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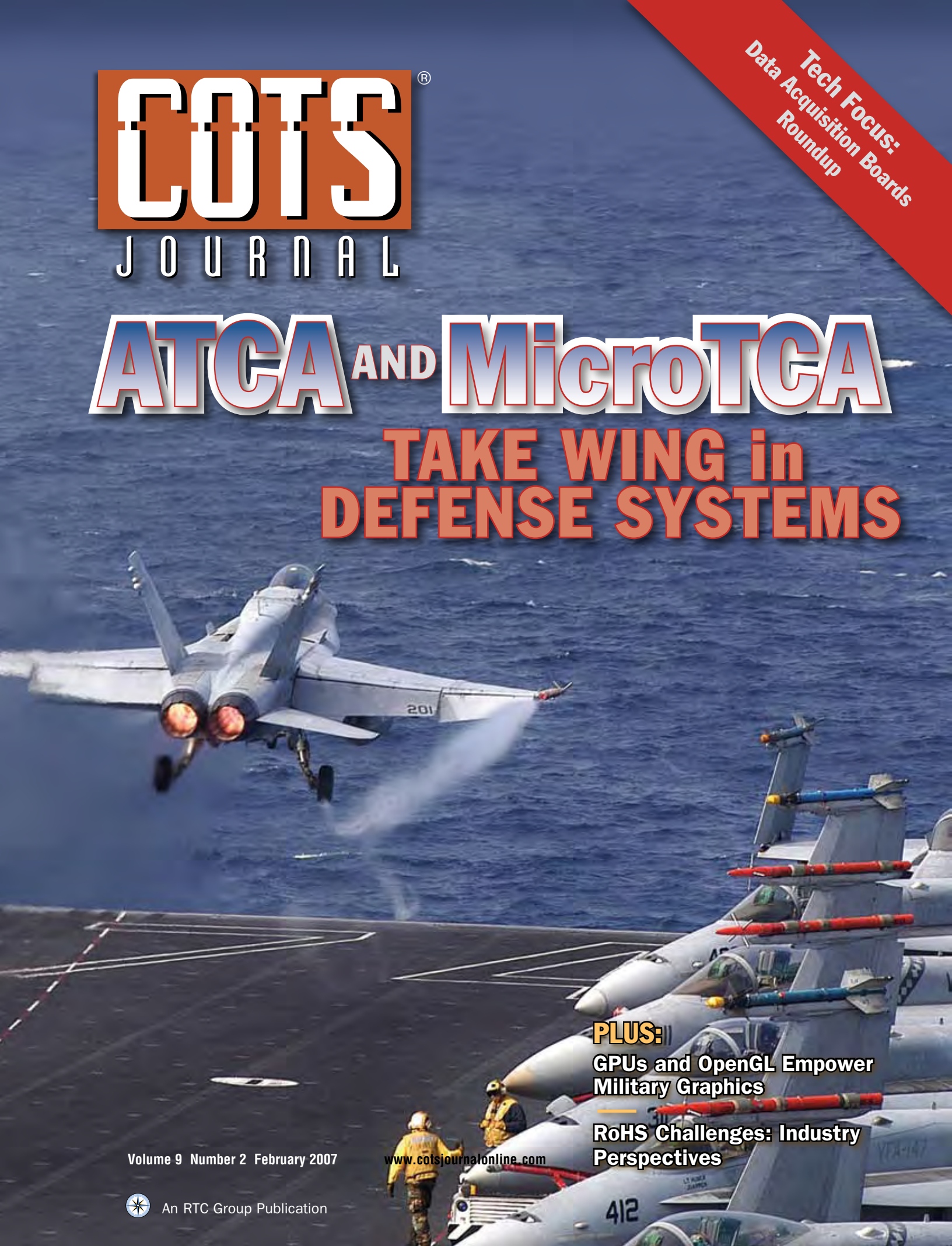
Tech Focus: Data Acquisition Boards Roundup

ATCA AND MicroTCA TAKE WING in DEFENSE SYSTEMS



PLUS:

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RoHS Challenges: Industry Perspectives

Volume 9 Number 2 February 2007

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EPIC™ XE–900 1.0 GHz CPU

Features	XE–900	XE–800	XE–700
CPU	Via Eden	AMD Geode GXI	STPC
Clock speed	400 MHz; 733 MHz; 1.0 GHz	300 MHz	133 MHz
BIOS	General software	Phoenix	Phoenix
DRAM support	to 256 MB	to 256 MB	32/64 MB
Compact/Flash	Type I or II	Type I or II	Type I or II
COM 1	RS–232	RS–232/422/485	RS–232
COM 2	RS–232	RS–232/422/485	RS–232/422/485
COM 3	RS–232	NA	RS–422/485
COM 4	RS–232	NA	RS–232
COM 5	RS–232/422/285	NA	NA
COM6	RS–422/485/TTL	NA	NA
LPTI	0	0	1
EIDE	2	2	1
USB	2	6	2
CRT	1600 X 1200	1280 X 1024	1280 X 1024
Flat panel	LVDS	yes	yes
Digital I/O	24–bit prog.	48–bit prog.	24–bit prog.
Ethernet	10/100 Base–T	Dual 10/100 Base–T	10/100 Base–T
Expansion	PC/104 & *Plus*	PC/104 & *Plus*	PC/104
Power	3.6A operating	1.6A max.	1.6A max.
Temp. range	–40° to 70/85° C	–40° to 80° C	–40° to 80/85° C
Shock/vibration	40/5g	40/5g	40/5g

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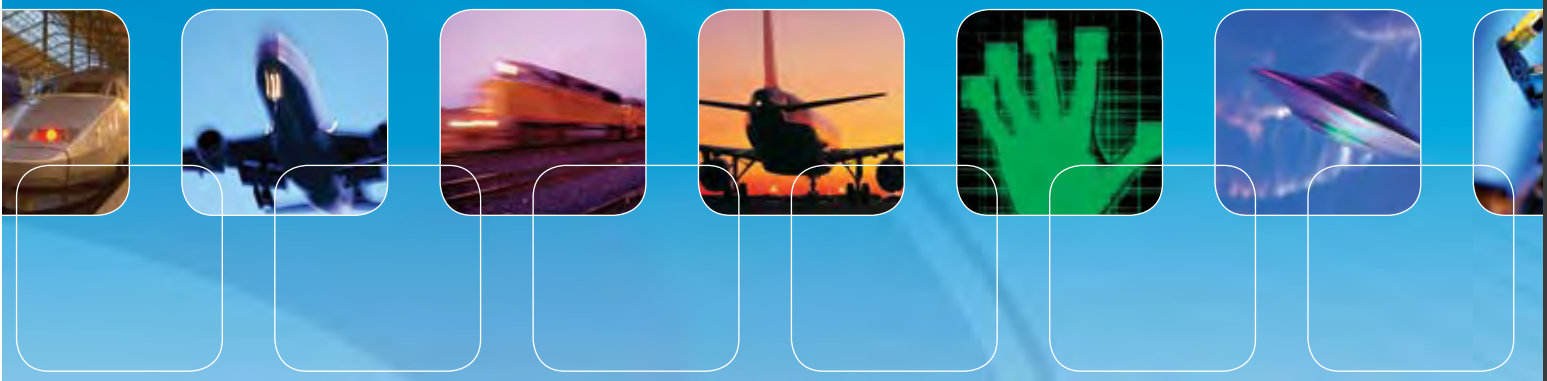

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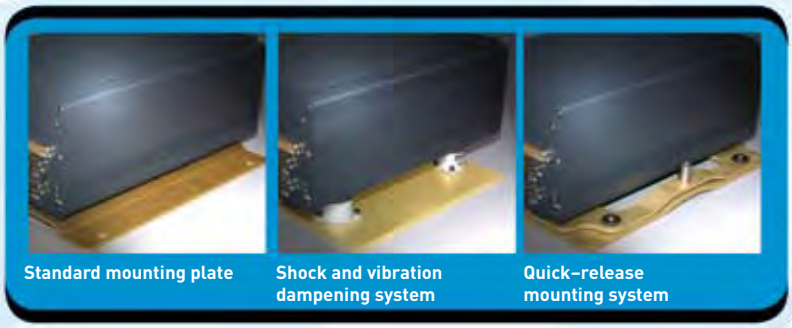
XMB mounting options



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COTS JOURNAL

Features

February 2007 Volume 9 Number 2

Special Feature

ATCA and MicroTCA in the Military

Tech Recon

Rugged Displays

System Development

RoHS Challenges: Industry Perspectives

Technology Focus

Data Acquisition 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.*

Departments

Coming in March...
...See Page 68

Cover Story ..... Page 16

An F/A-18C Hornet aircraft from Strike Fighter Squadron Three Two Three launches Nov. 14, 2006, off the flight deck of the nuclear-powered aircraft carrier USS John C. Stennis (CVN 74), participating in a joint task force exercise in the Pacific Ocean. The Center Barrel Replacement Plus (CBR+) upgrade replaces load sensitive structure with new structure, enabling the F/A-18 Hornets extended time in their strike fighter role until the new Super Hornet E/F models phase into fleet units.

Courtesy U.S. Navy photo by MassCommunication Specialist Seaman Apprentice Kyle W. Steckler).

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Clock Speed	100MHz	200MHz	400 / 660MHz	800MHz	1.0 / 2.0GHz
Memory	16 / 32MB	128MB	128 / 256MB	256 / 512MB	512MB
Exp. Bus	PC/104	PC/104	PC/104	PC/104-*Plus*	PC/104-*Plus*
USB	2	2	4	(4) 2.0 / (4) 1.1	(4) 2.0
IDE/SATA	IDE	IDE	IDE	IDE	IDE/SATA
Ethernet	10/100	10/100	10/100	10/100	Gigabit
Serial	4	4	4	4	4
Video			✓	✓	✓
Audio			✓	✓	✓
Analog Inputs	16 16-bit, 100KHz, 48 FIFO	16 16-bit, 100KHz, 512 FIFO, autocalibration	16 16-bit, 100KHz, 512 FIFO, autocalibration	32 16-bit, 250KHz, 2048 FIFO, autocalibration	32 16-bit, 250KHz, 1024 FIFO, auto autocalibration
Analog Outputs	(4) 12-bit	(4) 12-bit	(4) 12-bit	(4) 12-bit	(4) 12-bit
Digital I/O	24	24	24	40	24
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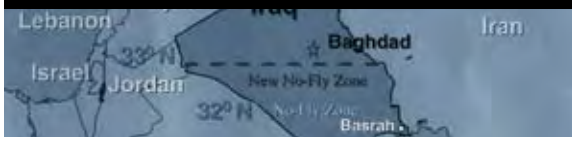

More "C" in COTS

As the politicians reshuffle cabinet positions and interests, and as funding is provided to repay Peter the funds that were robbed from him to pay Paul—Peter being everything non-Iraq-essential—a lot of things in the embedded electronics world are in flux and everyone is trying to find out product delivery and funding schedules. Into all this turmoil there are a few more issues that are going to keep the apple cart unsteady. Over the last four or five years, many big military systems suppliers espoused the concept of having the entire system designed and produced in-house rather than buying-in lower-cost subassemblies from embedded suppliers. That sometimes-successful concept was encouraged in the environment where a lot of defense money was floating around just looking for a home.

The new Congress has vowed to provide more scrutiny and oversight on military program spending. That really doesn't mean a lot for our end of the food chain, at least directly. What it does mean is that the big guys will start to focus on holding onto the "prize": the deliverable items. They will start to find ways to cut costs—in reality just profits—and relinquish their push to keep subsystem development in-house. We've seen this swing in primes' business plans before. Now the pendulum has reached its zenith and will start swinging in the other direction. That doesn't mean that subsystems that have been designed-in will be replaced, it just means that new applications or upgrades will be more receptive to lower overall cost buy-ins.

If a company's business plan includes designing and providing all the deliverable system elements down to our end of the food chain, the company requires all the same talents and disciplines typical in a vendor of subsystems plus all the big company overhead that goes with this type of organization. If these subsystems are only designed and built for in-house use in one or two different deliverable items, the company doesn't get to amortize development costs in as many programs the way subsystem vendors can. Yes, every subsystem—whether an in-house build or a buy-in—requires modifications to suit the military's requirement. It's the basic design that can get amortized over multiple customers. When people assert that the "cost" of a buy-in is not significantly less than an in-house ground up design and build, they really never compare apples to apples. They don't account for corporate contributions, overhead and other indirect costs that can be significant.

Shifting gears regarding the "C" in COTS. Going back to the early days of electronics, the military and space exploration led the demand for technology development. Then came the age of computers and industry leading tech development technology, while the military lagged and had to follow and use industry-developed technology or fall by the wayside. Now we may be at the forefront of the next change, where computers and industry are no longer the driving force in the development of technology. Personal consumer goods are, and now computers and industry will need to follow or fall by the wayside.

On the whole, the military's assimilation of technology has always been much slower than industry and still is. That said, the last few years has seen the military step up to at least have an interest in the leading-edge technology—not bleeding edge—that is being incorporated in the most advanced industry applications. Military subsystems are being purchased and deployed using some of the latest silicon. Contrast that with five or ten years ago when the military would generally opt to sacrifice potential performance in favor of years of demonstrated reliability.

With more and more silicon now developed for consumer goods, that silicon is finding its way into computers and industry. Will it be long before we see consumer electronics silicon—which has an even shorter lifecycle than what we currently deal with—as the mainstay across the board in military programs? That silicon is already pervasive in simulation and training applications. *COTS Journal* has always been at the forefront of the embedded technology going into military systems and will be on the crest of this wave of change. I need your thoughts and input, both users and suppliers. What are you experiencing, what are your needs, what technologies do you predict will find their way into military systems? Your input will ensure that we can explore the technologies you need for success in the pages *COTS Journal*. Call (239-463-1953) or e-mail me (petey@rtcgroup.com) and let me know what you see as the future.

The current political climate will probably drive more interest to subsystem vendors providing **C**ommercially available systems. And up until now the "**C**" in **C**OTS only meant **C**ommercial availability. Will it now also imply: "utilized in **C**onsumer goods?" How many years before we need to go to the Consumer Electronics Show in order to see what the future holds for the military system design? ▮▮

Pete Yeatman, Publisher
COTS Journal

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The Inside Track

Edgewater Completes Flight Demo of E1553 Bus Technology

Edgewater Computer Systems has successfully demonstrated its Extended 1553, or E1553, data bus technology in a joint industry flight demonstration. Also known as MIL-STD 1553B Notice 5, the technology has previously been demonstrated in a number of developmental and simulation environments including the C-130, F-16 (Figure 1) and F-18.

In December, Edgewater's E1553 technology was tested on a U.S. Navy A-3 jet aircraft operated by Raytheon at Raytheon's Flight Test Operations Center in Van Nuys, California. For the purposes of the test, E1553 was coupled onto the internal 1553 Navigation Bus of the A-3, which also hosted other legacy 1553 Line Replaceable Units (LRUs) communicating concurrently on the same bus. Raytheon verified that no bus errors were reported on the legacy 1553 equipment during the flight.

Adding high-capacity networking across the existing 1553 bus without changing the legacy software or disrupting the legacy communications has implications. It permits an open-architecture approach for cost-effective, robust networking and promotes key interfaces that enable substantial increases in capability with minimal impact to the warfighter.

Figure 1
Edgewater has successfully demonstrated its Extended 1553, or E1553, data bus technology in a flight demonstration. Also known as MIL-STD 1553B Notice 5, the technology has previously been demonstrated in a number of developmental and simulation environments including the C-130, F-16 (shown) and F-18.

The rate monitor maintained a consistent connection of greater than 100 Mbits/s through the entire flight. In order to use the available capacity of the E1553 network, Edgewater ran live streaming video along with bidirectional, bulk-data transfers in order to maximize the network capacity of the bus while maintaining a 10E-12 bit error ratio (BER). The current generation of E1553 technology, which is limited to approximately 100 Mbits/s due to FPGA performance restrictions, performed as expected. Edgewater's ASIC-based solution, due to be released this year, will be capable of supporting substantially higher throughput. In March 2006, the U.S. Air Force sponsored the revision to MIL-STD 1553B referred to as Notice 5, which is based, in large part, on Edgewater's development of E1553.

Edgewater Computer Systems
Ottawa, Ontario, Canada.
(613) 271-1101.
[www.edgewater.ca].

Nanobattery Vendor Inks R&D Deal with Army

The U.S. Army Armament Research, Development and Engineering Center (ARDEC) at Picatinny, NJ has signed a CRADA (Cooperative Research and Development Agreement) with mPhase Technologies to cooperatively test and evaluate the mPhase Smart Nano battery and ultra-sensitive magnetometer. The army researchers will further evaluate the prototypes using the Army's testing facilities at Picatinny Arsenal in New Jersey in order to potentially incorporate the technologies into programs sponsored by Picatinny.

The testing of the mPhase prototype nanobattery and magnetometer will help determine their applicability for the military in new fields like sensor networks and smart munitions. Some of the possible uses for the mPhase magnetometer are perimeter security applications, and navigation and "GPS denied" navigation applications. The potential military uses of the Smart Nano battery (Figure 2) include powering small electronics like sensors and as a potential power source for smart munitions.

Last spring, mPhase reported on initial tests at Picatinny. The company said that the structure of its prototype battery and magnetometer demonstrated extreme resiliency to shock and acceleration, surviving a test that subjected them to high acceleration at a g-Force of 12,000. The test, which involved a shot out of an air-gun, indicated that the underlying nanostructure of the prototype power cell could withstand extreme shock if used in military applications. The prototype magnetometer similarly withstood the stress test. Those tests paved the way for developing small guided munitions.

Figure 2
Shown here is an mPhase prototype nanobattery, placed on a penny to indicate its size. The potential military uses of the nanobattery include powering small electronics like sensors and as a potential power source for smart munitions.

mPhase Technologies
Little Falls, NJ.
(973) 256-3737.
[www.mPhaseTech.com].

Saft to Become Sole Li-SO_2 Battery Supplier to U.S. Military

The U.S. Defense Logistics Agency (DLA) has awarded battery supplier Saft a multi-year contract worth a potential $26.6 million. Saft will be the sole supplier of lithium sulfur dioxide (Li-SO_2) batteries for the U.S. Army, Navy, Air

Force and Marine Corps. The terms of the contract include six Li-SO_2 batteries for several portable military applications such as communication, GPS and rescue systems. The contract was awarded to Saft for 100 percent of the U.S. military needs for this type of battery. The contract with DLA is an indefinite quantity contract with a two-year base period for an amount of up to $10 million and three one-year option periods for a total amount of up to $26.6 million. The contract will be supplied from Saft's Valdese, NC facility that has been the leading supplier of these types of military batteries through both Middle East conflicts.

Saft America
Cockeysville, MD.
(410) 771-3200.
[www.saftbatteries.com].

General Dynamics Chooses OIS's Middleware for JTRS Radios

General Dynamics C4 Systems selected Objective Interface Systems' ORBexpress communications middleware as the sole Object Request Broker (ORB) for the Joint Tactical Radio System (JTRS) Handheld, Manpack, Small Form Fit (HMS) Cluster. The JTRS HMS radios include fourteen small, lightweight "form-factors" that will enable warfighters to be more agile and covert than current radios allow. Each JTRS HMS radio features an advanced core receiver the size of a credit card, which supports the primary radio functions for each form-factor. The JTRS HMS radio product (Figure 3) lines allow individual warfighters to have networked communications capability, enabling coordinated joint force and coalition operations.

As prime contractor, General Dynamics is integrating the

Figure 3
JTRS HMS radio product lines allow individual warfighters to have networked communications capability, enabling coordinated joint force and coalition operations. Shown here is the Manpack form-factor.

hardware and software operating environment of the JTRS HMS radios. The JTRS HMS radios are based on the Software Communications Architecture (SCA), developed by the U.S. Department of Defense. A key component of the SCA is the use of Common Object Request Broker Architecture (CORBA). Objective Interface's ORBexpress RT is a real-time CORBA ORB that enables software developers to simplify the development of distributed software applications, build scalable, efficient and robust applications, and reduce overall development time.

In July 2004, the U.S. Army awarded a contract to General Dynamics for the system development and demonstration (SDD) phase of the JTRS program. The contract was valued at $295 million with the total contract award for the SDD phase and LRIP expected to be approximately $1.4 billion. The first HMS radios were delivered for early testing and integration in October 2006. They will be integrated into the Future Combat Systems (FCS) intelligent munitions systems and unattended ground sensors as well as the Ground Soldier System.

General Dynamics C4 Systems
Scottsdale, AZ.
(877) 449-0600.
[www.gdc4s.com].

Objective Interface Systems
Herndon, VA.
(703) 295-6500.
[www.ois.com].

Army Evaluates Smart Battery System for Stryker Vehicle

The U.S. Army's Stryker team in Warren, MI, has entered into a one year test and evaluation of the new Battery Brain systems made by Smart Energy Solutions. Battery Brain is a device that constantly monitors the electrical discharge of the battery for nearly all kinds of vehicles When the Battery Brain detects that the battery is losing sufficient charge to start the vehicle's engine, the device automatically disconnects the battery to preserve its starting power. The contract will allow the government to evaluate Battery Brain technology, which supports operational assurance of vehicle performance in both field and administrative environments. This contract, which will be managed by the Stryker team at the U.S. Army's Tank-automotive and Armaments Command (TACOM) headquarters in Warren, MI, will enable the Army's current batteries from losing their starting power when systems discharge below the required 18 volts DC. The unit will also be evaluated to determine if it can survive in the Stryker (Figure 4) environment on a continual basis.

Smart Energy Solutions
Clifton, NJ.
(973) 248-8008.
[www.smgy.net].

Figure 4
The Army's Stryker team in Warren, MI is evaluating the Battery Brain for use in Stryker vehicles. The Battery Brain is a device that can detect when a battery is losing sufficient charge to start the vehicle's engine, and then automatically disconnect the battery to preserve its starting power.

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DISA Web Site Is at the Beating Heart of Net-Centric Transformation

The Defense Information Systems Agency is a combat support agency responsible for planning, engineering, acquiring, fielding and supporting global net-centric solutions to serve the needs of the President, Vice President, Secretary of Defense and other DoD Components, under all conditions of peace and war. In this new era of Net-Centric Operations, DISA is smack in the center of orchestrating the difficult balance between enabling the sharing of defense information while staunchly protecting it. DISA also ensures the integration and interoperability of command and control, communications, computers and intelligence (C4I) systems. DISA provides end-to-end Global Information Grid (GiG) system engineering, architecture and configuration management. The agency's major programs are Joint Command and Control (JC2); Net-Centric Enterprise Services; and the Defense Information System Network (DISN), including the DISN Subscription Service (DSS) and DISN Access Transport Services (DATS).

DISA's Web site provides a wealth of information and links to information related to defense IT. And because the vision is for all embedded military subsystems to eventually have some level of connectivity—directly or indirectly—with the GiG, embedded system developers need to keep up to speed with DISA activities. One of the key subsets of DISA's Web site is the Information Assurance Support Environment page, which serves as the jumping-off resource to all-things-IA. The site also links to centers of information on Spectrum Services, GIG Combat Support, Service Oriented Architecture (SOA) and Security Technical Implementation Guides (STIG).

Defense Information Systems Agency, Arlington, VA. [www.disa.mil].

Special Feature

ATCA and MicroTCA in the Military

ATCA Shines as a Military Communications Solution

The attraction to ATCA among military system designers is no longer theoretical. Primes like Lockheed Martin are tapping the architecture's advantages in high availability and system management.

Carl Peters, Architect
John McReynolds, Hardware Engineer
Steve Helding, Firmware Engineer
Lockheed Martin, Integrated Systems & Solutions

Military communication systems tasked to process wideband data have historically been designed from the ground up with custom non-standard chassis and custom circuit cards. The ATCA is the first embedded platform architecture that satisfies the needs of the wideband data processing using "off-the-shelf" bandwidth, availability, control, maintainability and management. With that in mind, Lockheed Martin is developing a military communications system that routes high-speed multi-gigabit wideband data to various users. This Wideband Data Subsystem (WDS) consists of four processing functions: Packetizer, Interfacing, Formatter and Maintenance. These processing functions use Advanced Telecommunications and Computer Architecture (ATCA) Hardware and Software as the basic infrastructure with application-specific features provided by Lockheed Martin-unique hardware, software and firmware.

ATCA was selected by a Lockheed Martin team with the goal of determining if the ATCA architecture could meet WDS functional and performance requirements. Lockheed Martin chose ATCA as its common hardware and firmware platform for the WDS because of the inherent high performance, redundancy, scalability, flexibility and expandability it provides for current and future military users.

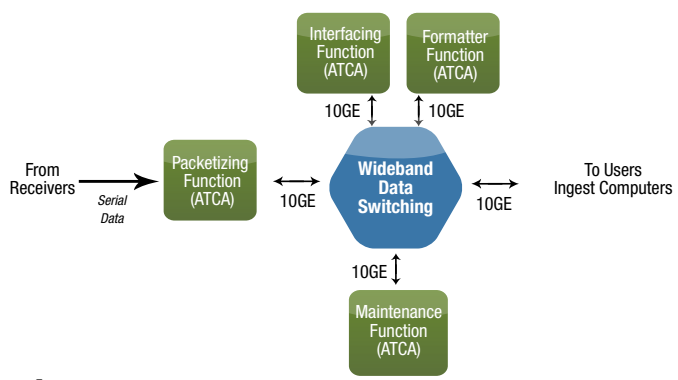

Figure 1

Lockheed Martin made use of ATCA in developing a military communications system that routes high-speed, multi-gigabit Wideband Data to various users. The Wideband Data Subsystem (WDS) architecture is designed to route very high-speed serial data from receivers and transforms the serial data into computer-readable formats.

Wideband Data Subsystem Architecture

The WDS architecture routes very high-speed serial data from receivers and transforms the serial data into computer readable formats (Figure 1). To perform this transformation, various processing functions are interconnected via 10 Gigabit Ethernet packet switches. The fully redundant WDS switching must route a minimum of 10 million 2,000-byte packets per second to the processing functions. The processing functions either ingest serial data from receivers or work on the payload data inside the stream of packets routed from the switching core. The work performed varies depending on the needs of users and the mission. Some examples of the work performed are ambiguity resolution, de-randomization, de-coding, acquisition, formatting and re-formatting. Each WDS processing function must operate at a minimum of 10 Gbits/s. This speed is critical to the WDS delay and acquisition timelines. It is also one of the reasons for selecting the ATCA platform, because the standard ATCA fabric data rate is 10 Gbits/s.

Off-the-Shelf Versus Custom Trade-Offs

The WDS architecture requires four different processing functions, Packetizer, Interfacing, Formatter and Maintenance, to perform its mission. These functions are designed using ATCA as the common platform. The WDS design team selected off-the-shelf ATCA products for the common chassis after performing numerous "CAIV" trade-offs (Cost as an Independent Variable). An honest trade-off of off-the-shelf embedded versus custom boxes demands that the military system communications requirements be understood and mapped to "standard" functions or features of the telecommunications industry. Those two industries tend to speak different languages.

After analyzing the hundreds of requirements, four primary ones—availability, management, control plane and data plane—stood out. Availability addresses the need for high mean time between failure (MTBF) and an ability to fault detect, isolate and return a failed ATCA Shelf to service. Management includes the characteristics of hot swapping, validation of blade registration, actively managing the blades power, cooling system and other maintenance issues. Separation of control plane and data plane was necessitated by security requirements to insulate the controlling of the ATCA from the user data being processed on the data plane. These WDS driving requirements were used to trade the different off-the-shelf or custom architectures. The trade-off results (Table 1) showed that ATCA satisfied these requirements out of the box and a clear difference between cPCI, VME or custom approach was apparent.

After ATCA was selected as the common WDS platform, embedded board vendors were needed to supply its contents. COTS suppliers were needed for the ATCA Shelf, Base Interface Switches, Advanced Mezzanine Card (AMC) Single Board Computers, AMC Hard Drives and Middleware. Several candidate suppliers were easily identified due to the depth of the ATCA vendor base. The depth of the ATCA ecosystem enabled Lockheed Martin to perform supplier trade-off studies, thereby identifying the best vendor to match the needs of WDS.

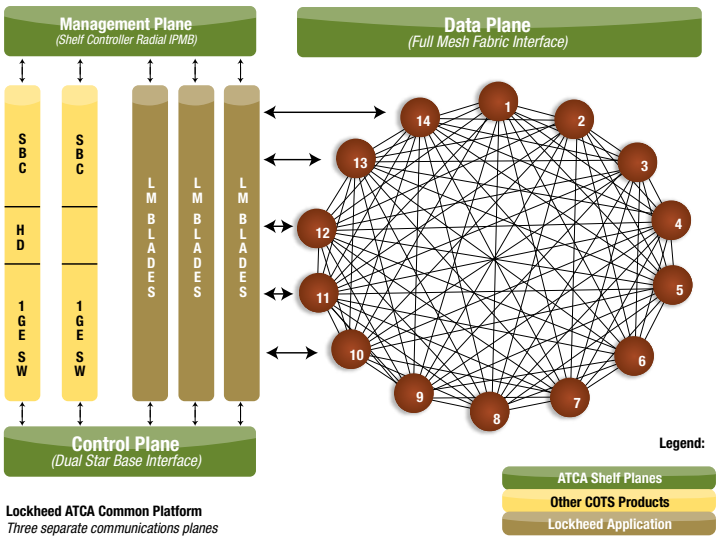

Figure 2

Shown here is Lockheed Martin's baseline ATCA common platform consisting of an ATCA Shelf (chassis) with fans, power entry modules, shelf managers, a backplane with dual-star base interface, full mesh fabric interface and radial IPMB shelf management, two base interface switches—each with two AMC slots—two SBCs and one hard drive.

The results of all the trade-off studies provided Lockheed Martin with a baseline ATCA common platform (Figure 2) consisting of a Shelf (chassis) with fans, power entry modules, shelf managers, a backplane with dual-star base interface, full mesh fabric interface and radial IPMB shelf management, two base interface switches (each with two AMC slots), two SBCs and one hard drive. The WDS processing functions, however, still needed the application-unique hardware, software and firmware and could not perform their missions solely on off-the-shelf products. A Lockheed Martin ATCA Reference Blade Design also supplied a "common ATCA blade design" for each of the seven unique Lockheed blades. Integrating the hardware, software and firmware products and Lockheed Martin-unique hardware, software and firmware components created the four different WDS processing functions.

The common ATCA platform provides 100 percent design re-use in each of the four processing functions. Following the selection and configuration of the WDS ATCA common platform, the design team focused on common blade designs, common firmware and user-specific functions. The WDS ATCA infrastructure established a method where unique application-specific blades, FPGA code or firmware is minimized. The four different processing functions have the same common platform; however, installation of the Lockheed Martin-unique software, firmware and application blades easily reconfigures the ATCA common chassis into a multipurpose device.

ATCA Application-Specific Blades

The Common ATCA platform provided the basic infrastructure for all of the processing functions. The hardware necessary to perform the user-specific communications functions, however, is not available in the COTS marketplace. As with the WDS Common ATCA platform, WDS Application-Specific Blades are designed around the COTS ATCA standard.

As an emerging standard, ATCA, and others, VME, cPCI and so on, can be interpreted many different ways creating a multitude of problems. The Lockheed Martin hardware engineering team, leveraging lessons learned, chose to develop a single ATCA Reference Blade design before beginning any application blade designs for the WDS processing functions. This initial brass board development created a common blade design for the Lockheed Martin-unique blades. The WDS hardware team originated a set of requirements for the ref-

erence design based on the ATCA standard. The requirements for the reference design focused on the common area of the blades and provided a standard interface for the application-specific payload area of each unique blade. These interfaces were dual -48 VDC power, Hot Swap capabilities, Intelligent Platform Management Interface (IPMI, an ATCA requirement), blade Common Host Interface Processor (CHIP) and the data plane interface.

Seven Lockheed Martin Application Specific ATCA blades are in development. Figure 3 shows one of the seven. Each of these designs takes advantage of Lockheed's common reference design. This common design reduced the total design time and is significantly reducing bench test and firmware integration efforts. With the ATCA Reference Design and ATCA common shelf goals completed, Lockheed Martin blade firmware and processing function shelf software efforts take over and begin integrating into the WDS processing functions.

ATCA Shelf Software and Blade Firmware

Just like hardware, firmware must also support four different types of WDS processing functions. Software and firmware items such as operating systems, file systems, network protocols, embedded operating systems and middleware interoperate on the Common ATCA platform.

The number of differing firmware components required on an ATCA chassis can seem overwhelming to the novice. Those who have worked on a VME or Compact PCI chassis probably have had one or possibly two single board computers controlling all of the off-the-shelf and/or custom blades in the chassis, and most of the internal control is via the backplane. ATCA is based on the newer serial bus technology versus VME and Compact PCI, which provided parallel address and data buses as part of the backplane. The ATCA shelf includes a base interface of 10/100/1000 Ethernet and a number of different fabric configurations and protocols to choose from.

For the WDS processing functions, Lockheed chose to support both the base interface 1 Gbit Ethernet control plane and the full mesh point-to-point 10 Gbit/s XAUI fabric data plane. The base Ethernet interface is provided on every blade in the shelf. Each blade is managed locally rather than across the backplane. While this adds some complexity in managing firmware communication between multiple processors, it does add a tremendous amount of flexibility to the hardware design.

ATCA Shelf Firmware

Each ATCA shelf, based on the current ATCA specification (PICMG 3.0 R2.0) is required to have two shelf managers. Lockheed's ATCA shelf vendor, Sanmina-SCI, provided two ShMM-500R shelf managers developed by Pigeon Point Systems in its SC6000 series shelf. Each shelf manager contains an AMD Au1550 MIPS-32 333 MHz RISC processor with 64 Mbytes of SDRAM

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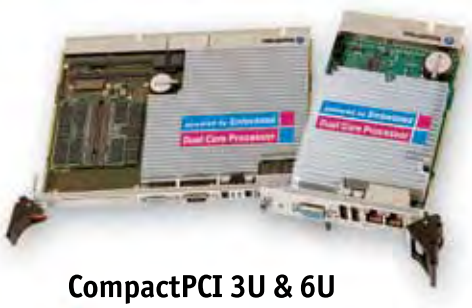

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- AT8400 - AMC carrier, GigE, PCIe and SAS switching
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and 16 Mbytes of flash memory and dual IPMB, Ethernet and serial interfaces. The operating system on the shelf manager is Monterey Linux, which is based on a Linux version 2.4.x kernel port tailored for the AMD processor and peripherals. Lockheed Martin maintains the firmware for the shelf manager, which is easily upgradeable as new versions become available.

All ATCA blades within an ATCA shelf must communicate with the shelf manager. The shelf manager will only enable their payload power supplies after each blade has registered and is allowed to power up. The shelf manager can also be configured to keep only specific blades in the shelf operating. Any different type of blade inserted into the shelf will not be allowed to power up. This is accomplished by having an IPMC (Intelligent Platform Management Controller) installed on each blade. Lockheed Martin uses the BMR-H8S-ATCA Reference Design from Pigeon Point Systems.

Unique Blade Firmware

On each of the seven unique WDS processing function blades is a unique Lockheed Martin firmware suite operating from an embedded Power PC (Figure 3). A Xilinx Virtex 4 FX FPGA provides CHIP with one of the two PowerPC processor blocks that the Lockheed Martin blade firmware executes in. The operating system used on these Power PCs is an RTOS (Real Time Operating System) called Wind River VxWorks from Wind River. Using an FPGA-based Power PC versus an ASCII microprocessor has been a challenge. The design of CHIP was created using the Xilinx EDK (Embedded Development Kit) for FPGAs to generate a BSP (Board Support Package) for VxWorks. The COTS EDK tool will also generate different BSPs for several different operating systems.

COTS ATCA Shelf Control and Management

The Lockheed Martin WDS ATCA common platform differs from the ATCA standard only where shelf control and management are performed. The ATCA standard assumes this function is performed external to the shelf. For the WDS architecture, the shelf control and management is implemented within each processing function. Embedding this into the shelf allows each processing function to operate independent of each other and to continue to operate in the event of a failure in the external control and management system. WDS refers to this feature as the shelf controller.

Figure 3

This is one of seven Application-Specific ATCA blades that Lockheed Martin has in development. Each blade takes advantage of Lockheed's common reference design and each has a unique Lockheed Martin firmware suite operating from an embedded Power PC. A Xilinx Virtex 4 FX FPGA provides CHIP with one of the two PowerPC processor blocks that the Lockheed Martin blade firmware executes in.

The shelf controller application controls the entire shelf as well as intercommunicating with the shelf manager and external interfaces. This application executes on an AMC SBC provided by Extreme Engineering. Called the SBC Xpedite 6244 (Figure 4), this AMC is based on a Freescale Power PC with a USB and serial port, serial SCSI port and four 10/100/1000 Ethernets, two SFPs interfaces on the front panel and two copper connections to the ATCA backplane base interface. The two interfaces are required to meet the high availability needs and avoid single points of failures. High availability is based on redundancy, reliability of the hardware and fault tolerant firmware.

The SBC executes Wind River Linux. Lockheed Martin could have generated its own Linux implementation. However, with a design life requirement of 14 years, the consensus was to provide a stable platform and development environment. Plus Wind River Linux supplies a rich suite of development tools as well as professional support. This also offers "one stop shopping" for both the shelf controller and the unique blade operating systems.

ATCA Service Availability

Middleware Trade Study

One of the key areas to consider when undertaking ATCA software development is standards-based applications. Eighty-three percent of the telecom industry has indicated that they will be implementing Service Availability Forum (SA Forum) Forum specifications. The SA Forum is a consortium of industry-leading companies whose mission is to "Foster an ecosystem that enables the use of commercial off-the-shelf building blocks in the creation of high-availability network infrastructure products, systems and services."

The Lockheed Martin WDS designers performed a six-month trade study on available off-the-shelf middleware applications including the possibility of developing an in-house unique solution. The unique WDS middleware solution, had it been selected, would have supported the WDS ATCA-based processing functions. Most likely, though, it would not be compliant with the SA Forum specifications. The results of the trade study directed that a middleware product be purchased and integrated into the WDS ATCA software baseline. Choosing to purchase the middleware (versus internal development) enables the software designers to focus on the WDS processing functions mission and not its infrastructure while still embracing the SA forum specifications.

The middleware CAIV trade looked at several vendors. The one selected was

OpenClovis Solutions, Petaluma, California. The design team recognizes that Clovis is a relatively young company, but they demonstrated a solid understanding of the ATCA standard and the SA Forum specification during the evaluation period. Also, since the control and status model used by the application of ATCA in WDS is slightly different from the telecom industry, the OpenClovis solution was flexible and they could implement their product on the WDS ATCA-based processing functions.

ATCA Is Lockheed Martin WDS Future

The ATCA "open architecture" is the future for Lockheed Martin WDS and other programs in the planning stages. The defense industry has longer design life requirements than other segments of the electronics industries. However, for Lockheed Martin it is always easier to maintain the architecture when the common platform is supported by the telecommunications industry with many different types of embedded product vendors. The off-the-shelf hardware, firmware and software products that are selected in the WDS architecture meet the ATCA standard and the SA Forum Specifications. Also, the unique application-specific hardware and firmware Lockheed Martin designed is compatible with any standard ATCA shelf. The unique blade firmware and shelf controller software is designed per the SA Forum High Availability Architecture

Figure 4

In Lockheed's Wideband Data Subsystem platform the shelf controller application controls the entire shelf as well as intercommunicating with the shelf manager and external interfaces. This application executes on an AMC SBC provided by Extreme Engineering. Called the SBC Xpedite 6244, this AMC is based on a Freescale Power PC with a USB and serial port, serial SCSI port and four 10/100/1000 Ethernets, two SFPs interfaces on the front panel and two copper connections to the ATCA backplane base interface.

ATCA Features vs. Other Solutions

Feature	Description	ATCA	VME	cPCI	Custom
Availability	Support five nines (99.999%)	Standard	Not Standard	Not Available	Implementable with a larger development budget than the cost of COTS products
Management *Security, Health, Status*	Power, Hot Swap, E-Keying, Temp, Cooling	Standard	Some Support	Some Support	
Control Plane *separate from Data plane*	Dual Star 1GE base interface	Standard	Not Standard	Supportable via custom designs	
Data Plane *separate from Control plane*	Full Mesh 10Gbps blade in blade	Standard	Not Standard	Not Standard	

Table 1

After analyzing the hundreds of requirements for the Wideband Data System, the Lockheed designers found that four primary ones stood out: Availability, Management, Control Plane and Data plane. The trade-off results in the table show that ATCA satisfied these requirements out of the box, and a clear difference between cPCI, VME or custom approach was apparent.

Specifications.

ATCA has allowed Lockheed Martin to pick and choose hardware, firmware and software components from outside vendors while still providing the high-speed application-specific communications our customers have learned to expect. This ability to quickly select products from the open market and combine them with unmatched application-specific hardware, firmware or software provides greater flexibility, commonality and expandability to meet the military's current and future requirements.

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Well suited for today's communications-oriented programs, MicroTCA has secured a foothold as an attractive form-factor.

David Pursley, Applications Engineer
Kontron

The requirements of today's military applications are often beyond the limits of traditional VME- or CompactPCI-based architectures. PICMG's recent ratification of the MicroTCA specification defines a standard that meets the most demanding requirements today and into the future, including increased computing power, very high communication bandwidth and high availability; all in an affordable, small form-factor.

To get a realistic sense of MicroTCA, it's important to analyze it from three perspectives. From the point of view of system designers and program managers responsible for the architecture selection the question is: "How do I know if MicroTCA is the best architecture for my next project?" For hardware designers—those responsible for selecting and building the system—the focus is on what system and components are needed to implement the application in the MicroTCA architecture. And finally, the software designers responsible for developing the executables running on the hardware platform need to know what's involved in developing software targeted for use in a MicroTCA system.

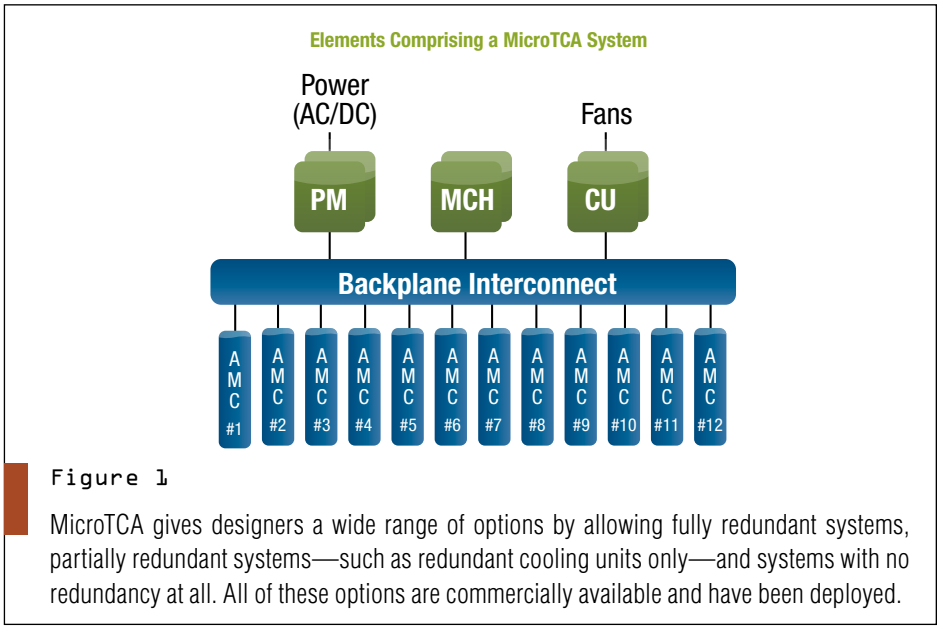

Figure 1

MicroTCA gives designers a wide range of options by allowing fully redundant systems, partially redundant systems—such as redundant cooling units only—and systems with no redundancy at all. All of these options are commercially available and have been deployed.

Comms Bandwidth Requirements on the Rise

In contrast to the majority of military applications from five or ten years ago, today's military programs, such as FCS (Future Combat Systems), JTRS (Joint Tactical Radio System) and WIN-T (Warfighter Information Network – Tactical), are heavily communication-centric. With that in mind, it's not surprising that the system architectures of yesterday struggle to meet the demanding communication bandwidth requirements of today's applications.

VME and CompactPCI architectures, while still viable for many applications, do not, for example, support the processing and communication bandwidth required for those advanced programs. Switched-fabric extensions—such as VITA 31, VITA 41 and PICMG 2.16—offer more bandwidth, but still do not meet the communication demands inherent in those programs.

Ratified in July 2006 as PICMG MTCA.0, MicroTCA offers extremely high communication bandwidth, high processing capacity and high availability in a small 2U form-factor. Design teams have deployed MicroTCA into a wide range of application spaces, including defense, government, aerospace, industrial automation and medical. Applications in these spaces present some similar requirements, including very high communication bandwidth and/or very high availability in a small form-

factor. When those are the requirements, MicroTCA becomes the logical implementation choice.

Where Does MicroTCA Fit in?

Choosing an embedded computing form-factor is a critical choice in any project. Table 1 provides a high-level overview of some of the more prevalent embedded computing form-factors and their advantages and disadvantages, specifically with respect to military, aerospace and government applications. The biggest advantages of MicroTCA are its small form-factor, high bandwidth and high availability. Measuring 2U in height by 3-6HP in width by 183.5 mm in depth, MicroTCA is a smaller form-factor than even 3U VME and CompactPCI cards.

Despite its small size, MicroTCA offers high bandwidth, both in terms of compute bandwidth and communication bandwidth. Up to twelve compute blades on a single backplane give MicroTCA a tremendous amount of computing resources, especially when each blade could be using a multicore processor. Quoted communication bandwidth capabilities range from 40 Gbits/s to over 1 Terabit/s—both numbers are theoretically correct because the actual bandwidth is implementation-dependent. With this amount of compute and communication power, MicroTCA has more than enough bandwidth for most demanding applications.

Gone now are the days when high availability—maximizing system uptime by "healing" it in the field—was a telecom-centric concept, not relevant for military systems. Demand for it is growing, and MicroTCA supports up to five nines (0.99999) availability through a combination of IPMI-based health monitoring, hot swap capability and support for full redundancy. Redundancy is implementation-specific, so any given system may have full redundancy, partial redundancy—redundant power and cooling subsystems is a common configuration—or no redundancy, depending on the system's cost and availability requirements.

Perhaps the biggest concern for MicroTCA in military and aerospace applications is ruggedization. The PICMG standards body has a working group investigating standardizing rugged implementations of MicroTCA, and ruggedized MicroTCA options are already available. For example, an ATR chassis is commercially available, and MicroTCA is being used or considered for use in conduction-cooled implementations. Also, it is important to note that concerns about the MicroTCA edge connector become less of an issue in conduction-cooled deployment, because each card is physically bound to the chassis. For this reason, it is possible that conduction-cooled MicroTCA will become common before "soft rugged" implementations that do not require conduction-cooling.

Putting the Pieces Together

Selecting a complete MicroTCA system is an optimization process involving six subsystems. As shown in Figure 1, these include power delivery, cooling, line cards

Figure 2

Available MicroTCA systems span a wide range of form-factors, ranging from simple 2-slot 1U systems through fully redundant 12-slot 8U systems (shown).

(AMCs), backplane, system management and chassis. Power delivery in MicroTCA is controlled with the Power Module (PM), which supplies 12V and 3.3V to the system. The designer must determine which power input(s) is required, as this may force other decisions for other subsystems. PMs supporting common military, telecom and commercial line voltages are available, including 12 VDC, 24 VDC, -48 VDC, -60 VDC, 120 VAC and 230 VAC. Designers also need to decide if redundant power supplies are a requirement, as this will also drive decisions in some other subsystems.

In convection-cooled applications, one or more Cooling Units (CU) are in the MicroTCA chassis, each consisting of air movers (fans) and associated electronics. The main decision the designer must make up front is whether redundant cooling systems are required. Airflow requirements and other thermal issues will generally be addressed during chassis selection.

The number and types of AMC boards are often two of the easier decisions when designing a MicroTCA system. Because there are no mezzanine cards in MicroTCA, the designer simply selects cards to do each purpose in the system. For example, if the system needs storage, it will need to have one (or more) SAS or SATA storage AMCs. If high-end graphics is a requirement, the system will need a graphics AMC. If more network uplinks are required, a GbE module is needed. Of course, the system will also need an appropriate number of processor AMCs (PrAMC) to run the software, keeping in mind that dual-core PrAMCs can be used to further increase compute power. As with the other subsystems, the designer must determine if full redundancy is required, and if so, it's important to plan for the appropriate number of AMCs.

Once the rough number and types of boards are chosen, the designer must select a backplane architecture that supports the communication bandwidth between the boards. The main decisions in choosing a backplane are topology and speed. A star topology will offer switched communication over the backplane. A dual-star is similar, but supports redundant switches to increase availability. Full mesh offers the highest possible bandwidth, but it is more expensive. Backplanes supporting 1 Gbit/s and 10 Gbit/s speeds are commercially available. Faster speeds offer more bandwidth, but cost more and require that the AMCs support those communication speeds.

System management is done through the MicroTCA Controller Hub (MCH), which performs electronic keying and enables (and monitors) power delivery to all the subsystems. It also functions as the network switch for the system, if one is needed. The MCH must be compatible with the communication architecture that was chosen, including communication topology (star, dual-star, full mesh) and communication type(s) (GbE, 10GbE, SRIO, PCIe, SATA, SAS).

The MCH must also explicitly support PM and CU redundancy, if that is required in the system. Furthermore, if the system requires redundant MCHs, you'll need to choose an MCH that supports redundant MCHs (and purchase two of them). Note that, in theory, a fully compliant MCH will be able to seamlessly handle any redundancy configuration presented to it. How-

Where MicroTCA Fits In

	cPCI/VME	VITA 31	VITA 41	PICMG 2.16	ATCA	MicroTCA
Compute Bandwidth (system)	Low	High	High	High	Very High	High
Comm. Bandwidth	Low	Med	Med	Med	Very High	High
High Availability	No	No	No	Yes	Yes	Yes
Form Factor	3U	6U	6U	6U	8U	2U
Rugged	Yes	Yes	Yes	Yes	No	Under way

Table 1

MicroTCA meets the architectural requirements of high bandwidth, high reliability and a small form-factor, with standardized ruggedization on the way.

ever, a cost reduction may be available by using a MCH that only supports the redundancy required.

Finally, with tentative decisions on all of the above subsystems, the actual chassis and form-factor can be chosen. A wide variety of form-factors are available, some of which are shown in Figure 2. MicroTCA's small form-factor also makes it amenable to customized chassis developed for specific deployed installations. The designer must choose a chassis that will support current and future needs of the system. Usually, a chassis will exist that meets all of the requirements, but it may be too large for the required form-factor. If this happens, redundancy or the number of AMCs will need to be reduced and/or the desired form-factor will have to be increased.

Easy App Development with MicroTCA

Since each blade looks like a Linux or Windows PC, software development doesn't typically incur any additional overhead. In fact, like other embedded applications, software development normally begins long before the hardware is available or even finalized. The processor AMCs are virtual PCs, and the other AMCs simply look like devices attached to the PC. For example, a graphics AMC looks like a graphics card and a storage AMC would look like an attached hard drive. Note that this means that any drivers for the peripheral AMCs must be installed on the PrAMCs that use them.

The only time where the MicroTCA architecture necessitates a change in the way software is developed is when redundancy is included in the system. While redundant Power Modules and Cooling Units are transparent to the blade, redundant communication (through multiple MCHs) is not. To take advantage of MCH redundancy, the application software will need to have a mechanism to switch between, for example, Ethernet interfaces when told to do so. To illustrate, an application may communicate via eth0 by default, but then use eth1 when eth0 is unavailable. This switching is done under software control.

Predictably, using MicroTCA does not eliminate software integration testing. However, it does make the testing as simple as possible by not adding additional complexity to the equation. To the application, a MicroTCA node and a Linux box on the designer's desk are essentially the same. Since general software debugging can be done outside the system, software system testing can actually focus on integration and system issues.

By minimizing the impact on software development, MicroTCA adds usability to its list of advantages. All of these—usability, compute power, communication bandwidth, high availability and a small footprint—make MicroTCA a leading architectural choice for the demanding military applications of today and tomorrow.

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Simon Collins
Graphics Product Manager
GE Fanuc Embedded Systems

The job of a military graphics application developer is a particularly difficult one. The human eye is a hugely sensitive instrument: it has five million cones for well-lit conditions and color perception and a hundred million rods for low-level lighting and peripheral vision. While it is possible to fool the eye—in fact, this is often necessary when designing displays—the graphics designer needs to be cognizant of its vital role in transmitting information that the brain can quickly interpret and act upon. The success of this function can, quite literally, be a matter of life or death.

In an ideal world, every graphics application would present picture-perfect images to the viewer. The world, though, is not ideal, and in the case of military graphics there are other considerations, notably cost and power dissipation. A third issue is that of time: how often the information to be presented needs to be refreshed. These three factors will likely determine the quality of the image that can be generated.

Processing Time vs. Realism

In the simplest of applications in which a straight line is generated on the screen, such as an altimeter or speedometer, this is easy enough to do in a vertical or horizontal axis. But what happens when the line is set at an angle? Most people are familiar with what are colloquially called "jaggies," more properly known as aliasing. This occurs when the underlying pixel structure causes a line to have "stepped" edges and, in finely textured images, moiré patterns.

Anti-aliasing is a fundamental graphics designer's tool (Figure 1). Generally, subtle color changes are introduced to the edge of the line and its surrounding space to give the illusion of a smooth line. But even such a simple technique comes at the price of a processing burden. Moving that simple straight line through an arc requires it to be repeatedly anti-aliased, demanding even more processing.

Any processing involves time, a key constraint on the graphics designer. Graphics application design is a good example of the paradox in which completeness and timeliness of information can be two opposing vectors. Now, anti-aliasing is a somewhat routine process. Whereas ten or more years ago it would have been performed in software and consumed CPU cycles, it is now more typically offloaded to a graphics processing unit (GPU) and executed in minimal time in hardware. The application developer may still need to decide which lines require anti-aliasing and which lines don't, in order to achieve the desired frame rate.

Additional effort is always required to process information presented to the eye, since it is highly susceptible to im-

Figure 1

Anti-aliasing has been applied to the diamond to smooth its jagged edges, which become apparent when the image is enlarged.

age anomalies and artifacts. Even small aberrations like a jagged edge on an object can cause momentary confusion and slow the viewer's response.

Superficially simple 2D applications, such as cockpit displays, challenge both the developer and the hardware. Here, the requirement is not photo-realism. Instead, it's to supply adequate and unambiguous information and constantly refresh it. If the underlying processing hardware is potentially inadequate, the combination of information complexity and the requirement to update it regularly enough for it to be usable can force choices about which information to omit, or whether to update some information on a less frequent basis.

Increasing Graphical Complexity

Fortunately, with the advent of the OpenGL (Open Graphics Library) standard specification, any call that the application code makes can be executed. OpenGL defines a cross-language, cross-platform API for writing applications that produce 2D and 3D computer graphics. Therefore, the question becomes whether the call is executed in software, with its associated performance penalty/overhead, or in hardware.

Since nearly anything that can be executed in hardware can also be executed in software, the target hardware can be transparent to the developer and the application will run in any hardware environment. The issue is the performance required by the application and the extent to which it must deliver realistic and timely graphical images. This implies that developer knowledge of the target hardware environment is a prerequisite.

Military graphics applications have increased in complexity beyond multi-instrument cockpit displays to simulation and training, for example, which borrow extensively from the computer gaming world in order to achieve maximum realism. This increase in complexity has been accompanied by an increasing focus on GPU hardware.

GE Fanuc Embedded Systems' Screaming Eagle SE1 VME graphics processor with its NVIDIA GeForce 7800GT GPU, and the GRA110 3U VPX graphics processor with its NVIDIA G73 GPU, are examples of this trend to provide the underlying hardware performance necessary for leading-edge 3D military applications (Figure 2). In these applications, the art of the graphics developer is to, as much as possible, make viewers believe that what they are seeing is real. The greater the perceived realism, the greater the degree of viewer immersion and the more "real" will be their responses.

The Impact of Desktop PC Gaming Hardware

For example, in embedded training or simulation, the detail in the image can make the difference between viewer believability or unbelievability. Nowhere is this more important than where light is involved. How it reflects off of different surfaces and textures, how it creates shadows and how these change with changes in the source and direction of

Figure 2

GE Fanuc Embedded Systems' GRA110 3U VPX graphics processor features NVIDIA's G73 GPU, commonly found in desktop gaming systems

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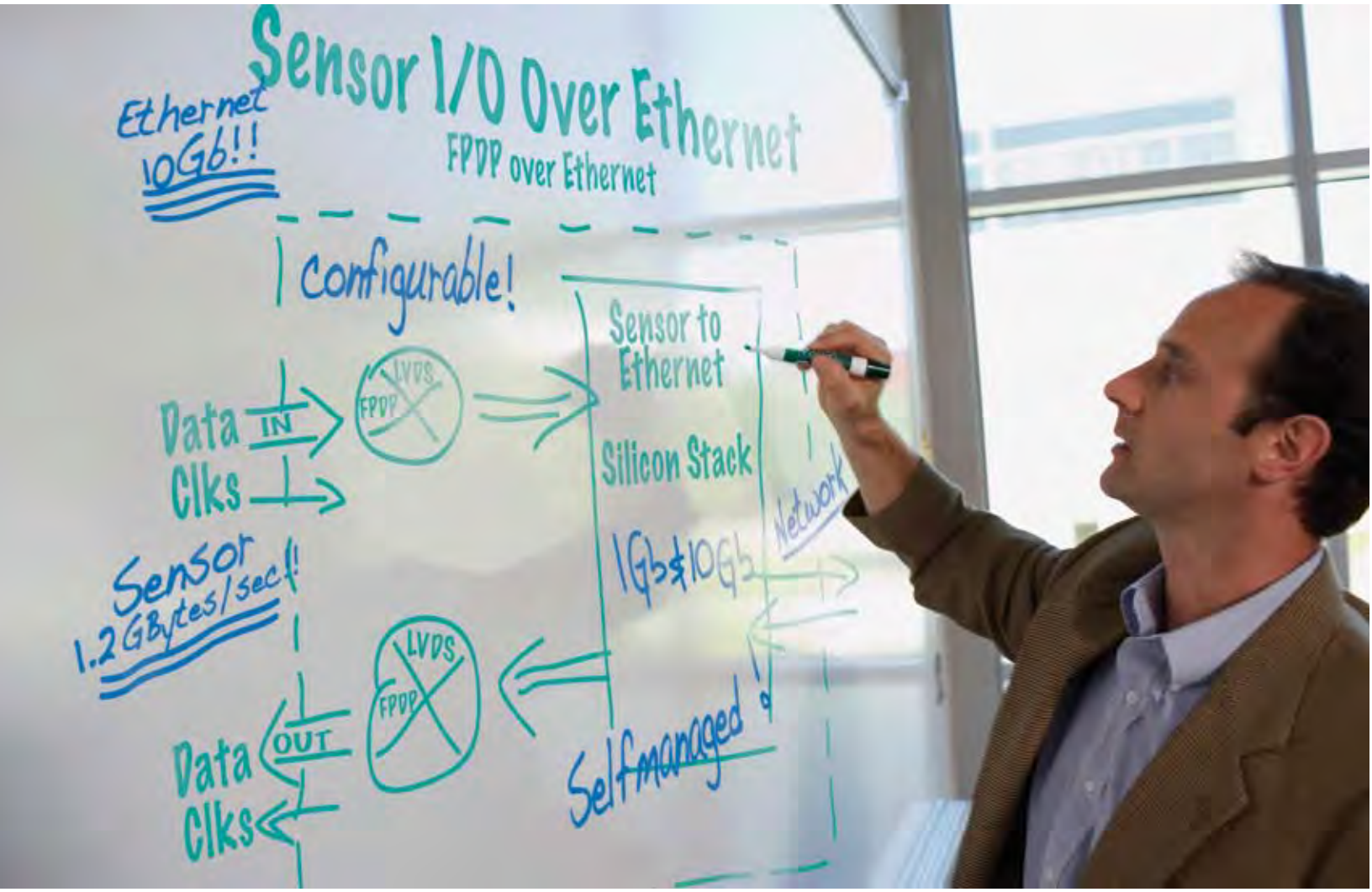

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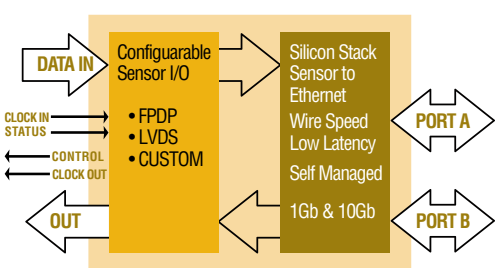

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the lighting, as well as changes in the position and movement of illuminated objects, is hugely complex.

OpenGL provides the requisite functionality in software to make all of this possible, but the processing complexity takes processor power. Desktop-grade graphics processing is therefore increasingly being used for these applications, since it can deliver the required level of detail in close to real time. In a less sophisticated graphics processing hardware environment, the application designer would need to make trade-offs.

In fact, significant effort has gone into creating a development environment that reduces processing overhead in order to provide maximum fidelity for a minimum hardware cost. An example of this is MIP mapping. OpenGL provides the functionality necessary to re-render an object, such as a helicopter, each time its size changes, for instance, while the helicopter disappears into the distance. However, this incurs two penalties.

The first penalty is loss of control over how the object is presented as it changes size. OpenGL will do the best it can, but key features that distinguish the object, such as the tail of the helicopter, may become blurred or disappear altogether. The second penalty is the processing overhead incurred in repeatedly re-rendering the image. MIP mapping allows the developer to predefine the original image in a series of sizes, preserving important detail and significantly reducing the GPU time required for rendering.

Challenges and Compromises

Graphics design in military applications, then, creates challenges. It can be said that no aspect of system design is more important than how the information the system generates is presented to the user. The developer's art is to maximize the ease with which the eye can interpret what is on the screen. But this must be done within the constraints of the target hardware, which may be determined by factors such as cost, size and heat dissipation. Only the most powerful hardware can deliver both maximum realism and maximum refresh rates.

Graphics design creates challenges for hardware manufacturers too. Historically, the needs of low-end graphics applications have been comprehensively met and manufacturers have continually tried to respond to the needs of very high-end applications. The challenge is to continue to strive for the high end, while not creating a gulf of capability between the extremes, allowing application developers to make even better choices about appropriate trade-offs.

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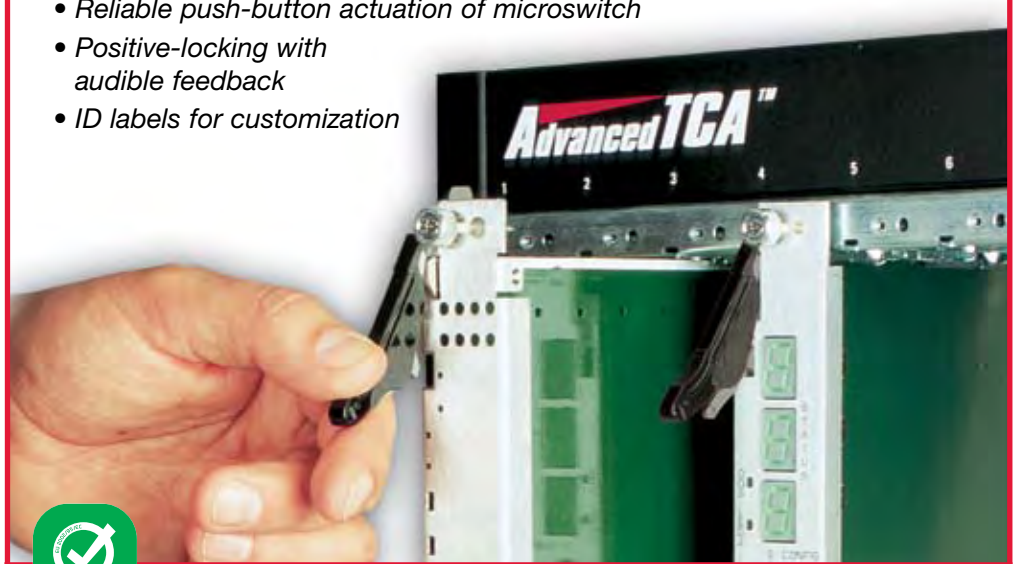

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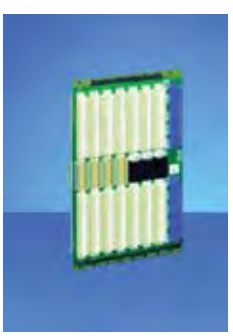

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Bus	AT Expansion Bus			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bus	PCI Universal Expansion Bus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		
Bus	PCI Bus Masters	4	4	4	4	4	4	4	4	4	4		4	4		
Bus	APIC (add'l PCI interrupts)	9	9	9	9	9	9	9	9	9	9					
CPU and BIOS	CPU Max Clock Rate (MHz)	1400	1400	1400	1400	650	650	650	650	650	650	333	333	333	100	100
CPU and BIOS	L2 Cache	2MB	2MB	2MB	2MB	256k	256k	256k	256k	256k	256k	16K	16k	16k	16k	16k
CPU and BIOS	Intel SpeedStep Technology	✓	✓	✓	✓											
CPU and BIOS	ACPI Power Mgmt	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0					
CPU and BIOS	Max Onboard DRAM (MB)	512	512	512	512	512	512	512	512	512	512	256	256	256	32	32
CPU and BIOS	RTD Enhanced Flash BIOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPU and BIOS	Nonvolatile Configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPU and BIOS	Quick Boot Option Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPU and BIOS	USB Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Peripherals	Watchdog Timer & RTC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peripherals	IDE and Floppy Controllers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Peripherals	SSD Socket, 32 DIP						1		1		1	1	1		2	1
Peripherals	ATA/IDE Disk Socket, 32 DIP	1	1	1	1	1		1		1				1		
Peripherals	Audio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Peripherals	Digital Video	LVDS	LVDS	LVDS	LVDS			TTL	TTL	LVDS	LVDS	TTL	TTL	TTL		
Peripherals	Analog Video	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA		
Peripherals	AT Keyboard/Utility Port	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peripherals	PS/2 Mouse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Peripherals	USB Mouse/Keyboard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
I/O	RS-232/422/485 Ports	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
I/O	USB 2.0 Ports	2	4	2	4											
I/O	USB Ports					2	2	2	2	2	2	2	2	2		
I/O	10/100Base-T Ethernet	1		1		1	1	1	1	1	1	1	1	1		
I/O	ECP Parallel Port	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
I/O	aDIO(Advanced Digital I/O)	18	18	18	18	18	18	18	18	18	18	18	18	18		
I/O	multiPort(aDIO, ECP, FDC)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
SW	ROM-DOS Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SW	DOS, Windows, Linux	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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Bus	AT Expansion Bus	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PCI Expansion Bus Master	✓	✓				✓							✓	✓
	McBSP Serial Ports	✓	✓				✓								
Analog Input	Single-Ended Inputs	16	16	16	16	16	16								
	Differential Inputs	8	8		8	8	8								
	Max Throughput (kHz)	1250	1250	40	500	100	1250								
	Max Resolution (bits)	12	12	12	12	16	12								
	Input Ranges/Gains	3/7	3/7	3/1	3/4	1/4	3/6								
	Autonomous SmartCal	✓	✓												
	Data Marker Inputs	3	3		3		3								
Conversions	Channel-Gain Table	8k	8k		8k	8k	8k								
	Scan/Burst/Multi-Burst	✓	✓		✓	✓	✓								
	A/D FIFO Buffer	8k	8k		8k	8k	8k								
	Sample Counter	✓	✓		✓	✓	✓								
	DMA or PCI Bus Master	✓	✓		✓	✓	✓	✓						✓	
	SyncBus	✓	✓				✓								
Digital I/O	Total Digital I/O	16	16	16	16	16	16	16	48	18/9	32	64	32	48	48
	Bit Programmable I/O	8	8		8	8	8	8	24	6/0				48	✓‡
	Advanced Interrupts	2	2		2	2	2	2	2					2	
	Input FIFO Buffer	8k	8k		8k	8k	8k							4M	8M
	Opto-Isolated Inputs										16	48	16		
	Opto-Isolated Outputs										16	16			
	User Timer/Counters	3	3	3	2	3	3	3	3	3				10	6
	External Trigger	✓	✓		✓	✓	✓	✓	✓					✓	
	Incr. Encoder/PWM									3/9					✓‡
	Relay Outputs												16		
Analog Out	Analog Outputs	2	2		2	2	2	4							
	Max Throughput (kHz)	200	200		200	100	200	200							
	Resolution (bits)	12	12		12	16	12	12							
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Military Suppliers Confront the RoHS Challenge

Most vendors of board- and system-level electronics to the military also supply commercial markets and depend on commercial components. That's why the RoHS directive's military exemption may not mean much a few years from now.

Ann R. Thryft,
Senior Editor

Although the EU's RoHS directive contains an exemption for electronics equipment used by the military, it's well known that the exemption may be temporary. Even if military equipment does remain exempt, since commercial component manufacturers and board makers supply both the military electronics market and the much larger, worldwide commercial electronics market, programs will definitely be affected.

But the problems encountered are not simple, and don't occur only at the board level. Many component makers have already transitioned to RoHS-compliant versions of their products. The vast majority of discrete resistors and capacitors have been compliant for the last five years or so. Most general-purpose ICs, such as memory, have made the transition. But some higher-end components such as processors are not being made in RoHS-compliant versions.

Other key components made with lead have been discontinued and are now available only in lead-free versions. The end-product must therefore be either changed to a fully RoHS-compliant configuration or discontinued, directly affecting defense customers, since non-lead versions may be subject to solder joint reliability and tin whiskering problems. Under these circumstances, board- and system-level electronics makers find themselves with few options except to use RoHS-compliant products. For all of these reasons, most defense systems based on commercial electronics will eventually contain RoHS-compliant components.

Since tin/lead is no longer the norm for many vendors, some board suppliers have experienced a cost increase of 10 to 100% on certain leaded parts and weeks may have been added to lead times. An additional wrinkle is the difficulty some board- and system-level makers have had in assuring the compliance of incoming parts and materials. Many companies are not using outside testing labs, but relying entirely on suppliers' declaration forms. While this works for many, it has not for everyone. Although there is no established standard operating procedure for RoHS testing yet, efforts are under way to develop standardized testing methodologies by a variety of national and international organizations. ▮▮

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RoHS-Related, Military-Related Sources

The Joint Council on Aging Aircraft/Joint Group on Pollution Prevention (JCAA/JGPP) industry consortium led by NASA performs reliability testing for military applications. It has completed a large test program, including thermal cycling, shock, vibration and combined environments. Results are publicly available online (http://acqp2.nasa.gov/JTR.htm).

The Lead-Free Electronics in Aerospace Project Working Group (LEAP-WG), in conjunction with the Government Electronics and Information Technology Association (GEIA), has released standards and guidelines on how to manage lead-free issues in the aerospace industry, including a tin whisker risk mitigation standard and program managers' guidelines (http://webstore.ansi/org). These standards are being recommended as DoD policy.

The U.S. Navy/University of Maryland's Center for Advanced Life Cycle Engineering (CALCE) (www.calce.umd.edu) has conducted reliability testing of lead-free materials, including solder joint reliability and tin whiskers, and has introduced models for assessing tin whisker risk and solder joint reliability.

The IPC international electronics standard organization's IPC-610D J-Std-001 addresses lead-free manufacturing practices (http://www.ipc.org).

The International Electronics Manufacturing Initiative (iNEMI) has worked in conjunction with the JEDEC standards organization to release a tin whisker acceptance testing standard and risk mitigation guidelines through the IPC (http://www.nemi.org).

Sources courtesy of Curtiss-Wright Controls Embedded Computing

We're seeing a mix of organizations that do and don't want to convert to RoHS-compliant designs. There are also some partial conversions, such as the "5 of 6" spec that removes five of the six restricted substances, but not lead. Building a hybrid system solution is sometimes an option if you can't get a board in a RoHS-compatible version. For example, 90% of the system may be RoHS-compatible and 10% not compatible for some time to come. Some manufacturers we buy from run two separate lines. Internally, we sometimes run RoHS-compatible and non-RoHS-compatible product lines. That requires a separate area and binning components separately. We are starting to see a need for that duality, but eventually it will disappear and everything will be RoHS-compatible. From the cost point of view the conversion is inevitable.

We have already converted some designs, such as our PMCs. These are largely storage products, where components for the next-generation design won't be available in leaded versions, such as SATA controllers. These must be converted to complete, 6 of 6, RoHS-compatible designs. Baseboards, such as many 6U VME cards, haven't been migrated yet, but the cards used on them will be, so that will mean hybrid assemblies.

To show that a particular model is RoHS-compliant, we added a symbol to the product's model number. The bill-of-materials changed and the entire design has been re-coded, redesigned and reallocated. Sometimes it costs more because there is a premium on RoHS-compliant components or processes. But this ratio will probably flip as volume goes to RoHS compliance. Our subcontractors use different types of test or analysis equipment for inspection purposes, while we are getting compliance statements for incoming parts.

Ken Grob, Vice President,
ACT/Technico

ACT/Technico, Warminster, PA. (215) 956-1200. [www.acttechnico.com].

"We're seeing a mix of organizations that do and don't want to convert to RoHS-compliant designs."

Curtiss-Wright Controls Embedded Computing is focused on the rugged deployed defense electronics market. A recent customer survey confirmed that the military market still wants a tin/lead manufacturing process, which has a proven reliability track record. Although we have completed a process capability to manufacture RoHS-compliant cards, we currently manufacture them only upon customer request. We will continue to focus on a tin/lead manufacturing process until the industry and research groups have conclusively demonstrated the reliability of lead-free manufacturing.

The two main reliability concerns with lead-free processes are solder joint reliability and tin whiskering. Lead-free alloy combinations used in component leads, solder and PWBs have, in some cases, demonstrated better solder joint reliability results than tin/lead. To address tin whiskers, many component manufacturers provide a matte tin finish with a whisker-resistant plating material such as nickel, and submit these parts to an annealing process.

For many years, the military market has successfully used lead-free parts, mostly passives, in a tin/lead manufacturing process. Curtiss-Wright follows a strict parts selection process that analyzes all of these factors. We re-ball or solder-dip components that are not compatible with our tin/lead process. Our comprehensive test program includes qualification, HALT, solder joint reliability and reliability demonstration. All boards are subjected to environmental stress screening prior to customer delivery.

Charles Falardeau, Director of Engineering Services,
Curtiss-Wright Controls Embedded Computing

Curtiss-Wright Controls Embedded Computing, Ottawa, Canada.
(613) 599-9199. [www.cwcembedded.com].

"Lead-free alloy combinations have, in some cases, demonstrated better solder joint reliability results than tin/lead."

To develop an intelligent plan for us and our customers, we decided which items needed to be converted to RoHS versions and which did not. Originally we planned to phase out non-RoHS products after one year from announcing a product's end-of-life. But we haven't yet decided how long to continue lead-based, non-RoHS products, since it is costly and inefficient for our contract manufacturers to run two lines side-by-side indefinitely.

The majority of our lines worldwide are RoHS-based with minimal lines still running non-RoHS processes. Key component suppliers have moved on to making RoHS versions of their main products, and that affects the defense business directly. The DoD and defense suppliers understand that this is a reality they must deal with. Our research has uncovered two alternatives for guaranteeing soldering quality as good as lead-based solder. One is to move up from IPC-A-610 Rev C Class 2, which most of the industry used previously, to IPC-A-610 Rev D Class 3. This is a high-performance electronic requirement for critical systems such as medical equipment that is very costly. Another is to look into the best alternative solder alloys.

In order to prove that components and build processes are RoHS-compliant, vendors must perform test and analysis. Each company that produces a product should be able to provide evidence that the product was built to RoHS requirements, by documenting that testing has been done either in-house or by a third party. We are doing a combination of inside and outside testing. Using outside labs is costly, but you get a declaration of conformity from all suppliers that their process and products are compliant.

Yasser Abusalih,
Director of Quality Assurance,
Kontron America

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

"Key component suppliers have moved on to making RoHS versions of their main products, and that affects the defense business directly. The DoD and defense suppliers understand that this is a reality they must deal with."

Like many COTS suppliers, we also supply other industries and purchase commercial devices. Our military customers want nothing to do with replacement materials for lead solder, such as silver, principally because there may be associated reliability problems. We decided not to respin all of our existing product designs for RoHS, but to begin doing so going forward starting a couple of years ago.

Most discrete parts and parts with leads can withstand the temperatures of both leaded and lead-free processes, but BGAs can be a problem. Our contract manufacturers use two soldering processes: all lead, where temperatures don't exceed 217° to 220°C and a "5 of 6" hybrid process at 240°C where the components, such as BGAs, are lead-free but the solder is leaded. Just because a vendor's component is lead-free doesn't mean that it is lead-free capable, meaning it can withstand processing at higher temperatures. Some lead-free components can't be processed above 220° or 230°C, so they must be placed by hand.

In ensuring incoming compliance, the biggest problem area is not PCBs but other parts, such as fans, third-party boards, connectors, lockwashers and labels. We keep certificates of RoHS compliance on all of our products and have added "-LF" to our RoHS-compliant part numbers, clearly describing those parts as "5 of 6" in our database. Most of what we ship is built with leaded solder; the rest may be a mix of leaded and non-leaded components.

Bob Kennedy, Quality Systems Manager,
Mercury Computer Systems

Mercury Computer Systems, Chelmsford, MA. (978) 256-1300. [www.mc.com].

"Our military customers want nothing to do with replacement materials for lead solder, such as silver, principally because there may be associated reliability problems."

NSL Analytical is an independent materials testing lab that does RoHS compliance testing for aerospace and commercial electronics. When the RoHS directive went into effect on July 1, we expected a spike in requests for sample testing, but that did not materialize. When talking with customers and potential customers about RoHS testing, the biggest issue is cost.

To test for all six restricted substances, the price is about $300 to $400 per sample or per homogeneous component. Each component of an electronic system must be sampled and analyzed, and there can easily be 20 to 50 or more, so the cost adds up. Some companies may instead want to do a risk assessment, sampling and analyzing only 70 to 80% of the system's components. In response to concerns about costs, we have purchased a handheld x-ray fluorescence "gun" to provide an alternative.

We are receiving more materials for spot checks, and some materials that may be out of spec, like solders, as well as some final products. Testing of more complex devices may hit further out in time. We haven't gotten many military-related materials yet. However, under the "China RoHS" law coming into play March 1, there are no exemptions for the military. In addition, there are a number of new RoHS-related state laws in the U.S. The overall effort is becoming global.

Dave Kluk, Technical Manager,
NSL Analytical Laboratories

NSL Analytical Services, Cleveland, OH. (216) 447-1550. [www.nslanaytical.com].

> "Under the "China RoHS" law coming into play March 1, there are no exemptions for the military."

If a vendor supplies a product to both military and non-military commercial markets, military customers must accept the RoHS version of that product. This is because there is no exemption for dual military and non-military use. For example, if a laptop computer is used in the home and office, it must meet RoHS requirements. The same laptop might also be specified in a military document, but it will not be available in a non-RoHS-compliant version. Most of our customers are military-based and they want non-RoHS-compliant products, so our products are typically not dual-purpose products that are also used in consumer applications. We also manufacture RoHS-compliant products for non-military customers.

The presence of RoHS-compliant components in products used for either commercial or military applications does not make that product itself RoHS-compliant. If we are building a newly designed product with recently released components, the RoHS version is pretty similar to the non-RoHS version in their components, but the two are built with different process lines: one is built with a leaded process, so it's not RoHS-compliant, and the other is built with a non-leaded process, so it is compliant.

We have run two separate lines for some products when a customer has requested a RoHS-compliant variant, and all of the product's parts were available in RoHS versions. But RoHS-compliant products are more the exception than the rule at the moment. Eventually, the military will have to use RoHS versions because there will be fewer non-RoHS components available.

Gerry Roth, Director of Operations,
TEK Microsystems

TEK Microsystems, Chelmsford, MA. (978) 244-9200. [www.tekmicro.com].

> "Eventually, the military will have to use RoHS versions because there will be fewer non-RoHS components available."

The widespread use of commercial components in military equipment is forcing defense contractors into the lead-free front line. This is because commercial component manufacturers, and by extension, board-level suppliers such as VersaLogic, cannot economically maintain both lead-free and leaded lines. Instead, they are withdrawing some leaded components or leaded board-level products from the market either by replacement with a lead-free alternative or no replacement at all. All components, from passives to semiconductors to LCDs, are being affected.

The military is aware of this. We work with several prime contractors that have migrated to using conformal coating in their assemblies. The coating doesn't prevent tin whiskers from developing but "traps" them, reducing the potential for a short. VersaLogic is currently manufacturing to accommodate a leaded manufacturing process that includes both RoHS and leaded components and a separate line to accommodate only RoHS-compliant components. We have thoroughly researched issues surrounding RoHS and developed manufacturing processes to ensure long-term product reliability. A comprehensive component approval process reviews all parts used on our products based on their finish type, which directly relates to their propensity to whisker. In addition, VersaLogic follows the latest iNEMI recommendations on part finishes to mitigate tin whiskers and we have eliminated use of some parts due to high-risk finishes.

We will continue to support military applications and build embedded product using now-legacy leaded processes when necessary and when possible. However, the fundamental objective of the COTS movement was to streamline the deployment of commercial, "state-of-the-art" technologies. Since commercial technologies are moving toward a RoHS model, the military must follow.

Tom Barnum, Vice President of Sales,
VersaLogic

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

"Since commercial technologies are moving toward a RoHS model, the military must follow."

The Challenges of RoHS Compliance and Testing

Although RoHS testing is not required to demonstrate producer compliance, it can help provide the documentation necessary to show due diligence. Efforts at standardizing RoHS testing are just beginning.

Carm D'Agostino, David Kluk and Adrian de Krom, Technical Specialists, NSL Analytical Services

The electronics industry, including manufacturers of aerospace electronics systems and subsystems, has been scrambling to comply with the European Union's Restriction of Hazardous Substances (RoHS) directive that took effect on July 1, 2006. With similar legislation pending in China, California, and 21 other U.S. states and Canadian provinces, the issue has taken on global implications. The RoHS directive has caused a great deal of confusion in the industry over what type of testing actually must be done to demonstrate compliance (Table 1).

Under the directive, suppliers of electronic equipment have to comply with regulations that guarantee that the entire unit is free of lead, cadmium, mercury and hexavalent chromium, as well as polybrominated biphenyl (PBB) and/or polybrominated diphenyl ether (PBDE), which are used as fire retardants.

Because RoHS is a product-based initiative, the responsibility for compliance falls on the producer of the electronic product. However, if a company re-brands products and imports them into Europe, it is considered to be the product's producer.

Although the directive does not obligate suppliers to document compliance, they run great risks if their product is tested and found to be out of compliance. Producers of non-compliant products will face fines and their products will not be allowed to enter the European market. Therefore, to protect themselves from prosecution, producers are strongly advised to show documentation indicating due diligence, meaning laboratory testing or full disclosure on all components.

Methods for Ensuring Compliance

There are many obstacles to compliance. First, suppliers often operate on thin margins and they may lack the time, funds and personnel to provide accurate substance information. Suppliers also are often not aware of all of the requirements of RoHS compliance and may not provide sufficient documentation.

One of the biggest problems is managing the mass of information generated. A supplier could realistically have hundreds of customers, each requiring a different materials declaration form. In addition, each form might have a different format. Since virtually no two companies use the same number or type of substances, suppliers could spend enormous amounts of time just filling out forms for their customers.

Figure 1

Although gas chromatography/mass spectrometer (GC/MS) testing provides a reliable indication of the presence of all six materials restricted by the RoHS directive, not all GC/MS equipment can detect the higher brominated forms of polybrominated diphenyl ether (PBDE).

Another problem is that the test methods presently available to demonstrate RoHS compliance are often inadequate. They may not be suitable for the substance or substrate being tested, or they may not be capable of meeting accuracy requirements. To address this issue, the testing industry and standards-making organizations are busy developing and verifying a variety of new procedures.

Finally, some producers are requiring direct input of test data into their reporting systems, and suppliers are faced with tailoring data for a variety of formats and forms, ranging from paper to electronic. Materials declarations formats and custom software are proliferating, and these multiple formats increase the burden on the supply chain.

Material	Pb, Cd, Hg	Cr(VI)	PBB/PBDE
Metals	Testing Needed	Testing Needed	Not Relevant
Ceramics	Testing Needed	Not Relevant	Not Relevant
Polymers	Testing Needed	Less Relevant	Testing Needed

Table 1

Materials affected by RoHS

Test Techniques	Substances	Test Methods		
		Polymers	Metals	Homogeneous Electronic Components
Mechanical Preparation	All	Direct Measurement Grinding	Direct Measurement Machining	Grinding
Chemical Preparation	All	Microwave Digestion Acid Digestion Dry Ashing Solvent Extraction	Acid Digestion	Microwave Digestion Acid Digestion Solvent Extraction
Analytical Methods	PBB/PBDE	Gas Chromatography/ Mass Spectroscopy (GC/MS) Liquid Chromatography (LC)	—	Gas Chromatography/ Mass Spectroscopy (GC/MS) Liquid Chromatography (LC)
	Cr (VI)	Colorimetry	Colorimetry	Colorimetry
	Hg	ICP/Atomic Emission Spectroscopy, ICP/Mass Spectroscopy Cold Vapor Atomic Absorption Spectroscopy, Atomic Absorption Spectroscopy		
	Pb/Cd	X-Ray Fluorescence, ICP/Atomic Emission Spectroscopy ICP/Mass Spectroscopy, Atomic Absorption Spectroscopy		

Table 2

Verification test procedures

To address this issue and bring some order to the process, Subcommittee F-40 of the ASTM International standards organization is developing a number of specifications. These include WK9114 – New Standard Practice for Declaration of Conformance with Materials Content Requirement, WK9115 – New Guide for Risk Assessment when Assessing Conformance or Compliance with Requirements, WK9866 – Standard Test Methods for Analysis of Tin-Based Solder Alloys and Pastes for Lead, Cadmium, Mercury, Antimony and Bismuth Using Inductively Coupled Plasma Atomic Emission Spectrometry, and WK11200 – Standard Test Method for Identification and Quantification of Restricted Substances in Polymeric Materials Using X-Ray Fluorescence Spectroscopy. The Subcommittee is also studying the adoption of standard test methods that address issues related to variability and interpretation of results.

The National Weights & Measures Laboratory (NWML) of the U.K. Department of Trade & Industry has developed a recommended guideline that allows producers to self-certify that their products comply with RoHS. NWML suggests using the following steps to help companies protect themselves against legal action.

1. *Assess the risk.*

Identify any weak links in the process. Analyze each stage of the operation and identify precautions that can be taken. Know what is happening in your industry sector and be aware of how and where your products are being used or marketed.

2. *Establish what you are going to do about it.*

Put reasonable safeguards in place to ensure you have done all that the law requires and that you are meeting accepted industry standards. Try to eliminate the chance of anything going wrong or control risks so that errors are detected and corrected early.

3. *Document your solution.*

Document your control system so it can be followed. Inform employees of your actions and train those responsible for operating the system of checks. Documented records should be kept that outline procedures followed and how processes were validated.

4. *Operate your system.*

This may require you to audit the system of checks and keep records of the audit.

5. *Review your system regularly to ensure that it remains effective.*

Types of RoHS Testing

Chemical testing of materials may be required for a number of reasons. First, it provides a more reliable alternative to supplier materials declarations. It also provides a way to confirm compliance and assess compliance.

Some test methods to determine the content of restricted materials already exist, but most are not appropriate for

testing electronic products. In addition, most methods are not recognized internationally, and not all are accepted by every country in the EU (Table 2).

Manufacturers of bench-top and handheld x-ray fluorescence (XRF) equipment have gained attention by claiming their systems can detect restricted materials without destructive testing. While XRF can play a vital role in RoHS compliance testing, its main strength is as a screening tool to identify concentrations of restricted substances that are significantly above regulated limits. X-ray fluorescence testing can be used to quickly determine whether a particular substance is present. However, it falls short where precise information concerning concentrations is needed.

Caution must be taken when relying on the accuracy of values generated using XRF because measurement errors of +/-30% to +/-50% in electronic components are not uncommon. These large margins of error are due in part to depth of penetration, beam size, spectral interference, matrix interference, lack of comparative standards and the availability of sufficient uniform surface area.

Thus, while XRF is useful for screen testing because of its speed and efficiency, it has limited use and applicability. A variety of test methods are more reliable for making accurate determinations. These include gas chromatography/mass spectrometer (GC/MS) testing, which provides a reliable indication of the presence of restricted materials. However, not all GC/MS equipment can detect the higher brominated forms of PBDE (Figure 1). ■■

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"Manufacturers of bench-top and handheld x-ray fluorescence (XRF) equipment have gained attention by claiming their systems can detect restricted materials without destructive testing."

System Development

RoHS Challenges: Industry Perspectives

Getting Ready for Round Two of RoHS

Some unforeseen consequences of RoHS compliance for military systems have emerged, and other RoHS-like restrictions loom, including China's pending mandate, which allow no exemptions, and the EU's upcoming REACH initiative.

Doug Patterson
Vice President of Worldwide Sales and Marketing,
Aitech Defense Systems

Newton's Third Law of Motion tells us that "for every action there is an equal, but opposite, reaction." What Newton didn't tell us is that the reaction may not exactly produce a favorable outcome. RoHS compliance is an example of this fact.

In the wake of the European Union's July 2006 mandate to eliminate hazardous substances from electronic components, unforeseen consequences have emerged that should be raising major red flags with the institutions that research and create the requirements for RoHS compliance. Within the military and defense industries, these red flags have not only been raised, but are flapping in the breeze.

The most notable repercussion of RoHS compliance is the problem of tin whisker formation, a major issue that is continually worsening as more RoHS-compliant components are used throughout electronic systems. As more component vendors switch their internal processes to "pure" (>97%) tin, some are neglecting to mark the devices with new, unique part numbers, and are failing to inform their defense industry customers

System	Synopsis
Heart Pacemaker	Class I Product Recall: Tin whisker short from tin-plated case of crystal component caused a complete loss of pacemaker output.
F-15 Radar	Tin whisker short inside hybrid package.
US Missile Program	Tin whisker from tin-plated relays.
US Missile Program	Tin whisker from tin-plated TO-3 transistor can short collector to case. Short erroneously turned on electrical unit.
Phoenix Air to Air Missile	Tin whisker shorts inside hybrid package.
Patriot Missile II	Tin whisker from tin-plated terminals.
GALAXY IV	Complete loss of satellite operation. Tin whisker short from tin-plated relays.
GALAXY VII	Complete loss of satellite operation. Tin whisker short from tin-plated relays.
SOLIDARIDAD I	Complete loss of satellite operation. Tin whisker short from tin-plated relays.
Additional Satellites	Three additional satellites of same general design have lost one of two redundant control processors due to tin whiskers.
Nuclear Utilities	Tin-plated contact support arms on relays grew tin whiskers causing a resistive shunt path.
Rocket Monitor Initiator	During assembly-level testing, the rocket monitor initiators were showing an ohmic short from the charge wires to the case.

Source: Adapted from the U.S. Navy and the University of Maryland's Center for Advanced Life Cycle Engineering (CALCE) position paper on Risks to High-Reliability Electronics and Associated Hardware from Pure Tin Coatings, Appendix B.

Table 1

System failures attributed to tin whiskers

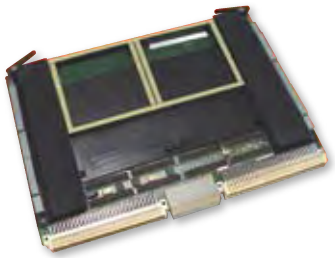

Figure 1

Components made with processes that use RoHS-compliant "pure" (>97%) tin run the risk of tin whiskering, which lowers reliability. When not correctly marked, those components may be used in SBCs for critical military systems, which must provide reliable operation and withstand harsh environments. The improved processing power and I/O functionality of Aitech's dual 7448 PowerPC processor C102 are targeted at harsh environment applications such as mission management computers, heads-up display controllers, radar and sonar processors and advanced IED automatic protection subsystems.

of the switch. In fact, "hybrid" reels of discrete passive parts are being shipped with mixed tin/lead and pure tin devices.

This is exceptionally bad for the defense industry, which in most cases cannot tolerate pure tin for deployed equipment, since the formation of tin whiskers lowers real-world reliability. Many non-rugged, commercial-only board manufacturers may be unaware of these ramifications in military applications and are either knowingly or unknowingly employing these components, which are not designed to withstand the harsh environments in which the boards must operate. Critical military systems that use SBCs, such as Aitech's new dual 7448 PowerPC processor C102, need to withstand harsh environments and provide reliable operation (Figure 1).

Studies have documented the growth of mono-crystalline tin whiskers at up to 5 or 6 angstroms per second (5 x 10^{-10} meters/sec). This represents a growing potential failure of about 1.3 microm-

eters in one month, or about 1.5 mm in a year. This rate is more than enough to potentially bring down an entire subsystem or the platform it is on in less than 12 months (Table 1).

Nor will failures be occurring only during operation. The U.S. Navy and the University of Maryland's Center for Advanced Life Cycle Engineering (CALCE) have recently focused research efforts on physics-of-failure mechanisms in complex electronic subsystems. Results have indicated that even components in passive storage form tin whiskers at an alarming rate.

For the first time, it has been discovered that tin whiskers have appeared even in alloys of Sn3Ag0.5Cu0.5Ce (tin/silver/copper/cerium) solder joints of ball grid array (BGA) packages after storage

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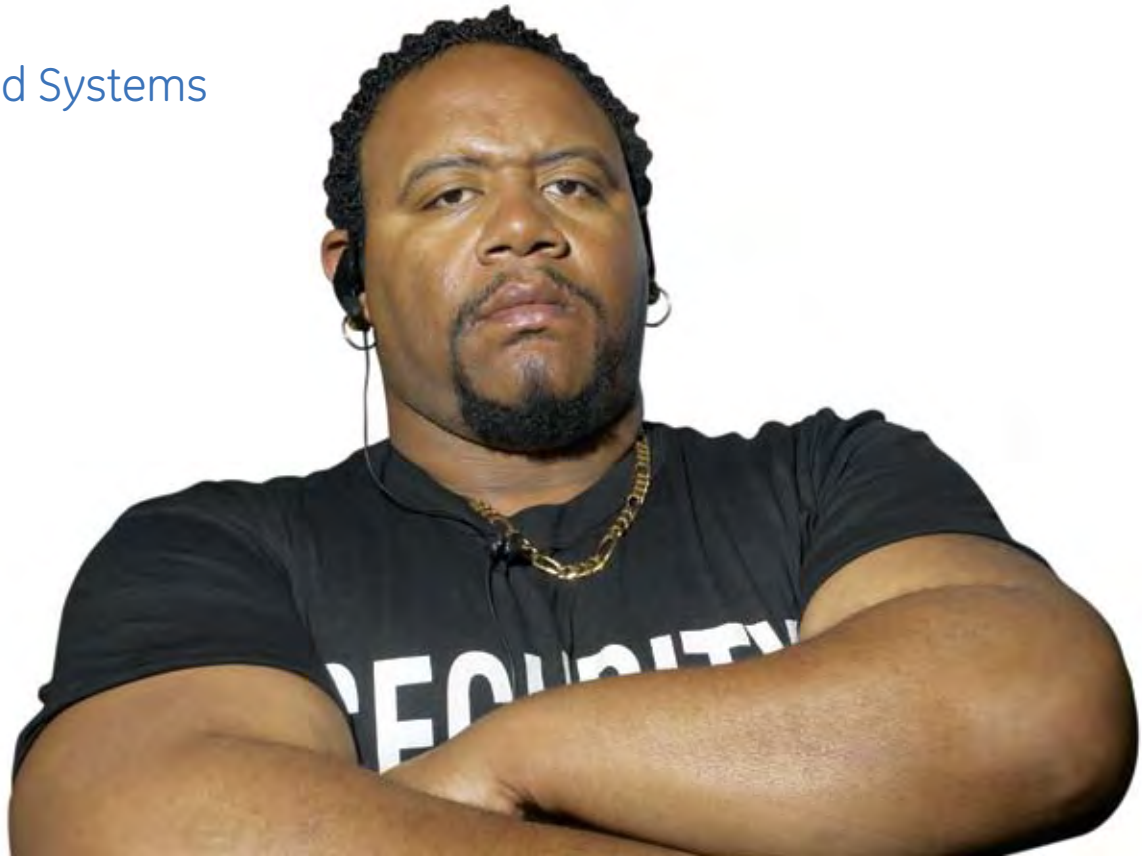

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at room temperature, i.e., natural aging, for less than three days. In addition, the whiskers grew at a high rate of 2.9 Ă/sec. In one particular case, they even formed after only one day of storage at an extremely high growth rate of 8.6 Ă/sec.

Also for the first time, experimental investigations are underway in an effort to finally explain why tin whiskers grow in the first place. These studies have shown that a number of CeSn3 (cerium/tin) clusters still existed in the Sn3Ag0.5-Cu0.5Ce alloy solder matrix after the reflow process, meaning that further natural aging in free ambient air for several days caused the CeSn3 phases to oxidize more rapidly than the surrounding alloy. This pressure generates physical/mechanical strain on tin cluster crystalline boundaries which helps "push" the tin whisker to begin to form. In this instance, hundreds of minute tin whiskers sprouted and grew to a length of hundreds of micrometers in a very short period of time.

The most commonly observed whiskers have been long, fiber-shaped ones of 0.1 mm to 0.3 mm in diameter, known as Type I. In extreme cases, short whiskers larger than 1 mm in diameter can also be found, known as Type II. Here, the surface oxide of the CeSn3 phase possessed a higher content of cerium than of tin, which implies that a cerium-depleted region of nearly pure tin was left beneath the oxide layer. The abnormal whisker growth was attributed to the resulting compressive stress.

In a surprising move, many of the larger prime contractors, working with each other and with outside industry experts such as CALCE, are attempting to address the problem through risk mitigation via post-chip manufacturing processes. These processes include pre-tinning pure tin parts with tin-lead solder alloys, heat treating/annealing the component's leads, the application of various conformal coatings at the board assembly level and other techniques. Although these mitigation techniques are not attacking the problem at the root cause, i.e. the component manufacturers, at least these are positive steps and hopefully in the right direction.

Now that some of the major issues with the requirements for compliance to European RoHS have surfaced and are being dealt with, the industry will need to start tackling China's RoHS-like mandate, the Management Methods for Controlling Pollution by Electronic Information Products law. The first required milestone of this initiative goes into effect on the first of March 2007.

"China RoHS," which is leaning toward more accountability, is considered by some to be even more stringent than European RoHS requirements. According to China's Ministry of Information Industry (MII), there are no approved exemptions; the line is clearly drawn. The entire supply chain is responsible and subject to penalties.

Each product must have four marks: a label defining whether or not the products contain any of the six hazardous substances; a table in the product documentation, which must disclose which hazardous substances are contained in the product and in which components they are present; packaging material must be disclosed on the outside packaging; and the date of manufacture must be marked on the product.

In addition, the EU has proposed to reform its methods for assessing the risks of hazardous substances. The Registration, Evaluation, and Authorization of Chemicals (REACH) initiative proposes a single regulatory framework to replace the system currently used in Europe to assess the risks of substances on the market before September 1981, as well as the risks of new substances. It differs from RoHS in that it targets chemical substances, not specific products. In addition, it is not a directive. Rather, it will be an immediately effective regulation at the EU level for all EU member states.

Some real issues have begun to surface. Their repercussions are not yet fully known, but these are at this moment causing real-world system failures in military systems. As these new initiatives become mandates, and companies continue to move toward compliance, it appears that there will be a need to delve deeper into the effects these new requirements will have on military systems in the long term as well as the short term. ■

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Technology Focus

Data Acquisition Boards

USB and FPGAs Revamp Data Acquisition

In both deployed military subsystems and system test labs, data acquisition is getting a face-lift thanks to FPGAs and USB.

Jeff Child,
Editor-in-Chief

While advances in radar, sonar, SIGINT and broadband comms technology over the years have been no less than phenomenal, the role of the data acquisition subsystems at the heart of those applications remains the same. They still capture, digitize and then move data onward for storage or processing. However, today's data acquisition systems are tasked to do all that at ever higher speeds and wider bandwidths.

Driving that are the twin trends toward higher sensor performance and the inclination to tie more sensors together into wider arrays. An example along those lines is the next-generation E-2D Advanced Hawkeye aircraft, which will feature a new radar system and multisensor integration (Figure 1). Meanwhile, data converters used in military applications, such as defense communications and radar systems, must operate at ever-increasing speeds and higher resolutions. As a result, the digital domain is encroaching on the antenna or sensor array. As this happens, military system designers face serious challenges when trying to move signal data in ever-increasing volumes.

To accommodate those demands, makers of high-end data acquisition boards and subsystems are designing the latest analog-to-digital converter (ADC) technology into system architectures designed to avoid bottlenecks at the back-end data movement phase. If one trend stands out in that scenario, it's the increasing use of FPGAs. More and more of these board architectures are embracing FPGAs as a means to efficiently channel digitized data as it's propelled to where it needs to go. Moving the analog to digital conversion closer to the front end is priority number one for applications such as radar, beamforming, electronic warfare and electronics counter measures. The sooner they get into the digital domain, the better such systems can operate in noisier environments.

At the lower-end of data acquisition, military projects are benefiting from the invasion of Universal Serial Bus (USB) into the realm of data acquisition. USB brings a blend of high performance, ease-of-use and high integration to data acquisition. That means fairly sophisticated test systems measuring temperature, vibration and other factors can be implemented on a desktop controlled by a PC rather than requiring a rack of A/D and controller boards.

Also by leveraging the bandwidth and performance of USB 2.0 technology, data acquisition applications can do bidirectional high-speed transfer of data between the USB device and a computer. This "signal streaming" approach makes it possible to acquire and generate multiple analog and digital I/O signals simultaneously. The products compiled in the next couple of pages reflect both those trends of FPGAs enhancing high-end deployed data acquisition and the mainstream data acquisition world being transformed by the migration to USB. ▮▮

Figure

FPGA-enhanced data acquisition systems are enabling the next generation of advanced airborne radar systems. Scheduled for first flight in 2007, the next-generation E-2D Advanced Hawkeye aircraft will feature a new radar system and multisensor integration. Shown here are the crew members at their stations inside the E-2C Hawkeye, the E-2D's predecessor.

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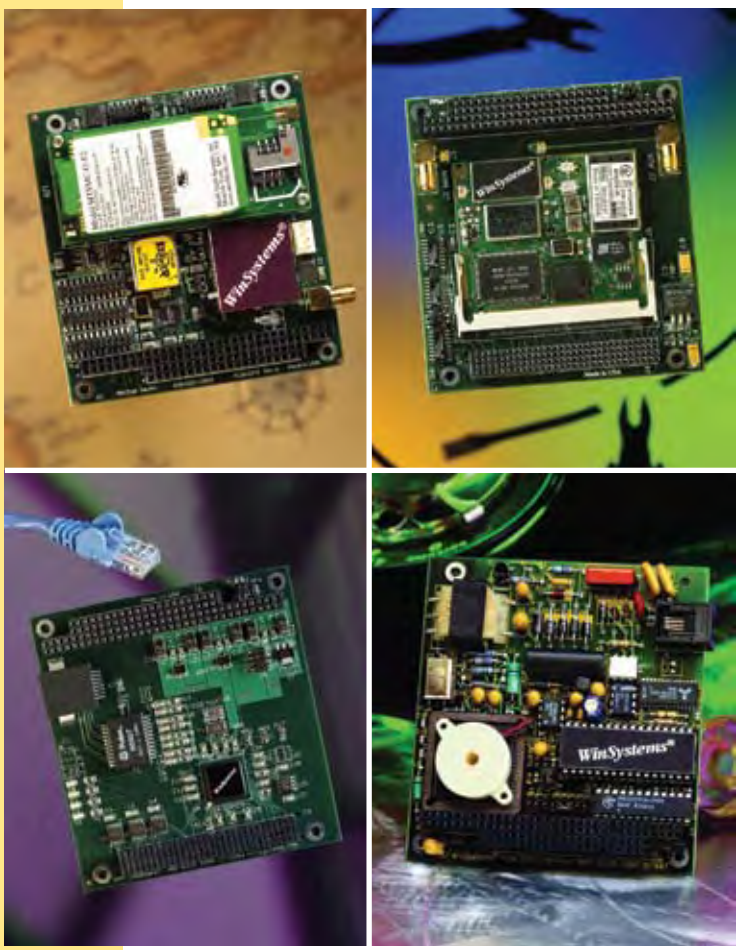

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Technology Focus:

Data Acquisition Boards Roundup

Counter/Timer Card Targets Measurement Apps

Timing and courting functions rank high as key functions of any data acquisition effort. Serving those needs, ACCES I/O Products provides its embedded digital counter/timer board—Model USB-CTR-15. This board is packaged in a small, rugged, industrial enclosure and features 15 independent 16-bit counter/timers. This USB device is an ideal solution for

adding portable, easy-to-install, counter/timer capabilities to any PC or embedded system with a USB port. The unit is a true USB 2.0 device, offering the highest speed available with the USB bus. It is fully compatible with both USB 1.1 and USB 2.0 ports. The unit is plug-and-play, allowing quick connect/disconnect whenever you need additional counter/timer devices on your USB port.

The USB-CTR-15 can be used for a wide variety of measurement applications including event counting, frequency measurements, position measurement, pulse counting, pulse-width modulation and pulse generation. The OEM version provides just the board without the enclosure or external screw terminal board and is ideal for a variety of military embedded OEM applications. The USB-CTR-15 features five fully undedicated industry standard 82C54 counter/timer chips. Each 82C54 provides three independent software programmable 16-bit counters. Available now, the USB-CTR-15 is priced at $249, and an OEM version is available for $199.

ACCES I/O Products

San Diego, CA.

(858) 550-9559.

[www.accesio.com].

VME/VXS Data Acq Boards Suit EW and Radar Designs

One can always tell when an embedded board form-factor has reached a critical mass—when data acquisition board products start to embrace it. Doing just that for VXS, Acqiris is expanding its product offering with a new family of VME/VXS (VITA 41 form-factor) boards. The series combines state-of-the-art Xilinx Virtex-4 SX and FX functionalities with advanced Acqiris data conversion technology to provide leading-edge performances in electronic warfare (EW), synthetic aperture and phased array radar, software defined radio, semiconductor and medical imaging applications.

The new VME/VXS product family incorporates Acqiris' JetSpeed II technology for clock generation and distribution, while supporting Gsample/s up-to-date ADC and DAC technologies that offer best-in-class performances. Based on a scalable, modular

architecture, the new VME/VXS boards feature two Xilinx Virtex-4 FPGAs, one SX55 targeted at digital signal processing and one FX100 for data flow control. The new family also provides support for the VXS interface, two optical links on the front panel, a VME64x interface as well as DDR2 SDRAM memory and auxiliary analog and digital I/Os. The first member of the VME/VXS products family is targeted for release this quarter (Q1 2007).

Acqiris USA, an Agilent Company

Monroe, NY.

(877) 227-4747.

[www.acqiris.com].

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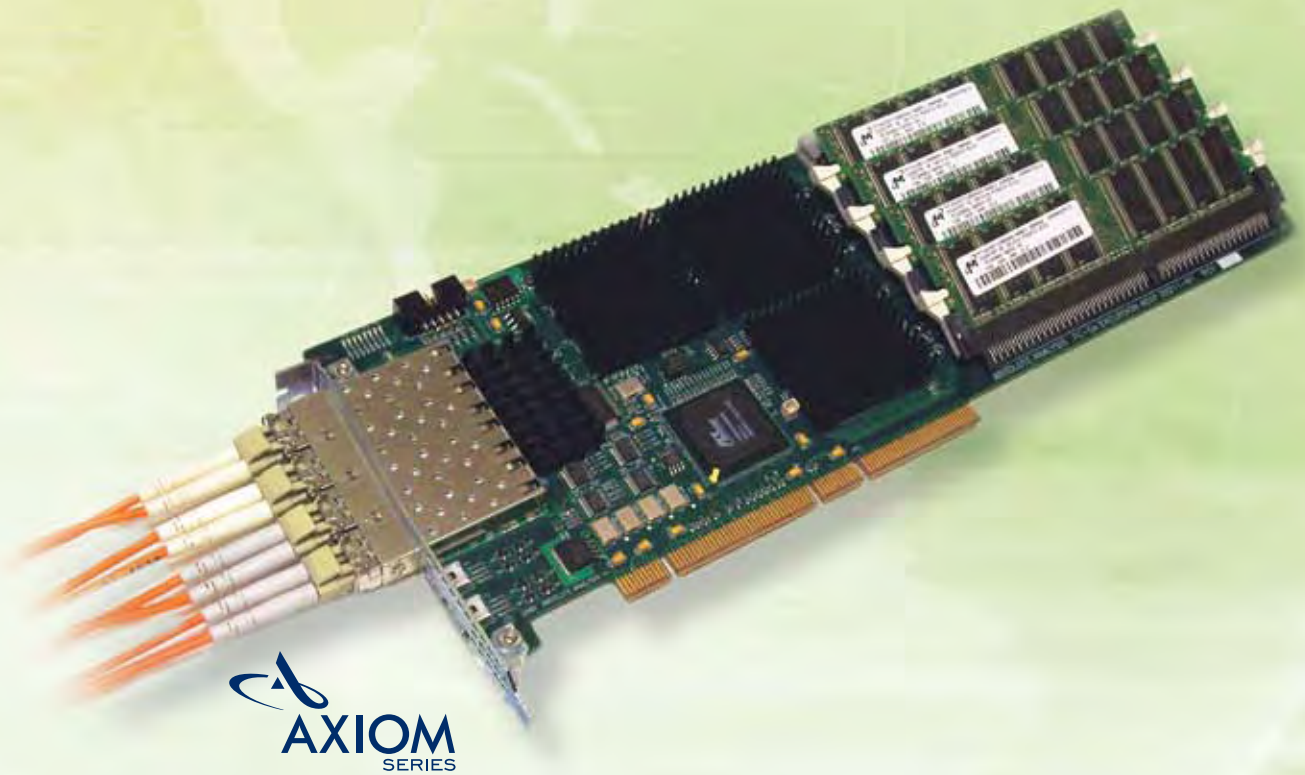

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Serial FPDP Card Enables Long Distance Data Capture

It's not always possible to get data conversion gear close to where the analog data is acquired. Serial FPDP is rapidly becoming the interconnect of choice for streaming data capture systems because it is a protocol optimized for maximum data rates and minimum overhead. It efficiently

accommodates many applications requiring great distances between the data input site and data processing stations. Along those lines, Conduant offers its StreamStor SFPDP (Serial Front Panel Data Port) mezzanine board for long distance, high-speed, data capture from Serial FPDP or other optical fiber data protocols. When combined with Conduant's StreamStor Amazon SATA disk controller, real-time data input performance exceeds 500 Mbytes/s.

The StreamStor SFPDP Mezzanine Board features four independent optical fiber interface ports for simultaneous data input and output available on each port. With data rate and wavelength options, the board can support cable lengths up to 25 kilometers. The StreamStor SFPDP Mezzanine Board exceeds the ANSI/VITA 17.1-2003 specification with sustained rates of 300 Mbytes/s (3.125 Gbytes/s). Wavelength options include 850 nm (nanometers) and 1300 nm for distances up to 25 kilometers. Data rates range from 1.06-3.125 Gbits/s on each of the four ports. The mezzanine board supports multiport recording whether bonded or independent. It is field-upgradeable and features customizable hardware.

Conduant

Longmont, CO.

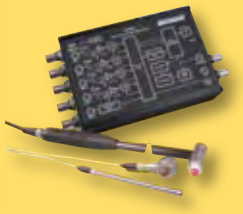
(303) 485-2721.

[www.conduant.com].

Portable USB Data Acq Module Has Four Sensor Inputs

Vibration analysis need no longer be relegated to the lab. With today's USB-based data acquisition solutions, the hardware needed can be ported along and plugged into a laptop in the field. For is part, Data Translation offers the DT9837, a high-performance multifunction USB module for sound and vibration analysis. The DT9837 has four independent 24-bit IEPE (Integrated Electronics Piezo Electric) sensor inputs that are synchronized with a tachometer input to provide data streams matched in time for field or laboratory use.

This rugged small module is self-powered via the USB connection to a PC or laptop, no external power supply is needed. This makes it ideal for portable measurement applications. BNC connections are provided for all I/O signals for secure and easy to use operation. The board sports four simultaneous 24-bit Delta-Sigma A/Ds with support for IEPE inputs including 4 mA current source and AC or DC sampling. Tachometer input support is provided in the A/D data stream for synchronizing measurements. The board supports sampling rates of over 52 kHz per input channel, with simultaneous operation of A/D and D/A subsystems for maximum performance. One 24-bit Delta-Sigma D/A converter is included for single value or ultra smooth waveform generation. The DT9837 is supported by Measure Foundry, Data Translation's popular rapid application



development and solution-based software package, which allows the user to create noise and vibration applications quickly and easily. The DT9837 high-performance USB module is priced at $1,495.

Data Translation

Marlboro, MA.

(508) 481-3700.

[www.datx.com].

Integrated Data Acq System Targets Acoustics

Gone are the days when a high-density acoustic data acquisition system required a backplane's worth of electronics. Today that functionality is available in a single 1U card. Exemplifying that trend, Radstone Sensor Processing—part of GE Fanuc Embedded Systems—offers its daqNet product, a fully integrated acoustic data acquisition/conversion system. Available in a rackmount 1U form-factor, daqNet is characterized by its high channel density analog (192 channels) and digital (240 channels) I/O. The uniquely

compact size and highly competitive pricing of daqNet make it appropriate for a broad range of sonar applications in surface ships and submarines, in vibration analysis and in test and measurement.

An autonomous high-speed acoustic server ideal for today's network-centric environment, daqNet provides data connections and control capabilities via dual Gigabit Ethernet interfaces. The server is easily configurable via the redundant dual Gigabit Ethernet connections using the SNMP protocol. With its plug-and play-capabilities, daqNet can be connected to the network, configured with the sample application provided, and the connection tested through hardware-implemented A/D and D/A test channels. daqNet is customizable using any combination of up to four I/O modules—analog input, analog output or digital I/O: each digital I/O module provides several options for triggering control including the ability to precisely synchronize digital and analog outputs for use in sonar transmit systems. An unlimited number of daqNet servers and channels can be synchronized in real time using Radstone Sensor Processing's advanced time stamping technology. Each daqNet supports master/slave configuration for redundancy in the event of a failure.

GE Fanuc Embedded Systems

Billerica, MA.

(800) 368-2738.

[www.radstone.com].

USB Data Acq Devices Feature Streaming Capability

By leveraging the bandwidth and performance of Hi-Speed USB technology, data acquisition applications can do bidirectional high-speed transfer of data between the USB device and a computer. Along those lines, National Instruments has added two high-performance M Series multifunction data acquisition (DAQ) devices for USB. The new NI USB-6221 and USB-6229 DAQ devices provide up to 32 analog inputs with a 250 ksample/s single-channel sampling rate, NI has extended its USB DAQ offering to 40 devices.

The USB-6221 and USB-6229—as well as bus-powered and other high-performance USB DAQ devices—feature NI "signal streaming" technology, which utilizes the bandwidth and performance of Hi-Speed USB technology to allow bidirectional high-speed transfer of data between the USB device and a computer. NI signal streaming technology makes it possible

to acquire and generate multiple analog and digital I/O signals simultaneously. Because the technology relies on message-based rather than register-based configuration, much of the configuration takes place on the device, avoiding unnecessary USB transfers. Engineers can stream more synchronous analog and digital data for data-intensive applications than is possible using USB DAQ devices alone. Additionally, with the plug-and-play connectivity of USB, engineers have an easy-to-use, portable solution for their measurement, monitoring and control applications. The USB-6221 and USB-6229 DAQ devices are priced from $999.

National Instruments

Austin, TX.

(888) 280-7645.

[www.ni.com].

Data-Capture and Processing Board Samples at 2 GHz

Signals in the 900 MHz range require some power processing to digitize. In the past it's been nearly impossible to directly digitize signal bandwidths up to 900 MHz, in order to capture wideband radar and communication signals as a single channel instead of digitizing several smaller bandwidth slices. Pentek has smoothed the way with its Model 6826 VME A/D Converter board. The Model 6826 features single- or dual-channel data acquisition at a blazing 2 GHz samples/s with 10-bit resolution using the new Atmel

AT84AS008 A/D device. The inclusion of the Virtex-II Pro FPGA is essential for processing these large bandwidth signals to extract information and reduce the data rates to a manageable level within the system. The board's ability to accept either single-ended or differential inputs preserves signal integrity across a variety of analog signal sources.

The Model 6826 also features extensive memory resources. Dual 64-bit, high-speed DDR SDRAMs provide a total of 512 Mbytes or 1 Gbyte of memory to store raw data in transient-capture mode. To support high-bandwidth data capture, the board includes several high-speed I/O channels to move the raw data off-board for storage or processing. Two or four channels of FPDP-II data ports, operating at up to 400 Mbytes/s each, deliver processed and de-multiplexed data through legacy connections to other VME cards. In addition, the board offers two serial switched-fabric VXS connections, each running full duplex at 1.25 Gbytes/s to support the new Xilinx Aurora, Serial RapidIO and PCI Express protocols. LVDS I/O is also available on either front or rear panel connections.

Pentek

Upper Saddle River, NJ.

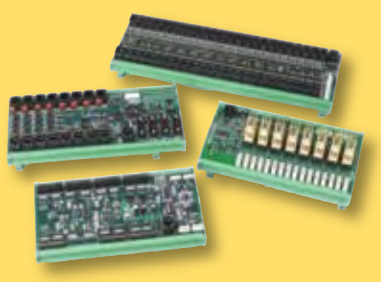
(201) 818-5900.

[www.pentek.com].

Module Links Ethernet with Multiple I/O Links

Many data acquisition systems can't have the luxury of having the sensors close to the processing gear. That's where remote data acquisition over Ethernet comes to the rescue. The military favors Ethernet for its longevity and ubiquity. Along those lines, Sensory offers its 2600 Series of measurement and control modules. It uses 10/100 Mbit/s Ethernet to connect a LAN to a virtually limitless number of I/O measurement and control points. A basic system is made from a model 2601 Communication Module, a 24 VDC power supply and an Ethernet connection.

The Communication Module distributes operating power and communications to as many as sixteen satellite I/O modules. It also monitors interlock signals and routes power to I/O modules through an innovative daisy chain. As an added bonus, each Communication Module includes four RS-232/422/485 communication ports for connecting to serial devices. More complex systems are formed by connecting two or more Communication Modules to a network switch, which in turn is connected to a LAN. Each Communication Module is then connected to satellite I/O modules as required. A wide range of I/O module types are available in the 2600 series. Each I/O module type has a specialized function such as analog I/O, thermocouples,



relays, digital I/O, and so on. A low-cost category-5 patch cable connects each I/O module to its Communication Module. Any combination of I/O modules may be connected to a Communication Module. All I/O modules have on-board DC/DC converters to power module circuitry.

Sensoray

Tigard, OR.

(503) 684-8005.

[www.sensoray.com].

VME/VXS Card Marries DACs and ADCs

Moving the analog to digital conversion closer to the front end is priority number one for applications such as radar, beamforming, electronic warfare and electronics counter measures. The sooner they get into the digital domain, the better such systems can operate in noisier environments. With all that in mind, TEK Microsystems offers the new Triton VXS-1, the first product to combine FPGA technology with a 12-bit, 2.0 Gsample/s DAC and a 10-bit, 2.0 Gsample/s ADC. Triton VXS-1 provides a 16x improvement in currently available resolution for demanding signal processing applications. The new 6U VME/VXS payload card is the first to provide both ADC and DAC on the same card.

Enhanced channel-to-channel synchronization between Triton and multiple Neptune 2 cards supports applications requiring up to 32 channels to remain coherent to within one sample. The precise synchronization between ADC and DAC channels means that active systems can have very low latency between the sampled input and the corresponding output. This benefits electronic warfare and radar system designers as the phase jitter on output signals will be reduced, leading to higher-fidelity transmitted signals. VXS adds a high-speed P0 connector to VME boards to support switched fabric intercon-

nects such as Serial RapidIO and PCI Express along with low-latency point-to-point links such as Serial FPDP and VITA 55. Triton couples the world's highest performance ADCs/DACs with a scalable FPGA based processing architecture. The Triton VXS-1 is available now and is priced beginning at $31,000.

TEK Microsystems

Chelmsford, MA.

(978) 244-9200.

[www.tekmicro.com].

PMC Does Dual-Channel 105 MHz A/D Conversion

For applications such as Software Defined Radio, SIGINT and data recording, the trick is to blend maximum performance with minimal latencies. VMETRO does just that with its PMC-FPGA05-ADC1, a Xilinx VirtexT-5 LX110 FPGA-based PMC module with integrated dual analog input channels. It closely couples the high-performance FPGA processing and the analog I/O. The analog input front end

incorporates dual-channel analog input with a full power input bandwidth of between 100 kHz and 110 MHz with a Signal to Noise Ratio (SNR) of 68 dB and a Spurious Free Dynamic Range (SFDR) of 82 dB. The full scale analog input is +10 dBm (2V pk-pk). Front panel clock and trigger inputs are also available.

The PMC-FPGA05-ADC1's high-performance dual analog interfaces combined with the processing power and PCI-X bus interface enable this PMC module to provide front-end processing. Processing on the PMC-FPGA05-ADC1 is provided by a Xilinx XC5VLX110 Virtex-5 FPGA. Supported by three banks of QDRII SRAM (8 Mbytes per bank) and two banks of DDR2 SDRAM (128 Mbytes per bank), the Virtex-5 FPGA is capable of performing sophisticated, high-speed DSP tasks in a small footprint. The PMC module supports a 133 MHz PCI-X interface as well as PMC digital user I/O via the Pn4 connector. Both of these interfaces are provided by the FPGA.

Software support for the PMC-FPGA05-ADC1 includes host drivers for Windows and VxWorks. Linux support is scheduled for the second half of 2007. The drivers support high-speed DMA to minimize potential bottlenecks between the analog input, the FPGA and the host processor. Pricing for the PMC-FPGA05-ADC1 is $7.995.

VMETRO

Houston, TX.

(281) 584-0728.

[www.vmetro.com].

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IEEE 1588 Grandmaster Clock Measures Time Transfer Accuracy

The IEEE 1588 protocol enables very accurate synchronization over Ethernet LANs and offers the ability to synchronize clocks to better than 100 nanoseconds accuracy with only a network connection. But testing the performance of IEEE 1588 products operating in a network is not easy. The XLi IEEE 1588 Grandmaster Clock with GPS reference from Symmetricom offers a solution for verifying these products' performance. It measures time transfer accuracy through network elements such as switches or through custom network topologies.

The XLi Grandmaster provides the precise time and is also equipped to physically measure how well that time is transferred through the network with precision down to 5 ns resolution. It can provide the time to a 1588 slave clock and measure the resulting accuracy, which is useful for characterizing the slave clock and the network topology between the Grandmaster and the slave. The XLi Grandmaster also measures time degradation through hubs and switches. GPS can be used as a common and precise time reference when an inconvenient distance separates the XLi Grandmaster from the slave, enabling accurate, easy, one-way path latency testing. One XLi Grandmaster operates as the source of time, and the other XLi Grandmaster measures the slave accuracy at the remote end of the network. Pricing is $9,995 for an XLi Grandmaster with one 1588 port and $12,495 for the two-port version.

Symmetricom, San Jose, CA. (408) 433-0910. [www.symmetricom.com].

Ultra-Wideband Recording/ Playback System Samples at 2 Gsamples/s

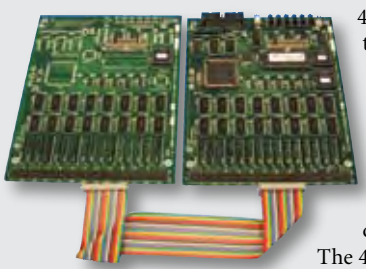
Systems deployed in radar, SIGINT, electronic warfare and software radio applications must store, analyze, process and play back large volumes of captured signal samples with instantaneous bandwidths in the GHz range. The VXS-based JazzStore UWB data recording solution from TEK Microsystems enables real-time, high-capacity recording and playback of broadband sampled analog data at rates of up to 2 Gigasamples/s. Its two-slot, scalable storage architecture is based on multiple RAID arrays that can store wideband sampled data for periods of up to several hours. The Triton 2 GHz A/D and D/A card provides wideband analog digitizing front-end and real-time playback. Combined with the Callisto multi-FPGA processing engine, it forms the JazzStore UWB.

The JazzStore UWB system can continuously record and play back at rates of up to 2 Gsamples/s (8-bit samples) or 1.6 Gsamples/s (10-bit samples). It hosts TEK Microsystems' JazzStore system-on-chip FPGA firmware: six SoC cores provide 12 high-performance data pipes directly into a set of up to twelve Fibre Channel RAID disk arrays with up to 24 terabytes of storage capacity for more than two hours' worth of 2 Gsamples/s samples. Access to the recorded data is enabled using a standard FAT32 file system. The JazzStore UWB supports VxWorks, Windows and Linux. Prices begin at $125,000.

TEK Microsystems, Chelmsford, MA. (978) 244-9200. [www.tekmicro.com].

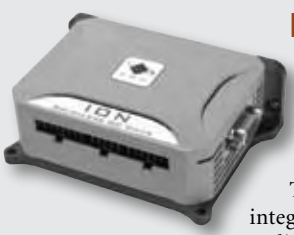
GPIB Bus Interface Board Set Supports 256 I/O Lines

The GPIB bus, with a quarter century of history behind it, remains a popular interface solution for linking up larger I/O arrays. ICS Electronics feeds those needs with a new GPIB-to-Parallel Interface for interfacing devices with TTL, CMOS or other digital signals to the GPIB bus. Designated the Model 4813H, this two-board set expands the number of digital I/O lines available in OEM boards up to 256 lines. Typical applications for the 4813H are interfacing test chassis or relay matrices that need a large number of digital signals to the GPIB bus.



The Model 4813H is an IEEE 488.2/GPIB-to-Parallel Interface that provides 256 parallel I/O lines that can be configured as inputs or outputs in 8-bit bytes. The I/O lines can be controlled as individual bits, or data can be transferred directly to or from a specific byte, or by strings of data characters to multiple bytes. The 4813H is a two-board set with a Master Board and Expansion Board interconnected by a short flat-ribbon cable. Pricing starts at $795 for 1-4 pieces.

ICS Electronics, Pleasanton, CA. (925) 416-1000. [www.icselect.com].



Distributed Module Lowers Motion Control Costs

The new mantra in military motor control systems is distributed architecture. Distributed architecture simplifies design, eliminates components and lowers cost for DC brush, brushless DC and microstepping control. Feeding that trend, Performance Motion Devices has rolled out the ION, a distributed-control module that combines network connectivity, positioning motion control and power amplification in a rugged, easy-to-use package. This single-axis module is available for DC brush, brushless DC, and microstepping motors.

To construct a complete low-cost multi-axis controller, one network-connected ION Drive is used per axis. This highly integrated approach eliminates the wiring complexity and cost of dedicated motion control cards connecting to separate amplifiers. ION provides profile generation, servo compensation, stall detection and field oriented control. The device supports distributed control in an asynchronous serial network (RS-485) version or a CAN bus network version. Multiple ION modules (up to 127) can be connected on a single network. ION provides an output capability of up to 15 amps peak, and 500W at 56 volts. Prices start at $223 in OEM quantities.

Performance Motion Devices, Lincoln, MA. (781.674.9860). [www.pmdcorp.com].

Rugged, Server-Class Dual-Core Xeon 6U cPCI Blade Is Manageable

The expansion of multiprocessing systems and Intel computing platforms to CompactPCI architectures is benefiting a new generation of military applications where scalability, extensibility and reliability are just as critical as performance and SWAP. An example of this trend is the 6U CompactPCI cPENTXM2 from Thales Computers, a rugged, server-class blade that uses the 1.67 GHz Dual-Core Xeon, Intel's most advanced low-power IA-32 technology, combined with the Intel E7520 server class memory controller hub (MCH). The cPENTXM2 is completely scalable and boasts up to 4 Gbytes of DDR2-400 SDRAM with dual Gigabit Ethernet ports on the backplane. It is compliant with switched backplane recommendation PICMG 2.16/VITA31 and supports PICMG 2.9/VITA 38 standard intelligent platform management interface (IPMI).

The cPENTXM2 provides two additional Gigabit Ethernet ports and two USB 2.0 ports on the front panel. A SATA port, two USB 2.0 ports and a PCI Express port are available on the back panel connector as PICMG 2.16 dual Gigabit Ethernet interfaces. The cPENTXM2 runs Red Hat Linux. It is available as a stand-alone board or pre-integrated into large systems with full data transport and management software based on standards such as MPI and HTTP. Pricing starts at $3,950.

Thales Computers, Raleigh, NC. (919) 231-8000. [www.thalescomputers.com].

PMC/XMC Transceiver Module Is Conduction-Cooled

The number of applications that demand wideband software radio resources in harsh environments is on the upswing. These include a significant range of military and aerospace applications such as unmanned aerial vehicles, battleground SIGINT and communications systems, deployment on tanks or torpedoes, or any system in which ambient or forced air will not provide adequate cooling.

Serving those needs, Pentek has released its Model 7141-703 PMC/XMC module. It features two 14-bit, 125 MHz A/Ds and a Xilinx Virtex-II Pro field programmable gate array (FPGA), and it is configured as a ruggedized module fully compliant with the ANSI/VITA 20 conduction-cooling specification and ANSI/VITA 42 XMC specification. This module is compatible with both cPCI and VME baseboards. Two full-scale, +10 dBm, analog HF or IF inputs are delivered through front-panel SSMCX connectors. Signals are transformer-coupled to two LTC2255, 14-bit A/D converters running at 125 MHz. The digitized output signals pass to a Virtex-II Pro FPGA for signal processing or routing to other module resources. These resources include a quad digital downconverter, a digital upconverter with dual 16-bit 500 MHz D/A converters, 512 Mbyte DDR SDRAM delay memory and the PCI bus. The Model 7141-703 PMC/XMC module's prices start at $15,995.

Pentek, Upper Saddle River, NJ. (201) 818-5900. [www.pentek.com].

Rugged 3U VPX Display Processor Targets Embedded Training, Digital Mapping

The demand is growing in embedded military computing for systems based on the 3U VPX form-factor, as well as for more pre-integrated, pre-tested subsystem-level products. The MAGIC1 Rugged Display Processor from Radstone Embedded Computing, now part of GE Fanuc Embedded Systems, is designed to fill both of those needs, as well as help military engineers develop and deploy significantly more sophisticated display applications, such as training, digital mapping and vehicle display. The MAGIC1 is based on the SBC340, a 2 GHz Intel Core Duo processor-based SBC, and the GRA110 3U VPX graphics processor card with NVIDIA PCI Express graphics capability.

The Core Duo CPU, with its 945GM Northbridge chipset, is connected to the NVIDIA G73 GPU via 16-lane PCI Express, providing maximum bandwidth between the two processors. The graphics processor card supports VAPS, GL Studio and iData display software. With dual-channel video output capability, the MAGIC1 can drive two independent displays. Up to 64 Gbytes of solid-state SATA disk storage are provided. Pricing starts at $17,514.

Radstone Embedded Computing, Part of GE Fanuc Embedded Systems, Billerica, MA. (800) 368-2738. [www.radstone.com].

Pentium III SBC Is First StackableUSB Module

The DoD gave the thumbs up years ago for USB to be used in military program, but it's been slow to reach its potential in the embedded realm. That's all changed with the advent of StackableUSB, a brand new embedded spec that defines a standard for stacking I/O boards onto a single board computer using the popular USB 2.0 interface. A single board computer, operating as a host, can communicate to multiple USB peripheral cards directly through mating USB 2.0 connectors resident on the CPU and I/O cards.

Micro/sys, the creator of StackableUSB has released the first StackableUSB CPU board on a Pentium III processor. In addition to all standard PC features, the SBC1685 also includes a Gigabit Ethernet port, four USB 2.0 high-speed ports, four USB 1.1 full speed ports and a CompactFlash interface. SBC1685 also offers a printer port, keyboard, mouse, external IDE and floppy controllers, and a watchdog timer. With up to 256 Mbytes of socketed SDRAM, and full PC-compatibility, high-performance embedded control systems can be implemented on this small industrial form-factor (PC/104 size) SBC. The basic SBC1685 starts at $895 in single quantity, with significant OEM discounts available.

Micro/sys, Montrose, CA. (818) 244-4600. [www.embeddedsys.com].

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Rugged Micro ATX Motherboard Supports Core 2 Duo

At today's level of semiconductor integration, the embedded motherboard option is an attractive alternative for some military applications. Sometimes the costs of a backplane or rackmount hardware are best avoided. Feeding that stand-alone computing need, the eAutomation Group of Advantech has introduced the AIMB-554 industrial micro ATX motherboard that supports the latest Intel Core 2 Duo, Intel Core Duo and Intel Core Solo processors with 400/533/667 MHz FSB.

In addition to performance-rich and energy-efficient features, the AIMB-554 comes with advanced I/O enhancements. The AIMB-554 offers multiple high-performance onboard I/O capabilities, with one PCI Express x16 slot for a higher end graphics card, one PCI Express x4 slot, two PCI 32/33 slots and eight high-speed USB 2.0 ports. The AIMB-554 has an onboard single/dual Gigabit LAN via PCI Express host interface. Two Serial ATA ports with RAID 0, 1 support, one RS-232 port, one RS-232/422/485 port and a parallel port are also included. The AIMB-554 complies with RoHS specifications and is fully compatible with Advantech's rugged micro ATX chassis. Pricing for the AIMB-554 is starting at $311.

Advantech, eAutomation Group, Cincinnati, OH. (513) 742-8895. [www.eAutomationPro.com].

Fanless System Targets Rugged, Space-Critical Apps

A new fanless, rugged system that supports two PCI expansion cards in one compact chassis targets space-critical, mission-critical applications requiring fanless operation, extreme reliability, low power operation and versatile I/O configuration, such as access control and security in transportation vehicles. The NICE 3100-P2 from Nexcom is based on Intel's Pentium M/Celeron M processor with 400 MHz FSB. The system supports either a Pentium M from 1.6 to 1.8 GHz with up to 2 Mbytes of L2 cache or a Celeron M from 1.3 to 1.5 GHz with up to 1 Mbyte of L2 cache, as well as LV and ULV versions of both CPUs. DDR 200/266 memory up to 1 Gbyte, one CompactFlash socket and a 2.5-in. hard disk drive bay are also included.

Housed in a compact 195 mm x 268 mm x 107 mm heavy-duty aluminum chassis, this system provides a wide variety of connection options with I/O ports located at both the front and rear of the unit. These include two 10/100 Ethernet LAN ports, six USB 2.0 ports (two front, four rear), VGA, TV-out interface and direct LVDS output via a DB44 connector. For added flexibility, the NICE 3100 also boasts three RS-232 ports, one RS-232/422/485 port and two 32-bit/33 MHz PCI expansion slots. DC to DC power is designed for onboard support of 12 VDC to 30 VDC, maximum 120 watts. Pricing starts at $450.

Nexcom UK, Newport Pagnell, UK. +44 (0) 1908 218914. [www. nexcomuk.co.uk].

Fibre Channel PMC Sports Independent 4 Gbit/s Channels

In demanding military data communications and storage applications based on PCI, VME and Compact PCI, system integrators can use help in simplifying the integration of high-bandwidth Fibre Channel data communications. The multi-protocol, dual-channel FX400 PMC from Curtiss-Wright Controls Embedded Computing enables application software to communicate simultaneously with SCSI and IP-based devices while eliminating the need for system integrators to interact with the FC interface. The card supports both SCSI Fibre Channel Protocol (FCP) and Internet Protocol (IP), including both File System SCSI and Raw Initiator SCSI.

Each of the FX400's dual, independent, 4.25 Gbit/s per channel FC paths support transfer rates of up to 400 Mbits/s in a single direction. Each channel also supports 1.0625 Gbit/s, 2.125 Gbit/s and 4.25 Gbit/s rates, using auto-speed negotiation to automatically detect and switch among rates. Hot-swappable Small Form-factor Pluggable (SFP) transceiver modules enable modification of the card's media interface configuration. Software support includes multi-protocol driver software, currently available for VxWorks and Linux. The FX400 is available in commercial, extended temperature and conduction-cooled configurations. Pricing starts at $2,395 for the commercial version.

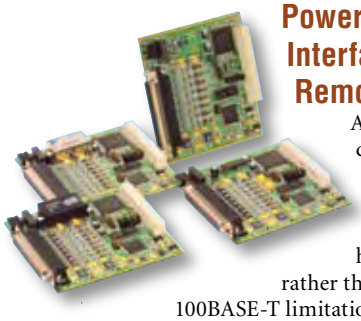
Curtiss-Wright Controls Embedded Computing, Leesburg, VA. (703) 779-7800. [www.cwcembedded.com].

5U MicroTCA Shelf Has Pluggable Fan Trays

MicroTCA is enjoying a rapid ramp-up in interest among military system designers. Elma Electronic has announced a new 5U MicroTCA shelf. The unit features pluggable fans trays and an air filter. The 5U MicroTCA shelf comes equipped with a 14-slot Dual Star backplane in the single module, full size format. The backplane offers ten AMC, two power module and two MicroTCA Carrier Hub (MCH) slots. Cooling is achieved via three pluggable fan trays with air filtering. Another feature of the Elma MicroTCA line is locking strips that securely hold the modules in place. Elma has stamped them so they can be cut at any incremental width, allowing flexibility in how many modules are plugged in and secured.

The Elma MicroTCA chassis line employs a modular design approach, allowing various sizes and configurations. This reduces the time, hassle and costs of customization. Elma now offers MicroTCA shelves in 4U, 5U, 6U, 7U and 8U heights and a Portable Tower in a 7U height. The 5U MicroTCA Shelf price starts under $2,000, depending on options.

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



PowerDNA with Fiber Interface Offers Distributed, Remote Operation

A new series of PowerDNA distributed automation and control systems extends the maximum distance between a PowerDNA I/O cube and its host computer to 2-20 kilometers rather than the 100-meter Ethernet/ 100BASE-T limitation. The DNA-FPPC series of 100BASE-FX-based fiber-optic I/O cubes are designed for aerospace and laboratory distributed data acquisition and control in large facilities or in any application where the host computer must be remote from the I/O subsystem. With off-the-shelf multi-mode fiber the maximum distance is 2 km, and with a special order single-mode fiber interface the maximum distance is 20 km.

The DNA-FPPC series is especially suited to high-noise environments. It offers virtually infinite electrical isolation between the host computer and the I/O system. The DNA-FPPC5 with three I/O slots measures 4 in. x 4.1 in. x 4 in. and the DNA-FPPC8 with six I/O slots measures 4 in. x 4.1 in. x 5.8 in. They are capable of 1,000 I/O scans in under 1 millisecond. The PowerPC-based DNA-FPPC series supports Windows and Linux as well as LabVIEW, MATLAB and DASYLab. The DNA-FPPC5 is priced at $1,395 and the DNA-FPPC8 at $1,595.

United Electronic Industries, Canton, MA. (781) 821-2890. [www.ueidaq.com].

Switching UPS Features Reliable Voltage Regulation

Uninterruptible power supplies (UPS) are critical to keep electronics running under the most severe conditions, ensuring seamless switchover on prime power loss. And severe conditions are part of the territory in many military systems. ITT Power Solutions offers a pair of UPS systems: the CM1001 and CM1002. Both provide excellent output voltage regulation, 115 VAC +5% over an input voltage/frequency range of 100-265 VAC/ 47-63 Hz, with full input to output isolation, line conditioning and surge suppression. In the battery backup mode, the UPSs provide the same high-quality power for a minimum of 15 minutes at 80% resistive load. The CM1001 boasts a power output of 400W, an input current of 4.5 Arms, an output current of 3.5 AAC, a charge time of 4 hours and weighs 30 lbs. The CM1002 offers a power output of 1,250W, an input current of 15 Arms, an output current of 3.7 AAC, a charge time of 8 hours and weighs 70 lbs.

The products offer fully isolated, true sine wave regeneration. The units have a hot-swappable, hand-removable battery module and they withstand MIL-STD 1275B voltage transients. Pricing for the CM1001 and CM1002 ranges from $1,500 to $3,400 depending on quantity.

ITT Power Solutions, West Springfield, MA. (413) 263 6200. [www.ittpowersolutions.com].

PC/104 Power Supply Boasts 90% Efficiency, Low Cost

PC/104 power supply technology has come a long way in the past couple years. They are now so integrated and efficient that they can easily serve the power needs of a stack of PC/104 cards, eliminating the need for an outside power subsystem. This trend is attractive to military system designers who prefer to design in modular blocks anyway. Exemplifying this trend, Sensoray offers a new PC/104 Power Supply, Model 209 that has a wide input voltage range of 8 to 30 VDC. Its three outputs of 5 VDC at 5A and ±12 VDC at ±0.5A supply power to the PC/104 and PC/104+ buses. Power output connectors are available for external devices such as video cameras and fans.

Input power is via a 3-pin removable terminal block or through a 2 mm circular power jack. The 209 uses planar magnetics and low ESR caps to achieve low noise and conversion efficiency of over 90%. To survive vehicular applications the 209 has a load dump circuit, a common mode input filter and reverse polarity input protection. The single piece price is $205.

Sensoray, Tigard, OR. (503) 684-8005. [www.sensoray.com].

PMC/XMC Is High-Performance Wideband Digital Receiver

In high-performance radar, SIGINT and ELINT applications, extracting clear signals from electronic clutter can be a real challenge. What's needed is a mixed-signal bridge between analog signals and digital processing, such as the Echotek Series ECV4-2 family of mixed-signal PMC and XMC wideband digital receivers from Mercury Computer Systems. With input clock capability of up to 1.5 GHz, the ECV4-2 family implements a flexible FPGA-based architecture in the space-efficient PMC/XMC form-factor. Each module provides unique I/O connectivity and functionality and is configured with a specific set of A/D and/or D/A converters that address a defined bandwidth and frequency for data conversion. Cards come in two- and four-channel versions, with A/D, D/A and transceiver configurations.

Two Virtex-4 FPGAs are provided on each card for user-programmable data processing (XC4VFX60 or XC4VFX100) and PCI/PCI-X interfacing (XC4VLX25). Support is provided for 133 or 100 MHz 64-bit PCI-X and 33/32 PCI. Memory includes 256 or 512 Mbytes of DDR SDRAM and 2 Mbytes of dual-port SRAM. Pre-loaded FPGA development IP is supplied and Linux and VxWorks are supported. Air- or conduction-cooled versions are available. Pricing starts at $6,000 in OEM quantities.

Mercury Computer Systems, Chelmsford, MA. (978) 256-1300. [www.mc.com].

1553 PCI-104 Card Supports IRIG-106 Chapter 10

The MIL-STD-1553 may be getting old in the tooth, but its popularity as a low-latency control bus hasn't faded a bit. Data Device Corp. has introduced a new PCI-104 card with up to four dual-redundant MIL-STD-1553 channels, five user-programmable digital discrete I/Os, selectable external or internal time-tag clock, and an IRIG-B time synchronization input. The new BU-65577C is a rugged card that can be used in both convection- and conduction-cooled applications. The PCI-104 and PC/104 Plus form-factors are commonly used in flight data recorders, displays and other avionics systems.

The BU-65577C card utilizes DDC's Extended Enhanced Mini-ACE (E2MA) Architecture. E2MA supports new standard features for each 1553 channel such as 2 Mbyte RAM with parity per channel, 48-bit/1 microsecond or 100 nanosecond time tag and built-in self-test. Its intelligent hardware offload engine provides extremely low PCI bus and host CPU utilization while storing 1553 Monitor data in a convenient IRIG-106 Chapter 10 format. The high-level library functions abstract all register accesses and memory allocation so that no specific hardware knowledge is required. The BU-65577C series is now available.

Data Device Corp. Bohemia, NY. (631) 567-5600. [www.ddc-web.com].

AMD Geode-Based SBC Is Fanless

A new low-power, fanless SBC from Adlink Technology is based on the AMD Geode GX 533 processor. The NuPRO-796 half-size SBC boasts CPU power consumption of only 1.1W to deliver low power, low cost and high computing performance. The board comes with the Geode CS5535 Companion Device chipset, 128 Mbytes of onboard DDR266 memory in a single SO-DIMM socket, one UltraATA 66 IDE connector and four SATA connectors with RAID support. Also included are an ACPI-compliant 10/100BASE-T LAN port, four USB 1.1 ports, integrated audio controllers with an AC'97 interface, two RS-232 COM ports with ESD protection and a watchdog timer.

Onboard CompactFlash support is provided, along with an ATX power connector for backplane-less applications. Options include four SATA-150 channels. The board supports VGA/CRT monitors (1600x1200, 16 bpp @ 85 Hz or 1280x1024, 24 bpp @ 85 Hz), TFT LCDs (1280x1024, 24 bpp) and LVDS. The NuPRO-796 is compatible with Adlink's compact, wallmount RK-604A chassis and the six-slot RK-606FC chassis. Pricing starts at $390. Volume discounts are available.

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

Network Control Board Sports Dual Intel Xeon Processors

Highly integrated network security and other demanding military network applications need lots of processing power as well as connectivity. With those needs in mind, WIN Enterprises has introduced the MB-09015, a high-performance network control board with dual Intel Xeon processors and up to 10 Gigabit Ethernet LAN ports. It features an Intel E7520 chipset with 800 MHz FSB and Intel Extended Memory 64-bit technology (EM64T) as well as up to 16 Gbytes of DDR-2 system memory. PCI Express technology is included to improve I/O bandwidth, providing a total system bandwidth of up to 32 Gbits/s.

The MB-09015 features six Small Form-factor Pluggable (SFP) GbE ports. An optional Ethernet module on four ports provides bypass functions to guarantee network connectivity. It can be configured as 4x GbE copper with bypass, 4x GbE SFP with bypass, or 2x GbE copper with bypass and 2x GbE SFP with bypass. Flexible network connectivity is enhanced with two serial ports, two onboard SATA connectors, two USB 2.0 ports, one parallel port, digital I/O (three input, three output), one E-IDE connector and one CompactFlash Type II socket. Single unit pricing for the MB-09015 is $1,224. Quantity discounts are available.

WIN Enterprises, N. Andover, MA. (978) 688-2000. [www.win-ent.com].

Mini-ITX SBC Supports High Def Video

The military's migration toward Net-Centric Operations is boosting demand for upgraded computing terminals at all the nodes of the network. Arista helps serve that demand with is new industrial mini-ITX-9452 motherboard. Mini-ITX has similarities to ATX, microATX, FlexATX and BTX form-factors, but is significantly smaller at 6.7 inches square. Mini-ITX boards can often be passively cooled due to their low power consumption architecture—an attractive feature in the military realm.

The new ITX-9452 CPU is equipped with a Socket 479 Intel Core Duo/Solo with a 667 MHz FSB. The system memory includes dual-channel 240-pin memory slots accommodating up to 2 Gbytes of DDR2-400/533 RAM. The motherboard requires a low, 1.58A, 5-V maximum power and has a programmable watchdog. The board's small form-factor is ideal for a variety of different chassis. Additional system features include integrated Intel 945GM support HDTV-Out, dual 18 channel LVDS and CRT. The motherboard is also equipped with eight USB ports and is compliant with USB 2.0. The retail price for the ITX-9452 starts at $380.

Arista, Fremont, CA. (510) 226-1800. [www.aristaipc.com].

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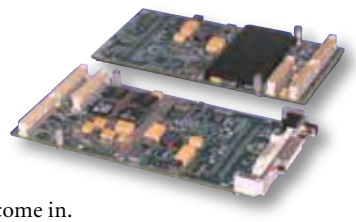
SBC Features LGA775 Socket, 865GV Express Chipset

A new PICMG 1.0 SBC from American Portwell Technologies, the ROBO-8713BVG2, is based on the Intel Core 2 Duo processor, running at up to 1.066 GHz. It also supports Pentium D, Pentium 4, or Celeron D processors via an LGA775 socket equipped with dual-core, hyper-threading, EM64T, EIST, XD and VT technologies. The board includes the price-competitive Intel 865GV Express chipset and 2 Gbytes of DDR 400/333/266 SDRAM in dual, 184-pin DIMM sockets.

I/O includes dual Gigabit Ethernet ports, dual SATA connectors, dual IDE channels, one FDD channel, eight USB 2.0 ports, dual serial ports, a parallel port, GPIO and watchdog timer. The VGA interface utilizes the Integrated Intel Extreme Graphics 2 graphics engine with Intel's Dynamic Video Memory Technology 2.0, with shared system memory of up to 64 Mbytes. List price is $495.

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

PMC Does Dual Independent Graphics Streams



Military graphics subsystems are reaping the benefits of silicon advances aimed at complex consumer gaming. Getting those complex graphics out to rugged battlefield environments is where embedded vendors like Aitech come in. Its latest offering is a dual-head graphics PMC that enables the simultaneous display of two independent graphics streams of high-performance, high-resolution graphics typically used in harsh environment applications.

The new M591 employs the advanced ATI M9 graphics processor with full featured, high-performance processing capabilities for both 2D and 3D polygon generation and texture mapping acceleration. The dual DVI outputs of the M591 are capable of independent resolutions of up to 1600 x 1200 pixels at 75 Hz with 32 bits per pixel and reaches 2048 x 1536 pixels at 85 Hz with data rates up to 122 Mpps (million pixels per second). TV output supports NTSC, PAL, RS170A and CCIR formats in addition to S-video (Y/C) signal formats, both interlaced and non-interlaced. The M591 comes in three ruggedization levels: commercial, rugged and military, including an air-cooled version per IEEE 1386-2001 and a conduction-cooled version per ANSI/VITA 20-2001. Pricing for the M591 starts at $2,995.

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

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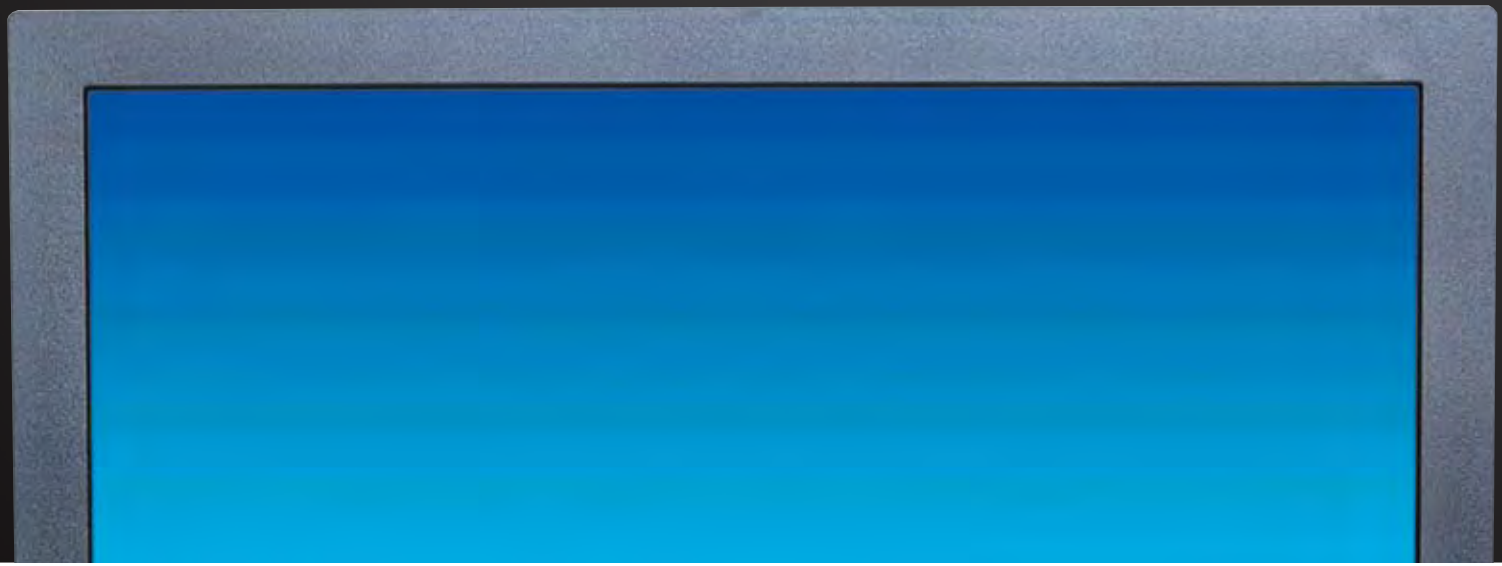


VME/VXS SBC Sports Core 2 Duo Processor

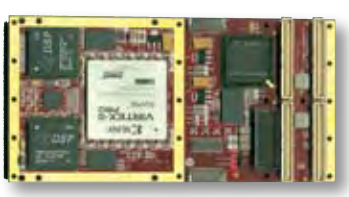
The age of dual-core processors has come into full swing, and military system designers are riding the wave. Concurrent Technologies has released an Intel Core 2 Duo processor-based VME/VXS SBC as a performance upgrade from the VX 405/04x released earlier in the year. The VX 407/04x uses the latest mobile dual core processor from the Intel embedded roadmap, the 2.16 GHz Intel Core 2 Duo T7400 processor, giving an even greater improvement in measured performance/watt. The VX 407/04x can access up to 4 Gbytes DDR2-667 soldered SDRAM at up to 10.6 Gbytes/s. The VXS switched serial standard—VITA 41.3 (1000 Mbits/s baseband IEEE802.3)—is optionally supported to provide fast data transfer between other compatible boards in the system.

To enable easy, fast transfer of data between the VX 407/04x board and other components in the system there are two networking options available: dual 10/100/1000 Mbits/s Ethernet interfaces (via P2) or an optional VITA 41.3 interface (via VXS P0) giving dual 1000 Mbits/s baseband IEEE 802.3 serial links onto a VXS backplane fabric. List prices for the 2.16 GHz Intel Core 2 Duo T7400 processor version starts from $4,375.

Concurrent Technologies, Ann Arbor, MI. (734) 971 6309. [www.gocct.com].

Conduction-Cooled DSP/FPGA Module Has PMC/XMC Interface

Military image processing and communications applications need lots of horsepower and I/O. The SMT417 PMC/XMC module from Sundance DSP combines two Texas Instruments 1 GHz TMS320C6416 DSPs, a Xilinx XC2VP50 FPGA and a fast 133 MHz, 64-bit PCI interface to provide a flexible platform for next-generation image processing and telecom systems. Using the FPGA, the SMT417 enables pre-processing to be done on-the-fly before the DSP receives the data. The Sundance-provided basic VHDL core for inter-DSP communication uses 25% to 50% of the FPGA for I/O and system functions, while the rest is available for user applications.



The SMT417 can serve as a pre-processing, post-processing or stand-alone module in many types of signal processing and conditioning applications. It features up to 256 Mbytes of SDRAM, seven RocketIO RSL interfaces and two Sundance high-speed bus (SHB) interfaces. A JTAG daughter card provides a standard interface to TI and Xilinx emulator cards. The JTAG interface can be used for firmware updates and/or software development. With full support by PARS and 3L Diamond development tools, parallel applications can be developed to utilize all of the available DSP and FPGA resources. OEM price is $5,500.

Sundance DSP, Reno, NV. (775) 827-3103. [www.sundancedsp.com].

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Index

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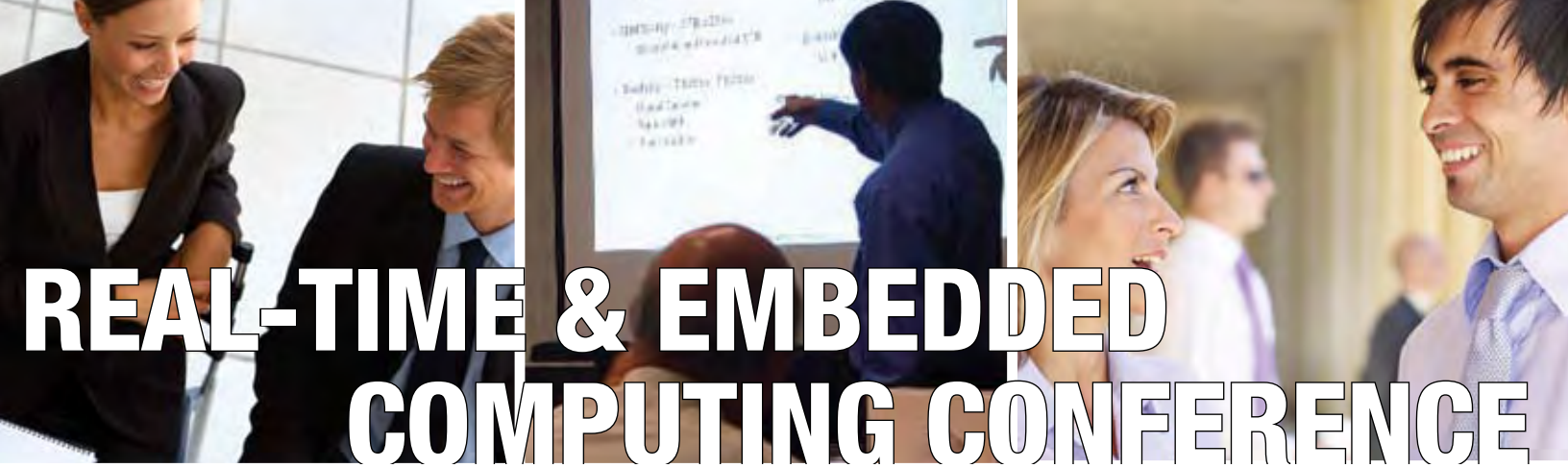
Coming Next Month

COTS JOURNAL

- *PC/104 in the Military.* PC/104 continues to gain fans in the military realm thanks to its compact size and inherent ruggedness. Sweetening the deal, a number of special enclosure techniques are used to suit it for extremely harsh environments. This series of articles looks at those techniques, the levels of ruggedization available and some of the special applications using PC/104 and PC/104-Plus. An update on the new PC/104 follow-ons, EPIC and EPIC Express, will be included also.
- *Switched Fabrics.* Switched serial fabric technologies—PCI Express, Serial RapidIO and others—continue to jockey for position as the favorite for high-end military embedded computing applications. This section explores how system designers can benefit from the marriage of switched fabrics with embedded computing form-factors like VPX, VXS, Compact PCI Express, MicroTCA and AMC.
- *Annual End-of-Life Directory.* COTS Journal is known for its unique coverage of key military technology issues in a way that you can't find elsewhere. Exemplifying that unique character is our Annual End-of-Life Directory. Now in its 8th year, the EOL Directory lists both key DoD organizations and commercial firms involved in solving the problems of component obsolescence. The section includes also examines how those obsolescence issues are complicated by Europe's RoHS initiative.
- *FPDP I & II and Serial FPDP Boards.* The Front Panel Data Port (FPDP) interconnect standard is a simple idea, but sometimes simple ideas are big winners. Using an inexpensive ribbon cable, FPDP links boards without eating up more than a tiny amount of board space. It's particularly useful in military applications like radar and sonar where FPDP is used as the interface to sensor networks. The Serial FPDP version adds speed and nullifies the length limitations of parallel FPDP. The Tech Focus section updates readers on FPDP/FPDP II/Serial FPDP trends and provides a product album of representative board-level products.



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COTS

Editorial

Jeff Child, Editor-in-Chief

Land Warrior Suits Up for Its First/Last March

Earlier this month the President released to Congress his defense budget for fiscal 2008. I'll admit my gut reaction was one of disappointment when I learned that the Army's $2 billion Land Warrior program was among the programs chosen to be terminated. By cutting $300 million of its funding, the program is now essentially eliminated, and its domestic program office shut down. The cut is consistent with the general theme of the 2008 budget proposal, which is defense modernization programs must yield to the demands of funding the ongoing war costs and plans for a permanent increase in the size of the Army.

Land Warrior, under its latest configuration, includes an advanced combat helmet with an optical display attachment, a modified M-4 rifle, digital imaging equipment, a GPS, a lithium-ion battery with a 12-hour life span, a voice/data radio, a computer subsystem, a multifunction laser, and a control card for identity management. Worn as part of the soldier's equipment, the system links the dismounted soldier to the digital battlefield, allowing him to communicate with fellow soldiers. A soldier can see where he is with just a glance into his helmet-mounted display, as opposed to pulling out maps and plotting coordinates.

COTS Journal has been following this program over the past several years in stories on wearable computers, small form-factor embedding computing, power/batteries technologies and software radio. And I've personally found all aspects of it fascinating and a vivid example of highly integrated embedded computing technology potentially transforming how a soldier can do his job. That said, can you imagine what the DoD's budget would look like if it made decisions based on what us technical editor types find interesting? Scary thought.

At last year's Association of the U.S. Army (AUSA) tradeshow, General Dynamics gave me a demo on the Land Warrior system in their booth, and I was pleased to see how well it had come together. General Dynamics C4 Systems has been the lead contractor for the program. Land Warrior has now been put in a curious position. The Army's 4th Stryker brigade combat team was preparing to deploy to Iraq with Land Warrior this spring. Soldiers from that brigade, as well as soldiers from a few other units, recently finished a successful test of the ensemble of digital communications and navigation equipment at Fort Lewis, WA.

The soldiers of the 4th Stryker BCT reportedly have requested to take Land Warrior into Iraq despite the program's elimination. And so the unit will go to Iraq equipped with the system in the coming weeks, as part of President Bush's surge effort. That's months ahead of the unit's scheduled deployment, and they will proceed without an additional phase of testing that had been scheduled at Fort Irwin, CA. The Stryker brigade is the ideal unit to field the Land Warrior system, which in its current version is dubbed the Land Warrior Stryker Interoperable because it's closely integrated with the Stryker vehicles. Crewmen riding in Stryker combat vehicles wear a similar system, called Mounted Warrior, which lets them stay connected to dismounted soldiers. There's some hope that the Land Warrior system, if it proves itself on the battlefield, will see its program resurrected—a rare but not unprecedented occurrence for the Army.

Among the reasons cited for Land Warrior's demise are its weight and battery life. In its latest configuration, the system weighs 9 pounds and has a 12-hour battery life. The battery technology is probably the biggest hurdle. While computing electronics inevitably enjoyed magnitudes of integration every few years, battery technology moves at the slower pace. For wearable combat systems a move to fuel cell battery technology may be necessary. For a typical 72-hour mission at 20 watts average power usage, a fuel cell with three fuel cartridges today weighs 6.3 pounds—only a third of the weight of lithium-ion batteries. Fuel cell systems are able to power the full range of devices that soldiers carry—from sensors to ruggedized computers to satellite radios.

The research from Land Warrior will be folded into the Future Force Warrior program, a component of the Future Combat Systems program. Land Warrior will likely resurrect under another form as a component of FCS. Certainly by the time FCS is completed in 2014, the weight and battery life issues of Land Warrior will be defused by further shrinking of embedded computing electronics and new battery solutions.

For its part, the FCS program is also getting trimmed down. Two of its classes of UAVs and one of its unmanned ground systems have been nixed from the program, along with the Intelligent Munition System. On the other hand, programs like the WIN-T (Warfighter Information Network – Tactical) are enjoying an increase in funds in the proposed budget with another $222 million, a nearly 100% increase over the previous year. WIN-T is a networking architecture designed to allow troops on the battlefield to plug into info networks through satellite, airborne and terrestrial links.

Satellite programs also were an exception to the general tightening of long-term system development program funding. The proposed space program spending was bumped $1.2 billion to $6 billion in the fiscal 2008 budget, with programs such as the Navigation Satellite Timing and Ranging Global Positioning System, Space-Based Infrared System-High and the Transformational Communications Satellite System all getting funding increases. All in all, in the coming year there will be no lack of interesting military technology systems for us to cover and to keep this editor happy.

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VICOR'S MIL-COTS VIPAC power supply provides designers with mission-critical power solutions. This user-configurable power supply accepts 28 Vdc input and is available with up to three outputs and 400 W. Built for military COTS ruggedized applications, the MIL-COTS VIPAC is compliant to both MIL-STD-461E and MIL-STD-704E/F. And, all Vicor products are made in the USA.

TALK TO US, and find out the benifits of using the new MIL-COTS VIPAC in your system. Experienced applications engineers will work with you and providethe world-class technical support that Vicor is famous for.

To get the data sheet, go to:
vicorpower.com/milvipac

- *28 Vdc rugged, low profile power supply*
- *Up to 400 W, multiple outputs*
- *-55˚C operation*
- *Integral MIL-STD-461E EMI & MIL-STD-704E/F filter*
- *MIL-STD-810F compliance for shock & vibration*
- *User-configurable with VCAD, Vicor's online design tool vicorpower.com/vcad*

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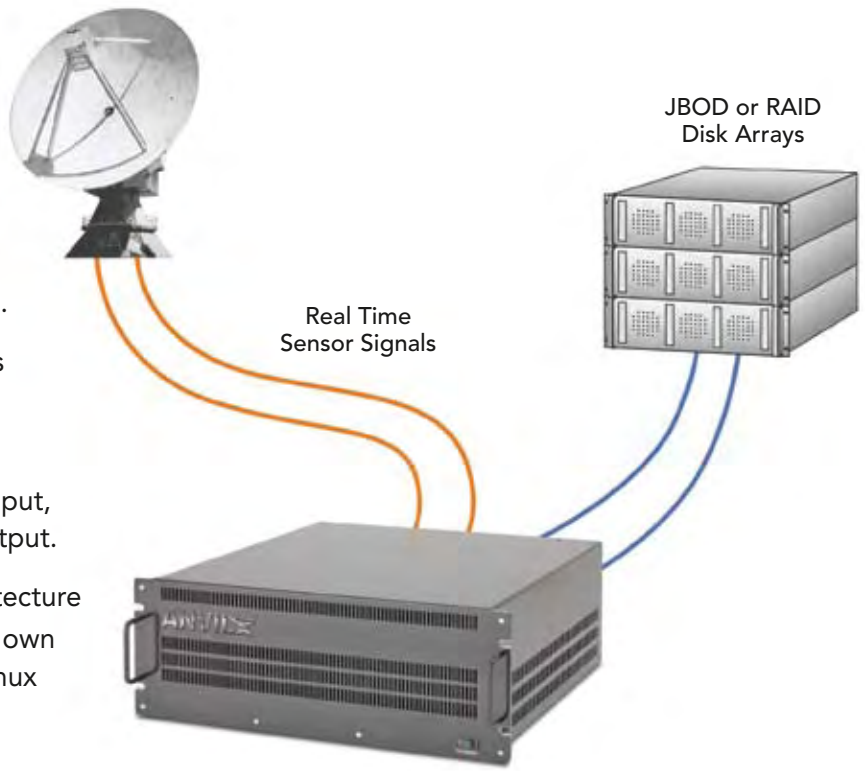
ANVIL™

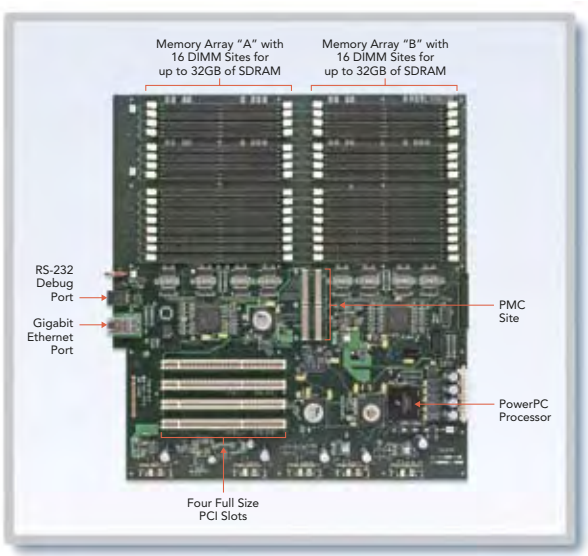
FRONT-END DATA RECORDER

Solid State SDRAM Data Recorder

- Up to 64GB of SDRAM memory based on industry standard registered DIMMs.
- Sustained Transfer Rates of over 1 GB/s
- Four full-length, full-height PCI slots to accommodate any off-the-shelf PCI I/O cards, such as Serial FPDP or A/D for input, and fibre channel, SCSI, or SATA for output.
- *"All-Digital"* embedded hardware architecture includes a PowerPC® processor with its own local memory, Gigabit Ethernet, and Linux or VxWorks® BSP.



Safely Capture Signal Data and then
Record to Secondary Disk Storage



Anvil is an *"All-Digital"* front-end solution to real time data recording. Providing the flexibility of four PCI slots and utilizing solid state SDRAM memory with a completely embedded hardware architecture, Anvil has been designed to optimally address the most critical stage of real time recording: effective capture of sensor streams. This approach ensures that valuable signal data will not be lost and that performance will be predictable over any number of recordings.

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