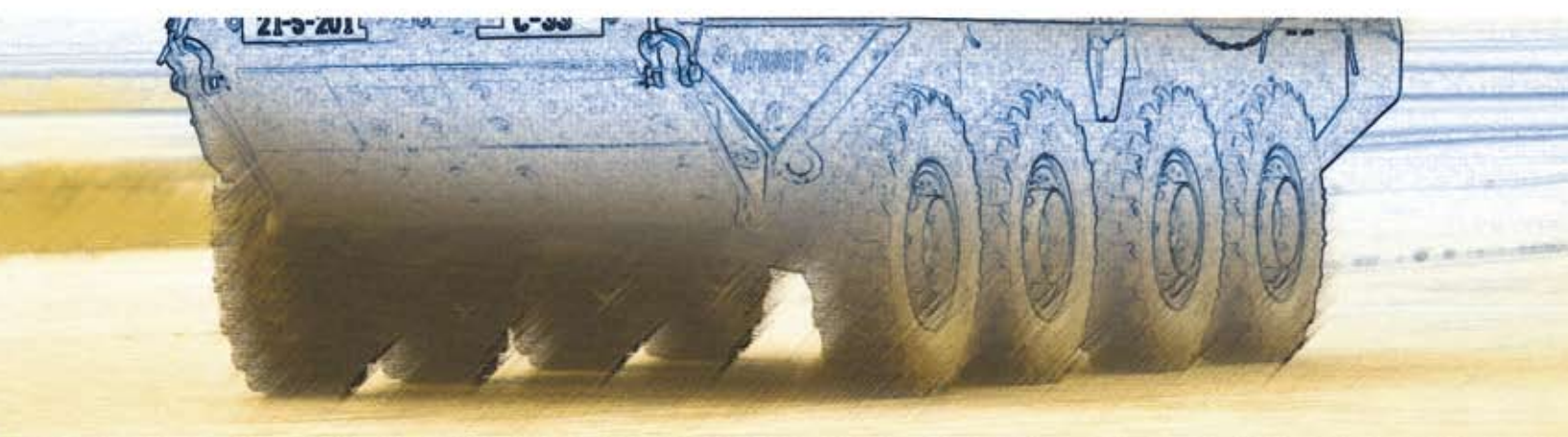

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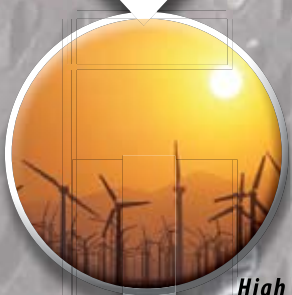

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