COTS JOURNAL

The Journal of Military Electronics & Computing

Tech Focus:
Solid-State Disk Drives

TECH REFRESH

MANEUVERS OVER TOUGH COMPUTING HURDLES

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Features

December 2008 Volume 10 Number 12

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System Development

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Technology Focus

Solid-State Disk Drives

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

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

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The Bradley Fighting Vehicle (in background) is among the earliest success stories of VME tech refresh and tech insertion. Recent upgrades to the Bradley improve target acquisition and fire control, navigation, and situational awareness. The MULE-T (foreground)—an Unmanned Ground Vehicle that's part of the FCS program—is shown undergoing testing a Fort Bliss.

Courtesy: U.S. Army

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Marina Tringali
Managing Editor

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HOME OFFICE

The RTC Group, 905 Calle Amanecer, Suite 250, San Clemente, CA 92673
Phone: (949) 226-2000 Fax: (949) 226-2050, www.rtcgroup.com

EDITORIAL OFFICES
Warren Andrews, Editorial Director/Associate Publisher
39 Southport Cove, Bonita, FL 34134
Phone: (239) 992-4537 Fax: (239) 992-2396

Jeff Child, Editor-in-Chief
20A Northwest Blvd., PMB#137, Nashua, NH 03063
Phone: (603) 429-8301 Fax: (603) 424-8122

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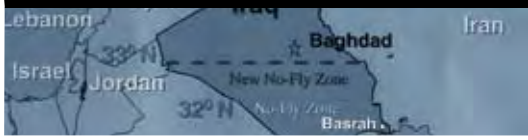

Foster Home at Last?

At the end of last summer I commented that people were once again ringing the death knell for conferences. I held off writing this month's column until we returned from MILCOM so I could report on how it went. In short, "it went very well." Last year, prior to going to MILCOM 2007, I went through the list of potential exhibitors and found about thirty that I should look at to find out what's changing in our industry. Prior to this year's MILCOM I found about sixty exhibitors that should be in my sights, twice as many as last year, and everyone I spoke with just kept raving about not only the quantity of attendees but also the quality. Didn't talk to one company that would not be exhibiting at the next MILCOM.

December 1 through 4, I/ITSEC will take place in Orlando. This had been the most promising venue for the military embedded electronics market. But somehow it never really caught on as anticipated. Where MILCOM has a very broad end product focus—virtually anything to do with data, voice, imaging or networking—I/ITSEC has only a narrow band where the relevance of embedded electronics stands out. The editorial team still plans to have a strong presence at I/ITSEC, but our focus there will be less on our industry's products currently going into these systems and more on what it is our industry should be developing for this market's needs in the future.

MILCOM presented *COTS Journal* with a unique opportunity. Several key analysts from Frost & Sullivan, Jane's and VDC had planned to be at the conference, so we organized an informal breakfast between a few suppliers and the analysts. We don't seem to have the "off the record" informal discussions about what we see as our marketplaces direction anymore. During our breakfast anyone could voice their opinion about any issue without fear of not fully presenting their company's mandated point of view. Analysts, suppliers along with Jeff and myself all left this meeting much more enlightened. Each and every one of us had opinions on every topic that came up, and we could have sat there until we all got hoarse if we didn't have other things to do. The analysts could bring in information from their research projects and discussions with key primes, PEOs and political leaders; the suppliers had actual contracts and programs they referenced; and Jeff and I added information about the overall technologies and business climate. What was surprising was how much we were mostly in agreement on everything.

Here is some of that consensus: The military portion of the embedded electronics market will be the best place to be for the next few years. The government will play musical chairs with programs, but overall there will be no major budget change in our segment for at least the next two years. If monies are taken from new programs they will be shifted to retrofits and upgrades. Anything that removes the warfighter from harm's way and communication will remain the focal point of the budget—at the possible expense of sophisticated aggressive systems.

COTS Journal's breakfast gathering at MILCOM 2008. Left side of table, from left to right: Larry White, Jane's DS Forecast; Bret Farnum, Extreme Engineering; Joe Eicher, Kontron; Brad Curran, Frost & Sullivan; Jeff Child, *COTS Journal*. Right side of table, from left to right: Rob Scidmore, Extreme Engineering; Lindsay Voss, Frost & Sullivan; Bernard Pelon, CSPI. End of table: Frank Phelan, Kontron. Present, but not in photo: Eric Heikkila, VDC; Pete Yeatman, *COTS Journal*.

The success and usefulness of this meeting for all parties ensures that we will have a similar "off the record" breakfast at the next MILCOM. We've also had some preliminary conversations with show personnel on finding ways to work more closely with MILCOM to get a better presence for embedded electronics as a key element in the conference. We may never see any reference to "command and control" in the conference's documentation, but it's not unreasonable that we may see a reference to embedded electronics in the future.

MILCOM just may be the big conference that for more than a decade we've all been hoping for. ▮▮

Pete Yeatman, Publisher
COTS Journal

The Inside Track

Green Hills OS Becomes World's First to Receive EAL6+ Security Certification

In a landmark milestone in the world of software security, Green Hills Software's INTEGRITY-178B operating system has been certified by the National Information Assurance Partnership (NIAP), a U.S. government initiative operated by the National Security Agency (NSA), to Common Criteria Evaluation Assurance Level (EAL) 6+, High Robustness.

The first of its kind, this certification is the highest Common Criteria security level ever achieved for an operating system. Only an EAL6+ High Robustness operating system is "certified to protect classified information and other high value resources at risk of attack from hostile and well-funded attackers." In contrast, the highest security standard to which any other operating system is certified only protects against "inadvertent or casual attempts to breach the system security."

Green Hills won't likely have to share the spotlight for EAL6+ status. No other operating system has even begun the stringent EAL6+ NIAP/NSA certification process. Furthermore, Common Criteria states that "EAL4 is the highest level at which it is likely to be economically feasible to retrofit to an existing product line." INTEGRITY was designed for EAL7—the highest level of security—and thus was able to meet the NSA's High Robustness requirements. INTEGRITY, used in the most advanced aircraft including the F-16, F-22, F-35, B-1 Bomber, Airbus A380 and Boeing 787, is available to business customers through the newly formed INTEGRITY Global Security, LLC.

Figure 1

Green Hills Software CEO Dan O'Dowd, second from left, holds the EAL6+ High Robustness Certification awarded for the company's INTEGRITY operating system during a briefing in Washington, DC last month. Joining O'Dowd are members of the Board of Advisors, Joe Levy, left, former Congressman Tom McMillen, and retired U.S. Air Force General Gene Habiger, right.

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

Saft Develops Powerful Electrochemical Cell for U.S. Army

Saft has successfully completed the first part of development of its new Ultra High Power lithium-ion (Li-ion) cell, the world's most powerful electrochemical cell. Saft delivered the first 50 prototype VL-U cells under its contract with the U.S. Army Tank-Automotive and Armaments Command (TACOM). Saft's rechargeable VL-U Li-ion cells will enable greater capability for directed energy and other defense applications.

Saft designed and developed the VL-U cell capable of producing continuous power of 10 kW/kg and pulse power as high as 30 kW/kg. The VL-U technology is an evolution of Saft's current VL-V and VL-A technology. According to Saft, this latest development makes the VL-U cells the highest power, rechargeable electrochemical cells available in the world today, with VL-V cells remaining the mature solution for many power-hungry defense applications and VL-A cells for civil applications.

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

Quantum3D System Chosen for B-2 Simulator

Quantum3D's Independence image generator system selected by Northrop Grumman for its Pilot Evaluation Simulator (PES) for the B-2 stealth bomber (Figure 2). Northrop Grumman is leveraging Quantum3D's Independence 3500 solution, an upgrade from its previous installation of the Independence 2500 in early-2005. The upgrade means that the PES will benefit from a higher performance simulator with a greater polygon count.

These improvements include volumetric clouds and other enhanced weather plug-ins provided by Quantum3D's Mantis software, such as shader-based rendering for enhanced lighting effects and anisotropic filtering for more realistic surface effects. The Independence 3500 IG features NVIDIA QuadroFX Graphics Subsystems configured in a unique system-level, parallel-rendering architecture. This technology insertion also provides Northrop Grumman with the use of open standards—such as the Common IG Interface standard for host interfaces and Gbit Ethernet.

Figure 2

A Travis KC-10 Extender, flown by members of the 9th Air Refueling Squadron, refuels a B-2 Spirit Stealth Bomber during a training flight.

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General Dynamics Completes Initial Delivery of WIN-T Gear

General Dynamics C4 Systems recently completed delivery of the first WIN-T Increment 1 equipment to the U.S. Army. Increment 1 builds on the former Joint Network Node-Network (JNN) and provides soldiers with a high-capacity, reliable, secure communications network when they are stopped or "at the halt." On schedule deliveries of WIN-T Increment 1 to the 5th Brigade, 2nd Infantry Division Stryker Brigade Combat Team (SBCT) (Figure 1) at Ft. Lewis, Wash. includes networking hubs, network management suites and network nodes. The equipment serves Battalion, Brigade and Division/Corps command posts and Expeditionary Signal Battalions. The 5/2 ID SBCT is training with the new WIN-T Increment 1 equipment in preparation for operational tests and evaluations.

General Dynamics is also under contract for WIN-T Increment 2, which will provide soldiers with an initial on-the-move broadband networking capability using satellite and radio links. Fielding begins in 2009. In addition, General Dynamics is developing the components to meet the full range of network capacity, security, and fully on-the-move capabilities under the WIN-T Increment 3 contract as the Army's transitions to modular equipment for its future fighting force. Limited user testing of Increment 3 begins in 2011. The award for WIN-T Increment 4, which represents the last of the developmental program elements, is pending.

Figure 3

The Stryker ICV is shown here offloading from a C-130 transport aircraft. The WIN-T Increment 1 gear delivered to the 5th Brigade, 2nd Infantry Division Stryker BCT at Ft. Lewis, WA includes networking hubs, network management suites and network nodes.

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

Navy Taps Concurrent's Real-Time Linux Systems for Aircrew Virtual Trainer

Naval Air Systems (NAS) Command has awarded Binghamton Simulator Company (BSC) a contract for the Aircrew Virtual Environment Trainer (AVET) program. BSC is building the Navy's first AVET unit using Concurrent's iHawk real-time multiprocessor systems powered by RedHawk Linux as the simulation host computer. The AVET program will provide safer and more cost-effective training for Navy airmen.

BSC delivered a prototype AVET to the Fleet Replacement Squadron 2 (FRS 2) at NAS Norfolk in September 2008 for a 90-day evaluation. Concurrent's iHawk system is serving as the simulator host. The prototype unit is a virtual environment trainer that demonstrates the technology BSC developed under a recent Small Business Innovation Research (SBIR) award from the Navy. The fully functional AVET is scheduled to be delivered to Naval Air Station North Island in September 2009, and will be the first of several projected units to support U. S. Navy aircrew readiness training. Concurrent is providing BSC with integrated iHawk platforms running the RedHawk Linux real-time operating system, as well as Concurrent NightStar advanced debugging and analysis tools and MAXAda 95 language system.

Concurrent
Pompano Beach, FL.
(954) 974-1700.
[www.ccur.com].

Lockheed Martin's F-35 ALIS Will Include NGRAIN Software

Lockheed Martin has released the NGRAIN-developed Visual Damage and Repair Tracking software to be deployed with the F-35 Lightning II Autonomic Logistics Information Systems (ALIS) software suite. ALIS provides a suite of software to support maintenance, supply and training operations for F-35 Lightning II (JSF) aircraft technicians worldwide. The software will be delivered to test sites with F-35 aircraft (Figure 4) in 2009.

The NGRAIN software, selected by Lockheed Martin in February this year, will be used by aircraft maintainers on the flight line to document aircraft exterior damage inspection findings and aircraft exterior repairs. The software will be delivered on portable, ruggedized Panasonic Toughbook computers. F-35 maintainers will use NGRAIN's intuitive 3-D visualization software to streamline and support accurate capture of aircraft exterior damage and repair details. Streamlining workflow, NGRAIN's Visual Damage and Repair Tracking software enables F-35 maintainers to accurately capture, store and track aircraft exterior damage and repair details by drawing directly onto a 3-D model of the aircraft.

Figure 4

The F-35 Lightening II turns during the 16th test flight in late April 2007. The F-35 is a supersonic, multi-role, 5th-generation stealth fighter. The JSF program is the largest defense acquisition program to date with a total projected value of more than $276 billion.

NGRAIN
Vancouver, BC
Canada
(604) 669-9973.
[www.ngrain.com].

COTS Websites

www.disa.mil/jsc

JSC Web Site Provides Wealth of Defense EM Spectrum Resources

It's clear that the military's reliance on spectrum-dependent systems will continue to grow. The electromagnetic spectrum will be used to see and sense the battlefield, to communicate warfighting intent, to engage the enemy beyond visual range, and to own the night. It will be used to guide smart weapons, to ensure effective communications, and to counter enemy command and control. At the same time, the increasing use of spectrum in the commercial realm makes it vital to manage the spectrum efficiently and plan for its use in both peace and war with increasing detail. With all that in mind, it's the charter of the Joint Spectrum Center (JPC) to ensure the DoD's effective and efficient use of the electromagnetic spectrum.

Reflecting that responsibility, the JSC's Web site serves as a useful portal to track all the operational, engineering and spectrum management related activities under the center's purview. The site provides access to the JSC's library of EM environmental effects (E3) engineering documents, as well as several EM spectrum related military specifications and standards documents. The Web site also offers information on the organization's E3/Spectrum Supportability awareness training courses. These courses cover a wide range of E3 topics useful to E3 program managers and engineers.

Joint Spectrum Command
Annapolis, MD.
(410) 293-2422.
[www.disa.mil/jsc].

Special Feature

Thermal Analysis for Boards and Enclosures

New Practices Revamp Thermal and Airflow Analysis

Rugged, complex integrated military computing systems are facing ever greater thermal design challenges. A variety of new tools, practices and strategies help smooth the way.

Jessica Isquith, Vice President of Marketing
Carlo Gavazzi Computing Solutions

Knowing how electronic components and enclosures respond to severe fluctuations in temperature and airflow is essential knowledge—knowledge that is critical before the system is actually subjected to the potential stress of a real-world high or low temperature and/or high altitude mil/aero application. An example along those lines is Echostorm's MDAR (Mobile Data Archive and Retrieval) box. The mobile device is designed to withstand the harshest of weather, and its unique shape was custom-designed to fit into existing U.S. Army One System Ground Control Stations. Initial production units of MDAR will be installed in AAI Corporation's ground control stations that will be used by the Shadow UAV (Figure 1).

As systems become ever more integrated, the demand is rising for more powerful systems and capabilities in smaller electronic packages. These smaller-sized chassis feature higher heat dissipation, so they require new technologies to maintain cool operating temperatures. Today the leading technology for cooling these boxes is a convection system that transfers the heat with acutane water-cooled plates or cold plates—as opposed to relying solely on natural convection and airflow. Thermal

Figure 1

An example system designed to withstand the harshest of weather is Echostorm's MDAR box. The unit gives soldiers in the field instant, searchable access to up to 30 days of archived data and full-motion video from a variety of unmanned aircraft vehicles. Initial production units of MDAR will be installed in AAI Corporation's ground control stations that will be used by the Shadow UAV (shown).

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simulation analysis can be performed to simulate these various liquid-cooled plate and cold plate options.

Fortunately there have been huge technology advances in recent years that feed these thermal analysis needs. Among these is the introduction of software and sensors that can be employed in both the design and production phases to analyze and verify thermal management and performance. More importantly, there are select electronic packaging solution providers that incorporate thermal and airflow analysis into their design, engineering and testing processes, thereby ensuring optimal performance for their customers' products, while accruing minimal long-term maintenance and replacement costs.

Evolution of Thermal Testing

In the early days of thermal analysis it wasn't possible to simulate by computer how a particular enclosure responded to temperature. Instead, test engineers worked with an actual product or prototype, and ran tests by inserting thermal sensors or thermocouples into the equipment and/or took infrared readings to measure variations in temperature. This manual testing and verification process was not entirely as comprehensive as the simulation testing methods available today, and was also occasionally subject to human error, and would usually require long lead times for production.

Fast forward to today and electronic enclosure manufacturers have simulation tools at their fingertips, allowing them to perform the most comprehensive analyses of a chassis' or card's thermal management operation. Such programs empower engineers to visualize and interact with potential configurations, and diagnose potential problems before they can limit system performance. They also minimize costly post-production changes to the system that can create downtime or, worse, send finished products back to the drawing board.

Multi-Step Process

There are multiple steps that are essential to the analysis process: The first step, referred to as design phase thermal analysis, involves the creation of drawings and 3-D models for the projected system. During this phase, software such as CFdesign (Figure 2) from Blue Ridge Numerics is used to create a detailed analysis of the complete thermal management picture—specifically how the cards, boards and chassis interact in terms of cooling. The thermal analysis simulation allows engineers to examine a range of component configurations to determine the best possible cooling solutions, ensuring the system performs

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optimally for its specific function and operating environment. Using such software, companies can ascertain the ideal location for components, including cooling and exhaust fans, card cages, air filters and ventilation panels. Using this thermal simulation in the prototype stage can reduce the total project cost by an average of 65 percent.

Early stage analysis is not just used to determine component configuration, but also to select the optimal physical composition of the chassis and components themselves. For instance, the software can simulate the properties of different types of metals, be they a particular grade of steel, aluminum, copper, and so on, as well as metallic coatings.

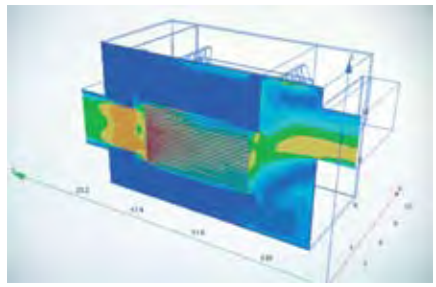

Figure 2

Carlo Gavazzi Computing Solutions uses CFdesign software to create a detailed analysis of the complete Thermal Management picture, specifically how the cards, boards and chassis interact in regards to cooling. Simulation Thermal Analysis lets engineers examine a range of card and fan configurations to determine the best possible cooling solutions.

Next, the thermal analysis guidelines determined during the design phase simulations are consulted to, first, build the unit, and then to plug the boards and cards into the system. During this production phase, verification can be performed on the chassis or card in thermal chambers. In this step, sensors, such as Cambridge Accuesense sensors from DegreeC, analyze airflow and temperature using the latest generation of advanced sensors. Ideal for testing all manner of chassis or card-cooling configurations, including conduction, convection and air- or liquid-cooled models, the sensors test and verify how the chassis or card operates in high-performance, high-power applications before it is ultimately deployed.

Partnering Is Key

Not every enclosure or system manufacturer has the in-house tools to accommodate the most thorough thermal and airflow analysis procedures, which have become necessary as technologies become increasingly powerful. Some companies only do product testing—they do not do the up-front analysis at all. Others only perform a cursory analysis—a van-

ity check so to speak—which can lead to major problems down the road. Still others might have the necessary tools to conduct analyses, but might fall short in other areas.

Before committing to a given manufacturer and that manufacturer's schedule, it's important to ascertain whether that manufacturer will not only conduct a detailed thermal analysis, but also provide you with the level of detail needed to produce an accurate production schedule, be willing to meet your deadlines and identify potential problems before they occur. The time to detect problems with material thickness, component placement, or heat and airflow is before the product is shipped. An optimal design can only result when the manufacturer takes a collaborative approach with the customer to the analysis process.

Useful for Upgrade Process

Simulated thermal analysis not only protects against developing insufficient products, but it can also be a useful tool in upgrading outdated systems—a necessary tactic in a world of ever-improving electronics. Often, customers want to increase the wattage in their existing components or materials, but use the same box. The latest thermal analysis technologies make it a lot easier to determine the feasibility of this request, especially if simulation technology was used in the original design process.

Manufacturers can provide definitive answers quickly by simply plugging in new criteria into the existing stored simulation. From there, engineers can quickly determine that, for example, an additional 50W of power will cause a 25° temperature increase—and this information can be provided within a matter of days. Manual thermal testing, on the other hand, requires the time-staking production of a completely new prototype. Months might transpire before the customer receives the necessary answer, and by that point, a new and more compact technology might have emerged.

Thermal analysis and airflow analysis have always been important steps in the design and production of electronic components, but now the technology is in place to take this analysis to new levels of accuracy and efficiency. There are also a select few electronics enclosure manufacturers with the expertise, systems and methodologies to turn to when you need the best thermal and airflow performance. ▮▮

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Special Feature

Thermal Analysis for Boards and Enclosures

Thermal Modeling: A Must at the Design Phase

Advanced thermal analysis tools are a powerful weapon for effective military embedded systems designs. But like any weapon, it's how you use them that dictates their effectiveness.

Ivan Straznicky, Senior Staff Mechanical Engineer
Curtiss-Wright Controls Embedded Computing

Military and aerospace systems must frequently operate in crowded, hot environments exposed to great thermal extremes. The dissipation of power as heat from the system's electronics must be managed for reliable operation, or in some cases, any operation at all. This requires designing a thermal model that depicts the relevant characteristics of the module and its boundary conditions, and then performing a thermal analysis to determine pertinent temperatures. The thermal analysis stage of a design is critical, particularly for military/aerospace applications that operate in extended temperatures.

Several Types of Analyses

Thermal analyses can take several forms, from simple first order calculations to full-blown finite element analyses (FEA) that incorporate computational fluid dynamics (CFD) for coolants such as air and liquids. Because first order analyses have limited value, it is of greater interest to consider the much more comprehensive thermal analyses that can be run on commercially available software tools. These analysis methods are typically used by board and enclosure designers to ensure that a thermal design is capable of sufficiently cooling the associated electronics well before any prototype hardware is built.

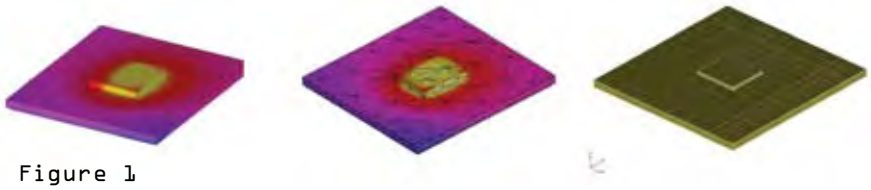

Figure 1

Once a reasonable thermal model is designed it must be "discretized" into tiny cells that enable an iterative solution of the governing equations. This mesh of cells should be fine enough in areas with high gradients (fluid boundary layers) and coarser elsewhere. Shown here is a compact model of a processor and two different meshed versions.

The fundamental purpose of thermal analysis is to predict component temperatures, and then compare them to allowable maxima. A good thermal design will result in predicted temperatures below maxima, and can often include some derating. For military/aerospace applications the accuracy of the predictions needs to be fairly high because of the relatively low temperature budget between allowable component temperatures and cooling boundary conditions. For example, a given microprocessor with a 100°C maximum operating junction temperature on a board with an 85°C card edge requirement only yields a 15°C temperature budget. This thin temperature margin necessitates the use of leading-edge thermal analysis tools and a solid understanding of how to use them.

The first step of thermal analysis is to model the physical/thermal design. This involves making certain judgments about how much detail to include at the various electronic packaging levels (such as die, component, board, system). Too much detail and the subsequent thermal analysis will take too long. Too little detail and the analysis accuracy suffers. For example, electronic component packages contain many details like die layers, die-to-substrate interconnects (solder balls or wire bonds), substrate layers, underfills, encapsulants and package-to-board interconnects (solder balls or leads). To model each, or even some of these details for every component on a board would result in a thermal model so large as to make its thermal analysis intolerably lengthy. A more practical approach is to use a mix of network models (two or more thermal "resistors"), compact models (lump parts of a package as one material) and detailed models, depending on the thermal significance of the part. The other elements of a printed circuit board must also be modeled in a similar practical manner.

Once a reasonable thermal model is designed, it must be "discretized" into tiny cells that enable an iterative solution

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of the governing equations—conservation of mass, momentum and energy. This discretization is called "meshing" and the resulting mesh size directly affects the solution (computation) time as well as its accuracy. Because solution run-times are directly dependent on cell count, an appropriate mesh size needs to be selected so as to obtain accurate results in a reasonable amount of time. This appropriate mesh size balance can be achieved through a mix of wise modeling (ref. preceding paragraph) and intelligent meshing. A good quality mesh will be fine enough in areas with high gradients (fluid boundary layers) and coarser elsewhere. Figure 1 shows a compact model of a processor and two different meshed versions.

After the mesh has been generated and checked, the analysis tool's solver is put to work by iteratively solving the set of governing equations cell by cell. A solution is declared once the iterations "converge"—in other words, when residual values from the equations fall below set criteria and monitored parameters cease changing appreciably.

The final steps of a thermal analysis involve post-processing the solution to obtain results of interest. For example, a thermal engineer analyzing a forced air-cooled board will likely be interested not just in temperature results, but also in air flow and pressure drop across the board. Commercially available CFD tools enable several methods of analyzing these results, including point probes, cut planes and object face analysis. Figure 2 shows the temperature (object face) and pressure drop (cut plane) results of a forced air-cooled board.

Accuracy of Results

Accurate thermal analysis results require more than good modeling and meshing. Other critical factors include power/heat loads, material properties (thermal conductivities), interface thermal resistances and general assumptions. The heat loads assigned to the various component models play a significant role in temperature results. Overly pessimistic assumptions, like maximum power dissipations for all components, lead to unrealistically high temperatures and/or over-engineered thermal designs. Overly optimistic assumptions are arguably worse since they may result in overheating. The judicious choice of component power dissipations requires communication between the component suppliers, and hardware, component and thermal engineers.

Material properties and interface thermal resistances will also have large impacts on thermal analysis results. Ideally, the values for these inputs are obtained from independent testing, otherwise large discrepancies are possible. In one example, a thermal interface material's (TIM) datasheet claimed a thermal conductivity of 7 W/m°K. However, testing showed the value to be less than 1/10th of that specified. Use of the datasheet value in a thermal analysis would result in a large error in the temperature prediction, particularly for higher power components where this TIM would likely be used.

The accuracy of results also depends on the many assumptions that are required for the analysis, some of which have been discussed above. Additional assumptions include:

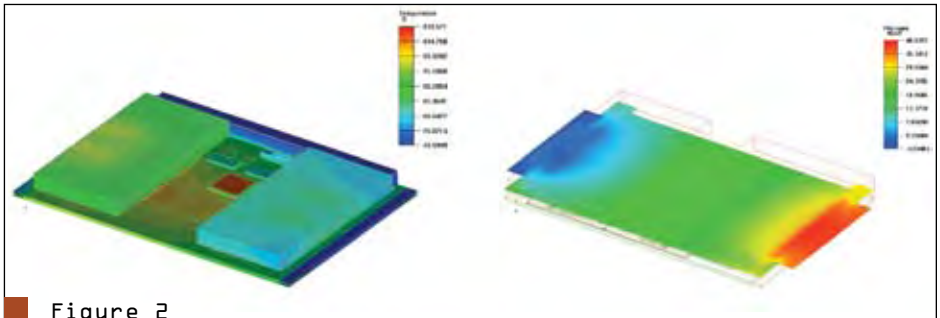

Figure 2

A thermal engineer analyzing a forced air-cooled board looks at not just temperature results, but also at air flow and pressure drop across the board. Shown here is the temperature (object face) and pressure drop (cut plane) results of a forced air-cooled board.

- Whether or not to include other heat transfer modes such as convection (for conduction "only" analyses) and radiation (for convection analyses).
- The specification of fluid flow as laminar, transitional or turbulent.
- The size of FEA solution space (how much volume to include around the board or enclosure)

The predictions generated by thermal analysis provide only an initial validation of the thermal design and enables prototypes to be made and tested. However, testing is the true validation of the design as it remains to be seen whether the assumptions made in the thermal analysis were realistic. Then again, the thermal test must operate the electronics in a realistic "worst-case" approach to fully validate the design. For example, one worst-case approach is to use the most stressful software code at the highest specified boundary condition temperatures. Critical temperatures (high power and/or hot parts) and power consumptions need to be monitored to enable meaningful comparisons between the test and analysis. An experienced thermal engineer can routinely attain a difference of 5% or less between test and analysis.

Analysis of Advanced Cooling Technologies

The discussion so far has focused on thermal analysis (and test) of typical standard electronics cooling methods—conduction and convection—but advanced cooling methodologies can also introduce new challenges into the thermal analysis process. One problem is that most commercial analysis tools are incapable of accurately modeling and analyzing phase change cooling. In the case of heat pipes the effective thermal conductivity approach is required. This approach either models the heat pipe with a very high axial conductivity and a lower radial conductivity (typically that of the heat pipe casing, usually copper), or it models the constituent elements of the heat pipe (casing, wick, fluid core) with different effective conductivities. Unfortunately, both of these approaches ignore very important limitations of heat pipes such as gravity/body force effects, capillary limits and condenser effects. Knowledge of these limitations, typically gained through extensive application testing, must inform the thermal analysis. Otherwise, the analysis may significantly over- or under-predict temperatures.

Thermal analyses have become an integral part of the design process for electronic modules and enclosures. They provide early assessments of thermal designs that enable important changes to be made if a design is found to provide insufficient cooling. To be effective though, the analysis predictions must be accurate, which can only be determined by testing. Accuracy is affected by many factors, chief among them being thermal experience. However, new cooling technologies promise to challenge even the most experienced thermal engineers and analysis software vendors. ■■

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Tech Recon

VME in Tech Refresh Programs

VME Tech Refresh Programs Abound

Numerous deployed and long design cycle programs continue to demand VME SBC upgrades—dropping into an existing slot with today's computing technology.

Jeff Child,
Editor-in-Chief

Often filling the role as the "cash cow" of the military embedded computer business, slot-card technology upgrade programs are continuing to do brisk business. That ability to insert new processing, memory and I/O functionality on legacy platforms is exactly why the military has favored modular slot-card form factors like VME in the first place.

The days are now gone when VME was the only option for new military system designs. That said, its ability to accommodate new technologies opens the door for a healthy stream of technology refresh business. A host of deployed programs and long design cycle programs continue to demand VME SBC upgrades that drop into an existing slot with the latest and greatest processing technology.

One example, detailed at a recent press event, is Thales-Raytheon Systems' upgrade of their Firefinder Weapons Locating Radars, which includes the AN/TPQ-36 Weapon Locating Radar (Figure 1) and the AN/TPQ-37 Artillery Locating Radar. The AN/TPQ-36 is an artillery, rocket and mortar locating radar. Location of artillery at ranges beyond the capability of the AN/TPQ-36 is provided by the AN/TPQ-37, the other radar that makes up the Firefinder system. Using only a different computer software program, the same operations shelter can be used for either Firefinder radar. The AN/TPQ-37 is a coherent, electronic-scanned, range-gated pulse Doppler radar.

In October 2005, the U.S. Army tasked Thales-Raytheon to craft a form, fit, function replacement for the Legacy AN/TPQ-36 Radar Processor. Requirements called for support of both AN/TPQ-36 and AN/TPQ-37 Radars, allowance for future upgrades, open architecture and a 12-month maximum development schedule.

Figure 1

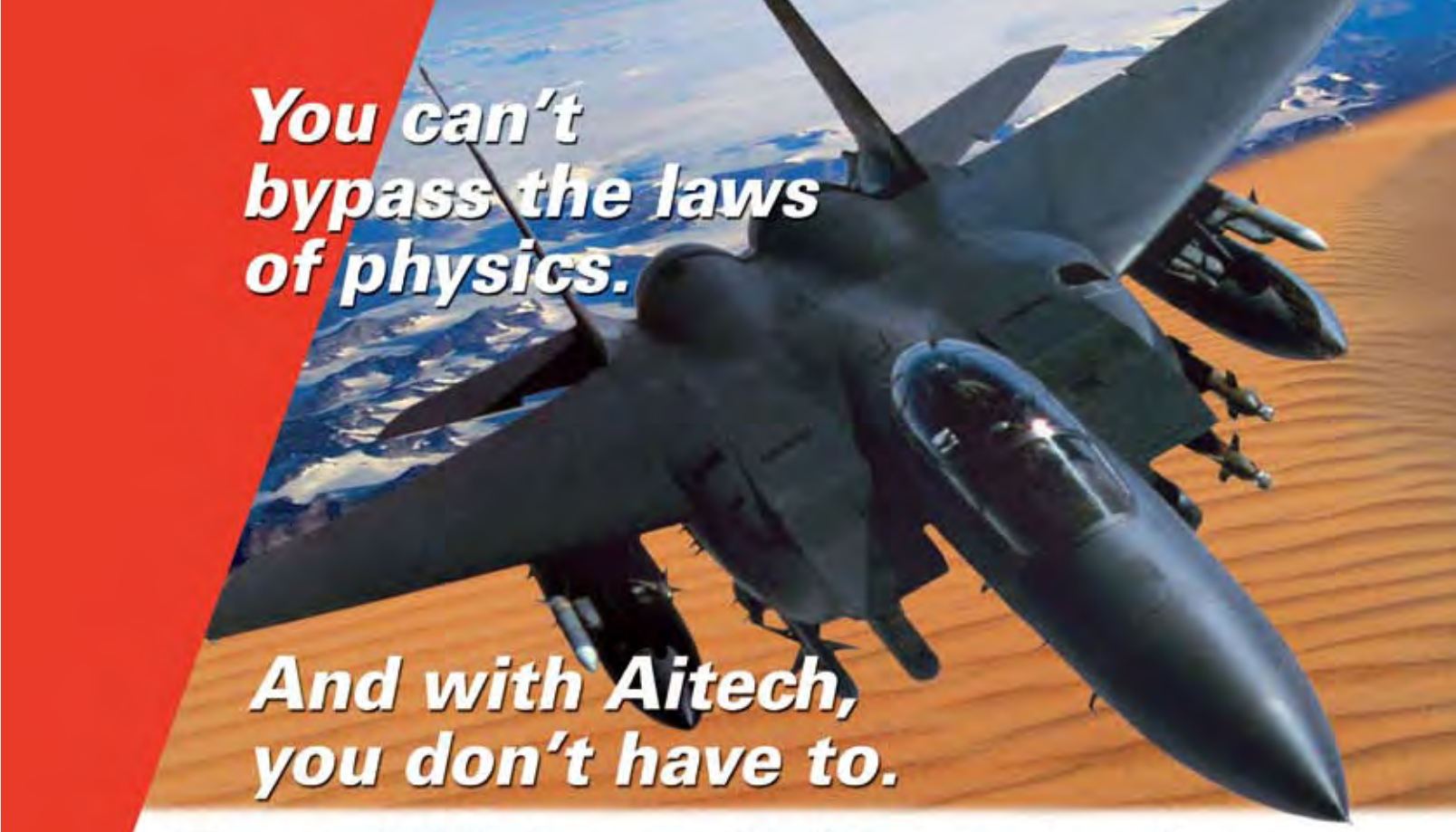
The AN/TPQ-36 Weapon Locating Radar is an artillery, rocket and mortar locating system radar. Location of hostile artillery and mortars by the AN/TPQ-36 is completely automatic. An upgrade to the AN/TPQ-36's radar processor consists of a 3-Card Slot VME Implementation with two PowerPC-based boards, two PMC and VME clock interface card.

While the original 1970 design of the AN/TPQ-37 radar processor was comprised of 128 circuit boards and used machine language, the AN/TPQ-36's radar processor, which was upgraded in 1994, was a VME-based system. For the new combined radar solution, Thales-Raytheon engineers chose a 3-Card Slot VME Implementation consisting of two Thales (now Kontron) PowerNode 3 Cards for signal and data processing, two PMC daughter cards for A/D and synchronization and one interface clock card. The system uses a real-time Linux OS.

The PowerNode 3 VME board sports dual Motorola PowerPC G4 7457 processors running at 1 GHz, 2 Mbytes of onboard L3 cache per processor, plus 2 Mbytes private SRAM. Up to 1 Gbyte of onboard SDRAM is accessible at the local bus speed of 133 MHz. The conduction-cooled boards have VME 2eSST (150 Mbyte/s) capability and have slots to two PMC slots.

Similar tech refresh programs abound in these opportunities and form the heart of much of the embedded-computer business. Among the highest profile of these include the F-18 Advanced Multi-Purpose Display program; Bradley Vehicle Electronics Upgrade; B-52 mission computer upgrade; Aegis Guided Missile Destroyer Sonar Upgrade; B-2 Bomber Radar Upgrade; Boeing B-1B Bomber Avionics Upgrade; and the C-130 cockpit upgrade. Most all of these upgrade programs involve standards-based embedded-computer solutions such as VME.

Now that the newer fabric-based VITA specs—VPX and VXS—are finally in a "productizing" phase of their development, the industry is starting to ponder a break with traditional VME and its long legacy of complete backplane backward compatibility. This won't happen overnight by any means. VME board vendors say that old VME 2eSST and VME64 are what they're shipping most today. Many new programs are looking to either make the leap to the VPX switched fabric-based backplane, or incorporate VXS to work alongside legacy VME boards in a hybrid solution. ▮▮



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Tech Recon

VME in Tech Refresh Programs

Tech Refresh Programs Weigh VME Compatibility Trade-Offs

VME continues to shine as the leading choice for tech refresh and tech insertion in military programs. The emergence of VXS and VPX adds both complications and opportunity into the refresh equation.

Richard Kirk, Global Product Manager
GE Fanuc Embedded Systems

VME has enjoyed more than a quarter of a century of success for a number of reasons. As an open architecture, it has created an ecosystem that delivers enormous flexibility to customers. It has also demonstrated a level of reliability and robustness that has seen it widely implemented in mission-critical applications. All that said, perhaps the foremost reason for its success has been its ability to reinvent itself—to adapt to changing application requirements and new technologies—such that it remains not only relevant in the twenty-first century, but actually delivers a compelling alternative to other architectures in terms of price/performance. By 2003, for example, the VITA 1.5 2eSST high-performance synchronous protocol was allowing VME users to achieve backplane transfers up to 320 Mbits/s—eight times the capacity of VME in its original 16-bit form.

Today's military programs have never had so many choices in terms of upgrading VME systems that are already in the field. It's important first, however, to make a distinction between "technology insertion" and "technology refresh"—terms that are widely used in determining the optimum way forward for a program. Technology insertion is generally taken to mean the simple replacement of an existing VME board with another that offers higher performance. Backplane and chassis remain unchanged. Technology refresh, on the other hand, is generally taken to mean a plan that sees more substantial changes to the underlying system—changes which may see original VME capabilities retained in some form,

Figure 1

The MLRS (Multiple Launch Rocket System) program is set to enter another round of VME technology insertions. For the next round, the MLRS program aims to reduce the number of boards per system from three to two.

or that may see the complete elimination of the original VME boards in favor of VXS, for example, or VPX.

Pin-Compatible Replacement

Technology insertion will include a pin-compatible replacement—a processor board, for example, with enhanced capability can be inserted directly into the existing backplane (compatibility mode) or can take advantage of the new functionality, but "break" the backward compatibility facility. As an upgrade strategy, it has been used by many military programs over the past two decades, with the MLRS (Multiple Launch Rocket System) program (Figure 1) about to embark on another round of insertions. Having begun with the GE Fanuc PPC2EP single board computer (introduced in 1998), MLRS decided to forego 100% pin-out compatibility in order to add functionality to the board that would allow them to reduce the number of boards per system from four to three. The program subsequently evaluated the PPC4EP before settling on its successor, the PPC7EP, which offers added functionality that allows communication with the latest weapons. For the next round of technology insertion, MLRS hopes to reduce the number of boards per system from three to two.

This strategy is a challenging one for board manufacturers. It requires them to adopt, as a core philosophy, a product development program that has technology insertion at its heart. This means, for example, that not only must pin compatibility be maintained from one generation of board to the next, but it also requires a commitment to developing a suite of layered software that, in effect, masks underlying hardware changes from the application.

Product Development Strategy

Technology insertion as a product development strategy is, of course, reliant on the board designer selecting key components that are compatible with previous iterations of the component and that have a reliable roadmap of regular performance enhancements. Here, what is now known as the Power Architecture—previously know as PowerPC—has played a vital role, and looks as if it will continue to do so. The recent announcement of the 8640 by Freescale—an alternative to the 8641 and similarly available in a dual processor configuration—with its promise of identical performance but with around 25% less power consumption/heat dissipation, demonstrates once more the enduring validity of technology insertion as an upgrade path.

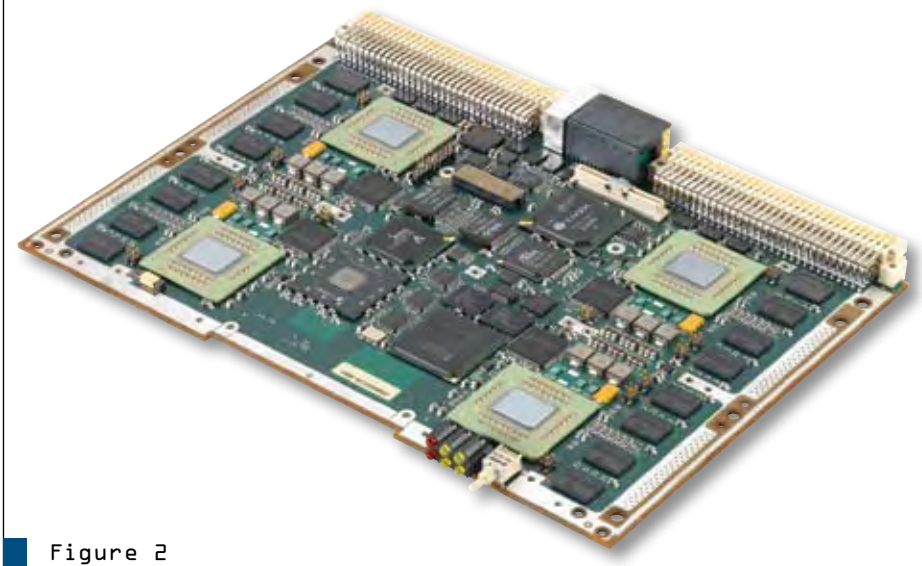

Figure 2

GE Fanuc's DSP220 VXS multiprocessor is used in Lockheed Martin's MEADS (Medium Extended Air Defense System) radar system program. Initiated a decade ago using the VME architecture, the next upgrade will embrace the incremental performance upgrade path made possible by VXS.

The technology insertion challenge is even greater for manufacturers. For a customer to be "guaranteed" the opportunity of technology insertion as and when required during the lifecycle of a program, there must be a commitment on the part of the board manufacturer to put in place the processes necessary to protect customers from obsolescence: in an ideal world, no major program would ever need to make a disruptive change to a system purely because a board or a compatible replacement is no longer available. In response to this requirement, a number of vendors offer product lifecycle management services as a dedicated resource that have allowed the support of programs for twenty years and more.

For many years technology insertion was the only way forward for a VME-based program. The arrival of serial switched fabrics such as PCI Express and Serial RapidIO, and the substantial promise of higher throughput and higher performance that they offered, changed the landscape. As it has always done, VME responded—this time, with VXS (VITA 41). VXS maintained mechanical and electrical compatibility with legacy VME boards using the traditional P1 and P2 connectors, but provided a new, high-speed P0 connector that allowed up to 2.5 Gbits/s data transfer: it was an incremental solution. And, very much in keeping with the open nature of the VME architecture, VXS was agnostic as far as which serial switched fabric was used.

An example of a major military program making the decision to use VXS for its technology refresh needs can be found in Lockheed Martin's selection of GE Fanuc's DSP220 VXS multiprocessor (Figure 2) and CRX800 22-port Serial RapidIO switch for the MEADS (Medium Extended Air Defense System) radar system program, which unites the United States, Germany and Italy in developing next-generation point defense capabilities. The MEADS program was initiated some ten years ago, based on the VME architecture, and the decision was taken

Figure 3

One example of a major military program making the decision to use VXS for its technology refresh is the Medium Extended Air Defense System (MEADS)—a mobile air and missile defense system designed to replace Patriot systems in the United States and Germany, and Nike Hercules systems in Italy. MEADS includes a lightweight launcher, 360-degree fire control and surveillance radars, and plug-and-fight battle management command and control abilities not found in current systems. The MEADS radar system uses a 22-port Serial RapidIO VXS switch.

The MEADS interceptor is the Lockheed Martin PAC-3 Missile Segment Enhancement (MSE), which increases the engagement envelope and defended area over the currently fielded PAC-3 Missile. MEADS features an open architecture that will provide for 21st century air and missile defense system-of-system integration capabilities that allow operational mission-tailoring for homeland defense or defense of maneuver forces.

to follow the incremental upgrade path made possible by VXS.

VXS: An Evolutionary Step

VXS represents an evolutionary way forward for major VME-based military programs. VPX, on the other hand, could be said to represent a revolutionary way forward. Some characterize the difference between the two in terms of VXS being a tactical decision—but VPX is a strategic decision. If VXS can be considered to be VME-centric while providing access to the world of serial switched fabrics, VPX is perhaps best characterized as being fabric-centric but allowing access to the VME world. And if VXS marked a departure in terms of technology refresh for military programs in that it required the substitution of the existing backplane with a new backplane—although existing VME boards could still be used—VPX sees a similar requirement for a new backplane, but existing VME boards no longer have a place other than in systems using a hybrid backplane.

VPX represents a different performance/risk alternative. VME, of course, is the ultimate safe choice, and VXS represents little risk at all: VPX is, as yet, relatively unproven—but also offers the greatest potential for significant performance increases. Numerous programs have elected to use it, but all are currently in the development or qualification phase: no VPX-based systems have yet been deployed. And while, for example, standard, off-the-shelf backplanes are widely available for VME and VXS, VPX backplanes represent a greater challenge with each having to be configured according to the unique demands of the application: a "generic" VPX backplane does not yet exist. Why, then, would a major program elect to go the VPX route?

Among military programs, it is true to say that VPX is mostly chosen as an architecture for new programs—programs where high performance is, of course, a prerequisite—but where small size and

weight are also key factors in applications such as unmanned vehicles. It's there that the attraction of converting an existing VME-based program to VPX primarily lies: the ability to deliver better performance, but from a smaller enclosure—freeing up space in a vehicle, for example, in order to accommodate new subsystems. It's also possible, given the greater performance density of a VPX board, that the number of boards necessary to achieve a given level of throughput or functionality could be significantly reduced.

3U VPX Capturing Mindshare

It is VPX in its 3U implementation that is really capturing designers' attention, primarily because it no longer suffers from the performance issues associated with small form factor VME and CompactPCI systems. Beyond this, the "fabric-centricity" of VPX allows the creation of larger mesh configurations or mesh clusters, eliminating the requirement for a central switch and saving valuable slots. For new programs, the lack of provision for VME compatibility in VPX's 3U form—as opposed to the VME capability provided with 6U VPX—is, of course, scarcely an issue.

It's also important to note that the creativity of designers has seen the development of hybrid systems that leverage the benefits of more than one of the candidate architectures. One program, which has not yet been revealed publicly, sees a system that combines VXS and VPX into a single solution that features a VPX SBC, a VPX multicomputer and a VXS switch. The drivers behind the selection of this approach were to minimize time-to-market: this meant reducing risk, which in turn meant leveraging existing legacy systems wherever possible in order to minimize development time.

The solution includes legacy front-end VXS-based proprietary capabilities and advanced VPX-based processing in a hybrid chassis in which the switch allows data to be transferred rapidly from the VXS-based front-end to the VPX quad core processor as well as for VPX inter-processor dynamic signal routing through the switches for back-end digital signal processing. This ability to dynamically route signals via a VXS switch within a single-supplier solution was a unique aspect of the proposed solution.

In summary, it could be said that the technology refresh options presenting themselves to a major program are: replace the board; replace the backplane; or replace the box. At one end, replacing the board will likely be the most cost-effective choice—and deliver the least incremental performance. At the other, cost is likely to be highest—but so too are the likely gains in performance and functionality. The good news is that developers are spoiled for choice. ■■

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System Development

Options in Small Form Factor Boards

Small Form Factors Mean Big Design Choices

Gone are the days when a severely space- or weight-constrained military system had to opt for a fully custom computer solution. A growing crop of small embedded computer form factors offers a wide range of choices.

Christine Van De Graaf, Product Marketing Manager
David Pursley, Field Applications Engineer
Kontron

Military applications represent some of the most challenging and broad-ranging design demands today. New technologies can be difficult to adopt and develop quickly, and as a result military markets frequently demand reliance on existing or legacy technology for speed and execution of a given design. On the other hand, new military programs, such as Future Combat Systems (FCS), Joint Tactical Radio System (JTRS) (Figure 1) and the Warfighter Information Network-Tactical (WIN-T) are so demanding and communication-centric, they require more performance than earlier architectures have been able to deliver within a small footprint. Wherever the application demands fall in terms of performance, designers must also consider issues of size, weight and power (SWaP), all critical to the overall performance of sensitive military applications.

When military budgets address not only cost, but also development time, enclosure space and performance factors, PC/104 or PC/104-compatible systems very effectively fit the bill. Stable platforms such as PC/104 and PC/104-compatible can be ideal for designs that do not require much, if any, hardware customization, and they have evolved to deliver increased performance within very small form factors.

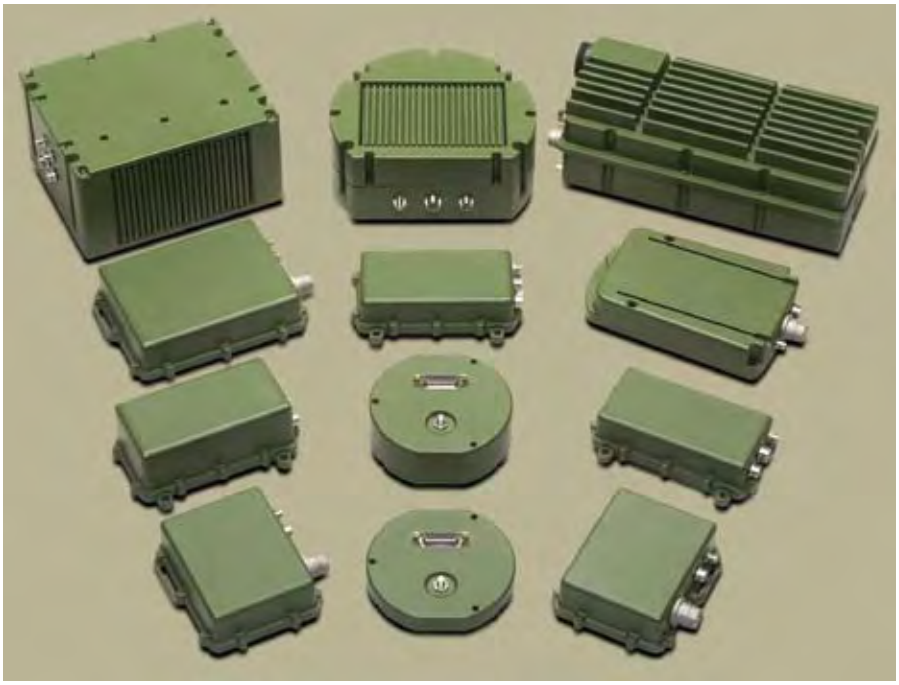

Figure 1

Advanced programs like JTRS are looking for a blend of high-performance computing but under very challenging size, weight and power constraints. Shown here is the family of JTRS HMS (Handheld/Manpack/Small Form Fit) Radios.

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Small Form Factor Boards Comparison Chart

Form Factor	Size (mm x mm)	Defense Apps. Suited For
3U CompactPCI	100 x 100	Avionics (such as UAVs); Graphics-based ground applications.
MicroTCA	155 x 135	Next-generation mobile network applications.
ETX	95 x 114	Avionics Rugged computing platforms (such as Ultra-Mobile PCs)
COM Express	125 x 95	Unmanned vehicles; Training simulators; Portable tactical communications devices
PC/104	90 x 96	Unmanned vehicles; Avionics

Table 1

Military embedded system developers have a lot of choices these days in small board form factors. Each of these has a solid base of products available today.

For more complex applications, military designers may consider computer-on-modules (COMs) such as ETX or COM Express including the Basic and Extended form factors in addition to compatible compact modules such as microETXexpress or nanoETXexpress. When communication and bandwidth requirements go beyond the limits of these established technologies, 3U CompactPCI and MicroTCA can step in with increased computing power, very high communication bandwidth and high availability in a small form factor. Table 1 compares the major standard small form factors available and their suitability for various defense applications.

PC/104 for Non-Custom Designs

As an off-the-shelf product, PC/104 and PC/104-compatible modules tend to be the norm for military applications in which very low cost, small footprint and moderate performance are among the main criteria. With little or no customization, these solutions prove more than sufficient for a wide range of implementations.

Comprised of a CPU board and optional peripheral boards stacked together, PC/104 eliminates the need for a motherboard, backplane or card cage. Fitted with stack-through connectors, these pin- and socket-bus connectors provide a reliable signal path even in harsh environments. With four corner-mounting holes for board support to resist shock and vibration, each module measures 3.575 inches x 3.775 inches (90 mm x 96 mm). When stacked, the card spacing is 0.6 inches.

The bus specifications for PC/104 are identical to ISA's with the exception that PC/104 reduces the drive requirement for most signals to 4 mA of sink current reducing overall power requirements and allowing ASIC devices to directly drive most bus signals without the need for separate driver components. PC/104's stability as a form factor and wide availability from nearly 75 vendors, make it an attractive option where "easy does it" and optimum performance is simply not necessary.

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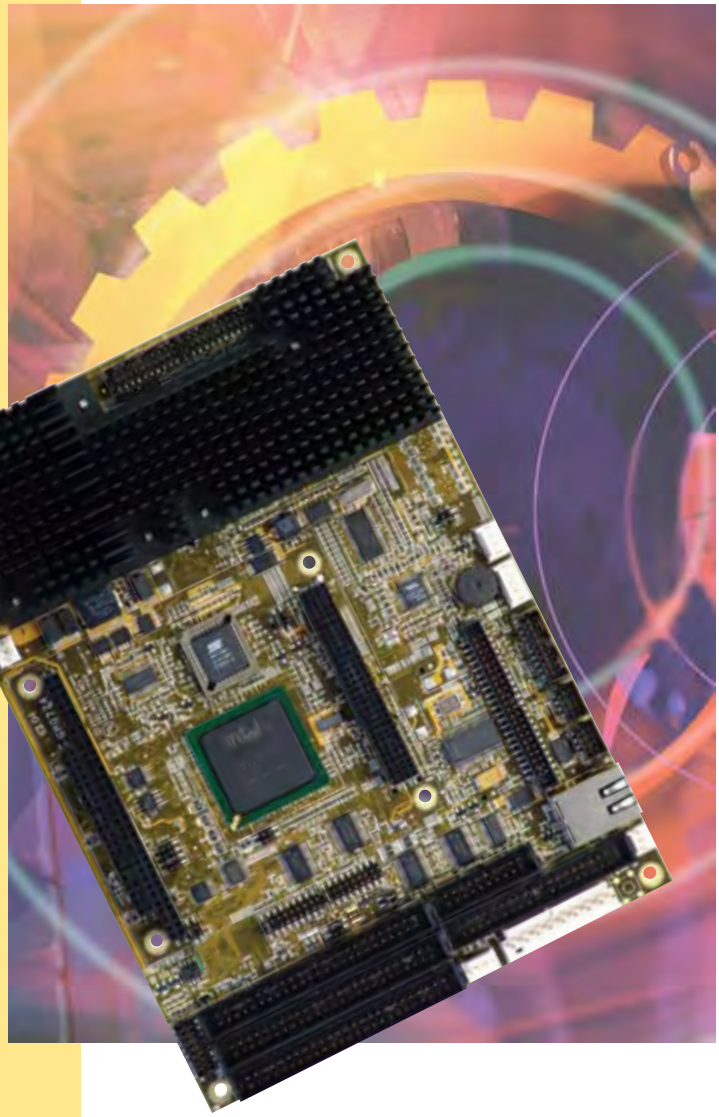

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Small Form Factors: Two Ends of the Thermal Design Spectrum

Standard MicroTCA has some level of ruggedness; it's currently being used in ground mobile installations. But new and more rugged versions are being fostered as derivative standards—largely focused on thermal issues—including rugged air-cooled MicroTCA (MTCA.1 and MTCA.2) and conduction-cooled MicroTCA (MTCA.3). The first of these specifications has a draft in review and will likely be ratified in the short term. MTCA.3 is just now underway, and its focus is conduction-cooled systems, functioning with no airflow at all in sealed environments. The most extreme thermal, shock and vibration profiles defined in ANSI/VITA 47 will be answered by MTCA.3, which will in turn define the AMC's conduction-cooled interface.

PC/104-Plus boards like the Kontron MOPSlcdLX PC/104-Plus often don't require active or passive cooling.

The scaled down size has the potential to concentrate heat and requires intelligent design to manage properly. Design techniques such as optimizing board layout, incorporating proper airflow handling and choosing the right power supply, all work hand in hand with features such as intelligent fans and thermal sensors.

PC/104 (see Figure) falls at the other end of the thermal management spectrum, meeting lower budgets in terms of size, weight, performance and thermal issues. With performance at the lower end, its power consumption is accordingly lower as well. Because of this, PC/104 does not need active cooling. PC/104 boards do not require fans or other more complex cooling systems, and they occasionally do not even require passive cooling. They can be cooled pretty simply with a heat sink or a heat spreaderplate and heat pipe, which is usually only necessary if the application is demanding. Completely enclosed systems by contrast will run more effectively with integrated cooling.

tended (more commonly referred to as ETX) standard, providing full PC functionality, minimum engineering and adoption cost, reliable connectors, slim design, and simple upgradability and scalability.

ETX modules are highly integrated and compact (95 mm x 114 mm, 12 mm thick) COMs. The standardized form factor and connector layout that carry a specific set of signals—found in all ETX modules—means designers can create a single-system baseboard, which will accept current and future ETX modules. Being able to build a system on a single baseboard using the computer as one plug-in component simplifies packaging, eliminating cabling and significantly reduces system-level cost—all key issues to mil/aero design.

ETX has further evolved, making advancements in its scalability and performance. The newer ETX 3.0 specification offers the same benefits of the original ETX standard, but also adds in 2x Serial ATA with no change in ETX pins, making new modules 100 percent pin-to-pin compatible with previous versions to ensure long-term support. Evolution continues with COM Express and its specifications that satisfy the higher performance market segments of the military and illustrate the trend toward size reduction and mobility. Figure 2 compares the sizes of the various COM standard form factors.

ETXexpress—a COM Express solution from Kontron—modules are 100 percent compliant with the COM Express spec and allow the application of high-speed COMs for PCI Express Bus and PCI Express chipsets. The new 220-pin high-speed SMT connectors for ETXexpress offer enormous performance capabilities. ETXexpress supports hardware solutions that are based on current bus systems such as 32 PCI and LPC (the ISA bus replacement) as well as up to 32 PCI-Express lanes (configuration dependant) including PCI Express Graphics. Gigabit Ethernet, USB 2.0, Serial ATA and Parallel ATA interfaces are supported as well.

Initially, COM Express was designed to accommodate the next generations of PCI Express (5 GHz) and Serial ATA (300 Mbits/s) interfaces, effectively doubling existing data rates to 160 Gbits/s and 1.2 Gbytes/s. For new and more portable military applications, designers now have additional options available in the COMs standard, including the microETXexpress (with a more compact footprint at 95 mm x 95 mm) and nanoETXexpress (with a minimized footprint that is just 39 percent of the original COM Express standard "Basic" form factor module) COM Express compatible modules.

COMs are appropriate for designs that include a lot of application-specific customization and can afford a two-board solution—module plus custom carrier board. Well suited to a high run of product and the need for some scalability from generation to generation, COMs are ideal for devices or applications that not only require scalability from generation to generation, but also within a single generation. Customizations designed into COMs' accompanying carrier board can last for generations with various CPU cores, for example, swapping out one for the next.

3U cPCI Accepted by Military

3U implementations of established architectures such as VME and CompactPCI can also address legacy issues inherent to military designs, and now offer new features that meet more requirements of harsh computing environments. For example, VME is more than well established in military design, and mil/aero is VME's largest market segment by revenue. As application requirements move toward requiring more bandwidth, 3U VME is less able to meet military's size and performance demands. In addition to limited industry support, 3U VME is also limited in terms of bus width, bandwidth and rear I/O pins, and these limitations eliminate it as a design choice for many applications. A 64-bit bus is not possible with 3U VME, so many designers turn to 3U CompactPCI, which has much higher bandwidth, Gigabit Ethernet capabilities and more powerful rear I/O.

Also VME in general presents far greater software development challenges than CompactPCI. A more extensive range of software is PCI-compatible in nondefense applications, and that comfort zone has crossed over for mil/aero designs. Even newer software engineers are

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		CMA157886PX1400HR	CMX158886PX1400HR	CMD158886PX1400HR	CMX158886PX1400HR-BRG	CMD158886PX1400HR-BRG	CME146786CX650HR	CME147786CX400HR	CME147786CX650HR	CML147786CX400HR	CML147786CX650HR	CMX147786CX400HR	CMX147786CX650HR	CME136686LX500HR	CME137686LX500HR
Expansion Bus	PC/104 ISA Bus	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PCI-104 PCI Bus	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
	PCI Bus Masters	4	4	4	4	4		4	4	4	4	4	4		4
	APIC (add'l PCI interrupts)	9	9	9	9	9	9	9	9	9	9	9	9		
CPU and BIOS	CPU Max Clock Rate (MHz)	1400	1400	1400	1400	1400	650	400	650	400	650	400	650	500	500
	L2 Cache (KB)	2048	2048	2048	2048	2048	256	256	256	256	256	256	256	128	128
	Intel SpeedStep Technology	✓	✓	✓	✓	✓									
	ACPI Power Mgmt	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0
	Max Onboard DRAM (MB)	512	1024	1024	1024	1024	512	512	512	512	512	512	512	512	512
	RTD Enhanced Flash BIOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Nonvolatile Configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	RTD Quick Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peripherals	Watchdog Timer & RTC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ATA/IDE Disk Chip (MB)	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096
	Audio		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		
	Analog Video	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA
	Digital Video	LVDS	LVDS	LVDS	LVDS	LVDS				TTL	TTL	LVDS	LVDS	LVDS	
	AT Keyboard/Utility Port	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PS/2 Mouse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Mouse/Keyboard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
I/O	**RS-232/422/485 Ports**	4	4	2	4	2	2	2	2	2	2	2	2	2	2
	USB Ports	4	2	4	2	4	2	2	2	2	2	2	2	2	2
	10/100Base-T Ethernet	1	1	1	1	1	1	1	1	1	1	1	1	2	1
	ECP Parallel Port		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	aDIO (Advanced Digital I/O)	14	18	18	36	36	18	18	18	18	18	18	18	18	18
	multiPort (aDIO, ECP, FDC)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SW	ROM-DOS Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DOS, Windows, Linux	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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

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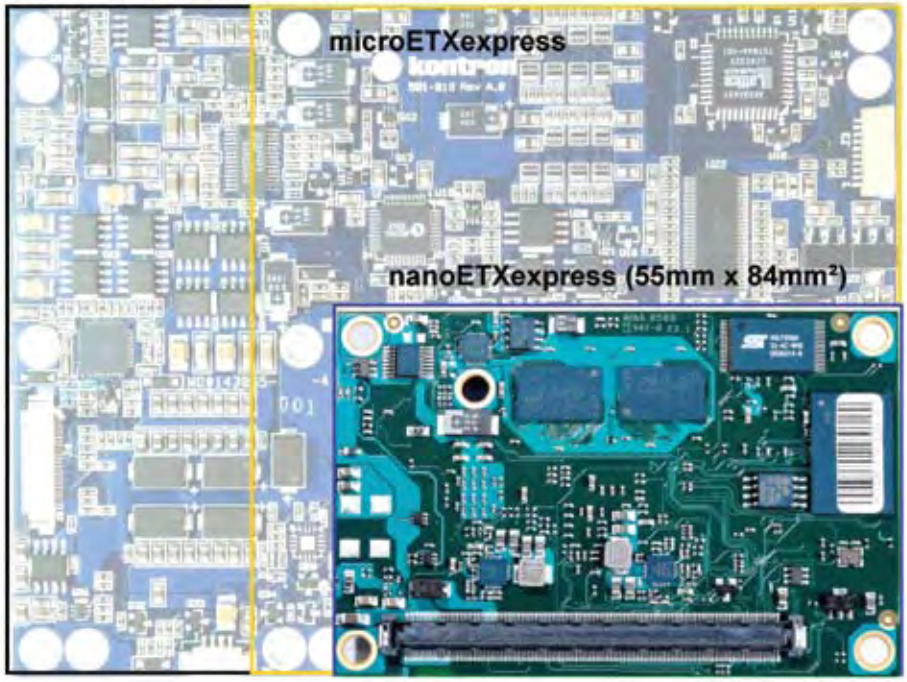

Figure 2
These overlaid images provide a clear comparison of related available COM Express solutions.

familiar with PCI-based programming. So, many years later, CompactPCI's staying power in military design is not only strong, but growing based on its ability to deliver rear I/O in a smaller 3U form factor, powerful industry support and the latest processing technology available on CompactPCI boards.

3U CompactPCI is rugged and can be air-cooled or conduction-cooled and has Rear I/O, unlike PC/104 and MicroTCA. It's also inherently stiffer than its own 6U counterpart, meaning it meets more rugged standards and is less vulnerable to shock and vibration.

Rear I/O has become an almost universal requirement in military applications because it provides different capabilities for different applications. The routing of board I/O signals to the backplane, either instead of, or in addition to routing them to the front panel, makes it much simpler to replace out in the field. The board itself can be considered a Line Replaceable Unit (LRU)—making maintenance simpler and less error-prone.

Overall, 3U CompactPCI has gained more popularity than its VME equivalent, thriving as its 3U form factor has kept up with the demand to reduce SWaP. In fact, with the range of processors on the market, it can have as much or as little power as needed. 3U CompactPCI is very widely supported and there is a broad range of rugged chassis available for this form factor. Lastly, if an older military system is already using CompactPCI, upgrades to the latest processors make an ideal replacement rather than moving to a new form factor.

Emerging MicroTCA

The MicroTCA standard has risen in fact to address the issues of form factor and bandwidth. MicroTCA is characterized by high processing capacity, extremely high communication bandwidth and high availability designed into a small 2U form factor. Demands for SWaP considerations in mil/aero applications are all factored into MicroTCA's 2U design. Initially developed for air-cooled telecom applications, MicroTCA still offers

a NEBS Level 3 rating, making it rugged enough to withstand greater shock and the vibration of a major earthquake.

MicroTCA's high bandwidth for both communications and computing is a direct result of up to 12 compute blades on a single backplane, which could potentially all use a multicore processor. A 3U or 4U system, for example, could have as many as 24 cores designed into MicroTCA's very small footprint. MicroTCA designs can tap as many as 21 high-speed serial connections on the backplane, resulting in bandwidth of 2.5 Gbits/s for each connection. A broad range of communications bandwidth capacities is possible—ranging from 40 Gbits/s to over 1 Terabit/s—depending on how the system is implemented.

Many of the newest military initiatives for modernizing the battlefield rely on networks using standard Internet protocols. MicroTCA is potentially a good design choice for supporting these applications, because it offers native support for IP-based network topologies packaged with high bandwidth, increased computing power and the small form factor these network-centric applications require.

WIN-T, which is based on Internet protocols, is using the MicroTCA architecture in its networked systems. Networks appear just as any PC-based LAN being run in an office environment would, with each MicroTCA blade using a standard network connection. Because of this simplicity, the software development phase for MicroTCA is also much less complex than that of established VME or even standard CompactPCI architectures.

Even with SWaP concerns as a priority, computing bandwidth and high availability must be met. MicroTCA delivers a small form factor advantage over both VME and CompactPCI including their derivatives VITA 31, VITA 41 and PICMG 2.16. Systems benefit from the generally smaller MicroTCA blades, which also tend to use less power. Add multicore and MicroTCA's processing power becomes even greater, even with a single backplane. 6U VME or CompactPCI designs can meet this bandwidth, but not when reduced to their smaller 3U form factors. MicroTCA is larger than the COM Express architecture, but with dimensions of 2U x 3-6HP x 183.5 mm, it is a smaller form factor than even 3U VME and Compact PCI.

Form Factor Choices Abound

Numerous options meet the bandwidth size, power and price point required for effective military designs. Being well versed in existing, new and evolving small form factors—along with the performance benefits and limitations they each bring to the table—is a way for designers to best understand the alternatives available to them in meeting the performance standards of any particular military application. ▮▮

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Technology Focus

Solid-State Disk Drives

SSD Products Climb Aboard New Form Factors

As solid-state drives continue to gain momentum in the military embedded realm, the crop of SSD products is moving into the latest board-level form factors.

Jeff Child
Editor-in-Chief

Free from the woes of moving parts, flash-based solid-state disks (F-SSDs) are able to operate under the harshest conditions, unlike magnetic hard disk drives. And because F-SSDs targeted for military and aerospace apps use the same fundamental flash components as the consumer realm, the price advantages can be leveraged across all markets.

The downsides associated with flash-based disks are quickly falling by the wayside. Random access speeds rival and now beat other media, retention and re-writing cycles have dramatically increased, and many systems offer a single-control erase-all function with or without power for security-sensitivity applications. Those factors have moved F-SSDs closer to the forefront as the lead option for rugged mass storage.

More Rugged than HDDs

In a rugged environment, the rotating mechanisms of a hard drive can fail, and are subject to partial and sometimes even total loss of data. Severe conditions including high shock, vibration, altitude, humidity and extreme temperature ranges increase failure rate percentages of hard disk drives, which is unacceptable for mission-critical systems. Responding to the growing demand for F-SSDs, the major vendors of F-SSD products continue to ramp the capacity, performance and security features of their products.

Exemplifying those trends is the Series 4 Data Transfer System (DTS) (Figure 1a) from L-3 Targa Systems. The unit consists of a Data Transfer Unit (DTU) and a removable Data Transfer Device (DTD), provides a compact self-contained system to store and retrieve data from 2.5-inch SATA flash disks and is designed to work in MIL-STD-810 and RTCA DO-160 environments. Capacities in this removable form factor are now available up to

A)

B)

Figure 1

L-3 Targa's Series 4 Removable Disk Data Transfer System (a) is used as removable SSD storage for the Moving Map Display aboard the UK's Tornado combat aircraft (b). A Tornado GR4 with wings swept is shown here at Kemble Air Day 2008, Kemble Airport, Gloucestershire, England.

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256 Gbytes. The Series 4 Removable Disk Data Transfer System is used as removable storage for the Moving Map Display aboard the UK's Tornado combat aircraft (Figure 1b).

SSD products introduced over the past 12 months span a wide range of form factors, including relatively new form factors like XMC and PCI-104. Last month Curtiss-Wright Controls Embedded Computing rolled out XMC/PMC-550, a new high-performance, rugged solid-state drive card. The XMC/PMC-550 is offered in both XMC and PMC form factor versions and is ideal for use in legacy and latest rugged deployed applications. The XMC/PMC-550's standard Serial ATA interface enables it to be easily supported and integrated into VME VPX and CompactPCI systems.

The XMC/PMC-550 NAND flash solid-state drive provides up to 32 Gbytes of disk space in an XMC (VITA 42.3) or PMC (IEEE1386.1) form factor. It is available in configurations of 8, 16 or 32 Gbytes, and is visible to the system as two independent SATA drives. Using multi-tasking technology, the XMC/PMC-550 delivers data transfer rates of up to 30 Mbytes/s for simultaneous read to each drive. The XMC/PMC-550 also comes with RAID 0 support that stripes data across the two independent SATA drives for maximum performance.

Figure 2

Certified for MIL-STD-810F shock-resistance and anti-vibration, Apacer Technology's SDM SSD series is available with a 7-pin or 22-pin connector that is oriented at 90 degrees or 180 degrees. Supporting SATA 1.5 Gbit/s and read and write speeds up to 35 Mbytes/s and 25 Mbytes/s respectively, the SDM is based on high-speed SLC (Single Level Cell) flash memory in capacities of 128 Mbytes to 4 Gbytes.

Serial ATA Interface Dominates

Serial ATA appears to be on its way to becoming the dominate interface technology for new storage subsystem designs. SCSI and Fibre Channel in contrast seem to be waning. Apacer Technology's newest SSD product is SATA based. The new SDM SSD (Figure 2) series is available with a 7-pin or 22-pin connector that is oriented at 90 degrees or 180 degrees and is designed for a variety of housing configurations adopted in embedded computers. Supporting SATA 1.5 Gbit/s and read and write speeds up to 35 Mbytes/s and 25 Mbytes/s respectively, the SDM offers outstanding reliability based on high-speed SLC (Single Level Cell) flash memory in capacities of 128 Mbytes to 4 Gbytes.

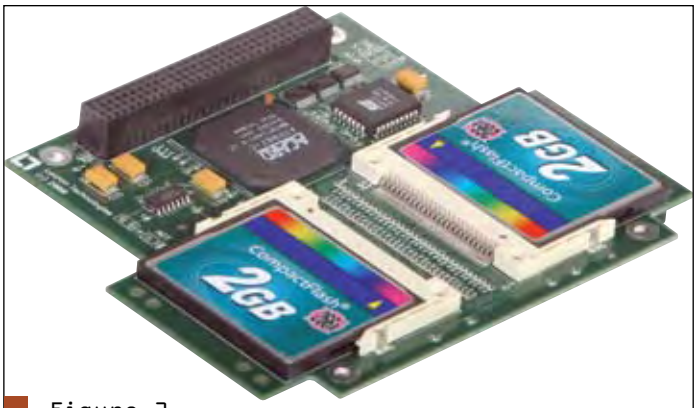

Figure 3

The LT-PCI-104-CF from Lauron Technologies is a high-performance PCI-104 32-bit, 33 MHz, 4 channel SSD RAID adapter supporting data rates of up to 120 Mbytes/s. It's available in 2 to 64 Gbyte capacities.

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

Also supporting the SATA trend, Super Talent Technology has released a new line of 1.8-inch Micro-SATA SSDs aimed at rugged laptops. At merely 5 mm thick, these Micro-SATA SSDs are slimmer than most 1.8-inch hard drives, and hold up to 120 Gbytes of data. In terms of performance, power consumption and shock and vibration resistance, the MasterDrive KX is substantially better than hard drives. As a result, the MasterDrive KX makes for an excellent upgrade for military laptops that need greater reliability, or to accelerate boot-up and load times.

Built with MLC NAND flash, the MasterDrive KX is offered in 30, 60 and 120 Gbyte capacities. With 0.1 ms access time and 120 Mbyte/s and 40 Mbyte/s max sequential read and write speeds, these SSDs provide lightning fast access to files. The Micro-SATA connector in a 1.8-inch form factor makes these SSDs an ideal upgrade for UMPCs (Ultra Mobile PCs).

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Figure 4

The new MiniBlade Specification uses a plug-in peripheral card that is retained with latches in its socket. This approach withstands rugged embedded environments better than consumer-grade dongles and thumb drives. The spec is based on the SiliconDrive II Blade product (shown), which was jointly developed by SiliconSystems and Samtec.

Size- and Weight-Constrained Apps

Small, space- and weight-constrained military applications are a natural fit for SSDs. The PCI-104 form factor—which is basically PC/104-Plus sans the ISA bus—continues to grow its territory, feeding the military's hunger for compact, stackable systems. The LT-PCI-104-CF from Lauron Technologies is a high-performance PCI-104 32-bit, 33 MHz, 4 channel SSD RAID adapter supporting data rates of up to 120 Mbytes/s. The module adopts the PC/104 stacking architecture offering embedded designs a compact Solid-State Storage device. This single-slot adapter is available in 2 to 64 Gbyte capacities. Since the adapter houses all SSD memory, the LT-PCI-104-CF provides a single card solution for non-rotating media requirements.

The unit has an MTBF that is greater than 1,000,000 hours provided by built-in EDC/ECC and Wear Leveling algorithms. For endurance, the unit offers erase/write cycles greater than 1,000,000, with an extended version that offers 2,000,000 erase/write cycles. The benefit of the built-in flash SSD controller/bridge is that it supports Ultra DMA modes, which yield data transfers at speeds of up to 133 Mbytes/s per channel. The unit supports RAID 0, RAID 1, RAID 0+1, RAID 5 or JBOD. Striping modes transfers data to all four channels simultaneously while mirror modes transfers data on both channels.

Also targeting the size- and weight-constrained segment of the market, the Small Form Factor Special Interest Group (SFF-SIG)

recently added an SSD connector spec to its list of working group projects. At ESC Boston, the SFF-SIG revealed its plans to adopt and enhance SiliconSystems' SiliconDrive II Blade Specification for small, rugged subsystems such as mass storage and other I/O technologies under the trade name MiniBlade. SFF-SIG is expanding its portfolio of next-generation industry standards that speed and simplify the development of small embedded systems

New SSD Connector Spec

The new MiniBlade Specification, created by various suppliers for embedded applications, takes the first step toward standardizing an ultra-small, mass storage solution for the small form factor embedded system market. A plug-in peripheral card that is retained with latches in its socket withstands embedded environments better than consumer-grade dongles and thumb drives. The SiliconDrive II Blade product (Figure 4), from which the spec is derived, was jointly developed by SiliconSystems and Samtec.

This new specification now forms the cornerstone of a new SFF-SIG Working Group to define the interfaces to allow a wide array of storage, communications, GPS and other I/O products to be compatible with the MiniBlade socket. The MiniBlade Specification, to be published within the next few months, will define the mechanical form factor and interface pin definitions for MiniBlade devices.

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

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

Lauron Technologies
Naples FL.
(239) 431-6237.
[www.laurontech.com].

SiliconSystems
Aliso Viejo, CA.
(949) 900-9400.
[www.siliconsystems.com]

Super Talent
San Jose, CA.
(408) 934-2560.
[www.supertalent.com].

Technology Focus

Solid-State Disk Drives

Solid-State Disk Drives Overshadow HDDs for Mil Apps

With the cost gap between SSDs and HDDs narrowing, military applications are hungry to reap the performance and reliability benefits of SSDs.

Pat Wilkison, VP of Marketing and Business Development
STEC

An uninformed decision about SSD selection could result in catastrophic system failures. That's clearly intolerable in life-or-death military systems. Early SSDs were designed for defense and aerospace applications with data storage requirements that were relatively small (in Kbytes and Mbytes) and performance requirements were modest at less than 10 Mbyte/s throughput with data access patterns that were sequential in nature. The complexity of a product that works in this application is very limited. There are some straightforward controller implementations that can enable this kind of performance.

Today, we have very advanced technology in SSDs, particularly those optimized for high performance and high reliability. The class of drives that are going into high-end storage arrays enable unprecedented levels of input-output per second (IOPS) for both writes and reads, fast sequential throughput and high levels of data integrity. The manner in which the enterprise OEMs are using SSD is to replace upwards of 50 of the 15K RPM HDDs, which implies that SSDs are capable of delivering the performance of more than 50 of the world's fastest HDDs and thus serving as a catalyst for adoption of enterprise SSDs for both business-critical and mission-critical applications.

SSDs are optimized for high-reliability and high-performance applications where important data is stored within the drive due to the fact that the drives are entirely electrical. Because they have no moving parts, they offer both rapid access to data as well as the improved drive reliability.

Flash Memory as the Media

Most people are familiar with MP3 players, such as the Apple iPod and USB thumb drives, examples of widely utilized consumer electronics that utilize NAND flash for storing media. NAND flash is a non-volatile semiconductor memory that retains data even when power is removed. Thanks to its competitive cost per Mbyte compared to alternative technologies, NAND flash has become the most widely utilized media in most portable consumer applications.

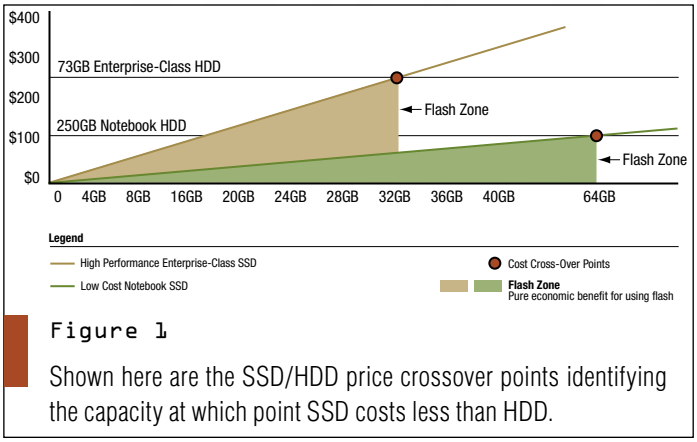

Figure 1

Shown here are the SSD/HDD price crossover points identifying the capacity at which point SSD costs less than HDD.

Traditionally, what suits the consumer market does not properly fit the needs of military applications. The primary reason being that unlike the iPod where data integrity is not critical, data and code storage in military applications is extremely important. As such, system engineers have to be extremely careful to select the proper technology and have complete confidence that important data is available when the system needs it.

NAND flash components are the media within SSDs. Strikingly different from rotating Hard Disk Drives (HDD), SSDs have the primary benefit of no moving parts. As such they can withstand extreme environmental conditions in terms of shock, vibration and temperature exposure. These characteristics are

important in most military applications. In fact, deploying even the most rugged HDD in applications exposed to heavy shock and vibration is still very risky (Table 1).

The Narrowing Price Gap

The significant price reduction of NAND flash components year after year has enabled the wide adoption of high-capacity SSD into more embedded applications. In fact, in most of the embedded applications, the storage requirement is limited: for example, a base station doesn't require more than 2 to 4 Gbytes of storage to store the code and to perform data logging. In the same way, a military PC normally uses less than 32 Gbytes. Besides the mechanical fragility, HDD have become less and less attractive from a cost perspective. In fact, while HDD manufacturers are fully focused in delivering twice as much the capacity year after year for the same price, in this process they normally obsolete low-capacity HDD to keep stable average prices. This was one of the foremost reasons NAND-based storage is taking over for HDDs in consumer applications that require less than 16 Gbytes, causing the demise of 1.8-inch and smaller HDDs.

SSD is a more cost-effective solution in all the applications that do not require extensive storage. The price crossover between SSD and HDD is constantly increasing, which means that OEMs can get more storage in SSD each year. In fact, NAND prices have historically decreased by an average of nearly 50% year on year, which translates into a nearly doubling of SSD capacity at the same cost.

A few years ago it was cost-effective to use NAND flash to replace an "industrial-class" HDD when the application was requiring just hundreds of Mbytes. But now SSDs provide an immediate cost savings for up to 32 Gbytes or 64 Gbytes of storage (Figure 1). Expect the price-parity capacity to double each year due to Moore's Law.

Total Cost of Ownership

Besides the immediate cost savings of moving to SSD when storage requirements are in this range, when looking for higher capacity products, one needs to consider the total cost of ownership (TCO). In this respect, key elements to consider are the hidden costs in operating one technology versus the other.

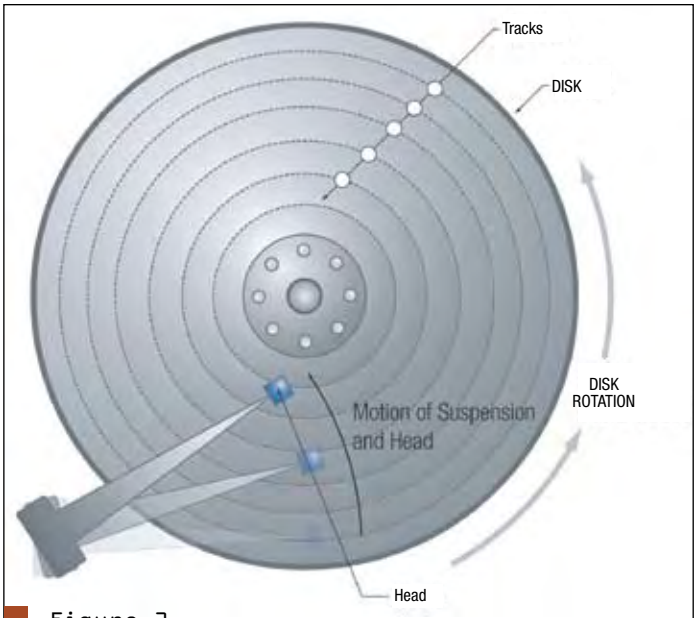

Figure 2

In order to read or write data on the disk, the read/write head needs to be physically moved to the correct place on the disk. That's a key reason why HDDs suffer from slow access time.

		Typical SSD	Typical Industrial HDD
Environmental	Operating Temperature Range	-40°;85°C	5°;55°C
	Non-Operating Temp Range	-55°;95°C	-40°;65°C
	Altitude	-305m;+24,384m	-61m; +3,048m
	Shock	1,500G	300G
	Vibration	16.3G	1.0G
	Idle Noise	0 (Active)	2.6 Bels (Idle)

Table 1

Because SSDs have no moving parts they can withstand extreme environmental conditions in terms of shock, vibration and temperature exposure. These characteristics are important in most military applications.

The major hidden cost of HDD is the poor reliability. Wherever HDDs are used, including the safest environmental conditions, HDD crash is the primary cause of system failure. This is due to the mechanical nature of the HDD that is composed by one or more platter constantly spinning and one or more heads that move across the drive to reach the right location where data are stored. To improve performance, the HDD manufacturers are increasing the speed at which the platters spin, thus compounding the reliability problem.

HDD MTBF ranges between 300,000 and 1,000,000 hours. While these numbers might not be very meaningful by themselves, their meaning becomes clear when comparing with SSD MTBF. SSD MTBF can range from 1,000,000 up to 8,000,000 hours. This is equivalent to saying that SSD are on average from 3 to 8 times more reliable than HDD.

	High-End Enterprise Performance	Mid-Range Enterprise Performance	General Purpose / Embedded Systems SSD	Notebook SSD	Ultra-Mobile SSD
Characteristics	Extreme I/O, exceptional bandwidth, highest levels of data integrity; I/F: FC, SAS & SATA	High I/O, fast bandwidth, high data integrity; I/F: SAS & SATA	Moderate I/O (faster than HDD), moderate bandwidth (faster than HDD), good data integrity I/F: SATA & PATA	Lowest $/GB, I/O better than HDD, bandwidth faster than HDD, relatively low data integrity; I/F: SATA & PATA	Lowest per unit price, low capacity, performance exceeding HDD; I/F: SATA & PATA
Relevance for the Military	Optimized for applications where data delivery, particularly database-intensive applications	Optimized for mixed-use applications where I/O is not as demanding as those to the left yet important	Optimized for universal storage device to replace HDD in systems which mandate higher mechanical reliability, higher data integrity, and higher performance than HDD	Not optimal for most military applications unless workloads are read-intensive. Mechanical reliability is considerably better than HDD	Very specialized device, not suited for mission-critical applications

Table 2

There are many solid-state storage options available to the military system designer. This table categorizes those options in terms of available SSD types.

Performance Differences

HDDs suffer from slow access time. The access time is affected by three main delays: the seek time, the command overhead and the latency. In order to read or write data on the disk, the read/write head needs to be physically moved to the correct place on the disk. This process is known as seeking, and the time it takes for the read/write heads to move between tracks over the surfaces of the platters is the seek time (Figure 2).

Command overhead refers to the time that elapses from when a command is given to the hard disk until something actually starts happening to fulfill the command. In a way, it is sort of like a "reaction time" for the disk. The latency is the time it takes for the platter to spin to get the sector under the head, once the head has reached the track. Considering all these delays, the best-in-class 15K RPM HDD has around 7 ms of access time.

As a comparison, the access time for high-performance SSDs is measured in just a few micro seconds. SSD provides much faster random access times achieving very high IOPS (number of operation that can be completed in one second). This means that system manufacturers can achieve parity in performance with fewer SSDs, decreasing the cost, power consumption and overall system size. Power consumption is indeed another very important component of the total cost of ownership due to the increased cost for energy and the growing sensitivity to power saving for environmental reasons.

Figure 3

The Single Chip Drive is suited for storing code and large amounts of data in any application where space is limited and durability and reliability matters.

Power Savings with SSDs

SSD active power consumption is considerably less than a comparable rotating disk; an enterprise-grade SSD consumes only 2.1W when active and 0.5W when idle. Based on the potential split between active and idle operation in a specific application, the SSD can lower the power consumption for disk storage 5 to 10 times. Furthermore, SSD runs much cooler and thus does not require any increased cooling, providing an additional cost savings and power savings to the overall system. Along with the power consumption of the HDD itself, an HDD also creates significant heat and requires significant cooling. For example, for every watt consumed by a blade server there is an additional need for 30-35 watts just to keep the drives within temperature specifications.

While these numbers might seem insignificant in isolation, they become huge when you think about power consumption across the battlefield or within data centers where hundreds of HDD are grouped in RAID to achieve high performance.

Many SSD Technology Choices

These considerations all form the basis of the growing interest for SSD technology in most military and embedded applications. Coupled with the fact that there are many types of SSD, the selection of the proper product in the correct format that fits each system is complicated. To combat this issue SSD products can be sourced in a multitude of different form factors and interfaces to provide the best compatibility for any application. Capacities range from a low of 128 Mbytes for code storage up to 512 Gbytes to completely replace the HDD in mission-critical applications.

To reach the best solution for a given system there are at least six variables that need to be taken into consideration when selecting a SSD device: the interface; the capacity requirement; the portability of the device (hot-swap, soldered, or fixed); the space available on the board; the speed requirement; and the budget.

The current trend for many applications is to move from parallel to serial interface to increase system performance, lower the cost and simplify the integration. Anticipating this trend, there are a plethora of SSDs available with interfaces ranging from USB, Small cards (SD and MMC products) and SATA interface products for the embedded market. When the application requires more storage, the most suitable choice is a pure SSD with Serial or Parallel ATA interface. The Single Chip Drive is an ideal solution for storing code and large amounts of data in any application where space is limited and durability and reliability matters (Figure 3).

In conclusion, there is a wide array of solid-state storage options available to the military system designer. The first step is to determine the application requirements and then align with the right solution. Then the vital requirement is to verify the intended SSD solution is the right one for the task. It is not a "one-size-fits-all" process, so it requires that extensive diligence be performed on the drive. Table 2 categorizes the various options in terms of available SSDs.

STEC
Santa Ana, CA.
(949) 476-1180.
[www.stec-inc.com].

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0.3 mm Pitch Sockets Support Devices Up to 6.5 mm²

Keeping up with the fast moving pace of IC packaging technology is a tough challenge for the military market. Fortunately socket manufacturers are constantly rolling out new socket solutions. Case in point, Aries Electronics now offers its high-frequency Center Probe and CSP/MicroBGA test and burn-in sockets in sizes up to 6.5 mm squared with pitches down to 0.3 mm. The reduced socket pitch meets the growing need to test smaller components while increasing reliability.

The cost-effective sockets feature replaceable interposer sets and require minimal handler tooling for use in an increased number of CSP, MicroBGA, DSP, LGA, SRAM, DRAM and flash devices. In addition, with an operating temperature from -55°C (-67°F) up to 150°C (302°F), the new sockets are ideal for devices that require exceptional thermal management qualities in a compact package. The heat-treated beryllium copper compression spring probes are plated in a minimum of 30 micron inches (0.75 micron mm) gold per MIL-G-45204 over a minimum of 30 micron inches (0.75 micron mm) nickel per SAE-AMS-QQ-N-290, so spring probes leave very small witness marks on the solder balls' bottom surface. Each socket is rated for a minimum of 500,000 cycles. Pricing for a 100-lead socket starts at $300.

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

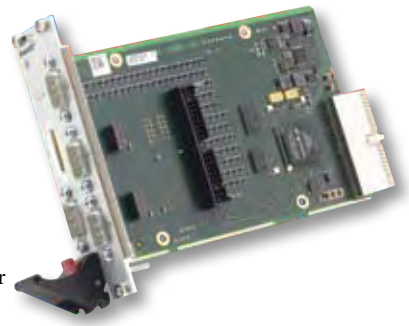
StackableUSB Card Blends Accelerometer and Analog/Digital I/O

StackableUSB is a young but emerging technology that ruggedizes USB in a compact form factor enabling the USB to move into harsh environments. The Micro/sys RoHS-compliant USB1600 is a tri-axial accelerometer solution that can be configured for sensing ranges from 1.5g to 200g making it the ideal solution for a wide range of motion sensing defense applications. Simple software algorithms can be used in conjunction with the module to determine linear motion as well as rotational motion, eliminating the need for an expensive gyro. Furthermore, the USB1600 comes equipped with an RS-232 level UART, SPI interface, I2C interface, and 20 pins that are user-configurable as analog input or digital I/O. All of these features are packed into a compact footprint measuring only 1.85- x 1.78-inch, one-quarter the size of the 104 form factor.

The USB1600 communicates with a host through the USB interface via an onboard 48-MIPS microcontroller, which comes pre-programmed with firmware for use straight out of the box. The USB1600 does not require a cable to utilize the USB technology, although one can be added if needed. Instead, the module uses the rugged StackableUSB connector. The StackableUSB technology ensures that the USB1600 easily tolerates industrial grade shocks and vibrations. The basic USB1600 starts at $275 in single quantity.

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

3U CompactPCI Board Offers Flexible I/O



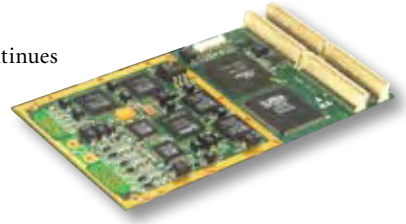
FPGAs have made a huge difference in the level of system functionality now possible on a 3U board. Exemplifying that trend, MEN Micro has released a new 3U CompactPCI board that combines the flexibility of user-defined FPGA technology tailored to specific application requirements with compact universal SA-Adapters boards, which provide the physics for legacy serial I/O, fieldbus interfaces and other small I/O functions. The new F215 Universal Interface Board provides the most diverse set of I/O configurations available for embedded computing systems.

The combination of these two technologies enables a host of different I/O interfaces on one board, including RS-232/422/485, HDLC, InterBus-S, CAN bus and binary I/O, making the F215 ideal for a virtually unlimited number of embedded applications. In addition, the board's -40° to +85°C operating temperature and soldered components enable the F215 to perform particularly well in rugged applications. All of the board's I/O functions are enabled via FPGA, making it a very flexible, inexpensive solution for serial I/O. The F215 can be configured with a simple customized I/O combination or function as high as a specialized eight-port CAN card or an intelligent three-slot I/O board with a Nios soft core. The FPGA automatically loads from a 4 Mbyte serial flash after power-up.

Pricing for the F216 Universal Interface board starts at $419.

MEN Micro, (215) 542-9575. Ambler, PA. [www.menmicro.com].

Video Distribution System for Mil/Aero Defense IP Nets



The demand for real-time distribution and storage of high-quality video in the deployed military market continues to grow. System developers need to apply video distribution to a wide range of aerospace and defense applications such as ship-wide naval distribution, local situational awareness, airborne distribution and simulation systems. Curtiss-Wright Controls Embedded Computing has announced VDS, a new digital video distribution system suite comprised of middleware and a comprehensive selection of video hardware. The VDS digital distribution systems support the capture, compression and distribution of video from a wide variety of sources to any display or recording station available over a local or wide area network (LAN, WAN).

JPEG2000, the primary compression algorithm employed in the VDS family, provides an optimal mix of quality, robustness and performance with compression that enables the transmission of multiple video streams over standard Gigabit Ethernet or other suitable network connections. VDS also supports the RTP (real-time protocol) standard used commonly for real-time video and audio distribution requirements. RTP controls the flow of video data to ensure optimized transmission over IP networks. VDS is controlled by a browser-based interface (primarily useful during development) and via an embeddable API. Pricing for VDS starts at $4,500.

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

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VXS GPU Platform Targets Sensor Stream Computing

Graphics processing units, or GPUs, now rank as the computing industry's most powerful, programmable floating-point graphics-rendering engines. With recent architectural advancements, the algorithmic scope to which GPUs can be applied has grown dramatically. For traditional signal processing algorithms like the FFT (Fast Fourier Transform), they provide unprecedented performance, particularly performance per watt. With the Mercury Sensor Stream Computing Platform, embedded stream computing customers can benchmark and evaluate application performance in their choice of GPU environments, and then migrate to a larger deployed solution.

The VXS-based Mercury Sensor Stream Computing Platform offers scalability in compute power, performance and thermal management, and allows for much greater, tunable performance for a variety of commercial and defense applications. The Platform leverages a dual dual-core Intel Xeon-based VX6-200 SBC, which offers unprecedented levels of compute performance and a wide selection of I/O interfaces. At the heart of the Platform is the VXS-GSC5200 dual MXM GPU module, which delivers very high bandwidth performance to each GPU from the host, as well as between GPUs. Each MXM GPU module can drive up to 3 display monitors (1 analog and 2 digital). Customer shipments of the Mercury Sensor Stream Computing Platform are planned for early 2009.

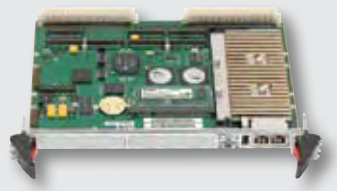
Mercury Computer Systems, Chelmsford, MA. (978) 256-1300. [www.mc.com].

STD Bus x86-Based SBC Targets Legacy Apps

The 4.5- x 7.0-inch STD Bus form factor was first introduced in 1978 and is still in use in a number of harsh environment applications. WinSystems has introduced the LPM-LX800, an STD board that incorporates the low power, AMD Geode LX800MHz 0.9W CPU. The LPM-LX800-G can be populated with up to 1 Gbyte of system DRAM and up to 16 Gbytes of CompactFlash. A high-performance video engine is on board that supports LCD and CRT displays simultaneously. Also, an Intel 82551ER, 32-bit PCI 10/100 Ethernet controller supports networking.

Further I/O support includes four USB 2.0 ports with in-rush and over-current protection, four independent RS-232/422/485 full-duplex serial UARTs, 48-lines of TTL-compatible digital I/O and AC97 audio. The LPM-LX800 contains the core logic to provide PC-compatibility for the I/O and bus interface logic including the UDMA100 controller for hard disks, keyboard/mouse controller, LPT interface, real-time clock and interrupt controller. A precision power-fail reset circuit, activity LED, PC/104-Plus expansion and watchdog-timer are also included. All of these features are included on the STD Bus board. The LPM-LX800 will operate over the industrial temperature range of -40° to +85°C and does not require a fan. The LPM-LX800-G is priced at $895 (quantity one).

WinSystems, Arlington, TX. (817) 274-7553. [www.winsystems.com].



VME SBC Features 1.3 GHz PowerPC and Rich I/O

VME remains the most widely installed slot-card embedded computer form factor in the military. And it's living up to its promise as a valuable path for military technology refresh and technology insertion. Feeding just those needs, Emerson Network Power has announced the MVME4100, its fastest single-core, next-gen VMEbus processing blade.

Equipped with expanded processing power for I/O and data-intensive applications, the MVME4100's 1.3 GHz 8548E system-on-chip PowerPC processor features a double-precision embedded scalar and vector floating-point APU that delivers next-generation, floating-point processing performance for today's demanding high-precision applications. The board offers a range of storage capabilities including 4 Gbytes of fully programmable NAND flash memory, 2 Gbytes of onboard DDR2 SDRAM and 512 Kbytes of non-volatile MVRAM memory. The blade's I/O capabilities include advanced 2eSST protocol availability capable of bandwidth up to 320 Mbytes/s, 4 GigE ports, 3 serial ports, USB 2.0 compatibility and PCI-E expansion options for maximum performance and flexibility. In addition, the board's I/O and firmware are fully backward compatible with existing MVME3100 and 7100 models to ensure easy interoperability with legacy hardware.

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

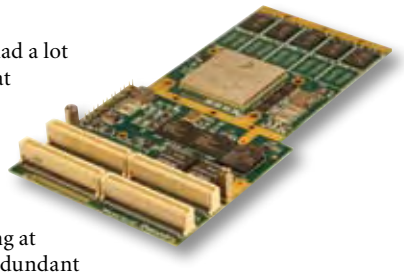
Time-to-Digital Converter Delivers 5-Picosecond Resolution

Precise time-to-digital conversion is vital in a variety of applications that includes weapon physics applications and 3D mapping using Lidar/Radar. Agilent's new single-hit time-to-digital converter (U1050A-002) has a truly unique 5-picoseconds timing resolution and a wide measurement range of up to 20 seconds, a ratio of 1:4.109. The U1050A-002 TDC has 13 identical hardware channels. Twelve channels are independent stop inputs; the 13th is the common start. The module can operate in either single-start or multi-start acquisition modes with the timing information on all the independent channels encoded relative to the common channel.

Time measurement on the U1050A-002 TDC can be based on either the internal low jitter (under 3 ps rms), high stability (±2 ppm) clock source, or an external 10 MHz reference input. Digitized data is fed directly to the onboard FPGA-based data processing unit. This handles the data and subsequent fast readout with direct memory access (DMA) mode, for increased data throughput to the PC. Pricing for the U1050A-002 multi-start, single-stop time-to-digital converter starts at $16,000.

Agilent Technologies, (408) 345-8886. Santa Clara CA. [www.agilent.com].

Conduction-Cooled PrPMC/PrXMC Sports PowerQUICC III



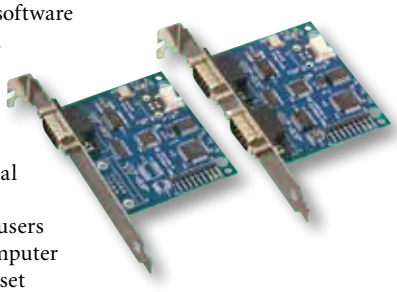
Compute-density is the watchword for a lot of today's military programs. The PowerQUICC processor has had a lot of success as a comms processor, but many want it for its pure performance and system-level features. With that in mind, Extreme Engineering Solutions (X-ES) has introduced the XPedite5201, a PrPMC / XMC based on Freescale Semiconductor's MPC8548E PowerQUICC III processor.

This conduction-cooled card comes standard with PCI-X support with optional PCI Express support via an XMC connector. XPedite5201 is an optimal solution for military system designers that need to include additional processing in an existing system, or want to take advantage of the advantageous performance/watt characteristics of the 8548E. XPedite5201, with the Freescale MPC8548E embedded PowerPC e500 core running at 1.333 GHz, includes up to 4 Gbytes of DDR2-533 SDRAM, up to 4 Gbytes of NAND flash and 256 Mbytes of redundant NOR flash. Rear I/O includes two Gigabit Ethernet ports, GPIO and two RS-232 serial ports. The new XPedite5201 is available today. Pricing starts at $6,000.

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

USB to Serial Adapters are Software Configurable

Sealevel Systems has announced new additions to its SeaLINK USB to serial product line: the SeaLINK/PC.SC (one-port) and SeaLINK+2/PC.SC (two-port) embedded USB to serial adapter with a PC bracket, perfect for adding serial ports to any PC using the computer's internal USB connection. The serial ports are software configurable for RS-232, RS-422, or RS-485, which eliminates need for an external converter and provides a clean, professional installation.

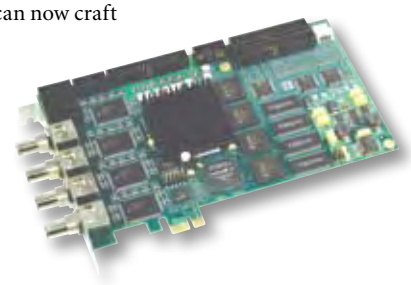


All configuration and electrical interface selections are handled through the driver software, so users never need to shut down the computer or open the system enclosure to set jumpers or dipswitches. Standard operating temperature range for SeaLINK products is 0 to +70°C, and extended temperature range (-40° to +85°C) models are available. Both models include a standard sized PC bracket and ship with an internal USB cable that is compatible with ATX, Mini-ITX and similar large motherboards with 0.1" USB header connectors. For smaller motherboards, an internal USB cable with a 2 mm header connector (Item# CA383) is available as an option. Both items are available immediately from stock priced at $179 for the SeaLINK/PC.SC and $229 for the SeaLINK+2/PC.SC.

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

PCIe Frame Grabber Boasts 16 Parallel Inputs

PCI Express has injected new life into the frame grabber technology. System integrators can now craft security systems that are free of performance bottlenecks. The PC EYE/JPG from American ELTEC is a 16-Channel PCI Express Frame Grabber for security applications using low-cost color cameras. It offers onboard JPEG compression hardware for 16 channels, along with an onboard scaling device and a fast PCI Express Bus interface with a bandwidth of 250 Mbytes/s. It records analog color camera data via 16 parallel inputs, all of which contain a separate fast AD converter.

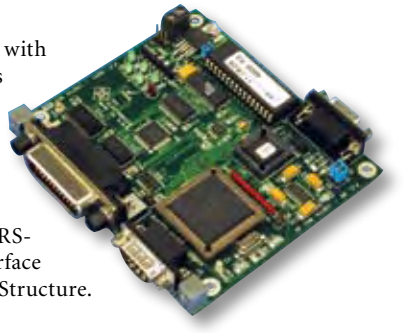


The PC EYE/JPG is intended for security applications where video images from up to 16 color cameras are fed into a PC's main memory for storage or into the graphics board for display. Data is acquired in compressed or in raw format. An onboard scaling unit can transform full-resolution images to CIF size or smaller for efficient display in split screen applications. There are 16 analog-to-digital converters (ADCs) that up to 16 cameras can be connected to. Each camera has its own ADC (SAA 7113-type) as well as its own color separator. Pricing for the PC EYE/JPG frame grabber is under $1,800 in single piece quantities.

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

GPIB-to-Serial Board Supports RS-422, RS-485

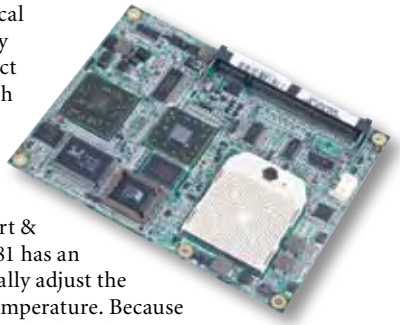
Serial interfaces like RS-422 and RS-485 can be found all over military electronic systems, often side by side with more modern I/O technologies. ICS Electronics makes a GPIB-to-Serial Interface Board for interfacing devices with an RS-422 or RS-485 interfaces to the GPIB bus. Designated the Model 4808, this new board provides an IEEE-488.2-compliant, GPIB-to-serial, data path to the device and includes an RS-232 to RS-485 converter that provides a transparent RS-232 communication path to the serial device. The 4808 is a new type of interface board that combines a GPIB interface and an RS-232 interface to control a serial device with RS-422 or RS-485 differential signals.



The Model 4808 is an intelligent IEEE 488.2/GPIB to Serial Interface that adapts any device with RS-422 or RS-485 signals to the GPIB or HP-IB bus. The 4808 provides the serial device with an IEEE-488.2-compatible interface that responds to all of the required IEEE-488.2 Common Commands and includes the 488.2 Status Reporting Structure. Prices start at $340.

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

COM Express Module Offers Security Feature



Mission-critical applications can't tolerate the normal weaknesses of a typical desktop computing system. They need to be smart enough to detect failures before they happen. With just that in mind, Advantech's new COM Express module, the OM-5781, works smart to maintain the reliability of an application through its "Smart & Secure" utility feature. SOM-5781 has an onboard chip that will dynamically adjust the fan speed to regulate the CPU temperature. Because the CPU fan runs at high speed only when the system is under high loading, power consumption and noise created by the fan can be drastically reduced. Using Advantech's "SUSI" API tool, a "reduce CPU speed" command can be immediately executed to prevent a system crash when SOM-5781 detects an abnormal status from the CPU fan. At the same time, an alarm message can also be issued to the system administrator via Ethernet.

With the high-speed AMD Turion CPU with integrated ATI graphic engine and chipset, the SOM-5781 uses the AMD M690E integrated chipset with high-performance ATI graphic engine, and an additional external 128 Mbytes of graphic memory (Side Port) can be added on SOM-5781 for an extra 20% graphic performance boost. SOM-5781 also supports 48/24-bit LVDS TFT LCD panels, DVI and PCIe x8 for external graphic cards.

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

2W DC/DC Converters Boast Compact Size

As mixed-voltage systems become more the exception than the rule, military systems are requiring more and more DC/DC converters in their system. Fortunately, converter manufacturers continue to offer more compact and functional products. Along such lines, Martek Power offers two new series of compact DC/DC power converters: the 200VFI and 200WFRS. The 200VFI series is a family of cost-effective 2W single and dual output DC/DC converters with 18 models that operate from input bus voltages of 5V, 12V and 24V; producing output voltage levels of 5V, 12V, 15V, ±5V, ±12V and ±15V. Measuring 1.25 x 0.8 x 0.4 inches, the models feature short circuit protection, 4000VAC input/output isolation and built-in PI filter. The 200VFIs are priced at $11.75 per unit for volume orders.

Also new are the 200WFS series of cost-effective 2W single and dual output DC/DC converters in an ultra-miniature "gull-wing" SMT package. Thirteen models operate from input bus voltages of 5V, 12V and 24V; producing output voltage levels of 5V, 12V, ±5, ±12V and ±15V for a wide choice. With many standard features such as 1000 VDC input/output isolation, 2:1 Input range and remote on/off control, the units are priced at $6.50 per unit for volume orders.

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

2U 20-inch LCD/Keyboard Has CAT5 KVM Switch

The military's migration toward net-centric operation is fueling demand for more displayed nodes where users tap into that network. Serving those needs, Neuro Logic Systems offers a ruggedized rackmount 20-inch LCD/sealed keyboard and integrated 16-port KVM switch. The RFT-20-2U-MIL-CAT5 is designed for military and harsh environment use and features a sealed, backlit, full-travel keyboard and sealed 38 mm 3-button trackball. When closed, the lightweight, aluminum alloy RFT-20-2U-MIL-CAT5 stows into a single, 17-inch deep 2U space in a transport case or standard RETMA equipment rack.

The high-quality, wide view angle 20-inch LCD is protected by strengthened, anti-reflective glass filters. The LCD native resolution is 1600x1200. The integrated 16-port CAT5 KVM switch allows the unit to connect up to 16 servers via a standard CAT5 Ethernet cable instead of using the older, larger and heavier analog cables. All the above features are installed in an aluminum housing designed to meet Military Specifications 461E, 167, 810 and 901D. While the RFT-20-2U-MIL-CAT5 was designed for military use, it is priced at a level that allows it to be used in any harsh environment situation including vibration, heat and cold. Pricing starts at $5,750.

Neuro Logic Systems, Camarillo, CA. (805) 389-5435. [www.nlsdisplays.com].

High-Density Serial Comms AMC Rated for Extended Temps

FPGAs have totally re-landscaped the way military systems can aggregate their I/O. With just that in mind, the TAM863 AMC serial communication controller from Tews Technologies is implemented in FPGA logic combined with the bus master-capable PCI interface. It guarantees long-term availability with the option to implement additional application-specific functions for customers. Several serial communication protocols are supported by each channel, such as asynchronous, isochronous, synchronous and HDLC mode. In addition, a maximum data rate of 10 Mbits/s is provided for synchronous protocols, and 2 Mbits/s is supported for asynchronous protocols. Multiprotocol transceivers are used for the line interface. The physical interface of each channel can be independently software selected for EIA-232, EIA-422, EIA-449, EIA-530, EIA-530A, V.35, V.36 or X.21. Physical connection is either through front panel I/O with an HD68 SCSI-V (VHDCI/Champ) type connector or rear I/O via P14.

In order to reduce CPU overhead and increase data rates for critical applications, the TAMC863 features a receive and transmit FIFO of 512 long words (32-bit) per channel. Data transfer on the PCI bus is handled via TAMC863-initiated DMA cycles with minimum host/CPU intervention. In addition, several interrupt sources can generate interrupts on INTA for each channel, and interrupts may be enabled or disabled separately.

Tews Technologies, Halstenbek, Germany. +49 (0) 4101-4058-19. [www.tews.com].

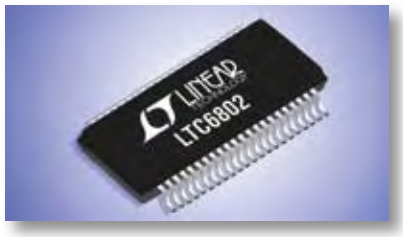
Net-Ready Data Acq System Boasts Preloaded Software

Military data acquisition systems once required big racks of boards. Now, thanks to technologies like PCI, the same functionality is possible in much smaller systems. A pair of new test, measurement and control products from Microstar Laboratories combines a 5-slot PCI backplane and a 10-slot Eurocard cage in an industrial-grade chassis. A Pentium M processor runs server software on a board that occupies one of the PCI slots. This software, and the software running on internal boards themselves, protects the application from local or network-related delays. The new hardware products, the DAPserver 500 and the ruggedized DAPserver 500R models each include a SATA hard drive.

DAPserver products conform to the signal-interfacing channel architecture used by Microstar Laboratories: signal connectors on 3U (100 mm high) Eurocard B (220 mm deep) expansion boards that typically pre-process a signal. A DAPserver can contain up to ten of these boards, and it can connect to many more in other rack-mounted industrial enclosures. Most Microstar Laboratories expansion boards multiplex inputs or outputs to or from DAP boards. Many perform additional functions.

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

Battery Stack Monitor Targets Battery Backup Systems



Battery life is a crucial concern in a number of mobile, portable military applications. Linear Technology eases that challenge with a highly integrated multi-cell battery monitoring IC, which is capable of measuring up to 12 individual battery cells. The LTC6802 high-voltage battery stack monitor from Linear Technology allows multiple LTC6802s to be stacked in series without optocouplers or isolators, for precision voltage monitoring of every cell in long strings of series-connected batteries.

With superior energy density, Lithium-Ion batteries are poised to be the power source of choice for these applications. However, designing a large, highly reliable and long-lasting Li-Ion battery stack is a very complex problem. Li-Ion cells are sensitive to overcharging or over-discharging, requiring that each cell in a stack is carefully managed. The LTC6802 makes this possible with quick and accurate measurements of all cell voltages, even in the presence of stack voltages over 1000V. The maximum total measurement error is guaranteed at less than 0.25% from -40° to 85°C, and all cell voltages in a battery stack can be measured within 13 ms. Each cell is monitored for undervoltage and overvoltage conditions, and an associated MOSFET switch is available to discharge overcharged cells. 1,000-piece pricing is $9.95 each.

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

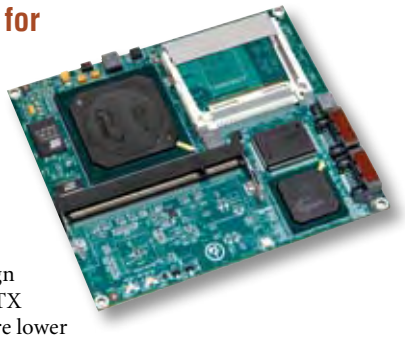
ETX COM Board Delivers Atom and TPM

Intel has incorporated the 1.6 GHz Intel Atom processor N270 into its Embedded Roadmap—thereby ensuring seven years lifecycle support. Using that processor, the ETX-DC Computer-on-Module from Kontron delivers an optimal balance between excellent performance and very low power. With 2.5 watts thermal design power (TDP) for the processor, 6 watts TDP for the Intel 82945GSE Graphics Memory Controller Hub and 1.5 watts TDP for the Intel I/O Controller Hub 7-M (ICH7-M), the ETX-DC requires a maximum TDP of 12-15W. This makes it suitable for harsh environments that require passive cooling and completely sealed housings. The new module also makes it easier to implement applications with high demands for MTBF and/or EMC. The new ETX-DC has a 533 MHz FSB and supports up to 2 Gbytes of DDR2-SDRAM SO-DIMM.

The optional onboard Trusted Platform Module (TPM 1.2) provides enhanced data security. Integrated graphics offer SDVO and support resolutions up to QXGA (2048 x 1536) via CRT, dual screen via LVDS for resolutions up to UXGA (1600 x 1200) as well as TV-out with HD resolution. The ETX module integrates all of these features on a footprint of 95 mm x 114 mm.

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

Mid-Range ETX Ready for Rugged Roles



As part of an initiative to extend its Extreme Rugged product lines, Adlink Technology has announced the first new Ampro by Adlink product since the Ampro acquisition was completed. The ETX 620 brings the proven design methodology of the high-end ETX 802 to harsh environments where lower processing performance is required.

Based on the AMD Geode LX 800 processor and chipset, the ETX 620 features the low-power AMD Geode LX 800 processor and CS5536 companion chip. ETX 620 is designed for extreme rugged environments, able to operate over temperature extremes of -40° to +85°C, vibrations up to 15 Grms and shock up to 50 Grms. With processor speed of 500 MHz and memory support for up to 1 Gbyte of DDR RAM, the ETX 620 fills the price/performance void beneath the ETX 802 module.

ETX 620 offers 2D/3D graphics and offers a choice of TTL or 24-bit LVDS LCD interfaces along with legacy CRT. The use of an Intel Ethernet controller allows wider temperature operation than possible with cheap alternatives. ETX 620 contains all of the PC-compatible subsystems without the I/O connectors themselves. The I/O and bus signals are passed through high-density surface mount connectors to application-specific carrier boards.

ADLINK Technology, San Jose, CA.
(408) 360-0200. [www.adlinktech.com].

Portable Development System Supports 6U Cards

Military system designers have been hard pressed to find a compact and portable system that supports 6U cards for lab and desktop use, yet also rugged enough to withstand transporting to and from the field. With exactly that in mind, the 522 Development System from Carlo Gavazzi features a versatile design for hardware and software developers looking for performance and functionality advantages over customary chassis configurations. The 522 Development System provides unobstructed access to both system and rear transition boards for device monitoring.

Addressing the needs of users deploying custom backplanes for specialized applications, the 522 Development System can accommodate VME64, VXS and VPX boards both in 6U and 3U form factors. Modular in design, the 522 system is available in both standard and custom configurations at competitive pricing. It also features high-performance cooling via 200 CFM speed-controlled fans that provide distributed cooling to both the front and rear card modules. The 522 Development System is available with a 7-slot (CompactPCI, 2 VME64X and 5 VPX) 6U VPX backplane offering high bandwidth in the latest VITA 46 standards with the proven legacy capabilities of VMEbus technology.

Carlo Gavazzi Computing Solutions, Brockton, MA. (800) 926-8722.
[www.gavazzi-computing.com].

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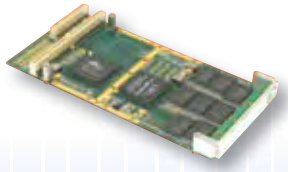

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Web: www.hsc-us.com

DFD25S [2.5-inch SSD for mission critical applications]

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- Password read/write protection
- Comprehensive SSD health-monitoring via S.M.A.R.T. commands
- Wear-indicator LED

Hagiwara Sys-Com US Co., Ltd.
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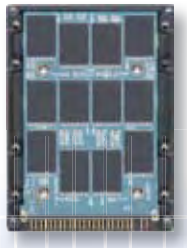

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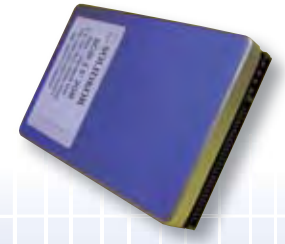

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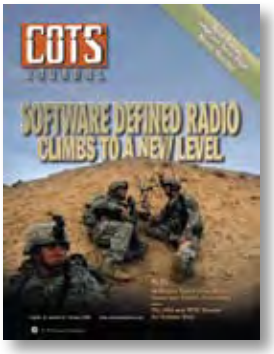
December 2007

Processor Boards Spin Toward Military Demands

January 2008

HALT/HASS Test Tactics Fly Ahead of the Curve

February 2008



Software Defined Radio Climbs to a New Level

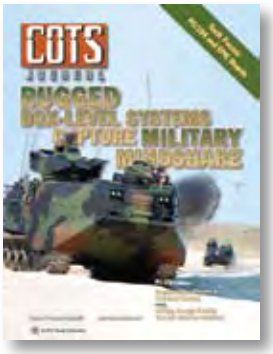
March 2008

VPX and VXS Eye Beachhead on VME's Legacy

April 2008

Large UAV Payloads Spiral Toward Autonomy

May 2008

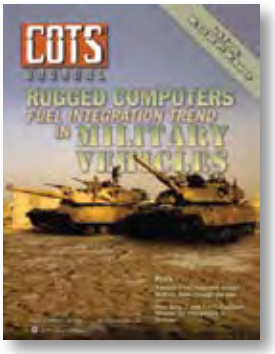


Rugged Box-Level Systems Capture Military Mindshare

June 2008

Rugged Ethernet Boards Embrace Fabric Roles

July 2008



Rugged Computers Fuel Integration Trend in Military Vehicles

August 2008

Multi-Function and Fabric Trends Revamp Military I/O

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Expert Analysts Shed Light on the Military Embedded Market

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Coming Next Month

COTS JOURNAL

- *Special Feature: Software Radio/JTRS Tech Update.* Advances in the software defined radio market continue to overlap nicely with the DoD's software radio efforts. For the DoD's Joint Tactical Radio System (JTRS) program many of the technology pieces are coming together with its organizational problems put to rest. This section explores the key technology trends driving SDR, and takes stock of developments in JTRS.
- *Tech Recon: Military Market Update.* The forces controlling the defense market are a blend of many long- and short-term factors. And in 2009 there's the change in Administration and economic troubles to be considered. In this section we examine market trends in broad cross-section of military and aerospace embedded computer applications. The update will also look at where some of the major programs are going and speculate on the probability of their success.
- *System Development: 10 Gbit Ethernet vs. RapidIO and PCI Express.* Switched serial fabric technologies continue to jockey for position as the favorite for high-end military embedded computing applications. PCI Express and Serial RapidIO have risen to the top, along with switched 10 Gbit Ethernet. This section explores how system designers can benefit from the marriage of switched fabrics with embedded computing form factors like VPX, VXS, Compact PCI Express, MicroTCA and AMC.
- *Tech Focus: Serial FPDP Boards.* The Front Panel Data Port (FPDP) interconnect standard is a simple idea, but sometimes simple ideas are big winners. It's particularly useful in military applications like radar and sonar where FPDP is used as the interface to sensor networks. The Serial FPDP version adds speed and nullifies the length limitations of parallel FPDP. The Tech Focus section updates readers on Serial FPDP trends and provides a product album of representative board-level products.

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Editorial

Jeff Child, Editor-in-Chief

There are multiple reasons why I've become a big fan of the MILCOM conference over the past couple years. And this year's MILCOM last month in San Diego was better than ever. The show offers great technical presentations, an impressive set of VIP keynote speakers, and a great mix of exhibiting companies comprised of primes, sub-primes and technology suppliers. Sweetening the deal, that list of technology suppliers has, over the past year, included a growing number of companies from our community: the military embedded computing and electronics industry.

Net-Centric Challenges

MILCOM is also where—probably more than any other event—there's serious and comprehensive "getting down to brass tacks" discussion about the DoD's progress toward Net-Centric Operations. The DoD's Net-Centric vision calls for real-time sharing of voice, video and data between soldiers, aircraft, satellites, ships, robots and UAVs, all over a global network. The technology areas fueling those goals include software and programmable radios, ultra-wideband optical communications and IP networking on land, sea, air and space platforms. Suppliers specializing in those areas were well represented at MILCOM.

I've often said that there's a great opportunity for the embedded computing industry that's inherent in the DoD's migration to Network-Centric Operations. Making every vehicle, aircraft, ship, ground installation and soldier part of a network will fuel demands for sophisticated compute-intensive radio and network nodes—each suited for a different environment, platform or user. Moreover, processing and displaying the information on all those network nodes—be they on aircraft, ships, vehicles or in soldier's backpacks—calls for upgrading the embedded computers and displays in all those platforms. Much of the network—the elements that don't need to operate in a harsh environment—are, of course, comprised of IT-based computing. And that dividing line between IT-based technologies and embedded computing technologies isn't always clear. What is clear, however, is that Net-Centric Operations means embedded computers and IT style gear will be connected and will need to interoperate with one another. Civilian and DoD networks infrastructures likewise are inter-linked.

At MILCOM 2008, John Grimes, Assistant Secretary of Defense Networks and Information Integration (ASDNII) and DoD Chief Information Officer (DCIO), and Jeff Child, *COTS Journal*.

One of the luncheon keynote speakers—Mike McConnell, Director of National Intelligence—touched on that topic and how it's a major security concern in his view. "The United States is the most vulnerable nation on Earth to cyber attack," said McConnell. "It's for a simple reason: we're the most dependent [on the Internet]. This conference is all about military communications and the ability to deliver assured information. But extend that thought beyond a military command and control regime to banking, our transportation, our electric power, global finance—all the things that, today, ride what we refer to as the Internet as one global net. Grandmother's fruitcake recipe is going over the net to the family, riding the same physical infrastructure as military, top-secret command and control, or banking and financial transactions that are moving hundreds of millions of dollars. That's why we are more at risk than any other nation."

Another luncheon VIP speaker at the show was John Grimes, Assistant Secretary of Defense Networks and Information Integration (ASDNII) and DoD Chief Information Officer (DCIO). In his talk, Grimes called for a cautious approach to using networked collaboration tools until there can be assurances such tools can be secured and would not introduce malware into Defense Department systems.

With all that in mind, it's perhaps fitting that Green Hills Software chose MILCOM as the event to announce that its INTEGRITY-178B operating system has been certified by the NSA to Common Criteria Evaluation Assurance Level (EAL) 6+. And in a further sign of cross pollination between the embedded industry and the business IT industry, Green Hills recently formed a division called INTEGRITY Global Security, LLC, aimed specifically at making its secure OS available to business customers.

I'm pleased to see MILCOM growing and succeeding—especially in this age where many conferences appear to be on the decline. And more than that, I'm looking forward to our industry—the embedded military hardware and software community—continuing to become more involved with this show. Many of the products and technologies they provide are extremely relevant to the military communications and networking space, so MILCOM is a good place to be. ▮▮

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