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Tech Focus: Graphics PMCs Roundup

DATA RECORDERS TASKED FOR DOUBLE-TIME SPEEDS, LONGER MISSIONS

PLUS:

Ruggedized MicroTCA Readies for Military Network Duties

Thermal Design: Hot Issue for Boards and Chassis

Volume 8 Number 9 September 2006 www.cotsjournalonline.com

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Features	XE–900	XE–800	XE–700
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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–232/422/485	NA	NA
COM 6	RS–422/485/TTL	NA	NA
LPT1	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
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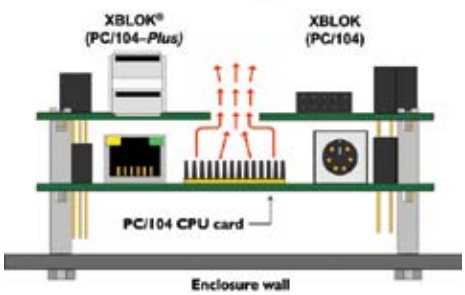

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NAME	DESCRIPTION	AMC.1	AMC.2
TELUM TSPE01	Processor AMC module with PowerPC® 7447A processor		•
TELUM ASLP10	Intel® Pentium® M processor AMC module	•	
TELUM 624/628-TEJ	WAN Edge Access I/O, 4 or 8 port T1/E1/J1, ITDM option	•	
TELUM 1001-O12M/S	WAN OC-12 module	•	
TELUM 1001-O3	WAN OC-3 module	•	
TELUM 1004-O3M/S	WAN OC-3 module	•	
TELUM 1001-DE	WAN DS3/E3 module	•	
TELUM 1204-O3	WAN intelligent AMC.2 multi-service 4-port OC-3 module		•
TELUM GE-QT	Gigabit Ethernet AMC 4 port NIC	•	
TELUM FC2312-FF	Fibre Channel HBA cards (fiber-optic media)	•	
TELUM FC2312-CC	Fibre Channel HBA cards (copper media)	•	
AT-AMC1	AdvancedTCA® carrier for 2-4 AMC.1 modules	•	
AT-AMC2	AdvancedTCA® carrier for 2-4 AMC.2 modules		•
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TELUM 2001-VGA	AMC VGA module	•	

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COTS JOURNAL

Features

September 2006 Volume 8 Number 9

Departments

Coming in October...
...See Page 73

Main Feature

Data Recorders

Tech Recon

CompactPCI, MicroTCA and AMC in the Military

System Development

Thermal Analysis for Boards and Enclosures

Technology Focus

Graphic PMCs

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.*

Cover Story ..... Page 14

The Joint Strike Fighter, or F-35, is a next-generation, supersonic, multi-role stealth aircraft designed to replace aging AV-8B Harriers, A-10s, F-16s, F/A-18 Hornets and U.K. Harrier GR7s and Sea Harriers. Shown here is the F-35C, which is the U.S. Navy's version of the JSF. The Navy's first stealth aircraft, the F-35C variant, has a strengthened internal structure to handle the loads associated with catapult launches and arrested landings, each of which are vital for carrier operations.

Courtesy: ImageCourtesy of Lockheed Martin

ATLAS PMC

The AtlasPMC is a dual-channel, high resolution PMC graphics controller for VME, CompactPCI and PCI systems available in two versions to match your application needs; full-featured multimedia or graphics-only.

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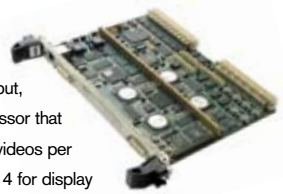

Cobra is a high-performance, multi-input, video windows processor that can accept up to 12 videos per card and select up to 4 for display as windows on a high-resolution, digital flat panel or analog display.

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PMC-704

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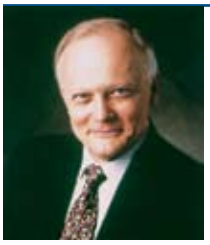
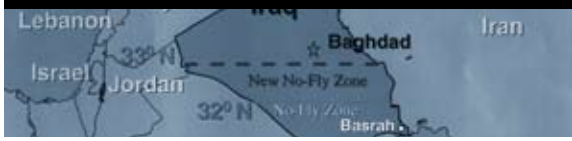
Publisher's Notebook





Every August, when I start to think about what to say for the September issue of *COTS Journal*, I feel like I'm in preseason, just like Football. September is when every organization goes back to full strength and noses get pressed even harder to the grindstone. What I say here should be inspirational, should take a look at what has happened and provide some vision of where things are headed in the fall.

As summer slips away, the task of orchestrating a communications chain that contains three or more people will no longer take weeks because of time off. Conferences will go into full swing and the number of daily e-mails and phone calls will double. When I'm up to my eyeballs in issues and problems I'm hoping for a break. But I know during the height of the vacation season I'm not at the top of my game. I tend to take longer to do things, because I'm not under as much pressure. That doesn't mean that I have more time to myself, it just takes me longer to do things. I'm sure I'm not alone with this problem.

In June we had our summer editorial meeting when we look at what we did the first half of this year, making adjustments where needed for the second half of the year. That's important because we create *COTS Journal*'s editorial calendar six months prior to the start of the calendar year. By the end of the editorial calendar those initial decisions are 18 months old, a time span that can equal an entire product life cycle in the embedded electronics market. Being nimble and staying on top of our game is critical. We've been the leader bringing the latest technology information to the military embedded marketplace for over eight years, and we don't have any intentions of relinquishing that position.

While contemplating issues to ensure that *COTS Journal* remains on target, I received an e-mail with an MPEG clip showcasing an electronically fired small arms weapons system. It claimed the ability to fire a quarter of a million rounds a second. It made me think: where would U.S. military capability be today if we had not made the move to utilize commercial technology? Don't bite my head off if I'm wrong on the details here, but I think in the mid-90s the Mil-Spec 1750A processor was 16-bit technology running at 16 Kbytes/s, while Pentiums and PowerPC processors were 64-bits running at 32 Mbytes/s. Today we have 128-bit multicore processors running at Gbytes per second. If we had continued along the 1750 path, I wonder what the equivalent iteration would be today—32-bits running at 1 Mbyte/s?

The issue that needs resolution now is how do we make the bureaucracy work faster. I see technology running like the Pentium and PowerPC and the bureaucrats "running" like the 1750. We were motivated to change our ways when, in the 90s, we feared our enemies would use COTS technology to develop more sophisticated products than ours if we stuck with Mil-Spec-only products. What's needed now is motivation to speed up the military and political bureaucracy. There is no doubt that if a technical solution will solve a military problem, we can develop and produce one quickly. There are fast-track procurement programs in place that allow for such development. But the most recent complaints from the bureaucrats are that too many programs are being fast-tracked. My complaint is that not enough are being fast-tracked. Let the bureaucrats figure out how they should work faster and harder to monitor and fund fast-tracked projects. This problem I'm sure is not just restricted to the U.S. defense department.

Nimble and Quick Won't Do It Alone

On the battlefield, we're now in a situation where our adversaries are nimble and quick to exploit any weaknesses they detect in our capabilities. Technology can only address a minor portion of this problem, and we need those solutions as quickly as possible. Every tactic on the adversary's part needs to be countered even before it is perceived as a viable and effective measure against us. Aside from the physical damage the enemy may inflict through the continued effective use of any one tactic, there's the positive propaganda effect prolonging hostilities. The most recent evidence of that was in the conflict in southern Lebanon.

Nimble and quick are characteristics that need to be in everyone's repertoire. But those attributes alone will not ensure success. Whether on the battlefield, in the embedded design lab or in the publishing business, you also need to have a valid understanding of your environment, your mission and all the tools available to be successful. We at *COTS Journal* are continuing to employ all these concepts in order to continue providing you, our readers, with the tools necessary for your and the military's success, thereby ensuring our success. ■■

Pete Yeatman, Publisher
COTS Journal

COTS JOURNAL

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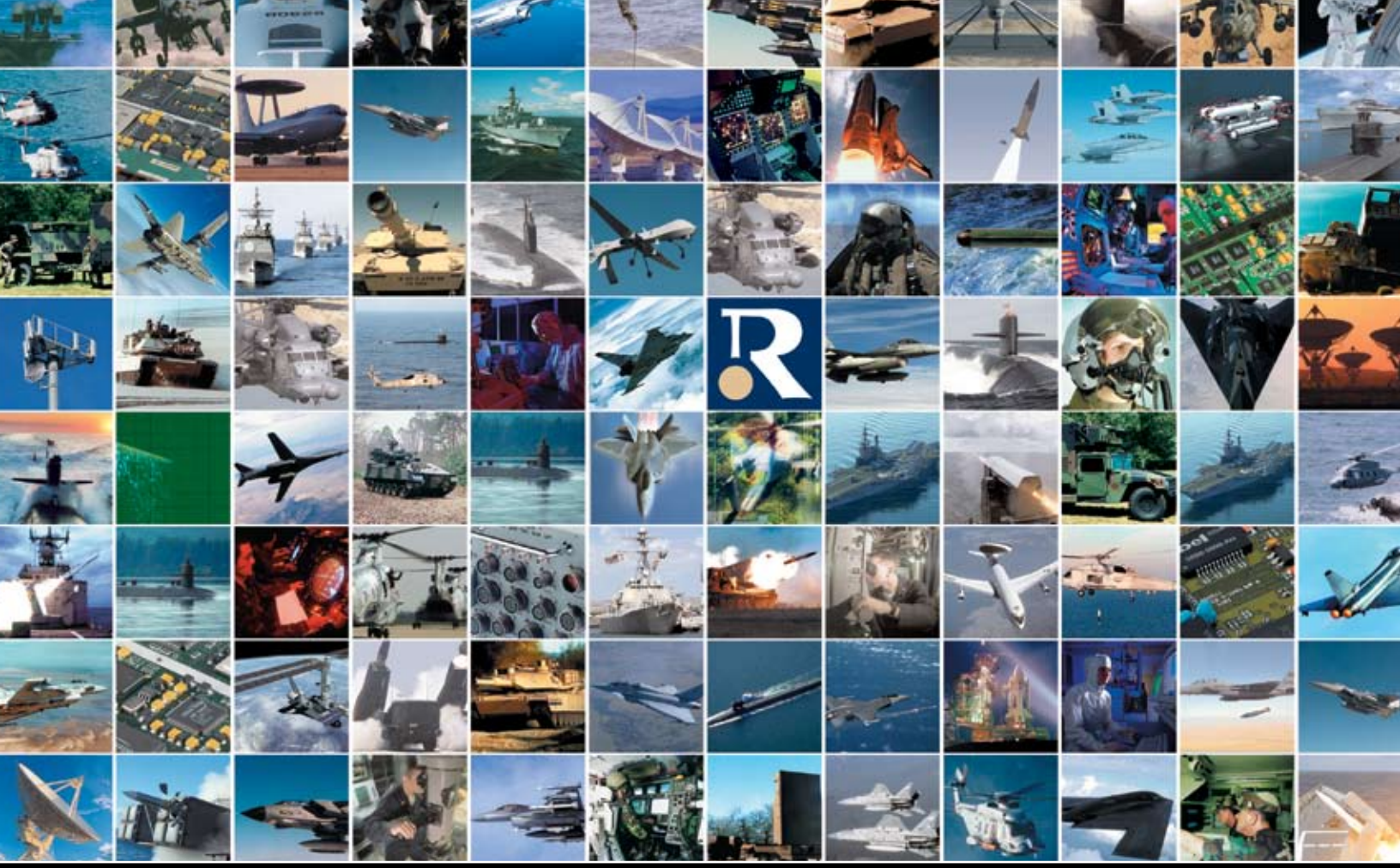

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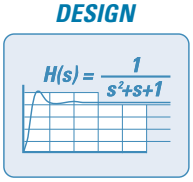

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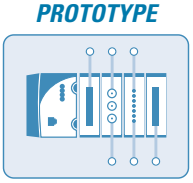

> I/O modules and drivers
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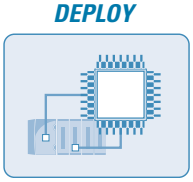

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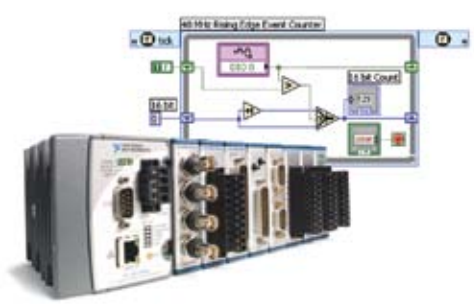

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Boeing Selects Aonix ObjectAda for Tomahawk Mission Planning Software

Boeing has chosen and licensed Aonix's ObjectAda for Windows in preparation for its plans to use it for ongoing software development and migration tasks on the Tomahawk Mission Planning (TMP) Software Platform (Figure 1). Boeing's interest in Aonix's ObjectAda for Windows hinges on several technical factors, including its full compatibility with Microsoft's .NET platform.

Driven by the prospect of obsolescence and diminishing support for their existing Ada development environment, Boeing's TMP group initiated a full-scale evaluation of available Ada compiler and tool solutions. Aonix reportedly proved to be the Ada vendor with compiler technology able to support a very large Ada source code base. Aonix's capability in meeting stringent performance and functionality requirements, and efficiently support a large software development team were also factors in the decision. In order to port a large code base without requiring a large investment of new engineering resources, Boeing's TMP group needed a multilanguage development environment to accommodate existing C, Fortran and .NET software assets.

The Aonix ObjectAda for Windows brings the improvements of ObjectAda 8.2 to the Windows development platform. In integrating current Windows improvements with the Aonix Ada 95 compiler, Aonix has delivered enhancements to the object code and symbolic debugging information generation and provided full compatibility with the Microsoft Visual Studio .NET 2003 development tools.

Figure 1

A Tomahawk Land Attack Missile (TLAM) is shown here launched from the U.S. Navy Arleigh Burke Class Guided Missile Destroyer, USS Porter (DDG 78). (DoD photo).

Aonix
San Diego, CA.
(858) 457-2700.
[www.aonix.com].

Rockwell Collins Forms Team to Pursue KC-10 Upgrade Program

Rockwell Collins, Boeing and Honeywell have signed an agreement to jointly pursue the KC-10 Aircraft Modernization Program (AMP). The KC-10 AMP (Figure 2) program calls for upgrading the fleet's avionics to meet Communications, Navigation, Surveillance/Air Traffic Management (CNS/ATM) requirements and will also include other airframe-related upgrades.

Under the terms of the teaming agreement, Rockwell Collins will serve as the prime contractor and will have Total Integration System Performance Responsibility (TISPR). Boeing will be responsible for non-avionics Non-Recurring Engineering (NRE) and installation of the systems, which will be completed at the Boeing facility at Kelly USA in San Antonio, Texas. Honeywell will support the evaluation of upgrade alterna-

Figure 2

A KC-10 Extender aircraft, from Travis Air Force Base, CA, refuels an F/A-22 Raptor. (U.S. Air Force photo).

Boeing Selected for U.S. Army Satellite Program

… And in other Boeing news: Boeing has been selected by the U.S. Army as one of six contractors to provide satellite communications systems and services for the Worldwide Satellite Systems program under a five-year, indefinite delivery, indefinite quantity contract valued at up to $5 billion.

The contract calls for six satellite terminal types, operating on a variety of military and commercial satellite bands, including C, Ku, X and Ka, and services for satellite operation and sustainment. The six types include combat support service very small aperture terminal (VSAT); fixed station satellite terminal; flyaway VSAT satellite terminal; military certified satellite terminal; prime mover/trailer mounted satellite terminal; and deployable satellite earth terminal.

Advanced Information Systems, a unit of Boeing Space and Intelligence Systems, will provide satellite communication systems, as well as engineering and support services, that provide commercial and tactical beyond-line-of-sight communications. Boeing's solution will support current systems and strategic satellite communications to sustain a flexible baseband, while offering continuous technological improvements in performance, logistics supportability, reliability and maintainability.

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tives for the autopilot/autothrottle systems.

In July the United States Air Force's Aeronautical Systems Center awarded the Rockwell Collins team with a $3.5 million contract for a Concept Refinement Study for KC-10 AMP. Results of the study will provide industry's perspective on potential acquisition approaches, strategies and diverse technical options for execution of the program. The KC-10 AMP contract award is expected in March 2008. Rockwell Collins and Boeing are currently teamed on the KC-135 Global Air Traffic Management (GATM) program under a similar agreement, with Honeywell providing product support. It is the only U.S. Air Force GATM upgrade program that is in full-rate production with more than 140 aircraft delivered.

Rockwell Collins
Cedar Rapids, IA.
(319) 295-1000.
[www.rockwellcollins.com]

Navy Boosts Contract Ceiling on ARINC's Engineering Work

ARINC Engineering Services, LLC has been awarded an estimated $8,693,085 increase on its current contract for engineering and technical support services to the Navy's SPAWAR Space and Naval Warfare Systems Center, Charleston, SC. The contract modification includes options that bring the cumulative value of the ARINC contract to an estimated $32,714,279.

ARINC Engineering Services provides turnkey systems engineering, design, technical and computer support services for SPAWAR under the contract, which was originally awarded in 2002. Other support includes operational subject matter expertise for electronic equipment, systems and subsystems for the Naval Air Traffic Control Air Navigation Aids and Landing Systems (NAALS) and Meteorology and Oceanographic (METOC) Systems.

The ARINC contract modification was competitively procured via the SPAWAR e-commerce central Web site, with 25 proposals solicited and one offer received. Work will be performed in Charleston, and is expected to be completed by April 2007. The Space and Naval Warfare Systems Center is the contracting activity.

ARINC
Annapolis, MD.
(410) 266-4000.
[www.arinc.com].

(a) (b)

Figure 3

The Army has specified Tyco's Pro Beam Jr. expanded beam fiber optic connectors (a) for use in the Mounted Battle Command on the Move HMMWV platform. Shown here, operating out of the Fort Gordon Battle Command Battle Lab, international exchange officers run simulations on a prototype Battle Command on the Move suite designed to operate in a Humvee (b).

Army Specifies Tyco Fiber Optic Connectors for Humvee Platform

Tyco Electronics' line of Pro Beam Jr. (Figure 3a) expanded beam fiber optic connectors has been accepted for use in the Mounted Battle Command on the Move (MBCOTM) HMMWV (Figure 3b) platform. The MBCOTM will also be considered for integration onto Bradley and Stryker vehicle platforms. The MBCOTM is a C4I mission equipment package integrated into TO&E authorized platforms that allows brigade and above commanders to move to the decisive point on the battlefield.

Pro Beam Jr. expanded beam fiber optic connectors are a ruggedized interconnect capable of high-speed data transmission between various communication network components, an essential aspect of digitizing the battlefield. With Pro Beam Jr. expanded beam fiber optic connectors, data rates up to 2.5 Gbits/s and beyond are possible.

The expanded beam fiber optic technology used in Pro Beam Jr. connectors withstands shock and vibration commonly found on tactical military vehicles. Furthermore, the connectors are very easy to clean and maintain compared to other fiber optic connectors. In addition to tactical communications, Pro Beam expanded beam fiber optic connectors have been deployed on military aircraft, radar systems, rugged communication systems and other hardware requiring high-speed, rugged-connection interfaces. Ace Electronics, in conjunction with Tyco Electronics, provides the U.S. Army and its contractors with value add services and integration of Pro Beam expanded beam fiber optic connectors and cable assemblies.

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Harrisburg, PA.
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Lexicon Site Indexes Terms for Space and E-Warfare

The military market is notorious for its overflowing numbers of acronyms and jargon. Likewise, the electronics realm is just as difficult to navigate in relation to its terminologies. And there's one subset of both communities that beats both in the jargon jungle—the twin fields of space and electronics warfare. Providing a complex glossary of just that area is the Space & Electronic Warfare Lexicon.

According to the site's operator, the purpose of the lexicon is to provide a convenient Internet-accessible source for space and electronic warfare terms, acronyms, abbreviations and related reference material for use by those who have an interest in such information. The glossary contains terms used in Electronic Warfare (EW), Command, Control, Communications & Intelligence (C3I) and related fields, and also terms related to emerging technologies in space, EW and other areas having military implications such as the Internet and non-lethal weaponry. Leveraging the power of the Web, the lexicon also includes numerous hyperlinks to related Web sites, as well as to diagrams and sound tracks associated with some of the terms. Photographs and video clips are also used when available. Adding some spice to the mix, the site recently added a summary of naval signal flags, International Morse Code, a Cold War civil defense manual, and even a World War I song book.

Space & Electronic Warfare Lexicon
echoplex@ieee.org.
Sarasota, FL.
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Main Feature

Data Recorders

Data Recorders
Get Faster, More Reliable

As all branches of the military acquire increasing amounts and types of real-time information from multiple sources, data recorders must capture it all at higher speeds for longer periods of time.

Ann R. Thryft,
Senior Editor

The more intelligence that can be acquired to help warfighters, the better they can do their jobs. In today's military, the data recorders used in military data acquisition applications must capture more intelligence from more sources than ever before, both SIGINT and ELINT. Longer recording times and higher recording speeds are also in demand.

At the same time, since more recorders are being located in the field—including on the ground, in the air and at sea—size, weight and power (SWAP) are becoming even more important. Data recorders are found in ground-based systems, laboratories and radio astronomy sites. They are key components in UAVs, as well as the Army's Apache helicopters and the Navy's Aegis Ballistic Missile Defense system (Figure 1).

The results are demands for higher-performance, sometimes smaller and lighter, rugged recorders that can accept a variety of signal types, both digital and analog, in real time and record them continuously on reliable media.

"Almost all of our customers are looking at how they can increase bandwidth and how they can record for longer periods of time," says Angsuman Rudra, director of systems at ICS Sensor Processing, part of Radstone Embedded Computing. "Gapless recording is also important, and with the increased importance of field-based data capture, portability is important."

Figure 1

Data recorders are becoming key components in a variety of military systems, including the Aegis Ballistic Missile Defense System. The maritime capability is designed to intercept short- to medium-range ballistic missile threats in the midcourse phase of flight. In the Pacific Ocean, a Standard Missile Three (SM-3) is launched from the guided missile cruiser USS Shiloh during a joint Missile Defense Agency/U.S. Navy ballistic missile flight test. Two minutes later, the SM-3 intercepted a separating ballistic missile threat target. *(photo credit US Navy)*

Faster Throughput, Longer Recording Times

Data recorder speeds are currently 400 Mbytes/s to 600 Mbytes/s for sustained, continuous recording and playback. Within the next year, the high end will jump to 800 Mbytes/s.

The very high-end 7U ICS daqPC Data Acquisition, Storage and Network System, for example, delivers a recording and play-

back speed of 600 Mbytes/s. Aimed at real-time applications that require acquisition, processing and archiving of analog input signals, this system achieves its high-speed record/playback capability using removable hard drives.

At 600 Mbytes/s, up to 1500 channels of data, each digitized with a 16-bit A/D converter, can be recorded in real time at a 200 kHz/channel sample rate. Alternately, three 40 MHz bandwidth (flat-top) signals can be recorded in real time at a 100 MHz sample rate. The daqPC features maximum storage of over 2.8 terabytes, a 1 Gigabit network interface and time-stamping support.

At the front end, sensor data must be captured accurately and safely. "This is real-time data: you can't ever slow it down or stop it," says Mike Jadon, Micro Memory's director of product marketing. The company's Anvil recorder is an all-digital front-end based on an embedded hardware architecture in a server form-factor. Up to 64 Gbytes of high-throughput, dual-access optimized SDRAM captures sensor data in two 32-Gbyte buffers. Each is full-duplex and can perform simultaneous reads/writes to secondary, external hard disk drive media.

Since sensors tend to be "bursty" and their bursts cannot be predicted, even in a streaming application there will be "dead spots" when no data is coming in. Targeted at radar and SIGINT applications, each of the Anvil's memory arrays can sustain data transfer rates of over 500 Mbytes/s. When the sensors produce bursts the recorder can accept their data and simultaneously write it to disk. Alternately, the data can be written during dead spots. PCI slots accommodate a variety of sensor input I/O including A/D, serial FPDP and custom LVDS or fiber links, as well as storage output I/O for Fibre Channel, SCSI or SATA.

"Snapshot" recording is becoming more popular in radar applications, especially SAR, says Jadon. Typically data blasts for a while, then stops for an even longer period, so the recorder must take in data faster than it can be sent to disk. A solution like the Anvil is used to receive data, "snapshot" it, and send it to disk, readying the recorder for the next snapshot.

In ground-based systems, data capture and playback is also essential for testing complex military system designs and PXI has become entrenched as a solution. For example, Conduant's data recorders are aimed primarily at very high-performance systems based on hard disk drives, although they can also accommodate solid state drives and CompactFlash. PCI Express is being used more often because of its advantages: higher bandwidth, full-duplex, point-to-point connections and the fact that it can run over an external cable. The company has introduced PXI-based data recorders and a PXI Express model, the StreamStor PXIe-416.

The 3U StreamStor PXIe-416 has four-lane endpoint connectivity to the host PXIe fabric and can record at 600 Mbytes/s sustained for more than 3.5 hours. It supports more than 8 terabytes of storage with a total of 16 disk drives, each with 500 Gbytes of capacity.

The StreamStor PXIe-416 records and/or plays back as peer-to-peer transfers within the PXIe fabric, eliminating contention with the computer system's non-real-time elements. A single unit can simultaneously record streams from multiple data sources within the PXIe fabric or simultaneously play back recorded data to multiple destinations in the fabric. Simultaneous recording and playback, as well as event marking, are also featured. Applications include high-speed image acquisition and recording RF signals in the field for later playback/analysis in a lab.

A large part of the need for higher throughput is in intelligence/surveillance/reconnaissance (ISR). Much of this recording activity is moving out of the labs and into ISR platforms, says Tom Bohman, VMetro's vice president for business development, recording products. For instance, data recorders in UAVs have very long-term ISR capabilities, recording and analyzing data over several days at a time. So SWAP have become major concerns.

VMetro's VME- and CompactPCI-based recorders use PMC sites that can integrate virtually any kind of I/O and Fibre Channel to go to the storage. Since FC is a storage area network (SAN), multiple recording systems can be connected in an array where any recording device can access any storage device.

Figure 2

Many real-time data recording applications depend on hard disk drive arrays, usually JBOD, because it is less expensive and delivers higher performance than RAID. SANbric, the six-disk JBOD array at the heart of VMetro's data recorders, features dual 2 Gbit/s Fibre Channel interfaces, 1.8 terabyte capacity and up to 385 Mbytes/s sustained recording using the company's Vortex recorders. The SANbric's sealed container can be isolated from shock at up to 72,000 feet.

Higher Storage Capacity, Improved Media

The need for higher throughput goes hand in hand with the need for higher storage capacities. Solid state media, in particular solid state disks (SSDs), have often been used in rugged environments. Micro Memory's Anvil data recorders use SDRAM instead of flash because of its higher speeds. Prices are usually comparable, but flash is very low-performance on writes, says Jadon. But SSDs cost more than hard drives.

Many real-time data recording applications depend on hard disk drive arrays, usually JBOD, also known as Just a Bunch of Disks. For example, SANbric, the storage portion of VMetro's data recorders, is an array of six 3.5-in. disks usually configured as a type of JBOD (Figure 2). Along with the company's Vortex Data Recorders, SANbric Rugged Storage Systems are being used in Jet Propulsion Laboratory's UAV SAR program. ■

Main Feature

Data Recorders

New Standards, Technology Eliminate Signal Processing Bottlenecks

In high-performance, real-time digital signal processing systems, data throughput limitations are being overcome by teaming switched serial fabric topologies with the enabling technology of FPGAs.

Rodger H. Hosking, Vice President
and Cofounder, Pentek

The most difficult problem for designers of high-performance, real-time digital signal processing systems for military applications is simply moving data within the system because of data throughput limitations. Driving this dilemma are processors with higher clock rates and wider buses, data converter products with higher sampling rates and digitized communication and radar signals with increased bandwidths.

VITA 41.0	VXS Base Specification
VITA 41.1	InfiniBand Protocol
VITA 41.2	Serial RapidIO Protocol
VITA 41.3	Gigabit Ethernet Protocol
VITA 41.4	PCI Express Protocol
VITA 41.5	Aurora Link Layer Pin Assignment
VITA 41.6	1x Gigabit Ethernet Control Channel
VITA 41.7	Processor Mesh
VITA 41.10	Live Insertion System Requirements
VITA 41.11	Rear Transition Module Standard

Figure 1

VITA 41 VXS draft specifications.

Figure 2

An XMC module with a single XMC connector, the Pentek 7140 software radio transceiver.

As if that weren't enough, there are also disk storage devices with faster I/O rates, FPGAs and DSPs offering incredible computational rates and system connections and network links operating at higher speeds. Traditional system architectures relying on buses and parallel connections between system boards and mezzanines fall far short of delivering the required peak rates, and suffer even more if they must be shared and arbitrated.

New strategies for solving these problems include deploying gigabit se-

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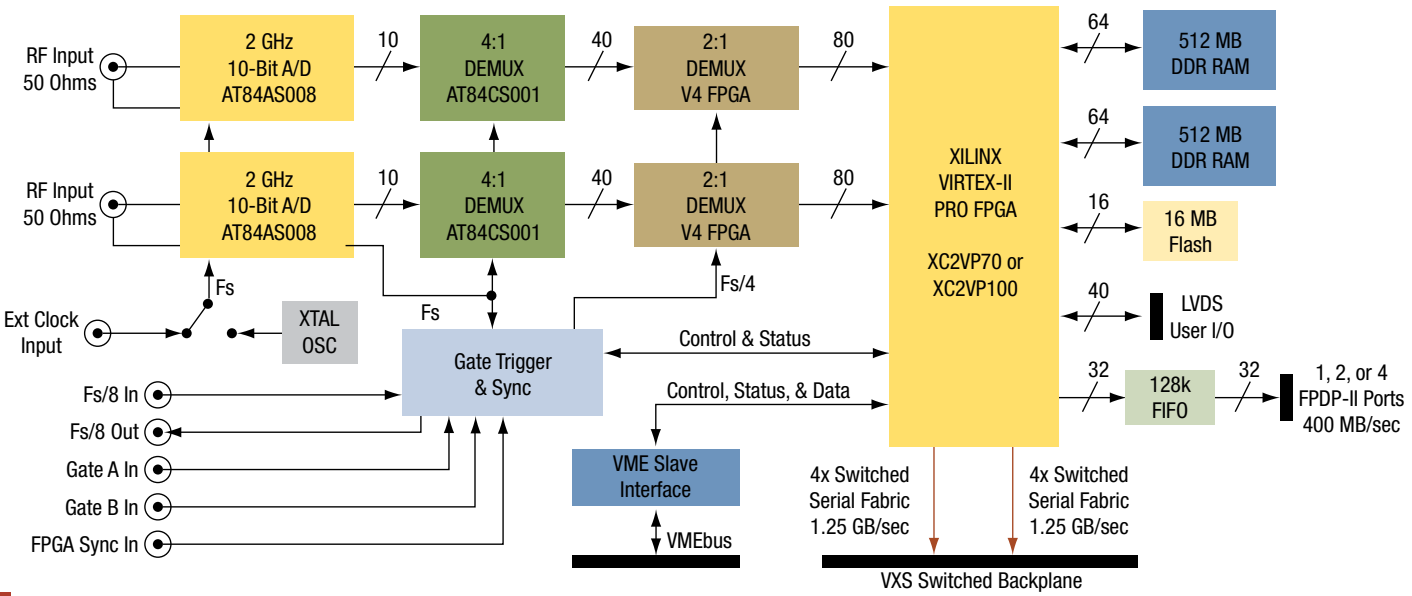

Figure 3

Pentek's Model 6826 dual-channel 2 GHz 10-bit A/D converter has a Virtex-II Pro FPGA and dual 4x VXS ports.

rial links, adopting switched fabric standards and using DSP techniques for data rate reduction.

Gigabit Serial Interfaces

To handle increasing bandwidths, new gigabit serial protocols have emerged to meet the special needs of various market segments. Fortunately, to help speed their adoption, these new protocols operate over many of the same high-volume, low-cost physical layer devices used for Ethernet.

Taking advantage of these new gigabit interfaces was obviously attractive to embedded system board vendors who are always looking for opportunities to adopt mainstream commercial technology. Defining industry standards around them was essential for acceptance by the conservative risk-averse markets served by embedded computing, especially government and military customers.

VXS and VXP: Switched Fabric for VME Cards

Introduced in 2003, the VXS switched fabric standard for VMEbus is defined in the VITA 41 draft specifications. VXS payload cards are processor, CPU, memory and data converter 6U VMEbus cards with a new VXS gigabit serial connector, called MultiGig RT2, installed between P1 and P2. The VXS switch card also uses the 6U VME board form-factor but, unlike the VXS payload card, the P1 and P2 connectors are removed to make room for multiple serial connectors. A new VXS backplane joins mating MultiGig RT2 connectors from each payload card to the switch cards. The VXS switch card implements the crossbar switching function to connect traffic between payload cards.

Each VXS link consists of four serial lines ganged together and operates in a full-duplex mode for simultaneous transfers in each direction. With two 4x links per VXS connector and a nominal bit frequency of 3.125 GHz, VXS allows data transfers between system cards at 2.5 Gbytes/s.

The VXS base specification defines the connectors and mechanical specifications for two types of cards, while sub-specifications define how various switched fabric protocols are implemented for InfiniBand, Ethernet, Serial RapidIO, PCI Express and Aurora (Figure 1).

A follow-on standard being defined under the VITA 46 draft specification, also known as VXP, extends the number of RT2 connectors on the payload cards by completely eliminating the P1 and P2 connectors. As a result, VXP payload cards support a much higher traffic bandwidth than VXS payload cards. Like the VXS specifications, VXP also has sub-specifications for

several fabric protocols and other enhancements.

XMC and AMC: Switched Fabric for Mezzanines

Mezzanine boards offer system designers an excellent way to connect a wealth of peripheral I/O and expansion functions to CPU, RISC and DSP processor boards. One of the most popular mezzanine formats is the PCI Mezzanine Card (PMC) that attaches to a carrier board using a 32- or 64-bit PCIbus. However, this often fails to meet data throughput demands as new peripherals get faster.

To relieve this bottleneck, the VITA 42 draft specification, also known as XMC, adds new gigabit serial connectors to the existing PMC module, but maintains the PCI interface. This promotes adoption of XMC, since vendors can include XMC interfaces on their new PMC designs that will be backward compatible with legacy PMC carrier cards (Figure 2).

XMC defines two 4x full-duplex gigabit serial ports per XMC connector, delivering a 2.5 Gbyte/s data transfer rate. With two XMC connectors installed, combined data bandwidth is 10 times faster than the 64-bit/66 MHz PCI bus. As with VXS, sub-specifications within VITA 42 further define operation with specific popular protocols.

ATCA, defined under PICMG 3.x, recruits switched fabrics to boost connectivity well beyond the bus architecture of CompactPCI. A related specification for Advanced Mezzanine Card (AMC) defines a new module for use in ATCA systems. The connector provides up to 21 gigabit serial ports, each consisting of one receive and one transmit LVDS pair and capable of future implementations with rates of up to 12.5 GHz.

FPGAs Eliminate Embedded System Bottlenecks

FPGAs deliver two different, highly effective solutions to data flow problems: implementation of gigabit serial links and intelligent reduction of data rates prior to delivery. For example, Xilinx offers RocketIO gigabit serial interfaces on its Virtex-II Pro, Virtex-4 and Virtex-5 devices, currently operating at speeds of up to 3.125 GHz. Altera's new Stratix II GX series doubles the earlier Stratix GX series transceiver clock rate to 6.375 GHz.

Once an FPGA is deemed necessary for other board functions such as DSP, state machines or control functions, FPGA IP cores can be installed for the next upper layers of specific protocols. This zero-overhead strategy for including serial fabric capability on embedded system boards allows both board vendors and customers to postpone the risky commitment to a specific fabric, yet builds a growing base of commercial products ready to be "cored" and deployed.

FPGAs can also implement DSP

algorithms to intelligently extract required information from a wideband source in real time. This can be done in the time domain, as in duty cycle averaging for radar pulses, or in the frequency domain, as in digital downconverters for communication systems. Reducing the data rate at the source not only eases demands on the data channel, it also reduces processor loading, memory utilization and disk storage requirements.

Putting It All Together

Pentek's Model 6826 dual-channel 2 GHz A/D converter illustrates most of these strategies and technologies (Figure 3). Two 10-bit A/D converters operate at sampling rates up to 2 GHz, and deliver output data through two de-multiplexing stages to reduce the data clock rate into the Virtex-II Pro FPGA.

Two banks of 512 Mbyte DDR RAM buffer a continuous time record of up to 250 milliseconds on both channels at the full sample rate of 2 GHz. As a front-end for high-performance recording systems, the board can deliver data to legacy systems through four FPDP-II ports at rates up to 400 Mbytes/s each. For next-generation recording systems, the dual 4x VXS ports provide a combined throughput of up to 2.5 Gbytes/s.

On this board, the FPGA provides multiple tasks: the electrical interface to the A/D converter, elastic data buffering, clock/gate/trigger control, LVDS I/O, SDRAM control, data formatting and the VXS interface. Yet, there is still unused capacity available for real-time DSP tasks. It's no wonder that FPGAs are found on virtually every new embedded system board.

Parallel Buses: The End of an Era?

With all of these new gigabit serial standards, it is increasingly apparent that the role of parallel backplane and parallel mezzanine buses for high-speed data movement is fading rapidly. Teaming switched serial fabric topologies with the enabling technology of FPGAs represents a true sea change in embedded real-time system strategies. Now that industry hardware standards are being finalized, components and connectors are available and a wide range of board-level products are being introduced, the next big challenge for the industry is standardizing the software to drive these interfaces. ■■

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Main Feature

Data Recorders

FPGAs Enable Real-Time Data Recording for Sensor Processing Applications

Military embedded sensor processing applications present challenges for real-time data recording, as data bandwidths can be high and size constraints can limit the opportunity to use additional hardware.

Steve Birch, Technical Director
TEK Microsystems

The ability to record and play back large volumes of sampled digital data, at real-time data rates, is a key capability for many military sensor processing applications. Deployed digital signal processing systems, as utilized in applications such as radar and signal intelligence (SIGINT), may employ a data recording system as part of the system's core mission or as a means of test and verification of system operation.

For example, in SIGINT applications, real-time data recording could be used to record data that has been sampled from an antenna/RF system. The recorded data might be used as a simple store, for subsequent offline analysis or replaying of the data. Alternatively, it may be an integral part of a real-time processing application whereby raw sampled signal data is stored to disk in parallel with a signal processing operation identifying signals of possible interest within this data. Once a portion of data has been identified, the corresponding raw data may be retrieved from the data store for further analysis or for use in jamming/spoofing operations.

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Challenges of Real-Time Data Recording

Recording systems using arrays of hard disks can be considered for real-time, high-volume data storage applications. Real-time data recording for military applications offers some specific challenges. Sensors and RF antennas may generate very high bandwidths of digital data. Data rates in excess of 3 Gbytes/s from a single sensor channel are not uncommon. In addition, embedded applications, especially those within rugged military operating environments, may be constrained in terms of size, weight and volume.

An obvious solution to the high data bandwidth requirements of military data storage applications is to employ multiple parallel sets of disk arrays and interface cards to achieve an aggregate bandwidth commensurate with application requirements. However, this solution may not be compatible with the size, weight and volume constraints of many embedded applications.

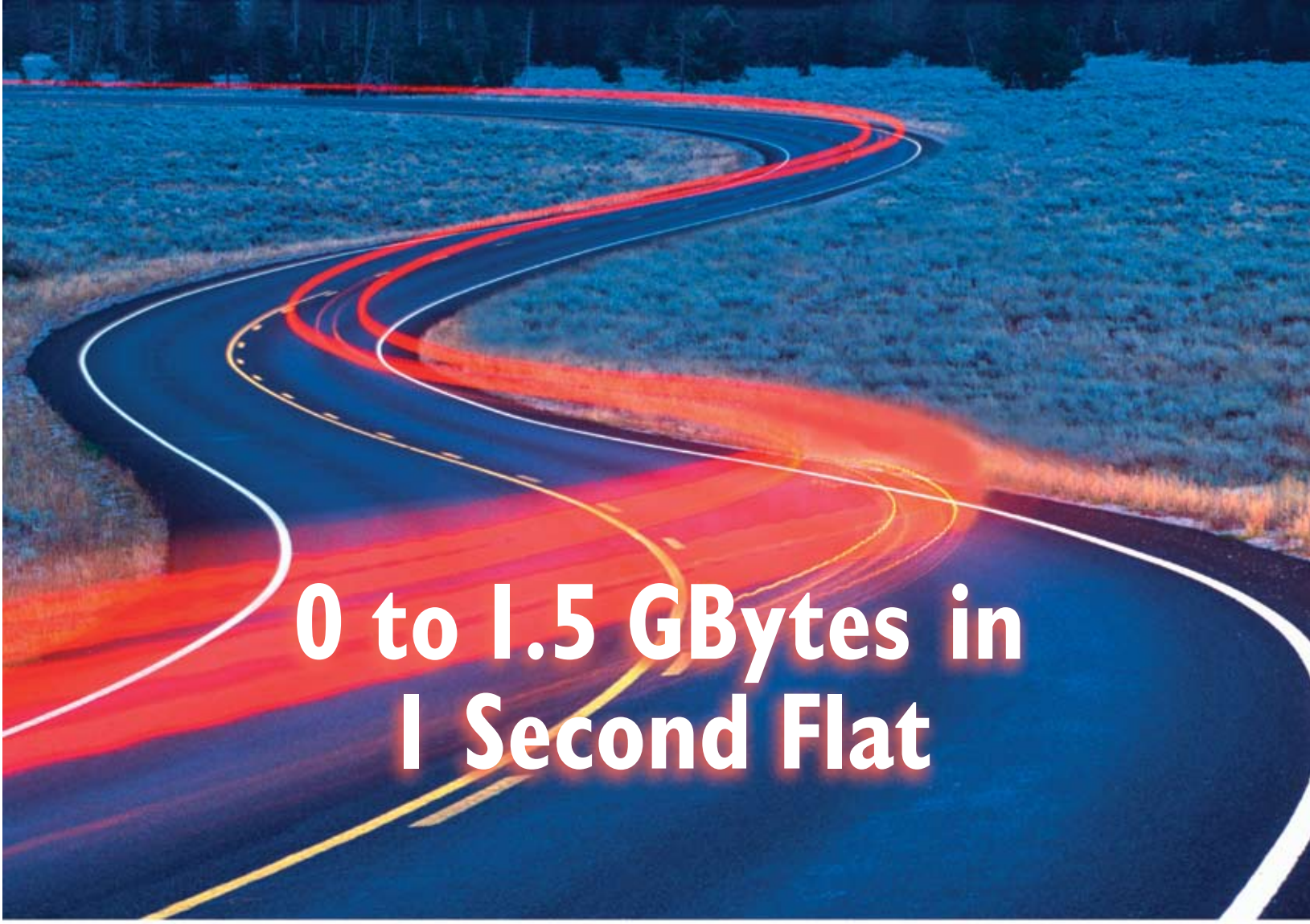
FPGAs are increasingly used in embedded processing systems to provide a flexible interface component and a high-speed data processing resource, such as for high-speed digital signal processing.

State-of-the-art FPGAs include a rich set of on-chip hardware resources that can be used to implement disk interfaces such as Fibre Channel. The Xilinx Virtex II Pro, Virtex 4 and Virtex 5 FPGA families include devices containing multiple, on-chip Multi Gigabit Transceiver (MGT) resources that can be employed to implement the physical layer of disk interfaces such as Fibre Channel.

With careful design, it is possible to utilize an FPGA's on-chip resources to implement a complete real-time data recorder application using firmware within the chip. Since it has many physical interfaces, the FPGA can be interfaced directly to one or more disk arrays. The resulting system can be scaled for very high recording bandwidths while still achieving a compact, single-chip solution. Further scaling can be achieved by utilizing multiple FPGAs in a system.

Example Application: Wideband Signal Processing and Recording

In RF systems, the trend is to digitize and process signals at the earliest possible point in the signal chain. This means digitizing signals at the fastest possible rate and highest resolution (number of bits) that can be achieved. Therefore, the benefits of digital domain processing can be gained across a wider portion of the



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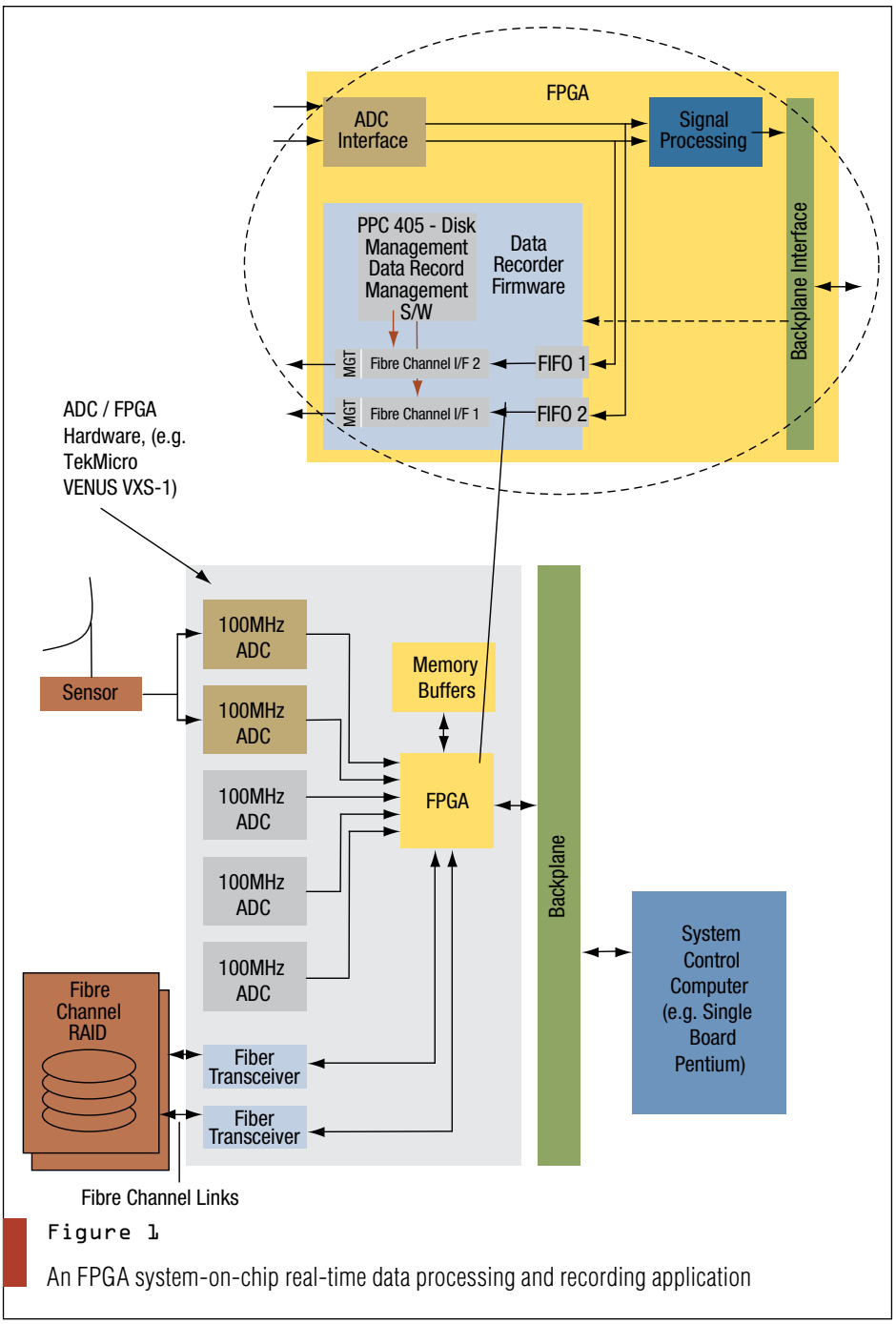

Figure 1

An FPGA system-on-chip real-time data processing and recording application

signal bandwidth of interest. In a SIGINT application, this translates into more effective processing of more communication channels simultaneously.

FPGAs are increasingly employed very close to the A/D converter portion of a system in order to enable early-stage signal processing to be carried out on data that may have been sampled at high clock rates. Operations such as decimation and channelization of the sampled data may be carried out at this stage. This is a good point in a system to insert real-time data recording firmware into the FPGA. Direct access to the raw sampled data is available and it is usually most useful to capture raw data, prior to any signal processing operations.

An example system includes real-time data recording firmware in an FPGA on an A/D converter card (Figure 1). The FPGA has been interfaced directly to a pair of Fibre Channel RAID arrays; no additional interface hardware is required. By using a pair of Fibre Channel disk arrays, a sustained recording bandwidth in excess of 300 Mbytes/s is achievable.

Data recording functionality is implemented in the FPGA using on-chip embedded processor resources. This allows software to be written for this functionality's complex elements, such as filing system management. Two of the on-chip MGT resources are also utilized to implement the physical layer of the Fibre Channel interface.

Commercial A/D cards (Figure 2) operate at sample rates in excess of 2 GHz with 10- or 12-bit-wide data samples. This means that a real-time data storage system would cope with data bandwidths of 3 Gbytes/s.

Employing multiple disk arrays and disk interfaces in parallel is the obvious way to add additional recording bandwidth to a system. FPGA implementation of the disk interface offers the possibility of implementing multiple instantiations of the interface in a single chip. Further scaling may be possible if multiple FPGAs are available.

Highly scalable data recording systems can be implemented by utilizing multiple FPGAs in a system. A multi-GHz digitizer card is connected to two FPGA processing cards via a high-speed backplane. Each FPGA card has five FPGAs, each of which can be employed in the system as a signal processing resource. By also instantiating parallel copies of the data recording firmware, a recording system with bandwidth scalable up to 3 Gbytes/s can be achieved. Each of the FPGAs connects to two Fibre Channel disk arrays and firmware is provided in the FPGAs to distribute the incoming or outgoing raw data to the appropriate devices.

The Solution: FPGAs

Real-time data recording is a common requirement in many military embedded sensor processing applications. Such applications present challenges for a data recording application as data

bandwidths can be high and size constraints can limit the opportunity to use additional hardware.

FPGAs are increasingly utilized in military embedded signal processing systems to enable processing of wideband sampled data. FPGAs also provide a rich set of on-chip resources that can be used to implement interfaces to hard disk systems via standard protocols such as SCSI, Fibre Channel and Serial ATA.

Real-time data recording functionality can be implemented in a system by adding firmware to the FPGA and connecting it directly to a hard disk array. The FPGA provides a very compact, system-on-chip recording solution. Alternatively, by scaling the firmware across multiple FPGAs, an order of magnitude increase in recording bandwidth can be achieved.

TEK Microsystems' Jazzstore SOC technology offers an FPGA implementation of a Fibre Channel-based data recording system. This technology complements the TEK Microsystems Jazz and Quixilica FPGA-based products, providing real-time data record/playback functionality for a wide range of demanding real-time applications. ■■

Figure 2

The Venus VXS-1 from TEK Microsystems forms the heart of the A/D converter portion of this data recording system. The board combines FPGA technology with five high-resolution A/D conversion channels and is suited to advanced, multi-channel sensor data acquisition and processing applications.

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Main Feature

Data Recorders

Solid State Flash Drives Help Ruggedize Data Recorders

Data storage is undergoing a transition from magnetic tapes and mechanical hard disk drives to solid state flash disks for superior ruggedness and security.

Dr. Balázs Bagó, Vice President Development, Heim Data Systems
Guy Freikorn, Solid State Disk Product Manager, Msystems

Figure 1

The Ultra ATA FFD solid state disk (SSD) from msystems is a drop-in replacement for a hard disk drive. With no moving mechanical parts, or substances such as gas that behave differently at high altitudes, the SSD is far more suited to meet harsh environmental and operational conditions.

The storage of mission-critical data has posed a dilemma for instrumentation recorder providers and users. Using ruggedized storage devices is extremely costly, yet affordable commercial media must be specially adapted for ruggedized applications.

Until recently, the cost of high-density storage systems capable of withstanding extreme temperature and vibration, while supporting high data rates, was beyond most program budgets. Project managers were forced to use media types such as linear tape to record their mission data. These offered, at best, marginal reliability in extreme conditions.

Depending on the type, each platform has unique operational requirements. Helicopter and rotary engine aircraft require systems that withstand 0.076 g2/Hz, and 20 g-peak half-sine wave vibration for applications such as catapults and traps on aircraft carriers. Fighter aircraft require operation in 10g linear acceleration and high jerk environments. Ground systems, such as tanks and combat vehicles, have extremely high temperature requirements (-40°C to +85°C) and must withstand high vibration and shock. These requirements are coupled with the need for operation in an extremely dirty environment.

Environmental Effects on Stored Data

Economic considerations require commercially available drives to be deployed in data acquisition equipment, leaving limited capability for designed-in protection against known environmental influences. For data storage, tape media has significant cost advantages, with the lowest cost per bit and high-volume efficiency.

However, the record/replay process requires the flexible, temperature- and humidity-sensitive tape to be mechanically moved across either fixed or moving heads. This process is highly susceptible to the effects of vibration and acceleration, causing tape debris, time base variations and head-to-tape separation. These effects result in error rates so high that

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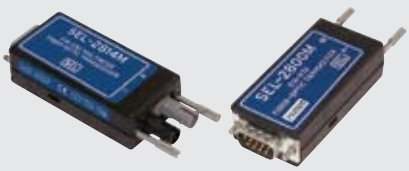

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Figure 2

Heim Data Systems uses msystems' SSD in Heim's data recorder by placing the disk in a ruggedized housing. By teaming up to meet the extreme requirements typical of mission-critical applications, the two companies have extended the operational limits of data recorders.

error detection and correction strategies cannot be guaranteed to work in non-benign environments.

Hard drives in hermetically sealed housings provide relatively good protection against foreign debris and the ambient environment. The rugged nature of platters and very lightweight head components provide a degree of built-in acceleration tolerance.

However, the drives rely on very fine gas bearings to separate the flying heads and platter. Both excess acceleration and reduction in air pressure at high altitudes in a lower cost, non-sealed drive are likely to cause a crash. Unlike the temporary loss of data experienced with an over-stressed tape drive, a single head crash can prevent normal access to all data on a hard drive and is likely to render the drive inoperable.

Providing Affordable Storage for Military Applications

Solid state media has the inherent advantage of no moving parts. The effects of temperature, humidity, shock, vibration, acceleration, altitude, fungal attack, RFI and foreign material intrusion can be controlled within desirable limits if the media is designed to meet the appropriate standards (Figure 1).

Although the reliability and longevity of individual bit storage elements are not as robust as magnetic media, this can be vastly improved by the sophisticated management of memory cells. Static and dynamic wear-leveling, standard and dynamic bad block management, and error detection and correction code extend the flash lifespan and result in highly reliable and rugged solid state storage media.

The ongoing trend of decreasing prices in solid state storage media, combined with its native ruggedness, has made this the most appropriate media for extremely ruggedized applications. Prices have already fallen to a level that promises a lower total cost-per-recording-system than the cost of earlier magnetic-based media. The additional costs for ruggedizing and hermetically sealing the tape or hard disk drives, and the extra space required for these solutions that often translates into additional cost overhead, make solid state solutions attractive on overall price as well.

Designing Rugged, Fully Electronic Data Recorders

Today, the use of digital processing improves data recorder signal quality, as well as data reliability and security. Redundancy can easily be added everywhere in the digital recording process to secure data transmission and storage with checksums. Sophisticated error detection and correction techniques can also be applied.

There are additional benefits to the fully electronic solution. The use of solid state disk (SSD) media that directly supports standard interfaces enables easy transfer of digitally stored data to commercial computers via standard interfaces such as SCSI, SATA, IDE, IEEE 1394, USB and Ethernet. Standard computer backup techniques can be used for data archiving, enabling low-cost yet highly reliable solutions.

Environmental extremes such as shock, vibration, dust, salt water, extreme temperature ranges and high altitude severely compromise the reliability of data recorders. A recorder that contains only electrical components can more easily be designed to withstand these conditions.

Typically, electronic components can easily be assembled and sealed against altitude, dust and salt water intrusion. Careful component selection and handling of worst-case timing during the design phase ensure operation at extreme temperature ranges. Vibration and shock can be handled mainly by careful mechanical design and the use of rugged interconnections both internally in the recorder and between the recorder and the media.

For example, msystems' SSDs are specifically designed to meet the environmental requirements of military missions. With no moving parts, they operate in the harshest environmental conditions defined by MIL-STD-810F: an operating temperature range of -40° to +85°C, a humidity range of 5% to 95%, shock conditions at 1,500g half-sine and random vibration of 16.3g (10 Hz to 2,000 Hz) at an altitude of 80,000 feet.

In data recorder design, vendors such as Heim Data Systems are constantly challenged to isolate the storage media from extremely harsh environments to make it even more rugged. Placing the SSD on an internal shock mount, as Heim did with msystem's disk, extends the vibration envelope beyond the MIL-STD-810F specification (Figure 2).

Declassifying Media to Protect Sensitive Data

Securing confidential data in emergency situations is essential for mission-

critical systems. Teamwork between Heim and msystems has resulted in successful data recorder operation in various secure, classified environments and operational scenarios requiring immediate declassification of the media, such as an aircraft crash or troop ambush in hostile territory.

U.S. security agencies define several levels of erasing sensitive data for various storage media types. Each U.S. military force has compiled its own internal document, based on DoD/NSA instructions.

Erasing is also known by several other terms. "Clearing" eradicates data on the media before it is reused, in an environment that provides an acceptable level of protection for the data stored on the media before clearing. "Sanitizing," or "purging," removes data on the media before it is reused, in an environment that does not provide an acceptable level of protection for the data on the media before sanitizing. "Destroying" physically damages the media so it is totally unusable, making data retrieval impossible.

Securely erasing magnetic media is difficult due to the extreme persistence of magnetization history in the magnetic domains of both tape and disk platters. The only effective, rapid security for stored data is complete destruction of the magnetic material. While very high-powered degaussers can prevent normal access to stored data, they are power-hungry, heavy, large and susceptible to operator error. They cannot be airborne or used quickly in an emergency.

Conversely, the erased state of a flash memory cell has very little dependence on its previous logic states. Carefully planned erasure sequences and known data pattern writing can quickly either establish or undo the security of every cell in a SSD. Memory chips can be erased and overwritten in parallel. Therefore, the built-in declassification algorithm supports erasing and multiple overwriting within seconds, leaving behind no trace of classified data.

Solid state flash disks are available that use this algorithm to perform secure erase and sanitize procedures. Once secure erase has been activated, auto-resume secure erase guarantees successful completion of the process in the event that it must be prematurely halted in an emergency.

As the density of flash continues to double every 12 months in the same silicon footprint, its cost continues to decrease, making it more attractive and affordable as a replacement for magnetic tape and mechanical hard disks in military applications. ■■

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Ruggedized MicroTCA: A Cost-Effective Solution for Defense/Aerospace Applications

A ruggedized version of MicroTCA provides the glue for marrying WiMAX and other networking schemes into the military's transition to network-centric operations.

Bob Sullivan, Vice President of Technology
Hybricon
Erik Bohman, Segment Marketing Manager Wireless Infrastructure, Intel

Two trends are emerging in today's defense/aerospace markets: the continuous migration to open-standards-based embedded computing and a transition to a network-centric paradigm. The migration to open standards-based technologies is driven by economics as well as time-to-market. Leveraging commercial technologies can significantly reduce program development costs and schedules, while improving interoperability.

Some vivid examples of the network-centric paradigm in action are high-profile programs such as the U.S. Army's Warfighter Information Network-Tactical (WIN-T) program, as well as the U.S. Army's Future Combat Systems (FCS) program (Figure 1). These programs aim to use a mobile network to link soldiers to a wide range of weapons, sensors and information systems, enabling joint interoperability, shared situational awareness and highly synchronized mission operations.

Figure 1

Exemplifying the network-centric paradigm are high-profile programs such as the U.S. Army's Future Combat Systems (FCS) program. A central aspect of the program is a mobile network to link soldiers to a wide range of weapons, sensors and information systems. Shown here is a graphic representation of the FCS Command and Control Vehicle, one of the key networking and communications hubs for FCS.

Bringing those two trends to reality requires two things. First is the integration of open-standards-based embedded subsystems on many different mobile platforms into a high-performance network. Second is ruggedizing those platforms for the defense/aerospace environment. Developing a non-commercial wireless networking technology and seamlessly integrating it into all of these platforms is a daunting task requiring significant investment of time and money.

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On the other hand, commercial open-standards-based embedded computing technologies are not designed to operate in many military environments. Two such technologies, Worldwide Interoperability for Microwave Access (WiMAX), or IEEE 802.16 and Micro Telecommunications Computing Architecture (MicroTCA), could be applied to create an integrated solution to address these new trends in military applications.

WiMAX for the Military

WiMAX is a commercial wireless networking standard with support for fixed, point-to-point wireless last-mile and backhaul, up through point-to-multipoint, multi-cell vehicular mobile delivery. It is garnering significant interest and early implementation in military applications for IP transmission of voice and data.

For example, the cost and benefits of bridging between the Joint Tactical Radio System (JTRS) and WiMAX under certain operational conditions is a powerful complementary option for supporting emerging missions such as peace keeping,

Figure 2

AdvancedMCs (AMCs) provide the board-level infrastructure in ruggedized MicroTCA.

Figure 3

This MicroTCA ATR Chassis from Hybricon provides a proof point for ruggedized MicroTCA.

disaster recovery, homeland security and special event support.

WiMAX technology is already being used by the U.S. Army in Iraq and on the sidelines at military installations in the continental U.S. A plan, or Concept of Operations (CONOPS), on how to leverage WiMAX technology with JTRS will ensure the war fighter's optimal use of the Global Information Grid (GIG). Consistent implementation, in the form of open-standards-based COTS components, and consistent, scalable performance are important goals for end-to-end C4ISR capabilities.

One way of achieving consistent implementation can be by deploying platforms based on PICMG specifications. The recently ratified MicroTCA specification, for example, leverages the proven PICMG AdvancedMC form-factor and management infrastructure for mezzanine blades that were originally developed for PICMG AdvancedTCA platforms. The AdvancedMC is a small

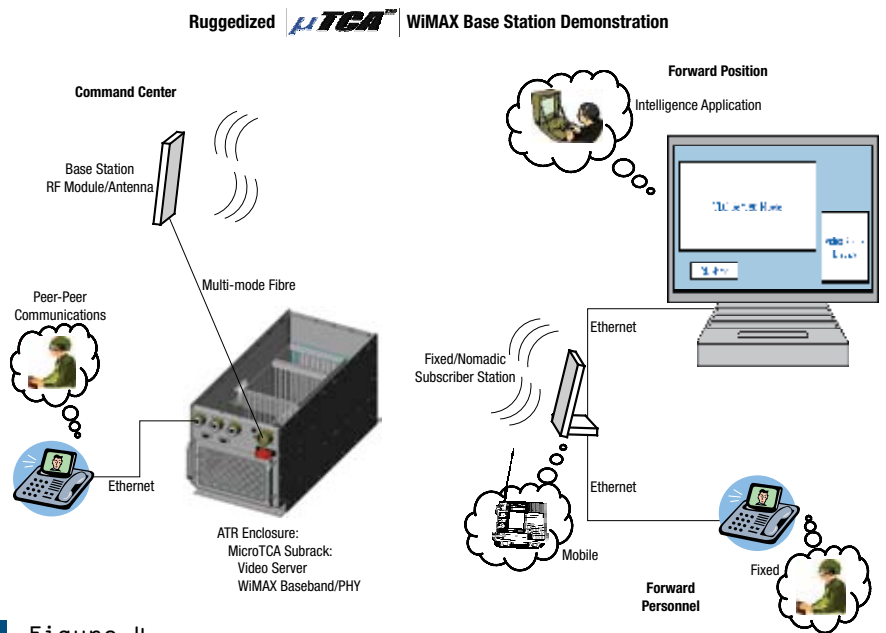

Figure 4

Shown here is a demonstration to be presented at next month's MILCOM show by Hybricon and Intel. The demo mixes rugged and enterprise components to show a vision of the future for broadband wireless connectivity at the tactical edge.

form-factor, hot-swappable module supporting high-speed serial fabric interconnect, and is aimed at communications applications (Figure 2). MicroTCA defines a family of small, low-cost, flexible, high-bandwidth and highly scalable platforms comprised entirely of AdvancedMC modules. It is an excellent fit for WiMAX deployment.

MicroTCA Mechanicals

The MicroTCA specification (MicroTCA.0 R1.0, July 6, 2006) provides requirements that define the basic mechanical characteristics and all of the functional behavior of the subsystems that must exist in a compliant platform. A MicroTCA chassis (or "shelf") is comprised of one or more cooling units, plus one or more MicroTCA carriers, each of which emulates a very large AdvancedTCA carrier blade, supporting up to 12 AdvancedMCs. Each MicroTCA carrier includes a backplane with fabric, clock, power and management interconnect, a card-cage (or subrack), one or more power conversion modules, centralized hardware management and, typically, a fabric switch. The latter two functions are hosted by the MicroTCA Carrier Hub (MCH), which may also be redundant.

The MicroTCA specification defines a number of possible chassis for- factors, but does not preclude alternatives, as long as the platform can accommodate and cool (or heat if necessary) a standard AdvancedMC module (one that is compliant to the PICMG AMC.0 specification) and MicroTCA-specific modules (such as MCH and Power Modules (PM).

A commercial MicroTCA platform is being developed that supports up to 10 single full-size AdvancedMC modules (75 mm x 180 mm x 6 HP). This integrated platform includes a 19" rackmount chassis, managed cooling unit, choice of full-size MicroTCA Carrier Hubs with Gigabit Ethernet or GigE + PCI Express fabrics, AC or DC MicroTCA PM, backplane, full-size Pentium M or MPC7448 processing modules, telecom I/O modules and full-size SATA storage module.

While commercial MicroTCA is in fact an open-standards-based technology, it has a number of limitations to overcome in order to make it suitable for use in military/aerospace environments. These limitations include shock and vibration tolerance, EMI/EMC emissions/immunity, operating temperature ranges and power input/conditioning.

Rugged MicroTCA Enters the Mix

Hybricon has developed a ruggedized MicroTCA ATR chassis that leverages a commercial MicroTCA platform, while also accommodating double-width modules (Figure 3). This ruggedized ATR platform remains compliant with the specification, and addresses many of the limitations of commercial MicroTCA for military applications.

By using the MicroTCA specification's optional locking provisions, the

ruggedized chassis firmly retains the MicroTCA card into the card cage, providing significant additional resistance to shock and vibration. Isolating the MicroTCA card cage inside the ruggedized ATR chassis, the ruggedized chassis attenuates the level of shock and vibration that is seen by the MicroTCA cards, allowing the chassis to meet stringent MIL-STD-810 shock and vibration requirements.

By adding a secondary EMI barrier, in addition to aggressive power line filtering, the ruggedized chassis is able to meet stringent MIL-STD-461 EMI/EMC requirements. Military circular connectors are used for copper and fiber I/O so that the ruggedized chassis is able to meet military ruggedization requirements for external connectors. And finally, a suitable military power supply front end is used so that the ruggedized chassis is able to meet specific military power supply requirements such as MIL-STD-704 aircraft power or MIL-STD-1275 vehicle power.

The operating temperature range is limited by the specifications of the AdvancedMC and MicroTCA cards that are used in a particular application. Commercial AdvancedMC and MicroTCA cards are suitable for less stringent military temperature ranges. For more demanding military applications, extended temperature range AdvancedMC and MicroTCA cards may be required. This is similar to the existing VME and CompactPCI form-factors.

MILCOM 2006 Demonstration

Based on customer feedback, Intel and Hybricon believe that the combination of WiMAX and ruggedized MicroTCA is an attractive open-standards wireless solution for many military applications. The companies have developed a demonstration platform that will be unveiled at MILCOM in October 2006 (Figure 4).

The demonstration shows the ruggedized MicroTCA ATR platform communicating over-the-air with a commercial WiMAX CPE (customer premise equipment). It simulates the equipment and data flows that might be encountered in a nomadic, "last mile" military application, such as from a command post to one or more forward positions. Here, the forward position might be reviewing video footage captured by a UAV or UGV, communicating via voice/video with the command post, and/or relaying live pictures of the theater.

Based on the use of purely commercial air-cooled MicroTCA and AMC cards, this demonstration is suitable for operating environments where commercial VMEbus or CompactPCI cards are used today. The companies are confident that MicroTCA can be extended to include rugged conduction-cooled applications as well.

The demonstration platform consists of a rugged ATR chassis with a shock-isolated MicroTCA card cage and military

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I/O connectors for electrical and optical I/O. The platform supports various types of power inputs, including MIL-STD-704 for aircraft or MIL-STD-1275 for vehicles, with MIL-STD-461 EMI containment. The ATR chassis supports up to 10 AdvancedMC modules, with a mix of double (150 mm) and single (75 mm) AdvancedMCs. The corresponding payload consists of one WiMAX Baseband double module, one Intel Pentium M Processor-based module, one SATA storage module, one MCH and one MicroTCA DC Power Module (PM).

The ruggedized ATR platform, which might be mounted directly in a vehicle or an equipment trailer at the command post, houses the WiMAX base station and server side components. The MCH module provides layer 2 Gigabit Ethernet switching between modules (over the backplane), and between external devices and modules (via front panel uplinks). The processor module, running WindRiver PNE/LE 1.3 (Linux 2.6.14) from the SATA HD, acts as a server for a static video stream. In this example, a VLC (VideoLan Client) server application is used, accessed via IPV4 over (backplane) Gigabit Ethernet.

A video phone acts as a client and server for command post voice and live images. In the demonstration, the video phone connects via Gigabit Ethernet to a MCH1010 front panel port. The WiMAX Baseband module acts as a gateway for the VLC server and the video phone. It communicates over the backplane via the MCH to each device, and routes IP-based voice and data via multi-mode fiber to an external WiMAX RF module. The external RF module and antenna operates in the 3.5 GHz spectrum, with a 3.5 MHz-wide channel, using Time Division Duplexing (TDD).

The client/forward position components include a subscriber terminal (integrated 3.5 GHz / 3.5 MHz, TDD WiMAX antenna, bridge and 10/100 Base-T Ethernet hub) that connects IP-based devices to the wireless link. A laptop running Windows is used for VLC client and DU meter applications and displays the static video and displays network utilization. A video phone acts a client and server for remote location voice and images.

Broader Applicability for MicroTCA

MicroTCA is an open industry standard that will be widely used in communications edge applications. With a large commercial base of applications, it will be highly cost-effective, and with its communications focus, it will provide cost-effective, advanced networking technology (such as WiMAX) that can be applied to the needs of the military. The MILCOM demonstration shows that ruggedized MicroTCA provides a solution for using open-standards-based computing technologies to aid the military's transition to network-centric architectures. By addressing those two trends, ruggedized MicroTCA can provide a compelling, cost-effective solution for a variety of defense/aerospace applications. ▮▮

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

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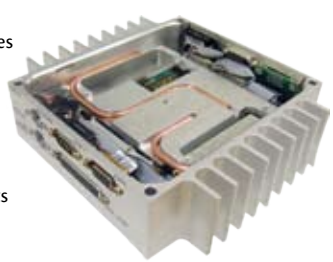

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Bus	AT Expansion Bus	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PCI Expansion Bus Master	✓	✓				✓							✓	✓
	McBSP Serial Ports	✓	✓				✓								
Analog Input	Single-Ended Inputs	16	16	16	16	16	16								
	Differential Inputs	8	8		8	8	8								
	Max Throughput (kHz)	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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System Development

Thermal Analysis for Boards and Enclosures

Advanced Thermal Modeling Techniques

The demand for operation of COTS components under severe environmental conditions can lead to adverse effects on reliability if a systematic thermal design approach is not taken.

Trevor Landon, Director of Advanced Technologies
Jeremey Pionke, Director of Engineering and
Paul Casto, Thermal Design Engineer
Technology Advancement Group

When COTS components are in deployed environments, it is increasingly important to ensure their environmental compliance. In the past, purpose-built military electronics with broader thermal operational ranges would have been selected for use in situations where severe environmental constraints were present. However, the current trend toward COTS in deployed electronics limits custom military electronics as a design choice.

Figure 1

System 3D solid model, front and bottom view.

The demand for operation of COTS components under severe environmental conditions can lead to adverse effects on reliability if a systematic thermal design approach is not taken. A significant contributor to the reduction in overall system reliability is inadequate cooling of electronic components. This problem is commonly addressed through the use of forced-air convection-cooling. To quickly ensure compliance of these components, advanced simulation techniques are used before the physical implementation of the design.

As the environmental requirements increase, so do the design challenges for the thermal engineer. Often, various environmental design requirements, such as salt fog and drip, are at odds with ideal thermal design situations. These additional design constraints further accentuate the need for accurate simulation models, which are needed to push the limits of COTS components. These constraints, which can range from severe EMI and shock and vibration to acoustic and drip susceptibility, impose a different set of challenges for engineers.

Many of the environmental restrictions on systems lead to design choices that can cause impedance in airflow. Systems with severe radiated EMI constraints need to be sealed or have very small apertures to limit their emissions profile. Similarly, a quiet acoustic target can impose a constraint on the thermal design by introducing baffles or physical barriers between an acoustic noise source and the exterior of the system. In an ideal case, the system is completely shielded and does not allow any openings into the system. This requirement is at odds with the goal of the thermal engineer who is trying to maximize airflow. Solid designs constructed to withstand shock and vibration mandate additional structural stiffening of the chassis, which can cause further restrictions on overall airflow.

Drip susceptibility presents another airflow restriction on the thermal design. In order to keep liquid contaminants out of the system, a strategy must be adopted that keeps certain sides of the system sealed and others louvered. This strategy imposes additional restrictions on the cooling solutions available to the design team. In particular, the minimum constraints for a system with a drip requirement are such that the top surface cannot be used for intake or exhaust ports and the sides typically require louvers. These requirements alone create a need for managed airflow through the system, forcing the extensive use of ductwork throughout the interior of the design. In order to adequately direct the airflow, creative methods of component placement are employed.

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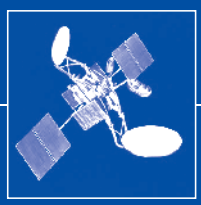

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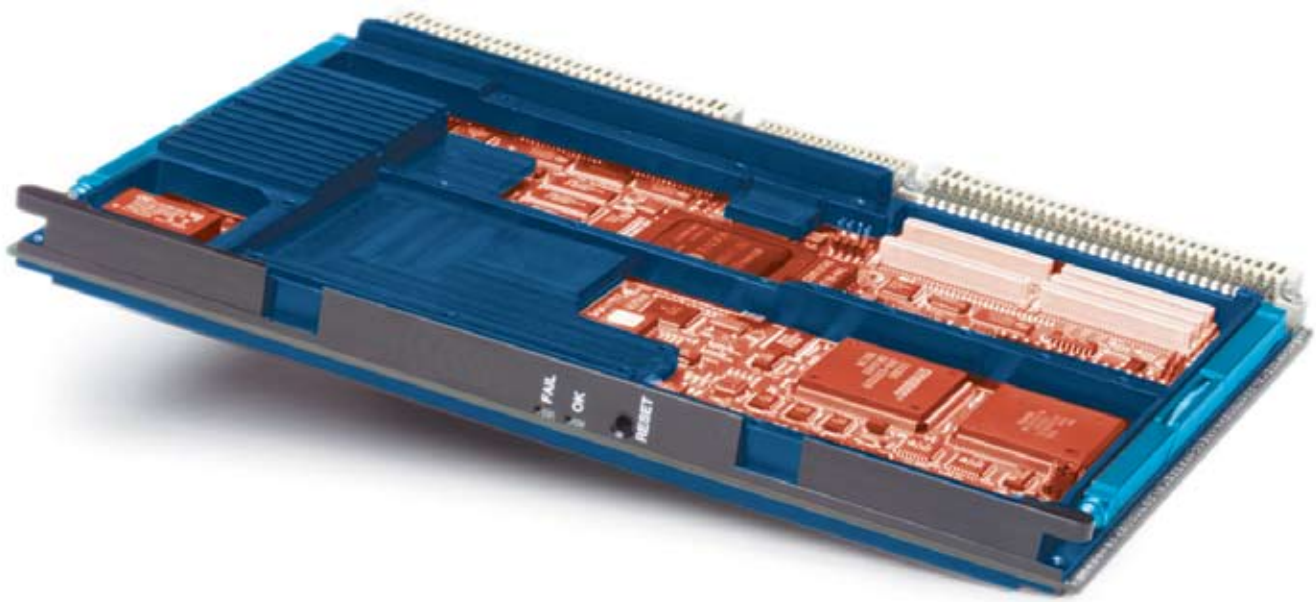

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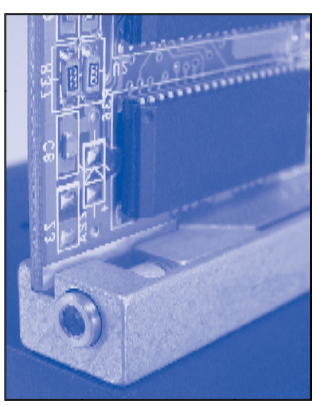

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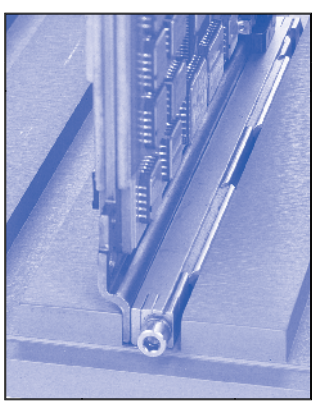

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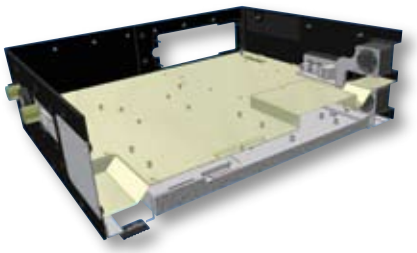

Figure 2

System cross section, with air paths exposed.

accurate models of the components must be created within the simulation tools in order to provide useful data. The accuracy of these models is a significant contributor to the overall success of the thermal simulation strategy and, as the number and type of environment constraints imposed on the overall system increases, the accuracy of these models becomes paramount. Failure to ensure accurate modeling will, at best, provide a limited amount of useful information and is more likely to produce misleading results.

The Case Study

Technology Advancement Group (TAG) recently implemented a design for a command and control display suite for the U.S. Navy. The system called for a large LCD screen with a touchscreen interface, a server with both magnetic and optical storage media, a built-in keyboard, video and mouse (KVM) switch, and three PCI expansion slots (Figure 1). This high level of functionality packaged within a small space posed significant thermal design challenges. To augment these challenges, the system had to be designed to strict EMI, shock, vibration, drip and acoustic targets.

Early in the design process, it was determined that a thorough thermal simulation would be required to meet the strict environmental requirements. An advanced computational fluid dynamics (CFD) tool was used to model the airflow throughout the system. A simplified 3D mechanical model was imported into the CFD tool from the mechanical designer's CAD model, which ensured the highest level of model accuracy for the multiple air paths created by the ductwork throughout the system.

The system's drip susceptibility requirement proved to be the biggest influence on thermal design, as it necessitated that both the intake and exhaust ports be located on the bottom panel. This design factor put real limitations on the airflow. To address this limitation, the system was broken into two logical units, the computer and the display subsystems. These were separated by a plenum, and the air paths were divided to simplify the overall design (Figure 2). This separation allowed the thermal engineer to individually tailor the airflow path for each subsystem. To meet the airflow requirements for many of the components, a series of metal dividers were introduced into the design. To further direct the airflow to areas of high thermal load, custom printed circuit boards were used to act as both cable replacements and airflow ductwork. This technique allowed for the creative replacement of cable bundles necessary for interfacing with many of the components.

Initial system simulations showed what appeared to be a violation of the LCD operating specifications within the display subsystem. As a result, more detailed simulations were created, focusing solely on this LCD. The generated model was based on available datasheets supplied by the manufacturer. In this case, very little thermal information was available from the manufacturer, which dictated the use of some basic assumptions for the LCD. These assumptions included the uniform distribution of thermal energy throughout the LCD and that all electrical energy was dissipated as heat.

The results from the initial simulation proved problematic. One assumption used to generate the LCD model, the even distribution of thermal energy, was being challenged. The available thermal data for the LCD was not granular enough to develop a comprehensive model. As a result, a simplistic model was developed from the data received from the COTS component vendor (Figure 3, left image). This simplified model assumed the cold cathode fluorescent lamps (CCFLs) dissipated the thermal energy evenly across the entire display. In the laboratory, it was noted that the extreme top and bottom of the LCD proved to be the source of most of the heat, whereas the center of the display remained relatively cool when compared to the up-

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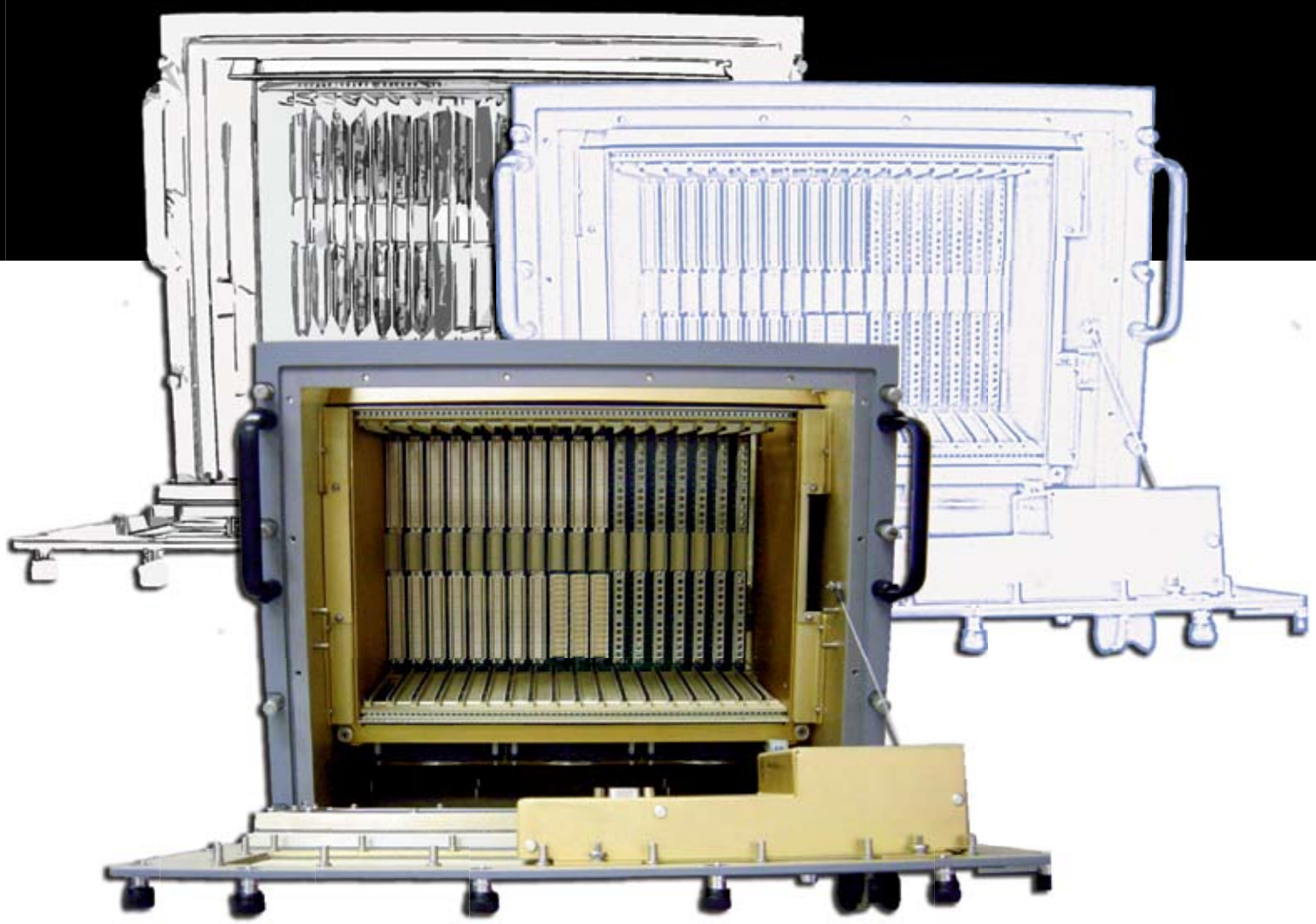

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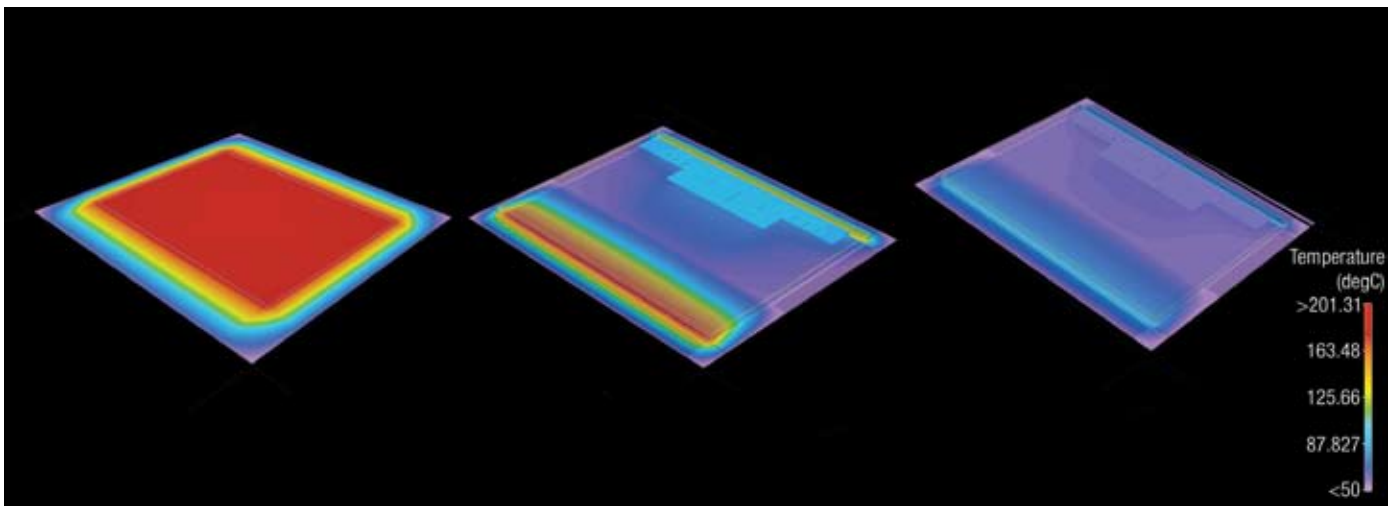

Figure 3

CFD model refinement, from initial to final (left to right).

per and lower edges. The observed behavior of the LCD did not match the simulation model; therefore further analysis into its construction was necessary.

To create a more accurate model, an LCD was dismantled and a more granular thermal model was generated. In addition, the material properties for the LCD metal housing, light diffuser and LCD glass were included in the model. In simulation, the model showed a lamp temperature of 110°C measured at an ambient temperature of 50°C (Figure 3, center image). Though this model appeared to more accurately reflect the thermal gradient observed in the laboratory, it was noted that the measured temperature of the LCD never appeared as extreme as the original model had suggested.

While the second simulation accounted for the physical construction of the LCD, it assumed a complete conversion of electrical energy into thermal energy. This is a typical practice when modeling individual components, but it did not reflect the observed behavior of the CCFL backlight tubes. This result dictated that further investigation into the efficiency of the CCFLs was necessary.

In order to further refine the simulation model, empirical techniques were employed to establish an approximate efficiency of the CCFL tubes under ideal conditions. This involved measuring the surface temperature of the LCD CCFL tubes when exposed to various ambient temperatures. The data was then collected and used to develop a simulation of an LCD that precisely replicated the empirical test results. This revised model had a significantly lower thermal load on the CCFL tubes than the initial simulation model, which is consistent with their high efficiency. This revised model was then used in the overall simulation model (Figure 3, right image).

The Results

After this final simulation model was complete, it was determined that the LCD was operating within the manufacturer's operating specifications when installed in the complete system. This result proved that assumptions made about the operation of components can lead to inaccurate models, thus generating misleading results. In this case, further investigation was prompted after what appeared to be a specification violation of the LCD. An iterative process of model refinement was utilized to remove concerns over the component's operating environment. As each component was more accurately modeled, the confidence in the model at the system level grew higher. Without this level of accuracy, the challenges facing the designers increase dramatically, causing potential schedule and budget overruns due to costly design changes. Additionally, the more accurate system models allow for greater design margin, which can then be used to push the limits of COTS components.

The iterative refinement process used for modeling the LCD module highlights a common problem with thermal modeling of COTS components. The data necessary to accurately model components is not always available, and the level of support from component vendors varies widely. Certain vendors, in particular the large microprocessor vendors, are very forthcoming with the information required to accurately model these high-power flux components. This is the first place to start in any thermal model, and extreme accuracy is vital for these system elements as they are often the limiting factor in any system design. The components of other vendors, who do not provide adequate data for thermal simulations, may require further analysis to implement accurate simulation models. This data provides a higher level of confidence in the overall simulation model's accuracy, thus ensuring the high reliability necessary for deployed COTS systems. ■■

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System Development

Thermal Analysis for Boards and Enclosures

Heat Kills: Designing Rackmount Chassis for Optimal Cooling

Heat kills, especially in the harsh environments found in many military applications, but mission-critical systems also need to provide the highest levels of reliability in life-or-death, forward-area and/or airborne deployments.

David Lippincott, Chief Technologist
Chassis Plans

With computer systems and associated electronic subsystems, heat kills. Especially when sensitive components are subjected to harsh environments found in many military applications. Unfortunately, such mission-critical systems also need to provide the highest levels of reliability, often in life-or-death, forward-area and/or airborne deployments.

One of the main differences between an industrial or militarized computer and an office computer is cooling. Industrial computers typically have one to four fans pulling in air through air filters in addition to the power supply fan, while office computers simply use the one small power supply fan for cooling. Industrial computers also generally create a positive pressure inside the chassis in order to control the entry of contaminants. Office computers run at a negative internal pressure and can become very dusty inside.

Figure 1

Rackmount chassis showing cards and cabling aligned to optimize airflow.

Additional cooling allows for higher power boards to be installed while also extending component life by limiting the maximum temperatures to which the components are exposed. In general, a 10°C temperature reduction will provide a 2:1 increase in MTBF.

Fan Selection

The primary consideration is to remove heat from the components in a system. There are a multitude of methods for accomplishing this including cold plates, thermally conductive pads and water-cooling, but fans are by far the most common method used because of their low cost.

There are two methods for selecting a fan. The first is to simply install as many of the biggest fans available as will fit. This works well if cost and noise are not factors. However, if noise is a factor, then more extensive design challenges come into play to balance the competing factors of low noise versus adequate cooling.

Even in military environments, many specifications include a noise limit for normal operation. A single chassis doesn't seem very loud. But with six chassis in a rack and several racks in a room, the noise can be deafening. Fans with higher speeds and "bigger" free airflow ratings may add to the problem because they generate significantly more noise. Often, such a fan is simply stirring the air and providing no real additional cooling benefit. Because the chassis pressure impedance curve (pressure required to move air) is nonlinear, doubling fan capacity does not double the air delivery. On the other hand, because the amount of noise varies directly with higher RPM rates, fans that are physically larger can actually run quieter because they provide the same volume of air flow with a lower fan RPM.

The actual airflow through a system changes as the square root of the increased pressure. Thus, doubling a fan's output pressure only increases the flow through the system by 41% ($\sqrt{2}$=1.41). Or, to double the flow through a chassis would require a 4x pressure rise. Remember that fans are primarily pressure generation devices, not positive flow devices.

Calculating Cooling Requirements and Airflow

The maximum allowable internal chassis temperature is determined by the component with the lowest operating temperature specification. Temperature rise inside a chassis is a constant factor depending on the installed boards. Thus the installed boards generate a temperature rise that is simply added to the inlet

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temperature to determine the temperature inside the chassis.

If one measures the temperature inside a chassis at room temperature, the internal temperature will rise by the same amount as an external temperature rise. If the internal temperature is 100°F at an outside temperature of 70°F (30°F internal rise), then the internal temperature will rise to 150°F when the ambient temperature is 120°F. (A temperature of 150°F is generally well above published operating limits for installed drives and boards.) The constant relationship between internal and external temperatures means that one can easily measure the temperatures inside the chassis in an office at room temperature and calculate what the internal temperature will be in the field at elevated temperatures.

One caveat is that fans are less efficient at higher temperatures because the air density is lower. Thus, a given fan will move less air at an elevated temperature. If calculations show a marginal condition at the expected operating temperature, then one should measure the actual internal temperatures with the chassis operating at an elevated external temperature.

A system with a 300W power supply at full capacity is generating 300W of heat. In addition, the power supply is generating additional heat because of its inherent inefficiency. Power supplies are usually about 70-75% efficient, so a 300W supply at full load generates 416W of heat. In general, the lost heat from the power supply is exhausted directly out of the chassis and does not affect the internal temperature. However, some chassis designs have the power supplies in the front of the chassis so their heat output is added to the internal air temperature.

A simple rule of thumb for calculating cooling flow requirements is:

CFM = 3.16 x watts/
allowed temperature rise (°F)

This calculation only represents required airflow, not the fan rating. It is a conservative number because there always is some radiated cooling and turbulent flow within the chassis that can help remove heat from components. In a well-designed chassis, one can count on getting only 40-50% of the free airflow rating for a fan. Thus, a 300W system with a 20°F temperature rise would need about 47 CFM through the chassis or a fan with a free air rating of 100 CFM.

Chassis flow resistance limits the amount of air that any fan can move through a chassis. The air filter has a tremendous effect on the system resistance, but if the application is deployed in a relatively clean environment, it may not need an air filter. It is also important to route cables to ensure they do not block or divert airflow (Figure 1). Power supplies always seem to have too many cables and too much wire that has to go somewhere. Keep it away from the fans.

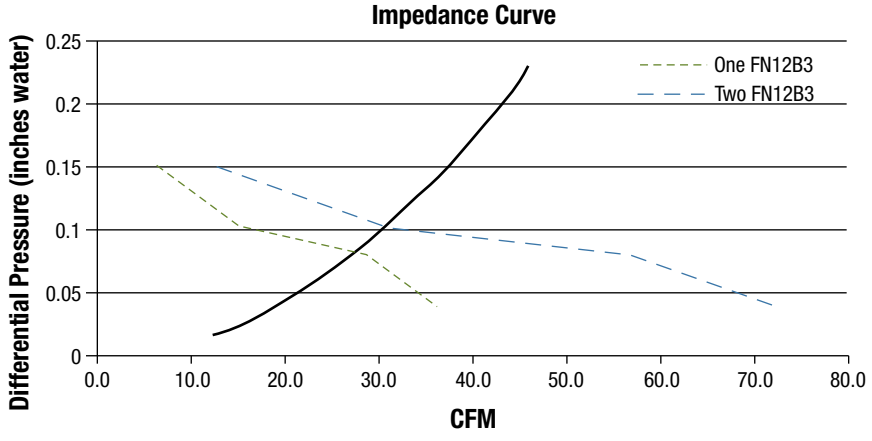

Figure 2

Airflow impedance curves for one fan versus two fans.

Chassis Impedance and Specialized Airflow Designs

Another key issue is chassis flow impedance, which is the friction on air passing through the front panel slots, air filter, internal structures, and out the rear slots and power supply. System impedance can only be determined by measuring actual flow through a chassis against the pressure required to generate that flow. Once this relationship is determined, a plot can be made of the chassis impedance with flow on one axis and pressure on the other. Various fan curves, as provided by the fan manufacturers, can be laid on top of this curve to determine actual airflow in CFM through a chassis. Figure 2 shows that airflow through an example chassis is 26 CFM with a single fan and 32 CFM with two fans.

Note that putting two fans in parallel doubles the fan curve on the horizontal flow axis. That is, two fans will not put more pressure into a system than a single fan will, but they will blow twice the air for a given backpressure. Putting two fans in series, such as an inlet fan and an exhaust fan, doubles the curve on the vertical pressure axis. The first fan boosts the pressure into the chassis and the second fan draws from that increased pressure, so two fans in series will not move more air than a single fan.

This is an important consideration in chassis design. For low flow impedance systems such as a 4U with ample vent openings, two fans in parallel produce better results than two fans in series. On the other hand, for a tight system, such as a 1U with minimum openings and small fans, putting fans in series can be beneficial because doubling the pressure overcomes flow resistance. Blowers are useful in high impedance applications because of the high pressure they can develop for a given flow.

Another important issue is the location in the chassis of the heat-generating components. Assuming relatively smooth airflow through a chassis, the air temperature will rise as it passes hot components. Therefore, if the processors are located at the front of the chassis, components down stream will be immersed in hot air, but if they are at the rear of the chassis, most of

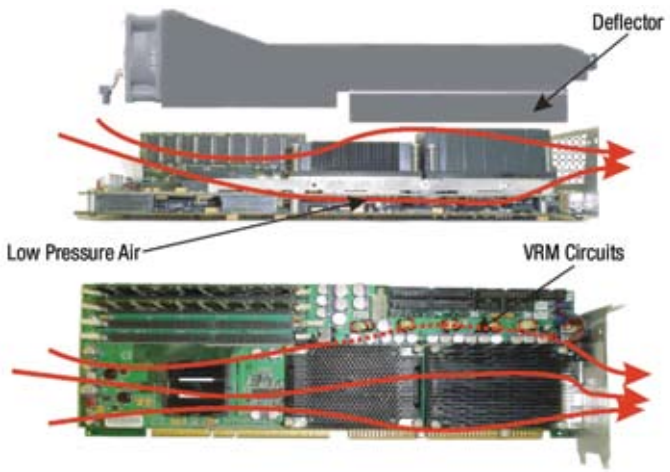

Figure 3

Custom cooling shroud directs more air over processors.
(Photo courtesy of Trenton Technology)

the heat is exhausted directly out of the chassis. Thus, sensitive components, such as drives, should be placed upstream of the heat-generating components. However, the new high-speed drives can be some of the worst offenders in generating heat.

Compounding this situation is the fact that, as processor speeds increase, the allowable processor case temperature (T_{case}) decreases. For example, with today's Xeon processors, cooling systems must be designed around a maximum power dissipation of 101W with a maximum T_{case} rating of 73°C. An XPT single board computer with dual Xeon processors can theoretically dissipate up to 202W. In addition, the power needed to drive these processors demands voltage regulation circuitry, which also generate heat. Other SBC components such as the chipsets, bridges, SCSI, video and Ethernet controllers generate additional heat, so the design engineer must have a plan to effectively manage and control SBC board temperature in order to maximize system reliability and value.

For some situations, such as the SBC example, specialized cooling solutions can be very helpful to both more effectively cool the high-heat-generating components and protect the rest of the assembly. As illustrated in Figure 3, the use of a custom-designed shroud with an integrated fan can channel air from the front of the rack directly over the processor section of the board and exit to the back of the chassis. This has the dual advantages of putting more air across the high-heat components without dissipating the airflow and also segregating the heated air from the other components.

An effective system cooling strategy must include the amount of heat generated by the components, the operating specifications of the most heat-sensitive components, the degree of latitude for noise, cost and size with regard to fan selection and the efficiency of the chassis design to minimize impedance and maximize cooling. While most industrial computer chassis are constructed with very similar layouts, differences in impedance and cooling effectiveness can vary significantly, especially with regard to newer high-performance, high-heat processors. Therefore, it is always a good idea to require that chassis suppliers provide fully documented impedance curves and to use system integrators that are well versed in all of the subtleties and intricacies regarding cooling design and testing. ■■

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System Development

Thermal Analysis for Boards and Enclosures

Thermal Considerations for COTS Embedded Systems Boards

Because of the higher heat generated by modern embedded systems, the cooling of these systems is critical. At the same time, there are many options available for addressing the heat issues

David Garcia, Program Manager
GE Fanuc Embedded Systems

Design requirements for embedded applications are continually requiring smaller and more densely packed components with greater functionality and performance to be crammed in tighter spaces. Because of the higher heat generated by today's more powerful embedded systems, cooling those systems and their components is more critical than it has ever been.

However, dealing with thermal management issues within an embedded system is nothing new to electronic system design engineers. And efficiently managing the heat characteristics of an embedded board and its components can lead to longer time in service and greater equipment reliability. The bottom line is that thermal design analysis and management must be an integral part of the design of both the embedded board and the system.

Consider the Options

There are many options available for addressing heat issues in relation to system design. Heat sinks are a readily available solution. These heat sinks come in a vast assortment of types and range of sizes. There are several special epoxies that are available that allow a heat sink to be "glued" to a component to provide an increased surface area to dissipate heat away from the IC. Internal component-mounted fans and enclosure-mounted fans can be incorporated to provide a constant airflow directly to the components and the internal system circuit board.

There is also the option of mechanically modifying the embedded system enclosure and mounting custom-designed heat sinks to its side, enabling heat removal from individual or multiple components. These types of heat sinks effectively turn the entire enclosure itself into a large heat sink.

System design restrictions that prevent the utilization of either fans or advanced cooling systems and that require hermetically sealed enclosures must often resort to slowing down the system clock or periodically placing the CPU into a low-power or sleep mode to decrease the amount of power required by the system. The option of utilizing a different board with decreased features, reduced clock speeds or an alternate CPU, FPGA, or DSP architecture is sometimes the only solution available to eliminate thermal problems with a system level design.

The capability of engineers to adjust the thermal footprint is part science and part art. While the science part is well known, the art part of thermal management is less well known and comes with board design experience and trial-and-error refinement techniques.

COTS Can Be Cool

Although commercial off-the-shelf (COTS) systems are built from commercially available components, the design, testing and qualification of a rugged system or module must ensure that the components—and the system itself—can withstand harsh military environmental conditions. This process begins at the level of materials, seals, temperature and EMI factors, and includes connectors and fasteners, paints and finishes, maintenance and manufacturing issues. Modules and systems must pass testing for vibration, shock, temperature and other environmental conditions such as humidity.

Historically, the price of military hardware was high due to the fact that military gear has to operate reliably in the harsh conditions of the battlefield. Then the military realized that if it could adapt commercial technology to the demands of military environments, it could benefit from both the

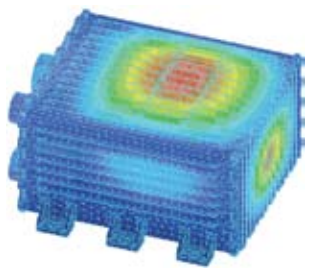

Figure 1

Heat from a Printed Circuit Board (PCB) is distributed to the top, sides and bottom of a system chassis through its mounting features.

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economies of scale and the advanced technology enjoyed by commercial products.

As a result, in the mid-90s many governments mandated that military contractors begin using commercial off-the-shelf (COTS) technology to reduce costs and keep abreast of technological innovation. Today, using COTS components in the military is standard practice because government agencies find it far more cost-effective to use off-the-shelf boards and assemblies rather than proprietary components.

However, many of the military's COTS-based systems require extensive modification to withstand the harsh conditions of a soldier's environment. Military specifications often require operation at ambient temperatures from -55° to +85°C, in high and low humidity and while undergoing extreme vibration and shock.

Heat Flow Paths (Conduction Cooling)

When conducting thermal analysis for board developments, there are several classic engineering considerations:

Component Junction-to-Case: Heat is generated at the core (junction) of electrical devices and conducted through the materials inside the device to its exterior case (Figure 1). The path from the exterior case into the Printed Circuit Board (PCB) is through its mounting features. These may be leads soldered into holes or surface mount solder pads. On high-power components, special attachments (conductive adhesive or soldering to case) may be made to decrease the thermal resistance between the component and PCB. This type of thermal resistance is called Case-to-Board.

Component Placement: The placement of a component on any PCB determines the conductive distance to cooler heat sinks. This may be critical due to the high relative conductive resistance, which may occur through thin (.002") thermal planes. Therefore, high-power components should be placed as close to heat sinks as possible.

Thermal Vias: These are plated-through holes under components that provide a direct heat conduction path through gold and copper to large thermal planes inside the PCB. For high-power components, as many vias as possible should be put under the component (Figure 2).

PCB Internal Solid Copper Thermal Layers: This is one of the primary routes of heat flow through circuit cards, so two layers of copper at almost the full height and width of each card are used to carry heat from vias under components to larger vias, which then connect to surface copper/gold pads.

Processor Mid-Plane Heat Sink and Gap Pads: For thermal management of processors, another conductive path is added from the top of high-power components through flexible Gap Pads and then onto the inside of an aluminum heat sink.

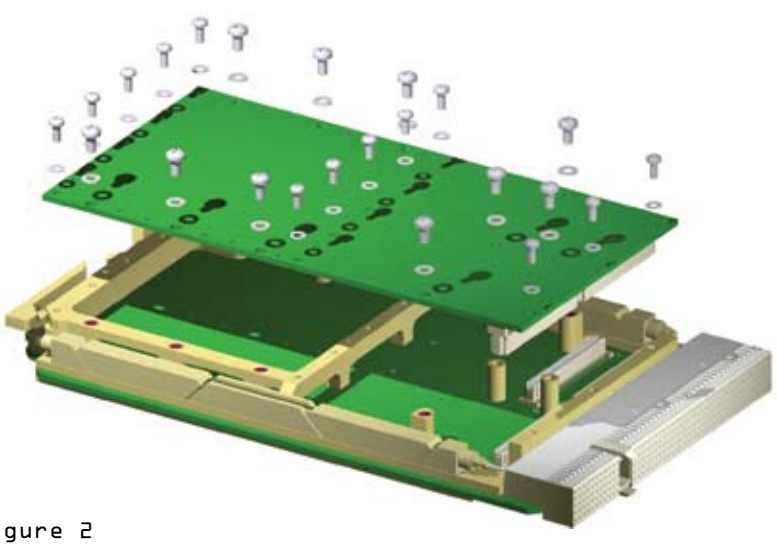

Figure 2

Plated-through holes (thermal vias) under the components provide direct heat conduction paths to large thermal planes inside a PCB.

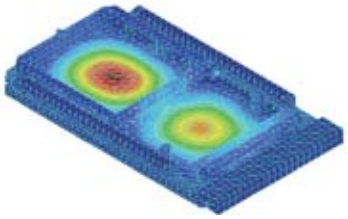

Figure 3

The details of PCB layer count, copper coverage and thickness, via count and interface areas all provide input to help determine the analysis of board temperatures.

Vacuum Interfaces: Items between the surfaces of the PCBs and the chassis are aluminum, which conducts heat well. However, there are multiple interfaces in any given heat flow path. Under vacuum, these interfaces increase thermal resistance as a function of pressure and surface finish. Some of the interfaces are from the PCB to the heat sink, from heat sink to back plate, and from back plate to chassis ledge. Once the heat is at the inside wall of the chassis, it is easily distributed to top and bottom due to the low resistance of the aluminum.

Thermal Analyses Considerations

For the thermal analysis, Finite Element Analyses (FEA) and other calculations should be used to help work through the following methodology:

Operational Assembly FEA Steady State Thermal Analysis: The first step of the analysis is a chassis level Finite Element Model. 3D CAD geometry is transferred to Analyses Design Space and acts as the basis for the analytical model. Other inputs are power, ambient fluid temperature, fluid type, fluid velocity, and chassis materials. This analysis results in the rail temperature for the chassis surfaces interfacing with the circuit card assemblies.

Correction for Thermal Interface Resistance: The rail temperature results should be corrected for thermal interfaces. Variables on thermal interface resistance are surface area, clamping force, surface fin-

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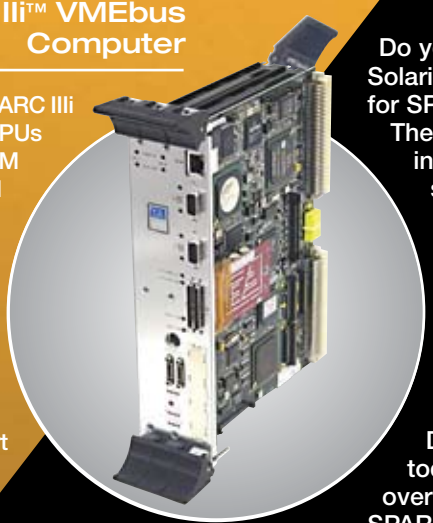

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ish and fluid pressure. The corrected rail temperatures are then used as inputs for a board-level computer-aided analysis. Specifics of the PCB such as layer count, copper coverage, copper thickness, via count and interface areas should be input into this model. Specific power locations must also be loaded. This analysis results in a picture of the board temperatures (Figure 3).

Component Case and Junction Calculations/Comparison to Vendor Data: Starting with board temperatures, Board-to-Case and Case-to-Junction temperatures should be added to obtain Junction operating temperature. This is compared to vendor-published operating maximums. These temperatures are also used in MTBF and FMEA calculations.

Testing

There are a number of important benefits gained by doing thermal analysis of products during the testing phase. The first benefit is immediate feedback, which provides information to help determine if the board design is on track. Secondly, testing will help to identify intermittent product failures, while the third benefit is that during stress testing, critical failure limits will appear at actual stress levels. Here are some testing considerations:

General: Test plans must be approved by the customer prior to the performance of the specific test. Tests should be conducted to verify compliance with customer requirements, as well as to collect test data to verify the accuracy of the design under operating extremes.

Acceptance Tests: Each board should be acceptance-tested prior to delivery. Each deliverable module should be subjected to configuration/workmanship inspections, functional performance tests and environmental stress screening tests conducted in accordance with customer-specified test plans and procedures, in order to verify that each board operates properly and meets workmanship standards.

Environmental Stress Screening: Each production board should be subjected to environmental stress screening by agreed-upon procedures to fully satisfy the requirements outlined by the customer.

Qualification Tests: Independent subcontractors should be identified to satisfy full testing requirements.

Choosing the right options for the right application is part of the art and science of embedded board design and it is familiar to most embedded system design engineers. The extreme operating conditions that are typical in defense and aerospace environments demand extensive thermal design testing and reviews, but there are many techniques available to board designers to lessen the impact of high board temperatures. ■■

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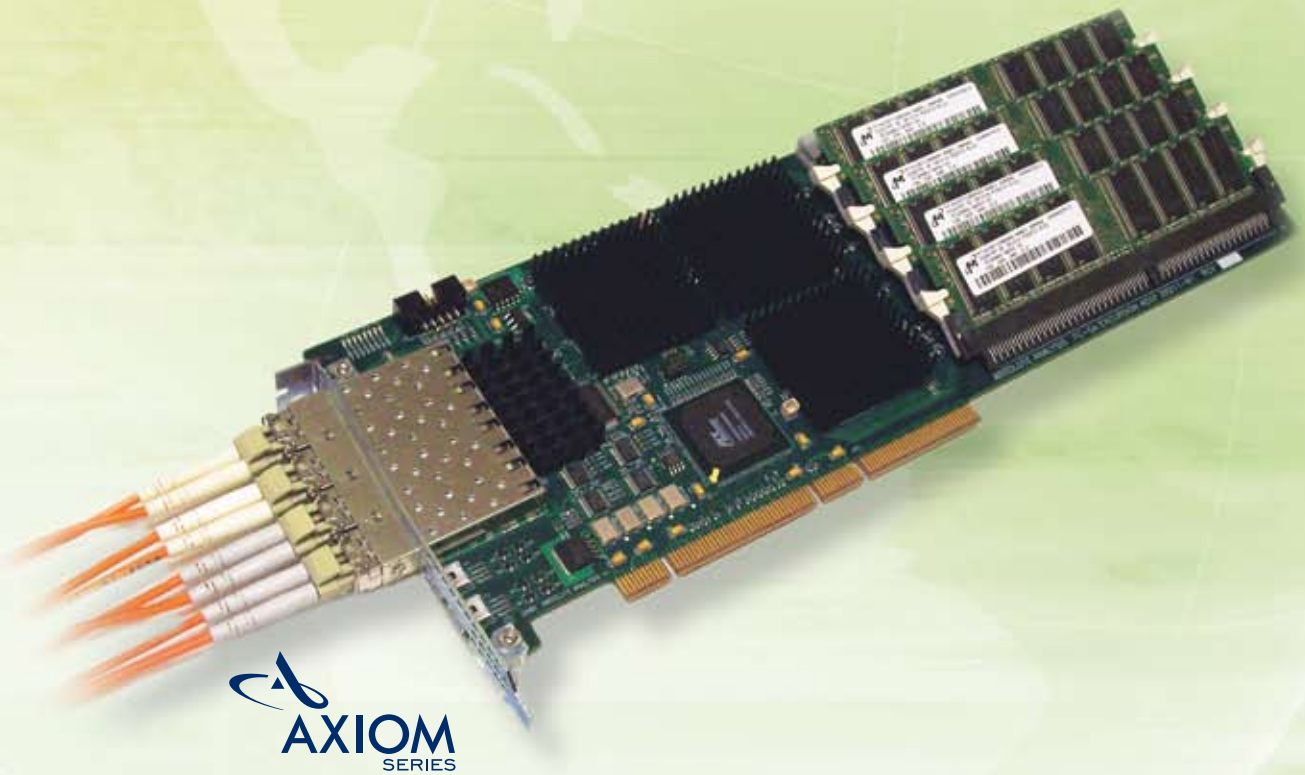

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Technology Focus

Graphics PMCs

Graphics PMCs Flex Their Multimedia Muscles

Makers of graphics/video PMCs are putting consumer graphics silicon to work to provide powerful integrated military solutions.

Jeff Child, Senior Editor

The days when it took a large multi-board chassis' worth of electronics to drive a display are long gone. By leveraging advanced commercial graphics silicon targeted for PCs and game boxes, military graphics subsystem integrators are able to blend a wealth of graphical and video features into the popular PMC form-factor.

Leading graphics processor vendors such as ATI, 3Dlabs, NVIDIA , Intel and Silicon Motion continue to boost performance and reduce power of their IC offerings. To drive today's military displays, PMC vendors—such as those whose products are compiled in the next couple of pages—are taking those chips and designing them into compact, modular subsystems capable of capturing and/or displaying complex graphics and video.

Among the most active areas of graphics/video PMC are the numerous avionics modernization programs underway. Many military aircraft have airframes that are expected to last for several decades, but their cockpit electronics are obsolete. The upgrade will replace the old "round dial" instruments with state-of-the-art "glass cockpit" displays, including a heads-up displays (HUD) for pilots. The upgrades also bring the aircraft into compliance with current navigation and safety requirements, standardize the avionics across the fleet, improve reliability, eliminate the requirement for a navigator in most of the aircraft and reduce aircraft life cycle costs.

A recent example is the C-130 Aircrew Training System AMP Modification Contract. Last month the Boeing Company received a U.S. Air Force contract to begin modifying the C-130 Aircrew Training System (Figure 1) as part of the C-130 Avionics Modernization Program (AMP).

Glass cockpit applications really push the envelope on the functionality requirements for graphics PMCs. One cockpit display needs to handle the real-time graphical instruments, while others display high-resolution mapping applications, while yet another displays video imagery. The trend among the current crop of graphics PMCs is to provide the capability to control any of those display jobs with the same product. Some even offer capability to support two video graphics engines enabling two display connections to be driven simultaneously with different resolutions and refresh rates.

Figure 1

Graphics PMCs are finding themselves designed into numerous avionics upgrade programs, such as this C-130 Aircrew Training System, which is part of the C-130 Avionics Modernization Program (AMP).

Because technologies change so fast in the consumer graphics chip arena, it's become routine in the military embedded space to keep the display control a modular function, relegating it to a PMC mezzanine. Even then, graphics chips move through the market so fast that obsolescence is perhaps even more of an issue in graphics than in other computing electronics such as processors and memory. With that in mind, some graphics PMC vendors have opted to employ FPGAs to implement their graphics processing rather than an off-the-shelf standard graphics engine.

The use of FPGA technology offers not only flexibility with regard to the desired functionality but especially regarding the long-term availability often required for industrial applications. IP cores are not affected by obsolescence common for standard graphics controllers. Guaranteed delivery periods of more than 10 years are no longer a problem. Having the graphics inside the FPGA also lets designers benefit from the physical robustness available in FPGA product lines such as extended temperature support and even radiation hardening. ▮▮

Technology Focus:

Graphics PMCs Roundup

PMC Weds Complete XGA Solution with 8 Mbytes of RAM

Thanks to the magic of semiconductor integration, you can now squeeze a complete high-res XGA controller system onto a single mezzanine card. In the past, such functionality would have required several boards. Exemplifying those trends, ACTIS Computer provides a XGA graphic controller PCI PMC. The PVGA-1722 graphic controller is designed for embedded systems requiring

a GUI (Graphical User Interface). This PMC module provides a complete solution for XGA resolution application. The graphic controller supports up to 8 Mbytes of memory and uses a 200 MHz RAMDAC, with a resolution up to 1280 x 1024. The 128-bit engine supports 2D and 3D acceleration through APIs.

The PVGA-1722 provides a flexible I/O interface usable for a wide range of display equipment. An analog RGB interface is available, on the front panel and on rear I/O connector (optional), for CRT applications. An S-Video output is available, on the front panel and on rear I/O connector (optional), for public information on TV monitor, plasma display and so on. A 24-bit LVDS interface is available on rear I/O and internally to connect TFT monitors. The LVDS interface provides an excellent SNR when used on remote display in industrial applications.

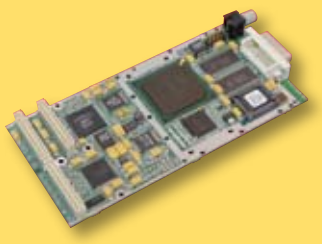
A native 18-bit LCD interface is available, on internal and rear I/O (optional) connectors, for a direct connection to LCD module without requiring additional converters. The PVGA-1722 is based on PCI 2.1 interface with a 32-bit at 33/66 MHz bus, and supports 3.3V PCI environment. A conduction-cooled version with rear I/O connections can be supplied for rugged applications. The PVGA-1722 is available now from ACTIS Computer at an OEM price of $350.

ACTIS Computer
Tempe, AZ.
(480) 838-1799.
[www.actis-computer.com].

Graphics/Video PMC Supports Multiple Standards

One of the tricky aspects of supporting graphics and video interface for military systems is the mess of standards that need to be addressed. Aitech Defense Systems comes to the rescue with a versatile graphics/video processing PMC for moderate to high-level applications. The new M585 Multi-Standard Graphics/Video provides 2D and 3D graphics processing, and includes extensive encoding and decoding capabilities to accommodate multiple channels of video input.

Based on the advanced 3Dlabs Permedia3 graphics processor and supported by a 32 Mbyte SDRAM frame buffer, the M585 uses multi-functional memory architecture to perform high-quality 3D polygon and texture acceleration, and to unify 2D graphics and graphics and video operations all in the same execution pipeline. Outputs include standard analog RGB, non-interlaced RGBHV and RGsB (sync-on-green) interfaces supporting



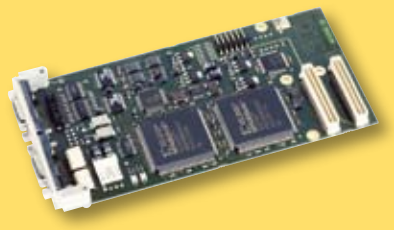
screen resolutions up to 1600 x 1200 (UXGA). The M585 also supports NTSC or PAL video output—both in composite and S-video signal formats—and is capable of driving flat panel displays ranging from VGA to UXGA resolutions in a single-link DVI-compliant interface. External synchronization is achieved through a variety of TTL or RS-422 video sync I/Os.

The Aitech M585 graphics/video card is available in two mechanical formats. An air-cooled version (per IEEE 1386-2001) is available for installation on top of commercial and rugged air-cooled carrier boards. A conduction-cooled version (per ANSI/VITA20-2001) is available for installation on top of IEEE 1101.2 conduction-cooled carrier boards. High-power components in each format are cooled by an aluminum heatsink. Pricing for the M585 starts at $4,475.

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

PMC Frame Grabber Links to Mono and Color Cameras

Numerous military applications entail working in color during daylight and in the infrared range at night. Serving just such needs, American ELTEC developed the p3i_MOCO/PMC module, which permits simultaneous connection of monochrome and color cameras.



This compact frame grabber is therefore predestined, for example, for applications working in color during daylight and in the infrared range at night. The module has three simultaneous channels—two monochrome channels and one color channel for PAL/NTSC/SECAM (CVBS or S-Video).

The p3i_MOCO/PMC frame grabber can be used, for example, in security applications with an infrared camera and a color camera. It simultaneously records the separate images from the two non-synchronized cameras. The image formats for the monochrome inputs are 8 bits/pixel and for color RGB24, RGB32 or YUV (4:2:2). The images are saved in separate memory areas. Digitization is carried out by four independent 8-bit A/D converters—for monochrome (2 x), luminance and chrominance. Individual sequences or images can be recorded in real time using DMA, and directly saved in the PC's main memory. The p3i_MOCO/PMC card is compatible with the PCI 2.2 standard. DLL drivers for Windows NT/2000/XP as well as LINUX drivers are available for the p3i_MOCO/PMC. In addition, comprehensive software support is available using third-party tools.

American ELTEC
Las Vegas, NV.
(702) 878-4085.
[www.americaneltec.com].

PMC Drives Dual Independent Displays

While the ability to drive dual displays is not new in graphics PMCs, it's a whole other deal to drive displays with different resolutions and refresh rates. Example applications include military image processing, mapping systems and command center video walls.

Feeding such needs is Concurrent Technologies' latest dual display graphics PMC adaptor. The IO PMC/DG1 is a high-performance, low-power adaptor supporting two video graphics engines enabling two display connections to be driven simultaneously with different resolutions and refresh rates.

The output of these engines feeds three display connections—an analog RGB (to CRT) interface and a digital TMDS (to DFP) interface available via a front panel DVI-I connector and a second DVI-D-compatible TMDS interface available via the rear P4 connector. The CRT interface supports resolutions of up to 2048 x 1536 and the DFP interface supports up to 1600 x 1200. The IO PMC/DG1 can be used with Concurrent Technologies' CompactPCI, VME, Multibus II or any other PMC-compliant host board. The IO PMC/DG1 PMC adaptor utilizes the ATI Mobility Radeon 7500, an embedded long life 3D/2D dual display graphics processor; this processor provides exceptional 2D/3D video graphics performance with low power consumption (typically 3.4W). The Mobility Radeon 7500 provides two video graphics

engines that support output pixel rates of up to 350 MHz sourced from 32 Mbytes of internal 183 MHz 64-bit DDR SDRAM. List price for the IO PMC/DG1 is $740.

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

Card Serves up Video, RGB, DVI and Stereo Audio

Part of the military's move to Net-Centric Operations entails sharing of real-time motion video and graphics making it available to tactical and strategic decision makers. Serving just that need, Curtiss-Wright Controls Embedded Computing offers a video-capture enhanced member of its Atlas family of dual-channel, high-resolution PMC graphics controllers. The new AtlasPMC/2 PMC card delivers video, RGB and DVI input capability and an extensive range of multimedia features including dual-head analog or DVI output

display, stereo audio I/O and an onboard USB 2.0 controller. The AtlasPMC/2 is based on ATI Technologies' RADEON Mobility 9000 (M9) mobile graphics processor.

This single PMC card solution provides support for a wide range of display types and resolutions. It displays analog VGA screen resolutions up to 1920 x 1200 over its front panel DVI-I and MDR20 connectors. The card can also be configured to output dual digital video (DVI) channels at resolutions up to 1600 x 1200 (1920 x 1200 with reduced blanking interval timing).

The AtlasPMC/2's outstanding graphics output capabilities are enhanced with a wide range of video input and multimedia features. Video input support on the card includes NTSC/PAL/SECAM, RGB and DVI input modes. The card's onboard USB 2.0 host controller simplifies use of popular devices such as USB-compliant video cameras. Audio support is provided by an on-board Stereo Audio I/O controller. The board is designed for use in 0° to +70°C operating environments. An onboard LM75 thermal sensor monitors local heat levels. For harsher environments, special extended temperature testing is available. U.S. list price for AtlasPMC/2 is $2,250.

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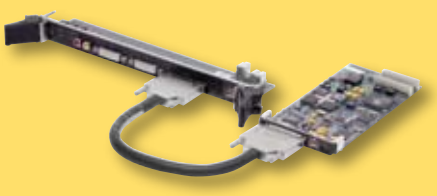
C4 Systems

Multi-Channel PMC Module Provides USB, Firewire

Designers of military aircraft cockpits and security equipment are power users when it comes to multimedia graphics and video. They require a blend of multi-channel, high-resolution video, high-resolution audio with overlay capability and rugged high reliability. With all that in mind, General Micro Systems offers the Radiant Workstation I/O module, a high-performance PMC multimedia module. Radiant features two independent high-resolution video output ports and a video capture port. Radiant also features high-resolution A/D and D/A conversion for audio input/output, four USB ports and three high-speed IEEE-1394B FireWire ports.

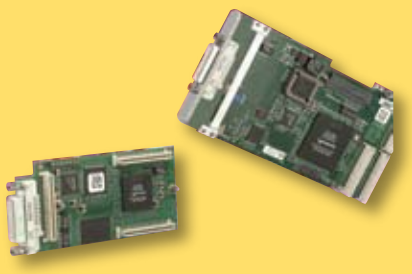
Radiant's two video ports, utilizing an ATI Radeon 9000 controller equipped with 64 Mbytes of RAM, feature 2D/3D graphics acceleration with DirectX and OpenGL support. Both ports support RGB (with or without synch-on-green) and digital flat panel displays with resolutions of up to 2048 x 1536 (24-bit color). The two monitors may display the same data, or be combined to provide a continuous display with a resolution of either 4095 x 1536 in side-by-side mode, or 2048 x 3072 in up-and-down mode. Data displayed on the two monitors can also be repeated on two other digital flat panel displays, thereby enabling Radiant to support up to four simultaneous displays. Radiant's video input port can be used to capture NTSC/PAL video from an external source such as a camera or video recorder while displaying the video simultaneously on the screen. Radiant costs $481 in single-piece quantity.



General Micro Systems
Rancho Cucamonga, CA.
(909) 980-4863.
[www.gms4sbc.com].

Module Enables FPGA Customized Graphics

Choosing a graphics subsystem has always been a game of tradeoffs to some extent. But what if you could use FPGAs to customize exactly the graphics functionality needed? Enabling that capability is MEN Mikro's PCI-based mezzanine modules P18 (PC-MIP) and P518 (PMC), which make graphics solutions flexible, long-term available and temperature independent—whether it be in PMC format or with identical functionality in the smaller and therefore more flexible PC-MIP format. The basic features of P18 and P518 provide frame-buffer functionality, implemented in a 16-Mbyte local SDRAM with 133 MHz and a 16/32-bit data bus. Both modules have an analog video output or a DVI digital video output. An LVDS interface for TFTs is accessible via rear I/O.



The complete set of graphics instructions is realized inside a Cyclone FPGA, with the FPGA acting as a PCI target (32-bits, 33 to 66 MHz). The different display modes are configurable by updating flash and are active after a system restart. The graphics clock is supplied by a 48 MHz oscillator. The entire board does not need more than 1W. Further graphics functions can be integrated into the FPGA depending on the application, for example, video compression, bit-blitter, rendering, pattern recognition or 2D/3D algorithms. Designers can even add totally different functions, such as video test pattern generators or digital I/O. Having the graphics inside the FPGA is the only alternative for temperature-critical applications that demand an operation temperature of -40° to +85°C from the manufacturer.

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Conduction-Cooled PMC Meets 810F and 461E Specs

The trend toward embedded training is ramping up the need for rugged graphics functions. Earlier this year, Quantum3D rolled out a conduction-cooled version of its Sentiris PMC.

The new Sentiris 4110 CD model offers the same industry-leading graphics and video performance, open architecture compatibility, image quality and value as the Sentiris 4110 CV Convection-Cooled models in a VITA-20-compliant, conduction-cooled PMC that is also designed to operate in the harsh environments defined by MIL-STD-810F and comply with the stringent EMI/EMC requirements of MIL-STD-461E. Similar to Sentiris convection-cooled models, the Sentiris 4110 CD features the same low power consumption, multiple high-resolution display support and video I/O capabilities as the Sentiris CV models, all while operating in temperatures from -40° to +85°C.

The Sentiris 4110 CD is based on the NVIDIA Quadro4Go embedded graphics processing unit, which supports 32-bit, 33 or 66 MHz PCI buses and features a 128-bit-wide memory bus with 64 Mbytes of dedicated graphics/video memory that provides 7.0 Gbyte/s graphics memory bandwidth and 400 million pixels per second trilinear filtered fill rate. With its on-chip transformation and lighting engine, Sentiris delivers OpenGL-

based 3D graphics performance of up to 5.4 million independent triangles per second and 4.8 million anti-aliased lines per second (based on Real World Benchmarks 2.3.3). The Sentiris 4110 CD Conduction Cooled PMC features an international, single unit list price of under $5,000, depending on options including conformal coating.

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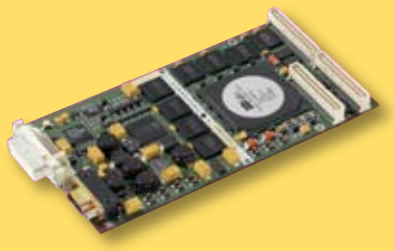
[www.quantum3D.com].

PMC Aims at Cost- and Power-Sensitive Apps

Whether it's merging graphics symbology with real-time sensor data or providing superior situational awareness to key personnel in harsh and demanding conditions, there's a lot of applications that are cost- or power-sensitive, yet need high-performance graphics. Along just those lines, Radstone offers the PMCGA4 as part of its family of rugged PMC graphics products. PMCGA4 is based on the P10 Visual Processing Unit from 3Dlabs. The



P10 has 128 Mbytes of local double data rate SDRAM, used for frame, Z-depth and texture buffers. A DVI 1.0 output gives high clarity digital video for driving suitable flat panel monitors, removing the need for D/A and A/D conversion stages thus improving noise immunity.

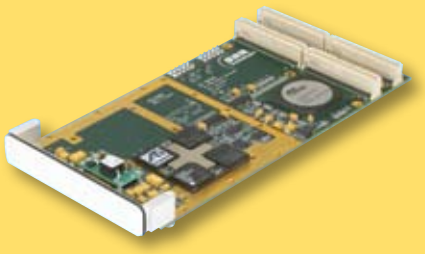
The PMC has 64 Mbytes of SDRAM, two independent output channels, and VESA output resolutions to 1600 x 1200. Support is provided for RS-170, NTSC and PAL video inputs. PMCGA4 is compatible with industrial standard PMC-P1386.1/Draft 2.1, and is available in four ruggedization levels to cater to applications in both benign and harsh environments. The conduction-cooled level 4 product conforms to CCPMC Draft VITA 20-199X. PMCGA4 is available in air-cooled and conduction-cooled versions. Pricing starts at $4,842.

Radstone Embedded Computing
Billerica, MA.
(800) 368-2738.
[www.radstone.com].

Rugged PMC Family Serves up 3D Graphics Processing

Graphics PMCs are vital for military and avionics applications such as cockpit avionics applications and terrain overlay systems, or any application that requires a small footprint and high display performance. Targeting three levels of those kinds of requirements, SBS Technologies' G2 Graphics PMC Module family consists of three models: the G2 Basic PMC, the G2 Dual PMC and the G2 Plus PMC. Each PMC module is available in a commercial grade, extended temperature or rugged conduction-cooled version. The G2 Graphics PMC line's various models are designed to operate in temperatures ranging from -40° to +85°C. Each G2 Graphic PMC shares the same features of 64 Mbytes of video RAM, integrated display output, reduced-power optimization and graphics acceleration to help reduce host processor overhead.

The economical G2 Basic PMC is designed for applications that need only a single display output channel. The G2 Basic provides a wide range of display output options including DVI with up to 1600 x 1200 pixel resolution, LVDS, RGB, NTSC, PAL and S-Video. The flexible G2 Dual PMC features the same video display output support options as the G2 Basic PMC and adds another display channel for those applications that require dual displays. The G2 Plus PMC provides dual display outputs plus up to two channels of video input capture, which make the G2 Plus PMC an ideal choice



for demanding video capture applications. The G2 Plus PMC's addition of graphics overlay capabilities is especially useful for applications requiring display and manipulation of multiple video streams. Pricing for the G2 Graphics PMC Module in single quantities starts at $2,200.

SBS Technologies
Part of GE Fanuc Embedded Systems
Albuquerque, NM.
(505) 875-0600.
[www.sbs.com].

Graphics Adapter Ready for Rugged Duty

In a harsh environment, state-of-the-art graphics can be both difficult and a life-saving benefit. With that in mind, Thales Computers offers the PMC-DGX multi-featured graphics acceleration PCI Mezzanine Card (PMC) for driving SXGA displays in harsh environment console applications. The product features dual independent display capability that can accommodate both legacy analog CRT and DVI-compliant digital video input flat-panel displays. The PMC-DGX, based on Asiliant Technologies' 69030 HiQVideo

Accelerator, provides state-of-the-art graphics performance—1600 x 1200 64K color at 60 Hz. In Dual View Display mode, it is able to display either the same image on two displays, separate images on each display, or a single image spanning both displays. With 4 Mbytes of embedded SDRAM, the PMC is able to support up to 664 Mbytes/s frame buffer bandwidth.

The PMC-DGX is available for convection-cooled or conduction-cooled (ruggedized RC class boards, operating temperature -40° to +85°C) environments. The single-slot graphics acceleration PMC incorporates a 66/33 MHz, 32-bit target interface, with 3.3V signaling (5V-compliant). A 32-pin PLCC BIOS socket can support a Flash EPROM with BIOS to enable the use on a "Wintel" platform.

In addition to the Wintel platform, the PMC-DGX is supported by the Wind River WIND ML 3.0 API on the Thales Computers' PowerEngine and PENTX product families and by the Linux-ABI Hard Real-Time Operating System LynxOS, release 4.0. For existing customers, the PMC-DGX can seamlessly replace the older CPCIGx and GTX8 graphics PMC boards. Pricing for the conduction-cooled version starts at $1,616 in single quantities.

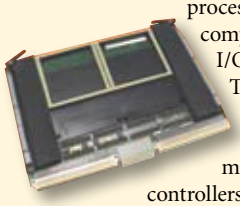
Thales Computers
Raleigh, NC.
(919) 231-8000.
[www.thalescomputers.com].

Get Connected with companies and products featured in this section.
www.cotsjournalonline.com/getconnected

Editor's Note: In the VME SBCs Roundup that ran in the July issue of COTS Journal, *the two products below each appeared with the wrong photo. We apologize for the mix-up, and are rerunning the two items here with the correct images.*

SBC Boasts Distributed Dual-Processing Scheme

This year is shaping up to be the year of dual processing. Processor and board vendors alike are in the thick of the trend toward maximizing the effectiveness of multiple CPUs in a system. Offering a unique approach to dual-processing, Aitech Defense Systems offers a rugged 6U VME single-slot SBC that maximizes functionality and power by incorporating dual processors that operate independently of one another, yet communicate over a high-speed PCI-X interconnecting bus. The new C102's processors use an asymmetrical distributed architecture so that each of the processing nodes functions as a complete subsystem complete with local memory resources and basic I/O interfaces, eliminating data flow bottlenecks.



The C102's improved processing power and I/O functionality make it ideally suited to function in harsh environment applications such as mission management computers, heads-up display controllers, radar and sonar processors, and advanced IED automatic protection subsystems.

The C102 incorporates one or two high-performance PowerPC G4+ MPC7448 processors operating at 1.42 GHz that feature on-chip 32 Kbyte L1 and 1 Mbyte L2 caches. The board provides up to 2 Gbytes of DDR SDRAM with ECC, 256 Kbytes of NVRAM, up to 256 Mbytes of Boot Flash memory and up to 1 Gbyte of user flash memory (512 Mbytes per processor node), as well as up to 16 Gbytes of NAND onboard flash file memory for mass storage. The C102 is available in both conduction- and air-cooled models, per IEEE 1101.2 and ANSI/VITA 1-1994 specifications, respectively. Pricing for the C102 starts at $6,750.

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

PowerPC Board Sports Dual PMC Sites

Using PMC modules is one way to provide flexible expansion for VME CPUs. American ELTEC has introduced a powerful 1 GHz version of its BAB 760 PowerPC board with state-of-the-art CPU design including PCI architecture, VMEbus and expansion through PMC modules. It offers the power of the PowerPC 750 GX CPU. The BAB 760 board can even be used for such complex tasks as image processing when combined with PMC frame grabbers. A PMC extender card permits one or two PMC modules to be fitted.

The Discovery I chip set used on the board—as well as the PCI architecture in combination with the FPGA-based VME interface—guarantees long-term availability. The BAB 760 requires only one VMEbus slot and has a double Eurocard format. A PowerPC 750 GX with a 1 Mbyte on-chip cache is used as the CPU, achieving a clock rate of up to 933 MHz; the CPU is clocked at only 933 MHz to ensure reliable operation throughout the full temperature range.

The board is equipped with an 8 Mbyte flash EPROM, providing storage for a stand-alone operating system or applications. A 512 Kbyte Boot ROM contains the initialization and test routines for start-up. Support is provided for OS-9 and VxWorks (on request) real-time operating systems, as well as ELinOS embedded LINUX. Pricing for the new 1 GHz BAB 760 Power PC board is $3,995 in single-piece quantities.

American ELTEC. Las Vegas, NV. (702) 878-4085. [www.americaneltec.com].

FPGA PMCs Enable Customized Solutions

In applications like radar, sonar and SIGINT, it is very costly to design specific hardware for every flavor of signal processing requirement. An alternative is to use a standard PMC platform and customize its signal processing and I/O functionality using onboard FPGAs. That's exactly the idea behind Acromag's new PMC-LX and PMC-SX modules. The boards support a variety of AXM plug-in I/O extension modules to interface different signal types to a user-configurable Xilinx Virtex-4 FPGA.

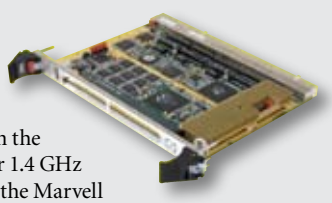
The PMC base card has 32 LVDS I/O channels available via P4 for rear connection I/O and conduction-cooled applications. PMC-LX models are optimized for high-performance logic with a choice of LX40 or LX60 Virtex-4 FPGAs while the PMC-SX model uses the SX35 FPGA designed for high-speed digital signal processing. PMC-LX models can be ordered with an LX40 or LX60 FPGA featuring 40K or 60K logic cells, respectively. They provide a high logic-to-feature ratio and a high I/O-to-feature ratio. The PMC-SX features an SX35 FPGA with 192 DSP slices and 35K logic cells. The SX35 can help you build custom pre/post/co-processing hardware or high-performance filters. FPGA modules start at $3,200 with varying performance levels plus $350 for the optional AXM digital I/O extension modules.

Acromag, Wixom, MI. (248) 624-1541. [www.acromag.com].

IPMI and Hot-Swap Ease SBC's Field Operation, Maintenance

Military users demand a lot from the systems they use, especially in the field. That includes the ability to swap out components and easily make upgrades or perform maintenance. With those needs in mind, GE Fanuc Embedded Systems has introduced a conduction-cooled PowerPC-based CompactPCI SBC equipped with hot-swap capability and the Intelligent Platform Management Interface (IPMI).

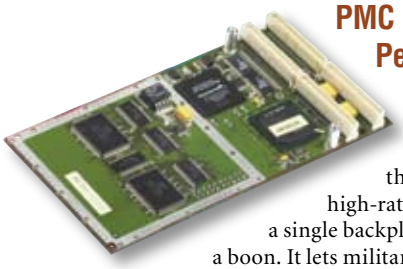
The 6U C2K's IPMI and hot-swap capabilities make field operation and maintenance easier by letting the end user monitor system status and, when needed, change boards without shutting down the entire system. It uses the 1 GHz MPC7447A or 1.4 GHz MPC7448 Freescale processor, and integrates the Marvell MV64460 Discovery III Bridge chip. The Discovery III includes a 333 MHz DDR SDRAM controller with a 167 MHz interface that can service memory up to 1 Gbyte. The board hosts two 64-bit PMC sites. I/O includes three Gigabit Ethernet ports, four RS-232/RS-422 ports, four RS-422/485 ports, two 1.5 Gbit/s SATA ports and three USB 2.0 ports.



VxWorks, Linux and Windows XP are supported. Pricing starts at $2,790.

GE Fanuc Embedded Systems, Albuquerque, NM. (505) 875-0600. [www.sbs.com].

PMC Delivers FPDP II Performance for Rugged Applications



For very high-performance applications that need multi-channel, high-rate sensor data transfer across a single backplane, FPDP technology is a boon. It lets military engineers bypass the potential bottleneck caused by a VME or PCI backplane and maximizes data transfer rates while minimizing the impact on other system functions. A new PMC from Radstone Embedded Computing provides the 400 Mbyte/s transfer rate of FPDP II for deployment in harsh environments.

The ICS-8500 features 8 Mbytes of swing buffer memory, setting it apart from boards that provide only limited FIFO capability. Available in convection- and conduction-cooled versions, the ICS-8500 offers similar functionality to the company's ICS-500-R and ICS-500-T PMC products, but is configurable under software control as either a receiver or transmitter. The FPDP II interface is provided via the P4 connector. When the ICS-8500 communicates with a non-FPDP II device, it automatically reverts to ANSI/VITA 17 FPDP operation at 160 Mbytes/s. A PCI 2.2 (64/66) PCI interface is also provided.

Device drivers for VxWorks, Linux and Windows are available. Pricing starts at $5,123.

Radstone Embedded Computing, Billerica, MA. (800) 368-2738. [www.radstone.com].

Versatile Network Appliance Is RoHS-Compliant

1U form-factor boards are becoming increasingly popular in military network and communications applications. Developers of smaller-scale network security and other network-based applications need a flexible development platform for a variety of solutions that can be scaled up in the future. A scalable network appliance from WIN Enterprises does exactly that.

The PL-01027 is a compact, 1U desktop appliance that can be used in several roles, including policy gateway, wireless security gateways, content filtering devices, network attached storage (NAS) and firewalls. It is architected using the VIA C7/Eden processor with VIA CN700 and the VIA VT8237R chipset. A variety of VIA processors are available to meet a range of application requirements, including 400 MHz, 1 GHz and 1.5 GHz.

Interfaces include four 10/100 Mbit/s PCI bus Ethernet ports with two ports bypass function, one USB 2.0 port, one console port, one mini PCI expansion socket and one 50-pin CompactFlash type II socket. The PL-01027 supports an E-ATA/SATA HDD and is RoHS-compliant. Options include Compact Flash. Dimensions are 9.1 in. x 6 in. x 1.7 in. Pricing in single units starts at $389 for the 400 MHz VIA processor version. Price does not include memory and hard drive. Quantity discounts are available.

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

Data Acquisition Processor Board Simultaneously Samples 16+ Channels

Data acquisition systems with high channel counts must sample inputs simultaneously on multiple channels. A mid-range data acquisition processor board from Microstar Laboratories can work in multiples, making it easy for military engineers to create systems that sample 16 or more channels at once, at 625 ksamples/s per channel. Two or more boards can be synchronized across a network.

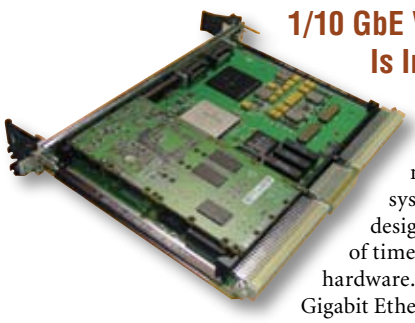
The DAP 5380a/526 is powered by a 233 MHz Pentium that runs DAPL, a multitasking RTOS optimized for data acquisition and related control functions. Each board has 16 analog inputs and can acquire

14-bit data at up to 800 ksamples/s per channel. The board can sample eight channels simultaneously at 625 ksamples/s per channel. For faster sampling, in four-channel mode the board samples up to four channels simultaneously at 800 ksamples/s per channel. It contains 128 Mbytes of onboard memory for data buffers and uses DMA bus-mastering to transfer data to the PC at up to 3.2 million samples/s.

DAPstudio can be used to configure and control the board. The board can also be configured and controlled from LabVIEW, DASYLab, MATLAB, C++, VB and any applications that use DLLs. The board costs $3,995 and DAPstudio costs $199.

Microstar Laboratories, Bellevue, WA. (425) 453-2345. [www.mstarlabs.com].

1/10 GbE VME Switch/Router Is Industry's Densest



Transforming legacy bus-based VME systems into high-performance, network-ready switched systems isn't easy. Military designers must usually spend a lot of time and effort, and use a lot of hardware. A high-density 6U VME64x Gigabit Ethernet (GbE) multilayer switch from Curtiss-Wright can perform this task cost-effectively.

The SVME/DMV-682 FireBlade GbE multilayer switch delivers 24 x 1 GbE ports and 2 x 10 GbE ports in a single VME slot. Each of the 24 1 GbE interfaces can individually auto-negotiate 10/100/1000 Mbit/s operation in a non-blocking manner. The FireBlade is available with GbE port counts of 12, 20 and 24. Four of these ports can be configured as Fast Ethernet (10BaseT/100BaseTX) to the rear panel, GbE Ethernet (10BaseT/100BaseTX/1000BaseT) to the front panel, or optical fiber (1000BaseSX) to the front. Each version of the FireBlade is available in either fully managed or unmanaged versions.

Network management interfaces include CLI, Telnet, SNMP and Web. Complete layer 2 switching, layer 3 routing, QoS, IP multicasting and security software over either IPv4 or IPv6, extensive BIT capability and secure memory erase are supported. Air-cooled and conduction-cooled configurations are available. Pricing starts at $7,999.

Curtiss-Wright Controls Embedded Computing, Dayton, OH. (937) 252-5601. [www.cwcembedded.com].

DC/DC Converters Meet MIL-STD 810F Specs

Military applications place high demands on power converters. Meetings those needs, XP Power has announced the MTC, a series of 4W to 35W DC/DC converters designed as a standard product family exclusively for defense and avionics applications. The MTC is a non-custom converter and is available in 5, 15 and 35W ratings. It offers substantial cost savings over traditional military power supplies and is available from stock to reduce system time-to-market. The converter meets the MIL-STD 810F specification for temperature, shock, vibration, bump, altitude, salt fog and other key parameters associated with military applications.

Suitable for systems with a nominal 28V input, it has a wide input range of 15.5V to 40V. Single output versions are available with output voltages of 3.3V, 5V, 12V, 15V or 28V. The ambient operating temperature range is -40°C to +100°C at the baseplate with -55°C screened units available to order. A complementary EMI filter module, the MTF is rated at 50W and includes active surge and spike protection as well as high-performance EMI filtering. The MTC is priced from $120 each for the 4W unit to $260 each for the 35W version. MTFs are $170 each. All prices are based on 100+ quantities.

XP Power, Littleton, MA. (978) 287-7260. [www.xppower.com].

Dual-Core CPU Board Rides PCI Express

Thanks to the new generation of switched fabrics such as PCI Express, military system designers and test engineers can do the same functions using a PCI Express-based PC that used to require whole racks of boards. Along such lines, Advantech has released the PCE-5120, a SHB Express (PICMG 1.3) System Host Board (SHB) supporting LGA 775 dual-core Intel Pentium D/Pentium 4/Celeron D processors up to 3.8 GHz with a 533/800 MHz front side bus. An Intel ICH7R I/O Controller Hub provides eight USB 2.0 and four SATA-II ports. With up to 10.7 Gbytes/s of bandwidth and 4 Gbytes memory of dual DDRII 533/667 SDRAM, the PCE-5120 offers fast system response and support for robust 64-bit computing. In addition to the PCIe x16 port, the PCE-5120 features four PCIe x1 links to the backplane to enable flexible support for expansion boards. The PCE-5120 has an onboard x1 PCI Express link for single or dual Gigabit LAN using an Intel 82573V controller, which enhances the network data flow with bandwidths up to 500 Mbytes/s. Four onboard SATA-II interfaces feature software support for RAID 0, 1, 10 and 5.

Advantech, Irvine, CA. (949) 789-7178. [www.advantech.com].

LabVIEW Version 8.20 Boosts FPGA Capabilities

Boasting a user community numbering over a million, LabVIEW ranks among the most popular graphical development platforms. And military system designers are well represented in that following. National Instruments has announced LabVIEW 8.20, the 20th anniversary edition of the LabVIEW graphical system design platform for test, control and embedded system development. LabVIEW 8.20 extends the LabVIEW graphical dataflow language with native support for text-based math with MathScript. LabVIEW 8.20 also brings significant improvements in control design and simulation performance and accelerates development of real-time system prototypes using standard PCs, FPGAs or custom designs.

Using MathScript, engineers can integrate their existing m-files created using the MATLAB software, or create new scripts with LabVIEW and mix and match graphical and text-based approaches to meet their design application needs and quickly prototype systems. For FPGA-based development, engineers can use new machine monitoring IP libraries and add third-party IP through the VHDL node in the LabVIEW FPGA Module. Third-party IP cores available for LabVIEW FPGA have been validated by Xilinx, Celoxica and Impulse C. New embedded targets supported in the LabVIEW 8.20 Embedded Module include TI 6713 and Philips ARM7 229x processors, as well as QNX and MonteVista Linux embedded OSs. LabVIEW 8.20 is priced from $1,195.

National Instruments, Austin, TX. (512) 683-0100. [www.ni.com].

AMC/ATCA Boards Target SRIO and GbE Backplanes

AMC, ATCA and MicroTCA are getting increasing attention from military designers. But to gain acceptance, they need a broad range of products to choose from. With that in mind, Embedded Planet has rolled out a suite of AMC and ATCA platform solutions incorporating Freescale processors and DSPs. The boards are designed to work together in deployable ATCA or MicroTCA systems supporting Serial RapidIO and Gigabit Ethernet backplane connections, and support Linux, Green Hills INTEGRITY and VxWorks.

The processor AMC modules feature the MPC8548E PowerQUICC III (EP8548A) and the dual-core MPC8641D (EP8641A). Both boards are AMC.4- and AMC.2-compliant and include a front-panel serial port and two GbE interfaces. The EP8122A and EP8144A DSP farm cards feature multiple high-performance DSPs. The EP8122A has eight MSC8122 quad-core DSPs with a GbE port to AMC channel 0. The AMC.4- and AMC.2-compliant EP8144A features six MSC8144 quad-core DSPs.

The EP568T AMC.4-compliant ATCA carrier board supports four single-width AMCs. Each AMC slot's fabric interface complies with AMC.4 and AMC.2 specifications for the common options and fat pipes regions. The AMC slots support either a single x4 or 4 x1 SRIO connections on AMC ports 4 - 7 and GbE connections on AMC ports 0 and 1 (AMC.1 Type E2).

Embedded Planet, Warrensville Heights, OH. (216) 245-4180. [www.embeddedplanet.com].

COM with 2x SATA Is ETX 3.0-Compliant

A new ETX Computer-on-Module (COM) from Kontron America gives military system designers access to SATA without the need to redesign their ETX baseboards. In the ETX-LX COM, 2x SATA are implemented by additional onboard pins, in accordance with ETX 3.0, to support ETX 3.0 COMs that are 100% backward compatible with previous ETX specifications. ETX COMs can now meet the latest requirements for embedded designs with medium- to high-performance demands.

Based on the energy-saving (0.9W) AMD Geode LX800 processor, the RoHS-compliant ETX-LX offers 4x USB 2.0, graphics integrated into the AMD GEODE CS5536 chipset and supports DDR SODIMM. At only 10 mm high, the compact, passively cooled COM with heat-spreader uses approximately 5W. The module's carrier board interface offers a 10/100 Base-T Ethernet port and two serial TTL interfaces. Up to 8 Gbytes of non-rotating storage media can be integrated via the onboard CompactFlash slot. Additional Ultra-ATA66 DMA storage media are connected via two IDE ports. CRT (SXGA), LCD (UXGA) and optional TV-out are supported.

Application-specific interface variations are controlled via PCI and ISA bus. Up to 1 Gbyte DDRAM is available. Software support includes Linux, Windows XP and Windows CE .Net. The ETX-LX is priced at $195 in small quantities.

Kontron America, Poway, CA. (888) 294-4558. [www.kontron.com].

VXS Processor Mesh Chassis Boosts Bandwidth

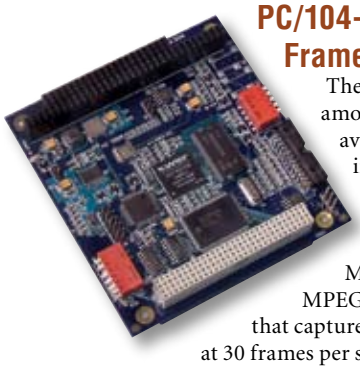
In a single chassis, the VXS Processor Mesh architecture boosts bandwidth to 112.5 Gbytes/s of aggregate throughput within the processing mesh, a boon to high-performance military systems. The first VXS Processor Mesh chassis from Elma Bustronic comes in various configurations with heights from 9U to 12U.

The chassis features a 12-slot Processor Mesh backplane, which features a combination of VXS mesh slots, VXS payload slots, central I/O and legacy VME64x slots. The 19-in. rackmount chassis features a scratch-resistant, powder-coated alodined aluminum enclosure. Power supply options are from 2 x 350W (N+1) to 750W, up to 3 x 600W (N+1). The front-to-rear cooling configuration features up to 3 x 118 CFM fans above and below the card cage in the 12U version. Various cooling options are available for each chassis height.

Options include rear I/O, drives and system monitoring. The Elma VXS Processor Mesh chassis price starts under $5,000, depending on volume and options.

Elma Bustronic, Fremont, CA. (510) 490-7388. [www.elmabustronic.com].

PC/104-Plus Card Does MPEG-4 Frame Grabbing



The PC/104 form-factors provide among the most compact solutions available for rugged system integration. Fortunately the product offerings in PC/104 keep expanding. Sensoray's latest contribution is the Sensoray Model 314 frame grabber, a low-cost MPEG-1/2/4 and MJPEG frame grabber that captures full-frame (720 x 480) video at 30 frames per second. Uncompressed video is available through the PC/104+ bus for previewing. It has two synchronized audio input channels and on screen display of text (OSD). Bit rates range from 800 Kbits/s to 10 Mbits/s.

The 314 can function as a conventional frame grabber by supplying real-time uncompressed video and snapshots of single frames. A 96-character buffer is available for adding text to each frame. The text is within a transparent box that may be positioned anywhere within the frame. This function is not available on the 314NC. The 314 performs motion detection in three user programmable regions of interest. For each separate region of interest, the user can set up different motion detection sensitivity. Within the regions of interest, motion can be further localized to a 16x16 pixel block. The cost for a single 314 is $328.

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

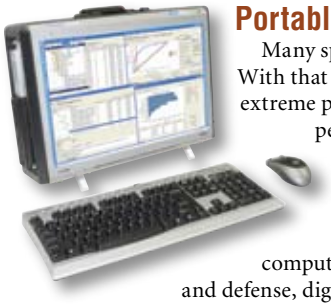
Comm Switching System Targets Mobile Tactical Command & Control

Mobile tactical Command and Control centers need the smallest, most powerful equipment possible. When it comes to voice communications technology, the only way to pack a lot of functionality into a small space is to digitize everything. That's exactly what Telegenix's PROCOM Communications Group has done in its all-digital voice communication switching system.

The 1U PROCOM-1800 series was engineered specifically to meet the needs of mobile combat communications systems, as well as smaller ATC towers, marine traffic control, emergency service dispatch and communications training and simulation. Utilizing a modular, component-based architecture, the PROCOM-1800 provides all-digital audio processing, switching and control of radios, landlines, interphone and intercom. It is easily mounted in a standard 19-in. EIA rack or console, provides support for both touchscreen and push-button operator stations and can be reconfigured and upgraded onsite.

The PROCOM-1800 features up to 28 interface ports, RJ-45/RJ-11 connectors for communication interfaces, full non-blocking and conferencing with multiple access to ICOM, TELCO, CRYPTO, RADIO, P.A. and AUX audio devices, a digital link to operator stations, independent record ports, MIL-STD-461 and EMI/RFI compliance and optional red/black capability. Price depends on the installation. A basic configuration begins at $45,000 and a typical setup is in the $60,000s.

PROCOM Communications Group, a Division of Telegenix
Cherry Hill, NJ. (856) 424-5220. [www.telegenix.com/procom.php].



Portable Workstation Features Dual PCI-X Slots

Many specialized field applications in the defense realm can't settle for compromise in their portable computing needs. With that in mind, NextComputing's NextDimension is an open-standards, high-performance, mobile workstation with extreme processing and graphics capabilities. Combining Dual PCI-X 64-bit/100 MHz slots with the best in processor performance opens up new possibilities for FlexTop applications. The open standards functionality of the slots themselves, and the system overall, allow the use of two COTS PCI cards for performance enhancement and/or specific application functionality, and the increased bus speed of the PCI-X 64-bit/100 MHz is backward compatible with all PCI cards.

Complex functions are enhanced with this configuration, such as those utilizing FPGA/DSP for reconfigurable computing. The NextDimension is well suited for development of tailored high-performance DSP solutions for aerospace and defense, digital content creation (DCC), Oil and Gas, and a variety of other industries requiring advanced imaging. Most major DSP/FPGA manufacturers now offer PCI-X 64/100-compatible interfaces, such as the Xilinx Virtex-5 FPGA family and Altera's Stratix line. Processor offerings include AMD's 940-based Opteron processors, including dual, dual core 2.2 GHZ and 2.6 GHz models, single core 3 GHz models, as well as AMD's low-wattage Opteron options.

NextComputing, Nashua, NH. (603) 886-3874. [www.nextcomputing.com].

Cell BE Processor Board Boosts Compute-Intensive Apps

The multicore Cell Broadband Engine processor delivers extremely fast processing speeds for very high-performance, compute-intensive applications such as video and image processing, rendering, ray tracing and defense signal processing, including network-centric operations. A Cell BE-based accelerator board from Mercury Computing delivers a whopping 180 GFLOPS of performance in a PCI Express ATX form-factor.

The Mercury Cell Accelerator Board (CAB) is the company's latest product based on the Cell BE, and is aimed at commercially available PC workstations. It enables real-time processing of massive data sets by replacing dozens of server blades with a single card.

The CAB supports Linux via a Yellow Dog Linux board support package (BSP) from Terra Soft Solutions. Mercury's MultiCore Plus Advantage software includes software development tools and libraries, such as the MultiCore Framework (MCF), optimized Scientific Algorithm Library (SAL) and the Mercury Trace Analysis Tool and Library (TATL). Pricing starts at $7,999 for a single board, with discounts available on higher volumes.

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

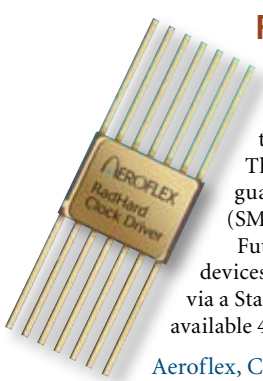
Multi-I/O Avionics PMC Saves Slots

For avionics applications that use combinations of MIL-STD-1553, ARINC 429 and serial data buses, every PMC slot is valuable. The BU-65590F/M multi-I/O PMC from Data Device Corporation (DDC) combines all of these interfaces on one card.

The BU-65590F/M provides up to four dual-redundant 1553 channels, 16 ARINC 429 receive channels, four ARINC 429 transmit channels, six user-programmable digital discrete I/Os, two RS-232 serial I/O channels, two RS-422/485 serial I/O channels, and an IRIG-B time synchronization input. Each 1553 channel has 1 Mbyte of RAM with parity, 48-bit/1 microsecond time tag synchronized to an IRIG-B input and built-in self-test, and can emulate a bus controller, remote terminal, or bus monitor. A combined RT/Monitor mode monitors all 1553 communications on the bus, including the 1553 channel's own RT address.

Each ARINC 429 channel supports high-/low-speed operation, message scheduling, label filtering and full error detection. Received data can be stored in either FIFO buffers or system address label mailboxes. Transmit data can be sent in FIFO mode or scheduled rate mode on each transmit channel. The card can be ordered with either rear I/O or front-panel I/O, and in convection- or conduction-cooled versions. Pricing starts at $2,700 depending on configuration and quantity.

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



Rad-Hard Clock Driver Targets Satellite Apps

Up in space where radiation is an occupational hazard, satellite applications call for extraordinary requirements—particularly critical components such as clock drivers. Aeroflex has added to its RadHard Clock Family, the UT54ALVC2525 RadHard Clock Driver for satellite applications. The device is a low-voltage, minimum skew, one-to-eight clock driver that distributes a single clock to eight high-drive outputs with low skew across all eight outputs. The UT54ALVC2525 withstands total ionizing dose irradiation from100 krads(Si) to 300 krads(Si), or 1 Mrads(Si) and is guaranteed to operate from 2.0V to 3.6V volts. The UT54ALVC2525 is available through a Standard Microcircuit Drawing (SMD) with QML Q and V qualification and is offered in a 14-lead ceramic flatpack.

Future RadHard Clock solutions include faster products with extended I/O compatibility options like LVDS, and more flexible devices offering a wider range of multiplication and division settings. The QML Q- and V-compliant UT554ALVC2525 is available via a Standard Microcircuit Drawing (SMD) 5962-06233 in a 14-lead flatpack. Prototypes are available now with production units available 4Q06. The UT54ALVC2525 is priced at $228 each for QML Q, 100 quantity.

Aeroflex, Colorado Springs, CO. (719) 594-8035. [www.aeroflex.com].

USB Removable Disk Stores up to 64 Gbytes

When it comes to removable storage, military and aerospace applications demand a step above the ordinary. The more compact and easily removable the storage solution, the better. One example is the 64 Gbyte Series 4 DTU Removable Disk System from Targa Systems. The Series 4 DTU product line provides 2.5-in. disk removability in harsh and rugged applications.

The Targa Series 4 DTU meets MIL-STD-810 and RTCA DO-160 environmental standards and transfers data at 18 Mbytes/s. It fulfills the requirements of various military and aerospace applications, such as map displays, imaging and mission loads. It can be used as a Network Attached Storage device, replacing Server Attached Storage in most airborne platform application systems, such as flight management, cockpit instrument display, terrain awareness and warning, map systems, radar systems, cockpit/ground communications, navigation positioning and satellite communications.

The Series 4 DTU product is available in a Dzus Rail Panel Mount (CDU style) form-factor unit with power input of either 28 VDC or 5 VDC. Both single- and dual-disk versions are available, as are a choice of interfaces, including SCSI-2, SCSI-3, USB and Ethernet. A Hard Mount version is also available. Depending on interface, panel-mounted DTU prices start at $4,990. Removable flash disks range in price from $4,000 to $19.000, depending on capacity.

Targa Systems, L-3 Communications Canada
Ottawa, Ontario, Canada. (613) 727-9876. [www.targasystems.com].

3U cPCI SBCs Sport 1.4 GHz Power CPU

CompactPCI, particularly in its 3U flavor, has earned acceptance among military designers. Continuing to feed those demands, Aitech Defense Systems announced two power-saving, rugged 3U CompactPCI single board computers with improved processing performance of up to 1.4 GHz and broader memory and I/O options. The Aitech C901 SBC and its low-power version, the C901L, feature Freescale 7448 PowerPC processors with on-chip L1 and enhanced L2 caches and AltiVec Technology. A fully populated C901 with 512 Mbytes of DRAM operates at a typical power consumption of 24.0W 1.4 GHz processor speed. The C901L version reduces that power consumption to less than 17.0W (at 1.0 GHz) for applications where power dissipation concerns are more critical than processor speed.

Both board configurations provide up to 1 Mbyte on-chip cache memory, 200 MHz memory buses, and 2 Gbytes of flash memory. They also offer six standard variants of I/O capabilities including multiple choices of Gbit Ethernet ports, Fast Ethernet ports, USB ports, high-speed serial ports and up to eight discrete I/O channels. An industry-standard PMC slot allows for installation of additional modules and functionality. Available in both rugged conduction-cooled and air-cooled formats, pricing for the C901 starts at $5,300.

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

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Coming Next Month

Coming Next Month in October *COTS Journal*

- *Mezzanines in the Military.* Military system designers love to think in modular blocks. That's why mezzanine technologies rank among the key product areas embraced by military integrators. Articles in this section examine the latest mezzanine choices such as XMC and AMC, with a look at developments in established mezzanine flavors such as PMCs.
- *Signal Processing Options.* Waveform-intensive applications like sonar, radar, SIGINT and SDR have an insatiable appetite for more digital signal processing muscle. As DSPs get faster, the board-level subsystems must keep pace by quickly moving data in and out of the onboard processors. This feature section delves into the tradeoffs between signal processing on DSPs vs. FPGA vs. general-purpose processors.
- *FPGAs for Software Radio.* The Software Defined Radio market is among the most dynamic segments of military system design. FPGAs are enabling reductions in SDR cost, size, complexity and power consumption. Articles in this section delve into the key technology trends driving SDR, with an update on the latest status and developments in the JTRS program.
- *PC/104 and EPIC Boards.* PC/104 has become entrenched as a popular military form-factor thanks to its compact size and inherent ruggedness. Sweetening the deal, a number of special enclosure techniques are used to outfit PC/104 for extremely harsh environments. This section updates readers on these trends along with a look at the new PC/104 follow-ons, EPIC and EPIC Express.

Editorial

Jeff Child, Editor-in-Chief

Transformation Transformed

Many eyebrows were raised—mine included—when the DoD revealed last month its plans to close the Office of Force Transformation. As part of a significant overall reorganization—designed to streamline and coordinate its activities—the DoD decided to close the OTF, and has no plans to replace it with any single new entity.

The reorg calls for different parts of what used to be the OFT to move to different places within the DoD. They will be separated and embedded within the Office of the Secretary of Defense Policy and the Defense Research and Engineering Office. The policy office's reorganization is expected to begin on Oct. 1 with completion scheduled for March 2007.

The job of coordinating future initiatives in network-centric operations will reportedly remain with John Garstka. Garstka is currently the OFT's assistant director for concepts and operations, and under the reorg he will work in the capabilities section of the new policy office.

Fending off charges that all this means a de-emphasis on transformation, Terry Pudas, acting director of the OTF explains the move in a positive light. "The idea is to enable the department to be more flexible and agile in dealing with the pace of change characterized by the information age," Pudas wrote in a recent Defense News editorial piece. "As a result, one should not be too surprised to see once separate offices like OFT integrated with more long-standing entities across the department. That is a positive sign of cultural change and the bedrock of transformation."

I can half buy the argument that a culture of transformation now is so embedded in the Defense Department that an organization like the OTF is no longer needed. My concern is that now there will no longer be a central voice advocating the priorities for transformation.

Launched in 2001, the OFT was a personal initiative of Defense Secretary Donald Rumsfeld. He envisioned it as a catalyst for innovation in entrepreneurial defense policy and military technologies. Among its core functions was the coordination of network-centric operations. In fact, the OFT's first and only Director, Vice Adm. Arthur K. Cebrowski, was credited for coining the term "network-centric warfare." When Cebrowski died last year, he was never replaced, and many have speculated that Cebrowski's unique drive and perspective on transformation were the inspiration behind creating the office in the first place.

The U.S. Military's move toward net-centric operations calls for real-time sharing of voice, video and data between soldiers, aircraft, satellites, ships, robots and UAVs, all over a global network. Such a network promises a complete "sensor-to-shooter" cycle that's nearly instantaneous. The technology areas fueling those goals include software and programmable radios, ultra-wideband optical communications and networking in space.

In support of that network-centric concept, the OTF funded several separate analytical case studies based on real combat operations, events or exercises. These ranged from how Stryker brigades' access to information bolstered their combat performance in Iraq to how the government of Singapore—the most networked nation on Earth, responded to the SARS health crisis. Those studies helped to illustrate the force-multiplying benefits of sharing information.

The military's move to net-centric operations will represent lucrative areas of opportunity for the embedded computer market. Every node of that network—whether it's on a aircraft, vehicle, ship, command base or carried by soldiers—needs a computer and supporting subsystems—display controllers, storage interfaces and so on—to process, collect and display the networked information.

The theme of net-centric operations intersects all the major technologically advanced programs—Joint Tactical Radio System (JTRS), Warfighter Information Network-Tactical (WIN-T) program and the Army's Future Combat Systems (FCS) program to name a few. Because these programs depend and intersect with one another and all enable and involve joint operations between the U.S. Military branches, the need for coordinating network-centric concepts is critical. The FCS intends to network its systems with JTRS radios.

The JTRS program, although restructured earlier this year, still faces many challenges. A GAO report issued this month cited some of those changes. Among the issues cited in the report is how such a networked environment open to a large number of potential users has generated an unprecedented need for information assurance. That's resulted in a lengthy, technically challenging, and still evolving certification process from the National Security Agency. The DoD has historically had difficulty managing joint programs primarily because of interservice differences involving funding and requirements.

Meanwhile, interoperability of UAVs has been a challenge that falls under the category of net-centric operations. Detailed standards for such interoperability between UAVs have gotten lost in the shuffle, with the Service Branches usually developing differing systems that rely on technical patches to permit interconnection at much slower data rates.

Maybe there's no magic solution to solving the bumps in the road toward network-centric operations. But I don't quite see that the "future is now" when it comes to that particular area of DoD transformation. It seems to me that at least one of the OTF's initiatives, that of network-centric operations, still could benefit from a separate coordinating body. ▮▮

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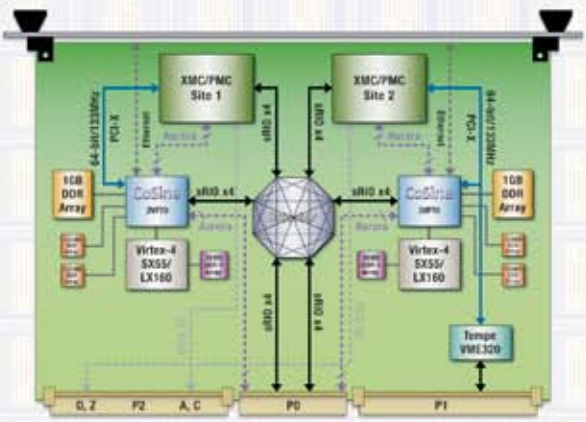

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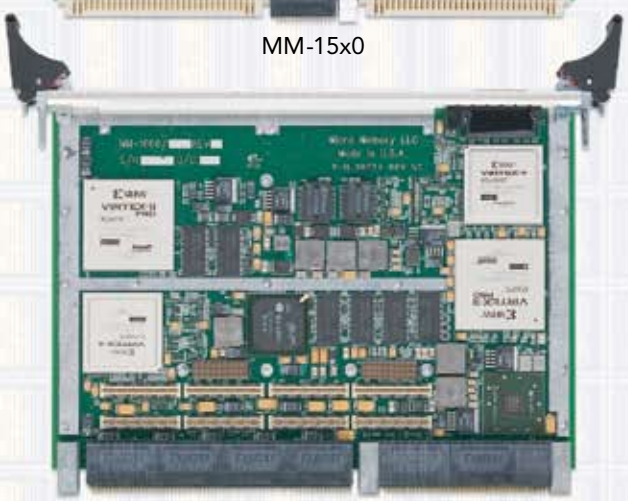

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