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DEPARTMENTS

E-CAST

Next-Gen VME: VITA 41 (VXS) reliably "switches" on
February 28, 2 p.m. EST
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COVER
A pair of LAV III (Stryker) vehicles ready for inspection at Fort Lewis, Washington. Used extensively in Iraq, the Stryker is configured for personnel transport and insertion, C4ISR, and several other forwardly deployed missions. Like the LAV III, rugged data storage systems protect their contents in a variety of rough missions, and increasingly rely on solid state disks using flash memory. We profile several aspects of rugged data systems, from battlefield enterprise storage to data recorders. See articles starting on pages 12 and 26. (Photo courtesy of U.S. Army, taken by Dwight Larson.)

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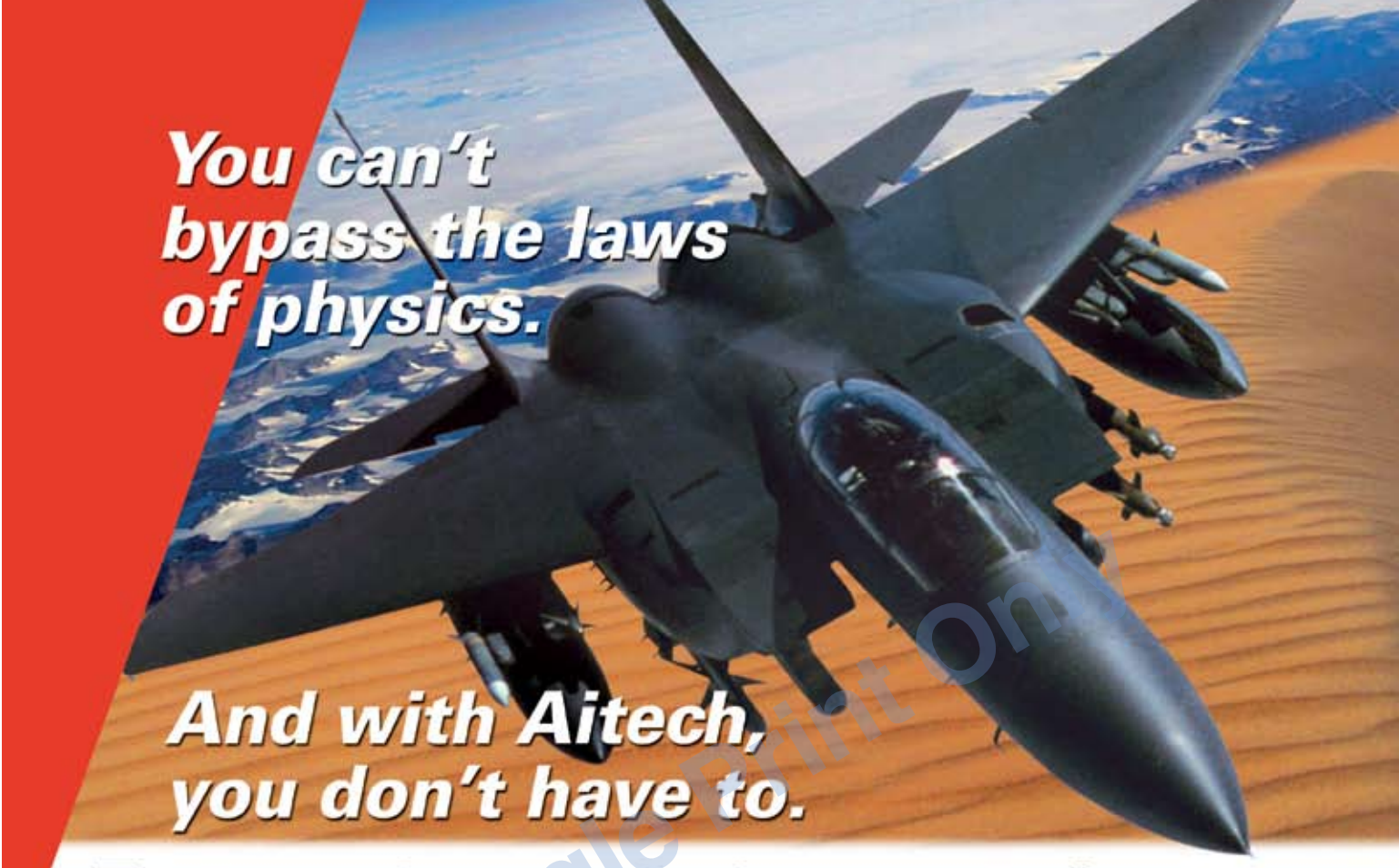

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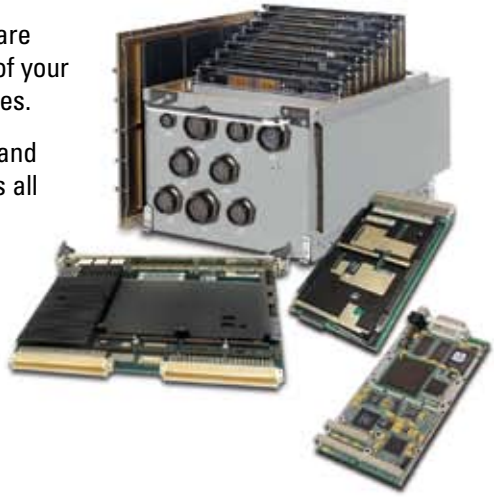

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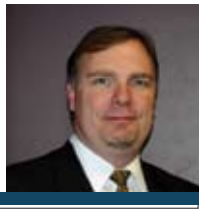
Hope for the RFID-pressed



By Don Dingee

You have probably read all the hype against RFID lately: massive but unfulfilled revenue projections; the failed Alien technology IPO and reports of some vendors losing money; tags anticipated to appear on everything from cereal to cows to C-17-borne cargo containers but rolling out slowly; and images of security and privacy breaches from *skimming* (unauthorized reads, usually from long distance) of passports and e-wallets by evildoers. There seem to be as many negative voices ready to declare imminent failure of RFID technology as there were voices proclaiming its instant runaway success a few short years ago. It is depressing, but it looks more than a bit overdone.

The reality is that RFID early adopters found niches where it works well, and innovators are now proving its worth in larger deployments. Vendors are learning to operate with market-based pricing in applications with reasonable volumes instead of chasing unrealistically aggressive high-volume, low-cost goals. The resulting wave of RFID adoption is starting to look big but will take several years to reach shore with its realistic potential, while smaller waves continue to arrive sooner as more applications deploy successfully.

Your mileage will vary

One point to understand in these initial waves of adoption is that not all RFID systems are created equal. Those who venture in without carefully studying tag and reader technology can get in over their heads quickly.

Most of us immediately think of *passive* RFID because the potential for item-level tagging in retail and pharmaceutical has received most of the attention to date. Passive tags are those that lie quietly and wait until stimulated by a reader at close range, drawing power through electromagnetic coupling and providing data or being written in response to the reader's requests. Because of their simplicity, passive tags can be physically small and less expensive. Most of the intelligence is in the reader.

Despite the attention, item-level tag implementations have been moving along a bit more slowly, for three reasons: tags are still relatively expensive, higher usage volumes require a sizable investment in reader systems and software to manage the implementation, and the underlying specifications have been transitioning to a better state of interoperability with the rollout of specifications such as EPC Gen 2. With tags continuing to get less expensive and the EPC Gen 2 format allowing Wal-Mart, the DoD, and others to finally read the same tags, item-level implementations are becoming more common.

According to IDTechEx, more than 20 percent of the total 2006 RFID spent was on *active* RFID. Active tags contain a battery and transmit information to a reader, so they are generally larger, more sophisticated, and more expensive.

Systems based on active RFID have moved more quickly because they generally track limited quantities of higher value items, can be highly accurate because the tag transmits its data, and have usage models with a containable security and information management challenge. Integrators such as Lockheed Martin's Savi Technology subsidiary have deployed a number of successful implementations of active RFID.

On the horizon

Coming to a mobile device near you are near-field UHF (or near-field communication) readers and tags. For distances generally less than tens of centimeters, near-field targets ticketing, financial transactions, and similar applications. Readers are now being embedded into mobile devices, with the device providing the network connection to access real-time information after reading pointers from the tags.

Also coming to locations near you are *agile* RFID readers such as the ThingMagic Mercury5 implementing EPC Gen 2 dense reader mode and applying Software-Defined Radio (SDR) technology. Advances in new specifications such as Real-Time Location Systems (RTLS) look to make systems even easier to implement.

We will be in this tug of war between the need for *frictionless commerce* and the need for privacy and security for some time. It is really a problem for any networking technology, especially wireless technology, and it is certainly not unique to RFID. What has drawn the attention and wrath of the pundits is the sensitive nature of RFID uses. These include passports, e-wallets and financial transactions, item-level tags on retail items, and others. But that should not stop the technology from progressing and innovative companies from developing techniques and new breakthroughs.

I'm planning to be at RFID World in Dallas in March, meeting folks with new technology and more interesting applications. As always, e-mail your thoughts and ideas to ddingee@opensystems-publishing.com, especially if you see something interesting on the RFID landscape.

Field Intelligence

By Duncan Young

MicroTCA looks set to make military impact

Military embedded computing applications have tended to shun telecommunications equipment standards, creating two major markets for embedded computing manufacturers to serve. Telecommunication standards are intended for static, temperature-controlled environments, using large module sizes and, particularly in the case of the value-added service providers, employing rapid technology churn to achieve year-on-year cost efficiencies for their services. Out of this rapid technology evolution, new standards have emerged for telecommunications-oriented embedded computing in the form of the Advanced Telecom Computing Architecture (AdvancedTCA) and its associated standard for the Advanced Mezzanine Card (AdvancedMC). MicroTCA takes AdvancedMC one step further by creating from it a small form factor, fabric-based embedded computing architecture that will have broad appeal in many more markets than its telecom progenitor, including a host of traditional and new military applications.

AdvancedMCs can be produced in two basic sizes with options on width: a single module of approximately 3" x 7" and a double-size module of approximately 6" x 7". They are mounted on carriers that plug into an AdvancedTCA racking system using high-speed serial connections such as PCI Express or Ethernet to interconnect with AdvancedTCA modules in the rack. AdvancedMCs are often used to provide the multitude of external connections and protocols found in telecom systems, providing a very flexible way of mixing and matching an AdvancedTCA system to the user's requirements.

MicroTCA dispenses with the bulky AdvancedTCA equipment practice, instead inserting AdvancedMC modules directly into a backplane mounted in a 300 mm practice racking system that supports levels of size and complexity ranging from just one or two single-size AdvancedMCs to large mixed configurations of single- and double-size modules. Without the supporting environment of AdvancedTCA, MicroTCA needs its own form of power and system management plus a high-speed fabric switch, which is provided by a MicroTCA Carrier Hub (MCH). An MCH occupies a single backplane slot supporting up to 12 MicroTCA backplane slots. Keys to the success of MicroTCA include its size, performance, scalability, support for different fabrics (PCI Express, Ethernet, and Serial RapidIO), and high-availability capabilities, such as multiple redundancy with hot swap of modules, power supplies, and cooling. Figure 1 illustrates MicroTCA's main architectural features.

Significance to the military

VME and, to a lesser extent, CompactPCI products have dominated the COTS era for embedded computing so far. Many of these have found their way into high-profile, very rugged applications in main battle tanks, armored vehicles, combat aircraft, helicopters, Unmanned Aerial Vehicles (UAVs), and weapons systems of many types. Experience has shown that the 6U form factor of VME and CompactPCI offers the ideal balance of size, power capacity, performance, functionality, and ruggedness for many military applications, making the double-size format of MicroTCA potentially attractive for these applications. The introduction of new fabrics plus demands for more performance and connectivity have pushed the current standards to their limits, ushering in a time for reevaluation and step changes of technology to stay at the cutting edge. In the case of VME, two new standards have emerged: VITA 41 (VXS) and, for more ruggedized applications, VITA 46 (VPX). These new standards introduce fabric-centric capability to VME products similar to MicroTCA, enabling VME to continue offering the ruggedized military market the required performance and specialized connectivity for some considerable time to come.

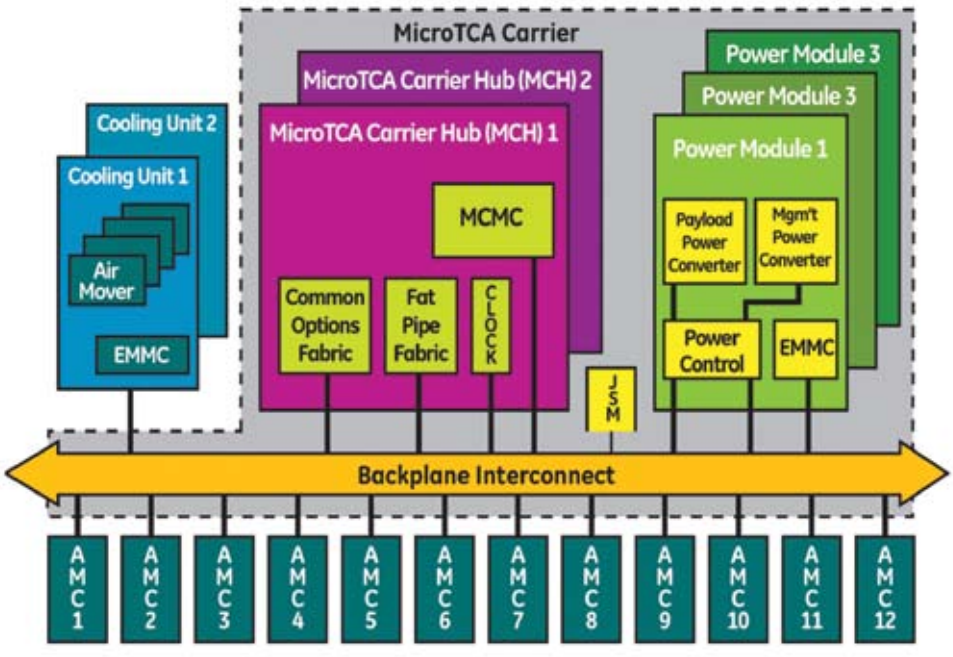


Figure 1

The recent successes of 3U CompactPCI in rugged military applications underline the growing need for smaller form factors where space and weight are critical. Adding extra capability to existing weapons platforms and the development of smaller, lighter UAVs are primary application areas for 3U CompactPCI today. But these application areas where VME and CompactPCI excel are at the very rugged end of the environmental spectrum. Developing MicroTCA to meet these demanding conditions would be very costly, and its key benefits likely would not add any perceived operational value. Form factor and architecture have minimal effect on the price of a rugged embedded computer; pound for pound or cubic foot for cubic foot, the recurring purchase price will be the same if the same level of performance, functionality, and power dissipation is required.

MicroTCA's high availability offers little additional benefit for many rugged applications. For example, a combat aircraft's mission may last no more than a few hours, but during that time 100 percent reliability is essential. The equipment must operate flawlessly at all times throughout the platform's operational envelope. Reliability is more important than high availability in this case because hardware and application software cannot be stopped and reconfigured if something goes wrong. Also, some classes of application are more suited to high availability and redundancy than others. Hardware redundancy works well for table-driven applications such as switches, routers, gateways, and concentrators but is excessively complex for intelligence-driven systems such as mission computers, flight control systems, and artificial intelligence applications. These require duplicate execution and synchronization at the operating system level and regular comparative checks of results.

Military application potential

MicroTCA does not have to compete with the established leaders in these rugged markets to be successful. Many other more directly suitable markets exist or are emerging that VME and CompactPCI will not be able to address as effectively. Existing markets include naval combat systems, both for submarines and surface ships as well as manned surveillance aircraft with pressurized work areas. Topping the list of product selection criteria for these systems are reasonable product longevity, tightly controlled configuration management, and long-term evolutionary road maps.

Mission times for naval vessels can extend to many months during which maintenance and repair activities must be carried out with minimum disruptions, so maintainability and availability are key features. These systems can use predominantly commercial grade products as their environment is carefully controlled. Open standards are vital for integrating the combat system with the many other systems found on these platforms, including sensors, weapons, Electronic Warfare (EW), self-defense, communications, propulsion, and navigation. Today VME is used extensively in this market because it offers many operational advantages over, for example, PCs or boxed servers. MicroTCA can offer these same advantages plus high availability and projected price point benefits.

With the advent of spiral development principles and the introduction of planned, regular technology refreshes, many programs operating in protected environments are learning to use the latest commercial technologies to their advantage. Defense policy aims to make technological superiority the ultimate advantage, but operational considerations often prevent deployment of the latest hardware. Excluding the specialized display requirements of combat systems, the embedded computing elements could be implemented using commercial grade PCs and servers regularly refreshed with the latest high street offerings. Cost is a big enabler of technology refresh. With its high levels of functionality and performance supported by its volume telecom market, MicroTCA is projected to offer rapid technology cycles and competitive price points that will make more consistent technology refresh both a necessary and affordable reality.

Military communications

The development of the Global Information Grid (GIG) and the Internet-like information battlefield of the future have highlighted the demand for ever-more bandwidth in the field and integration of the many diverse fighting and intelligence-gathering platforms from all the services. The Army's command structure of the future will have access to unprecedented amounts of information in the form of digital voice, data, and video from a multitude of sources. MicroTCA is ideally suited to the Army's need to develop its communications infrastructure and to satisfy its thirst for increased bandwidth via its satellite network. Mobile installa-

Figure 2

tions on trucks, containers, and Humvees such as command posts, UAV ground stations, and satellite terminals are all candidate applications. The broad range of functions available off-the-shelf in AdvancedMCs for the telecom market make implementation straightforward using well-proven building blocks and software. Figure 2 illustrates a range of AdvancedMC modules produced by GE Fanuc Embedded Systems, ready to serve mobile military communications applications. MicroTCA's small size means it can be protected from the external environment by *cocooning* without the expense of complete ruggedization, making it practical to implement in large numbers.

Road to deployment

Of course, MicroTCA cannot march out of the wire center straight to deployment. For many market segments, specialized interfaces will be required as well as environmental assessment and enhanced packaging. PCI Express and Serial RapidIO will be the key enablers to meeting the military interface and graphical display performance challenges. MicroTCA looks set to become the first serious contender to bridge the gap between the telecommunication and military markets, and could provide the breakthrough for standards-based, embedded computing into the military communications infrastructure that will become the backbone of the digital battlefield and the GIG.

To learn more, e-mail Duncan Young at young.duncan1@btinternet.com.

For additional reading

For more information on the growing MicroTCA trend, visit:

- ***Rugged MicroTCA: A swappable alternative, Q & A with Richard Moore, Kontron***
  www.smallformfactors.com/articles/id/?1861
- ***MilTCA? Not yet,***
  by Joe Pavlat, OpenSystems Publishing
  www.compactpci-systems.com/columns/foreword/pdfs/2006,12.pdf
- ***MicroTCA systems: Modular and scalable,***
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  www.mil-embedded.com/columns/industry_analysis/2006/Winter/Pavlat/

Cell BE not risky

Dear Editor,

One article printed in your DSP-FPGA.com Resource Guide – "The processing challenges in making network-centric warfare a reality" by Neil Harold of Nallatech – caught my attention and misses several points in characterizing the Cell Broadband Engine (CBE) as a relatively risky technology with a little-known future, tools, or ecosystem.

First, CBE was the result of a five-year, $400 M investment by Sony, Toshiba, and IBM. This is hardly a temporary event of little significance. On the contrary, this is the future of high-performance signal, image, and stream processing. What was the equivalent R&D investment for Virtex-5?

In addition, detailed road maps for the processor are well-known to almost every major U.S. defense integrator. CBE is available in five different form factors from Mercury Computer Systems, as well as from IBM directly in the QS20 blade, customized boards, or multichip modules. As a result, our clients are now evaluating CBE for radar, sonar, targeting, pattern matching, medical imaging, encryption, seismic analysis, and ray tracing.

There are other inconsistencies which, in fairness to your readers, should be addressed. First, peak performance from all nine processors is actually 230 versus 200 GFLOPS. Second, the difference between FPGAs and CBE goes far beyond simply clock speed. Essentially, Cell derives its blinding speed from a set of remarkably efficient cores with fewer transistors, larger register files, controlled branching, deeper pipelines, and a three-tiered memory hierarchy that dramatically improves subsystem performance.

IBM is also building out a large ecosystem of partners specializing in high-performance tools, compilers, debuggers, schedulers, and operating systems. This past year, IBM released its third version of the CBE software development kit and completed 24 workshops, 26 Web conferences, 10 podcasts, and trained almost 800 advanced programmers. In addition, 9,000 developers took CBE training online.

Finally, CBE shares many of the same programming challenges as those from the recently introduced Intel and AMD multicores. The result is that FPGAs, while impressive, are now relatively mature. There is now a renaissance in high-performance computing, one that will see a growing field of contenders and unprecedented power for military systems.

Regards,
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More information on CBE is available at:

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Enterprise storage enters the battlefield

Storage area networks enable advanced applications

By Ron Godshalk

Using a Storage Area Network (SAN) as a sensor fabric where sensors, storage, and processors are tied together with a Fibre Channel fabric, sensor data can be routed to processors and/or storage and used to emulate sensors or archive raw and processed data. Enterprise storage based on Fibre Channel is useful in ultra-wideband sensor applications such as radar, sonar, and signal intelligence. It has numerous possible applications on the battlefield, but some key application and integration challenges must be overcome.

The predominate application of Fibre Channel in military systems has been as a high-performance data network, but it is the enterprise storage capabilities of Fibre Channel that may soon make the most dramatic impact on the future of military systems.

Enterprise storage technology is actually a diverse set of technologies developed to address the needs of the corporate data center. This includes mass storage, SANs, Fibre Channel, RAID, hard disk and solid-state drives, and shared file systems. These technologies allow enormous quantities of data to be acquired, shared, processed, and post-processed by networks of specialized embedded computers, server farms, and remote workstations, enabling new classes of powerful analysis tools to mine this data in real time. These tools are analogous to Google Search, which continuously acquires website text from around the world and mines that data.

These analysis tools will depend on high-performance mass storage for both short-term data caching and long-term data storage.

A storage area network can be utilized as a *sensor fabric* where a Fibre Channel network (switches) is used to interconnect wideband sensors, processors, and high-performance mass storage as shown in Figure 1. Sensor data can be routed to enterprise-class storage technology or processors. Storage can be used to archive processed and raw data or to emulate sensors. The structure of the SAN is easily scaled in terms of performance and capability without re-engineering existing components.

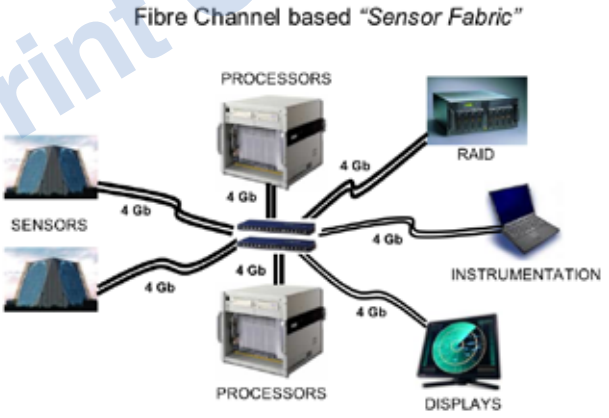

Figure 1

SANS and Fibre Channel – Overview

Mass storage technology's commercial applications can be broadly divided into three categories: desktop, server, and enterprise. *Storage area networks* apply only to the enterprise class. The enterprise uses a dedicated Fibre Channel data network to allow many processors to efficiently share multiple storage devices. The collection of Fibre Channel switches, cables, and interfaces used to implement this dedicated data network is referred to as the *storage area network,* but the term is often used more expansively to include the storage devices as well.

Today, Fibre Channel is the best option for this data network. It is broadly supported by a well-established ecosystem of storage components, network components, software drivers, and shared file systems that make it the only real choice. Eventually, 10 GbE will become a viable competitor to Fibre Channel but that will require broad support by the major storage vendors, which should occur within the next five years.

Prior to the introduction of Fibre Channel, enterprise storage applications were substantially limited by the interface of the day, the SCSI bus. Although the performance of SCSI has been increasing, it is still limited: It is a local bus with support for only a few devices and a short cable length. A true network technology is needed that can perform efficient block data transfers over longer distances, provide redundant connectivity, improve reliability, and be easily scaled.

Fibre Channel technology started with 1 Gb links in 1997, followed a few years later by 2 Gb, and is at 4 Gb today. In 2007, we will see the introduction of 8 Gb Fibre Channel. All Fibre Channel ports are backward-compatible with slower speed ports, which has allowed enterprise SANs to be incrementally upgraded over the years with minimal disruption. In addition to the performance improve-

ments, storage capacity has grown substantially over the years from about 100 GB in a 3U rack to more than 9 TB.

This market has been large enough and competitive enough that many vendors continually invest in next-generation components and supporting software elements such as drivers and management tools. The same is true for the storage subsystems vendors.

Enterprise storage technology as applied to military systems

As stated earlier, because of its ability to connect to storage systems, Fibre Channel is expanding beyond networking for use in any military system with high-capacity or high-performance storage requirements. Table 1 shows how Fibre Channel's characteristics can meet the needs of military storage networks.

But there are other benefits of using a broadly supported commercial network technology such as Fibre Channel for military systems where overall product life-cycle costs are critical. The major elements of system life-cycle costs include development, maintenance and support, training, and upgrade costs, as well as costs related to technology obsolescence. The use of Fibre Channel can help control costs in all of these areas as itemized in Table 2.

Enterprise storage based on Fibre Channel is useful in ultra-wideband sensor applications like radar, sonar, signal intelligence, network data collection, and multichannel security video recording. The nature of a Fibre Channel sensor fabric allows raw data to be retained for post processing and archiving. For example, imagine being able to record all cell traffic in downtown Baghdad to a mass storage device, and then after an event, being able to then mine that archived data for useful information related to the event. A dual-channel 4 Gbps Fibre Channel-based sensor could source nearly 800 MBps of data that could be distributed to processors for real-time processing or directly to a storage subsystem for offline processing.

Desired attribute	Fibre Channel capability
Data networking and storage	Processing nodes, sensors, switches, and storage
High performance	1, 2, 4, and 8 Gbps
High capacity	9 TB in a 3U rack
Redundant	Dual port nodes with failover
Scalable	Thousands of nodes possible
Standards-based	ANSI under T11 working group

Table 1

Reduced development costs	Standards-based Broad protocol support Mature tools
Reduced production costs	Widely available commodity components
Reduced field support and maintenance	Network-based test tools Custom testers can be implemented on PCs
Reduced upgrade costs	Scalable architecture Commercial industry pays for technology enhancements
Reduced obsolescence	Commercial technology and standards with history of backward compatibility

Table 2

Once mass storage – for example, sensor fabric – is an integral part of the system, it can be used for system emulation, validation, and built-in test by using the mass storage system to emulate the sensors. This provides, in effect, a sensor playback mode.

However, there are challenges in applying commercial storage technology to military systems – particularly with regard to the ruggedization of mechanical (rotating) hard disk drives. Mechanical hard drives don't do well in high-vibration environments, through wide temperature ranges, and are sensitive to dust. Fortunately, environmental enclosure solutions are available for mechanical drives. The capacity and performance of flash-based solid-state hard drives is approaching those of the rotating drives, making it possible to entirely eliminate the fragile drives going forward. Flash drives with capacities of near 200 GB and 65 MBps performance are available, whereas mechanical disks have capacities of 300 to 750 GB with 65 to 90 MBps performance.

Using Fibre Channel and storage in an embedded system

Figure 2 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 Fibre Channel 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, maintain, and scale.

Implementation details of a sensor fabric

Our example considers a generic mid-performance system consisting of a sensor (radar, sonar, digital radio, and so on) that produces a 240 MBps data stream. The sensor will send the data through a switch to four processors, each processing 60 MBps of data. The data is processed to extract any real-time information, and that information is then passed on to either a display processor or mission computer. Additionally, processed data is sent to a storage device. It is possible to send raw data directly to storage, but that will not be considered in this example. The data rates are 240 MBps from the sensor, 60 MBps to each processor, and 10 MBps of processed data from each processor going to the display processor for a total of 40 MBps. 40 MBps are also being written to storage. Therefore, each processor has a total of 60 MBps inbound and 20 MBps outbound.

Now that the performance requirements are determined, it must be decided which Fibre Channel protocol to use. One of the better standard protocols is FC_AE_RDMA. Remote Direct Memory Access (RDMA) provides relatively low latency and line rate performance. It allows direct transfers to or from another node's memory. SCSI-FCP is also a good protocol that has higher latency than RDMA, but still provides line rate performance. SCSI-FCP allows for more control and interaction between the nodes transferring data and is the standard protocol used for storage subsystems. TCP/IP over Fibre Channel may sound like a good alternative, but it suffers from the same performance limitations that Ethernet-based TCP/IP does: All the data must be processed by the host processor's stack, which will consume most of the processor's CPU cycles at these data rates.

Another decision is whether the system requires redundant connections. These would typically involve the use of dual-channel I/O boards, similar to the one shown in Figure 3, on the sensor and processors and two switches. Dual-channel I/O boards and storage subsystems are standard, so the trade-off is the cost of an extra switch. Typical redundant systems operate in an active/passive configuration where only test messages are sent on the backup path until a failure is detected on the primary path, but active/active redundancy is also possible.

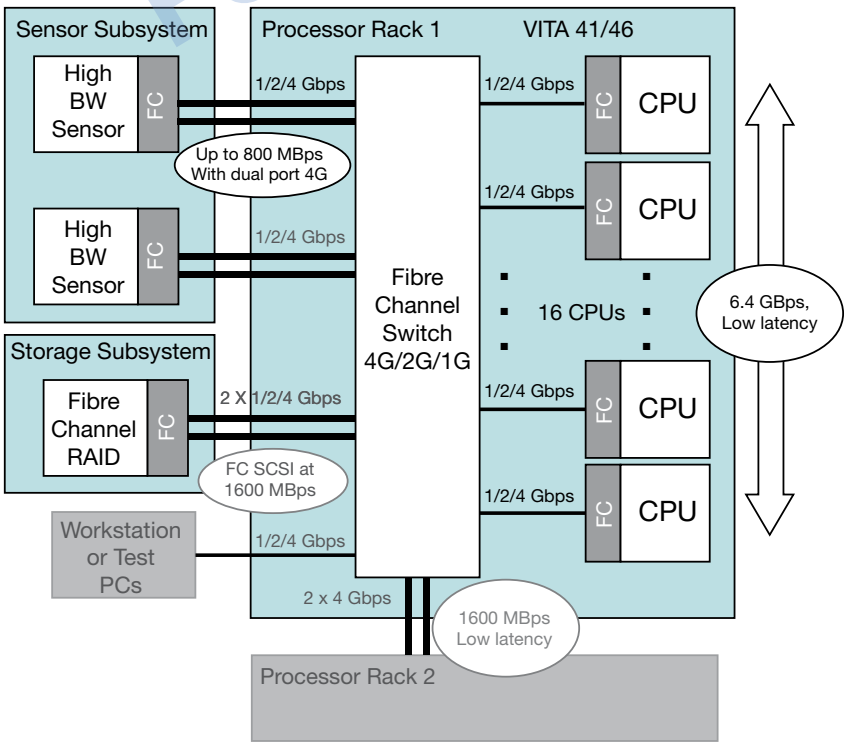

Figure 2

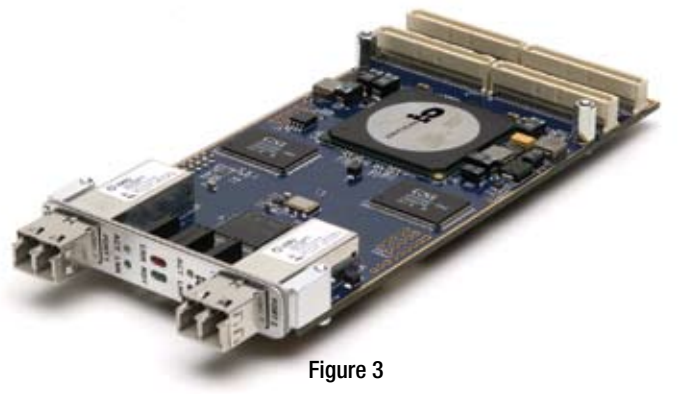

Figure 3

With redundant connections, the sensor will require a 4 Gbps interface to support its 240 MBps, and all other nodes could work with 2 Gbps interfaces. The switches will have to support 4 Gbps anyway, making the use of 4 Gbps on all nodes reasonable as it provides a large growth reserve.

The next decision is whether to use copper or optical interconnects. Copper cabling for Fibre Channel works best for short distances, especially at 4 Gbps on a backplane to interconnect modules in a rack. Rack-to-rack connections should use optical cabling as it weighs less and does not create/is not sensitive to electromagnetic interference. Most rugged I/O boards provide an option to run the Fibre Channel signals through the rear I/O to allow them to be distributed on the backplane as well as an option to provide direct fiber optic connections

The storage unit has cost, reliability, and performance trade-offs that should be considered early in the system design. A RAID will generally provide the highest functionality and performance but at substantial extra costs over a simple JBOD. Without a RAID controller the JBOD is cheaper, but now the devices accessing the storage must contend with handling multiple drives, whereas a RAID generally presents itself as a single drive.

A minor, although important determination to be made is to decide which file system will be used to access the storage. Extremely high-performance systems may

Fibre Channel as a sensor data network

A *sensor fabric*

Sensor-to-processor connectivity has typically been the domain of proprietary interface implementations, or specialty technologies such as VITA 17 Front Panel Data Port (FPDP) 1.28 Gbps or VITA 17.1 Serial Front Panel Data Port (SFPDP) 2.5 Gbps. These types of technologies have the advantage of simplicity and relatively low latency. They have the strong disadvantage of extremely limited network capabilities – typically none – and require the use of special-purpose interface hardware in the processor system. They also don't provide the direct connection to storage that Fibre Channel inherently provides.

Fibre Channel provides a true switched network, with capabilities to route data to multiple destinations, multicast, and broadcast. Since Fibre Channel links provide full duplex operation with reliable flow control, it prevents overrun conditions.

need a raw file system, whereas a system that stresses data integrity may need a slower journaling file system. Whichever file system is selected, it must be available on all systems that will be accessing the storage. This is usually more of an issue when the storage will be processed offline by a workstation that may be running a different OS than the embedded system.

The final step is to put the system together and write the applications. One advantage of Fibre Channel is that it is easy to set up a lower-cost development system with commercial grade products and then migrate to a fully ruggedized system.

The future of enterprise storage in the military

Enterprise storage technology will allow military systems to achieve much higher levels of intelligence and capability than currently exist. The battlefield is evolving rapidly, and advanced *knowledge-based* systems that can quickly distill intelligence from the wide array of broadband mobile sensors will likely make the difference between success and failure. Enterprise storage technologies will undoubtedly be a critical part of these systems by allowing raw information to be collected, retained, and made available to the knowledge base for improved intelligence.

Ron Godshalk is the Vice President of Engineering at Critical I/O and has more than 25 years of experience in high-performance computing and embedded systems. He has led the development of all six generations of Critical I/O's Fibre Channel products. He has an MS in Computer Engineering from the University of Southern California and a BS in Computer Engineering from Lehigh University.

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Securing your flash data

By Valerie Andrew, ACT/Technico

Securing data from unwanted attackers has escalated in worldwide importance, both in the public and government sectors. High global interconnectivity has rapidly created the need for more measures to be put in place; financial and network access control industries have aggressively sought to improve standards governing product security certifications (for example, FIPS and ITSEC). Some military agency regulations that govern these security measures include the DOD 5220.22 M, NAVSO P-5239-26 (Navy), AR380-19 (Army), and AFSSI-5220 (Air Force).

Embedded design engineers are increasingly required to put greater emphasis on protecting the data in their systems from security threats. Since attackers are skilled at devising inventive means of breaking software encryption, greater emphasis is being placed on the physical hardware protection. Short of complete destruction of a device, there are new methods of ensuring that the data is protected.

There are four basic methods of securing data on solid-state flash: secure-erase destructive, where the drive is no longer usable; secure-erase nondestructive, where the data is overwritten but the drive is intact; write-protect, where the data cannot be overwritten; and read-protect, where the data cannot be accessed.

Solid-state flash drives have made substantial strides in performance and, more recently, in capacity and cost. Environmental qualifications for flash drives far surpass rotating and magnetic media in reliability, shock and vibration, and temperature ranges, making them far simpler to qualify for stringent applications such as avionics. This is making them one of the most desirable storage solutions for applications requiring tight data security, such as surveillance, ISR, missile guidance, radar, mission data recording, and more.

ACT/Technico offers a hardware-initiated, mezzanine-based solid-state flash secure storage module, the Secure PMCStor (see figure). It provides three of the four above-mentioned methods of data protection: secure erase, with destructive or nondestructive erasure; and write protection. These methods can be enabled via an external switch or signal, which means there is less dependency on possible software glitches, as well as an easier path to qualification.

Valerie Andrew is Manager, Strategic Marketing, at ACT/Technico. She can be reached at ValerieA@acttechnico.com.

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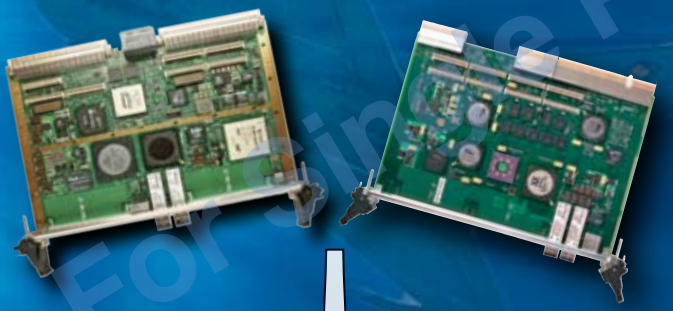

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Solid-state drives meet military storage security requirements

By Gary Drossel

While many designers still utilize consumer-grade storage in military applications, these solutions offer subpar security and insufficient reliability in the long-term compared to solid-state storage technologies developed for use in critical environments. Solid-state drives offer robust, customizable, and scalable security algorithms that, when combined with inherent environmental ruggedness, make solid-state drives ideal for military embedded systems.

A captain in the Dutch Air Force leaves a portable hard drive in his rental car. The contents: details of reconnaissance missions and security measures for the 1,200-man Dutch military presence in Afghanistan. The drive, which had no security encryption, is later found by two young men and copied onto a computer. The data is later returned to the officer, but incidents such as this one demonstrate all too clearly the need for the security of military systems worldwide.

Designers must come to understand that the security requirements of military embedded systems are fundamentally different from those of consumer electronic devices. In contrast to consumer applications, military embedded systems require data to be rendered invalid and inaccessible when the storage device is improperly removed from the host system for which it was intended. The host system must maintain ultimate control over security algorithms to protect data and prevent IP theft. These algorithms can be as simple as ensuring that the correct storage product is in the host, or as intricate as tying the software IP and mission data directly to the storage device. Since the security algorithm is host-centric and not device-centric, the algorithm itself can be completely proprietary and therefore much more secure. This security platform – combined with mechanical scalability, low power consumption, and long product life cycle – makes solid-state drives very attractive to military embedded system designers.

Examining the considerations

Storage devices for military embedded systems must meet a daunting number of criteria in addition to protecting mission or application data and software intellectual property. Data integrity is paramount, and the drive itself must not be susceptible to corruption due to power disturbances. The equipment needs to be highly portable, so the technology must have low power consumption characteristics and must be small and light enough to fit seamlessly in a vehicle or aircraft, or be carried by an individual soldier. Such systems must be able to handle extreme environmental conditions such as shock, vibration, and altitude, and should tolerate a wide range of temperatures. There is a need for a

Market concern	Hard drive	Solid-state drive	Flash card
Corruption due to power disturbances	Adequate	Requires enhanced protection circuitry	Poor
Product life cycle	Less than one year	Multiple years	Less than one year
Wear-out	Environmental and mechanical concerns	Very good – write/erase endurance exceeds 2 M cycles	Write/erase endurance less than 10 K cycles
Security	Possible password protection via ATA specifications. No sweep, scrub, or purge	High-end drives provide several security options such as password protection, sweep, scrub, and purge	Possible password protection via CompactFlash specifications. No sweep, scrub, or purge
Power consumption	> 2.5 W	> 2.5 W	< 1 W
Mechanical dimensions	2.5"	2.5"	CF

Table 1

multiple-year product life cycle and high endurance rating to make sure the drives operate reliably for several years.

How different forms of storage stack up

With all these considerations, it is not surprising that storage products originally designed for the consumer electronics market do not in general meet the needs of military embedded systems. Table 1 illustrates the design trade-offs of traditional storage solutions for military embedded systems.

As the table shows, solid-state drives offer more advanced security options, better environmental performance, and longer product life cycles than hard disk drives, but designers must be careful when choosing these solutions. Traditional solid-state storage solutions designed to satisfy high capacity and advanced data security requirements have been mechanically confined to 2.5"or 3.5" hard drive form factors. This is not only because of the number of storage components – usually NAND flash – required to achieve the desired capacity, but also because of the physical size of the microprocessor and associated logic used to provide the host system interface and the solid-state memory management algorithms. These circuits have neither been able to scale to smaller form factors nor have they been able to achieve power consumption rates less than the typical 2.5 W of rotating hard drives.

Applications requiring smaller mechanical form factors such as CompactFlash or PC cards used in consumer applications present their own set of challenges. While these products offer relatively good environmental performance and consume little power – in general, less than 1 W – there are still concerns about product life cycles, endurance, and security capabilities.

In addition, most drives and flash cards customarily designed for use in consumer applications do not provide security technology such as fast erase or purge that will prohibit data from falling into the wrong hands. In addition, their password protection algorithms may not be flexible enough to allow the host system to implement its desired algorithm.

The ideal solution for military applications, therefore, is a mechanically scalable, low-power storage solution that is impervious to power disturbances, maintains a long product life cycle, prevents field failures due to wear-out, and provides access to low-level security *hooks* so the host can define its own security algorithm.

Security concerns worth consideration

Many military embedded applications require advanced security levels. Data recorders and wearable and field computers require features such as ultra-fast data erasure and sanitization, data zones with independent security parameters, and secure areas for designers to access and create their own encryption and decryption keys. These features protect

application data and software IP from theft or from falling into the wrong hands as illustrated in the 2001 incident where a Navy surveillance plane collided with a Chinese jet and was forced to make an emergency landing in China.

Military-focused OEMs want to perform two key functions in their application to protect mission data and software IP. First, there is a need to ensure that the end user is utilizing a qualified storage device in the system. In some instances, perhaps for security, warranty, or service purposes, the OEM needs to know that the specific drive originally shipped with the equipment is indeed still in the system. This type of technology prevents a rogue storage device from entering a secured system. Without this technology, it is possible to place a similar product with the same part number from the same vendor into a system. That similar part number may contain incorrect or malicious data that may or may not be detected before it is too late. With the type of technology described here, the system would not even boot and the chances for errors (or worse) would be greatly diminished. Second, there is a need to tie mission data and software IP to the specific drive for which they were intended to prevent theft and ensure software integrity.

One possible method to accomplish this is for the drive to reserve a specific area that is only accessible to the OEM through a proprietary command. That area could store specific host system information so that when the drive boots up, the host reads the data in this secure area and looks to match that data with a host serial number or other identifier. If there is no match, the drive is inaccessible. That area could also store data that the host could use as the key to its proprietary encryption algorithm.

Preventing data from falling into the wrong hands

Data in a hard drive, a solid-state drive, or a flash card is stored in 512-byte increments called *sectors*. Each sector also has associated with it a 16-byte control block as illustrated in Figure 1. Control blocks store bad block information, error correction, and perhaps some proprietary monitoring information that must be maintained if the drive is to be reused.

Data security features can be initiated via software through hardware initiation such as a switch connected directly to the storage device, a vendor-specific command structure, or through some combination of both. Consideration should be given to the specific implementation and the required drive technology. Magnetic media such as hard disks and tape drives provide the lowest initial price per gigabyte at the expense of environmental performance, multi-year product life cycles, and the ability to quickly erase all data on the drive. It can take a matter of hours for large amounts of data to be scrubbed from magnetic media. Even then, the process needs to be repeated to prevent data *ghosts* or portions of data that remain on the drive that can be recovered with specialized equipment. The result is a very time-intensive process not at all well-suited to the quick-erase needs of military systems.

Attempts were recently made by military contractors and research institutions to improve erasure time by exposing drives to extremely high-powered magnets – a process also known as *degaussing*. Researchers made custom neodymium iron-boron magnets and special pole pieces made of cobalt alloys and used them to erase hard drive data.

Erasure time was reduced from several hours to several minutes, but other problems presented themselves. For one, the magnets weighed about 125 pounds, causing severe limitations in most field applications and virtually eliminating possible use in mobile computers. The mechanics of the magnets proved to be a challenge as well. Mechanisms had to be fabricated that would push the drives past the magnets, further adding to the weight consideration. Users had to physically pull drives out of their enclosures to pass them through the magnetic field. This added more steps to the data removal and greatly impacted the amount of time required to erase the data.

Later improvements on the magnet exposure process have brought the weight down to as little as six pounds, still a consideration for wearable computers but better for vehicle and aircraft mounted equipment. There is still the necessity of pulling the drives from their enclosures to place into the mechanism by hand, which can significantly slow the overall process.

Other methods of eliminating data are still under consideration. In recent years, exposing drives to heat-generating thermal material has been explored. Repeated tests of this method, however, have not been promising. Evidence has shown that despite the damage a thermal reaction can inflict, amounts of data on drives could still be recovered.

The act of physically crushing or shredding a drive to prevent future use and data access is another alternative, but one that carries with it certain drawbacks. For one, even badly mutilated drives can still yield useful amounts of data. Another factor is the machinery necessary to destroy the drives, which can be very heavy. As with using heavy magnets, the extra steps of removing the drives from their enclosures and inserting them into the machinery for destruction make this more awkward.

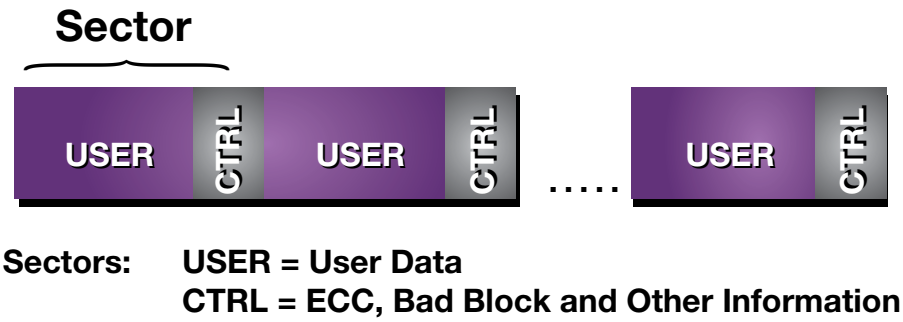

Figure 1

The solid-state difference

Because the physics of solid-state drives are significantly different from those of their magnetic counterparts, so is the way solid-state drives write and erase data. Figure 2 illustrates a typical floating gate cell in a nonvolatile storage component. Charge on the floating gate allows the threshold voltage to be electrically manipulated to levels that represent a logical 0 or 1. The process of erasing and writing revolves around tunnel release and tunnel injection of electrons onto the floating gate. These processes allow no possibility of ghost images on the device after an erase, so no scrubbing technology is required. In fact, the erase process itself is a form of data scrubbing since the operation consists of writing "00"s then "FF"s.

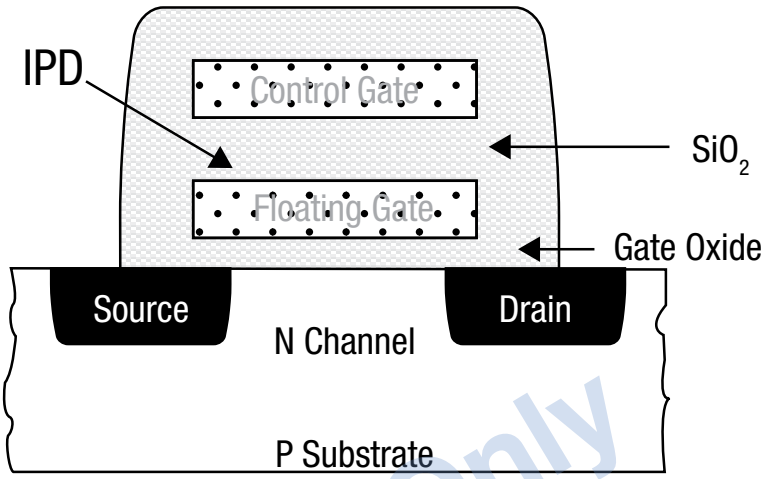

Figure 2

In addition to the type of media, the system designer must determine whether or not the drive should be reusable or rendered unrecoverable after executing the fast erase – or *sweep*. He should also determine what needs to happen with any data that may be in non-user-addressable areas like bad blocks or spares. Standard ATA commands will not be able to address these areas. The designer may also want to implement a multiple-step command sequence to ensure the erase is not initiated erroneously.

Consideration should also be given to providing enough power to complete the erase, but this may not always be possible. In such an event, intelligence must be built into the drive so that an incomplete sweep operation will finish the next time the power is applied – independent of the host system. The designer must also

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Bus	AT Expansion Bus			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PCI Universal Expansion Bus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
	PCI Bus Masters	4	4	4	4	4	4	4	4	4	4		4	4
	APIC (add'l PCI interrupts)	9	9	9	9	9	9	9	9	9	9			
CPU and BIOS	CPU Max Clock Rate (MHz)	1400	1400	1400	1400	650	650	650	650	650	650	333	333	333
	L2 Cache	2MB	2MB	2MB	2MB	256k	256k	256k	256k	256k	256k	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
	RTD Enhanced Flash BIOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Nonvolatile Configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Quick Boot Option Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Peripherals	Watchdog Timer & RTC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	IDE and Floppy Controllers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	SSD Socket, 32 DIP						1		1		1	1	1	
	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
	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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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						
	Resolution (bits)	12	12		12	16	12	12						
	Output Ranges	4	4		3	1	4	4						
	D/A FIFO Buffer	8k	8k				8k	8k						

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model the time required to fully erase the drive based on the criticality of the data. Table 2 and Figure 3 illustrate the benefits of proprietary commands that can be used to provide a fast erase mechanism versus using standard ATA commands.

Table 2 contrasts the time it would take to fully erase a storage product by using advanced storage technology (for example, a vendor-specific command) and using standard ATA commands. These benchmark times show that data can be erased significantly faster if advanced security technology (such as fast erase or sweep) is used.

It is also important to understand how the drive implements the fast erase feature. Some require the entire contents of the drive to be erased. Others can sweep only the most critical or classified data by implementing advanced zoning technology. Use of this technology allows the system designer to be able to partition the drive into different zones with different security parameters. One zone could hold standard operating systems or nonclassified data files. A second zone could be a read-only lookup table, and a third zone could store classified data. Designers then have the flexibility to only sweep that zone with the classified data. Depending on the size of the classified partition versus the size of the drive, erase times could be cut by more than half.

Capacity	Vendor-specific commands (in seconds)	Standard ATA commands (in seconds)
32 MB	3.4	5.2
64 MB	5.9	10.4
128 MB	2.8	20.7
256 MB	3.3	41.4
512 MB	4.9	82.9 (1.38 minutes)
1 GB	5.9	166.5 (2.77 minutes)
2 GB	6.8	333.5 (5.55 minutes)
4 GB	8.3	671.5 (11.19 minutes)
8 GB	13.8	1343.9 (2239 minutes)
16 GB	14.7	2621.7 (43.69 minutes)

Table 2

The future of storage

New technology is continually evolving to meet the stringent security demands of military embedded systems. The overwhelming success of solid-state drives in the consumer electronics sector will continue to motivate traditional hard drive users to seek lower-power, more portable,

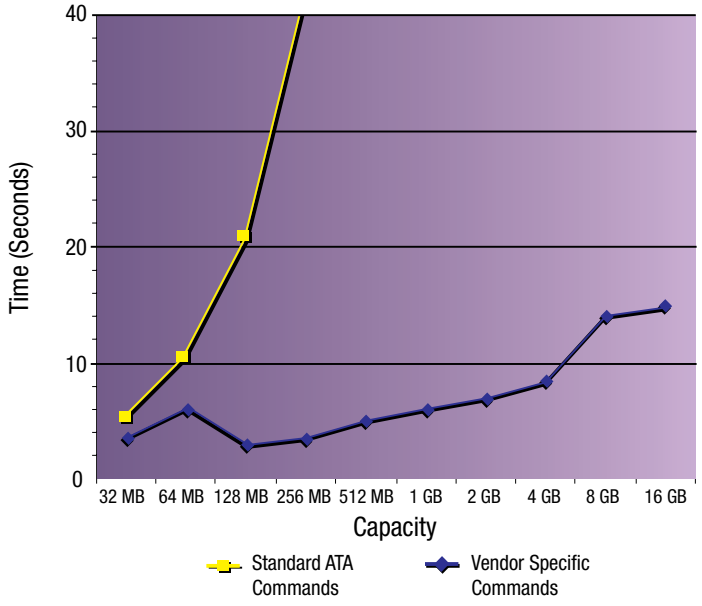

Figure 3

more rugged solutions. Storage vendors targeting the military embedded system space will continue to leverage the economies of scale this success has brought. However, they must provide robust, host-centric security methodologies to enable OEMs to define their own security algorithms, and they must provide the engineering and technical support required to ensure a smooth implementation of storage into more complex military and embedded systems.

Gary Drossel, *VP of Product Planning, joined SiliconSystems in 2004 and is responsible for managing technical marketing and application engineering for SiliconSystems' complete product line. A 16-year embedded computing industry veteran with a wealth of knowledge concerning solid-state storage technology, he has also played a leading role in developing the company's marketing strategy, including product roll-out and customer introduction. Gary received a BS degree in Electrical and Computer Engineering from the University of Wisconsin.*

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Solid-state flash disk: Bringing cost-effective ruggedness and security to data recorders

By Rochelle Singer and Guy Freikorn

Digital technologies have brought vast improvements to the reliability and security of data recorders. Now, as advanced technologies in solid-state flash disks make them available with higher-capacity memory at increasingly lower costs, manufacturers are relying on them to deliver a new generation of data recorders with superior reliability and tighter security.

Storing data securely and reliably has posed a dilemma for mission-critical data recorder manufacturers and users. On one hand, ruggedized storage devices that can accommodate the required harsh condition specs are extremely costly. On the other hand, affordable COTS devices cannot meet the mission-critical requirements of the military and aerospace industry without being specially ruggedized. Until recently, high-capacity storage systems capable of supporting high data rates in environmental and operating extremes exceeded most program budgets.

But the widespread use of digital technologies has brought costs down while boosting the reliability and security of data recorders. The use of solid-state disks (also known as *solid-state drives*) instead of tape media or mechanical hard disk drives brings additional benefits to data reliability and security. As the cost of solid-state disks continues to drop and memory capacities increase, data recorders are becoming more rugged and secure than ever before.

"As the cost of solid-state disks continues to drop and memory capacities increase, data recorders are becoming more rugged and secure than ever before."

Defining ruggedness requirements

Environmental extremes such as shock, vibration, dust, salt water, extreme temperature ranges, and high altitude severely compromise the reliability of data recorders containing mechanically moving parts. A recorder containing only electrical components can more easily be designed to withstand these conditions. Typically, electronic components can easily be assembled and sealed against altitude, dust, and salt water intrusion. Careful component selection and handling of worst-case timing during the design phase guarantees operation at extreme temperature ranges. Vibration and shock can be handled mainly by careful mechanical design by using rugged interconnections both in the recorder and between the recorder and the media.

Each platform, depending on the type, has unique environmental requirements. Helicopter and rotary engine aircraft require systems that withstand 0.076 g^2/Hz, and 20 g-peak half-sine wave vibration for applications such as catapults and traps on aircraft carriers. Fighter aircraft requires operation in 10 *g* linear acceleration and high-jerk environments. Ground systems such as tanks and combat vehicles have extremely high temperature requirements (-40 °C to +85 °C) and must withstand high vibration and shock. These requirements are coupled with the need for operation in an extremely dirty environment.

Riding the digital technology wave

Data recorders use fully digital technologies that convert the sensor data into digital form. The use of DSP improves the signal quality, as well as both data reliability and security. Redundancy can easily be added everywhere in the digital recording process to secure data transmission and storage with checksums and to enable the application of sophisticated error detection and correction techniques.

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

Comparing data storage solutions

Three types of data storage solutions are used prevalently in data recorders, each with its own advantages: tape media, hard disk drive, and solid-state drive. However, with the move to digital technologies, the once-favored tape media is increasingly being replaced by fully electronic solutions.

Tape media

Tape media has significant cost advantages for data storage with the lowest cost per bit and high-volume efficiency. However, the record/replay process requires that the tape, a flexible media that is sensitive to temperature and humidity, be mechanically moved across either fixed or moving heads. This process is highly

susceptible to the effects of vibration and acceleration, causing tape debris, time base variations, and head-to-tape separation. These effects result in error rates so high that error detection and correction strategies cannot be guaranteed to work in nonbenign environments.

Hard disk drive

Hard disk drives in hermetically sealed housings provide relatively good protection against foreign debris and the ambient environment. The rugged nature of the platter(s) and very lightweight head components provide a degree of built-in acceleration tolerance. However, the drives rely on very fine gas bearings to separate the flying heads and platter. Both excess acceleration and air pressure reduction at high altitudes (in a lower-cost, nonsealed drive) are likely to cause a crash. Unlike the temporary data loss data experienced with an overstressed tape drive, a single head crash can prevent normal access to all data on a hard drive and will likely render the drive permanently inoperable.

Solid-state disk

Solid-state disks have the inherent advantage of no moving parts. The effects of temperature, humidity, shock, vibration, acceleration, altitude, fungal attack, RFI, and foreign material intrusion can be controlled within desirable limits if the media is designed to meet the appropriate standards. Although the reliability and longevity of individual bit storage elements are not as robust as magnetic media, they can be vastly improved by the sophisticated management of memory cells. Static and dynamic wear-leveling, standard and dynamic bad block management, and error detection and correction code extend the flash lifespan and result in highly reliable and rugged data storage.

Table 1 summarizes the pros and cons of these data storage solutions for digital recorders; Table 2 takes a close-up look at critical specs of the solid-state disk versus the hard disk drive.

The ongoing trend of decreasing prices for higher-capacity solid-state storage has made the solid-state disk the most appropriate media for extremely ruggedized applications. The price of solid-state storage has already fallen to a level that promises a lower total cost per recording system than the cost of the earlier magnetic-based storage media. As prices continue to fall due to advanced technologies and processes and the increasing volume of flash used in the consumer electronics space, NAND-based flash is predicted to keep on climbing in terms of bit growth and revenues, as shown in Figure 1.

The additional costs for ruggedizing and hermetically sealing tape or hard disk drives – and the extra space required for these solutions – often translate into additional overhead costs. In contrast, solid-state solutions offer a more attractive overall price.

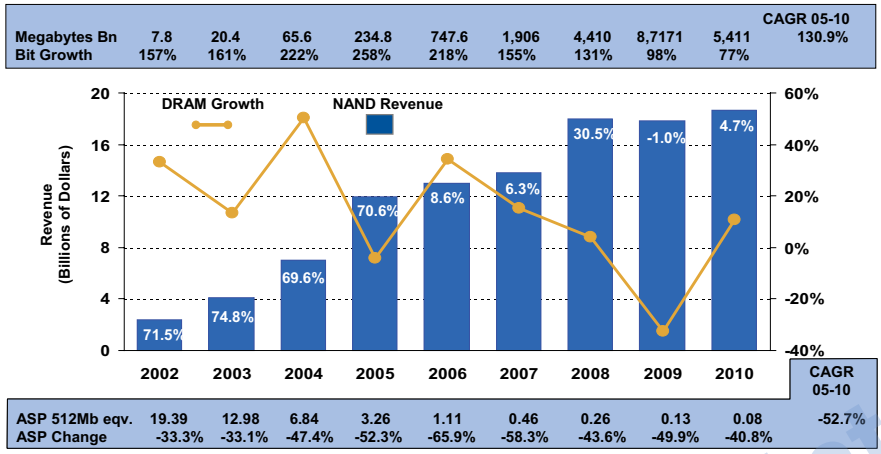
Media	Key attributes	
	Pros	Cons
Tape	Lowest cost/bit High-volume efficiency	Sensitivity to temperature, humidity, vibration, and acceleration result in high error rates
Hard disk drive	Good cost/bit in high capacities Some degree of built-in acceleration tolerance	Poor reliability in harsh environmental conditions Moving parts are unreliable Excess acceleration and air pressure reduction can render drive inoperable Hermetically sealed hard disk drive reduces cost advantage
Solid-state disk	No moving parts Withstands harsh environmental conditions	Requires effective flash management, strong error detection, and error correction to overcome low data reliability with installed flash media

Table 1

Parameter	Solid-state disk	Hard disk drive
Operating temperature	-40 °C to +85 °C	5 °C to +60 °C
Operating shock	1,000 *g*	300 *g*
Operating vibration	16.3 *g*	1 *g*
Humidity	5%-95%	8%-90%
Operating altitude	80,000 ft	10,000 ft
Actual/fielded MTBF	> 1,400,000 operating hours	< 330,000 operating hours
Write/Erase cycles	5 million	600,000
Average access time	0.1 ms	17 ms
Sustained read (highest)	45 MBps	40 MBps
Sustained write (highest)	40 MBps	40 MBps
Read/write IOPS (highest)	14,000	9,000
Power on spin-up	None	5 W
Power for read/write (average)	1.5 W	2.3 W

Table 2

NAND Flash Market Forecast: Still Caution Ahead in 2007; DRAM Influence?



Source: Gartner Dataquest, November 2006
Semiconductor Forecast Worldwide--Forecast Database [SEQS-WW-DB-DATA]

Figure 1

Solid-state disks from companies such as SanDisk (Figure 2) are designed to meet the environmental requirements of military missions. With no moving parts, they can operate in the harshest environmental conditions defined in MIL-STD-810F: operating temperature range of -40 °C to +85 °C, humidity range of 5 percent to 95 percent, shock conditions at 1,500 *g* half-sine, and random vibration of 16.3 *g* (10 Hz to 2,000 Hz) at an altitude of 80,000 feet.

Meeting security requirements in emergencies

Securing confidential data in emergency situations is essential for mission-critical systems. Security agencies in the United States define several levels of "erasing" sensitive data for various storage media types such as tapes, magnetic disks, and optical disks. Each U.S. military force has compiled its own internal document, based on the DoD/NSA instructions.

Since erasing is a generic term, several others terms are used:

- ***Clearing:*** Data on the media is eradicated before it is reused in an environment that provides an acceptable level of protection for the stored data prior to clearing.
- ***Sanitizing (also called "purging"):*** Data on the media is removed before it is reused in an environment that does *not* provide an acceptable level of protection for the stored data prior to sanitizing.
- ***Destroying:*** The media itself is physically damaged to make it totally unusable, thereby making data retrieval impossible.

Magnetic media

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

Solid-state disk

Conversely, the "erased" state of a flash memory cell has very little dependence on its previous logic states. Carefully planned erasure sequences and known data pattern writing can quickly establish or destroy the security of every cell in a solid-state disk. Memory chips can be erased and overwritten in parallel, so that a built-in declassification algorithm can provide erasing and multiple overwriting support within just seconds – leaving behind no trace of classified data. Solid-state flash disks are available today that can sanitize the drive in seconds with secure erase and sanitize procedures.

Figure 2

Once secure erase has been activated, autoresume secure erase guarantees successful completion of the process. The SanDisk Serial ATA (SATA) family of flash disks provides secure erase, sanitize, and autoresume capabilities.

Delivering digital benefits to data recorders

With the current trend of cost reduction in flash media combined with new technologies that enable increasingly more data to be stored in ever smaller silicon die, the flash-based solid-state drive is now cost-effectively bringing fully digital technologies to the data recorder industry.

The benefits are at least twofold. In contrast to the conventional tape media and the mechanical hard disk drive, the solid-state disk is capable of operating under a far wider range of environmental extremes in harsh field conditions. Unlike magnetic media where magnetization history can only be destroyed by physically destroying the tape or hard disk drive, the solid-state disk provides erasing and multiple overwriting support to destroy classified data almost instantly, while making sure that it remains totally unusable.

As flash prices continue to drop annually by 50 percent, these benefits are set to make the solid-state disk increasingly popular as the storage solution of choice for data recorders.

Rochelle Singer *is marketing and technical writing documentation manager for SanDisk's embedded division. She has been with msystems, recently acquired by SanDisk, since 2001. She has more than 20 years of industry experience as a marketing and technical writing specialist and has held numerous positions in companies such as National Semiconductor and the Weizmann Institute of Science. Rochelle received a BA in English Literature from Barnard College of Columbia University and an MFA in Creative Writing from Brooklyn College.*

Guy Freikorn *is SanDisk's solid-state drive product manager and has been with msystems, recently acquired by SanDisk, since 2005. Through his role as product manager, Guy maintains close contact with customers in providing them with advanced, flash-based storage solutions to meet their requirements. Guy earned a BA in Computer Science and Management from Open University of Israel.*

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In the world of high-performance data acquisition and data recording, a perfect storm is brewing

System architects seek greater bandwidth and faster peripherals

By Philip Brunelle

Emerging bus architecture standards such as PCI Express and other technology advances are converging to create a new world for high-speed data capture. There's enormous opportunity for growth as PCI Express replaces shared bus architectures with its point-to-point functionality. With 30x performance improvements over base PCI implementation, we will see an impressive theoretical threshold of 4 GBps top-end performance, thus breaking down traditional barriers to high-end data acquisition and recording.

In the world of real-time systems, standard bus architectures including PCI, VME, PXI, and CompactPCI are fundamental to addressing a broad spectrum of high-performance applications with modular instruments and high-speed recording devices. Data movement within a real-time system is throttled by the slowest link in the overall architecture. While performance has been widely addressed for CPU, disk drive, RAM, and network architectures, the data bus available in standard motherboards continues to rank as the slow zone of total system throughput. But now with emerging standards like PCI Express, a new world of nearly unlimited bandwidth is quickly unfolding. The elements are converging to form the perfect storm of high-speed data capture.

In with the new, out with the slow

The PCI bus has long been the standard for expanding general purpose PCs to enable a broad range of I/O, storage, and networking capabilities. At its inception, the PCI bus provided an impressive 132 MBps performance in a 32-bit architecture. This performance, however, is only a theoretical limit. In practice, the PCI bus is designed to be shared among multiple devices. Just as traffic lights regulate the flow of interconnected roadways, a bus manager or arbitrator ensures equitable use of the PCI bus by one or more competing resources. The arbitrator, by itself, results in performance degradation and a 20-25 percent overhead. The practical limit on the 32-bit bus is therefore significantly slower, or less than 100 MBps. In fact, the device may have to share the available bandwidth with other devices on the shared PCI bus, and the result can be significantly lower than 100 MBps.

Because of the limitations of the PCI bus, designers have used serial fiber data links and specialized controllers that bypass CPU and bus limitations to achieve data recording rates in excess of 200 MBps (see Figure 1).

Over the years, chip designers have been able to compensate by developing new offerings like 64-bit and higher clock rate versions of the PCI bus. While each successive standard provides

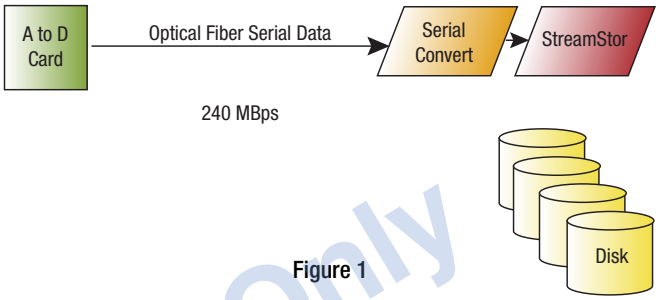

Figure 1

higher aggregate bandwidths, system architects have struggled to overcome the inherent complexities and limitations of shared bus architectures. In real-time systems where bottlenecks can cause disastrous data loss, the inability to guarantee a sustainable throughput forces designers to significantly over-design solutions. The 64-bit and higher clock rate PCI solutions raise design expense and complexity and reduce the number of devices that can share the same bus. And still, the mighty bus arbiter has the final say in who gets the available resources.

In a point-to-point bus topology, a shared switch replaces the shared bus as the single shared resource by means of which all of the devices communicate (see Figure 2). Unlike in a shared bus topology, where the devices must collectively arbitrate among themselves for bus use, each device in the system has direct and exclusive access to the switch. In other words, each device sits on its own dedicated bus, which in PCI Express lingo is called a *link*.

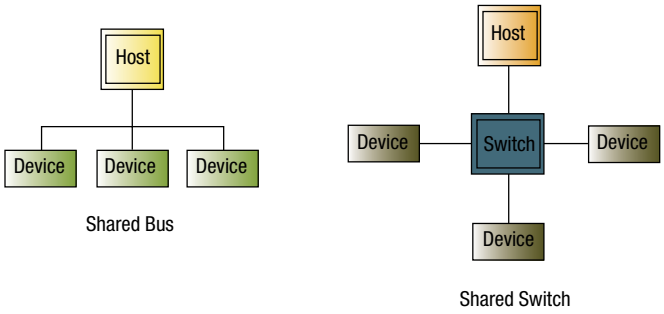

Figure 2

The emerging PCI Express standard now offers to provide a high-speed alternative by dedicating *lanes* for high-speed traffic within a computing environment. The concept involves establishing point-to-point, dedicated data lanes. The arbiter in the PCI world is replaced by a Root Complex that is designed to establish true point-to-point data links and then remove itself from the equation. The results are astounding with 4 GBps (16 lanes) in each direction with minimal overhead once the connection is established. PCI Express paves the way for superior performance in the most demanding real-time applications.

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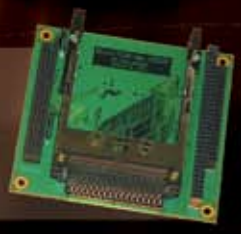

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Real-world, real-time improvements

In real-time environments, PCI Express affords a clean pipeline for data with its point-to-point architecture. PCI Express also includes impressive expansion possibilities. With dedicated, uninterrupted high-speed bandwidth to each individual device on a dedicated lane and zero requirements for bridging, applications can extend over significant distances without suffering performance degradation. Systems with 150 I/O boards can be built, and additional chassis can be connected with low-wire-count copper cabling that can operate at distances of up to seven meters.

The PCI Express specification will preserve software investments, and standard PCI and PCI Express cards can operate in the same system. Module manufacturers can supply instrument and I/O controllers that plug into PCI, PCI Express, or both buses. CompactPCI and PXI are also adopting the PCI Express specification to bring the same benefits to the industrial and test markets.

A single lane connecting two PCI Express termination devices is called a *by one* or written as an x1 link. More rapid interconnect speeds may be achieved by utilizing multiple lanes in parallel between PCI Express and termination devices such as sensors and recorders. Links can be increased from x1 to x16, which leads to performance ranges from 250 MBps to 4 GBps total bandwidth. In addition, all PCI Express lanes are full duplex, which allows data to flow in both directions simultaneously at full data rates.

At the top end, PCI Express can allow for performance up to 4 GBps for dedicated applications – first generation, 16 lanes, only counting one direction – or a 30x performance improvement over the base PCI implementation. That's four times faster than the fastest implementation of PCI Express (PCI-X 64/133). This allows an enormous opportunity for growth as PCI Express replaces shared bus architectures with its point-to-point functionality. PCI Express continues to capitalize on the high performance and low cost of PC technology that commodity desktop systems are shipping with PCI Express. As this first generation of PCI Express delivers much improved performance over PCI, PCI Express's next generation is being positioned to offer yet higher lane speeds. This will further break down traditional barriers to high-end data acquisition and recording.

The storm is here

PCI Express is highly scalable and takes advantage of newly available high-performance serial channels in FPGAs. These devices help bridge the development gap between legacy PCI buses and PCI Express. Hardware such as frame grabbers, controllers, and disk drives are able to easily capitalize on low-cost FPGAs to quickly implement PCI Express as we enter the petabyte (10^{15} bytes) world of massive storage potential.

Standard bus architectures including PCI, VME, PXI, and CompactPCI, in relative terms, have held data transfer

rates in the slow zone. Shared bus arbitration has constrained the PCI bus, and high pin counts have made it too expensive and complex for wide adoption. Today, PCI Express offers an impressive theoretical threshold of 4 GBps top-end performance.

In addition to increased bus bandwidth advances, the disk drive industry has introduced advanced *perpendicular* – aligning the bits vertically, perpendicular to the disk to compress more data in less space – recording capability. By recording data

(continued on page 34)

Solid-state drives reporting for duty

By Tom Bohman, VMETRO Inc.

Rotating storage fits many semi-rugged applications, but in platforms such as helicopters, tanks, and other tactical vehicles, hard disk drives usually can't survive for long once the action starts. This problem leaves these platforms' electronics designers with limited storage options.

For extremely harsh applications beyond the limits of hard disk drive technology, new solid-state drives are reporting for duty. Today's drives are denser, faster, more durable, and cost effective for use in a broader range of applications.

Ideally, packaging for these solid-state drives would allow them to fit next to existing electronics without requiring external boxes and additional connections. Since many tactical applications already have their electronics packaged in either conduction- or air-cooled ATR enclosures, one solution would be to mount the solid-state drives inside the ATR enclosure.

Designers could cobble together ad hoc solutions by mounting and cabling the drives. A more elegant solution, though, would mount solid-state drives on a carrier that inserts into an ATR slot the same way that signal processing and I/O hardware does. An example of this approach is the VMETRO VMDRIVE (see figure), which mounts solid-state drives onto a carrier ready to fit into an available ATR slot.

With mounting accomplished, cabling is simplified. The carrier pulls the necessary power for the drives from either the VME or CompactPCI backplane in the ATR enclosure. Fibre Channel interfaces are designed into the unit and presented at the front panel. These can be cabled in various SAN topologies to high-performance dedicated storage controllers or single board computers with Fibre Channel interfaces.

Solid-state drive solutions such as these give designers better options and simplify adding electronic storage to the most rugged tactical defense platforms.

Tom Bohman is VP of Business Development for I/O and Recorder Products at VMETRO Inc. He can be reached at tbohman@vmetro.com.

vertically at densities of 230 GB/square inch, terabyte drives are now emerging. As data densities go up, data transfer rates also increase. This will allow faster data recording for longer periods of time. Together with PCI Express, this advance in disk technology enables a new level of performance that was previously difficult and prohibitively expensive to attain.

PCI Express and other technology advances broaden the application set and enable Conduant and its StreamStor technology offerings to perform at full potential. Conduant's new PCI Express based product features four-lane endpoint connectivity to the host PCI Express fabric. Coupled with PCI Express,

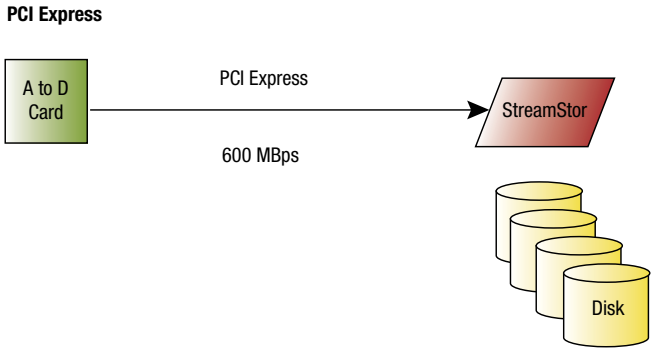

Figure 3

the full potential is limited only by the performance of the storage subsystems. With the introduction of PCI Express, data transfer rates have increased to 600 MBps (see Figure 3).

Lightning speeds usher in a new world of performance

Many industry segments are poised for the furious speeds PCI Express will make possible as components and peripherals are adapted to take advantage of the emerging technology. New applications will appear as the dedicated bandwidth of PCI Express allows the petabyte world to open up. As we see subsystems riding this emerging bus standard, new solutions and capabilities will unfold. The perfect storm is converging.

Philip E. Brunelle *is cofounder of Conduant Corporation. His 27 years of experience in electrical engineering include product development for StorageTek, MiniScribe/Maxtor, and Harris Corporation. Phil holds three U.S. patents relating to different methods of improving the performance of disk drives and systems. He earned his BSEE from the Rochester Institute of Technology.*

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Product review: rugged case for Treo 650/700 smartphones

By Chris A. Ciufo, Editor

Several documented instances show that soldiers use their cell phones in battlefield conditions when roaming service is available. And with today's smartphones like the Treo 650 and 700 – which save Word and Excel documents, display map data, and even record and playback video and audio clips – it's not inconceivable that war fighters may take their personal PDAs into battlefield environments.

Ergonomics

But without a rugged skin like the patented OtterBox 1920, a consumer-class Treo doesn't stand a chance in dusty, dirty, or wet environments – much less banged against the hard-sided walls of an armored vehicle. So it was with excited anticipation that I agreed to try out the 1920 case on my own Treo 650. First the good news: The case is extremely well designed with exemplary attention to detail, and it does what OtterBox intended (www.otterbox.com). It seals the Treo from the elements and protects it from minor drops and (believe it or not) boot kicks (Table 1).

Environmental protection	
Drop and shock	MIL-STD 810F, Method 516.5, Procedure 4
Water protection	MIL-STD 810F, Method 512.4, Procedure 1, Immersion
Dust intrusion	MIL-STD 810 F, Method 510.4, Procedure 1 Blowing Dust

Table 1

I found that my Treo fit inside the case quite easily, as the clamshell comes apart with a plastic toolbox-like latch at the back. Once inside, the case mimics all the Treo's buttons, including the keypad, function keys, five-way navigation button, and even the side volume controls. The Treo's screen is doubly protected via a hinged hard plastic windshield and an internal flexible plastic cover that still facilitates the touch screen features.

Access to the I/O ports is possible, and the power/sync connection is protected by a water-resistant rubber plug. The top-mounted Secure Digital I/O (SDIO) slot can be accessed via a top door, though I found it was just easier to remove the entire Treo from the clamshell. OtterBox even included a handy side slot for storing the Treo's stylus, should you still want to navigate the screens using the stylus instead of the buttons.

Ease of use

And herein lies the second edge of the proverbial double-edged sword. While the OtterBox 1920 does everything it promises to do – namely, protect your Treo 650/700 – the user sacrifices functionality in the process. To start with, once your Treo is inside its cozy cocoon. The Treo's backlit keyboard doesn't shine through the opaque rubberized keys very well, making them hard to see in darkness. Worse, the bluish number keys are completely illegible without ambient light.

In addition, at first I found that hitting the "down" arrow on the five-way pad was the same as selecting "enter." It puzzled me. Once I shoved the Treo further up into the clamshell this problem was solved, but I still found that reading the very bottom of the LCD screen was tough because of 1) parallax on the inner plastic cover; and 2) the thumb handle used to swing up the screen's windshield distorted the bottom of the screen. Most of the time I ended up flipping up the hinged windshield and using the stylus anyway.

I was also dubious of the side slot designed to keep the stylus close at hand. It wouldn't have been too hard for the stylus to peel off and disappear. A better design might've been a recessed tunnel into which the stylus plunged – less likely to be pried off the side.

I also found that, as expected, the Treo's normally very loud speaker was muffled by the water-resistant case. While turning up the volume helped, this problem persisted with the microphone, and my callers complained they couldn't hear me very well. The only "turning up" possible here was shouting. There's not really much OtterBox could do to solve this problem as long as they want to keep the phone's microphone free from dirt and moisture.

Smaller than a breadbox

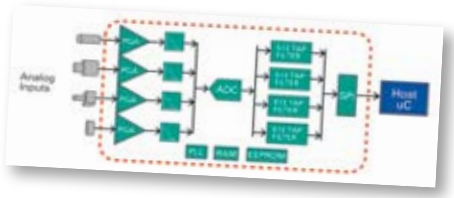
Finally, the whole package is pretty big. That's expected when the phone is cradled in heavy plastic and rubber bumpers. But the rear latch itself takes up about 5 or so millimeters, and it can catch on pockets as you shove the case inside, opening up the clamshell and disgorging the Treo. Also, because of the case's size, it doesn't fit well in pockets (except cargo pants on the battlefield), and the mandatory belt clip isn't included (it's optional).

And speaking of heft, holding the case up to the side of your head to talk on the phone is a bit like holding a 1960s vintage Japanese AM transistor radio up to your ear – it works but is kinda awkward in today's smaller-is-better trend.

Function still rules

In the end, the OtterBox 1920 for the Treo 650/700 is a compromise product. If you really need to protect your smartphone from the elements, there's no question this is the case for you. It would easily survive the rigors of typical battlefield use. However, the user must be prepared for some compromises in the process.

Editor's Choice Products



Handy little digital filter

We've all been trained to believe that filters come in two primary flavors: low-cost discrete analog types that drift with time and temperature and full-blown DSP types that are increasingly incorporated in big honking FPGAs with FFT capabilities. But now there's an alternative: a nifty little mixed signal FIR filter that's designed to sit between an analog input and an MCU or FPGA. The QF4A512 is available in industrial temperature ranges and designed for use in medical, industrial, military, and myriad other applications. The fundamental architecture of this little guy is shown in the block diagram – and is so obvious that it's a wonder no one ever thought of it before. But the design is patented, along with some related IP.

Implementing any common digital filter types such as Lowpass, Notched Lowpass, Highpass, Bandpass, Dual Bandpass, Bandstop, Dual Bandstop, and variations thereof, the key to success is the Windows-based software that allows designers 512 taps per channel to tune their filter to meet the application. From the four independent front-end programmable gain amplifiers all the way through the 16-bit A/Ds and into the programmable filter sections, the user can configure gain, A-to-D sampling rate, power consumption, and output speed. Nearly everything about the device is programmable, making it an ideal way to perform complex – er, make that "sophisticated" – filtering without requiring costly and power-hungry FPGAs. In fact, the back-end SPI interface is designed to bolt up to 8051s, TI MSP430s, ARM7TDMIs, and anything in between. The QF4A512 is only one of the company's several ingenious devices, and there are development boards, reference designs, and way-cool software tools that'll even talk to MatLab. We think this device is pretty amazing.

Quickfilter Technologies
www.quickfiltertech.com
RSC# 32709

Rugged CompactPCI blade server

At the AFCEA West show in San Diego, a good percentage of the COTS products on display pertained to military datacom and telecom. That's why the cPENTXM2 from Thales might be an ideal choice for deployed servers. This 6U CompactPCI blade SBC is complete with Intel's 1.67 GHz dual core Xeon with 667 MHz FSB and E7520 server-class memory controller hub. The board is functionally identical to the VME-based PENTXM2, giving users the ability to choose their favorite form factor: CompactPCI for rugged and VME for really rugged. This simplifies software development and materiel logistics.

The scalable SBC can be equipped with up to 4 GB ECC DDR2-400 SDRAM, and the dual GbE ports routed to the backplane are compliant with PICMG 2.16/VITA 31 (switched Ethernet). The board also supports PICMG 2.9/VITA 38 IPMI management software. Two additional GbE ports, plus two USB 2.0 ports, can be routed to the front panel. Other I/O includes Serial ATA, SXGA graphics, two serial ports, PS/2, and a PMC mezzanine connector. A conduction-cooled CompactPCI version will be available in the first half of 2007.

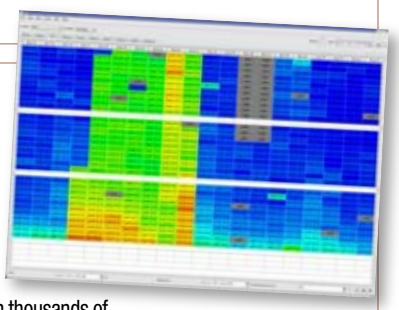
Thales Computers
www.thalescomputers.com
RSC# 32712

Military geo map mash-up

In Web-speak, a *mash-up* is where two or more websites combine data to create a new set of data and capabilities. Perhaps the best known mash-up is Google Earth, where satellite images can be overlaid on top of 2-D map information, and 3-D perspectives can be added as if one were looking toward the ground at a sideways angle. Similarly, FortiusOne announced a new beta Web service for fast and intuitive map analysis called *GeoIQ*. More than just displaying "pushpin" information on a 2-D map, GeoIQ uses colorful heat maps to show data query results and analyses: "How does location A compare to location B?" in terms of any number of data parameters or criteria.

Military uses for this COTS mash-up could include IED or insurgent attack analyses over time plotted on a map of Baghdad, monthly materiel supplies expended per encampment location, or simply sensor alarms plotted per geographic coordinates. Any combination of overlays is possible, but combining database information with geographical locations provides more meaningful human analysis than simply reviewing spreadsheets or charts. Available in three versions: GeoIQ API for Developers is a robust programming interface; GeoIQ API for Enterprise allows users to combine data from disparate sets of geographic data; and GeoIQ Web mapping allows nontechnical users the ability to instantly start analyzing multiple geographic data sets. It's kind of like Web 2.0 meets the battlefield.

FortiusOne
www.fortiusone.com
RSC# 32711



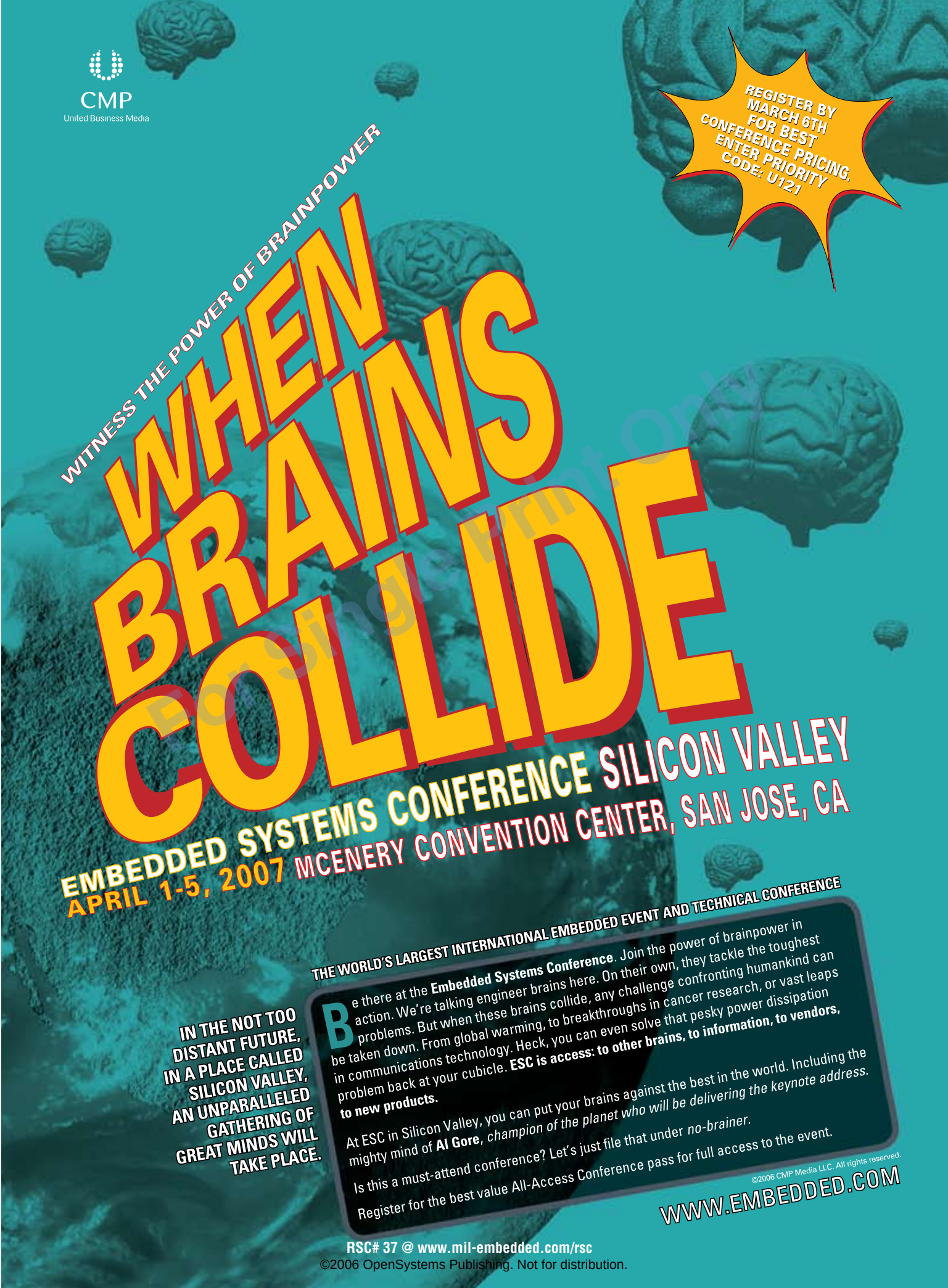
Feds give away cluster software

"Cluster computers" are used to replace what have been traditionally known as "big iron" mainframe and super computers. In practice, using tens or even thousands of low-cost CPUs can often rival the horsepower of traditional super computers – if the clusters can be properly managed and kept fed with data. The smart folks at Sandia National Laboratories – one of the federal labs that keeps tabs on nuclear research – have developed a software tool called *OVIS* that provides real-time, intelligent monitoring of computational computer clusters. Even better, the non-trivial tool is available as open source for free at http://ovis.ca.sandia.gov. OVIS offers a statistical approach to computational platform monitoring and analysis.

Instead of using absolute thresholds for the cluster nodes, OVIS "observes the overall statistical properties and environmental effects, characterizing individual device behaviors and comparing them to a large number of statistically similar devices." Since clusters don't all need be identical, this model works especially well in heterogeneous environments. When nodes deviate from the norm, they are deemed "aberrant" and appropriate steps can be taken. OVIS also allows users to visualize the spatial distribution of a particular characteristic over the entire cluster system and provides an XML-based cluster configuration information template. In short, the tool is one way of managing information flow among clusters.

Sandia National Laboratories
http://ovis.ca.sandia.gov
RSC# 32710

Editor's Choice Products are drawn from OSP's product database and press releases. Vendors may add their new products to our website at www.opensystems-publishing.com/vendors/submissions/np/ and submit press releases at www.opensystems-publishing.com/news/submit. OSP reserves the right to publish products based on editors' discretion alone, and does not guarantee publication of any product entries.



Backplane-based AMD and Intel single board computers

Company/Website	Model	Form factor	Processor name/ Max. frequency	Number of separate CPUs	Description
Motorola Inc., Embedded Communications Computing www.motorola.com/computing	ATCA-7107 AdvancedTCA Processor Blade	Advanced TCA	Intel Pentium M 1.8 GHz	1	A high-performance processor blade with four PMC sites, RoHS (5 of 6) compliant
Motorola Inc., Embedded Communications Computing www.motorola.com/computing	ATCA-7221 AdvancedTCA Processor Blade	Advanced TCA	Intel Xeon LV 2.8 GHz	2	A high-performance processor blade with SMP and complete software operating environment including OS
Concurrent Technologies www.gocct.com	AM 100/20x Xeon CPU	AdvancedMC	Xeon, Xeon LV, Xeon ULV 2.0 GHz, 2.0 GHz, 1.66 GHz	1	A high-performance AdvancedMC processor module with Intelligent Platform Management Interface (IPMI) Version 1.5 according to AMC.0
Intel www.intel.com	MPCBL0050 SBC	AdvancedMC	Xeon LV (Dual core) 213 GHz	1	A single board computer optimized to support first-generation AdvancedTCA chassis that limit front-board power to less than 200 W
Kontron www.kontron.com	AM4002	AdvancedMC	Pentium M 2.0 GHz	1	An AdvancedMC processor module
Diversified Technology www.atcatogo.com	AdvancedTCA Node	AdvancedTCA	Xeon LV 3.06 GHz	2	A processor-based node board designed for the next generation of telecom equipment markets
GE Fanuc Embedded Systems www.sbs.com	ATCA-7820 CPU Blade	AdvancedTCA	Xeon LV 2.0 GHz	2	An AdvancedTCA single board computer
Intel www.intel.com	MPCBL0020	AdvancedTCA	Pentium M 2.0 GHz	1	A flexible single board computer, compliant with the AdvancedTCA specification
Advanet www.advanet.co.jp/en	A6pci8019	CompactPCI	Pentium M 2.0 GHz	1	Pentium M CompactPCI CPU board with up to five GbE ports supporting packet switching for telecom switching applications
Concurrent Technologies www.gocct.com	PP410/03x 2xPMC SBC	CompactPCI	Core Duo 2.0 GHz or 1.66 GHz	1	A high-performance, dual PMC CompactPCI SBC featuring the Intel E7520 server class chipset
General Dynamics www.gdcanada.com	PC6020	CompactPCI	Pentium M 1.6 GHz	1	6U conduction-cooled CompactPCI single board computer
MEN Micro www.menmicro.com	D601	CompactPCI	ULV Celeron, Pentium M 1 GHz, 2 GHz	1	A conduction-cooled CompactPCI SBC
Motorola Inc., Embedded Communications Computing www.motorola.com/computing	CPCI-7070 Processor Board	CompactPCI	Pentium III 1.0 GHz and 700 MHz	1	A CompactPCI host slot processor board
Motorola Inc., Embedded Communications Computing www.motorola.com/computing	CPCI-7145 Processor Board	CompactPCI	Pentium M 1.8 and 1.6 GHz	1	A high-performance CompactPCI processor board
Curtiss-Wright Embedded www.cwcembedded.com	SCP/DCP-1201	CompactPCI (3U)	Intel Core Duo/Solo ULV 1.67 GHz	1	A ruggedized, air- or conduction-cooled, multifunctional 3U CompactPCI board
Dynatem www.dynatem.com	C3PM	CompactPCI (3U)	Intel Pentium M 1.4 or 1.8 GHz	1	3U CompactPCI compatible platform for embedded, rugged applications
General Dynamics www.gdcanada.com	PC3010	CompactPCI (3U)	Pentium M 1.8 GHz	1	3U CompactPCI, conduction-cooled single board computer

Company/Website	Model	Form factor	Processor name/ Max. frequency	Number of separate CPUs	Description
MEN Micro www.menmicro.com	F11N	CompactPCI (3U), PXI	Pentium III ULV, Celeron ULV 933 MHz, 650 MHz	1	A RoHS-compliant 3U single board computer
MEN Micro www.menmicro.com	F17	CompactPCI (3U), CompactPCI Express	Core 2 Duo 2.16 GHz	1	3U CompactPCI or CompactPCI Express SBC
Mercury Computer Systems www.mc.com	CCR-100 SBC	CompactPCI (6U)	Pentium M/ Celeron M 2.0 GHz, 1.30 GHz	1	Single-slot 6U CompactPCI SBC
Mercury Computer Systems www.mc.com	CCR-200 SBC	CompactPCI (6U)	Dual Intel Pentium 738/745/755 1.4, 1.8, or 2.0 GHz	2	Single-slot 6U PICMG 2.16 SBC
Mercury Computer Systems www.mc.com	Momentum Series CX6-200	CompactPCI (6U)	Dual Core Intel Xeon ULV 1.66 GHz	2	6U CompactPCI single board computer
ADLINK Technology www.adlinktech.com	NuPRO-796	PCI	Geode GX533 400 MHz	1	PCI half-size AMD Geode GX533 SBC with LAN, LVDS, Serial ATA, and CF
Chassis Plans www.chassis-plans.com	S6313	PCI/PCI Express	Xeon 3.6 GHz	2	SBC that supports PCI Express, PCI-X, and PCI passive backplanes
Chassis Plans www.chassis-plans.com	S6396	PCI/PCI Express	Xeon 3.6 GHz	1	SBC that supports PCI Express, PCI-X, and PCI passive backplanes
Chassis Plans www.chassis-plans.com	S6483	PCI/PCI Express	Pentium 4 3.4 GHz	1	A single board computer offering graphics class PCI Express x16 interface, dual 10/100/1000 Ethernet, four ATA/300 ports, and onboard video
Chassis Plans www.chassis-plans.com	S6490	PCI/PCI Express	Core Duo 2 GHz	1	A single board computer featuring graphics class PCI Express x16 interface, dual 10/100/1000 Ethernet, four ATA/300 ports, and onboard video
Dynatem www.dynatem.com	DPD/RPD	VME	Core Duo 1.66 GHz	1	A VMEbus single board computer
GE Fanuc Automation www.gefanuc.com/embedded	V5D	VME	Pentium M LV 1.4 GHz	1	A 6U VMEbus single board computer
Curtiss-Wright Embedded www.cwcembedded.com	SVME/DMV-1901	VME (6U)	Intel Core Duo/Solo 1.67 and 2.0 GHz	1	A 6U VME single board computer suitable for the defense and aerospace market
Thales Computers www.thalescomputers.com	PENTXM4	VME (6U)	Dual-core Intel Xeon ULV 1.67 GHz	2	A server class manageable 6U single slot VME single board computer featuring a dual-core processor and a Board Management Controller (BMC)
Concurrent Technologies www.gocct.com	VX 405/04x	VME, VXS	Intel Core 2 Duo 2.16 GHz	1	An SBC that optionally supports the VXS switched serial standard - VITA 41.3 (1000 Mbps baseband IEEE802.3)

Data was extracted from OSP's product database on February 5, 2007. Search criteria included keywords "Athlon," "Opteron," "Pentium 4," "Pentium M," "Xeon," "Core Duo," "Core 2 Duo," "Sempron," "Celeron," "Intel," "AMD," and "Advanced Micro Devices" on products entered Sept. 1, 2006 through search date within *VME and Critical Systems, CompactPCI and Advanced TCA Systems, and Military Embedded Systems* magazines. Products were also selected according to relevance to the product guide's theme. Entries have been edited for publication, and OpenSystems Publishing is not responsible for errors or omissions. Vendors are encouraged to add their new products to our website at www.opensystems-publishing.com/vendors/submissions/np/.

By Sharon Schnakenburg

DATA ACQUISITION

ACCES I/O Products, Inc.
Website: www.accesio.com
Model: USB-IIRO4-2SM **RSC No: 32458**

USB/104 module featuring four optically isolated digital inputs, four relay outputs, and two RS-232/422/485 serial ports • Four optically isolated inputs as well as four Form C electromechanical 1A relays • Small (4" x 4" x 1.8"), rugged industrial enclosure • Custom high-speed function driver • PC/104 module size and mounting compatibility • All required power drawn from USB port, no external power adapter required • Extra downstream USB expansion port • DIN rail mounting provision • Multifunction I/O adapter for USB 1.1 and 2.0 port hosts • Factory options include two serial ports only version, four digital I/O version (USB-IIRO-4DB)

L-3 Communications Advanced Products & Design
Website: www.L-3Com.com/apd
Model: VideoScout-MC **RSC No: 32468**

A self-contained, portable video exploitation and management laptop system with integrated L/S or L/C receiver to capture, leverage, and disseminate video and metadata from manned and unmanned surveillance and reconnaissance assets, including UAVs • Users have direct access on the laptop to view, exploit, archive, search, retrieve, annotate, geo-reference, and disseminate incoming video and metadata • Stream video in real time • Create derivative video, clips, snapshots, and segments • Pause, rewind, fast forward, zoom • Compound search capabilities • Windows-based user environment, interoperable with other Windows applications • 60-minute built-in Digital Video Recorder (DVR) • Integrated with FalconView mapping software

DEVELOPMENT PLATFORM

iWOW Connections
Website: www.iwow.com.sg
Model: iWOW TR-800 **RSC No: 32531**

A GSM/GPRS module designed with a robust platform for easy development of machine-to-machine applications • Quad-band for wide coverage and global access • Slim design measures 3 mm in thickness • Weighs only 8.3 g • Can be easily integrated into any environment • Dual antenna connection options • Can be mounted via onboard microminiature connector or directly on the antenna soldering pad • Equipped with industry standard communication protocols such as TCP/IP, MMS, and Push-to-Talk, which can be embedded to simplify the data transfer process

DEVELOPMENT TOOLS

MicroBee Systems
Website: www.microbee-systems.com
Model: HG-1700-IMU-104 **RSC No: 32065**

An FPGA-based SDLC interface for the Honeywell HG-1700 and HG-1900 Inertial Measurement Units (IMUs) • Register based • Can be accessed to control operation and acquire IMU data and time information • All I/O registers have the capability of being either directly accessed via the FPGA base I/O address block or as individually mapped I/O addresses in the ISA I/O space • The SDLC interface is clocked at 1 MHz as required by the HG-1700 IMU • Outputs two message types, 1 and 2, and the interface can acquire each message type individually or simultaneously • The IMU SDLC clock is provided by a 10 MHz oscillator divided by 10 to 1 MHz • The 10 MHz clock provides 100 nS time tag resolution for each incoming inertial message relative to a GPS 1PPS signal • The interface also provides a 16C550 UART RS-422 high-speed interface for general purpose Serial I/O

Microchip Technology, Inc.
Website: www.microchip.com
Model: PIC18F1330 MCUs **RSC No: 32294**

An enhanced flash microcontroller with nanowatt technology, high-performance PWM, and four-channel, 10-bit A/D converters • Suitable for basic, open-loop, and low-end closed-loop motor control that is not algorithmically intensive • Effective in motor control applications where cost and space are primary design concerns, via the combination of a specialized PWM peripheral with up to six channels and 10 MIPS performance at 40 MHz in packages as small as 18 pins • Ideal for limited space applications • Provides an upward migration path from the general purpose PIC16F microcontroller families and migration to the PIC18F4431 family for more sophisticated motor control applications • Provides electronic motor control of three-phase ACIM VF motors, brushed DC motors, three-phase BLDC motors, and stepper motors

ENCLOSURE + CARD RACK + POWER SUPPLY

Pulizzi Engineering
Website: www.pulizzi.com
Model: PC 3365 Series **RSC No: 32405**

A series of rack-mount Power Distribution Units (PDUs) • 19" rack-mount is 2U (3.5") tall • Front panel features indicator lights and circuit breakers (North American version only) • Power input is located on the rear through an attached 15' power cable along with power output, with an integrated cable restraint and management system • Rugged enclosure is all steel and has a durable black powder coat finish • Comes standard with electrical noise power filtering providing protection from Electromagnetic and Radio Frequency Interference (EMI and RFI)

FABRICS: FIBRE CHANNEL

Critical I/O
Website: www.criticalio.com
Model: FCA2460 **RSC No: 32462**

An AdvancedMC Host Bus Adapter (HBA) that provides 4 Gbps Fibre Channel connectivity to AdvancedTCA systems • Complies with the AdvancedTCA Advanced Mezzanine Card standard (AMC.1 with PCI Express host interface) • Ideal for networking and storage applications • Two independent Fibre Channel interfaces that, when combined, can achieve sustained data rates of 1,500 MBps, 10 usec RDMA data transfers, and up to 300,000 SCSI I/O operations per second • Supported by drivers for VxWorks, Linux, Windows, and other specialized operating systems • Suitable for next-generation computer systems in telecom, military, and enterprise computing applications • 100% software compatible with Critical I/O's PMC and XMC Fibre Channel interfaces • Interface dissipates only 6 W but provides two independent 4 Gb Fibre Channel ports, four-lane PCI Express host interface, hot-swap capability, and extensive integrated hardware BIT • Supports VxWorks, Linux, and Windows • Compatible with x86 and PowerPC AdvancedTCA processor blades

Crosshairs Editorial

By Chris A. Ciufo

This year's top trends affecting the military

A qualitative look at what may become 2007's most compelling tech stories

The technology tradeshow season is upon us. In January and February, there are *at least* five tradeshows that offer a glimpse of what's in store this year for military technology. From the Consumer Electronics Show, Bus&Boards, MacWorld, and AFCEA West/TechNet to Europe's huge Embedded World, COTS technology is the backbone of the modern military. From the flying Chinese USB-enabled toys shown at CES in Las Vegas – which show how cheaply UAVs can be made – to the AppleTV at MacWorld that brings IPTV to the masses, much of this technology may ultimately find its way into military use in some fashion or another. The following are some of my predictions for 2007, in no particular order of importance.

Low power

When Transmeta showed Intel four years ago that IA-32 microprocessors could be made to run efficiently at lower power, Intel grabbed some ideas from its Israeli design group, effectively ditched the Pentium 4 CPU, and ushered in what would become the Pentium M (Dothan). With lower CPU frequencies and power and higher performance, Intel (x86), AMD (x86), ARM (ARM7/9/10), P.A. Semi (PowerPC), and others continue to add horsepower while making battery-powered doodads more efficient.

In military apps, saving power means reducing heat, which means less strain on the cooling system. In airborne and manpack applications, less heat also means less weight and translates into longer battery life in portable systems. As iPods, MobiBLUs, Nintendo Wiis, and DishPlayer multimedia devices pervade the civilian entertainment market, low-power technology will rapidly be adopted by military system designers.

FPGAs and reconfigurable logic

To me, it seems the march toward FPGAs in military systems is a no-brainer, obvious trend. But I'm biased in favor of FPGAs because I spend a lot of time researching signal processing applications, which increasingly use FPGAs' parallelism to solve DSP problems. However, on a broader scale, reconfigurable FPGAs are not yet a foregone conclusion in most military systems. But they will be.

Companies such as Actel are securing rad-hard design-ins with their flash-based FPGAs, and both Altera and Xilinx are conducting SEU studies to show the robustness of their products in radiation situations. Additionally, Altera's HardCopy variants of Stratix FPGAs will eliminate the last remaining myth against FPGAs: that they might "forget" their RAM-based configuration at power-up. With Lattice increasing their logic densities and including a free LatticeMico32 soft processor – and both Altera and Xilinx ramping production on the densest FPGAs the world has ever seen – look for FPGAs to move out of DSP-only applications and start providing reconfigurability to general military systems. Make no mistake: FPGAs *will* become as common as CPUs in defense systems.

Built-in hardware and software security

On the hardware side, Intel's Virtualization Technology (part of the **T* initiative) in Core and Core 2 processors and peripherals will allow applications to run in hardware partitions, providing "walled gardens" between code sets. This goes hand-in-hand with some of the partitioned embedded RTOSs such as Green Hills' INTEGRITY-178 and LynuxWorks' LynxSecure kernel. These RTOSs allow applications and even other operating systems like Windows or Linux to run in secure partitions on top of an EAL-certified kernel: If one partition "dies" or becomes corrupt, the entire system maintains operation.

On the civilian side, security concerns are driven by viruses, spyware, phishing, zombies, and just plain old theft. Biometric devices such as fingerprint readers in Lenovo, Toshiba, and other laptops secure entire systems from unauthorized use, while Trusted Platform Modules (TPMs) on motherboards provide software authentication prior to code execution. Also, as we went to press, Microsoft announced for sale the consumer version of Windows Vista, which at its core is all about security.

Similar to some of the embedded techniques just mentioned, Microsoft's new Address Space Layout Randomization (ASLR) moves code around in memory, preventing hackers from predicting where code will run and (presumably) foiling the classic buffer overflow exploit. With so much happening on the civilian side, these mainstream security technologies (and others) will absolutely roll over into the military market very quickly.

Open standards and trade associations

COTS innovation ushered in multivendor open standards options for military designers, signaling a dramatic reduction in prime contractors' vertical integration programs and "bespoke" proprietary systems. Today, more vendors than ever are offering up their proprietary ideas to consortia and trade associations in hopes that other companies will jump onboard. The military benefits as new form factors, software modules, and interoperable technologies become available from a larger supplier base.

Some hardware examples in the past 30 days alone include StackableUSB from PC/104 vendor Micro/sys, and MEN Micro's Universal Submodule Specification (USM) for FPGA-based mezzanine boards. Increasingly, hardware and software organizations and IC groups including the PC/104 Consortium, PICMG, VITA, the Fabless Semiconductor Association (FSA), the VSI Alliance, and the Eclipse Foundation will be called upon to "institutionalize" more open standards. And the military will reap the benefits of more interoperable technology.

Have any other new technology ideas? E-mail me at cciufo@opensystems-publishing.com.

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