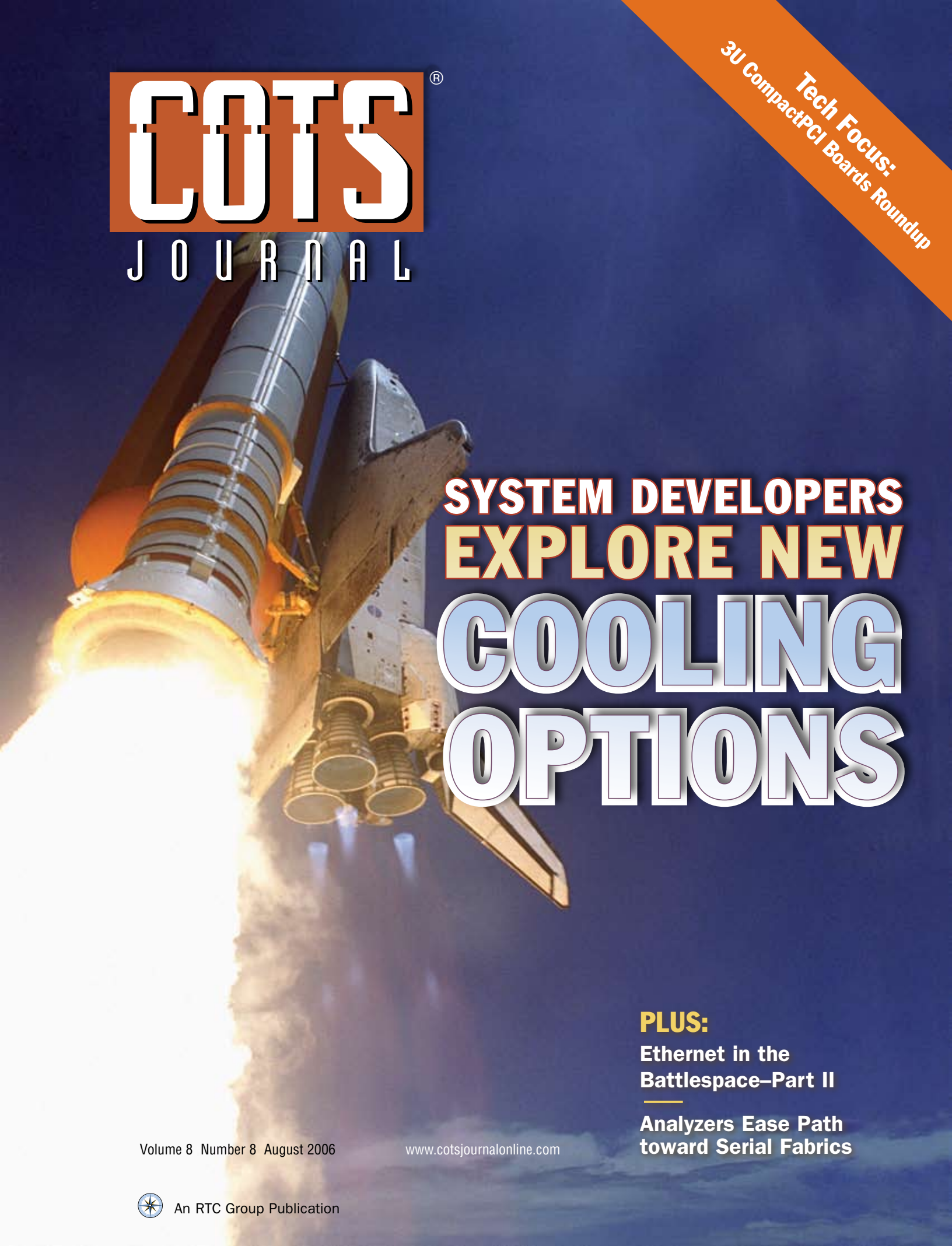
COTS JOURNAL®

Tech Focus: 3U CompactPCI Boards Roundup



SYSTEM DEVELOPERS EXPLORE NEW COOLING OPTIONS

PLUS:

Ethernet in the Battlespace–Part II

Analyzers Ease Path toward Serial Fabrics

Volume 8 Number 8 August 2006 www.cotsjournalonline.com

An RTC Group Publication

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Compact/Flash	Type I or II	Type I or II	Type I or II
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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
Power	3.6A operating	1.6A max.	1.6A max
Temp. range	–40° to 70/85° C	–40° to 80° C	–40° to 80/85° C
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Please call for a datasheet

303–430–1500

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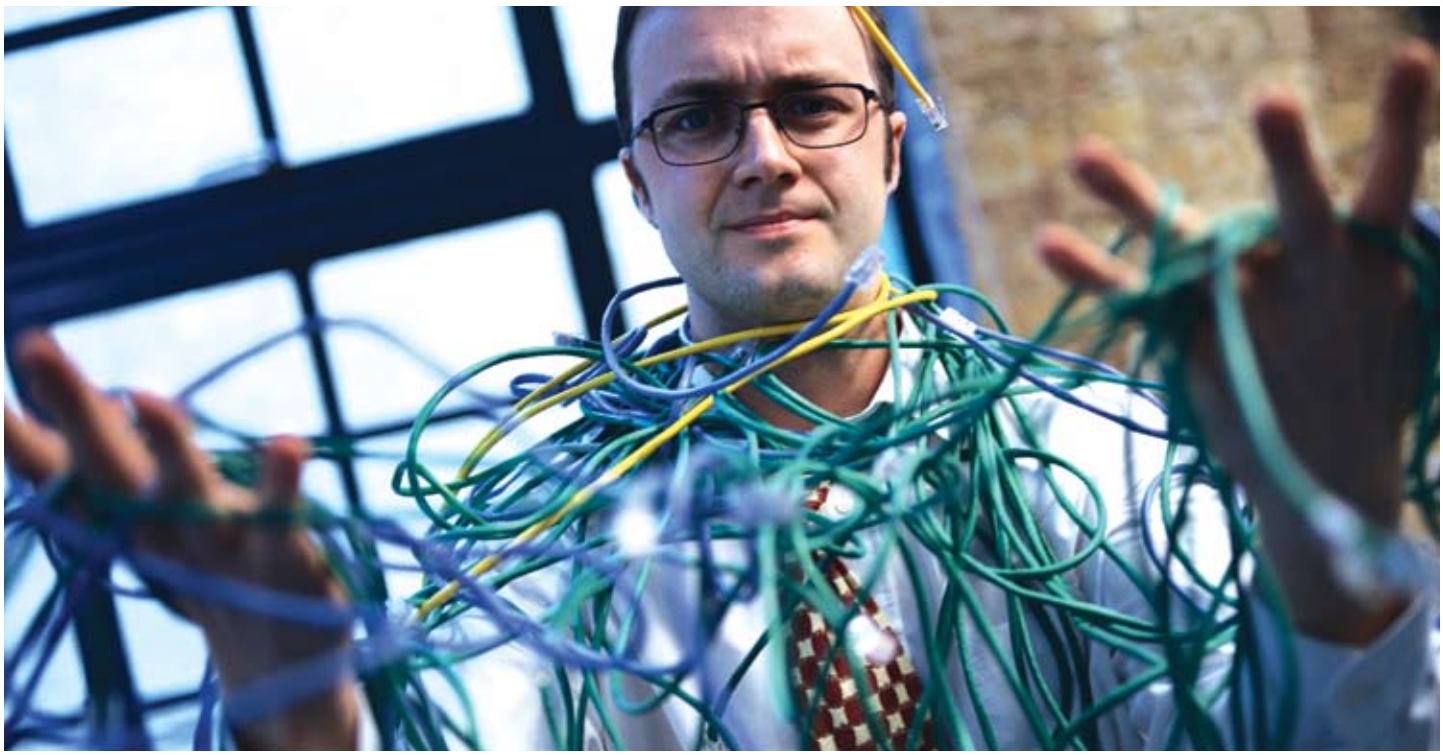

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Cut your cabling weight with our new 10 Mbit 1553 PMC.

P-10SF, 10 Mbit 1553

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COTS JOURNAL

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Cooling Technologies

System Development

Bus Analyzers

Technology Focus

3U CompactPCI

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 27

Making history as the first human-occupying spacecraft to launch on Independence Day, the Space Shuttle Discovery and its seven-member crew launched on the afternoon of July 4th to begin the two-day journey to the International Space Station on the historic Return to Flight STS-121 mission. Members of our *COTS Journal* editorial staff had the good fortune to be at Kennedy Space Center for the launch (see p. 7 of July *COTS Journal*). During the 12-day mission, the Discovery crew tested new equipment and procedures to improve shuttle safety and delivered supplies and made repairs to the space station.

Courtesy: NASA

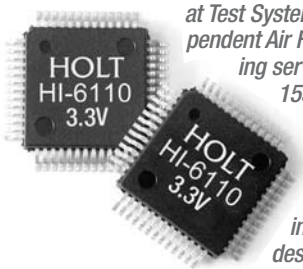
HOLT INTEGRATED CIRCUITS INC.

Great Things in Small Packages

News Release

VALIDATED MIL-STD-1553 RT SOLUTION NOW AVAILABLE FROM HOLT INTEGRATED CIRCUITS

Mission Viejo, CA (March 27, 2006) – Holt Integrated Circuits today announced successfully achieving full MIL-STD-1553 RT Validation with their HI-6110, single-chip CMOS 3.3 volt MIL-STD-1553 Message Processor. Testing was performed at Test Systems, Inc., an independent Air Force approved testing service for MIL-STD-1553 remote terminals in Phoenix, Arizona. The HI-6110 is a true single-chip CMOS integrated circuit designed to implement the MIL-STD-1553 data communications protocol between a host processor and a dual redundant 1553 data bus, and supports MIL-STD-1553B Notice 2 and MIL-STD-1760 Stores Management.



The HI-6110 is a single-chip protocol device and includes on-board dual redundant transceivers as well as Manchester Encoder / Decoders, MIL-STD-1553 message-level protocol engine, and sufficient on-chip data storage for single message buffering. With exceptionally low power the device dissipates less than 500 mW on-chip power at 100% duty cycle. The HI-6110 may be configured as a Bus Controller (BC), a Remote Terminal (RT), an addressed Monitor Terminal (MT), or as a non-addressed MT. All that is needed to interface to the MIL-STD-1553 bus is an isolation transformer for each bus (also available from Holt). The host CPU communicates with the HI-6110 over a 16-bit parallel Input / Output bus. The status of message sequencing and the data transfers are flagged by pins and register bits. Registers provide for configuration, status information, error information, and the type of the currently executing command.

The HI-6110 Message Processor introduced by Holt is the first completely new IC design provided to the market in years. Care has been taken to provide customers only what they need, and eliminate unnecessary legacy operating modes. The HI-6110 uses system memory for 1553 message data which is configured by the user to specifically meet the needs of the application. As a result, the device can be offered in a small package that takes full advantage of the host processor / memory at a price offering significant cost savings to the system designer. The HI-6110 is offered in either a 52-pin plastic quad flat pack (PQFP) or a 64-pin plastic chip-scale package.

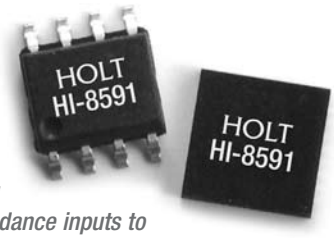
"Designers of military avionics data bus systems have waited a long time for a simple, fully integrated MIL-STD-1553 terminal IC that acts as a peripheral device to the system's host processor," says David Mead, Executive Vice President and COO of Holt Integrated Circuits. "The 3.3 volt HI-6110, with its exceptionally low power consumption, allows the designer to focus on their system application, and hand off the detail protocol management to the message processor."

Engineering samples of the HI-6110PQI in the 52-pin PQFP package are now available from Holt, along with an accompanying Remote Terminal evaluation / demonstration board to customers wishing to evaluate the device for new production designs.

News Release

3.3V ARINC 429 LINE RECEIVER OFFERS EXCEPTIONAL INPUT COMMON-MODE PERFORMANCE

Holt Integrated Circuits announces the newest of their 3.3 volt ARINC 429 CMOS products with the release of the HI-8591 and HI-8591-40 Line Receivers. The HI-8591 is a highly integrated CMOS bus interface receiver designed to operate from a single 3.3 volt or 5 volt supply. The part is designed with high-impedance inputs to minimize bus loading, and has exceptional input common-mode performance in excess of ± 30V, making it immune to ground offsets around the aircraft.

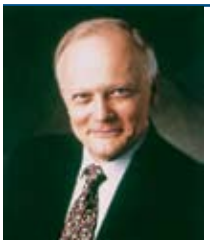


Like other Holt ARINC 429 Receiver products, the 3.3V HI-8591 is offered in a "-40" variant to simplify the circuit design in applications where lightning protection may be a concern. The HI-8591-40 requires only the addition of external 40K Ohm resistors in series with RINA and RINB to allow the part to meet the pin injection lightning protection requirements of DO-160D, level 3.

"The demand for 3.3 volt databus products is increasing," says Jerry Donaldson, Marketing Director at Holt. "Holt is successfully implementing our strategy to expand our 3.3 volt offerings with both ARINC 429 and MIL-STD-1553 products, while continuing to support the long-term production and customer support of our industry standard 5 volt products."

The HI-8591 and HI-8591-40 are available in the very popular 8-pin plastic SOIC and an ultra-small 16-pin 4mm x 4mm LPCC Chip-scale package. Other package options in both plastic and ceramic configurations are available to meet alternative customer requirements, with temperature screening and processing from Industrial to full Military.

Publisher's Notebook



The Pencil versus the Python

The military market is totally different than the non-military market and that's proving to provide deep consternation to people that are new to the Mil market. Roughly eighty percent of you that read *COTS Journal* are pretty tightly linked to the development of embedded military systems. The rest of you are more at the management and decision making end of military systems and you're reading this magazine to stay abreast of what technologies are affecting your market so you can make the best decisions possible.

Last week I received several phone calls from people trying to understand the dichotomy they see when they read about what's going on in the Mil market. Financial publications are stating that the second quarter of this year has been one of the more profitable quarters for prime Mil contractors in many years. Yet some embedded suppliers are having tough times and the U.S. Army is begging Congress for money to keep operating. The Army has decimated its travel budget and has shut down almost every form of spending that doesn't provide material to support its overseas campaigns. I understand that the Army is carrying the major load in Iraq and Afghanistan and their needs are more desperate than the Air Force or the Navy. But why should the Army be solely responsible for begging for funds?

Embedded suppliers are still seeing a slowdown in new orders and release of shipments—a trend that I fear will continue right into the elections this November. What explains then the near record profits for some of the major suppliers of big systems? There are two reasons: one is fact and one is speculation. The military market is still a very slow market—from design win to first production deliveries followed by the potential of a decade of deliveries until a program reaches end-of-life. Acquiring and fulfilling a contract for a Mil program is analogous to a python eating: it takes a long time to catch something and then it takes an even longer time to get it from one end to the other.

So the delivery of tanks, radar systems—or whatever produced the primes' record results for Q2—had funding committed a long time ago. Canceling or delaying these kinds of deliveries usually incurs charges that in many cases can equal taking the deliveries. Delivering the platform is at the tail end of our python. Meanwhile, the embedded market is closer to the head of the python and that end hasn't seen much activity since the end of last year. Irrespective of the outcome of this November's elections there will be a significant increase in available funds right after. No one will want to labeled as not caring for the welfare of the nation's sons and daughters that are in harm's way. This will start a frenzy to get things into the head of this python.

Now here's the speculative part concerning profitability: At one time or another most of us have contracted to have some construction done in our homes. We get a quote with a statement of work and we start. A little ways down the path we realize that we screwed up and we want something changed. Before the contractor won the job they would do almost anything, including "sharpen their pencil" on the quote. Now ask that contractor for a quote on the change order…Well, there's drafting charges and procurement cost, and delivery charges and worker delays…

In the non-military embedded world suppliers always have to have a sharp pencil, even for change orders. There are always new programs and contracts that you want from that customer. And with short product lifecycles, and multiple programs each customer is involved with, the last thing a supplier wants to do is get a bad reputation or seem unresponsive. Like vultures, your competitors are just waiting for you to make a misstep. But in the military market, at least at the platform level, there are a limited number of suppliers. Almost every one of them is a specialist in one way or another. So there doesn't seem to be the same interest in sharpening the pencil.

I remember going back a decade or two and seeing some cost justifications on some product changes. There were two pages of line items with 0.5 hours of this and 1.7 hours of that and I knew damned well that all someone did was put in one line on a computer and two milliseconds later the drawings were done. And so were the QA instructions, Tech Manuals, and so on—all were completed. The real cost for the change was the paper that had to be reprinted—and that was minimal—but the justification (all profit) was unbelievable. Seeing that reminded me of putting that addition on my house. So are we seeing more of the python or just a dull pencil? ▮▮

Pete Yeatman, Publisher
COTS Journal

COTS JOURNAL

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The Inside Track

Formation's Rugged Hard Drives to Fly in AC-130H/U Gunships

Deep Development Corp., a division of Gatekeeper Systems, has integrated Formation's ToughDisk 3500 rugged hard disks into its Viperfish ASX high-resolution digital video recorders for use in U.S. Air Force AC-130H/U gunships. The recorders enable the Air Force to record planes in action as they escort convoys, protect air bases and facilities, and carry out air strikes. They also help Air Force officials review their operations.

ToughDisk rugged hard disks are high-performance, removable data storage units built specifically to withstand extreme temperature, shock, vibration, humidity and dust conditions. The TD3500 is a rugged drop-in replacement for standard 3.5-in. low-profile disk drives with 73 or 100 Gbyte capacity and SCSI or ATA interfaces.

The Viperfish ASX recorders, designed and manufactured by Gatekeeper's Deep Development Corp., were selected after U.S. officials tested the surveillance equipment for more than a year. Gatekeeper has completed delivery of its first order of recorders and has received a second order for recorders.

Figure 1

Viperfish ASX high-resolution digital video recorders on the U.S. Air Force AC-130H/U gunships enable the Air Force to record planes in action as they escort convoys, protect air bases and facilities, and carry out air strikes.

Formation
Moorestown, NJ.
(856) 234-5020.
[www.formation.com].

Agilent Test Products Tapped for Major IPv6 Interoperability Event

Agilent Technologies' Network Tester and N2X products were selected as the sole test vendor for the latest phase of the industry's leading IPv6 interoperability event, Moonv6. The Agilent Network Tester and N2X enabled vendors to assess their product's real-world performance and resilience to network threats in an IPv6 environment. Agilent's solutions provide the industry's most comprehensive portfolio for validating real-world performance, stress resilience and scalability of next-generation network security and triple-play infrastructure equipment.

The Moonv6 multi-vendor interoperability tests were conducted the week of July 24 by the Joint Interoperability Test Command (JITC) and University of New Hampshire's Interoperability Lab (UNH-IOL), with the goal of validating the maturity of network security devices and other service systems that support IPv6. The U.S. Department of Defense (DoD) will use the results to determine a baseline set of standards to which vendors must adhere in anticipation of the U.S. government-mandated IPv6 cutover beginning in 2008.

Agilent worked with the JITC and UNH-IOL to enable major equipment vendors to validate the real-world performance levels of their IPv6 implementations. Participants used Agilent's application mix test methodology to exercise their equipment's application aware functionality and defense mechanisms. Based on this methodology, the transition traffic forwarding test suite delivered a realistic distribution of seven application protocols over native IPv4 and IPv6, while simulating network threats and exploits. In addition, the new Agilent N2X E7896A DHCPv6 protocol-emulation software thoroughly stressed and measured the vendor equipment's address-allocation capability, critical for future data, voice and video service environments.

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

General Dynamics Chooses Aitech to Provide Subsystems for FCS

Aitech Defense Systems has been selected by General Dynamics Land Systems (GDLS), Sterling Heights, MI to provide the Remote Interface Control Card (RICC) for the Future

Figure 2

The FCS Manned Ground Vehicle (MGV) platforms share a common architecture that focuses on high performance, commonality and reliability. They will be capable of being transported by C-130 aircraft. Shown here is a graphic representation of the Mounted Combat System (MCS), which provides direct and Beyond-Line-of-Sight (BLOS) offensive firepower capability.

Combat Systems (FCS) Manned Ground Vehicle (MGV).

The FCS program is the Army's flagship Simulation-Based Acquisition program to be executed in accordance with the Army framework entitled Simulation and Modeling for Acquisition, Requirements and Training (SMART). Modeling and Simulation are expected to play a crucial role in the early development to achieve product integrity, because it reduces risk and reaches a balance of performance and cost. Each RICC will be installed in one Remote Interface Unit (RIU) enclosure. The RIU enclosure will be developed by GDLS.

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

DoD Awards RFID Tagging Contract to Psion Teklogix

The United States Defense Distribution Center (DDC) has awarded Psion Teklogix a contract worth an estimated $1.8 million to deploy GlobeRanger's iMotion Edgeware throughout DDC facilities by the end of 2007. Under the terms of the contract, Psion Teklogix will work with GlobeRanger, a provider of RFID, mobility and sensor-based software, to deploy iMotion Edgeware in 26 DDC sites around the world. This three-year contract, which begins immediately, will start with installations in the U.S. in 2006 and will be completed in worldwide sites by 2007.

The contract was issued to help DDC comply with the passive RFID mandatory tagging mandates set by the DoD. DDC began an initial implementation in December of 2004 at two strategic distribution centers to receive goods from suppliers that have been tagged with passive RFID tags. With this new contract and the additional installations, DDC will now have the largest passive RFID installation within the U.S. government.

Prior to the awarding of the contract, Psion had been working with DDC on various projects over the past several years. In addition, GlobeRanger began working with DDC on their initial RFID implementation in December of 2004. Recognizing the synergies between the two companies, Psion and GlobeRanger partnered together in early 2005 to deliver RFID solutions for government entities, including the addition of GlobeRanger products to the Psion Teklogix GSA Schedule. This DDC contract win is the first joint effort for the companies.

Psion Teklogix
Mississauga, Ontario, Canada.
(800) 322-3437.
[www.psionteklogix.com].

BAE Systems Selects VMETRO Conduction-Cooled Processors

VMETRO has received a contract to supply conduction-cooled Phoenix VPF1 digital signal processing boards to BAE Systems in Nashua, NH for the U.S. Army's Tactical Signals Intelligence Payload (TSP) Program. The Phoenix VPF1 Dual PowerPC, Dual Virtex-II Pro FPGA VME/VXS Digital Signal Processors will run the signal processing algorithm as well as perform real-time processing of the sensor data. The initial contract is valued at approximately $500,000. The design is being included in similar programs as part of BAE Systems' common platform initiative.

TSP is a subsystem intended for the Army's tactic UAVs. The payload collects and processes radio frequency energy that will be displayed on the payload operator's work station in a ground processing facility. The system provides the ground tactical commander with an airborne collection capability that is responsive to real-time emerging operational intelligence requirements. TSP will provide a critical capability to see and understand the enemy on future battlefields. BAE Systems' TSP offering is fully scaleable for employment on other platforms, large or small. The offering is based on using predominantly commercially available off-the-shelf hardware components.

Figure 3

Endevco, a vendor of mission-critical sensors, will provide high-performance, high-accuracy accelerometers and pressure sensor microphones for the first F-35 fighter test aircraft, part of the Joint Strike Force program, being built by Lockheed Martin.

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

Endevco Delivers First Ship Set of F-35 Flight Test Sensors

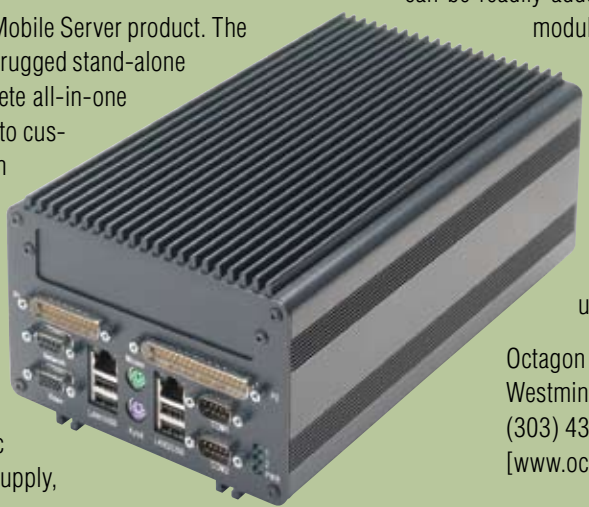
Endevco has announced the delivery of the first ship set of sensors for the F-35 Lightning II flight test program to Lockheed Martin, Ft. Worth, Texas. The vendor of mission-critical sensors will provide high-performance, high-accuracy accelerometers and pressure sensor microphones for the first F-35 fighter test aircraft, part of the Joint Strike Force program, being built by Lockheed Martin. Delivery of the first ship set of Endevco flight test sensors for the program follows a five-year partnership between Endevco and Lockheed Martin to develop sensor requirements as flight test parameters evolved. Endevco sensors will take flight aboard the first F-35 test aircraft, which recently debuted to the public and was named Lightning II at Lockheed Martin's assembly facility in Ft. Worth.

Endevco
San Juan Capistrano, CA.
(949) 493-8181.
[www.endevco.com].

Octagon's XMB Wins *COTS Journal* Flagship Product Award

In the June issue of *COTS Journal* we held our first ever Flagship Product Award contest. A team of judges comprised of the editorial staffs of *COTS Journal* and its sister publication *RTC* magazine, were asked to vote on which product showed the best blend of technical innovation and suitability to the defense market.

The winner was Octagon Systems' XMB Mobile Server product. The product exemplifies the growing trend toward rugged stand-alone box-level systems. The drawback to a complete all-in-one system has always been the lack of flexibility to customize to application requirements. Octagon Systems nullified that drawback by offering a product that marries the complete system approach with the ability to mix and match I/O and other functions via PC/104 add-in cards. That product is their XMB Mobile Server, the latest member of the company's I-CORE line of rugged computers with expandable I/O and fanless operation. The basic unit includes the processing power, power supply, memory and I/O for most applications.



Standard I/O includes dual Ethernet, quad USB 2.0, dual serial, CRT and LCD video and digital I/O. Because the XMB-1 is fully functional out-of-the-box, additional I/O such as GPS, analog, GPRS and video camera can be readily added via PC/104, PC/104-Plus and XBLOK modules. An option panel can be easily removed and punched for custom annunciators, connectors and controls. Generated heat is efficiently channeled directly to the case to help prevent internal hot spots. The XMB Mobile Server operates in ambient temperatures from -40° to 75°C, depending upon the processor speed, user options and mass storage devices.

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Westminster, CO.
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Main Feature

Ethernet in the Battlespace - Part II

High-Performance Ethernet Fabrics for Military Systems

Ethernet is gaining acceptance as a real-time military interconnect. But enhancements to plain-vanilla Ethernet are needed to provide real-time capabilities.

Greg Bolstad, Chief Systems Architect
Critical I/O

It has for many years been a goal of system designers to use a single networking technology to fulfill all of the interface needs of high-performance military systems. The diverse interface needs of such a system may include board-to-board and box-to-box interfaces, as well as sensor interfaces and peripheral interfaces. In the majority of military systems today, a disparate set of interface technologies is used. For example, Serial Front Panel Data Port might be used as a sensor interface; VME, RapidIO, Star Fabric or Raceway might be used as an intra-processor board-to-board interface; InfiniBand might be used as a box-to-box interface; and Fibre Channel might be used as a storage peripheral interface. Ethernet is almost always in the mix as well, but generally only for non-real-time general-purpose networking and debug purposes.

This mishmash of interface technologies leads to high development and support costs due to many diverse protocols and technologies, with different hardware and steep learning curves for each. But what if a common networking and interface technology could satisfy most, if not all, of these interface needs? Technology is rapidly advancing to the point where this is a realizable goal. Ethernet technology, in particular, has seen rapid advances in both speed (up to 10 Gbits/s now, with 100 Gbits/s under consideration), and in implementation, with the various flavors of "TOE" (TCP Offload Engine) that are becoming available. These advances, especially the recent developments in hardware-based TOE solutions, also known as Silicon Stack Ethernet, are rapidly making Ethernet the common networking technology of choice for real-time embedded systems.

How Does Ethernet Measure Up?

"Ideal" Network Attribute	"Traditional" Ethernet	1G/10G Ethernet (with Silicon Stack)
High Bandwidth	No	Yes
Low Latency	No	Yes
Deterministic	No	Yes
Reliable under High Loads	No	Yes
Low Host CPU Impact	No	Yes
Interoperability	Yes	Yes
Connect Everything	Yes	Yes
Standard APIs	Yes	Yes
Standard Network Apps	Yes	Yes
Low Cost Infrastructure	Yes	Yes

Table 1

Summarized here are the ideal network characteristics and how they stack up against both traditional Ethernet, as well as the latest generation of Ethernet network interface hardware.

An Ideal Network for Military Systems?

An ideal network is not defined by the interface technology itself; rather it is defined by the set of network characteristics that military system designers deem essential or desirable. In fact, from a basic building block point of view, all modern high-performance network interface implementations are comprised of the same building blocks. They include a host processor interface (for control and status), multiple DMA engines to move data efficiently to and from host memory, internal data buffering, protocol offload engines that handle framing, headers and routing, and a physical interface layer. The differences between different interface technologies lie only in specifics of the protocol and physical interface layers.

Traditionally, Ethernet would not be viewed as a likely candidate for the ideal military network technology. But advances in technology and implementations now make it a very strong contender. Table 1 summarizes the ideal network characteristics mentioned above, and shows how they stack up against both traditional Ethernet, as well as the latest generation of Ethernet network interface hardware. While traditional Ethernet provides everything needed for general-purpose networking, it clearly does not provide

the attributes needed for high-performance, high-reliability embedded military systems. Some of these network attributes (such as latency, determinism and reliability under high loads) that might be characterized as merely "desirable" in non-military applications become absolutely essential in high-performance, mission-critical military applications. These attributes are provided only by the latest generation of hardware-based TOE called Silicon Stack Ethernet.

The Inherent Advantages of Ethernet

The strength of Ethernet has always been the use of rock-solid, widely adopted interface standards and protocols, including UDP, TCP, IP, the Sockets API, and a host of others. While the physical interface technology has progressed, the interface protocol standards have remained relatively unchanged. These standards ensured interoperability, straightforward development and integration, and protection against obsolescence; things that are as important in military systems today as they were 30 years ago. The common theme of all of these advantages is controlling system costs by minimizing development and support complexity, and avoiding obsolescence.

Ethernet as Applied to Military Systems

The benefits of using a common networking technology such as Ethernet are many, especially for military systems where overall product lifecycle costs are critical. The major elements of system lifecycle costs include development, maintenance and support, training and upgrade costs, as well as costs related to technology obsolescence.

The Evolution of Ethernet

Ethernet in its early days was essentially a bussed technology, with multiple nodes tied onto 1/10/100 Mbit/s common lines or hubs. In addition to low bit rates, the common line approach led to severe problems with collisions and flow control in even moderately loaded systems. This, of course, led to the common (and correct, at the time) view that Ethernet was hardly useful as a performance networking technology, and especially not for mission-critical military systems.

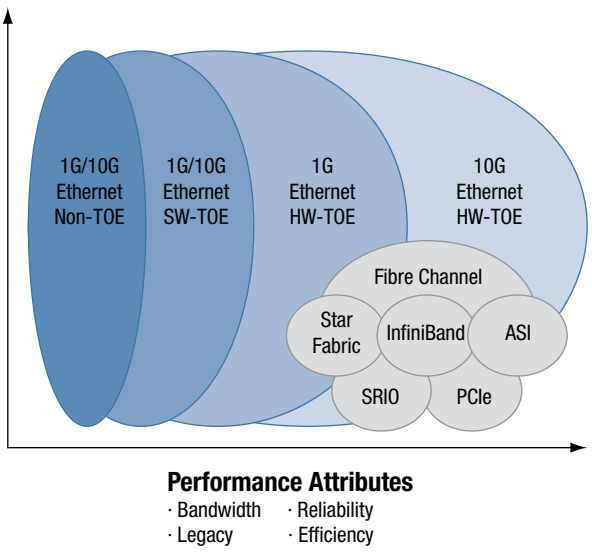

Figure 1

The graphic positions Ethernet, along with a variety of other network technologies, in a two-dimensional "application space." This application space is meant to convey the requirements that system designers face in choosing network technologies for typical military embedded systems. The horizontal axis is termed Performance Attributes, with higher performance technologies to the right, while the vertical axis (Usability Attributes) encompasses those attributes that make an interface technology flexible, long-lived and easy to use.

The Ethernet performance picture began to improve dramatically with the introduction of fully switched Gbit Ethernet, which completely eliminated the collision and flow control problems of older Ethernet, as well as supplying a theoretical 250 Mbyte/s bidirectional bandwidth on a single 1 Gbit/s link, and up to 2,500 Mbytes/s on a single 10 Gbit/s link. But with Gbit Ethernet, a new problem soon surfaced, a problem that had been masked up to that time by the low network performance of old 10/100 Mbit Ethernet—the problem of excessive host CPU loading from the use of software-based networking stacks. With Gbit Ethernet, these software stack implementations have become a critical performance bottleneck, a bottleneck now being addressed to varying degrees by the many (and often misnamed) implementations of TCP Offload Engines (TOE).

TOE Enables High Performance

The Gbit Ethernet performance bottleneck is being addressed today through the introduction of TCP Offload Engine technologies of varying flavors, with the best TOE implementations providing over a 1,000 to 1 efficiency advantage over non-TOE Ethernet. And while efficient TOE technology is important for efficient 1 Gbit Ethernet, it becomes absolutely essential for 10 Gbit Ethernet and beyond. Silicon Stack Ethernet, with its data flow pipelined architecture and hardware protocol offload, is a particularly important development.

Figure 1 positions Ethernet, along with a variety of other network technologies, in a two-dimensional "application space." This application space is meant to convey the requirements that system designers face in choosing network technologies for typical military embedded systems. There are a number of network technologies shown in Figure 1; most of these are point solutions that were really intended to solve a specific interface problem and thus tend to focus on particular performance attributes, with much less focus on broad usability attributes. Ethernet, on the other hand, has always had a strong focus on a rich set of usability attributes, and now with 1 Gbit, 10 Gbit and TOE, Ethernet has expanded its reach to encompass the highest performance levels as well.

The Different Flavors of Ethernet "TOE" Technology

TOE technology is critical to the use of Ethernet in data-intensive military systems. However, all TOE technologies are not cre-

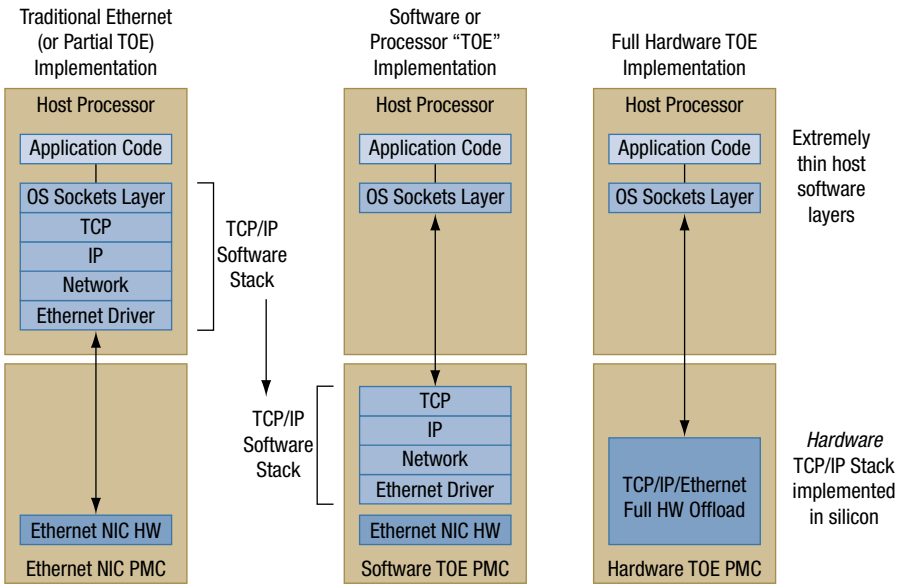

Figure 2

Compared here are the Ethernet implementation approaches from a network stack implementation point of view. The partial TOE shown on the left essentially means a standard Ethernet NIC, which has been augmented with some degree of offload hardware, such as checksum capability or TCP segmentation capability.

ated equal. TOE implementations generally fall into one of three categories: Partial TOE, Software TOE, or Full Hardware TOE. Of these, Partial TOE is the least effective of the three, while full hardware TOE is by far the most effective for use in high-performance embedded systems. Figure 2 compares Ethernet implementation approaches from a network stack implementation point of view.

Partial TOE (shown on the left in Figure 2) essentially means a standard Ethernet NIC (Network Interface Controller), which has been augmented with some degree of offload hardware, such as checksum capability or TCP segmentation capability. Partial TOE implementations are specifically designed to work with existing desktop and server type operating systems and network stacks. These stacks (the Microsoft Windows stack, for example) have the capability in certain situations to "offload" some time-consuming functions to partial TOE NICs to improve network efficiency (as measured by reduced host CPU load) by a factor of two or three as compared to traditional all-software implementations.

Partial TOE can be effective in office or commercial data center applications where

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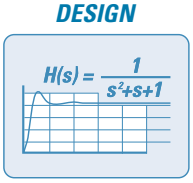

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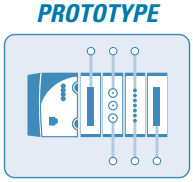

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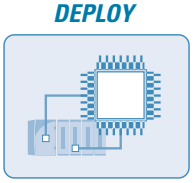

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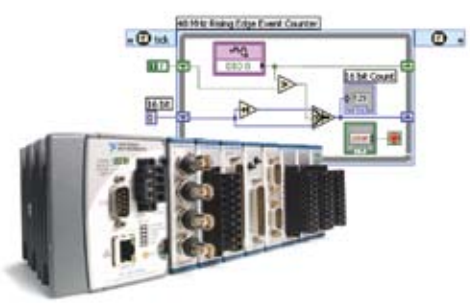

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Attributes of Different TOE Approaches

Problem Associated with "Traditional" Ethernet	Goal for TOE Implementations	Processor- or SW-Based TOE	Silicon Stack Ethernet
Consumes Lots of Host CPU	Low host CPU utilization	Yes	Yes
High Latency	Very low latency	No	Yes
Poor Determinism	Excellent determinism	No	Yes
Unpredictable Data Rates (depends on Frame, MSS sizes)	Line rate, regardless of frame, MSS sizes	No	Yes
Data loss under high loads	No data loss	No	Yes

Table 2

This table summarizes the specific problems associated with traditional Ethernet that TOE technology is trying to address, and examines just how successful the different types of TOE are at addressing these problems.

moderate network performance needs are coupled with the availability of powerful multi-GHz host processors. Unfortunately, the modest performance levels of embedded-class host processors require more than a 2x or 3x improvement in efficiency. In addition, the network stacks provided in most current embedded operating systems used in military systems do not typically have the flexibility to even leverage partial offload.

Software-based TOE (also known as processor-based TOE) attempts to solve the efficiency problem by simply moving the software network stack to a different processor. Processor-based TOE PMCs (center) are basically full processor PMC boards (CPU, memory, bridges, etc.) that implement a traditional TCP/IP stack in software that runs on a general-purpose CPU. This addresses the problem of high host CPU load, as the host processor is no longer handling the network stack.

That said, the price paid for this approach is latency that can be higher than even traditional host stack implementations, as data must now be transferred first from the host processor to the "offload" processor, and once there, it still passes through a full network stack. And because these implementations are still software-stack-based, they suffer from all of the other problems of traditional Ethernet, including high and non-deterministic latencies and susceptibility to data loss under high network load conditions due to the software-intensive implementation.

Full hardware TOE is the only TOE technology that solves all of the problems associated with traditional Ethernet implementations. With full hardware TOE, the network stack is moved to dedicated hardware, essentially connecting the TOE offload hardware directly into the user level sockets API. The problems associated with a software protocol stack are completely eliminated, because the protocol stack is instead implemented as a pipelined hardware data path. With full

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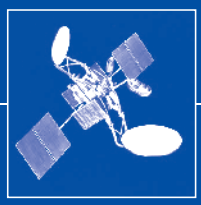

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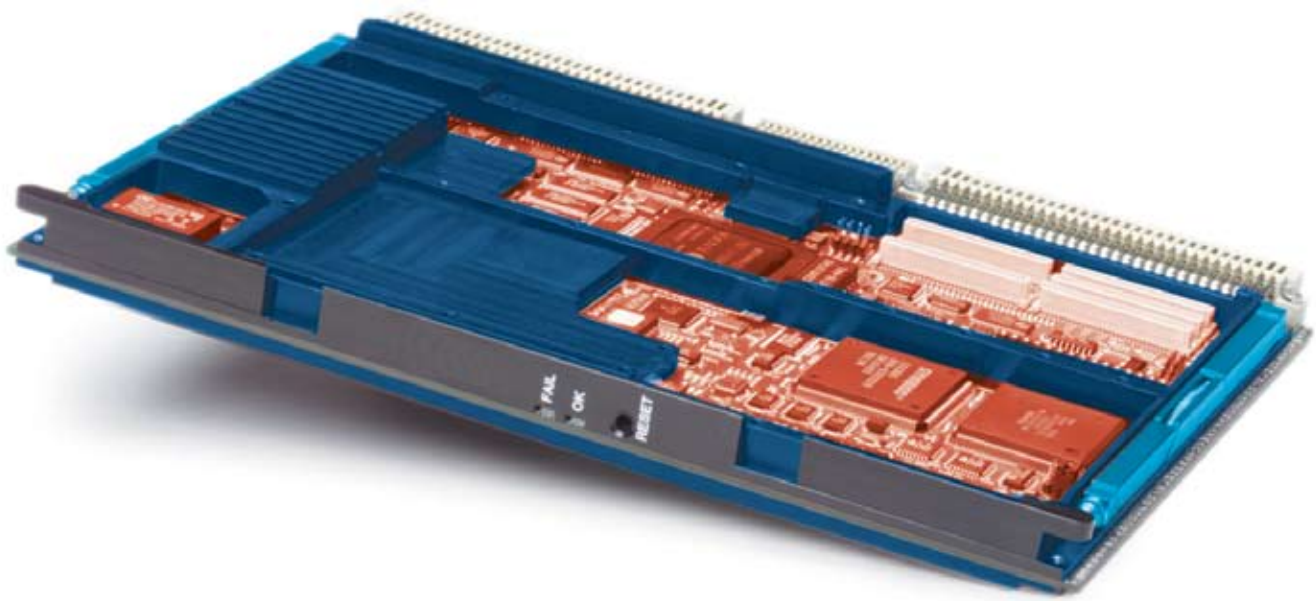

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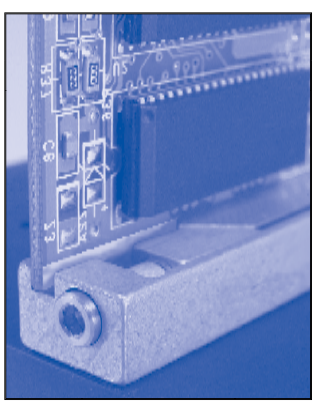

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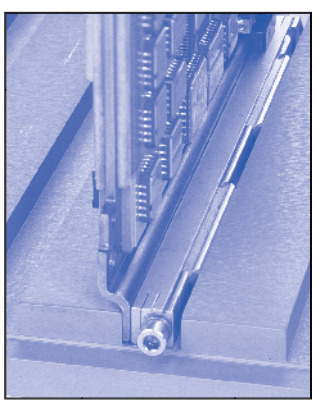

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Realizable Ethernet TCP/IP Performance Using TOE

Technology	Non-TOE	Software-Based TOE	Silicon Stack Ethernet
1G Ethernet	20 MByte/s 250 usec latency	80 MByte/s 300 usec latency	240 MByte/s 15 usec latency
10G Ethernet	20 MByte/s 250 usec latency	150 MByte/s 300 usec latency	2400 MByte/s 5 usec latency

Table 3

Listed here are the performance levels that can reasonably be expected when using the different flavors of TOE technology.

hardware TOE it takes no more host CPU cycles to send 100 Mbytes of TCP/IP data than it does to send a single byte, as every transfer is handled fully by hardware. The use of full hardware TOE brings determinism, latency and performance to levels that are unattainable with any other flavor of TOE solution. Since full-hardware TOE attains such a different level of performance than any previous generation of TOE has achieved, it is generally not referred to as TOE, but simply as Silicon Stack Ethernet.

Table 2 summarizes the specific problems associated with traditional Ethernet that TOE technology is trying to address, and examines just how successful the different types of TOE are at addressing these problems. And Table 3 highlights the performance levels that can reasonably be expected when using the different flavors of TOE technology.

Figure 3 shows a specific example of a multiprocessor embedded system with network requirements that include sensor I/O, interprocessor communications, data recording and instrumentation. This example system uses a common Ethernet fabric to fulfill all of the system's networking and interface needs, providing very high levels of performance, compatibility and interoperability. Because a common high-performance network and common user APIs are used, it becomes very easy to route data anywhere. Systems with rich and standardized connectivity such as this example are significantly more straightforward to develop, to maintain and to scale.

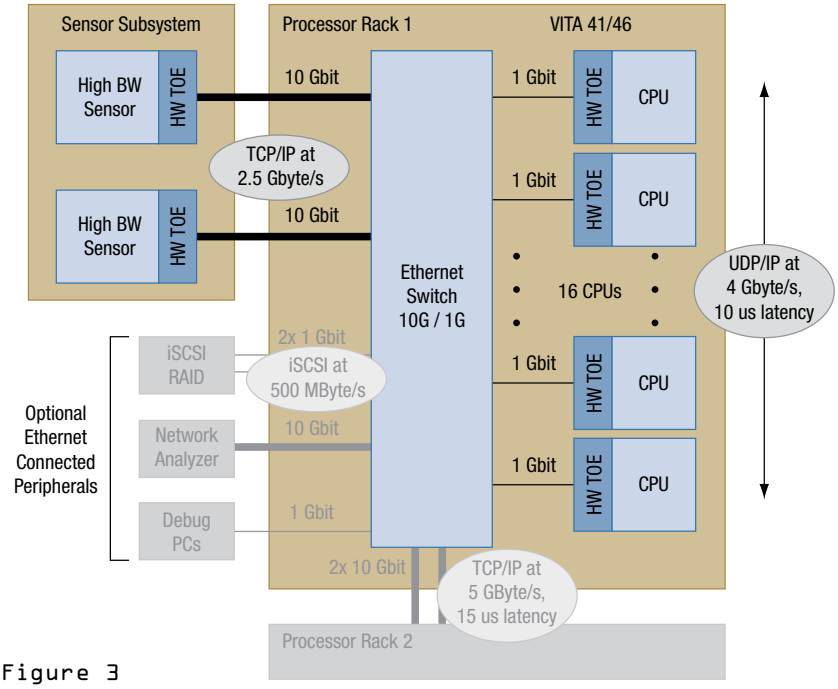

Figure 3

Depicted here are the major blocks of a military embedded system with network requirements that include sensor I/O, interprocessor communications, data recording and instrumentation. This example system uses a common Ethernet fabric to fulfill all of the system's networking and interface needs, providing very high levels of performance, compatibility and interoperability.

Silicon Stack Ethernet

Critical I/O has addressed the 1 Gbit and 10 Gbit Ethernet performance bottleneck with XGE Silicon Stack Ethernet PMCs, which implement full TCP/UDP/IP/RDMA/iSCSI offload in hardware, and thus eliminate all of the disadvantages associated with software-based TOE approaches. Critical I/O's Silicon Stack technology provides very high performance, low CPU loading, very low message latencies and highly deterministic operation. While the Silicon Stack hardware datapath handles all standard networking protocols (such as TCP/UDP/IP), powerful on-chip firmware programmable protocol engines are also available for special-purpose protocols or custom protocol extensions.

There are many advantages in using 1 Gbit and 10 Gbit Ethernet technology in data-intensive military systems. The use of Gigabit Ethernet allows interoperability with a wide variety of standard, low-cost Ethernet hardware and protocols, while the incorporation of effective TOE PMC technology allows ultra-high-performance operation where needed. However, software Ethernet "TOE" PMC implementations are generally not up to the task of providing high-performance operation. They suffer from unpredictable data rates, high latencies and poor determinism, largely due to the reliance on a complex software TCP/IP stack and its time-consuming interactions with traditional Ethernet NIC hardware. Only the specific combination of 1 Gbit or 10 Gbit Ethernet with Silicon Stack technology provides the levels of performance and reliability needed to meet the most demanding networking and interface requirements of data-intensive military systems. Yet it retains all of the compatibility and usability advantages that users have come to expect from Ethernet.

While Ethernet has long been discounted as a high-performance fabric, especially for military applications, the introduction of 10 Gbit Ethernet switches and Silicon Stack technology now makes Ethernet an excellent choice as the standard network fabric for the next generation of high-performance, mission-critical military systems. ■■

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Main Feature

Ethernet in the Battlespace - Part II

Cost, Complexity Drive Ethernet Switching Layer Debate

Choosing between a Layer 2 or Layer 3 Ethernet Switching solution calls for careful consideration of the tradeoffs in the cost and ease-of-use.

Joe McCarthy, System Software Engineer
ACT/Technico

Near-term advances in Ethernet switching technology will enable Ethernet to grab an ever-larger share of defense system data traffic. Rugged 3U and 6U Layer 3 Ethernet switches capable of wirespeed switching in hardware are now becoming available at reasonable costs.

Any applications requiring high speed and large amounts of data transmission, such as air traffic control, surveillance and homeland security, will benefit from using Layer 3 switching. Silicon that performs Layer 3 switching in hardware for both IPv4 and IPv6 of board-level products is just starting to become available. By the end of this year, military system designers will no longer need to worry about the need to shoehorn a commercial router into a rugged military application. The question will be: Layer 2 or Layer 3? The simple answer is that a Layer 3 switch is needed where a router would otherwise be used. For simplicity and lowest cost, an unmanaged Layer 2 switch is truly a plug-and-play solution.

The Bane of Ethernet: Collisions

At its lowest level, Ethernet is very much like the "party line" used in the early days of telephone. With a party line, several customers shared the same wires. When it was time to use the telephone, you picked up the phone and listened to see if the line was in use. If the line was in use, you hung up and tried again later. Sometimes, multiple users would find the line quiet and attempt to use it at the same time. When this happens today on an Ethernet link, it is called a collision.

A primary objective of network design must be to keep collisions to a minimum. The telephone company solved its collision problem by providing each customer with their own set of wires, an excellent technical solution to the problem, just not very efficient. Thousands of miles of copper wire would sit idle at any given time.

In the computing world, things are handled differently. Ethernet switches allow efficient network sharing by effectively reducing the size of the local "collision domain." The collision domain is simply the part of the network where collisions are possible. Network segments connected with cables, hubs and repeaters are in the same collision domain. Network segments connected via bridges, switches and routers are in different collision domains.

Cabling, Repeaters and Hubs

Early 10Base5 networks were connected with a thick coaxial cable sometimes called "Thicknet." Because it was difficult to install, most users migrated to 10Base2 networks using a thinner coax cable (sometimes called "Thinnet") or to 10Base-T using two pairs of copper wires. Most commercial users have abandoned 10Base5 and 10Base2 cabling methods, but because of the long lifecycle of military programs, 10Base2 may still be in use. Today, Gigabit Ethernet is often implemented using four pairs of Category 5 wire or a pair of fiber optical cables. Adding Ethernet to the backplane of a system along with an Ethernet switch can simplify cabling significantly and increase system reliability.

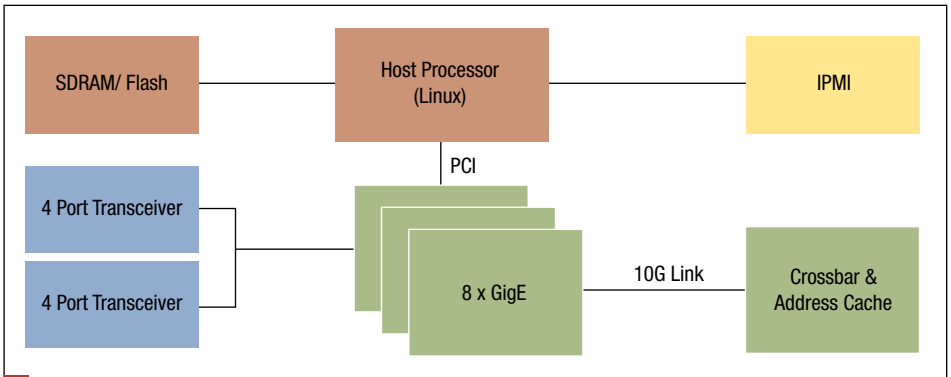

Figure 1

These are the main function blocks that comprise a board-level Ethernet switch.

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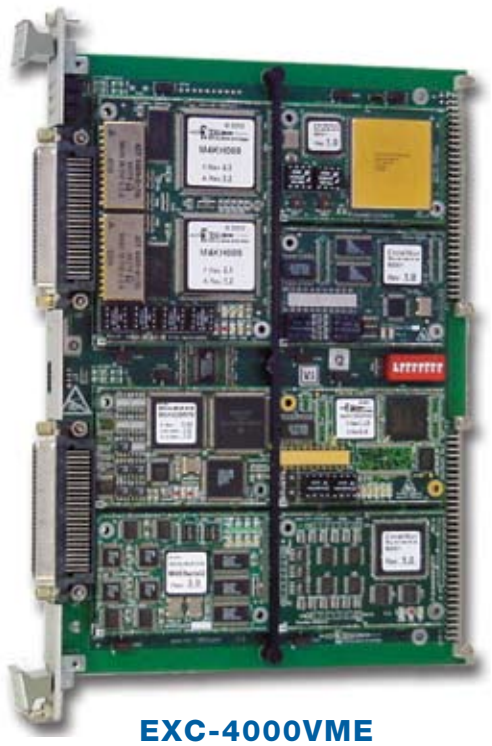
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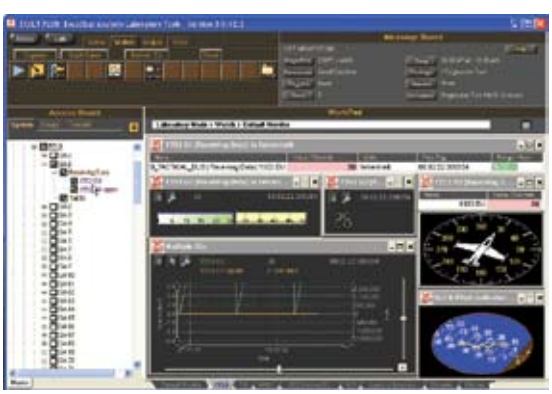
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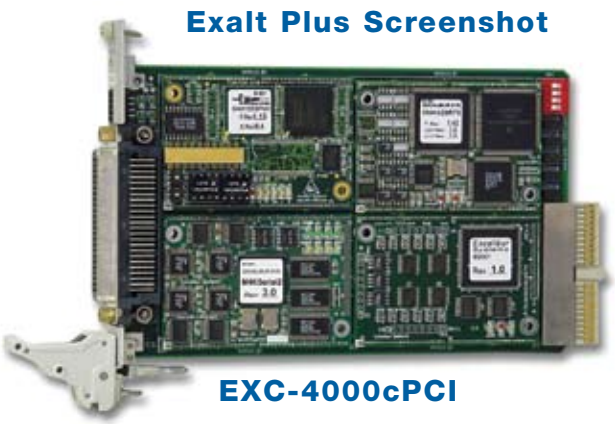
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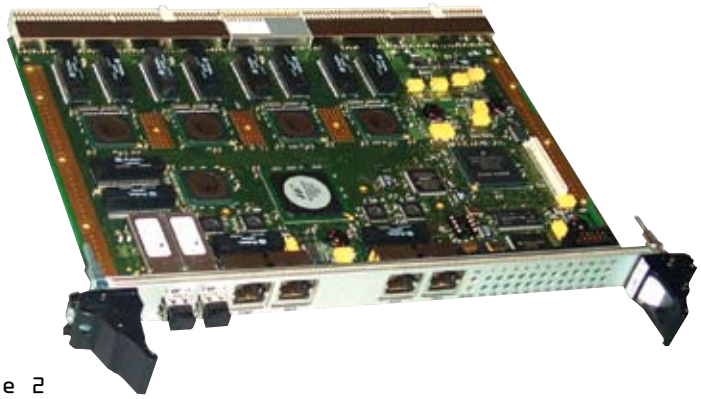

Figure 2

Shown here is an example of an extended temperature, rugged 6U Ethernet switch in the VME form-factors

A repeater regenerates an Ethernet frame, which is then transmitted beyond the natural distance limitations of the media the frame is using. A hub will accept an Ethernet frame in one port and blast the frame out of all the other ports. Both devices have the effect of extending the collision domain of the Ethernet segment on which they are located. It should be obvious that as the size of the collision domain increases, so do the number of collisions. This decreases the amount of network bandwidth available to do useful work.

Switches

A switch is a network element that decreases the size of the collision domain by only sending traffic where it needs to go. Figure 1 provides a simplified block diagram of a board-level Ethernet switch. Different types of switches are available, but they all generally function by "learning" where to send Ethernet traffic. Limiting the distribution of network traffic to a small segment makes more network bandwidth available for everyone else.

Extended temperature and rugged 3U and 6U Ethernet switches in VME and cPCI form-factors are available from multiple vendors. One example is depicted in Figure 2. The majority of switches in current use function on "Layer 2" of the seven-layer Open Systems Interconnect (OSI) network model. Switching is done at near wire speed in hardware based upon the Media Access Control (MAC) address at this level.

Layer 2 Switching

A Layer 2 switch operates by inspecting Ethernet frames as they arrive. The 48-bit destination address, the first field in an Ethernet frame, immediately follows the preamble and start of the frame delimiter. This is a fixed pattern that alerts the receiver to an incoming frame. As soon as the first 48 bits are received, the hardware can start looking up the port address in its local address cache. If the address is found and the destination port is on the same switch port as the frame was received, the frame is simply discarded, as the destination has already seen this frame. If no match is found, the frame must be sent to all ports. When the destination device answers, the switch will store the correct port number for this address in its address cache. Future traffic between these two ports will proceed in a point-to-point manner.

Frames are forwarded between ports using one of two methods: cut-through or store-and-forward. In cut-through mode, a switch starts transmitting a packet to the destination port as soon as the destination port address is determined. In other words, frame retransmission starts before the frame is fully received. This offers the lowest possible latency between ports. When store-and-forward is used the entire frame is received, checked for errors, and then retransmitted. The problem with cut-through switching is that the switch retransmits the frame before it is fully received. If the Ethernet frame is corrupt in some manner, the switch is retransmitting a defective packet.

Layer 3 Switching

Layer 2 switching reduces the size of the collision domain by limiting the flow of network traffic to only the ports that need to see this traffic. But there is another problem a network designer must solve: the size of the "broadcast domain." Most of the traffic on the Ethernet network is point-to-point (unicast) traffic. A small portion of network activity is broadcast traffic intended for multiple destinations.

For instance, a network client might broadcast an address resolution protocol (ARP) request to learn the MAC address of another client on its local subnet. If all of the switches in the network were Layer 2 switches, this broadcast would be seen everywhere. To filter this type of traffic, one needs to look further into the Ethernet frame. This requires looking at information processed in Layer 3, necessitating the use of a Layer 3 switch.

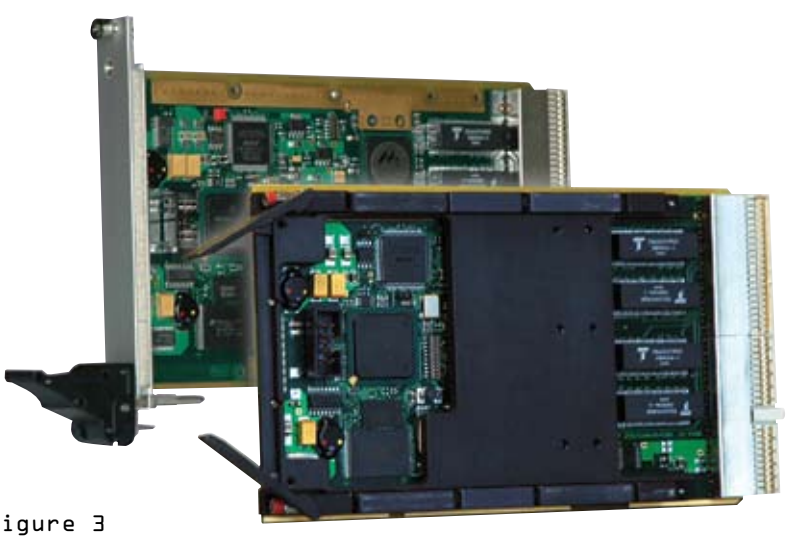

Figure 3

Shown here is extended temperature, rugged 3U Compact PCI Ethernet switch cards.

A Layer 3 switch performs functions similar to the Layer 2 switch using the IP address of the destination instead of the MAC address. If the only thing the Layer 3 switch is doing is switching the packet based upon the IP address instead of the MAC address, then there is no advantage to the Layer 3 switch, as the packet should end up in the same place. The Layer 3 switch offers an advantage by supporting advanced routing protocols and filtering packets based upon the subnet for which the packet is destined. In addition, putting a Layer 3 switch "inside the box" will reduce the hardware footprint of the system, simplify cabling and reduce the total cost of the system.

Routing algorithms used at Layer 2 are much easier to implement into hardware than Layer 3 algorithms. Historically, Layer 3 switches have been provided at the box level by major router vendors. Integrating a commercial router into a military program is difficult at best.

Software Bottlenecks

Until recently, board-level switch vendors used software to handle some or all of the Layer 3 functionality. Using software on a host processor puts a significant bottleneck in the network path. Consider first a Layer 2 switch with 24 Gigabit Ethernet ports. All of the ports can be sending and receiving data concurrently at near wire speed. For a switch operating in cut-through mode, data has started to exit the switch even before the frame is fully received.

If Layer 3 software is introduced into the equation, network traffic must be routed to and from a local host processor. The single link to the processor becomes a congestion point. Even if the local host processor could keep up with this volume of traffic (it can't), the time spent leaving the switch and traveling up and down the network stack will increase network latency and reduce the amount of bandwidth available to the application. Software is a good solution when the primary problem that needs to be addressed is functionality, not performance. When performance is a primary consideration, a solution based upon hardware is always the most desirable.

The Ethernet snowball started down the mountain in about 1980, and has grown in mass and speed to the current point where it is the predominant interconnect technology in the world. Advances in switching hardware are making Layer 3 routing solutions available to the system designer in rugged board level packages. 10 Gigabit Ethernet solutions will start to find their way into many military and aerospace applications in the near future. Ethernet is an excellent solution for future-proofing a design that needs to span many years.

There are excellent reasons to design a system around one's favorite "open standard" or bus, be it InfiniBand, Serial Rapid I/O or PCI Express. Including Ethernet in a design ensures that you will always have some way to interconnect with just about any product that you can still build or buy, when testing is finished and program funding kicks into high gear. ■■

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Tech Recon

Cooling Technologies

Cooling Technologies
Take Aim at Mil Systems

The growing compute density in military systems means more power and heat that must be thermally controlled. New methods are becoming developed to hit those targets.

Ann R. Thryft
Senior Editor

The more that defense engineers can insert the latest off-the-shelf commercial electronic technologies into their designs, the better it is for warfighters using those systems. Military engineers want the fastest processors and communications interfaces, the biggest FPGAs and the densest memory chips. But the high temperatures and constraints on size and weight of many defense applications make it tough to keep these components cool enough to perform within their specified operating temperature ranges and maintain reliability.

At the same time, each new device generation tends to burn more power and produce more heat than before, and ruggedization efforts are becoming more expensive. The amount of work it takes to engineer a system's thermal design is increasing. Advanced signal processing and graphics-intensive subsystems are especially notorious for consuming lots of power.

Other factors affecting these trends include new VITA specifications such as VPX (VITA 46), which provides for higher power consumption levels and higher voltages, and VITA 48 (REDI), which calls for a 1-in. pitch that allows more and bigger chips on the board. The result is that power dissipation of a typical 6U module is expected to nearly double in the next four years and to nearly quadruple by 2010.

Traditional cooling methods in military system designs have included forced-air cooling and conduction cooling techniques. But these may be nearing their useful limits as military engineers begin designing in next-generation chips. Several different approaches are being examined as successor technologies. Some of these are addressed by VITA 48, which provides for multiple cooling methods: convection, conduction and liquid.

These new techniques include evaporative, or "phase-change," cooling, sometimes called spray cooling, and liquid flow-through (LFT) cooling. A closed-loop evaporative cooling system

Figure 1

Several different new cooling techniques are being used for thermal management in military systems. Evaporative cooling methods are cooling the radar electronics on the Phalanx Close-In Weapons System (CIWS), a fast-reaction, rapid-fire 20-millimeter gun system that detects, tracks and engages anti-air warfare threats such as anti-ship missiles and aircraft. Shown here on the Nimitz-class aircraft carrier USS John C. Stennis (CVN 74) off the coast of Southern California, the CIWS provides U.S. Navy ships with a terminal defense against anti-ship missiles and littoral warfare threats that have penetrated other fleet defenses. Photo by Photographer's Mate 3rd Class Phillip Morrill, courtesy of U.S. Navy.

Some programs will retain forced-air cooling methods because they are simpler, tend to cost less and have a relatively minimal impact on the platform.

sprays a fine mist of non-conductive liquid onto the hot spots of the electronics, dissipating heat when the mist evaporates. The resulting vapor circulates through a heat exchanger and condenses into liquid, which is used again at the beginning of a new cycle. This technology has been used in land and sea defense applications (Figure 1).

LFT is targeted especially for applications where liquid is already available. It depends on microchannels to provide more surface area that can dissipate more heat, as well as LFT coldplates that weigh less than conduction coldplates. This newer technology is at the prototype stage and has not yet been used in deployed systems.

Some programs will retain forced-air cooling methods because they are simpler, tend to cost less and have a relatively minimal impact on the platform. One new approach engineers the flow of air to make it work more efficiently. Called Finely Managed Air cooling, this method has already been deployed in UAVs, wide-body aircraft and surface ships for the past two years. It directs air cooling to each critical component based on its specific cooling requirements. ▮▮

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Tech Recon

Cooling Technologies

Finely Managed Air Cools High-Performance Mil Systems

Compared to more traditional air-cooling implementations, Finely Managed Air techniques provide increased thermal capabilities and performance density for defense systems.

Michael Gust, Manager, Mechanical Systems Analysis
Thomas Roberts, Product Marketing Manager
Mercury Computer Systems, Inc.

The trend of escalating power consumption of both processors and infrastructure chips presents an increasing challenge for deploying high-performance processor systems in military environments. Most programs prefer to retain forced air as the cooling method, but the challenge is to make the air work more efficiently.

The Finely Managed Air cooling approach creates an effective cooling infrastructure for defense systems with increased thermal capabilities and performance density. It has been in production use for approximately two years, and has been selected for use on multiple deployed military programs including unmanned aerial vehicles (UAVs), wide-body aircraft and surface ships.

High Performance: The Driving Force

The driving force behind the development of Finely Managed Air cooling was the need of high-end embedded applications to leverage the highest performing processing elements—e.g., the fastest clock-rate processors or the largest FPGAs—within the space and environmental constraints of a deployed platform. Working against this need is the accompanying greater amount of heat.

The ability to effectively dissipate this additional heat is hindered by shrinking silicon die area. Even if a processor consumes less power after a die shrink, heat energy is concentrated in a smaller area and therefore harder to remove. As a result, these smaller chips may actually operate at or near their maximum junction temperatures. In such situations, the primary thermal parameter of interest shifts from total heat dissipation to heat flux.

In space-constrained situations, cooling can be addressed with liquid flow-though or spray-cooling technology. But these approaches involve subsystems of pumps, nozzles and heat exchangers. For many defense programs, forced air remains the preferred cooling method because of its lower cost, greater simplicity, potential for lower overall system weight and minimal impact on the platform. The challenge thus becomes making the air work more efficiently. The basic premise of Finely Managed Air is to address the heat flux problem by ensuring that the proper amount of air cooling is directed to each critical component based on its specific cooling requirements.

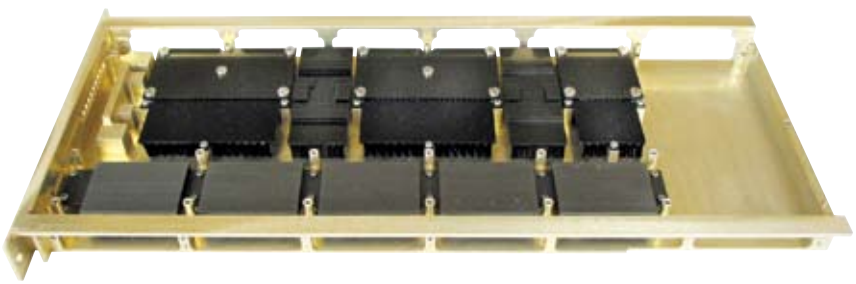

Figure 1

Heat sinks mounted to a PCB cover.

Finely Managed Air Design Techniques

Finely Managed Air design techniques begin with a new approach to heat sinks. When size and weight are not major constraints, a heat sink can be many times the area of the processor and several inches thick. Often, a fan is mounted directly on the heat sink to ensure that the processor gets sufficient air.

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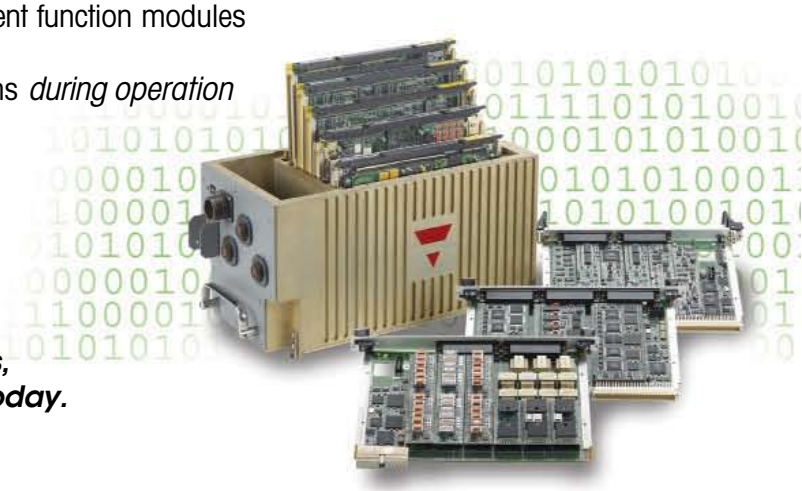

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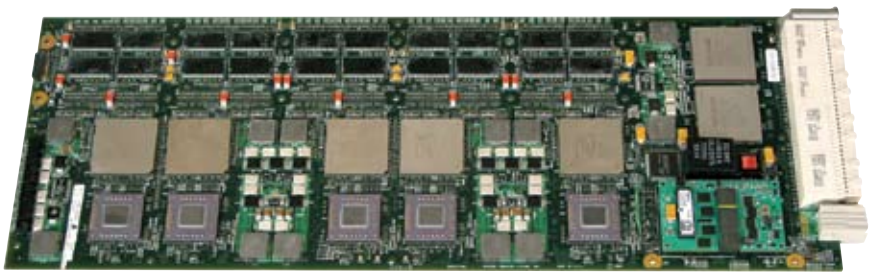

Figure 2

Module with hotter components on leading edge of airflow.

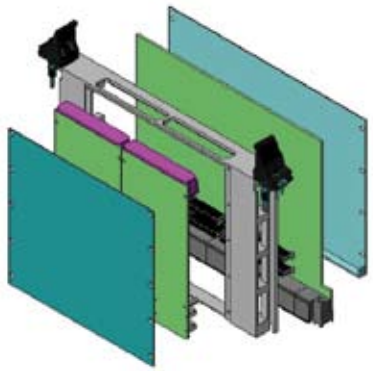

Figure 3

Air-cooled REDI module.

But for size-constrained defense electronics, even placing heat sinks on a large percentage of the board's components is impractical. The heat sink's mounting hardware consumes area on the PCB and its through-holes can complicate routing in critical areas. This forces a tradeoff between cooling effectiveness and the system's performance density.

Finely Managed Air cooling eliminates this tradeoff by mounting heat sinks on a cover that encloses the board, rather than the board itself (Figure 1). The number of mounting points for the cover is much lower than the number of mounting points for all of the heat sinks, thus minimizing the impact of the through-board mounting on signal routing and component layout.

The cover-mounted heat sinks can be either hard-mounted to the cover or spring-mounted/loaded. A thin thermal interface material (TIM) layer fills the gap between component and heat sink. For spring-mounted/loaded heat sinks over critical components, this TIM layer can be held to a maximum thickness of 0.005 in, thus keeping the temperature drop across this interface to a minimum. For hard-mounted heat sinks over less-critical components, a thicker TIM layer is used to accommodate mechanical tolerances.

Finely Managed Air cooling also carefully controls where cooling air goes. In a common air-cooled system airflow follows the path of least resistance, bypassing parts of the system with the highest impedance—such as dense fins over hot components—in favor of areas with lower impedance. In a Finely Managed Air system, each board has a cover tailored to the profile, placement, characteristic impedance and airflow requirements of its components. The cover controls bypass airflow by shaping flow paths that direct cooling air to critical areas. Controlling airflow patterns over the board ensures that all components receive their required amount of cooling air.

Another set of techniques addresses a critical consideration for deployed systems: providing an upgrade path for modules without requiring chassis-level changes. The challenge is that new modules, with new processing components, typically generate more heat. It is still necessary to provide the proper amount of airflow to the new modules.

A two-step design approach addresses this issue. First, airflow through the chassis is initially balanced on a slot-to-slot basis. This is done by adjusting flow at the card cage level to ensure that each of the slots is similar from an air-cooling perspective. The card cage is constructed to ensure that each slot has the same airflow and pressure drop characteristics.

Second, flow impedance of the individual modules is controlled by air me-

tering plates added to the module frame at the air inlet and/or the air exit. These plates travel with the module so they can be moved to any slot and provide the same thermal performance. Assuming that the system chassis has sufficient airflow and pressure drop, lower-power dissipating modules have air metering plates installed, creating an artificially high pressure drop. Modules with higher levels of power dissipation are outfitted with metering plates that give them lower impedance. This ensures that each module will receive its required allocation of cooling air. Upgrades can be accomplished without impacting the installed system and without affecting existing modules.

Further techniques can enhance the effectiveness of Finely Managed Air cooling. High-power dissipating and/or thermally critical components can be located on the edge of the board where cooling air enters. In a chassis, where the air flows vertically across the board, a long (deep) board that is not very tall provides the maximum thermal dissipation for a system by combining this longer leading edge with a lower-flow resistance due to the board's lower height (Figure 2).

To maintain high processor density in a given vertical space, two boards can be stacked vertically with an air intake in the middle. This arrangement achieves two leading edges of inlet air, enabling high density without resorting to "columns" of the hot components—such as processors—heating one another.

Finely Managed Air in Use

Mercury's PowerStream 7000 system demonstrates the practical effectiveness of Finely Managed Air techniques, including the concept of using a board cover to manage and direct airflow. This system delivers high-performance, high-density computing to multiple deployed programs. With more than 100 PowerPC processors, a standard version provides 1 TFLOP of processing power in a chassis roughly the size of a college dorm room refrigerator. It is designed to operate with an inlet air temperature of 55°C at altitudes of up to 10,000 feet. Processing boards each support five PowerPCs and draw between 100-120W.

Next-generation systems will support FPGAs, with even greater cooling challenges. Other future versions of this system will include boards that support the Cell Broadband Engine (BE) processor, a multicore chip comprising a 64-bit Power Architecture processor core and eight synergistic processor cores.

The field-proven concepts and techniques of Finely Managed Air have influenced the air-cooled component of the VITA 48 draft standard for Ruggedized Enhanced Design Implementation (REDI). This standard includes a definition of board covers, plenums and mechanical mating of mechanisms for Finely Managed Airflow (Figure 3). ■■

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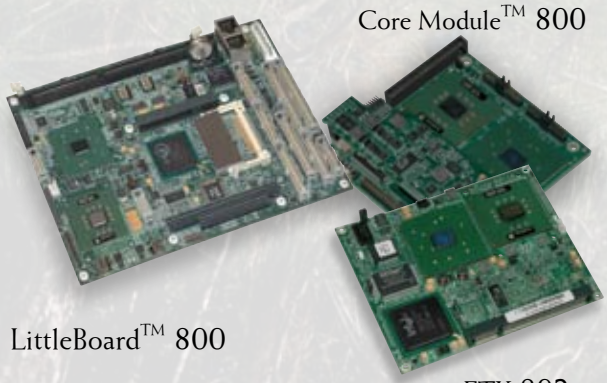

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Cooling Technologies

Cooling Technology Enables Leading-Edge Commercial Platforms in Mil Systems

Evaporative cooling solutions are taking on the highest heat loads in the worst environments, enabling insertion of the latest commercial technology into military systems.

Jay Parker, Vice President of Business Development, ISR

Over the last few years a new cooling technology has taken exceptional strides toward enabling the use of commercial off-the-shelf equipment in military systems.

Until recently, most processors used in systems designed for the military did not generate enough heat to require cooling systems, aside from a fan and heat sink. Today, however, traditional cooling methods are hitting a thermal wall as processor speeds increase, creating more heat. Additionally, ruggedization efforts have become more expensive, resulting in solutions that lag farther and farther behind current technology. A new approach to cooling is being taken by designers of military systems that will allow them to utilize the latest commercial technologies, offering the most advanced systems to the warfighter. Evaporative cooling, or "phase-change" cooling, is on the leading edge of filling that need.

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The Benefits of Evaporative Cooling

Traditionally, large heat sinks and fans were the main avenue for cooling heat-intensive areas of electronics, such as processors, video cards and power supplies. Due to the weight of the heat sinks attached to these components—sometimes up to 2 lbs.—a costly and time-delaying process of board "ruggedizing" has been employed so that these boards can survive the effects of the shock and vibration to which they are subjected. However, the use of evaporative cooling allows commercial equipment to bypass this ruggedization process. Instead, the latest technology can be inserted directly into the system.

Evaporative cooling uses a fine mist of non-conductive liquid, which is sprayed

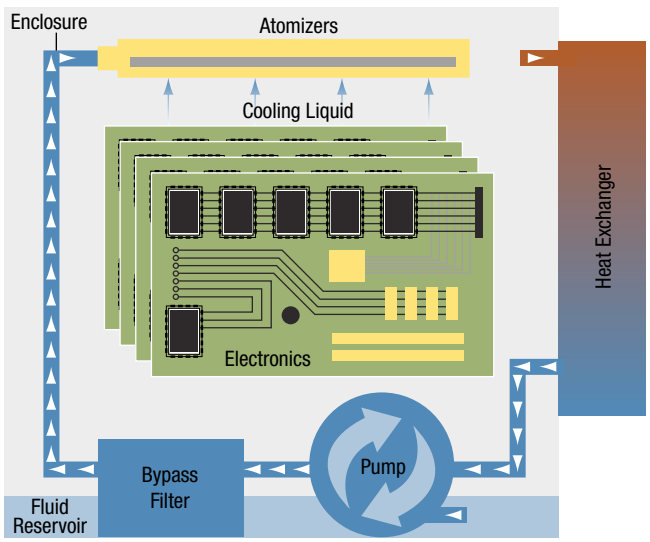

Figure 1

In ISR's SprayCool evaporative cooling system, a non-conductive and non-corrosive coolant is sprayed directly onto electronics to provide cooling. It vaporizes, and heat is rejected to the enclosure and/or through a heat exchanger, condensing the vapor back into a liquid, which is then reused in the next cycle.

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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	1000	1000	650	650	650	650	650	650	333	333	333	100	100
	L2 Cache	2MB	2MB	512k	512k	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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Fail Safe Boot ROM					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	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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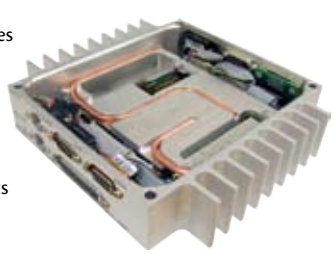

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Bus	AT Expansion Bus	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PCI Expansion Bus Master	✓	✓				✓							✓
	McBSP Serial Ports	✓	✓				✓							
Analog Input	Single-Ended Inputs	16	16	16	16	16	16							
	Differential Inputs	8	8		8	8	8							
	Max Throughput (kHz)	1250	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
	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
	Opto-Isolated Inputs										16	48	16	
	Opto-Isolated Outputs										16	16		
	User Timer/Counters	3	3	3	2	3	3	3	3	3				10
	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						
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Figure 2
A SprayCool 20-slot enclosure.

onto the electronics' hot spots, where it evaporates, taking the heat with it. This process operates in a manner similar to the way that perspiration cools the human body. The vapor that results is circulated through a heat exchanger and condensed back into a liquid to be sprayed again at the beginning of a new cycle, in a closed-loop system (Figure 1).

Placing the electronics in this thermally controlled operating environment reduces heat-related failures, reduces thermal cycling and allows a much larger heat load to be cooled. This process is extremely efficient, in fact, hundreds of times more efficient than air cooling. This means that not only can higher heat loads be cooled where conduction cooling fails, but less energy is required to cool the system. Therefore, as processors continue to become more powerful, and at the same time create more heat, evaporative cooling technology is increasing the available thermal headroom, which will enable processors currently being developed to be cooled.

While evaporative cooling technology focuses on thermal control, there are many other benefits that come to the forefront when this solution is used. Without the need for large heat sinks and air channels, electronic density increases while size and weight are decreased. As a result, the amount of electronics processing can be increased by a factor of three while retaining the same footprint. Without the need for heat sinks and air channels, electronic devices can be packaged more closely together.

Another benefit is that the electronics are in a completely sealed system, which protects them from environmental factors such as sand, dirt or moisture. In many situations, as with systems deployed currently in Iraq, excess heat is compounded by plugged filters and boards covered with the talcum-like sand that severely reduces cooling and operational capabilities. Sealing these systems reduces environmental concerns because the electronics are not in contact with the outside environment.

Unlike heat sinks and fans, which reject heat at the source, evaporative cooling can reject heat away from the source.

Because the vapor can be transported, the heat can be rejected at distance from its place of origin. This means that the heat does not get pushed into the surrounding area, whether inside of a tank or inside of a data center. Instead, the heat can be rejected outside of the vehicle or building, reducing the temperature around the electronics and lowering the noise levels of the fans.

The Future of Evaporative Cooling

The future of evaporative cooling technology in military applications is promising. Systems are being deployed in land, sea, aerospace and government computing applications.

One company developing and deploying this technology is ISR. Its evaporative cooling technology and products, called SprayCool, have been developed in close coordination with the military and prime system integrators (Figure 2). The first implementation of this technology in a military environment was in the Marine Corps' Advanced Amphibious Assault Vehicle (AAAV).

Since then, just as the AAAV has been transformed into the Expeditionary Fighting Vehicle (EFV), the electronics in its evaporative cooling system have gone through three board upgrades and extensive testing. As a result of the technology's versatility and the associated savings resulting from its use, the Department of Defense issued a Value Engineering Award to ISR. This award estimates that the company's evaporative cooling products will save the DoD $300 million over the life of the EFV program.

These evaporative cooling products are also enabling the use of commercial equipment in other programs, such as cooling the radar electronics on the Phalanx Close-In Weapons System (CIWS). This is a fast-reaction, rapid-fire 20-millimeter gun system that provides U.S. Navy ships with a terminal defense against anti-ship missiles that have penetrated other fleet defenses.

Another example is in the work of Northrop Grumman and the Air Force on the Global Hawk Unmanned Aerial Vehicle (UAV). Here, SprayCool evaporative cooling products are performing in extreme environments from -65° to 70°C at an altitude of 70,000 feet for extended periods of time. They are also being designed into additional military programs where heat, environmental issues, noise and other factors are creating barriers to utilizing the latest commercial technology.

Evaporative cooling solutions are taking on the highest heat loads in the worst environments, while at the same time allowing the insertion of leading-edge commercial technology into military systems. Utilizing this technology will make the latest electronic systems available to the forward-deployed warfighter. ■■

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Tech Recon

Cooling Technologies

Liquid Flow-Through Coldplate Passes Muster

Keeping electronics cool is a big challenge in the military/aerospace environment of high temperatures and volume/weight constraints. Liquid flow-through cooling promises to do the job for at least the next decade.

Michael Benjamin, Technology Team Leader,
Advanced Cooling Systems
Parker Hannifin
Ivan Straznicky, Senior Staff Mechanical Engineer
Curtiss-Wright Controls Embedded Computing

As thermal trends in electronics point to increasing heat densities and heat loads, the importance of cooling grows. The difficulty of keeping devices such as processors below maximum operating temperatures is greatly exacerbated in military/aerospace applications, where high temperatures and volume and weight constraints work against cooling.

With air-cooling and conduction-cooling methods nearing practical limits, liquid flow-through (LFT) cooling is being closely examined as a natural successor, particularly in applications where liquid is already available.

Meeting the Cooling Challenge

To date, air cooling and conduction cooling at the card level have served military/aerospace applications well. Thanks to innovations that continue to push out cooling limits, such as embedded heat pipes and processor shunts, these approaches will continue to meet cooling needs for many products.

However, substantially more effort is required to thermally design today's products than even two to three years ago, and that effort is expected to continue rising. In addition, newer and higher-power products will challenge the ability of conduction and air-based convection to keep device temperatures below maximum limits. This is especially the case with commonly specified boundary conditions, such as the 85°C card edge temperature and the 70°C inlet air temperature. For these and future generations of products, LFT cooling is being examined as a potential successor to conduction and air cooling.

LFT Cooling

Single-phase LFT cooling is a relatively straightforward cooling approach

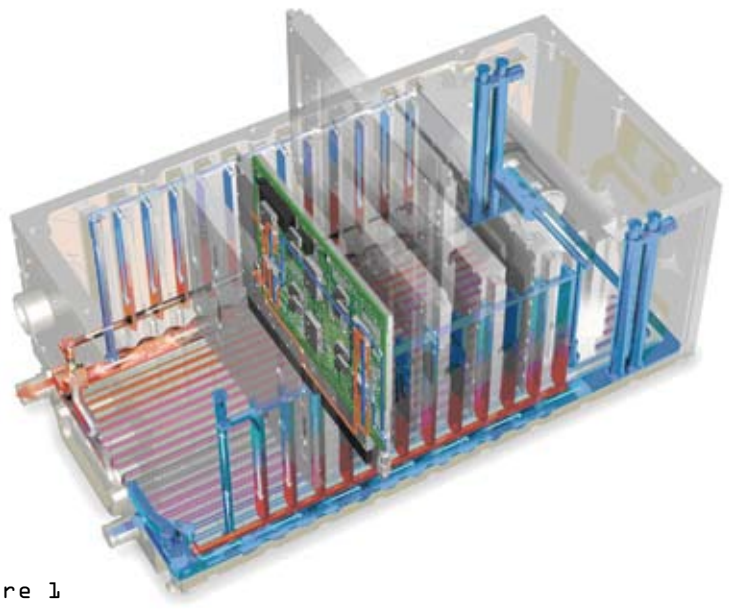

Figure 1

Example LFT system. Circuit cards with LFT coldplates are housed in a chassis supplying liquid coolant via a manifold fed by a pump module. Courtesy Parker Hannifin.

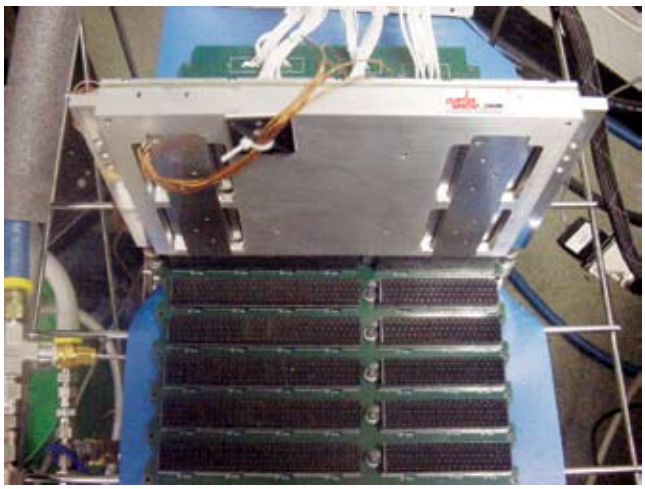

Figure 2

LFT coldplate test setup for flow and thermal testing, performed to validate the analysis results.

using liquid convection to remove and transfer heat. In an example system, circuit cards with LFT coldplates are housed in a chassis that supplies liquid coolant via a manifold fed by a pump module (Figure 1). Heat is removed by the coldplate and the warm liquid is moved to the return manifold. The warm liquid can then either be routed to a heat exchanger integral to the chassis, or to a remote heat exchanger.

Efficient cooling performance of such a system is dictated largely by where heat transfer takes place, namely the coldplates and the liquid-air or liquid-liquid heat exchanger. Other system configurations are possible. For example, the pump module can be external to the chassis.

LFT Coldplate Design

Modern coldplate designs resemble conduction coldplates, but add quick disconnect (QD) liquid connectors for coolant inlet and outlet. The VITA 48 (VPX-REDI) working group is currently developing a sub-standard, VITA 48.3, for liquid-cooled modules. It specifies envelope dimensions and other basic requirements for LFT modules, including QD location. The coldplate's internal design is left open for innovation and maximizing cooling performance. The standard calls for a minimum of 400W and a target of 600W on a 6U card.

Parker Hannifin and Curtiss-Wright Controls Embedded Computing designed and fabricated an LFT coldplate within a 6U VPX-REDI (VITA 48) format to meet or exceed the 600W target.

Early VITA 48 coldplate design performance, which achieved cooling up to 400W on a 6U card, indicated that changes were required, such as the use of microchannels to cool high-power areas of the card. Microchannels are fluid channels with dimensions between tens of microns and hundreds of microns. They improve heat transfer considerably without associated increases in flow rate or pressure drop.

Using microchannels, an LFT module was designed to represent very high-power, multiprocessor card designs. To demonstrate even higher power density, the 0.85-in. pitch standardized in VITA 48 was used.

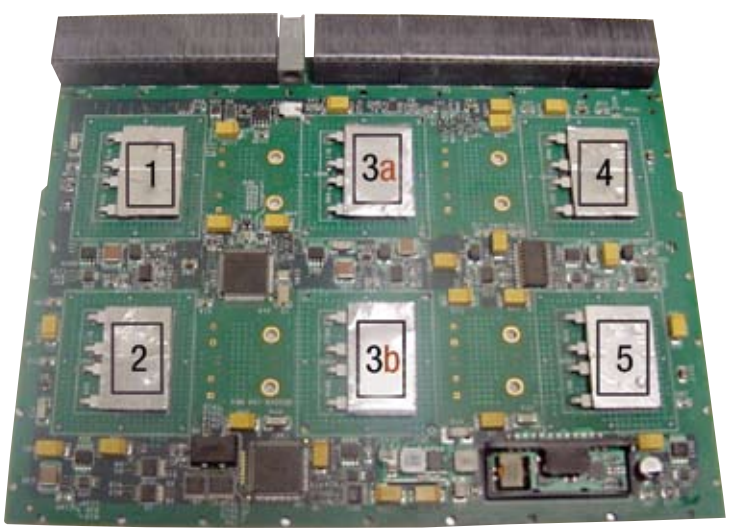

Figure 3

Heat load card for LFT coldplate thermal testing, showing six heat load locations.

Fluid Flow and Thermal Analyses

Quantifying the LFT coldplate's capabilities started with fluid flow analyses. A flow resistance network was created to simulate the coldplate and various flow rates were modeled. The results showed pressure drops across the coldplate, without QDs, for various flow rates and coolant temperatures. The coolant used for this analysis was polyalphaolefin (PAO).

At a temperature of 21°C and a flow rate of 2.4 lbs./minute—derived from the VITA 47 requirement of 4.0 lbs./minute/kW and a 600W power dissipation—the pressure drop is 12.3 psi. Adding the QDs' pressure drop to this data point results in a total module pressure drop of 18.3 psi, which is higher than the 15 psi currently specified in ANSI/VITA 47-2005. However, 2.4 lbs./minute is not required to cool 600W or more when the coolant inlet is 21°C, as will be seen below. A much lower flow rate could be used, resulting in a much lower pressure drop. A proposal has been submitted for VITA 47, currently under review, to allow a higher pressure drop of 20 psi at 21°C, in order to account for the flow rate dependence on inlet temperature.

Thermal analyses of the LFT coldplate were performed using computational fluid dynamics (CFD) software. The maximum

coldplate temperature in one microchannel area was 84.1°C for a power dissipation of 150W, and a PAO flow rate of 0.6 lb./minute at 55°C inlet. Including the other thermal resistances between the coldplate and the heat generation area, the junction temperature was below 100°C. This means that four such heat loads, totaling 600W, could be cooled at a 2.4 lbs./minute flow rate of PAO at 55°C inlet.

Flow and Thermal Test Results

Flow and thermal testing were performed to validate the analysis results (Figure 2).

The pressure drops for various flow rates and two temperatures, 21°C and 40°C, were measured. At 2.4 lbs./minute and 21°C, the pressure drop of the coldplate, including QDs, is 16.3 psid, lower than predicted in the analysis above and closer to the current ANSI/VITA 47-2005 requirement. This disparity appears to result from the analysis' assumption of hydrodynamically fully developed fluid flow, whereas the channel lengths in the coldplate probably do not result in fully developed flow.

Thermal testing was performed using a 6U by 160 mm load board representing a very high-power, multiprocessor circuit card (Figure 3). The four heat loads located near the corners of the board were used to represent very high-power processors (100 to 150W each), and the remaining two heat loads represented lower power components (25 to 50W each).

Power dissipation values were calculated from measured heat load resistances and currents. Due to differences in the heat load resistances, the high-power loads were not equal. However, a comparison between thermal test results and analysis results can be made by using the 155W location. The maximum coldplate temperature of 87.3°C is slightly higher than the analysis maximum of 84.1°C. However, the test power was higher (155W vs. 150W) and the test flow rate was slightly lower, at 2.4 lbs./minute for four high-power areas, plus one lower power area. Therefore, there is good agreement.

It can be seen that, using LFT coldplates, very high-power dissipation can be cooled both locally—such as processors—and globally, i.e., a 6U card. Furthermore, excessive flow rates and pressure drops are not required, enabling a reduction in size, weight and power requirements of LFT system components such as pumps. These and other benefits of LFT cooling make it a prime contender to supplement and extend traditional conduction and air cooling for higher-power cards. ■■

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Bus and Fabric Analyzers Smooth Transition to New Interconnects

As military system developers migrate to serial interconnect schemes, bus analyzer vendors are keeping pace with a rich set of protocol analyzer solutions.

Jeff Child
Editor-in-Chief

As the U.S. Military transitions itself into a Net-Centric organization, up goes the demand for faster, wider and deeper avenues for moving data. Whether it's analog sensor processed and moved to digital information for analysis and display, or vast volumes of situational awareness data processed and distributed, or video data captured and moved to storage arrays, the critical enablers are buses, serial interconnects (fabrics) and networks. Bus and protocol analyzers play a key role in the development of these next-generation systems. And as the military migrates (slowly but surely) away from traditional parallel buses—like VME and PCI—toward serial switched fabric and networked solutions, analyzer vendors are keeping pace with a new crop of analyzer systems for each of the new interface schemes.

Analyzer tools for serial interconnects such as Serial RapidIO, PCI Express and Serial FPDP have been rolling out over the past couple years, some in their third or fourth generation. Meanwhile, other analyzer tools such as real-time spectrum analyzers and network protocol analyzers continue to advance to new levels of capability.

Figure 1

The PETracer Gen2 Summit x16 analyzer from LeCroy captures and analyzes second-generation PCI Express bus traffic at data rates up to 5 Gbits/s per lane. LeCroy has designed the PETracer Gen2 Summit with real-time monitoring tools to analyze response and latency of transactions, data throughput, and link utilization.

More Complex than Parallel Analyzers

Providing analyzer solutions for the new generation of serial fabric schemes raises new complications that weren't an issue in traditional parallel bus analyzers. With parallel buses—like PCI, PCI-X and VME—all of the protocol signals associated with data transfer are simultaneously presented and act in parallel. Developers could see bus signals and interpret bus conditions by simply capturing and viewing the raw signals with relatively simple development tools. In contrast, serial bus topologies present new challenges in the test and debug phases of device development. Serial bus protocols require additional headers and footers, such as CRC, to ensure data transfers are secure and error-free. These extra bits are included in the data packets and require additional interpretation, further increasing the complexity of validation and the test process.

For its part, LeCroy introduced last month its fourth-generation protocol analyzer for PCI Express. Called the PETracer Gen2 Summit x16 (Figure 1), the system captures and analyzes second-generation PCI Express bus traffic at data rates up to 5 Gbits/s per lane. Unlike other analyzers, the PETracer Gen2 Summit records and displays all traffic, even at high lane widths and high data rates. The tool provides users with much more useful results because the system displays added views and greater analysis tools within the trace display. LeCroy has designed the PETracer Gen2 Summit with real-time monitoring tools to an-

alyze response and latency of transactions, data throughput and link utilization.

The analyzer supports spread spectrum clocked (SSC) traffic, lane swizzling for flexibility in board configurations, and multi-link operations where PCI Express ports are bifurcated into narrower links. Also featured is auto link sensing for links of varying width. The Raw Mode Recording is another newly developed capability, which records bytes just as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a decoded protocol analyzer display.

Meanwhile, Agilent Technologies recently announced an advanced graphical user interface (GUI) for its E2960A family of serial protocol tester tools. Agilent's E2960A protocol analyzer also now supports PCI Express x16 bus width, providing customers in computing and communications with a complete suite of protocol-analysis tools for any lane width from x1 through x16.

The GUI's easy-flow function creates a viewing environment that allows users to arrange and view the data in a way that matches their needs. This new interface also provides easy-search and easy-filter features that allow users to find similar fields or frames with a single mouse click. These capabilities dramatically improve the ease of navigation and interaction with the analyzer's powerful triggering functionality.

Figure 2

An example of a form-factor-specific analyzer product is VMETRO's Vanguard Express PCI Express Protocol and Link Analyzer for the AdvancedMC (AMC). Designed for debugging, testing and validating the PCI Express protocol, the Vanguard Express AdvancedMC allows testing of AMC.1 type 1, 2, 4 and 8 modules.

PCI Express Invades Embedded Realm

More than any other switch fabric, PCI Express has infiltrated nearly every category of standard embedded computing form-factors. Supporting that trend, form-factor-specific PCI Express Analyzers have started to emerge. An example is VMETRO's Vanguard Express PCI Express Protocol and Link Analyzer for the AdvancedMC (AMC) form-factor (Figure 2). AMC is expected to gain inroads into the military realm, particularly if the associated MicroTCA form-factor comes together as planned.

Designed for debugging, testing and validating the PCI Express protocol, the Vanguard Express AdvancedMC allows testing of AMC.1 type 1, 2, 4 and 8 modules. The Vanguard Express AdvancedMC is a self-contained unit that installs between the device under test and the host system, and allows testing with minimal intrusion to the system under test. The Vanguard Express AdvancedMC is operated via USB or Ethernet while using VMETRO's BusView 5 Graphical User Interface software. A single workstation can control multiple Vanguard analyzers for monitoring different protocols and form-factors including PCI Express, PCI-X/PCI, PMC, CompactPCI or VME.

Real Time Performance Analysis is also included with the Vanguard Express AMC Analyzer. The Vanguard Express statistics engine offers concurrent real-time measurements including Event Counting, Link Utilization, PLP Distribution, TLP Distribution, DLLP Distribution, Payload Length Distribution and Transfer Rate. In addition, post processing statistics are generated on any acquired trace data using the Trace Count feature, which calculates performance information based on trace samples of interest.

Serial RapidIO Solution

While not enjoying quite the widespread adoption of PCI Express, the Serial RapidIO fabric holds a solid following, particularly among system designers that gravitate to Freescale processor-based computing, like the PowerPC. Earlier this year, Future-Plus Systems introduced the FS4410, a Serial RapidIO (SRIO) protocol analysis probe for use with Agilent Technologies logic analyzers. It will be used by designers involved in development of computers and peripherals incorporating the SRIO architecture. The FS4410 allows non-intrusive probing of SRIO buses at a data rate of 3.125 Gbits/s.

The FS4410 connects to the system under test with a full-size or half-size mid-bus probe to monitor bus traffic in real time. A flying-lead probe is also offered for applications requiring maximum passive-probing flexibility. The FS4410 features 8b/10b data acquisition at 3.125, 2.5 or 1.25 Gbits/s. It supports x1 lane and x4 lane modes, and debug of physical, transport and logical layers (messaging, I/O and streaming). An optional modification adds user-selectable PCI Express analysis capability. A USB port provides probe control from a PC.

Serial FPDP

Another parallel to serial transition is happening in the popular Front Panel Data

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Port (FPDP). Gaining ANSI approval in 2003, Serial FPDP—or ANSI/VITA 17.1-2003—supports 1 Gbit/s, 2 Gbit/s and 2.5 Gbit/s link speeds. Serial FPDP continues to gain popularity as a general-purpose link for applications where low latency and high throughput are desirable. The protocol has won acceptance in numerous military radar, sonar and imaging applications. Serial FPDP (ANSI/VITA 17.1-2003) addresses the distance limitations of FPDP, replacing the parallel connection with a serial interface based on the Fibre Channel physical layer.

Offering a Serial FPDP analyzer solution is Absolute Analysis with its Axiom Series. At the heart of the Axiom Series is the advanced Protocol Analyzer Engine with speeds up to 4.0 Gbits/s, which is combined with the company's Investigator software applications. The tool does full line-rate capture of Serial FPDP traffic. Data is displayed in Frame, word, 10b, 8b, and K/D views. The analyzer provides real-time statistics and frame-building traffic generation with error injection. A LinkTester feature stresses media for jitter, noise, and power and characterizes errors. Multi-channel, time-synchronized data capture is also supported.

Meanwhile Fibre Channel, while far from new as serial interconnects go, remains a popular choice, particularly as a back-end storage network interface for radar and SIGINT installations. Catalyst Enterprises recently announced support for the Linux operating system on their FCA Series of Fibre Channel protocol analyzers (Figure 3). Today's military test and development labs use a variety of operating systems, with Linux becoming increasingly prevalent. Linux provides a low-cost and simple platform for software development, even when the end application requires a move to an RTOS or Embedded OS solution. A lot of programs—the Army's Future Combat Systems program for example—follow that strategy.

Catalyst FCA products provide full protocol analysis and test support, including Bit Error Rate Tester (BERT) capabilities for all Fibre Channel link speeds. A unique speed negotiation feature, AutoSpeedTrack, allows the user to capture any mixture of Fibre Channel speeds on a single analyzer and display these captures in a single interleaved display.

Figure 3

Catalyst Enterprises recently added support for Linux on their FCA Series of Fibre Channel protocol analyzers. Catalyst FCA products provide full protocol analysis and test support, including Bit Error Rate Tester (BERT) capabilities for all Fibre Channel link speeds.

Real-Time Spectrum Analysis

Another key area of analyzer technology important for the military is real-time spectrum analysis. Radar pulse measurements, for example, are a critical part of radar, EW and ELINT systems. Tektronix's Real-Time Spectrum Analyzer (RTSA) and its pulse measurement software offer a comprehensive analysis solution for characterizing the transient radar pulse.

The RTSA's transient signal capabilities can provide analysis displays and performance insights that simply are not available on other analyzers. Overlapping Fast Fourier Transforms (FFTs), Frequency Mask Triggers (FMTs) and 20 ns resolution, plus the test industry's most complete automatic pulse analysis measurement software, can provide the diagnostic detail necessary for efficient troubleshooting of the modern radar, EW or ELINT system. Digital RF applications including Software Defined Radios that use complex modulation techniques also require that same analysis capability.

Tektronix recently rolled out its RSAVu off-line analysis software. With RSAVu, system developers can acquire signals using their Tektronix Real-Time Spectrum Analyzer (RSA) and then analyze the captured information off-line on a PC. The PC-based RSAVu software can provide the same analysis capabilities as exist on the Real-Time Spectrum Analyzer. Users can capture files on one RSA instrument and share these with multiple PC users for off-line analysis. A single RSA instrument can acquire a data file and transmit this to a remote location for analysis, enabling the application and product experts to perform the analysis no matter where they are in the world. ▮▮

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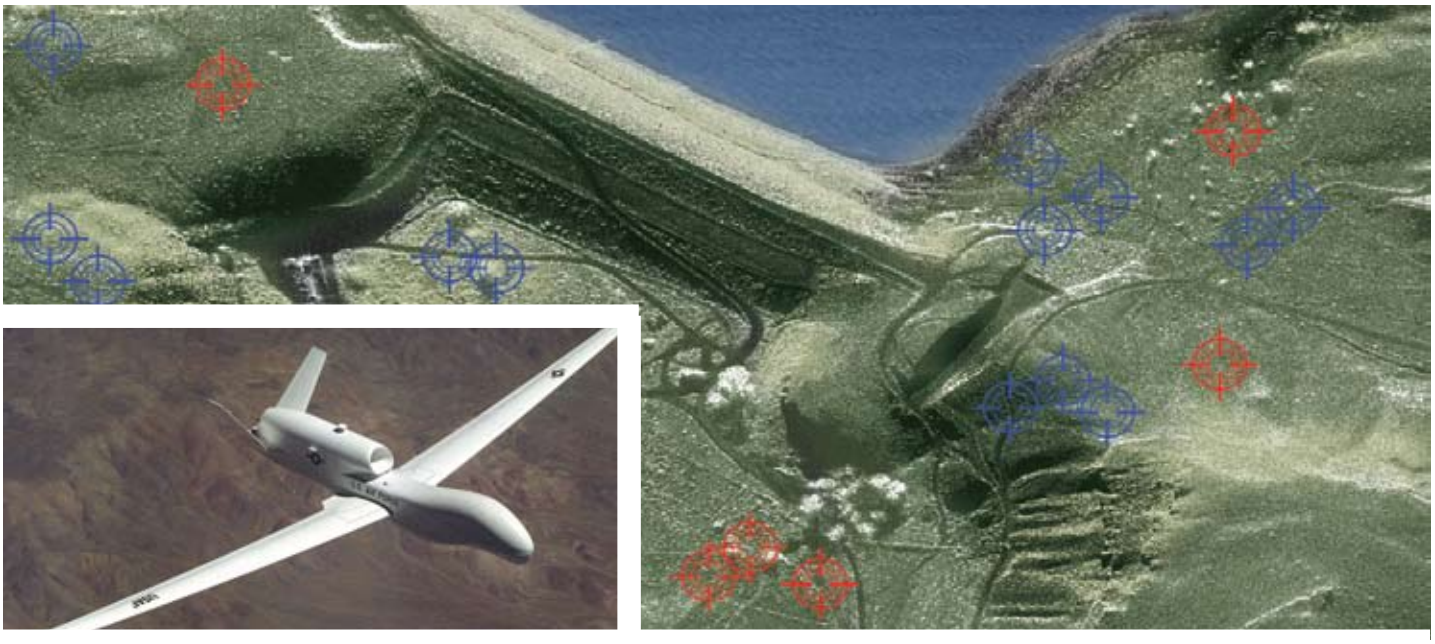

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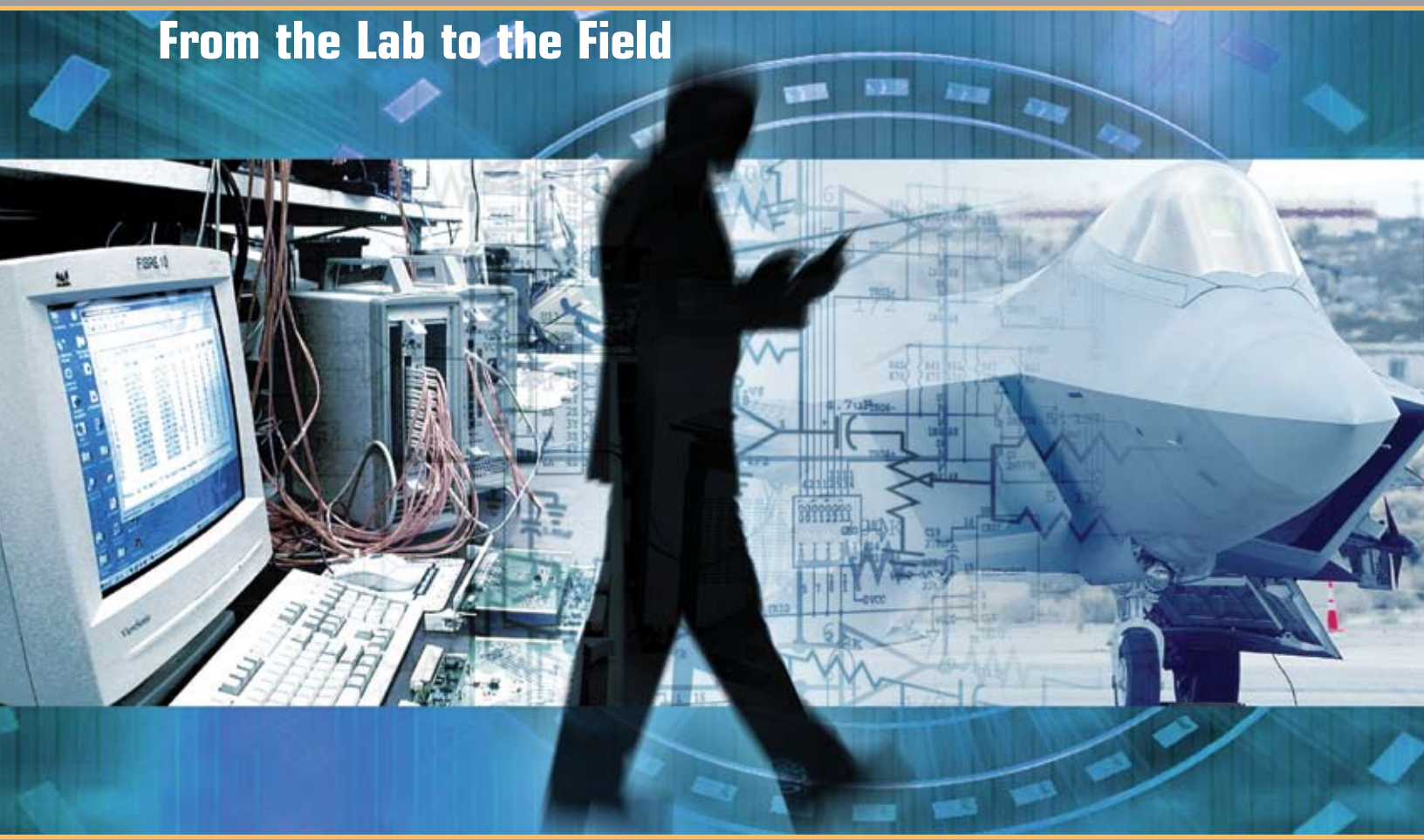

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Conduction-Cooled 3U CompactPCI Flies High

The demand for conduction-cooled 3U CompactPCI SBCs just keeps on growing as mil/aero systems get smaller, lighter and more compute-intensive.

Ann R. Thryft
Senior Editor

The military started adopting CompactPCI in a big way not long ago. Demand for it continues to rise in a wide range of rugged, embedded applications including ground mobile, shipboard and airborne systems. Programs using 3U boards include Future Combat Systems (FCS) and some Navy initiatives. The FCS Integrated Computer System (ICS), for example, is based on 3U cPCI. One of the primary design considerations for the ICS is compute density: packing more processing muscle into an ever-smaller space.

For this reason, between last year and next year the 3U CompactPCI form-factor is expected to grow in military designs by about a third in North America alone. This growth is driven by the fact that, in an increasing number of defense and aerospace platforms, size, weight and power are

Figure 1

Conduction-cooled 3U CompactPCI can be found in a growing number of military systems with size, weight and power constraints, such as UAVs. With a body length of only 21 inches, the Tactical Micro Unmanned Aerial Vehicle (TACMAV) is small enough to be carried in a soldier's backpack and launched by hand. The TACMAV UAV is used by foot patrols in Iraq for surveillance and intelligence gathering.

Photo by Lance Cpl. Bernadette L. Ainsworth, U.S. Marine Corps, courtesy of U.S. Army.

becoming critical factors while the need for compute density is expanding. 3U cPCI boards and systems based on them are being inserted into a host of space-constrained applications for manned and unmanned combat vehicles of various kinds, such as avionics, vetronics for smaller vehicles and small UAVs (Figure 1).

Conduction-cooled 3U cPCI SBCs are winning a place on the bill of materials, especially in the highly integrated systems found in some of the newer defense designs. For example, new transportation platforms in combat vehicles need even more high-performance, ruggedized embedded computers than ever before for networking, imaging and data storage, and 3U cPCI is filling that need.

In harsh environment, high-performance applications that require high reliability under extreme operating conditions, conduction-cooled 3U boards are employed in leading-edge computing, embedded network control and signal processing, functioning as system controllers, peripheral controllers and I/O processing nodes.

Those environments include radiation-hardened and radiant-tolerant space applications, such as the Orbital Express program and NASA crew exploration vehicles (CEVs). Military designers in DARPA-funded programs are turning to space hardware based on conduction-cooled 3U cPCI for use in mission computing, robotic control, and data storage and capture.

The latest crop of these boards includes mostly general-purposes SBCs, many of them based on the Freescale MPC7447A/7448 PowerPC or other processors with similar performance, such as the PPC 750GX superscalar control processor. To help keep the heat down even more, several boards are equipped with a range of power management technology.

New this year is the appearance of dual-core processor boards with twice the CPU density. Mercury's offering has two 7448 processors, while Curtiss-Wright Controls Embedded Computing's new SBC is based on the Intel Core Duo running at 1.67 GHz. That board also supports both a PMC site and a backside PCI Express XMC site, an industry first. ▮▮

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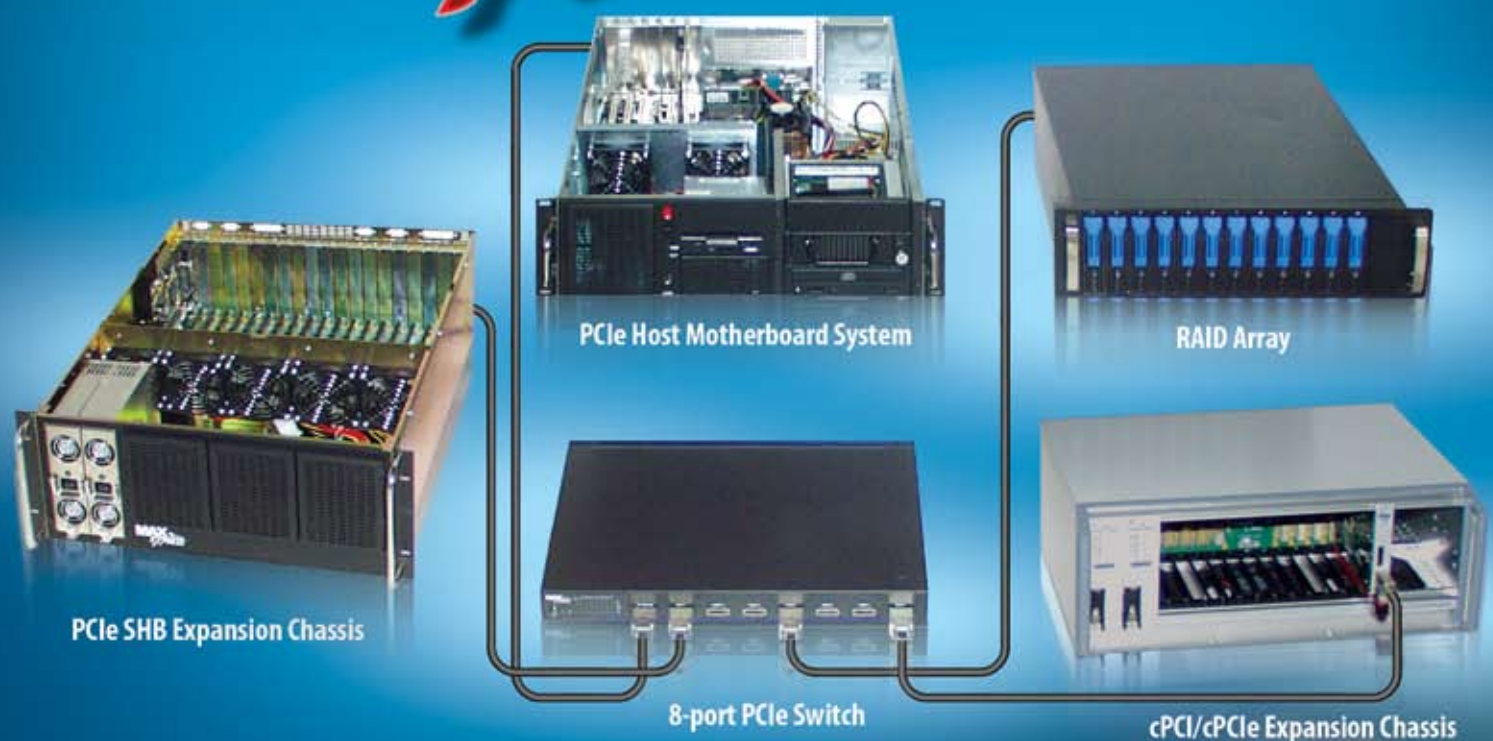

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Technology Focus:

3U Conduction-Cooled cPCI Boards Roundup

SBC Targets Rugged Mil Apps

The 3U form-factor has become the CompactPCI flavor of choice for space-constrained applications. No other standard form-factor permits such high levels of compute and I/O densities. ACT/Technico's offerings in this space are its 680x series of conduction-cooled 3U CompactPCI SBCs. Based on the Freescale MPC7447/7448 processor, the boards are ideal for a wide range of rugged, embedded applications including ground mobile,

shipboard, airborne and homeland security.

These new processor boards are designed around Freescale's PowerPC e600 processors, the MPC7447A at 1 GHz or the MPC7448 at 1.4 GHz. These processors feature a high-frequency superscalar PowerPC core capable of issuing four instructions per clock cycle into 11 independent execution units: four integer units, one double-precision floating point unit, four Altivec units and load/store and branch processing units. The e600 core provides 2310 Dhrystone 2.1 MIPS at 1 GHz with the 7474A and 3230 Dhrystone 2.1 MIPS at 1.4 GHz with the 7448. The e600 core is expected to scale beyond 2 GHz and to support multiprocessing.

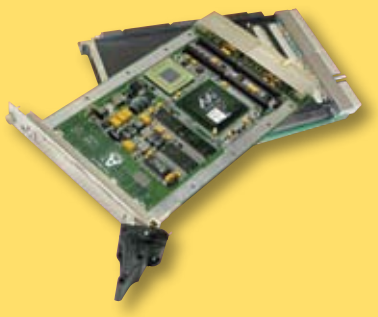
The 680x boards integrate numerous I/O: two Gigabit Ethernet channels, two high-speed USB 2.0 ports, two multi-purpose serial controllers and two high-speed ports. The boards support up to 512 Mbytes of DDR ECC SDRAM, 128 Kbytes of ultra-fast SRAM and 64 Mbytes of flash EPROM. A 64-bit PMC card can be added via a single PMC expansion slot. Designed to meet the most severe environments, the boards are available in standard and extended temperature ranges, in addition to the conduction-cooled version. 680x series software is based on UBOOT, along with a comprehensive power-on Built-in-Test (BiT). Board Support Packages (BSPs) are available for VxWorks and Linux. Pricing for the 680x series starts at $3,063 in low quantities.

ACT/Technico
Ivyland, PA.
(215) 957-9071.
[www.acttechnico.com].

Rugged SBC Monitors Own Temp

Most military applications require highly reliable operation under extreme environmental conditions. The ability to fit into small spaces and extremely low power consumption are also high on the demand list. Fortunately, vendors such as Aitech Defense Systems continue to roll out new products aimed at those needs. The company's C900 rugged, single-slot, 3U CompactPCI SBC not only delivers high performance, but also accurately self-monitors temperature and controls power dissipation via onboard sensors.

The C900 controls power consumption in several ways. It incorporates the low-power version of the advanced G4+ MPC7447A/7448 PowerPC microprocessor, and operates at 1.167 GHz at the industry's widest temperature range of -55° to +85°C. The board consumes only 2 amps at 3.3V. Integrated on-chip cache includes 32 Kbytes L1 instruction and data and 1 Mbyte L2. AltiVec support lets users take advantage of the processor's real-time vector processing



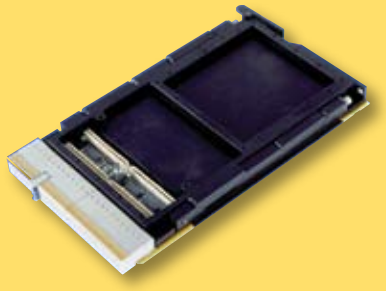
capabilities. Up to 1 Gbyte of ECC fast DDR SDRAM, 64 Mbytes of user flash, 32 Mbytes of boot flash, up to 1 Gbyte of NAND flash and 128 kbytes of NVRAM for storing application-specific parameters are provided.

The Marvell MV64460 Discovery III system controller integrates both a memory controller and a dual PCI/PCI-X bridge operating at up to 133 MHz. The C900 integrates two Gigabit Ethernet ports, two high-speed serial communications ports, two USB 2.0 ports and up to eight general-purpose discrete I/O channels, as either eight single-ended or four RS-422 differential channels. The board is PICMIG 2.0, Rev. 3.0-compliant, and equipped with a PMC slot. It is available in both air- and conduction-cooled versions. Pricing starts at $4,210.

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

3U Board Boasts Intel Core Duo

In many defense and aerospace platforms, size, weight and power (SWP) are critical design considerations. Developed for applications that need all three, Curtiss-Wright's SCP/DCP3-1201 SBC packs Intel's 1.67 GHz Core Duo processor into the 3U CompactPCI form-factor, available in



both conduction-cooled and air-cooled configurations.

Featuring the Intel Lindenhurst 7520 North Bridge and Intel 6300ESB I/O Controller Hub (ICH), the S/DCP3-1201 can be configured with either Core Duo or Core Solo CPUs. One PMC expansion site with 64-bit PCIx is provided. An additional 1 x 8 PCIe XMC site on the backside of the card is optional. Memory includes a 2 Mbyte L2 Advanced Transfer cache, up to 1 Gbyte of ECC DDR2 SDRAM and up to 2 Gbytes of USB user flash. A rich complement of I/O includes two Gigabit Ethernet ports, three USB 2.0 ports, six COM (RS-232) ports, two SATA ports and eight GPIO lines.

Support for clock calendar and NVRAM from system-supplied battery backup and/or onboard capacitor is provided. A user-programmable operating frequency allows dynamic, user-controlled power consumption adjustment. The board can be configured in any of five ruggedization levels, from L0, L50 and L100 air-cooled to L100 and L200 conduction-cooled. Board Support Packages (BSPs) for Windows, Solaris and Linux are available. Volume pricing for the S/DCP3-1201 starts at under $4,000.

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

PowerPC Card Features Gigabit Ethernet

The military has its own unique needs when it comes to networking. Two of these that rank especially high are communications that are certifiably secure, and safety-critical reliability. To meet these needs, Extreme Engineering offers its XPedite6032, a 3U conduction-cooled CompactPCI module hosting Freescale's MPC7448 PowerPC processor that is tolerant of extended shock up to 40g peak sawtooth for 11ms and vibration of 0.1g2/Hz from 5 to 2,000 Hz. These elements combine to make the XPedite6032 ideal for military communications systems that require high bandwidth

and processing power and must function under extremely harsh conditions. Typical applications include baseboard controllers, LAN/WAN Networking and processing nodes.

The XPedite6032 utilizes the Freescale 7448 embedded PowerPC processor, operating at up to 1 GHz, with AltiVec co-processing. The board provides a 1 Mbyte L2 cache, up to 512 Mbytes of 266 MHz DDR SDRAM and up to 128 Mbytes of flash that has been soldered to the board for increased reliability. A full complement of I/O includes two RS-232/422 serial ports and PCI-X CompactPCI and PMC interfaces. The serial interface and two Gigabit Ethernet interfaces are accessible through the backplane's J2 connector. One conduction-cooled PCI-X PMC slot is provided for higher-speed conduction-cooled PMC module support.

Software BSPs from Extreme Engineering include IntegrityOS, Linux V2.6, LynxOS, LynxOS-178, VxWorks and QNX. Pricing starts at $5,995 for a single unit and is less than $4,000 in volume.

Extreme Engineering Solutions
Madison, WI.
(608) 833-1155.
[www.xes-inc.com].

SBC Features Dual 7448 PPCs

The challenge of high-density computing is packing the greatest amount of functionality into the smallest possible standard form-factor, while also retaining the most flexibility. Designed for space-constrained applications, Mercury Computer Systems' Momentum Series CP3-102 provides twice the processor density of available 3U SBCs with two PowerPC 7448 processors.

The conduction-cooled CompactPCI CP3-102 contains two MPC7448 processors with AltiVec vector processing technology, running at up to 1.4 GHz. The two processors share a common 1 Gbyte of ECC DDR2-400 memory, and are connected to each other in an SMP configuration for easier programming access. Up to 128 Mbytes of bootable flash and up to 128 Kbytes of serial EEPROM are provided. The Tsi109 host bridge includes a 167 MHz MPX bus, a 200 MHz DDR2 SDRAM interface, an I^2C interface, a PCI-X bus, two UARTs, and two GMII ports.

Standard I/O connected through the backplane includes two Gigabit Ethernet ports, two RS-232 ports, two USB 2.0 ports and eight GPIO lines with programmable interrupt. The PICMG 2.0 CompactPCI interface includes a 32-bit 33/66 MHz PCI slot, auto-system/peripheral configuration and supports up

to seven external masters. The Momentum Series CP3-102 is available with Board Support Packages (BSPs) for VxWorks and Linux, as well as in an air-cooled version. Price is $5,950.

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

3U Boards Court Space-Constrained Apps

Military designers creating subsystems for small, lightweight systems such as UAVs need lots of processing power in a minimum-sized package. With that in mind, Radstone offers the latest in its PowerPact3 family of 3U CompactPCI products, the IMP2A. Designed around the Freescale 7448 PowerPC processor operating at 1.4 GHz, the IMP2A packs a powerful SBC into an extremely space-efficient and lightweight 3U form-factor.

The Marvell Discovery III Integrated System Controller combines high-bandwidth memory control and PCI bridging with an array of communication peripherals, including high-speed serial and Ethernet ports, all on a single chip. The board features up to 512 Mbytes of DDR memory, 128 Mbytes of flash memory and a PCI-X-capable PMC site are included. A range of I/O options is offered, including up to two Gigabit Ethernet channels, up to 12 bits of discrete digital I/O, and up to two serial channels capable of high-speed operation in either asynchronous or synchronous mode and software programmable as RS232/422 or 485.

The IMP2A is the first SBC to use Radstone's "embedded side bar" technology that offers superior conduction cooling. It is also fully supported at the chassis level by either the RDS evaluation/development chassis or the RT4 deployment chassis, Radstone's application-ready CompactPCI platform that comprises four conduction-cooled 3U slots. The system slot is pre-loaded with an SBC, leaving three slots for I/O and peripherals. The IMP2A benefits from Radstone's industry-leading Deployed Test software modules, including built-in test (BIT) and Background Condition Screening (BCS). Five air/conduction-cooled ruggedization levels are available. Software support includes Board Support Packages (BSPs) for VxWorks and VxWorks6. Pricing begins at $4,300.

Radstone Embedded Computing
Towcester, UK.
+44 (0) 1327 359444.
[www.radstone.co.uk].

Rugged 3U SBC Targets Harsh Environments

Fitting a high-performance embedded computer into the limited space available in many military applications is now easier, thanks to the small footprint of 3U CompactPCI SBCs. Even better is a small SBC that's been ruggedized. Serving just such needs, SBS Technologies, now a part of GE Fanuc Embedded Systems, offers the CV1 3U cPCI SBC, designed to operate in harsh, demanding environments.

The CV1 is based on the G4 PowerPC and supports core processor speeds of up to 1 GHz and bus clock rates of 167 MHz. It is ideal for

military applications, such as UAVs deployed in harsh environments, that must work in an extended temperature range of -40° to +85°C. Ample I/O to work with is provided, including two Gigabit Ethernet ports, two 32-bit 33/66 MHz PCI bus interfaces, an RS-232 and an RS-422/485 serial I/O port, and 10 GPIO lines to the backplane with separate interrupts and interrupt masking capability. A PCI/cPCI bridge handles 32-bit data transfers to and from the cPCI backplane. This allows the CV1 to operate as a system controller or peripheral processor card through its dual mode capability.

The CV1 supports the Linux, VxWorks and other operating systems, as well as the SBS Ready Driver interoperability program. Pricing in OEM quantities starts at $2,300.

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

Compact Board Is Tactical Computer

In avionics and defense vehicles, storage, networking and imaging applications demand high-performance, compact, real-time systems. The compute engine driving those systems must share these same characteristics. The PowerEngineC7 3U CompactPCI SBC from Thales Computers was designed with those applications in mind. The PowerEngineC7 is the first member of the company's family of rugged 3U CompactPCI embedded computers for military and aerospace applications.

The PowerEngineC7 is based on IBM's 800 MHz PowerPC 750GX dual issue, superscalar control processor. The 32 Kbyte L1 cache has a 32-byte line, an 8-way set associative instruction cache and a 32 Kbyte 32-byte line, 8-way set associative data cache. The 1 Mbyte internal L2 cache has ECC clocked at processor frequency. Up to 512 Mbytes of DDR SDRAM with ECC supports code execution copied from flash memory, and is soldered to the board for increased ruggedization. The board includes 64 Mbytes of system flash, 128 Mbytes of user

flash, a dual Ethernet 10/100 port and dual serial lines. The IEEE P1386/1386.1 PMC expansion slot has a 32-bit 33/66 MHz PCI bus interface. A predefined area of the memory is protected from PCI and Ethernet accesses and allows the definition of a dedicated PPC communications area.

The PowerEngine C7 is rugged conduction-cooled (-40° to +85°C). It supports VxWorks 5.5.1 for Tornado 2.2.1. Pricing starts at $4,450 in single quantities.

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

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VXS SBC Has Independent Dual Processors

Military systems requiring massive parallel processing for intensive floating-point/integer calculations need an SBC with completely independent dual processors. Unlike other dual-processor boards, the two Pentium M processors on the V469 PATRIOT VXS SBC from General Micro Systems are entirely decoupled, offering 100% redundancy, including power, cooling and I/O.

Each M-760 Pentium M processor operates at 2 GHz with 2 Mbytes of L2 cache and 533 MHz FSB, and has its own Fibre Channel connection with boot capability. They communicate via a direct Gigabit Ethernet (GbE) link. Independent communication by either processor to the rest of the system or to multiple PATRIOTs is accomplished via independent GbE facilities through the VITA 41.3 VXS connector. Each side features up to 8 Gbytes of 266 MHz 128-bit ECC RDDR memory, dual GbE ports with copper or fiber interface, quad USB 2.0 dual serial ports, XVGA video, UDMA IDE, a Special Application Module (SAM-III) interface, and 2 Gigabit full-duplex Fibre Channel with 2 Mbytes of SRAM buffer and flash BIOS. Power consumption is 70W typical.

The V469 PATRIOT supports Windows XP/2000, VxWorks Tornado II and Linux. Pricing starts at $4,700 in quantities of 100 units.

General Micro Systems, Rancho Cucamonga, CA. (800) 307-4863. [www.gms4sbc.com].

PXI Embedded Controller Is First with Intel Core Duo

Dual-core processors bring a wealth of benefits to multithreaded applications such as RF test and multitasking environments, as well as multi-channel, multi-rate data-logging applications. A new dual-core PXI controller from National Instruments is the first to use the 2 GHz Intel Core Duo T2500 processor, improving the performance of multithreaded applications up to 100% compared to single-core PXI controllers with the same processor clock rate.

The PXI-8105 controller works with all PXI modular instruments and data acquisition modules. It uses the Mobile Intel 945GM Express chipset, which includes the PCI Express bus. The controller's ExpressCard/34 slot uses the PCI Express and USB 2.0 serial interfaces to provide up to 2.5 Gbit/s throughput in each direction. Other integrated peripherals include Gigabit Ethernet, four USB 2.0 ports, GPIB, serial and parallel. 512 Mbytes of dual-channel 667 MHz DDR-2 memory, along with analog and digital DVI-I video and a 60 Gbyte serial ATA hard drive, are included.

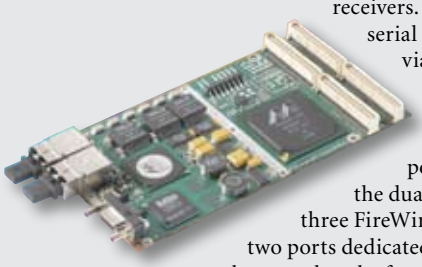
Windows XP Professional is preinstalled. The controller supports all National Instruments software, as well as C, C++, Visual Basic and Microsoft Visual Studio .NET. Pricing begins at $4,499.

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

PMC Has GbE, FireWire Support

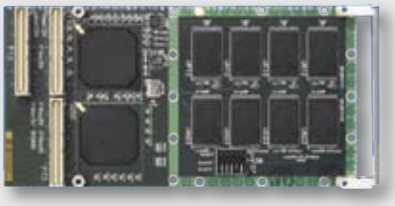
In the defense market, engineers want the flexibility to accommodate the widest possible range of peripherals. The PMCD3 rugged multifunction PMC from Radstone Embedded Computing lets them do exactly that.

The PMCD3, which is 64-bit/133 MHz PCI-x-capable, provides up to five Ethernet ports in total (three copper and two optical), three of which can be active at any one time. Two copper ports are dedicated to rear I/O, while a third can optionally route to either the front or rear. The two optical ports are dedicated to front I/O via low-profile optical receivers. Up to two fast sync/async serial ports are implemented via the Marvell Discovery III integrated system controller while up to two standard async serial ports are implemented via the dual UART. A maximum of three FireWire ports are available with two ports dedicated to rear I/O only. A third can be routed to the front.



Software support includes driver support for Wind River's VxWorks, LynxOS from LynuxWorks and Green Hills Software's INTEGRITY. The PMCD3 is available in any of five air- and conduction-cooled ruggedization levels. Price starts at $1,980.

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



Rugged Flash Disk Mezzanine Card Delivers High Density

In some harsh military environments, extreme temperature, shock or vibration make the use of mechanical hard disk drives impractical. To meet that need, Curtiss-Wright Controls Embedded Computing has introduced a ruggedized flash disk PMC/XMC card that delivers up to 64 Gbytes of high-speed storage.

The PBOD can function either as "just a bunch of disks" (JBOD) or as a RAID device via software support. In systems that support USB flash drives it appears to the host OS as up to eight drives that can be independently operated at over 10 Mbytes/s each. Using RAID software, the array appears as a single logical drive with a sustained aggregate data rate exceeding 40 Mbytes/s. ECC NAND flash correction includes 1 bit per 256 correction and 2 bit error detection. Other features include PMC 32-bit, 33/66 MHz or XMC 1 lane PCI Express, hardware write protect and SmartMedia page management.

Options include Hardware Flash Destruct for secure applications. The PBOD is available in 8, 16, 24, 32 and 64 Gbyte configurations, as well as L0, L50 and L100 air-cooled configurations and L100 and L200 conduction-cooled ruggedized levels. Pricing starts at under $2,500 in volume for the 8 Gbyte version.

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

Low-Profile Military OCXO Is Low G-Sensitive

Space avionics and military platforms for next-generation communications, navigation and targeting systems can be the most demanding when it comes to precise time and frequency. What's needed are improved phase noise and superior frequency stability. The 9250 military oven controlled crystal oscillator (OCXO) from Symmetricom is designed for ground tactical and airborne applications where superior frequency stability and phase noise are required.

The 9250 delivers low G sensitivity in a small, low-profile, hermetically sealed package 1.50 in. x 2.76 in. x 0.9 in. high. All inputs and outputs are accessible via feed-through pins on the side of the chassis. It can withstand a wide range of operating environments with minimal degradation in frequency accuracy and stability. The 9250 achieves less than -100 dBc phase noise at 1 Hz from the 10 MHz carrier. Based on an ovenized 10 MHz, 3rd-overtone, SC-cut crystal resonator, the 9250 features <3E-10 per day aging and <3.0E-10 G sensitivity. It operates at altitudes up to 50,000 feet. Analog tuning range is ± 5E-7 over 0 to 6 VDC. I^2C digital tuning is optional.

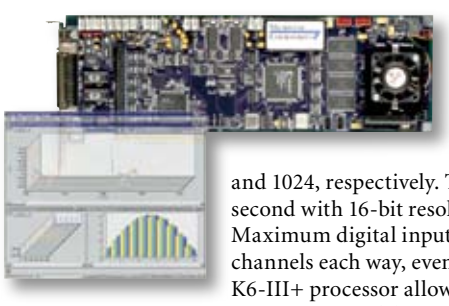
Price for the 9250 OXCO is $1,995.

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

Data Acquisition Processor Board Boasts Fast Sampling

Engineers developing data acquisition applications under Windows that need fast 16-bit sampling and significant processing will welcome a new data acquisition processor board. The DAP 5216a/627 from Microstar Laboratories runs a real-time OS and can be controlled from PC software.

The board includes a 400 MHz CPU and acquires 16-bit data at 500k samples/s. DAPstudio can be used to configure the DAP board to perform the application's low-level, real-time tasks, and to run the complete application. The board can also be configured and controlled from LabVIEW, MATLAB and other third-party software, as well as from C++, VB and other applications that allow DLL calls.



The DAP 5216a/627 includes 16 analog inputs, 2 analog outputs, 16 digital inputs and 16 digital outputs. External rackmounted hardware can extend these channel counts to 512, 66, 128 and 1024, respectively. The board can convert one million values per second with 16-bit resolution on each of the two onboard analog outputs. Maximum digital input and output rates are 2 Msamples/s on all 16 channels each way, even when running concurrently. The onboard AMD K6-III+ processor allows fast real-time processing. Low latency, 0.1 ms task time quantum, delivers fast response. The board costs $3,995.

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

PCI Express Analyzer Reduces Debugging Time

Military system designers need a PCI Express analyzer with a breadth of features that can be used for a wide variety of development projects. A new analyzer from LeCroy fills that need.

The PETracer Edge is based on a card platform that supports x1/x2/x4 lane widths at 2.5 Gbyte/s speeds. Two versions are available. The PRO is a full-featured, low-cost analyzer and the EXPERT boasts advanced features that enable deep analysis of bus management and protocol operation issues for error troubleshooting. Both versions let users quickly find errors via powerful triggering, filtering and error reporting. Difficult to understand protocol traffic can be easily followed with annotated views and charts that display events by logical and chronological occurrence. CRC re-checking displays reliable and complete decodes of transaction layer packets, data link layer packets and all PCI Express primitives.

The PETracer Edge uses the CATC Trace software system to assist users in analyzing how PCI Express components work together in diagnosing problems. The CATC Trace, which utilizes a Windows-based graphical display, embeds detailed knowledge of the protocol hierarchy and intricacies, as defined in the protocol specification. List price is $9,950.

LeCroy, Chestnut Ridge, NY. (845) 425-2000. [www.lecroy.com].

Software Radio XCVR Module Boosts FPGA, Memory, A/D

Engineers designing IF and RF communication systems are dealing with more complex waveforms, more channels in radar and beam-forming applications and communication systems with wider bandwidths. These drive the need for better DSP processing performance, high-speed interconnects and increased data sampling rates. The Model 7142 PMC software radio transceiver module from Pentek fills the bill with four 14-bit 125 MHz A/D converters coupled to two Virtex-4 FPGAs.

The Virtex-4 SX55 handles signal processing or routing to other resources, which include a Virtex-4 FX that handles I/O, a DC-to-160 MHz digital upconverter, a 16-bit 500 MHz D/A converter and 768 Mbytes of DDR2 SDRAM. The FX device includes a PCI bus interface with 9-channel DMA controller and a VITA 42-compliant XMC dual 4x gigabit serial interface.

IP can be added to the SX55 FPGA via the SX55 design kit. The FX design kit allows installation of IP cores for various gigabit switched serial fabrics. An optional version of the Model 7142 replaces the SX55 with the LX100 FPGA for applications requiring a maximum number of logic slices. Five ruggedization levels are available. Price starts at $13,500.

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

SpaceWire PHY Is QML Q and V-Compliant

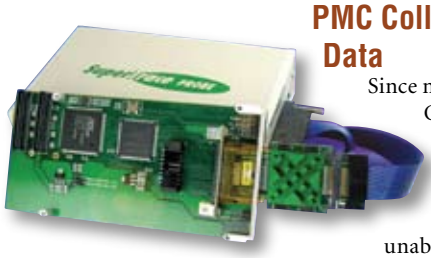
The simple SpaceWire protocol that governs serial communication between satellite components provides a high-speed, low-power serial interface and simple user interface. A new SpaceWire physical layer transceiver from Aeroflex is available in QML Q and V production.

The UT200SpWPHY01 PHY is designed to handle the critical timing issues associated with the SpaceWire Data/Strobe Encoding scheme. It supports data rates up to 200 Mbits/s with data/strobe transmit skew less than 400 pS. It has a 3.3V power supply and the added benefit of cold spare on LVDS pins. ESD performance of LVDS inputs/outputs is greater than 8000V HMB. The PHY is designed to withstand 300 krad(Si), upsetting charge particle strikes to 40 MeV-cm2/mg, and is SEL immune to greater than 100MeV-cm2/mg.

The UT200SpWPHY01 is packaged in a space-saving 28-pin flatpack and is QML Q and V-qualified. Pricing is $1,069 in lots of 100. A dual-link SpaceWire solution, consisting of the UT200SpWPHY01 Physical Layer Transceiver and the UT200SpW02 SpaceWire Protocol Handler, can be purchased as a set in quantities of 100 for $3,762.

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

PMC Collects TimeMachine Data



Since most processors on Compact PCI- or VME-based systems lack a real-time trace port, some military software developers have been unable to take advantage of the advanced debugging capabilities of Green Hills Software's TimeMachine tool suite. TimeMachine lets developers visualize and replay software execution, allowing bugs and inefficiencies to be easily and quickly eliminated. A new card from Green Hills connects to an available PMC slot on the system to provide TimeMachine data.

Using an adapter that connects to a free PMC slot, TraceEdge-PMC outputs TimeMachine data to a Green Hills SuperTrace probe, which collects up to 1 Gbyte of data and uploads it to the developer's workstation. The Green Hills INTEGRITY RTOS comes bundled with the PCI device drivers required to interface with the TraceEdge-PMC adapter.

TraceEdge-PMC is available for all PowerPC processors. The SuperTrace probe is also available for a wide range of processors with on-chip trace capability including ARM, PowerPC, MIPS and V850. The TraceEdge-PMC card alone costs $2,000 and the SuperTrace Probe plus PMC card costs $11,900. A MULTI Professional or TimeMachine license is required.

Green Hills Software, Santa Barbara, CA. (805) 965-6044. [www.ghs.com].

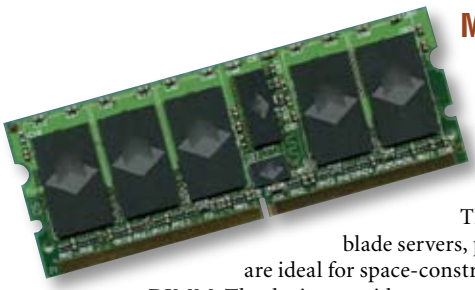
EMC Immunity Test System Range Boosted to 9 kHz - 1 GHz

An upgraded test system for conducted and radiated EMC immunity from Schaffner Test Systems features a broader frequency range, an enhanced LCD screen, a new user interface and easy-to-use firmware.

Using either internal or external amplifiers, the NSG 4070 can test to industry standards such as IEC 61000-4-6, BCI, IEC 61000-4-3, IEC 61000-4-20 and IEC 61000-4-21. The system has a 5-in. x 7-in. LCD screen, a 9 kHz to 1 GHz integrated signal generator, a 9 kHz to 1 GHz four-channel power meter, and an integrated power amplifier module for different frequency ranges up to 1 GHz and up to 75W nominal output power. A USB memory stick can be plugged into the front panel to access test and measurement data.

Firmware lets the NSG 4070 be operated independently from an external PC or remotely controlled. The firmware features soft key menus that provide easy control of test parameters. A full range of IEC 61000-4-6-compliant coupling/decoupling networks for the NSG 4070 are available, as well as a current injection probe and EM-clamp as coupling options for RF-conducted immunity testing. Pricing starts at under $20,000.

Schaffner Test Systems, Edison, NJ. (732) 225-9533. [www.schaffnerusa.com].



Mini-DIMM Serves Up 1 Gbyte of DDR2 SDRAM

Cramming the most computing and memory into a small space is the priority in many next-generation military programs. Supporting that trend, White Electronic Designs Corporation (WEDC) announced the launch of its 1 Gbyte DDR2 SDRAM Registered, Mini-DIMM w/PLL. The device is a 128 Mbits x72 double data rate II (DDR2) SDRAM high-density module consisting of nine 128 Mbits x8 with 4 banks DDR2 Synchronous DRAMs in fine ball grid array (FBGA) packages, mounted on a 244-pin DIMM FR4 substrate (JEDEC Standard).

The preliminary Mini-DIMM standard has been accepted by JEDEC and is targeted to be used in blade servers, printers and applications needing a small form-factor. In addition, registered Mini-DIMM modules are ideal for space-constrained military applications that require DDR2 memory but do not have the space for standard size DIMM. The device provides programmable CAS# latency, serial presence detect (SPD) with EEPROM and differential data strobe for transmitting and receiving data. Defined as part number WV3HG128M72EER-D7, the 1 Gbyte DDR2 SDRAM is priced at $169 each in volumes of 1,000 pieces. All DDR2 modules are available as RoHS-compliant.

White Electronic Designs, Phoenix, AZ. (602) 437-1520. [www.wedc.com].

1553 PC/104-Plus Card Delivers Four 1553 Channels

A new PC/104-Plus 1553 card from Data Device Corp. provides up to four dual-redundant 1553 channels, five user-programmable digital discrete I/Os and an IRIG-B time synchronization input. This ruggedized card can be used in both convection- and conduction-cooled applications.

The BU-65578C PC/104-Plus card utilizes DDC's new Extended Enhanced Mini-ACE (E2MA) architecture. For each 1553 channel, this architecture supports 2 Mbytes of RAM with parity per channel, 48-bit/1 microsecond time tag synchronized to an IRIG-B input, low CPU utilization and built-in self-test. Each 1553 channel can emulate a bus controller, remote terminal, or bus monitor. Each also includes a combined RT/Monitor that can monitor all 1553 communications on the bus, including the channel's own RT address.

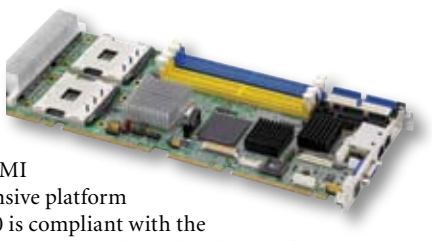
The BU-65578 includes high-level C API Library Software that supports all advanced architectural features, as well as driver support for VxWorks, Linux and Windows for MIL-STD-1553 functionality. Pricing starts around $2,500.

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

PICMG 1.3 Host Board Sports Dual 3.6 GHz Xeons

Because of the long design cycles in the defense market, it's critical for military systems to design in the fastest, most advanced embedded computer possible. An example along those lines is Advantech's new PCE-7210, a SHB Express (also referred to as "PICMG 1.3") System Host Board (SHB) with support for dual Intel Xeon/Xeon LV processors up to 3.6 GHz. Equipped with the Intel E7520 chipset and the Intel 6300ESB I/O controller, this optimized server board supports up to 8 Gbytes of dual-channel DDR2-400 ECC registered RAM.

The PCE-7210 provides two PCIe x8 and one PCIe x4 connections, offering up to 10 Gbytes/s of bandwidth to the SHB Express backplane. Another PCIe x4 is linked to a Broadcom BCM5715C dual-port Gigabit LAN chip, enabling high throughputs for heavily loaded network environments. Additionally, an optional IPMI module provides comprehensive platform management. The PCE-7210 is compliant with the RoHS specification, and is fully compatible with Advantech's 13-slot SHB Express backplane, the PCE-7B13-64A1E, and comprehensive chassis. Additional SHB Express backplane will be available soon. The PCE-7210 and the PCE-7B13-64A1E are available now, with shipments scheduled to start mid-August. The PCE-7210 is priced at $1,430 per unit.



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

Multiplexing Converter Unit Targets Tactical Nets

As the DoD transitions to fully Net-Centric operations, fast, reliable networking gear like multiplexing protocol converters are becoming critical building blocks. Ultra Electronics-DNE Technologies has announced a new, modular multiplexing protocol converter for use in tactical networks. The product, called the CV-MCU2, can be software-configured to perform CDI/NRZ/Fiber conversions or up to 4:1 multiplexing in a single 1-RU chassis. The CV-MCU2 allows the tactical user to configure a single unit as either a multiplexer or a modem, or any combination of the two, allowing the circuits to operate independently or be combined as needed without replacing hardware modules when a reallocation of circuits is required.

A universal copper/fiber/NRZ module used in the CV-MCU2 provides both an increase in port density and circuit flexibility to the tactical user, supporting up to five 20 Mbit/s protocol conversions per 1-RU chassis. In addition, these modules now provide interoperability with deployed Canoga Perkins 2270 Fiber Optic Modems, allowing the CV-MCU2 to be a viable space-saving alternative when installing new modems in tactical communications vans. All cards are hot-swappable, and can be configured via a front-panel LCD interface, or through Serial DB-9 or Telnet RJ-45 ports.

Ultra Electronics-DNE Technologies, Wallingford, CT. (800) 370-4485. [www.ultra-dne.com].

Real-time Data Recording Front End Is All Digital

The safe, effective capture of signal data ranks as the most critical stage of sensor data recording. Serving that need, Micro Memory has introduced the Anvil, an "all-digital" front-end solution for real-time data recording. Based on a completely embedded hardware architecture and solid-state SDRAM memory, Anvil includes up to 64 Gbytes of high throughput, dual access SDRAM memory, which has been optimally implemented to capture sensor data, rate buffer and seamlessly transfer it to secondary, external hard disk drive media. The platform's four full-length, full-height 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.

The system offers native PowerPC processing and Gbit Ethernet with optional support for x86 processor platforms via a PrPMC site. Providing 32 sockets for industry standard SODIMM modules, Anvil can provide up to 64 Gbytes of solid-state, SDRAM memory. Each of the two memory arrays within Anvil can sustain data transfer rates of over 500 Mbytes/s. Available now, initial list pricing for the Anvil is $30,000 per unit with volume discounts available.

Micro Memory, Chatsworth, CA. (818) 998-0070. [www.micromemory.com].

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DC/DC Converter Series Is Designed for Battle

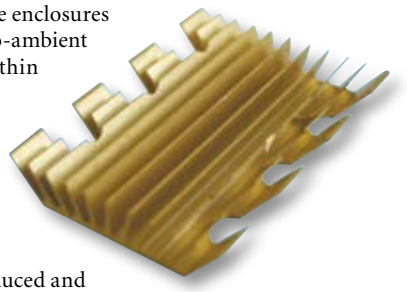
Battlefield military applications put a lot of stress on DC/DC converters. Ensuring smooth operation in extreme shock, vibration and weather conditions is no easy task. XP Power has met those challenges with its new MTC, a series of 4W to 35W DC/DC converters designed exclusively for defense and avionics applications. Available in 5, 15 and 35W ratings, the converter meets the MIL-STD 810F specification for temperature, shock, vibration, bump, altitude, salt fog and other key parameters. Input immunity with the complementary filter module, designated MTF, meets MIL-STD 1275A/B and MIL-STD 704A. EMI performance meets MIL-STD 461E with the filter installed.

Single output versions are available with output voltages of 3.3V, 5V, 12V, 15V or 28V. The MTC is fully featured to minimize external circuitry. It includes an inhibit line, the ability to synchronize with an external frequency source, output voltage programmable by resistor or external voltage, thermal warning "battle mode" signal on the 35W units, over-voltage protection and over-current protection. Both the MTC and MTF are available now. 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].

BGA Heat Sinks Cool in Low Air Flow Conditions

Cooling today's electronics is becoming one of the most challenging hurdles faced by today's military system designer. In order to use the latest and greatest processors, designers are forced to live with the rise in power dissipation associated with faster speed CPUs. And since military applications typically shun the idea of cooling with fans, there's an ever increasing demand for better ways to cool components directly using sophisticated heat sink solutions. With that in mind, Advanced Thermal Solutions, Inc. (ATS) has introduced a low-profile, high-performance heat sink designed for cooling hot BGA components in low airflow velocity conditions. The EX2 heat sink is only 9 mm in height, which allows its use inside enclosures where space is limited. Its case-to-ambient thermal resistance is 1.8°C/W within an air velocity of 600 ft/min.



EX2 heat sinks weigh just 16 grams and can be securely attached to a component with double-sided, thermally conductive adhesive tape. With no mechanical hardware needed, weight and assembly time are reduced and valuable board space is conserved. Prices for EX2 heat sinks start at less than $8.00 each in volume orders.

Advanced Thermal Solutions, Norwood MA. (781) 769-2800. [www.qats.com].

MIL-DTL-24640 Cable Designed for Shipboard Use

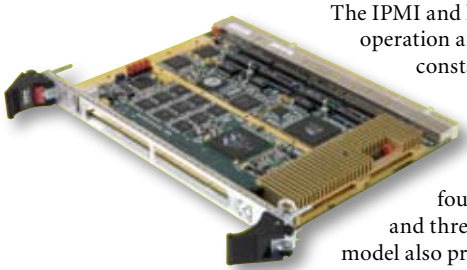
MIL-DTL-24640 cables are typically used on military marine craft and are applied in communication systems, control and instrumentation electronics as well as power and signal transmission. Shipboard cabling requires some unique characteristics to survive the special nature of such environments. Feeding that need, Tyco Electronics has introduced Raychem brand MIL-DTL-24640 lightweight shipboard cables. The new cables are qualified on a number of DoD slash sheets contained in the MIL-DTL-24640 specification and meet the rigorous requirements of flame, smoke emissions, halogen content and severe water blocking requirements. One of the main advancements with the new Raychem cable is the use of water swellable tapes and yarns to block the ingress of water. Legacy cable following MIL-DTL-24640 typically use silicone water block methods, which have lesser flexibility and handling attributes.

By using water swellable tape and yarn, the cable is kept dry, which allows for cleaner and faster handling compared to silicone water blocking methods. In addition to the range of cables called out on the specification, Tyco Electronics is able to design custom lightweight marine cables using the MIL-DTL-24640-qualified jacket. Prices range from $2.22 to $3.60 per foot.

Tyco Electronics, Harrisburg, PA. (800) 522-6752. [www.tycoelectronics.com].

6U PICMG 2.16 SBC Board Delivers Flexible I/O

Gone are the days when a single board computer had to be either a fast processing solution or an I/O powerhouse. Exemplifying that trend, GE Fanuc Embedded Systems has announced a 6U CompactPCI C2K SBC that uses the 1 GHz MPC7447A or 1.4 GHz MPC7448 Freescale processor and provides extensive I/O ports. For increased I/O expansion, the C2K hosts two 64-bit IEEE1386.1 PMC sites, and the PLX PCI 6254 CompactPCI Backplane Bridge allows the C2K to operate as a system controller or peripheral processor card.



The IPMI and hot-swap capabilities of the C2K make field operation and maintenance easier by allowing the end-user to constantly monitor system status and, when required, change boards without shutting down an entire system. The C2K gives engineers a great deal of flexibility with multiple I/O, including three Gbit Ethernet ports, four RS-232/RS-422 ports, four RS-422/485 ports, two 1.5 Gbit/s SATA ports and three high-speed USB 2.0 ports. The convection model also provides one high-speed USB 2.0 port at the front panel and 16 programmable GPIO ports with independent interrupts. Optional configurations available include support for extended temperature operations and conduction cooling. Available now, pricing for the convection model of the C2K SBC in OEM quantities starts at $2,790.

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

1553 PCI Card Supports VIO Signaling

Despite its age, the MIL-STD-1553 data bus standard remains a popular solution as a deterministic interface control technology. Targeting 1553 system developers, Alphi Technology has announced the PCI-1553-PLX-x. It implements a complete single channel, dual-redundant MIL STD-1553 bus terminal on a half-size PCI Card. Operating with 5V or 3.3V VIO signaling, the board supports Full Bus Controller, Remote Terminal and Bus Monitor modes. Support is provided for both direct coupled (short stub) and transformer coupled (long stub) configurations. Features include a bus master interface, flexible processor to memory interface, external 64 kword SRAM, external clock inputs, front panel I/O connectors and onboard transceivers and transformers.

The PLX 9080 PCI-x's standard operating temperature is 0° to 70°C, with support for -20° to 85°C. Non-operating temp range is -40° to 85°C. Other environment specs include an airflow requirement of .5 CFM, humidity from 5 to 90% (non-condensing), altitude range from 0 to 10,000 ft, vibration capabilities at 0.5G RMS 20-2000 Hz random and shock of 20G, 11 ms, one-half sine. Software libraries and drivers are available.

Alphi Technology, Tempe, AZ. (480) 838-2428. [www.alphitech.com].

Data Acq System Accommodates Multiple cPCI Digitizers

It used to require a large rackmounted data acqusition apparatus to do high throughput measurements and analysis for military sysgtems. Now that same functionality is possible in a compact system that can be run from a PC. Along such lines, Acqiris now offers the MAQlink3000, 5000 and 8000 systems, which can accommodate multiple 8-, 10- and 12-bit CompactPCI digitizers. Each includes a high-speed interface for desktop PCs or laptops, so acquired data can be processed by the highest speed processors. In addition to the PC interface, the MAQlink systems can accommodate up to 28 high-speed acquisition channels. These channels are all controlled through Acqiris' unique AcqirisMAQS multi-channel acquisition software installed on the interfaced PC.

With AcqirisMAQS, a client-server software suite, vital information can be seen with a multiple waveform display on the PC monitor. Data is more accessible with an oscilloscope-like graphical user interface (GUI). MAQlink's modularity enables users to select only the hardware components needed for a specific application and expand to a larger system as needs grow. This helps reduce instrument obsolescence and increases return on investment. Pricing for a MAQlink system starts at $5,790.

Acqiris USA, Monroe, NY. (877) 227-4747. [www.acqiris.com].

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Compact Ethernet Switch Provides Fiber Optics

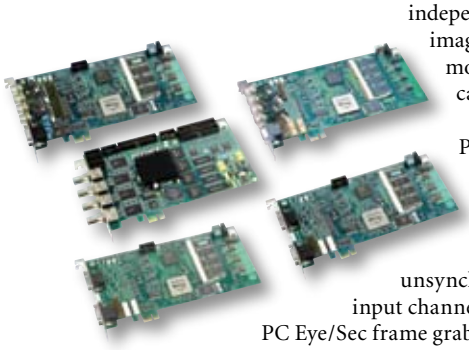
Attracted by its longevity and ubiquity, the military has warmed to the idea of using Ethernet. It's hard to beat a network technology that's been around nearly 30 years, and shows every sign of being around in some form for another 30 years. Harting is feeding that trend with its compact designed Ethernet switch ESC TP06/FX02-SC. This latest addition to the Harting IP 30 switch family connects up to 8 Ethernet devices: six RJ45 and two multi-mode fiber optic ports with SC connectors. Developed for industrial applications with a robust metal housing, the 22.5 mm size permits a space-saving network installation.

The RoHS-compatible ESC TP06/FX02-SC is adapted for mounting on DIN-rail according to EN 60 715. This Ethernet switch has quick and simple network diagnostics via integrated LEDs along with an operating temperature from -10° to +70°C. The ESC TP06/FX02-SC is the second entry into Harting's unmanaged Ethernet switch family. The user can now select solutions between RJ 45 and those with additional LWL-Ports in SC-connection technology. Products with ST-connection technology will supplement the Harting Ethernet switch family in the near future.

Harting North America, Elgin, IL. (847) 741-1500. [www.harting-usa.com].

Frame Grabber Family Rides PCI Express

PCI Express was by no means the first switched fabric to come on the seen, but it's shaping up to be the most widely accepted, in both military and commercial markets. American ELTEC offers a family of five PCI Express frame grabbers that can be used in conjunction with its new EUROCOM 400 COM Express SBC with dual-core Intel Xeon processor LV 2.0 GHz CPU. The PC Eye/RGB is a color frame grabber for PCI Express. It supports two RGB cameras in multiplex mode with reset/restart functions. The PC Eye/Quadro is designed for use with up to four simultaneously running synchronized cameras. It digitizes four parallel, independent monochrome image signals (quadro mode) from free running cameras.



The first in ELTEC's PCI Express frame grabber family, the PC Eye/Async is a frame grabber for four simultaneous unsynchronized monochrome input channels. And finally, the PC Eye/Sec frame grabber was developed specifically for security and monitoring applications. It interfaces with up to 16 standard composite video (CVBS) color cameras conforming to NTSC standards. Pricing for American ELTEC's PCI Express frame grabbers varies depending upon model and quantity. The PC Eye/Mono frame grabber is priced at $682 in single piece quantities.

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

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Coming Next Month

COTS JOURNAL

Coming Next Month in the September issue of *COTS Journal*:

- *CompactPCI, MicroTCA and AMC in the Military.* As military applications push for more integrated and small footprint electronics, form-factors such as CompactPCI—particularly its 3U flavor—offer a solution. cPCI also has passed the litmus test of maturity that is so important in defense markets. Meanwhile, MicroTCA is gaining interest as an even more integrated solution, using the growing selection of AMC mezzanine cards essentially as slot cards. Articles in this section examine the latest trends along those lines, as well as an update on where these technologies fit in current military programs.
- *Data Recorders.* Selecting a data recording solution for a military system might seem a straightforward task. But in reality it ranks among the more critical and challenging decisions engineers have to make. Consider the multitude of components found in modern sensor systems and the differing characteristics of those components. Pairing sensor acquisition/analysis subsystems with recording and storage subsystems requires consideration of interconnect pre-processing and reliability issues. Articles in this section step readers through these issues and highlight the current crop of data recording systems.
- *Thermal Analysis for Boards and Enclosures.* Embedded electronics—and microprocessors in particular—continue to climb up the power consumption curve. That power gets dissipated as heat energy, which puts a lot of pressure on system designers to properly analyze and deal with that heat. Combine that with the military's nearly insatiable demand for computing density, and it's clear that thermal analysis is moving to the center of designers' concerns. This section explores the latest techniques board and enclosure vendors are using to test the thermal performance of their respective product lines.
- *Graphics PMCs.* It used to take a whole multi-board chassis' worth of electronics to drive a display. By leveraging advanced commercial graphics silicon targeted for PCs and game boxes, military graphics subsystem integrators are able to provide a wealth of video and graphics features in a rugged PMC solution. This Tech Focus section updates readers on Graphics PMC trends and provides a product album of representative board-level products.

Editorial

Jeff Child, Editor-in-Chief

SOTM in the Summer Heat

I'm not sure why it is, but for the past couple years, the summertime is when I get the most offers from companies to come visit and take a tour of their facilities. When my schedule allows, I always accept such invitations. There's nothing like seeing stuff first hand. With no insult intended to other companies I visited, I have to say that this summer General Dynamics C4 Systems wins the prize for the most memorable experience. Even though I picked the hottest day of the year to make the drive down to their Massachusetts facility, it was well worth it.

After some invaluable face time with the company's communications and network managers, they gave me a tour of their CHS (Common Hardware/Software) ruggedization labs and environmental testing facilities. But the grand finale—worth braving the 105-degree heat outside—was a demo in the General Dynamics parking lot, where they let me ride in a Humvee outfitted with the company's next-generation SATCOM On-The-Move (SOTM) system called TCN-Mobile. The TCN-M, or Tactical Communications Node–Mobile, is a derivative of the WIN-T TCN, stripping away some of the user services but preserving the essential transmission system elements so as to meet the strict payload requirements of an up-armored Humvee. General Dynamics is the prime contractor for the Warfighter Information Network-Tactical (WIN-T) program.

Current-generation Joint Network Nodes (JNNs) are designed for stationary operations and have been widely used in the current conflicts in the Middle East. In contrast, WIN-T network nodes are required to operate while on the move. Many have speculated about the advantages such a mobile tactical network would offer during an operation like the Army's all-out drive to Baghdad at the early phase of Operation Iraqi Freedom. TCN-Mobile, developed by General Dynamics C4 Systems, was created in response to the Army's directive to armor all tactical vehicles to protect our soldiers from weapons such as Rocket Propelled Grenades (RPGs) and Improvised Explosive Devices (IEDs).

The added weight of that armor dramatically reduces the weight budget left over for the SOTM electronics. As a result, the new SOTM system is integrated into a much smaller volume, compared to the current-generation JNNs. For example, the stationary system, boards and subsystems—like the Cisco router—were housed in 19-inch racks and relied heavily on server computer blades and subsystems in 1U form-factors, and some CompactPCI cards.

But the architecture leverages today's highly integrated board-level solutions to accomplish the task in half the space, and considerably less weight. The system does its Net-Centric Waveform/FDMA satellite communications via Ku-band Commercial or Ka-band Military Wideband Gapfiller satellites. Aside from that SATCOM gear, the system also employs a Highband Networking Waveform (HNW) and mounts a ATQH 10m mast for line-of-sight communications—for use when the satellite link is unavailable—and an extended Wide Area Network to mobile command post implemented with inexpensive 802.16d/e links. TCN-M's modular design enables it to be configured or populated with a combination of hardware and software modules to meet the needs of the mission.

From the vehicle, while in motion, they had me surf the Web from a terminal in the passenger seat and make a phone call from the onboard Voice-over-IP phone. The phone call and the Web access were both done accessing the Internet via satellite using the vehicle's onboard satellite dish antennae. Caught up in the fascination of the demo, I couldn't help myself: I emerged from the vehicle declaring "It works!"

To me, the experience brought home the idea that the pieces are coming into place to complete the U.S. Military's move toward Net-Centric operations. That vision 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.

Within that scope is the idea of doing all communications—voice, data and video—over Internet Protocol—or Everything-over-IP (EoIP) as the term is called. Certainly there are other ways aside from IP to implement such comms capabilities, but the EoIP idea seems to be winning out over alternatives. A critical part of that is the move from Internet Protocol version 4 (IPv4) to Internet Protocol version 6 (IPv6).

The full payoff with IPv6 for the military is its ability to provide IP peer-to-peer connections for embedded systems. If the various electronic subsystems in an aircraft wing, for example, have their own IP address, diagnostic data about its status could be accessed while the aircraft is in flight. With SOTM technologies advancing forward, it looks like the Military is well on its way toward achieving the Net-Centric vision. For me, it was a real privilege to be given the opportunity to take the technology—literally—out for a test drive. Thank you General Dynamics. ▮▮

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