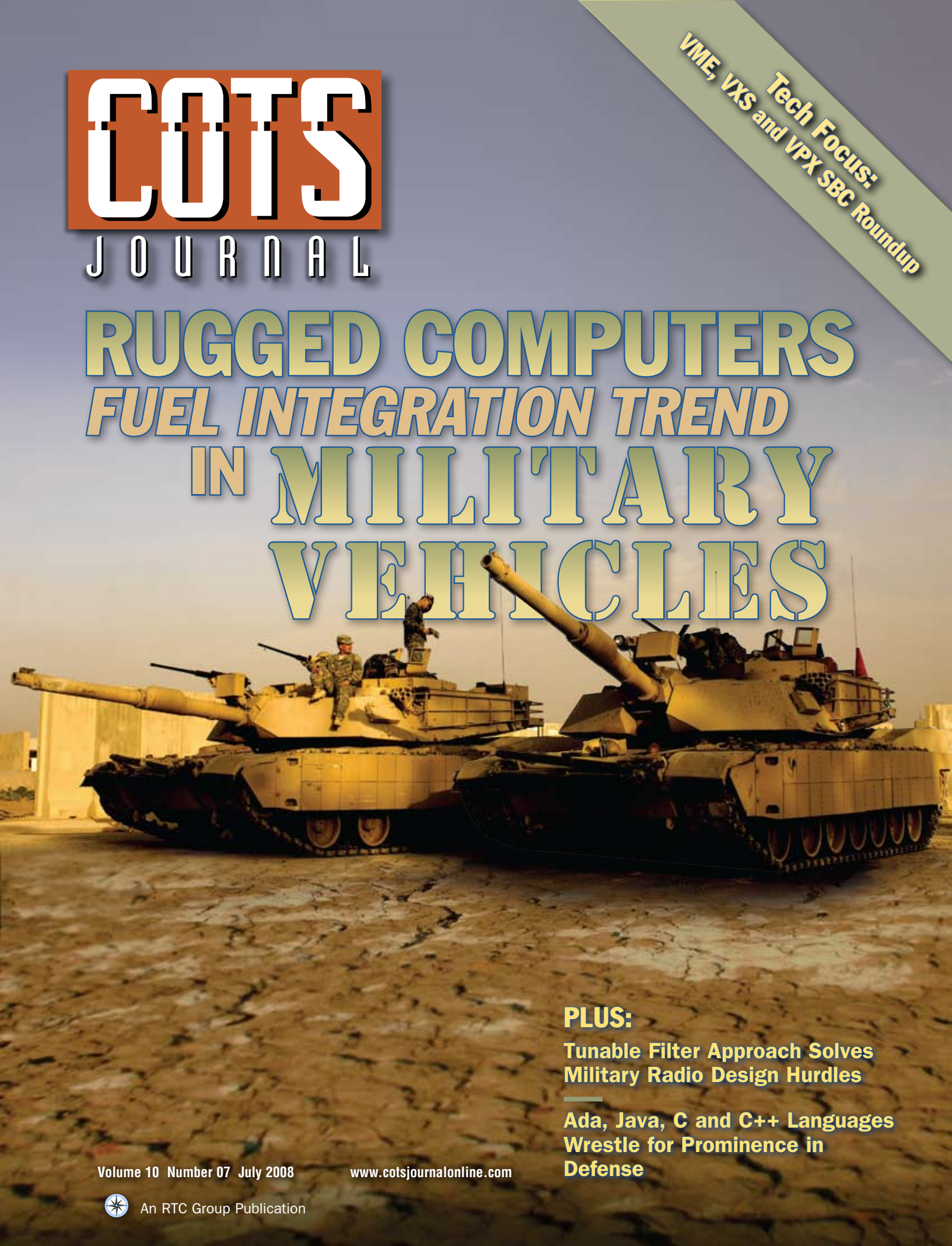
COTS JOURNAL

Tech Focus: VME, VXS and VPX SBC Roundup

RUGGED COMPUTERS FUEL INTEGRATION TREND IN MILITARY VEHICLES



PLUS:

Tunable Filter Approach Solves Military Radio Design Hurdles

Ada, Java, C and C++ Languages Wrestle for Prominence in Defense

Volume 10 Number 07 July 2008 www.cotsjournalonline.com

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(clockwise from left) HiDAN™ turret control with secure SSD storage, HiDAN*plus*™ showing stackable modularity, and IDAN® with shock mount isolation base plate.

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COTS JOURNAL

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Tech Recon

Next-Gen Military Radios

System Development

Java vs. Ada for Defense Apps.

Technology Focus

VPX, VXS and VME SBCs

COTS View

RoHS Two Years Later

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.

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Cover Story ..... Page 12

Abrams tanks are among the Current Force vehicles that will be part of the first spin-out of FCS future force technologies such as the FCS Large Networking Processor. Shown here, soldiers prepare to ride inside an M1A1 Abrams heavy tank with an Abrams Integrated Management System and the Tank Urban Survivability Kit to conduct a patrol near Baghdad. The soldiers are assigned to 1st Platoon, Delta Company, 2nd Combined Arms Battalion, 69th Armor Regiment, out of Fort Benning, GA.

U.S. Air Force photo by Staff Sgt. Jason T. Bailey

COTS JOURNAL

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In the field of rugged computing, there is simply no substitute for experience. Fortunately, our systems have been deployed for many years by the land, sea and air forces of the world, and we have learned from that experience. The result is a product offering that encompasses scores of rugged boards and systems in VME, VPX, cPCI. For more details, visit **www.gefanucembedded.com/milaero.**

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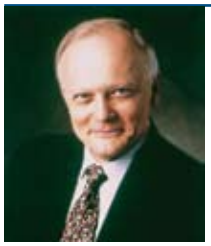
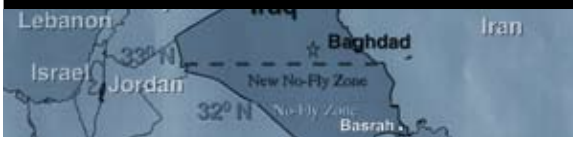


Publisher's Notebook



Budgets and the Pendulum

It's a good time to be an enemy of the republics of the world. It seems republics can only cope with thinking about defense for a half-dozen years—or until someone puts a stick in their eye. We follow that period by focusing on things that are more popular vote-getters, again unless someone puts a stick in our eye. When we finally—and we always do—get the stick in our eye once again, the people that set the problem in motion by not keeping an eye on the ball immediately start a witch hunt to look for who they can blame other than themselves.

This isn't a rant about our government. However, we are part of the team. Let's start with France. They plan to cut over 50,000 defense jobs with more than half coming from the Army, whose current level is just under 125,000. Couple that with a shortfall in budgeting for military equipment orders along with base closures and you see a major consolidation of France's military capability and involvement. Between the time that I write this and when it's printed, President Sarkozy will release a white paper providing more detail and some numbers to these changes.

With a 2008 defense budget of just under $50 billion, France isn't alone. Germany's budget has been over the years vacillating around $45 billion. But the lack of an increase in personnel salaries there is causing a decline in troops. The UK still appears to be bucking the trend of budget reductions with an increase of their 2008 budget to $67 billion. However, their Army had a troop level high of just over 150,000 in the early 90s, and it was just over 100,000 last year. These numbers come from the European Defence Agency and I can't say they paint a completely accurate picture. I can't go through currency exchanges year on year. And some countries include civil police and so forth in their budgets. But everyone—one way or another—is pulling back, or predicting a pull back in troops. Judy Dempsey wrote a good general piece about the changing face of EU defense spending in the May 22nd issue of the *International Herald Tribune* that provides an overview of all this.

It's too easy for everyone to assume that the current political changes regarding defense are a condemnation of the Iraq conflict. The European troops being pulled out of Iraq are not being redeployed to other trouble areas, but instead are being brought home for anticipated troop declines and a reallocation of federal budgets. That sort of reminds me of what the U.S. did in the nineties at the conclusion of the cold war. At least Germany had the foresight in the nineties to make major economic investments in Russia. They may have learned something from the Marshall Plan post WWII—or maybe they were just being carpetbaggers. The U.S. on the other hand didn't do either and just sat by letting Russia flounder and force us to make major increases in our defense budget to shore up a devastated military this decade.

The point to a lot of this is: Doesn't anybody even consider what's been done in the past and try to avoid doing the stupid things again? And now from a republic closer to home: James Finley, Deputy Under Secretary of Defense for Acquisition and Technology, recently stated that he thinks things have gotten out of hand with cost-plus contracts, saying that they provide little if any incentive to accurately project the cost of a project. Once a project is awarded it's time for the winner to start putting a story together as to why the cost to the government will be no where near what the original award was. Finley suggests that there shouldn't be any drastic reactive changes that would affect delivery of products or services that are needed by the military, but rather some sort of orderly conversion away from cost-plus contracts. His suggestion is firm-fixed price contracts with an incentive program. The logic on how this will work is still unclear to some of us, although I think everyone is in agreement that we can't go back to fouling things up like we did in the 90s. And we need to get away from how we've been screwing things up this decade.

The scariest thing about all this is that for over a year we've been writing about how the pendulum of government procurement policy has once again reached its limit. And, like any pendulum, it has no choice but to start shifting back to something more reasonable. Why is it that this was so obvious to us with no inside information but it took the DoD until now to see the light? Is there any chance that we can move the pendulum to center and have it stop? I doubt it. So in five or six years someone will be writing about how things are now screwed up in the other direction. In the meantime, anyone with a desire to defeat the republics of the world will be able to expand their efforts to infiltrate or defeat us by using our predictability against us. They're in for at least six good years. ▮▮

Pete Yeatman, Publisher
COTS Journal

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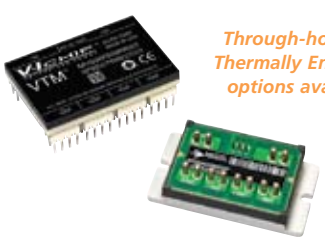

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The Inside Track

Expand Network's Gear Tapped for JSTARS BLOS System

Northrop Grumman and the U.S. Air Force have integrated Expand Network's Accelerator 4820 and Accelerator 6940 into the Joint Surveillance Target Attack Radar System (Joint STARS) Beyond Line of Sight (BLOS) communication system to provide application acceleration and bandwidth optimization. Expand Networks Accelerators enhance the functionality of the Joint STARS BLOS communications architecture by providing the Beyond Line of Sight system with accelerated WAN performance to minimize bandwidth requirements for Internet protocol (IP) traffic. The accelerators are deployed in production Joint STARS aircraft and ground stations.

The Accelerators mitigate the effects of latency and ensure that all applications receive adequate capacity. Optimization is achieved through the implementation of Expand Networks' patented byte-level caching, compression, Space Communications Protocol Standards (SCPS-based) TCP acceleration and Quality of Service capabilities. The E-8C Joint STARS is an airborne battle management, command and control, intelligence, surveillance and reconnaissance platform. Its primary mission is to provide theater ground and air commanders with ground surveillance to support attack operations and targeting that contributes to the delay, disruption and destruction of enemy forces.

Figure 1

The E-8C Joint STARS is an airborne battle management, command and control, intelligence, surveillance and reconnaissance platform. Here, Capt. Steve Grogan controls an operator workstation inside a Joint STARS aircraft.

Expand Networks
Roseland, NJ.
(973) 618-9000.
[www.expand.com].

Army Awards DataPath $3.7 Million for SatComm Hubs in Afghanistan

DataPath has been awarded $3.7 million by the U.S. Army to manufacture and install DataPath DKET LT satellite communications hubs in support of the U.S. military Joint Task Force in Afghanistan. The systems will be deployed by U.S. Central Command (CENTCOM) to deliver high-bandwidth voice, video and data connectivity that provides the SATCOM network in the region with global reach. DataPath has worked with the U.S. military since 1998 to build the DKET network.

With this order, the DKET network will include more than 75 advanced SATCOM hubs that serve as a vital communications backbone for U.S. military operations around the world. The DataPath DKET LT is a highly transportable, self-contained earth terminal that establishes headquarters-level network-hub connectivity anywhere the mission demands. Program Manager WIN-T's Commercial SATCOM Terminal Program (CSTP) at the U.S. Army Communications-Electronics Command in Fort Monmouth, N.J. made the award through the CSTP Blanket Purchase Agreement contract.

DataPath
Duluth, GA.
(678) 597-0300.
[www.datapath.com].

CPU Tech Wins Order for Electronics on Bradley

BAE Ground Systems has awarded CPU Technology a delivery order for production kits containing an Acalis MultiCore System-on-a-Chip (SoC) for use in the Bradley Combat System. The Acalis family of Field Programmable MultiCore SoCs consists of highly integrated, low-power multicore devices that can be configured to meet the requirements for a particular system. The Acalis CPU420 contains numerous processors, memories, controllers, interfaces, and several critical functions.

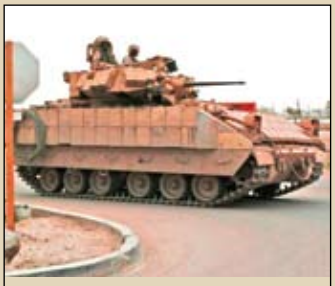

Figure 2

The M2A3 and M3A3 Bradley Fighting Vehicle Systems include enhancements that provide increased situational awareness and digital command and control capabilities.

According to CPU Tech, the system design was accomplished in less than half the industry norm using industry-leading development tools available with Acalis. With high-fidelity, cycle-accurate models of the Acalis CPU420 and the other system components, the design team simulated the entire kit and its surrounding systems on SystemLab PS, a real-time

platform simulator. The system-wide visibility enabled the kit to be debugged quickly and efficiently while completing the testing and system integration virtually.

CPU Tech
Pleasanton, CA.
(925) 224-9920.
[www.cputech.com].

Quintron Provides DICES System for Recent Delta II Rocket Launch

Quintron Systems announced its participation in the successful launch of the United Launch Alliance (ULA) Delta II rocket from Vandenberg AFB with the NASA Ocean Surface Topography from Space Mission (OSTM) / Jason 2 spacecraft payload. ULA voice communications was provided by the Quintron DICES equipment, now in the tenth year of operation for the Delta II launch vehicle at VAFB. In addition to DICES, Quintron engineers and technicians provide ongoing pad operations support, including closed-circuit television distribution, range and vehicle safety systems, and related control system transmission and distribution across the VAFB operating theater.

Figure 3

A Delta II rocket from Vandenberg AFB launches with the NASA Ocean Surface Topography from Space Mission (OSTM) / Jason 2 spacecraft payload. ULA voice communications was provided by the Quintron DICES gear.

The OSTM/Jason 2 satellite was a joint American and European Oceanography satellite designed to continue a growing legacy of monitoring changes in sea levels and the impacts on the global climate. The Jason 2 will enter orbit below the Jason 1 satellite. The Jason 1 is then set to be replaced after a period of three weeks. The Jason 2 project is a response to the international demand for programs to study and observe oceans and the climate through a worldwide ocean observation system.

Quintron Systems
Santa Maria, CA.
(805) 928-4343.
[www.quintron.com].

PrismTech to Provide Waveform Portability Help for Navy SDR Systems

PrismTech Solutions Americas, a wholly owned subsidiary of PrismTech Corporation, has been selected to provide waveform portability support to the U.S. Navy's software-defined radio (SDR) systems. The work will be conducted through a support services contract overseen by the U.S. Navy's Space and Naval Warfare Systems Command (SPAWAR). Scientific Research Corporation (SRC) serves as the prime contractor.

In this role, PrismTech Solutions Americas will work closely with SRC—which is providing technical and logistical support—to provide the Navy with support and expertise related to the authentication of Joint Tactical Radio Services (JTRS) waveforms and Software Communications Architecture (SCA) compliance. PrismTech has provided SDR and JTRS product and services—under its Spectra2 product line—to numerous companies within the defense industry. The company also recently completed work for the Joint Program Executive Office (JPEO) for JTRS to help define waveform portability industry guidelines.

PrismTech
Burlington, MA.
(781) 270-1177.
[www.prismtech.com].

Army Taps Akermin's Biofuel Cell to Power Ground Sensors

Akermin, the developer of proprietary stabilized enzyme catalyst technology, has signed a contract with the U.S. Army's Communications-Electronics Research Development and Engineering Center (CERDEC) to develop a biofuel cell using enzyme-based electrodes that provides extended runtime to unattended ground sensors. The sensors will have military and homeland security applications.

The company designs Stabilized Enzyme Biofuel Cells (SEBC) that replace standard metal catalysts, such as platinum, with immobilized enzymes to convert environmentally friendly fuels to electricity. They are less expensive and eliminate the potential for long-term environmental damage by the precious metals. The goal is to develop a long-lasting fuel cell for military ground sensors that can be left unattended long term. The value of long runtime in remote geographies and hazardous environments lies in the reduced risk to U.S. Army personnel by limiting the number of times they have to service the equipment. Akermin's technology immobilizes enzymes in a polymer matrix in conductive contact with an electrode, providing a stable operating environment and allowing them to convert fuels to electric power over several years. Akermin has already developed a "world-first" prototype for a commercial partner that is entering field trials.

Figure 4

Akermin's power cell technology has a long runtime that will reduce risk to U.S. Army personnel by limiting the number of times they have to service the equipment. Shown here, a soldier does Unattended Ground Sensors (UGS) training at Fort Bliss.

Akermin
Saint Louis, MO.
(314) 812-8150
[www.akermin.com].

COTS Websites

www.calce.umd.edu

CALCE Is Rich Resource on RoHS and Life Cycle Management

The Center for Advanced Life Cycle Engineering (CALCE) is recognized as a founder and driving force behind the development and implementation of physics-of-failure (PoF) approaches to reliability, as well as a world leader in accelerated testing, electronic parts selection and management, and supply-chain management. CALCE is at the forefront of international standards development for critical electronic systems, having chaired the development of several reliability and part selection standards. In a recent example, CALCE conducted tests on field failures of ceramic capacitors that are occurring with greater frequency and are traceable to a number of manufacturing processes, handling and circuit board assembly issues. Some recent examples include a new software created by the CALCE for estimating the failure risk posed by tin whisker growth on electrical conductors in electronic hardware. Another tool they've released is software for estimating the life expectancy of solder joints in electronic hardware under temperature cycle loading.

CALCE is staffed by over 100 faculty, staff and students, and in 1999 became the first academic research facility in the world to be ISO 9001 certified. Collectively, CALCE researchers have authored over 35 internationally acclaimed textbooks and well over 1000 research publications relevant to electronics reliability. Over the last 15 years, CALCE has invested over $75 million in developing methodologies, models and tools that address the design, manufacture, analysis and management of electronic systems.

CALCE, University of Maryland, College Park, MD. (301) 405-5323. [www.calce.umd.edu].

Special Feature

Military Vehicle Electronics

Rugged Computing Takes Center Stage in Military Vehicles

As pressure increases for compute density, combined with low weight and power requirements, developers of military vehicles electronics are turning to integrated box-level computing solutions.

Jeff Child
Editor-in-Chief

For both next-generation and Current Force military vehicles, the pressure is on to find ways to meet the trickier cooling, shock and vibration problems that emerge when more computing gear is packed into those vehicles. As a result, the challenges facing developers of today's military vetronics (vehicle electronics) are dramatically more complex than vetronics of a decade ago. The sophistication of onboard communications and control electronics is expected to multiply. Even the term "vetronics" is now starting to become obsolete because it connotes a focus on electronics and not the embedded computing and networking that are the staples of today's systems.

An added challenge for vetronics designers was introduced with the Army's directive to armor all tactical vehicles to protect our soldiers from weapons such as Rocket Propelled Grenades (RPGs) and Improvised Explosive Devices (IEDs). The added weight of that armor dramatically reduces the weight budget left over for the onboard electronics. As a result, many system designs had to go back to the drawing board and integrate into a much smaller volume.

Figure 1

RTD Embedded Technologies makes box-level PC/104-based systems qualified for demanding applications like military vehicles. RTD's HiDANplus is part of its rugged HighRel line of systems that is built using frames milled from solid aluminum blocks to exacting specifications, ensuring that the solution is rugged and reliable. The watertight HiDANplus version has environmental sealing and EMI suppression O-rings coupled with MIL I/O connectors.

Rugged Box-Level Systems

One general trend that's aided the drive for reducing the size and weight of vehicle-based embedded computing systems is a move toward stand-alone rugged boxes. Embedded board vendors are adding stand-alone rugged box-level systems to their military market offerings. These complete system boxes—which often support standard form factor boards inside them—provide a complete, tested and enclosed computing solution that eliminates complex integration chores for customers.

Currently there's about a dozen or more vendors that have some sort of stand-alone rugged box-level system in their offerings—many even have whole product lines in that category. Among these are Advantech, Aitech Computers, Ampro Computers, AP Labs, Curtiss-Wright, DRS Technologies, General Micro Systems, GE Fanuc Embedded Systems, Macrolink, MEN Micro, Octagon Systems, Parvus, Quantum 3D, Rave Computer, RTD Embedded Technologies, Tracewell Systems, VersaLogic, VMETRO, WIN Enterprises and WinSystems.

Exemplifying this trend toward stand-alone rugged boxes, RTD Embedded Technologies makes box-level PC/104-based systems qualified for demanding applications like military vehicles. RTD's rugged HighRel line of systems is built us-

ing frames milled from solid aluminum blocks to exacting specifications ensuring that the solution is rugged and reliable. Frames for thermally sensitive components have internally milled heat sinks and embedded heat pipes to move heat to the outside walls of the enclosure, allowing operation from -40° to +85°C without the use of active cooling. Optional shock-mount bases withstand specific shock and vibration specifications.

RTD's IDAN box-level product consists of any RTD PC/104, PC/104-Plus, or PCI-104 boards mounted in its own frame and wired to the standard PC connectors on that frame, thus eliminating the need for module-to-module wiring inside the case. This solution maintains PC/104's modularity and lets system designers configure a system as rapidly as one would configure a stack of boards. The product line is also available in a watertight version, HiDANplus, (Figure 1) with environmental sealing and EMI suppression O-rings coupled with MIL I/O connectors. HiDANplus does inter-module communications via a custom wiring harness that is enhanced by an internal 100 pin stackable signal raceway.

Gladiator Tactical UGV

Last fall Quantum3D's Thermite was tapped for the U.S. Marine's Tactical UGV called Gladiator (Figure 2). Carnegie Mellon University (CMU) National Robotics Engineering Center selected the Quantum3D's Thermite Tactical Visual Computer (TVC) and IData Human-Machine Interface (HMI) Software Tool Suite as key components for the U.S. Marine Corps Gladiator Tactical Unmanned Ground Vehicle (TUGV) Operator Control Unit.

The Thermite TVC was chosen for its light weight, small form factor, ease of mounting, long battery life and advanced computational, storage, video and 2D/3D graphics capabilities. Those factors—coupled with its support for a variety of display devices—enable the Gladiator OCU to meet its mission objectives, including interactive mission planning. With its IData-based HMI, the Gladiator OCU will provide tele-operators with an intuitive user interface that supports 2D/3D graphics, live video display and digital maps with MIL-STD-2525B Symbology for both the Gladiator platform and its mission payloads.

Figure 2

The Marine Corps Gladiator TUGV will provide the USMC Air-Ground Task Force with a tele-operated, semi-autonomous vehicle specifically designed to increase human survival by neutralizing threats and reducing risks to Marines on the ground.

The Gladiator TUGV will provide the USMC Air-Ground Task Force with a tele-operated, semi-autonomous vehicle specifically designed to increase human survival by neutralizing threats and reducing risks to Marines on the ground. The unit will be equipped with remote unmanned scout, reconnaissance and surveillance capabilities. In support of the Gladiator TUGV program, Quantum3D is providing Thermite TVC systems and the IData HMI Software tool suite to CMU, which is using them to develop and deploy the Gladiator OCU, as well as to provide data display, storage and distribution capabilities.

Land/Water Environmental Solution

An example of a box-level solution providing complete environment control is SprayCool's line of enclosures. SprayCool recently introduced its Multi-Platform Enclosure (MPE). The MPE chassis employs the company's patented two-phase cooling technology. The MPE's controlled operating environment enables all electronics to operate effectively in the military's most demanding environments.

In May SprayCool was awarded a contract by General Dynamics to supply additional enclosures for the Command Variant of the USMC Expeditionary Fighting Vehicle (EFV). The units will be used to support ongoing hardware/software integration efforts throughout the current System Design and Demonstration (SDD) phase. Once deployed, the EFV will help the Marines sustain inland combat operations by maximizing tactical surprise; minimizing vulnerability on land; providing improved firepower, lethality and survivability; and providing on-the-move command and control capabilities. The heart of the C2 architecture is the Multi-Processor Unit (MPU) that SprayCool is under contract to provide.

The Command Variant of the USMC EFV uses high-end commercial-grade electronics in a SprayCool enclosure to deliver mission-processing demands. The commercial boards in the SprayCool MPU, which were originally designed to be air-cooled, include five servers, a switch, an I/O board and two expansion cards. The SprayCool MPUs are fully rugged, sealed enclosures that enable commercial boards to meet the temperature, vibration and EMI requirements of MIL-STD 810F and MIL-STD 461, and have been extensively tested in the EFV vehicle environment.

The SprayCool 9-slot enclosure uses the company's patented 2-phase liquid-cooling technology for maximum environmental control and flexibility, and can operate in temperatures ranging from -40° to +60°C. The product is also easily upgradeable, capable of accepting

Future Combat Systems: An Update

The Army's Future Combat Systems (FCS) program continued to roll forward over the past year, with a number of key milestones met and contracts awarded to vendors in the embedded computer market. In the most recent of these, General Dynamics C4 Systems and Rockwell Collins awarded an $8 million contract to Curtiss-Wright Controls to provide VPX-based General Processor Modules (GPM) for use in the Integrated Computer System (ICS) of the U.S. Army's Future Combat Systems (FCS) program. The Integrated Computer System combines a wide range of previously independent computing applications into a single, integrated, secure processing environment. ICS is a common computing environment for 13 of the 14 platforms in the FCS family of systems, which comprises a network of sensors, unmanned aerial platforms and manned and unmanned ground systems. Under terms of the contract, Curtiss-Wright will supply the processing modules to General Dynamics and Rockwell Collins for integration into the ICS system.

Significant progress was made in the last year in a key program that interfaces with FCS: The Warfighter Information Network-Tactical (WIN-T). WIN-T is the U.S. Army's on-the-move, high-speed, high-capacity backbone communications network, which links ground-level warfighters with commanders and the DoD's Global Information Grid. In February, General Dynamics C4 Systems and teammate Lockheed Martin successfully completed the engineering field test and preliminary design review for Increment Two of the Warfighter Information Network-Tactical (WIN-T), which means the program is on schedule to conduct limited user tests in 2008 and deploy new technology to soldiers in 2009. WIN-T Increment Two provides a mobile broadband network that will enable commanders and command posts to carry out battle plans and to collaborate while on the move.

The engineering field test conducted at Ft. Dix and Lakehurst Naval Station in New Jersey provided a means to assess technical maturity of key features needed for network mobility. These technology features include the Network Centric Waveform, which enables mobile platforms to access the WIN-T network; the Highband Networking Waveform, a wideband, wireless wide area networking capability; and the WIN-T Network Management System, which uses commercial-standard network and systems management protocols and interfaces to provide the necessary automation to keep mobile forces networked. The preliminary design review, a detailed analysis of the system design to determine that it meets the documented performance and engineering requirements, was conducted in Foxboro, Mass.

a wide range of card types within the same chassis, simplifying the technology refresh cycle.

VPX in Mil Vehicles

Not all the new design activity in military vehicle electronics revolves around box-level systems. Earlier this year, Curtiss-Wright was awarded the first publicly announced contract win involving VPX—and it was a vehicle design win. Northrop Grumman awarded Curtiss-Wright a contract to provide radar processing subsystems for use in the U.S. Marine Corps' Ground/Air Task Oriented Radar (G/ATOR) Program. The initial contract, valued at $4.3 million, is for development, which is expected to be completed in 2010. The production phase of the program will be executed as an option under the current contract, and is planned to start in 2010.

Curtiss-Wright will supply Northrop Grumman Electronic Systems with a rugged airflow-through radar processing subsystem. Curtiss-Wright's solution uses open architecture-based standards and software to provide a high-performance, modular, scalable solution for the G/ATOR Processor. Curtiss-Wright's new VPX boards and subsystems deliver the high-performance and advanced ruggedization that the G/ATOR program requires, with the additional cost and design advantages of an open architecture structure.

This subsystem will be designed and manufactured at Curtiss-Wright's motion control facility in San Diego, CA, and will include the latest DSP, FPGA and single board computer products from its Leesburg, VA and Ottawa, Canada locations. The High Mobility Multipurpose Wheeled Vehicle (HMMWV)-mounted Ground/Air Task Oriented Radar (G/ATOR) uses active electronically scanned array (AESA) technology to provide aircraft detection and tracking, cruise-missile detection and tracking, ground-weapon location and air-traffic control.

Current Force Vehicle Electronics

Not to be ignored are the many upgrade and test programs underway for Current Force military vehicles. An example along those lines is the Army's Direct Support Electrical System Test Sets (DSESTS) and Test Program Sets (TPS). DRS Technologies was awarded a $13.6 million contract from the U.S. Army to continue manufacturing DSESTS and TPS for the U.S. Army's M2A2 and M3A3 (Figure 3) Bradley Fighting Vehicle Systems. The contract was awarded to DRS by the Army's Tank Automotive and Armaments Command Life Cycle Management Command's (TACOM LCMC) Joint Manufacturing and Technology Center at U.S. Army Garrison, Rock Island Arsenal in Illinois.

As part of this contract DRS will produce Bradley A3 Test Program Sets; Bradley tube-launched, optically tracked, wire-guided (TOW) missile Test Program Sets; and components for Bradley Fighting Vehicle Systems and DSESTS kits. Product deliveries are expected to be completed next month. DRS produces a variety of automatic test equipment designed to diagnose the condition of electronic components and systems installed on the Army's Abrams Main Battle Tanks, Bradley Fighting Vehicle Systems and on U.S. Marine Corps Abrams Tanks and Light Armored Vehicles. The company's DSESTS are used at 89 military bases in the U.S. and are deployed internationally. The DSESTS are designed to support the Army's vehicles as part of their modular transformation from existing division-sized units into brigade-sized combat teams.

In other Bradley technology activity, BAE Systems was awarded a contract modification at the end of last year from the U.S. Army TACOM Life Cycle Management Command, totaling $709.4 million, for the reset of Bradley Fighting Vehicles (Figure 4) and associated components. This modification represents the largest national level reset award for Bradley Combat Systems to date. When combined with an earlier award of $234 million for long-lead materials and the option worth $57 million, this effort represents over $1 billion for the reset of Bradley Fighting Vehicles.

Under the base contract, BAE Systems will reset 1,042 Bradley A3 and ODS Combat Systems returning from Iraq and reset additional A3 components. The contract also carries an option for an additional 58 vehicles. Vehicles that undergo the reset process not only have their useful life restored that was consumed during combat operations, they also receive the latest survivability enhancements and other improvements to greater protect our soldiers in future conflicts. Vehicle deliveries under this contract are scheduled to begin this summer and continue through June 2009, while resetting the components will begin this month and continue through December 2008. ■■

Figure 3

The A3 upgrade version of the Bradley features an advanced digital architecture that integrates communications equipment, digital sensors, battle management systems, embedded diagnostic and training systems.

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Special Feature

Military Vehicle Electronics

Military Vehicles Present New Power Challenges

New-generation military vehicles will be tasked to function as mobile power plants. That's forcing vetronics designers to rethink the power architectures and cooling schemes used on board.

Gary Mulcahy, Chief Technology Officer
John Santini, VP Engineering
TDI Power

Next-generation military vehicles will be providing unprecedented levels of export power and standardization. Conventional design techniques will come up short in terms of power density, reliability and cost for these applications. System designers will need to seek out alternative equipment design and construction techniques for highly reliable power conversion that will provide these applications new levels of standardization and performance.

Present-generation deployable land-based systems (Figure 1) generally derive their power from vehicle engines or portable generators. These typically provide 120/240 VAC or 28 VDC at power levels from 10 kW up to 30 kW. Problems associated with the present practice include excessive audible noise, thermal signature and fuel usage. All of these lead to increased risk for the war fighter, as well as increased pressure on logistics. New-generation military vehicles that employ electric hybrid technology present an opportunity to significantly address these issues by providing "Export Power" that is sourced by the vehicles' onboard energy storage plant and provided to systems outside the vehicle.

On present-generation systems, more often than not export power is sourced from the vehicle's 28 VDC alternator. At the typical power levels being demanded by today's export power loads (many times significantly greater than 10 kW), operating currents can easily top 500A, presenting problems with expensive, large conductors and especially with the overload protection components required to break this much current.

Higher Voltage Storage Plants

New-generation vehicles will employ higher voltage energy storage plants such as Nickel-Metal Hydride or Lithium-Ion Batteries or Super Capacitors. These will typically operate at 300 VDC to optimize hybrid motor operation. Along with the ability to provide significant amounts of power with drastically reduced audible and thermal signatures, the availability of this higher voltage power presents some significant advantages to the export power conversion system. Distribution currents are reduced by 90%—for example from 500A to 50A—from the 28V case, and components within the power converter can be reduced in size due to reduced operating currents.

Military vehicles present challenges to power conversion assemblies due to the severe environment they must operate in, and the mission critical nature of their deployment. By their very nature, they will be operating in remote areas where maintenance may be limited and unanticipated failures catastrophic. More often than not export power converters will be located outside the crew space of a vehicle, fully exposed to the elements. Many times they can be located below the fording plane of the vehicle, requiring the assembly to be immersion compatible. Operating temperatures generally range from -46° to +54°C. Mechanical vibration and shock requirements are typically characterized by MIL-STD-810F, Methods 514.5 and 516.5.

A survey of required power conversion density requested by various vehicle manufacturers indicates a range from 3.4W/in^3 to as high as 10.3W/in^3. Typical cooling requirements call for either forced air cooling or liquid cooling. The choice of cooling methodology is absolutely critical in the successful deployment of this type of equipment.

Forced Air Cooling

In dealing with severe environments in both the commercial and military markets, TDI has a great deal of experience with both sealed and unsealed equipment solutions. The highest power conversion density is achieved through the use of direct fan cooling, circulating air through-

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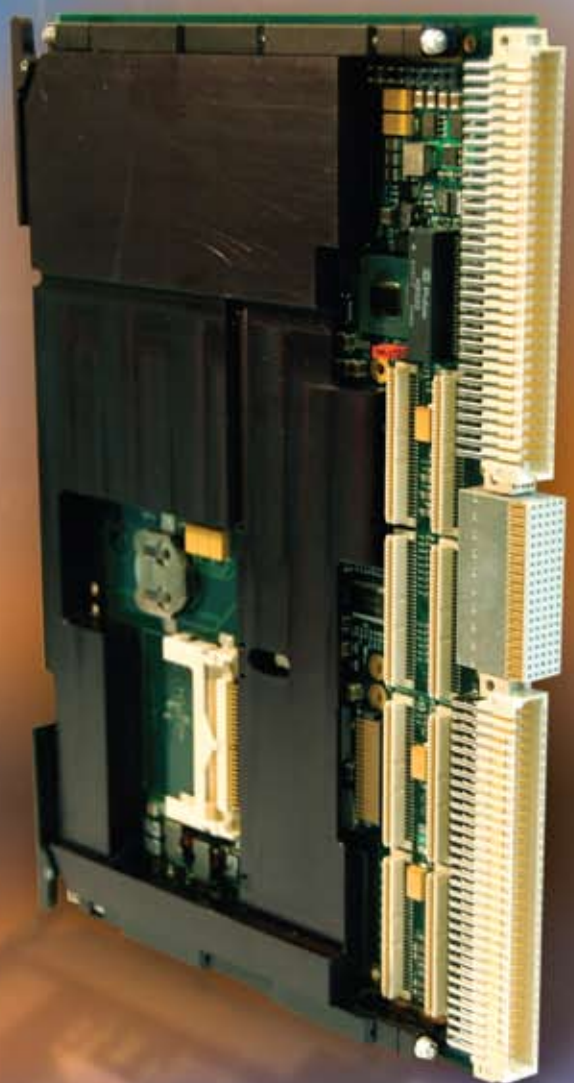

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out the inside of the power conversion assembly. However, this is only advisable if the unit is mounted in a protected location where relatively clean air is available. Otherwise, the solution is prone to dust and dirt buildup on internal components and the addition of moisture can form conductive "mud," which can precipitate failures. Given the tactical nature of these vehicles, under extreme conditions dust and dirt buildup will overcome even the extra protection measures.

Figure 1

Present generation deployable land-based systems generally derive their power from vehicle engines or portable generators. Problems associated with the present practice include excessive audible noise, thermal signature and fuel usage. All of these lead to increased risk for the warfighter. Shown here, a truck loaded with deployable command and control components remains on standby for loading aboard a C-5 aircraft.

The best chance for success for an externally mounted, air-cooled converter in a military vehicle is an indirect system where there is no direct air impingement on internal components. This arrangement uses fans to cool heat sinks—usually referred to as a "wind tunnel" design—and allows the electronic components to be protected from the environment by locating them on the other side of the aluminum heat exchanger. While this approach offers more protection, it also results in a larger package. Figure 2 shows a typical wind tunnel design that has been deployed by TDI in both airborne and ground-based applications. The unit depicted there is a 10 kW DC-AC inverter that meets military requirements. Package size for the unit is 20 x 8.17 x 12 inches, and it delivers approximately 5W/in^3 at 10 kW from an input voltage of 360 VDC.

While the wind tunnel approach fully isolates electronic components from the external environment, there are some limitations associated with it. First, it requires a fan that is exposed to the environment. This is a wear out mechanism that has to be taken into account. If the air inlet or outlet is blocked, operation may be compromised. It's also not compatible with full immersion unless contained in an additional water-tight vessel. Moreover, designs tend to be fully customized, providing little opportunity to leverage solutions into different applications.

Liquid Cooling

The use of liquid cooling allows the electronics package to remain sealed, while also allowing the heat exchanger to be located in a potentially more convenient location, such as the front of the vehicle. Typically, the cooling liquid employed is either water or a mixture of water and ethylene glycol (antifreeze). The most common approach to liquid-cooled systems has all heat producing components mounted to a flat cold plate, which has liquid circulating through it. The liquid is then circulated through an external heat exchanger to cool it. Figure 3 shows a

unit TDI has designed and deployed with this approach. This is an immersion-compatible, vehicle mounted converter that produces 21 kW of 28 VDC and 110 VAC power from a 300 VDC input, while being cooled with 80°C coolant delivered from the vehicle.

While this can be an efficient cooling system, it requires a large amount of engineering time to design, keeping all the heat producing components in contact with the cold plate as well as maintaining good electrical connections to a printed circuit board. One of the limitations of the cold plate approach is that it depends on flat shapes for heat transfer. Often times this results in an assembly that is spread out over a larger than ideal physical area, which can result in electromagnetic noise containment issues. Likewise, this type of assembly generally requires an excess of wiring, resulting in higher cost and potentially reduced reliability due to the increased number of interconnects.

Beyond a simple cold plate, more exotic and integrated liquid-cooling structural members can be deployed. Such units are available providing 7 kW of DC output power and using a central liquid-cooled extrusion that is highly customized to provide cooling for a number of both flat and irregularly shaped components. While this type of design addresses some of the limitations presented by a flat cold plate, it requires a higher level of engineering design, resulting in a completely customized unit that is not adaptable to other applications.

Figure 2

The best chance for success for an externally mounted, air-cooled converter in a military vehicle is an indirect system where there is no direct air impingement on internal components. Shown here is a typical "wind tunnel" design that has been deployed by TDI in both airborne and ground-based applications.

Next-Generation Liquid-Cooled Products

In determining a strategy to address new generation liquid cooling requirements and provide the best performance in vehicle applications, this technology must be able to meet the following objectives:

1. Meet the environmental requirements of vibration, mechanical shock and liquid immersion.
2. Work with coolant temperatures much higher than was dealt with in the past (up to 80°C in some instances).
3. Meet the EMC requirements of MIL-STD-461.
4. Provide solutions that are not so highly customized as to jeopardize development timelines or cost budgets.
5. Provide a good basis for reliability expectations.

Taken together, items 2 and 5 present a particularly challenging requirement. Analysis of existing units shows that while it is not too difficult to control the temperatures of components with the larger share of power losses, it is very difficult to control temperatures of components with relatively low losses, but which don't have a good connection to the heat transmission path. It is not unusual for the internal ambient air temperature inside water-cooled units to be 40°C, or higher, than the coolant temperature.

If the coolant is 80°C, then internal ambient air temperature can easily reach 120°C, or higher. This presents some real problems for certain component types. For example, integrated circuits contained in PC board-mounted SMT packages may dissipate a few hundred mW. These depend on the ambient air that surrounds them to carry this heat away, and with an effective

ambient of over 120°C, reliability is compromised. Likewise, there are many passive components whose reliability quickly falls off as temperatures increase above 100°C.

Managing the Heat

Methods for controlling this effect include reducing the internal ambient temperature rise above coolant temperature, or improving the thermal path from the component to the coolant. Internal air temperature rise can be reduced by circulating air inside the box and employing an air-to-liquid heat exchanger. However, this generally takes up a significant amount of room and adds the reliability impact of a circulating fan.

Improvement of the thermal path can be achieved by surrounding the sensitive components with a thermally conductive compound that ultimately contacts with a liquid-cooled surface. While this method is effective, the design needs to comprehend this need from the very beginning, otherwise a short path from the component to the coolant might not be achievable. Given these considerations, TDI considers a modularized liquid-cooled approach as a good fit for military vehicle applications. The modularized liquid-cooled approach also presents some advantages with regard to design for electromagnetic compatibility. By partitioning assemblies, the EMI filter can be fully isolated and shielded from

Figure 3

The most common approach to liquid-cooled systems has all heat-producing components mounted to a flat cold plate, which has liquid circulating through it. The liquid is then circulated through an external heat exchanger to cool it. Shown here is a unit TDI has designed and deployed with this approach.

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noise-generating assemblies, thereby simplifying filter design.

Non-Conventional Liquid-Cooling Technologies

TDI has developed a new technology that utilizes oil to encapsulate electronic components so as to provide a highly thermally conductive path between these components and the ultimate heat dissipater. The initial deployment of this technology is in convection-cooled, environmentally sealed products for commercial, industrial and military use.

The advantage of oil in these applications is that it is an insulator, so it can be used in direct contact with the electronic components. Complete circuit board assemblies are immersed in the oil, and this produces a relatively isothermal environment that greatly increases component reliability.

Recently this technology has been expanded to include heat dissipation through circulating oil. TDI has deployed this technique on commercial hybrid vehicle components such as battery chargers and DC/DC converters. The oil used is typically a UL-approved, environmentally friendly, vegetable-based transformer oil. However, hydrocarbon-based mineral oil has also been successfully tested and we believe that diesel fuel could also be used in this application. The advantage of diesel fuel would be that it is already used on the vehicle and is logistically an excellent choice.

Advantages of Direct Coolant Circulation

Advantages of circulating coolant directly to electronic components include the extreme protection from exterior environmental effects and buffering from shock and vibration effects. This approach allows you to use existing air-cooled assemblies with little or no changes. Perhaps the biggest advantage that can be achieved with this method of cooling is the reduction of overall operating temperatures. Since most liquid-cooling technologies that have been considered to date share the coolant loop with other heat sources, power electronic components end up operating at unusually high temperatures. These higher operating temperatures will ultimately have a deleterious effect on system reliability. By cooling the power electronics with a lower temperature coolant that comes in direct contact with the components, their operating temperature will be significantly reduced, resulting in a significant improvement in reliability.

Great opportunities for reduced design cycle time and improved performance are presented through the use of standardized cooling topologies that can be employed across various power conversion assemblies. Further, extremely significant gains can be made through the use of direct circulating coolant on component approach. ▮▮

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Joe Gentile, VP Government Business Development
Paratek Microwave

The ambitious goals set by the DoD for the Joint Tactical Radio System (JTRS) program have driven major radio prime contractors and their subcontractors to develop higher performance subsystems that can meet those goals. One of the key areas requiring innovation has been RF filtering, an absolute necessity for operating effectively in dense electromagnetic radiation environments while having the frequency agility needed to communicate using multiple waveforms in rapid succession. A high-performance, continuously tunable broadband filter that is small and consumes little power has the essential characteristics needed to support next-generation military radio development.

Road toward Digital

The relentless advance of semiconductor technology embodied in Moore's Law has made it practical to move from drift-prone analog electronics to low-cost reliable digital processing for many applications. This advance has led to dramatic improvements in analog-to-digital converter (ADC) and digital-to-analog converter (DAC) technology, among others. Many high-performance commercial and military radios now use a single analog conversion between RF and a fixed intermediate frequency (IF) where an ADC directly samples the IF receive signal and a DAC generates the IF transmit signal.

This process, called IF Sampling,

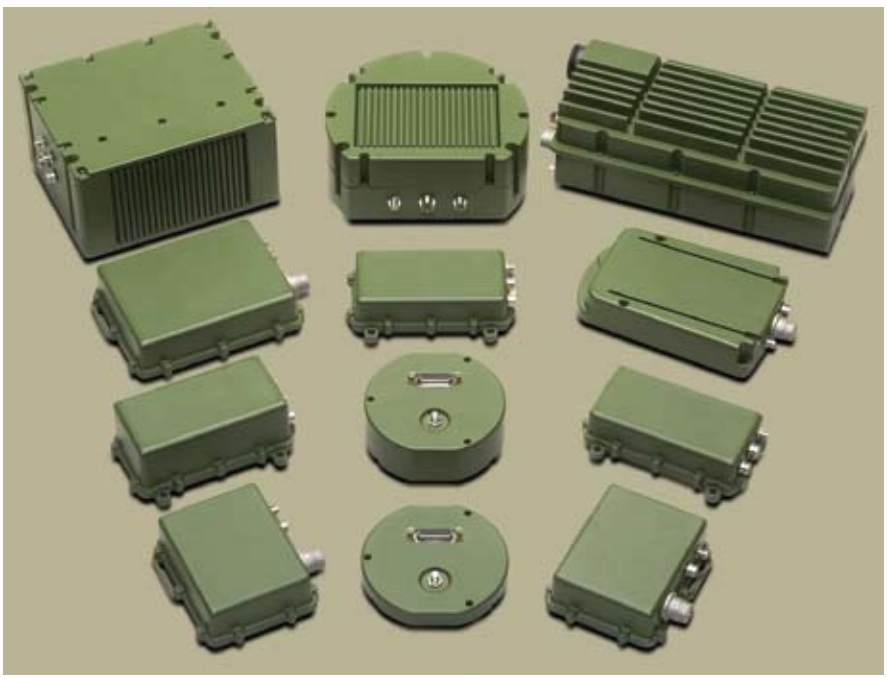
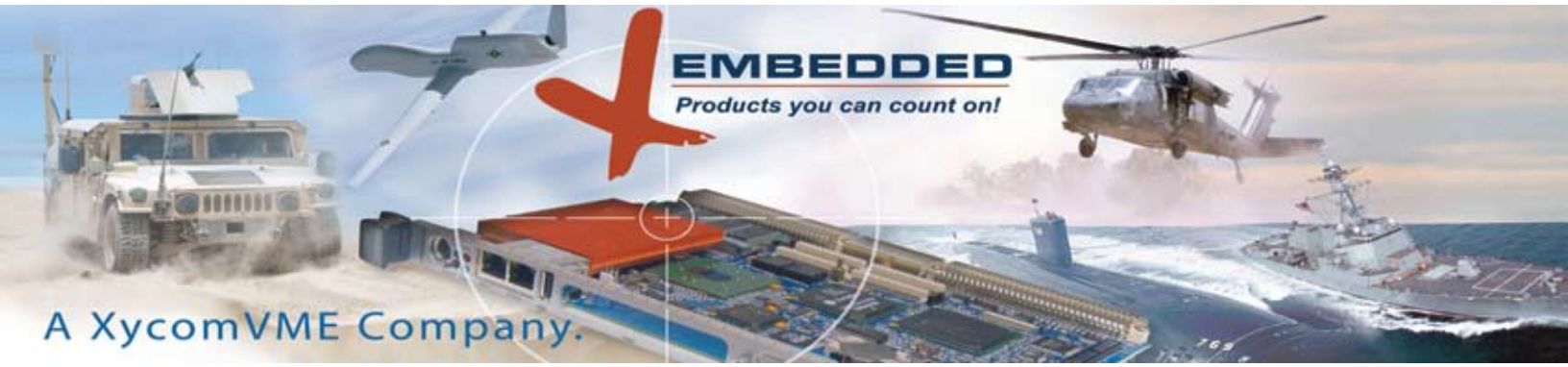


Figure 1

Arrayed here is the family of JTRS HMS (Handheld/Manpack/Small Form Fit) Radios. The JTRS HMS radios are suitable for embedment into platforms requiring a Small Form Fit radio for the 2 MHz to 2.5 GHz frequency range.



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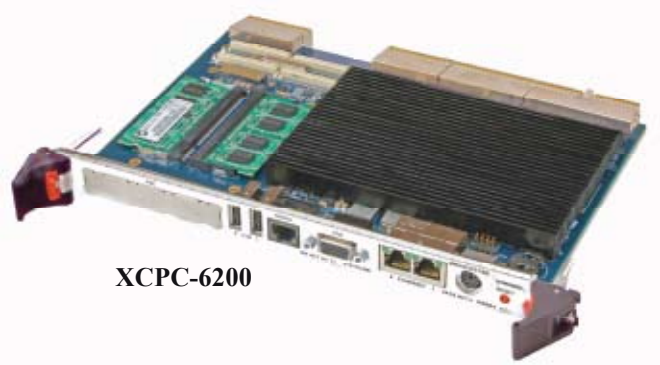
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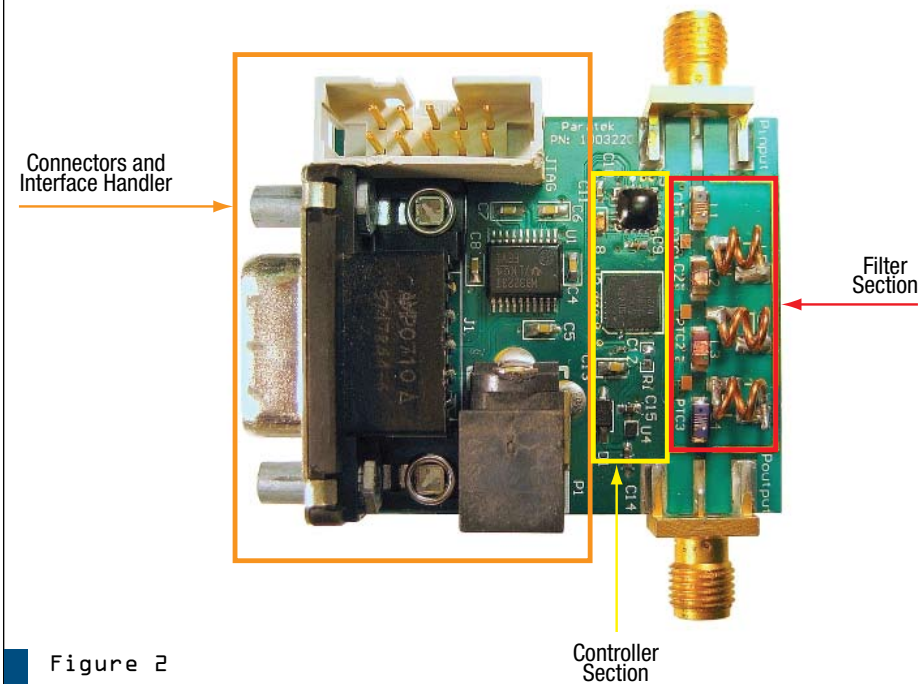

Figure 2

Paratek built this single sub-band filter demonstration board using its ParaScan tunable material, configured with an 8% bandwidth Chebyshev 3-pole bandpass filter tunable over 230-400 MHz.

significantly reduces signal distortion by eliminating a large portion of the analog signal processing employed in a traditional radio. The push toward smaller and lighter radios using digital processing is most apparent in software defined radio (SDR) applications such as the multi-service Joint Tactical Radio System (JTRS). Figure 1 shows the family of HMS (Handheld/Manpack/Small Form Fit) Radios. The JTRS HMS radios are suitable for embedment into platforms requiring a Small Form Fit radio for the 2 MHz to 2.5 GHz frequency range.

Next-generation radios are making the leap to direct RF sampling near the antenna. Direct RF sampling is now feasible for fixed-band commercial applications below 1 GHz; however, military radios (JTRS and others) typically need to cover a very broad frequency range, while at the same time having significant immunity to high-power signals in adjacent frequency bands. The key to making a high-performance direct RF sampling military radio is a low-loss, high-intercept tunable filter that can be placed between the ADC or DAC and the antenna to limit the signal spectrum to the operating band.

Direct RF Sampling Theory

The Nyquist theorem states that an analog signal can be completely represented by digital samples as long as the maximum signal frequency is less than half the digital sample rate. This occurs because the sampling process generates replicas of the analog signal in the frequency domain that are separated by the sampling frequency. If the signal violates the Nyquist Theorem by possessing frequencies at or greater than half of the sample rate, the higher frequencies appear to fold into lower frequencies in a process called aliasing.

For the case of a UHF radio operating over 225 to 400 MHz, the Nyquist theorem indicates that a radio would require a sample rate of at least 800 MHz.

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However, if an analog filter is placed over a band of interest, it is often possible to sub-sample a signal. Aliasing does occur, but since the filter function is known, the true RF frequency can be mapped to the aliased frequency that is present in digital samples. If the filter bandwidth is selected properly, signals that could potentially overlap the desired signal never reach the digitizer.

High-performance radios have employed bandpass sampling for a number of years. In these radios, the RF signal is typically down-converted with analog components to 70 MHz. The 70 MHz signal is bandpass filtered and then sampled at a rate several times the signal bandwidth rather than at the much higher Nyquist rate. As an example, a 10 MHz bandwidth signal at 70 MHz could be sampled at a rate of 25 MHz rather than at 140 MHz+, the much higher rate specified by the Nyquist theorem. Early ADCs and DACs often had difficulty with IF sampling because key parameters such as spur-free dynamic range and signal-to-noise ratio rapidly degraded at frequencies above the first Nyquist zone.

As the demand for IF sampling radios has increased, ADCs have been optimized to sample signals above the Nyquist frequency. Consequently, ADC datasheets often provide detailed performance specifications at frequencies well above the Nyquist frequency. It is now possible to obtain 14- and 16-bit ADCs that specify sub-sampling performance at frequencies exceeding 500 MHz, and 8- and 10-bit ADCs that specify sub-sampling performance up to 18 GHz. These high frequency ranges are extending the sub-sampling trend from fixed IFs to direct sampling of the RF spectrum.

Tunable Filters for Next-Gen Radio

The ideal tunable filter for next-generation radios should have the following characteristics: low insertion loss, high selectivity, high power handling and linearity, low power consumption, low weight and small size, and high reliability. For many years

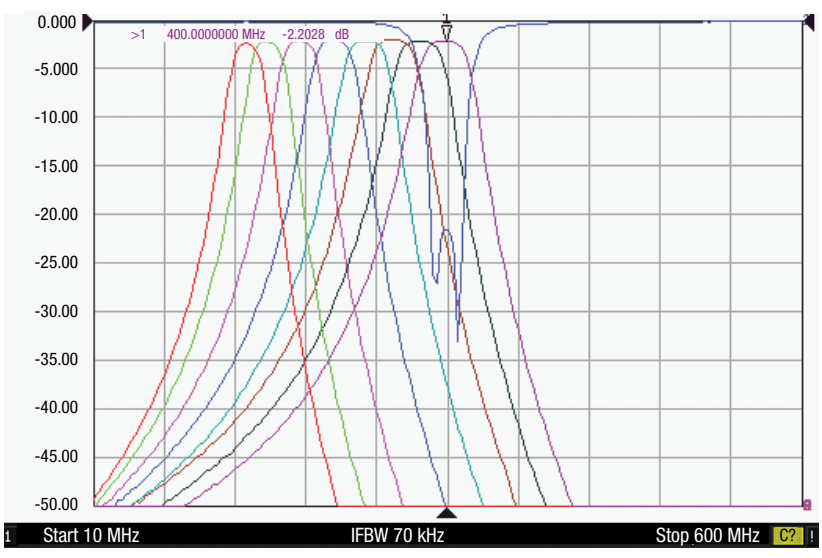

Figure 3

Shown here is the measured response of the filter as it is tuned across the band. The purple trace shows the rejection response and the dark blue trace shows the input return loss at 390 MHz.

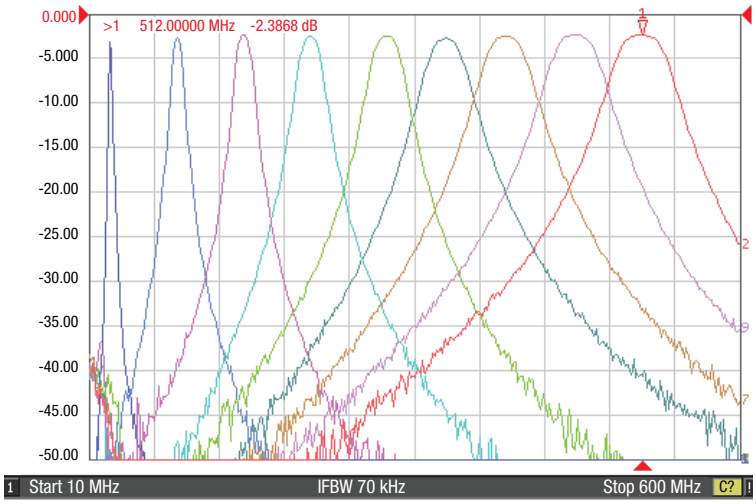

Figure 4

The Paratek filters incorporate a custom High Voltage ASIC, which generates all tuning voltages in response to commands from the microprocessor. These voltages generate the capacitance values required to tune the filter to the center frequency requested by the radio. Performance across the range is shown here.

Filter Board

Controller Board

Figure 5

In order to minimize the footprint, the RF and control boards were laid out separately and then stacked for this implementation. For height-constrained applications, the boards could easily be laid out side-by-side.

tunable filters have been built from PIN diode switches or varactor diodes. PIN diode-based tunable filters typically have discrete tuning steps that limit tuning resolution, require significant board space, and consume large amounts of power. Conversely, while varactor diode-based filters have low power consumption, a compact form factor and continuous tuning, they cannot handle the high RF signal strength often found in military applications.

Mechanically tuned cavity filters could fill the bill for the first four properties, however, multiple bulky and heavy filters would be needed, and moveable components, such as they employ, generally have low reliability. Tunable superconducting filters have excellent performance characteristics, but they will only fill the need for relatively large fixed locations due to the need for a cryogenic cooler.

MEMs have shown potential for years but they continue to be hampered by poor performance in key metrics, such as reliability and die size—especially for HF and VHF applications. What filter design engineers need is a technology that combines the best of all these worlds. With that in mind, Paratek has developed an electronically tunable material called ParaScan, which takes advantage of the efficiencies of standard semiconductor processing techniques to produce unique tunable capacitive devices. The material is a patented form of Barium Strontium Titanate (BST) containing proprietary dopants.

The material is deposited on substrates such as ceramic or sapphire to form voltage-variable capacitors that, with added bias resistors, form unique Passive Tunable Integrated Circuits (PTICs). PTICs have the small size and voltage-tunable characteristics of varactor diodes while maintaining superior linearity at high power levels. PTICs distinguish themselves from traditional BST tunable capacitors by having higher intrinsic Q values than pure BST with lower leakage, higher

breakdown voltage and better reliability, along with IP3 values ranging from 50 to 70+ dBm. Higher Q leads directly to lower insertion loss and better selectivity, both key enabling parameters for RF sampling radios.

A single sub-band filter demonstration board has been built using the tunable material, configured with an 8% bandwidth Chebyshev 3-pole bandpass filter tunable over 230-400 MHz. Figure 2 shows the filter board. The filter section measures 1.0 x 0.4 x 0.3 inches with the controller section slightly smaller for a combined size of 1.0 x 0.75 x 0.3 inches. Using a network analyzer, the measured response of the filter as it is tuned across the band is shown in Figure 3.

Covering Key JTRS Frequencies

Paratek has used the same tunable technology to develop a continuously tunable 30-512 MHz 2-pole bandpass filter that covers key JTRS frequencies. With an insertion loss under 2.5 dB, and a 2.4 x 1.6 x 0.7-inch package, this probably represents the state of the art in filter technology today. Manufacturability is a key factor in the design process of this filter; the level of automation achieved during the assembly, calibration and testing of each unit coming off the production line is such that every sub-band is calibrated with no human intervention required. Automated software routines eliminate all hand-tuning labor, a major improvement over older technologies.

Fully automatic temperature compensation has been incorporated into the microprocessor, ensuring virtually zero temperature drift over the -40° to +85°C temperature range of the filter. All filters incorporate a custom High Voltage ASIC, which generates all tuning voltages in response to commands from the microprocessor. These voltages generate the capacitance values required to tune the filter to the center frequency requested by the radio. Performance across the range is shown in Figure 4.

Multiple 2-pole sub-bands were fully integrated with PIN diode switches through single input/single output SMA connectors for ease of integration into a radio. This filter has a 10% bandwidth, though a 5% bandwidth version is also available. In order to minimize the footprint, the RF and control boards (shown in Figure 5) were laid out separately and then stacked for this implementation. For height-constrained applications, the boards could easily be laid out side-by-side.

The goal of a true all-digital radio has long been sought after. Government and specialized-service radios, plus military software defined radio applications such as the Joint Tactical Radio System (JTRS), can benefit from advances in semiconductor technology. RF filters like Paratek is developing will be required for many years to come in ensuring optimum performance in an increasingly crowded signal spectrum. Tunable filters provide a key breakthrough in analog filters as next-generation military radios push to become lighter, smaller, and more capable. ▮▮

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System Development

Java vs. Ada for Defense Apps.

Real-Time Concurrent Issues Drive Ada versus Java Choice

On the surface, Ada and Java offer similar features to support real-time embedded military applications. But under the hood, they differ significantly in their underlying philosophy.

Benjamin M. Brosgol, Senior Technical Staff
AdaCore

Choosing a programming language for a military system project is a major decision, affecting all phases of software development. For several reasons the language's role is especially critical in embedded real-time systems. First, the application must deal with multiple concurrent activities—monitoring sensors, handling asynchronous user input and so on—but programming with concurrency is intrinsically more difficult than single-threaded (sequential) processing. Second, correctness depends not only on computing the "right answers," but doing so within time constraints that may have little or no tolerance for missed deadlines. Compounding the challenge, these requirements may conflict. Concurrency can introduce nondeterminism, but real-time response demands time and space predictability.

Although the embedded systems domain has no shortage of candidate languages to choose from, few provide features that address concurrency and real-time requirements. C and C++ in particular lack standard support for concurrency, leaving it to be solved through external libraries or Operating System calls and thus compromising software portability.

Not all languages ignore concurrency and real-time. Two technologies in particular—Ada and Java—address these requirements, but in very different ways. Since Ada and Java are seeing increased attention these days, developers and managers need to understand what these language offer and how they compare.

Ada is no stranger to the defense community. Its original design in the early 1980s was sponsored by the DoD with the goal of providing a common, modern language—one that would embody sound software engineering principles—for long-lived, real-time embedded applications. An example program relying on Ada software is the U.S. Air Force C-130 Avionics Modernization Program (AMP) (Figure 1), an effort to standardize configurations, lower the cost of ownership, and increase survivability of its aging C-130 aircraft.

Two Revisions of Ada

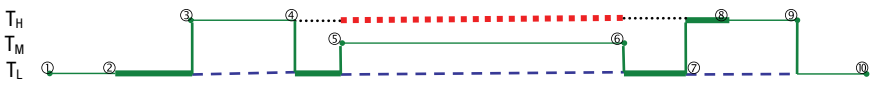
The Ada language has since undergone two revisions, Ada 95 and Ada 2005, which have broadened its application scope and increased its support for the high-reliability embedded systems domain that was its initial target. The availability of the new Ada 2005 ISO standard, coupled with the increasing recognition of safety and security as key system requirements, have kindled a renewed interest in Ada, and the language is enjoying something of a renaissance both within the DoD and outside.

Figure 1

Ada language has a rich legacy in the military realm. Among the programs that relied on Ada is the C-130 Avionics Modernization Program (AMP). The Software Common Operating Environment (SCOE) uses the GNAT Pro Ada compiler and development environment from AdaCore.

Meanwhile, Java technology dates back to the mid-1990s, when it burst onto the computing scene promising a hardware/OS-independent approach to software development and deployment, providing portability at the binary (bytecode) level. Java components ("applets") could be produced on one platform, and then downloaded and executed securely on another, irrespective

Unbounded Priority Inversion



- **T_H is a high-priority thread, T_M a medium priority thread, and T_L a low-priority thread.**

① T_L awakens and starts to run.
The other two threads are blocked, waiting for the expiration of delays.
② T_L locks a mutually exclusive resource.
③ T_H awakens and preempts T_L.
④ T_H tries to lock the resource held by T_L, and is blocked, thus allowing T_L to resume.
- This priority inversion is necessary.

⑤ T_H awakens and preempts T_L.
- This "unbounded" priority inversion is indirectly preventing T_H from running.

⑥ T_H completes and TL resumes.
⑦ T_L releases the mutually exclusive resource and is preempted by T_H, which can then lock the resource.
⑧ T_H releases the resource.
⑨ T_H completes execution, allowing T_L to resume.
⑩ T_L completes execution.
- **The unbounded priority inversion may cause T_H to miss a deadline.**

Figure 2

Some priority inversions are unavoidable, but an unbounded priority inversion can prevent a thread from meeting its deadline and must be prevented.

of their hardware and operating systems.

The Java platform consists of three elements: An object-oriented programming language that was designed as a reaction against the perceived complexity and insecurities of C++; a virtual machine execution engine ("JVM"); and a class library / Application Program Interface. The language and class library have evolved since their inception, under the guardianship of Sun Microsystems and its Java Community Process, and Java has moved steadily from its initially projected domain (downloadable "applets") into many other areas; for example, it serves as the basis for open tool frameworks such as Eclipse. Its dynamic flexibility and extensive class library—including network and GUI support—make it an attractive candidate for Web-based systems.

Concurrent Programming

A concurrent program consists of one or more threads of control that share an address space and communicate either indirectly through shared data, or directly through an explicit control mechanism. Shared data in general require state-based mutual exclusion: for example, a consumer thread that removes elements from a buffer must wait until the buffer contains data, and then it needs mutually exclusive access to the buffer while removing the element.

A thread has execution resources—a stack—and system-maintained properties such as priority. The threads' concurrency may be either actual—on a multiprocessor platform—or virtual—multiplexed on a uniprocessor under the control of a scheduler. By using concurrent programming constructs, the developer can narrow the semantic gap between a system's design and its implementation. However, verifying the correctness of a multithreaded program is much more difficult than for a sequential program. The number of potential execution states is considerably larger, and a variety of concurrency-specific errors are possible:

- *Unprotected accesses to shared data:* one thread modifies a data structure while some other thread is accessing the same data.
- *Race conditions:* the effect of a program depends on the relative speed at which the threads are executing.
- *Deadlock:* two threads cannot make progress because each is blocked, waiting for some resource that is held by the other.

A language's concurrency features may be judged to a large extent by how it helps the programmer deal with these issues.

Concurrent Programming in Ada

In Ada a thread of control is modeled by a task. Tasks can communicate either directly through a co-routine-like synchronous mechanism known as the rendezvous, or indirectly through asynchronous accesses to shared data. Ada's principal facility for manipulating shared data is the protected object, which consists of encapsulated data, protected operations that are invoked to access the data, and a conceptual lock that ensures mutual exclusion. Associated with some operations are preconditions known as barriers, a generalization of the classical condition variable construct for state-based mutual exclusion. A barrier is evaluated when the operation is invoked and (if any tasks are blocked waiting for the condition to be true) automatically reevaluated on completion of other operations.

Protected objects are building blocks for defining synchronization mechanisms such as semaphores and pulsed or broadcast signals. Ada semantics help the programmer avoid the concurrency problems mentioned earlier. The locking behavior for protected objects ensures that while one task is updating a protected object, no other task can access it. Meanwhile, the barrier reevaluation rules help prevent subtle race conditions that can occur with lower-level constructs such as explicit wait and signal on condition variables.

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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		
CPU and BIOS	CPU Max Clock Rate (MHz)	1400	1400	1400	1400	1400	400	650	400	650	400	650	500	500
	L2 Cache (KB)	2048	2048	2048	2048	2048	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		
	Max Onboard DRAM (MB)	512	1024	1024	1024	1024	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
	Audio		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	Analog Video	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
	USB Ports	4	2	4	2	4	2	2	2	2	2	2	2	2
	10/100Base-T Ethernet	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
	multiPort (aDIO, ECP, FDC)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SW	ROM-DOS Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DOS, Windows, Linux	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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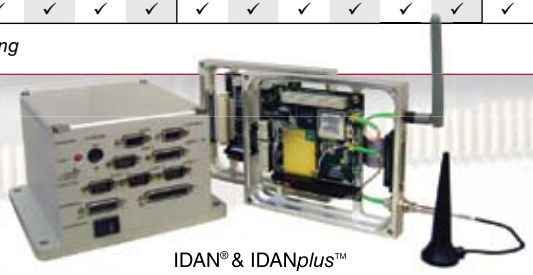

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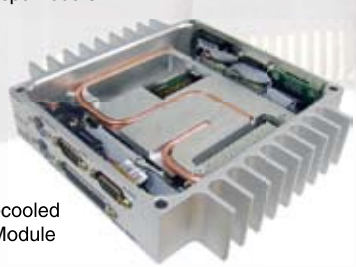

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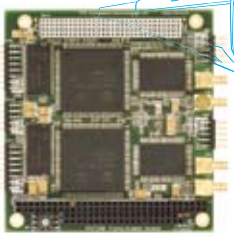

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Bus	Active Bus	PCI	PCI	ISA	ISA	PCI	PCI	PCI	PCIe	ISA	ISA	ISA	PCI	PCI	PCIe	PCI
	Passthrough Bus	ISA				ISA	ISA		PCI				ISA		PCI	ISA
	DMA or PCI Bus Master	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
	McBSP Serial Ports	✓	✓			✓	✓	✓	✓							
Analog Input	Single-Ended Inputs	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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Ada defines a policy known as ceiling locking for protected objects. The programmer assigns to each protected object a "ceiling" that is no lower than the priority of the highest priority task that could access that object. A task performing a protected operation executes at the ceiling priority for that object. So long as protected operations do not block, deadlock on that protected object is prevented (on a uniprocessor).

Concurrent Programming in Java

Java's built-in concurrency features have a POSIX flavor and are rather low level. Threads do not communicate directly but instead synchronize on shared objects. Synchronizing on an object grants the thread a lock on that object, thereby blocking other threads that attempt to synchronize on the same object. A synchronizing thread that needs the object to be in a particular state can invoke the wait() method on that object, which unconditionally blocks the thread. It can be awakened when some other thread invokes the notify() or notifyAll() method on the object.

Java's low-level model is susceptible to the concurrency problems mentioned earlier. Synchronizing on an object does not prevent other threads from making unsynchronized accesses to the same object. Unlike Ada's protected objects, Java's synchronization mechanism does not enforce encapsulation. In Java, the "wait / notify / notifyAll" protocol is prone to subtle race conditions. The classical "nested monitor" deadlock can arise in Java, for example when each of two threads attempts to synchronize on two objects, but the threads perform the synchronization in different orders.

These problems are compounded by Java's heap-based object semantics. If one object logically contains some other object, this is implemented by allocating two separate objects, with the containing object referring to the contained object. Sharing such a data structure across threads requires careful analysis of how to arrange the synchronization. Although some of these issues are addressed by the concurrency utilities added to Java 1.5, the underlying thread model still provides a weak foundation for reliable concurrent programming.

Real-Time Programming

A real-time application generally involves threads with several kinds of release characteristics: Periodic threads, which execute at a determined time interval, and Aperiodic threads, which execute in response to hardware or software events. Each periodic thread has a period, a deadline, and a budgeted computation time. An aperiodic thread has a deadline and a budgeted computation time; a sporadic thread is an aperiodic thread with a minimal interarrival time: the duration between releases. Regardless of whether it

Real-Time Programming in Java

The Java language was not initially targeted to real-time requirements and suffers from three problems.

- The need for automatic storage reclamation (Garbage Collection) interferes with execution time and space predictability.
- The range of priority values is narrow (10 values) and the behavior of the thread scheduler is only loosely defined.
- Threads are susceptible to unbounded priority inversion.

However, interest in applying Java to real-time systems led to an effort to overcome these issues. Initiated in the late 1990s, this work culminated in the Real-Time Specification for Java (RTSJ): an extension of the Java platform that includes an API and specifies constraints on the JVM implementation. The RTSJ addresses the real-time issues through several features: memory areas that do not require garbage collection, either because their objects are not reclaimed, or because they can be reclaimed with a relatively simple stack-like implementation; a range of at least 28 distinct priorities; and a predefined priority-based scheduler with similar semantics to Ada's built-in task dispatcher. In RTSJ support is required for Priority Inheritance as a "monitor control policy" to manage priority inversion.

The RTSJ allows the user to specify release characteristics directly—periodic, aperiodic, sporadic—as parameters to constructors for the various kinds of real-time schedulable objects. This is more explicit than in Ada and helps support schedulability analysis. On the other hand, the RTSJ has some challenges. As an extension (superset) of the full Java platform, it is not appropriate for environments with limited memory capacity. The memory area facility is rather complex, and the need to carefully analyze where objects are allocated is not a natural style for Java programmers. Indeed, implementations based on Real-Time Garbage Collection instead of RTSJ memory areas may be the more practical approach for some environments. There is also the underlying issue of Java as a dynamic Object-Oriented language, which goes against the grain of technology conservatism in the real-time community.

is periodic, aperiodic, or sporadic, at each release the thread must execute no more than its budgeted time and complete its computation before the deadline.

A language for real-time programming should have a convenient way to express these various kinds of threads and their properties. The challenge for real-time programmers is to guarantee schedulability: for a given set of periodic/aperiodic/sporadic threads, all deadlines will always be met. A technique known as Rate-Monotonic Analysis is the key theoretic underpinning: assign priorities to periodic threads based on their periods—higher priority to threads with shorter periods—and convert aperiodic/sporadic threads to equivalent periodic server threads. An algebraic computation of the threads' processor utilization provides a test for schedulability. Several issues need to be addressed in order to apply Rate Monotonic Analysis in practice:

- *Resource predictability.* It must be possible to predict a thread's Worst Case Execution Time, so that a computation budget can be established, and likewise it must be possible to guarantee that the program does not exhaust its stack or heap space.
- *Scheduler support:* The thread scheduler needs to supply a sufficient range of priorities and provide priority-based (FIFO within priority) semantics; i.e., "run until blocked or preempted."
- *Avoidance of unbounded priority inversions:* A priority inversion occurs when a higher-priority thread is blocked by a lower-priority thread. Some priority inversions are unavoidable; for example, when a high-priority thread needs access to a resource that is locked by a lower-priority thread. However, an unbounded priority inversion (Figure 2) can prevent a thread from meeting its deadline and must be prevented.

Ada meets the real-time programming requirements through several mechanisms. First off, in Ada time/space predictability is facilitated by a compiler directive "Pragma Restrictions" that identifies features that are not used. By avoiding features with hard-to-analyze space or time utilization, the programmer in effect defines a custom subset with predictable performance. A major potential predictability problem in Java—interference from the Garbage Collector—does not arise in Ada.

Ada's priority range contains at least 30 values, and the language-defined task dispatching policy is priority-based, FIFO within priorities. The ceiling locking policy mentioned earlier prevents unbounded priority inversions, and in fact minimizes the blocking time: a task is blocked at most once—by a lower priority task that is using a shared object—during its execution.

The original Ada tasking model was the focus of much of the research on Rate Monotonic Analysis during the late 1980s. Ada helped advance the state of real-time design beyond the traditional "cyclic executive" and sparked the formulation of the Ravenscar Profile: a subset of tasking features that is expressive enough for programming real applications but simple enough to be implemented on small-footprint embedded systems and to be certifiable for compliance with safety standards. In contrast, the Java language was not initially targeted to real-time requirements. The side bar "Real-Time Programming in Java" explores some of the issues and solutions involved in using Java for real-time apps.

Differences Under the Hood

Concurrency and real-time support present difficult issues for programming language design. Ada and Java address these challenges through approaches that

share some surface similarities—explicit features for concurrency, direct support for real-time development based on Rate Monotonic analysis—but that differ significantly in their philosophy and in their likely appeal. Ada provides a general concurrency model that can be restricted to meet the time/space predictability requirements for real-time applications, including safety-critical systems that need to be certified against standards such as DO-178B. The language supports but does not require Object-Oriented Programming. Ada's likely appeal is to the traditional real-time community who are looking for a standard language solution offering greater reliability and portability—or lower safety certification costs—than C and C++.

Java provides a general concurrency model that has been extended by the RTSJ to meet real-time predictability requirements. The real-time extensions are very much in the spirit of the rest of the language, with an emphasis on flexibility. The RTSJ does not claim to address safety-critical requirements; subsetting is needed. An effort to define a safety-critical profile of the RTSJ has been underway since 2003 and is currently in progress. Java is heavily based around Object Orientation; trying to program without using the OOP features leads to a contrived style that sacrifices many of the language's advantages. The RTSJ's likely appeal is in environments where the Java language has been chosen for other reasons, and where the system has some real-time requirements

All that said, the Java / Ada decision need not be "either/or." Mixed-language programming is provided by Java through the Java Native Interface, and by Ada through a standard interfacing framework. The enhancements in Ada 2005 make such interfacing easier, and there is current implementation support for mixed Ada/Java development. In a large system it may make sense to program different components in different languages—for example, a user interface in Java, hard real-time elements in Ada—thus taking advantage of the strengths of both. Ada and Java, rather than competing in the embedded defense system arena, may turn out to be comrades in arms. ■■

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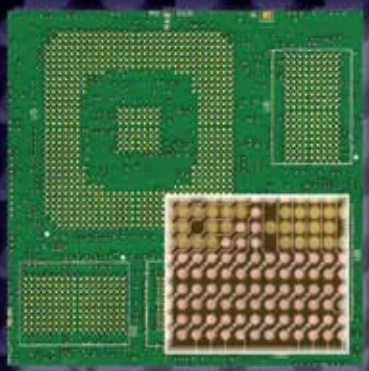
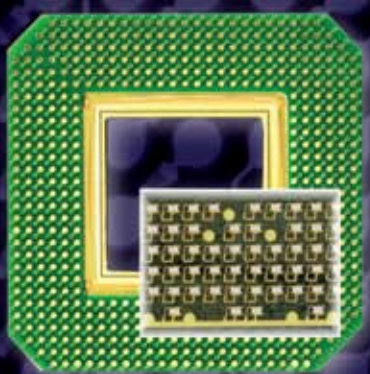


2000's



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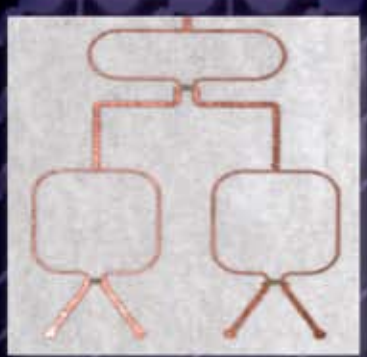

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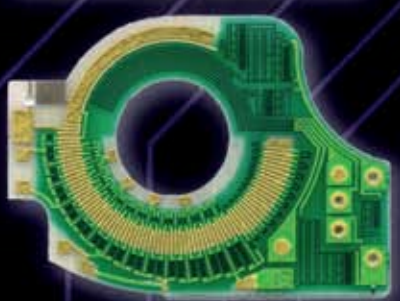

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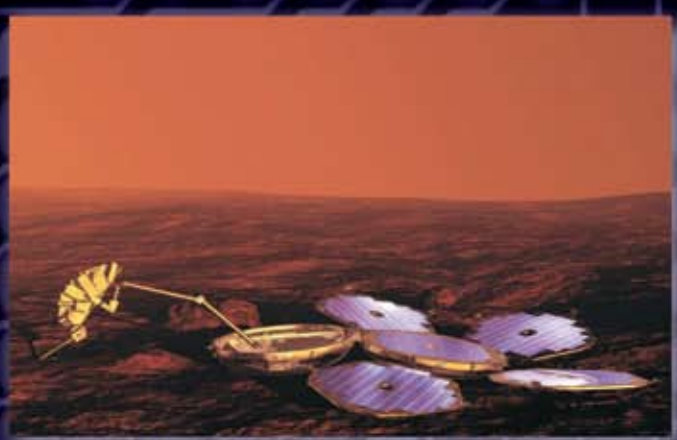

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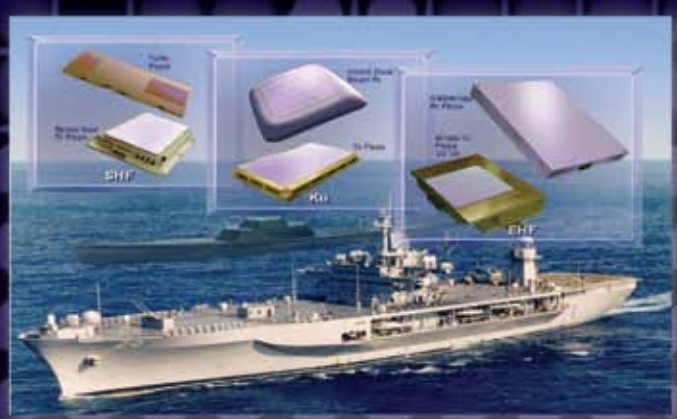

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Gap Analysis Strengthens Link Between Requirements and Verification

As military systems trend toward greater software control, the need for traceability and improved verification processes is greater than ever. Gap analysis helps smooth the way.

Brian Hooper, Field Applications Engineer
Bill St Clair, Technical Evangelist
LDRA

Gap Analysis is a technique regularly used in business to ascertain the maturity of working processes and to identify areas for improvement. One area that is regularly flagged by gap analyses of software projects is the troubling field of requirements traceability, a key discipline for safety-critical projects. It's also one of the remaining areas of software development that is yet to be fully automated.

Gap analysis offers an opportunity to examine operating processes and generated artifacts, typically employing a third party for the assessment, without the pressure and constraints of a formal assessment or certification. The outcome will be notes and findings upon which the company or individual project may act, valuable information that will help improve processes such that the formal assessment or certification, when carried out, is much more likely to be passed at the first attempt.

Companies involved in systems and software development for the defense industry, through working to standards such as DO-178B, are familiar with the efforts required to achieve certification for their products from the relevant authority. The need for certification has mandated business evolution such that processes and project plans are documented, requirements are captured, implementation and verification are carried out with respect to the requirements, and all artifacts are fully controlled in a configuration management system.

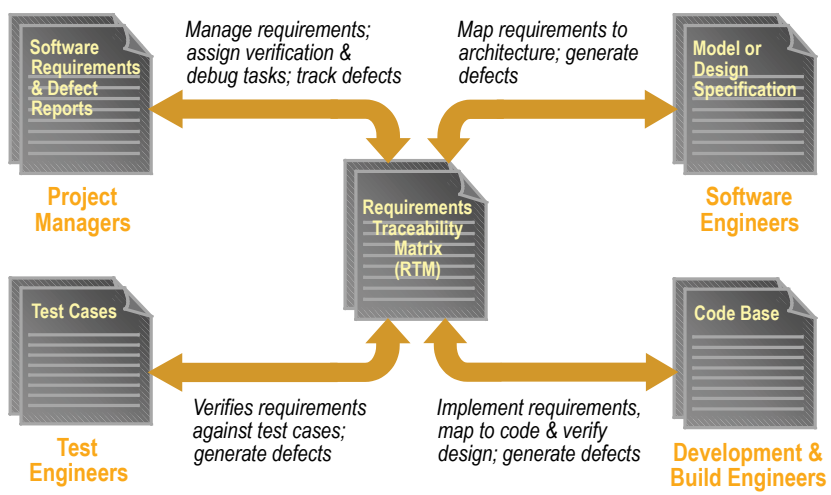

Figure 1

Requirements drive the iterative development approach. Project Managers and Analysts need to get the latest project requirements out to the team. Developers, testers and writers need to know what to build, test and document. And executives and managers need to know what's happening with their projects.

Reliance on Software Control

An ever-increasing reliance on software control has meant that many companies from non-military business sectors that do not have a traditional requirement for sophisticated software development processes and practices, now find themselves compelled to undertake

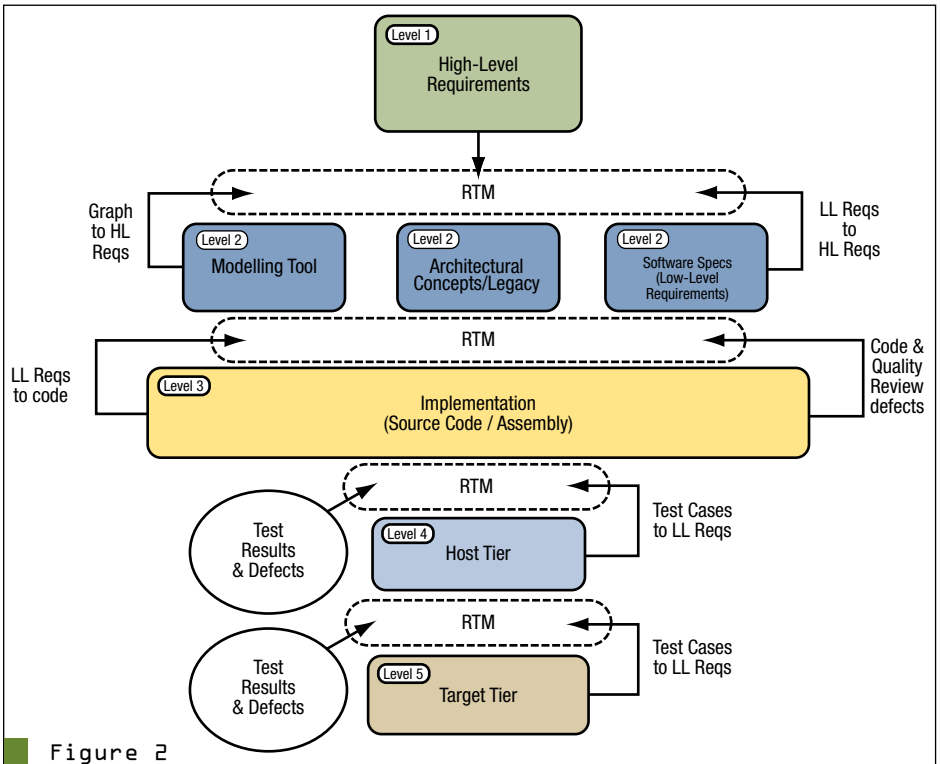

Figure 2

A Requirements Traceability Matrix (RTM) must be represented explicitly in any lifecycle model to emphasize its importance. With this elevated focus, the RTM will be constructed and maintained efficiently and accurately as an integral part of the development process, thereby avoiding any last-minute panic and associated costs. Table 1 explains the various levels in this model.

safety-related assessments to prove the quality of their products. Conversely, developers of military embedded systems continue to seek improvement and have been looking to commercial industries for inspiration, one significant example being the adoption of MISRA C and C++ coding standards.

With the need for increased software quality across different industries, companies are looking outside their own market sector for best practice approaches, techniques or standards. Gap analysis provides an established method by which these companies may isolate the areas in which they need to improve with respect to a standard such as DO-178B; in addition, the results allow the company to correctly and efficiently focus resources in order to achieve that improvement.

When companies undergo gap analysis, the results often show maturity within each individual phase of the software development lifecycle and a high level of investment in tools to efficiently undertake each phase. However, the results regularly reveal one particular area of concern, that of traceability between the software development phases. More often than not, the construction and maintenance of traceability matrixes is performed as a low-priority task and carried out manually, requiring continual human interaction and interpretation regarding what traceability means.

Traceability Is Critical

Evidence of traceability is a key deliverable for most project standards, and failings in this area have major repercussions when certification is undertaken. With there being a strong correlation between requirements degradation and software defects, companies are becoming more focused on ways to mitigate this risk through rigorous requirements and traceability management. Meanwhile, as the defense industry is attempting to save costs through the use of commercially developed components, there is a drive to reconcile the difference between military standards and commercial standards under which products are developed to further trim costs, particularly in the areas of verification and certification, which can account for 50% to 70% of the overall development budget.

Requirements traceability is widely accepted as a development best practice to ensure that all requirements are implemented and that all development artifacts can be traced back to one or more requirements. A Requirements Traceability Matrix (RTM) is also a key deliverable within many development standards.

Despite good intentions, many projects fall into a pattern of disjointed software development in which requirements, design, implementation and testing artifacts are produced from stand-alone, silo-like development phases resulting in tenuous links and references between themselves and the overall RTM. This pattern is just as evident on projects using state-of-the-art requirements management tools, modeling tools, IDEs and testing tools. Focusing on requirements in particular, the lack of reference to later development phases is attributable to the centralized, database-like architecture and application model of most requirements management tools; there is plenty of functionality to encourage good quality and good management in the requirements domain, yet little to aid the downstream effort where projects are designed, implemented and tested.

How DO-178B Defines Compliance Determination

The certification authority determines that the aircraft or engine (including the software aspects of its systems or equipment) complies with the certification basis. For the software, this is accomplished by reviewing the Software Accomplishment Summary and evidence of compliance. The certification authority may review at its discretion the software lifecycle processes and their outputs during the software lifecycle.

Old Ways and Assumptions

In many companies, the requirements manager is a database specialist with responsibility for the RTM on multiple software development projects, usually with limited knowledge of those projects. The RTM is maintained in a lightweight repository with no direct connectivity to the software development artifacts nor to the status of these artifacts. Management is typically one of manually bringing the RTM updates and the relevant artifacts to the requirements repository, whether on paper or via email or even over the telephone. If any formal structure is in place, it is typically a set of intermediate files managed in tools such as Microsoft Excel where omissions and mistakes are inevitable.

The traditional view of software development is to show each phase flowing into the next, perhaps with feedback to earlier phases, and a surrounding framework of configuration management and process. Traceability is assumed, via the relationships between phases; however, the mechanism by which trace links will be recorded is seldom stated. The reality is that, while each individual phase may be conducted efficiently thanks to investment in up-to-date tool technology, these tools are likely to contribute to the RTM by accident rather than design. With such a low profile and little support from tooling, it is no surprise that the RTM is poorly maintained over the duration of projects and typically completed as a rush job. In truth, the RTM sits at the heart of any project (Figure 1). Whether or not the links are physically recorded and managed, they still exist. For example, a developer will create a link simply by reading a design specification and using it to drive the implementation.

This alternative view of the development landscape immediately illustrates how pervasive the RTM is and the importance that should be attached to it. It is therefore vital that project managers consider investment in tooling for RTM construction with the same priority and enthusiasm attached to the purchase of requirements management, version control, change management, modeling and testing tools. Furthermore, the RTM must be represented explicitly in any lifecycle model to emphasize its importance. Figure 2 shows a way that it might be done. Table 1 explains the various levels in this model. With this elevated focus, the RTM will be constructed and maintained efficiently and accurately as an integral part of the development process, thereby avoiding any last-minute panic and associated costs.

Lifecycle Model Example Emphasizing the RTM

Level 1 High-Level Requirements	A definitive statement of the system to be developed and the functional criteria it must meet. This level may or may not need to be elaborated further.
Level 2 Design	A representation of the design of the system described by Level 1. Above all this level must establish links or traceability with Level 1 and begin the process of constructing the RTM. Capture low-level requirements, these being requirements specific to the design and implementation domain with no impact on the functional criteria of the system.
Level 3 Implementation	Produce the source/assembly code in accordance with Level 2. Verification activities begin, including code rule checking and quality analysis. Maintenance of the RTM presents many challenges at this level, tracing requirements to source code files may not be specific enough, linking to individual functions may be required.
Level 4 Host-based Verification	Begin formal verification – the test strategy may be top-down, bottom up or a combination of both. Make use of software stimulation techniques, automated test harnesses and test case generators as necessary. Test cases should be repeatable at Level 5 if required.
Level 5 Target-based Verification	Specific to embedded software, especially where safety criteria require verification. A further RTM layer, tracing from source code to object code, may be generated where a component has been assessed as safety-critical.

Table 1

Listed here are the levels depicted in the model illustrated in Figure 2.

High Visibility Common

For aerospace and military projects developed under the constraints of standards like DO-178B, such as air-traffic control or missile guidance systems, following a model where the RTM has high visibility is commonplace. Gap analyses show that some degree of automation to gather traceability information is often in place, principally across the early lifecycle phases where tool support is strongest. However automatic tracing to implementation and verification artifacts is typically weak, therefore more can be done even by companies who believe their processes and toolsets are generally strong.

Gap analysis highlights time and again that requirements traceability remains a low-priority, manual task prone to error and omission for many projects, even in the defense industry where there is a long history of rigorous process and standards adherence. Consequently, when a certification case is being assembled, the time and effort required to construct a requirements traceability matrix (RTM) is huge and a serious impact on the costs accrued by a project. Clearly the development of an RTM can be easily automated with investment commensurate with that made in other areas of the development lifecycle, such as modeling and version control. The return on investment has been reaped from tools that manage requirements, support design and enable verification; further cost savings and process improvements are also available to project managers in the realm of requirements traceability. ▮▮

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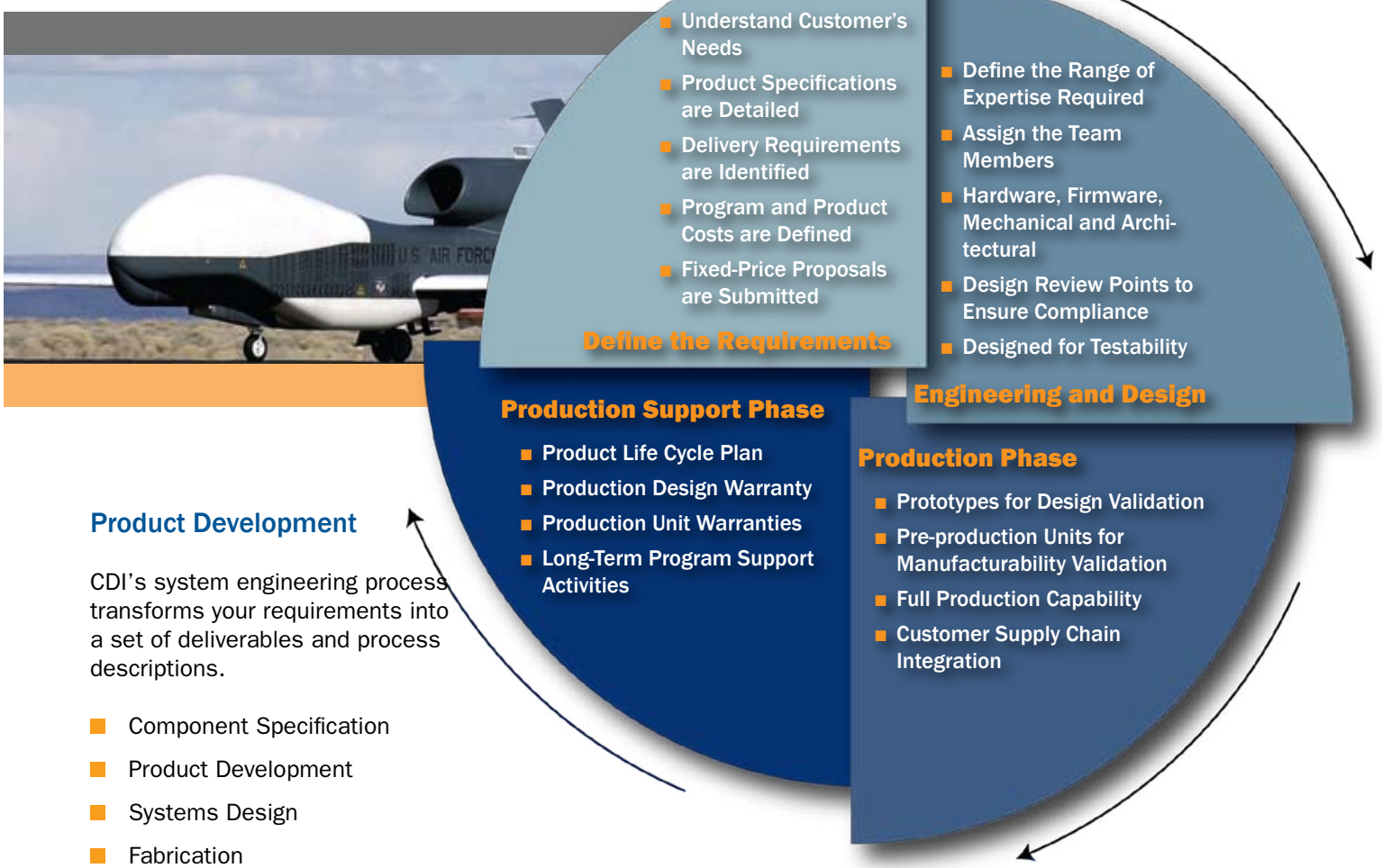

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Technology Focus

VPX, VXS and VME SBCs

VME, VXS and VPX Keep Pace Evolving Military Needs

VME's installed base is strong, but new military platforms are looking toward VXS and VPX.

Jeff Child
Editor-in-Chief

At over a quarter century old and still going strong, VME is still the dependable choice for military system designers. But its dominance is starting to wane as competing technologies threaten to destabilize the towering mountain that is VME. Leading this sea change are two emerging VITA specifications: VXS and VPX, which are changing the way system designers think about building multiprocessing systems. Both architectures share one thing in common: they replace some or all of the existing VME connectors with a connector designed for high-speed serial switched fabrics such as PCI Express and Serial RapidIO.

Serial switched fabrics promise massively higher data rates than those of which VME is capable—a growing requirement in today's demanding military embedded computing environments—with a four lane (x4) PCI Express port rated at up to 8 Gbits/s in each direction, while a similarly configured Serial RapidIO port attains up to 10 Gbits/s. Both VXS and VPX offer full support for serial switched fabrics. The question for military computing developers is: How do you distinguish between these two apparently competing solutions? Fortunately there are some clear differences between the technologies that help us here.

VXS is designed to be fully compatible with legacy VME boards, and hence only the optional P0 connector is replaced by a high-speed fabric connector. VPX takes a different approach, replacing legacy connectors with fabric connectors and yet still offering backward compatibility, this time through a hybrid backplane arrangement with a flexible combination of VPX and VME bus slots.

One key difference may be in the arrangement of the fabrics. VXS uses a single 15-wafer 7-row Multigig RT2 P0 connector, providing a maximum of two x4 fabric ports per payload slot. A typical VXS system will accommodate up to eighteen payloads and one or two switches. This arrangement works well for larger systems but represents a significant overhead in smaller systems, perhaps employing five or fewer boards.

Centralized switch slots as found in VXS really come into their own with larger systems. For critical, high-availability applications, it is possible to accommodate more than one switch, typically configured in a dual star layout to allow for failover. The real benefit, however, comes in the sophistication of the interconnection architectures that dedicated switching slots permit.

Figure 1

A Marine Humvee cruises up a dusty slope during a perimeter patrol in Iraq. Being the primary source of transportation for the Marines of the Perimeter Patrol Teams, the Humvee helps them accomplish their responsibilities of keeping the surrounding areas free of any threats. Photo by: Lance Cpl. James B. Hoke.

In the first publicly announced contract win involving VPX, Northrop Grumman earlier this year awarded Curtiss-Wright a contract to provide radar processing subsystems for use in the U.S. Marine Corps' Ground/Air Task Oriented Radar (G/ATOR) Program. Curtiss-Wright will supply Northrop Grumman Electronic Systems with a rugged airflow-through radar processing subsystem. Curtiss-Wright's solution uses open architecture-based standards and software to provide a high-performance, modular, scalable solution for the G/ATOR Processor. The Humvee-mounted (Figure 1) Ground/Air Task Oriented Radar (G/ATOR) uses active electronically scanned array (AESA) technology to provide aircraft detection and tracking, cruise-missile detection and tracking, ground-weapon location and air-traffic control. ▮▮

Technology Focus:

VPX, VXS and VME SBC Roundup

6U VME SBC Targets New and Legacy Systems

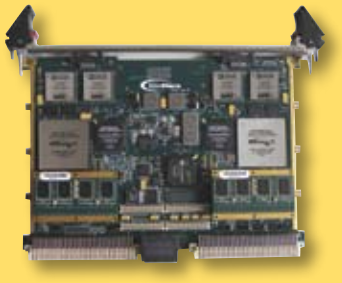
One of the key strengths of VME—and reasons why the military so embraced it—is its ability to maintain backward compatibility with legacy systems while folding in new technologies as they emerge. Serving both sides of that puzzle, Aitech Defense Systems has released the new high-performance C108. For newer applications, the rugged 6U single-slot VME SBC offers up to 1.4 GHz of processing power via the G4+ PowerPC (PPC) MPC7448 processor, the highest performing Freescale PowerPC. For legacy applications, the board features pin-to-pin backplane and I/O compatibility with previous Aitech processor boards employing the PPC MPC74xx processor family, allowing easy, cost-effective upgrades to newer technology.

The C108 supports new and legacy systems via a host of diverse I/O interfaces, which include a Gigabit Ethernet port, two Fast Ethernet ports, two dual-redundant MIL-STD-1533B interfaces, two USB ports, eight serial ports and 16 discrete I/O channels. Two PMC expansion slots enable standard, quick and easy increases to the board's functionality. For new programs, Aitech has added an onboard, optically isolated CAN Bus 2.0B to interface with modern vehicle electronics and major functional subsystems without sacrificing one of the onboard PMC sites as well as to reduce modern subsystems costs. Pricing for the C108 starts at $6,640.

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

DSP/FPGA-Based VXS Card Is Conduction-Cooled

VXS has found a solid niche as a "here and now" solution for marrying switched fabric performance with legacy VME backward compatibility. BittWare's latest VXS offering is the GT-6U-VME (GTV6), which features two Altera Stratix II GX FPGAs (2SGX90 or 130), two processing clusters consisting of two ADSP-TS201S TigerSHARC DSPs from Analog Devices, and up to 3 Gbytes of DDR2 SDRAM memory. This conduction-cooled board is optimized for high-end, multiprocessing applications, while also providing complete flexibility for future adaptability, ideal for existing and future military applications requiring embedded signal processing in a VXS/VITA 41 form factor.

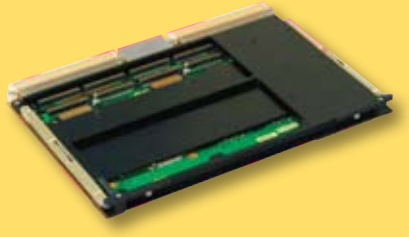


The GTV6 implements a dual BittWare ATLANTiS framework to interface between the FPGAs and DSPs. The GTV6 also features two clusters of two ADSP-TS201S TigerSHARC DSPs, which are interconnected by a 64-bit cluster bus running at 83.3 MHz. The commercial (air-cooled) version is shipping now; the ruggedized version will begin shipping Q308.

BittWare.
Concord, NH.
(603) 226-0404.
[www.bittware.com].

Conduction-Cooled VME Card Has 1.5 GHz Core 2 Duo

Despite all the buzz about the emerging fabric-based VME follow-ons, it really is still VME64 that's actually deployed in most existing military systems. Demand remains high for marrying the latest and greatest computing technology to legacy VME64 slots. With just that in mind, Concurrent Technologies has introduced a VME64 SBC supporting a dual-core processor, IEEE 1101.2 conduction-cooling and dual PMC/XMC sites. The single-slot VP 417/031-RC uses the latest mobile dual-core processor and server chipset from the Intel embedded roadmap—combining the performance of the 1.5 GHz Intel Core 2 Duo processor with the Intel E7520 server-class chipset interfacing with up to 4 Gbytes of soldered DDR2 ECC SDRAM at up to 6.4 Gbytes/s.



The VP 417/031-RC conduction-cooled board, including conformal coating, operates at altitudes of -1000 to +50,000 feet (-305 to +15,240 meters) and meets various VITA 47 classes and associated MIL-STD-810F test methods, including operating over -40° to +85°C (VITA 47 class CC4) and the ruggedized design operating at a shock of 40g (11 ms, half-sine) and random vibration, 0.1 g2/Hz (10 Hz-1 KHz) with 6 dB/octave from 1 KHz to 2 KHz (VITA 47 class V3).

Concurrent Technologies
Woburn, MA.
(781) 933 5900.
[www.gocct.com].

6U VPX-REDI Board Blends FPGAs and PowerPC

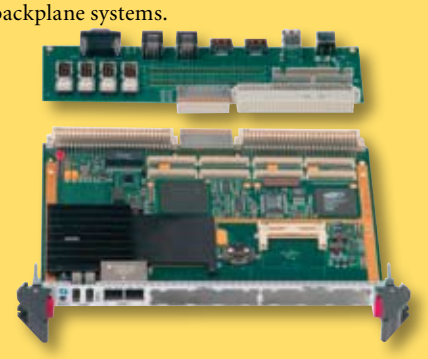
VPX boards are slowly starting to roll out from military SBC vendors. This could pan out to be the year of VPX. Early to game, Curtiss-Wright Controls Embedded Computing offers the CHAMP-FX2, its first FPGA-based VPX-REDI (VITA 46/48) compute engine. The new 6U board combines the flexibility of Xilinx FPGA-based reconfigurable computing, high performance Power Architecture (PowerPC) processing, and the high-bandwidth of serial switched fabrics.

Taking full advantage of the VPX standard's support for high-bandwidth serial switched fabrics, the CHAMP-FX2 uses Serial RapidIO to connect its three computational nodes and its onboard XMC mezzanine site with up to four 4-lane SRIO connectors to the backplane. The board's memory support includes double data rate (DDR2) SDRAMs and quad data rate (QDR-II+) SRAMs that complement inter-node bandwidth by providing multiple, independent memory banks for each of the dual Virtex-5 FPGAs. High-speed serial ports are provided to connect the FPGAs to each other, to the XMC site, and to front-panel or back-panel connections. The CHAMP-FX2 is designed to operate in rugged environments and is available in both air- and conduction-cooled formats. Volume pricing for commercial and rugged versions of the CHAMP-FX2 is available.

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

Ruggedness, Low Power Combine on VME SBC

Packing the most performance possible into a single VME slot, at low power, is now an easy feat. Dynatem has accomplished that with its Core-Duo based DPD VME SBC. The DPD is a single-slot VMEbus (and VME64)-compatible platform based on the Intel low-power Core-Duo (Yonah) processor. The DPD takes advantage of the Core-Duo's low 15W power consumption as a rugged SBC. The DPD requires only 5V from the backplane. This enables full functionality in legacy VMEbus backplane systems.

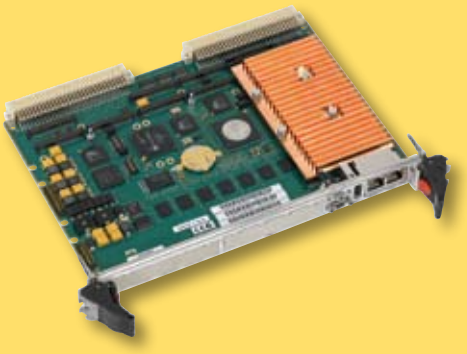


Shock and vibration immunity were major goals in the DPD design. All major components including processor, chipset and memory are BGA-based. The only socketed devices on board are the optional CompactFlash and optional battery, both of which are securely fastened when required. The DPD is available as an IEEE 1101.2-compliant, conduction-cooled VMEbus module with wedge locks and a full-board heat sink for high shock/vibration environments and temperature extremes. The DPD comes installed with 2 Gbyte ECC-compatible DDR2-400 memory. Memory is BGA for the best shock/vibration spec. Two SATA ports, VGA video, two Gbit Ethernet ports, four RS-232 ports, one RS-422 port, an IDE interface, PS/2 mouse and keyboard, and two more USB 2.0 ports are routed to the backplane. Conventional PC I/O is accessible with industry-standard connectors on optional rear I/O modules. The two onboard mezzanine card interfaces include one PMC site based upon the 64-bit PCI-X bus. Pricing for the DPD starts at $4,738 in single quantity.

Dynatem
Mission Viejo, CA.
(949) 855-3235.
[www.dynatem.com].

Dual-Core PowerPC VME Board Runs at 2eSST Rates

The era of dual-core processors is rolling into full swing. Featuring a dual-core PowerPC processor and 2eSST high-speed VMEbus interface, the MVME7100 from Emerson Network Power is designed to enable defense/aerospace OEMs to add performance and features for competitive advantage while providing backward compatibility to protect their investment in VMEbus technologies. The MVME7100 offers flexibility to support varying I/O requirements with the same base platform, simplifying part number maintenance, technical expertise requirements and sparing. It also provides optimal speed, which is achieved due to the independence of the PCI buses for each PMC site. In addition, the board's non-volatile memory feature prevents system memory loss in the event of a power loss.

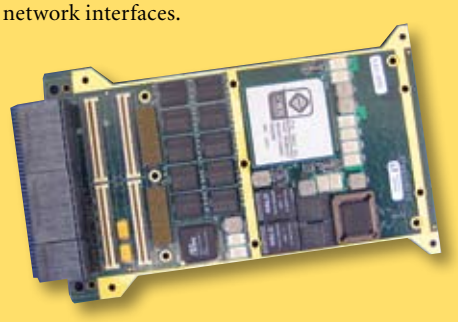


The MVME7100 is based on the system-on-chip Freescale MPC8641D with dual PowerPC e600 processor cores, high-capacity DDR2 memory, up to 8 Gbytes of NAND Flash, PCI-X, USB and 2eSST. The MVME7100 series features dual integrated memory controllers, DMA engine, PCI Express interface, Gbit Ethernet and local I/O. The system-on-a-chip implementation offers power/thermal reliability and lifecycle advantages not typically found in alternative architectures. The MVME7100 also supports packages for VxWorks and Linux. The MVME7100 will be available in July 2008 with prices starting at $5,495.

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

VPX SBC Serves Up Dual 2 GHz PA Semi CPUs

High compute density is top priority for a variety of today's advanced military programs. This year will probably see many compute-intensive offerings in the VPX-REDI form factor. An early offering along such lines is Extreme Engineering's XPedite8070, a high-performance 3U VPX-REDI single board computer that is ideal for ruggedized systems requiring high-bandwidth processing and low power consumption. With two PA Semi PA6T cores running at up to 2.0 GHz while dissipating less than 17W, the PA6T-1682 delivers optimum performance per watt. The PA Semi PA6T-1682 PWRficient integrated platform processor combines dual PA6T cores and high-performance communication with two DDR2 SDRAM channels and a plethora of network interfaces.

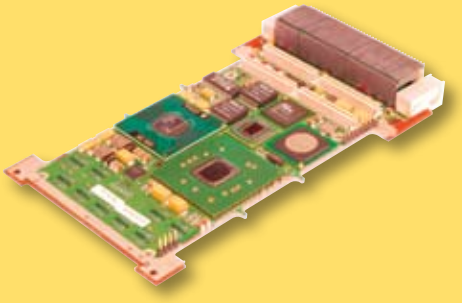


XPedite8070 supports two separate channels of up to 1 Gbyte each of 400 MHz DDR2 ECC SDRAM, as well as up to 1 Gbyte of NAND Flash. XPedite8070 provides the option of utilizing PCI Express, 10 Gigabit Ethernet XAUI and Gigabit Ethernet P1 interconnects. XPedite8070 also supports dual Gigabit Ethernet, GPIO, I2C, PMC I/O, XMC I/O, and dual RS-232/RS-422 ports out the P2 connector. To the system designer, XPedite8070 provides a feature-rich solution to support the next generation of rugged embedded applications. Both a VxWorks Board Support Package (BSP) and a Linux 2.6 LSP are available. Single quantity pricing for XPedite8070 starts at $7,800 with large program/OEM pricing closer to $5,000, depending on volume, memory and processor configurations. The XPand1000 development chassis is available for $2,000.

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

3U VPX SBC Boasts Core 2 Duo and Server-Class Memory

Memory architectures that used to take up a room full of servers are now possible on a single 3U VPX card. Along those lines, GE Fanuc Intelligent Platforms offers its VPXcel3 SBC320, 3U VPX SBC featuring Core2 Duo processing technology combined with a server-class memory controller. Available in five air- and conduction-cooled ruggedization levels, the SBC320 is designed for demanding space-constrained embedded computing applications where leading-edge processing capability is coupled with low heat dissipation.

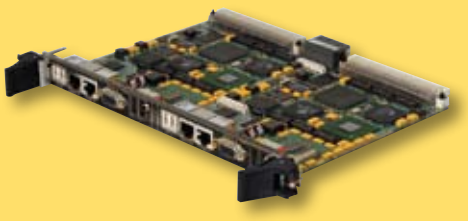


At the heart of the SBC320 is an Intel Core2 Duo L7400 low-voltage processor running at 1.5 GHz. Up to 2 Gbytes of DDR2 SDRAM with ECC are supported, with 128 Mbytes of user flash memory. Two 4-lane PCI Express ports running at 2.5 GHz to the backplane support the high levels of system throughput enabled by the serial switched fabric VPX architecture, while maximum connectivity is delivered via two USB 2.0 ports, two SATA 150 ports, two 10/100/1000BaseT Gigabit Ethernet ports, two UART (RS232) ports and a PCI-X-compliant PMC site. The Intel 3100 chipset combines server-class memory and I/O controller functions into a single component, creating the first integrated Intel chipset specifically optimized for demanding embedded applications. Covers for the SBC320 are optionally available to allow 2-level maintenance. Comprehensive operating system (Linux, VxWorks and Windows) and deployed test software (BIT, BCS) support is provided.

GE Fanuc Embedded Systems
Charlottesville, VA.
(800) 368-2738.
[www.gefanucembedded.com].

VXS Card Works Like Two Boards in One

Redundant computing nodes are vital for many mission-critical defense applications. That used to mean two or more separate boards, taking up extra backplane slots. General Micro Systems offers a way to do that using just a single board. A VXS 4.3-based processor board, the new V469 Patriot, replaces anywhere from two to four VME boards. This 6U board is a true dual-processor architecture, with each processor sharing absolutely nothing with the other processor, as if they were in two different VME slots.



The two processors are linked together with the Gigabit Ethernet or may be linked via VITA 41.3 VXS, thus providing a massive server density unlike any other technology. To provide even more processing muscle at lower power, the new dual core processors will be used to provide quad-processing capabilities. The V469 utilizes two of the new M-760 Pentium M processors, each operating at 2.0 GHz with 2 Mbytes of L2 Cache and 533 MHz FSB. The V469 provides up to 8 Gbytes of 266 MHz RDDR memory with ECC. Standard I/O functions on each side of the Patriot include: dual Gigabit Ethernet ports with Copper or Fibre interface, 2 Gbit, full duplex Fibre Channel with 2 Mbytes of SRAM buffer and Flash BIOS to support Boot capabilities, quad USB 2.0, dual Serial ports, XVGA Video and UDMA IDE interface. An optional I/O interface module allows one Compact Flash and one USB 2.0 device to be added to each side. Pricing for the 4 Gbyte V469 Patriot starts at $4,700 (100s).

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

VME64x/2eSST Board Sports 1.7 GHz PowerPC

VME and the PowerPC processor architecture together form the heart of today's installed base of military embedded computer systems. Supporting that tradition, Interface Concept has rolled out a new VME SBC based around the Freescale 1.7 GHz MPC7448 PowerPC. This low-power PowerPC design provides 1 Gbyte of SDRAM-DDR with ECC. Both fast NOR and large NAND flash memories are implemented on board.

The IC-e6-VMEa runs as a system controller or a standard single-slot board. An automatic detection can be used with the VME64x backplane. The VMEbus interface is based on a combination of the Tundra Tsi148 VME bridge and the latest generation of Texas Instruments transceivers. The 2eSST bus protocol capabilities provide up to 300 Mbyte/s transfer rates across the VMEbus. The board supports three Gbit Ethernet channels, one console port and one USB 2.0 controller. A quad UART provides four additional asynchronous channels available on the P2 connector. The 64-bit PCI/PCI-X bridge allows the VME SBC to control two PMC mezzanine boards with the PnIO routed according to the VITA 35. Thanks to its SATA controller, the IC-e6-VMEa can manage directly four storage devices. The IC-e6-VMEa board can operate from -40° to 75°C. The conduction-cooled version runs at 1.4 GHz. Prices start at $4,800.

Interface Concept
Briec de l'Odet, France.
+33 (0)2 98 57 30 30.
[www.interfaceconcept.com].

Server-Class VME SBC Has Twin Dual-Core CPUs

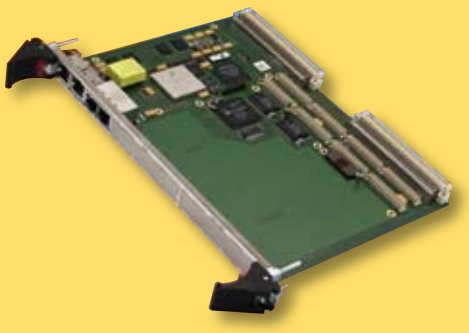
The trend toward multicore processors is sweeping across the computing world, and the embedded computing market is riding that wave. The military's desire to pack in as much compute density as possible couldn't be happier with this technology direction. The first server-class, manageable, 6U single-slot VME SBC that features a dual-core processor and board management controller has just doubled its processing power. The PENTXM4 from Kontron (formerly Thales Computers) has two dual-core Intel 1.67 GHz Xeon ULV processors, compared to the company's PENTXM2 board, introduced last year. It comes with the Intel E7520 server-class memory controller hub, 2 Gbytes of DDR2-400 SDRAM and an onboard 4 Gbyte flash disk drive, and is targeted toward symmetrical processing systems.

The board's VITA 38 intelligent platform management interface (IPMI) feature provides for easy scaling into a multiprocessing system. Interfaces include a dual SATA-150 port, a triple USB 2.0 port and EIDE. The PENTXM4 runs Red Hat Linux and features an extensible firmware interface (EFI) BIOS/firmware that boots Linux 2.6, VxWorks, LynxOS, Microsoft Windows and Red Hat Linux Enterprise.

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

2eSST, 6U VME SBC Boasts 320 Mbyte/s Transfers

The wide and broad installed base that VME enjoys in the military continues to drive demand for compatibility with legacy VME implementation. With that in mind, MEN Micro offers a new 2eSST, 6U VME SBC that reaches a data transfer rate of up to 320 Mbytes/s using a Tundra TSI148 bridge controller. Built around Freescale's new PowerQUICC-III PowerPC MPC8548 consisting of a highly integrated e500 core with an FPU and MMU as well as L2 cache support, the new A17 provides clock frequencies of up to 1.5 GHz. The board's advanced technology offers exceptional performance levels while maintaining backward compatibility with older standards, such as VME64X and VME.



The soldered 2 Gbytes of fast ECC-controlled DDR2 SDRAM memory firmly withstands shock and vibration. The flash disk for program storage is also soldered, and the fast, non-volatile FRAM. The A17's front panel has two Gbit Ethernet and two COM interfaces accessible via an RJ45 connection. Two additional Gbit Ethernet channels are available at the optional P0 rear connector. The board offers two PMC slots that operate at up to 64-bit/66 MHz. One of the mezzanine slots supports rear I/O and can be used for XMC modules with a PCI Express x1, x2, x4 or x8 link. The second PMC-only slot, connected to the onboard FPGA, can also be used for individual additional functions implemented in the FPGA. The SBC operates over an extended temperature range of -40° to +85°C (-40° to +185°F). Pricing for the A17 starts at $2,397.

MEN Micro
Ambler, PA.
(215) 542-9575.
[www.men.de].

VXS Board Sports Two Dual-Core Intel Xeons

The range of VXS products available indicates a rich ecosystem developing around the architecture. Among Mercury's VXS offerings is the VX6-200R/C VXS SBC based on dual dual-core Intel Xeon processors. The architecture supports 4-way symmetric multiprocessing (SMP), which provides significant performance advantages for compute-intensive applications, while requiring minimal software porting. The VX6-200C model provides the same state-of-the art levels of performance in a conduction-cooled format. The board features an Intel E7520 Memory Controller Hub, and dual DDR-400 memory interfaces access up to 4 Gbytes of memory. 4 Gbit Ethernet ports are standard. The VX6-200R/C supports optional SVGA video with onboard ATI RAGE Mobility M graphics chip (air-cooled version) along with RS-232 serial I/O high-speed serial ATA-150 (SATA).

The VPA-200's high-speed backplane interface brings VXS performance using RapidIO as the fabric connection. The VPA-200 has the bandwidth for distributed computing and data acquisition applications that require fabric connectivity. The VX6-200R/C also supports new and traditional I/O cards, including: IEEE 1386/1386.1 64-bit PCI mezzanine cards (PMC-X) and the latest VITA 42.3 switched mezzanine cards (XMC) with PCI Express in one single-wide PMC-X/XMC site. The VX6-200R/C is available in air- and conduction-cooled versions.

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

6U VME SBC Sports 2.16 GHz Core 2 Duo-CPU

Dual-core microprocessors have moved beyond just being exotic niche technology and are now firmly in the mainstream. Targeting military programs in need of refreshing their VME SBC technology, Themis Computer offers its TC2D64 high-performance, low-power VME SBC. Themis' TC2D64 is designed for a wide range of commercial and military applications in challenging environments—up to 30G shock at 20 ms.

The TC2D64 is based on the low-power Intel Core 2 Duo processor clocked up to 2.16 GHz, and Intel's 7520 chipset used in high-performance Xeon servers. The TC2D64 memory is expandable to 4 Gbytes of DDRII-400 memory. TC2D64's memory modules feature a screw down design to withstand high shock and vibration. The TC2D64 has extensive I/O including two Gbit Ethernet ports, a SATA port and two USB 2.0 ports. I/O expansion is provided by an onboard 64 bit/66 MHz PMC slot along with a PCI Express connector to a new, optional XMC expansion board with two XMC slots for either PMC modules or new PCI Express XMC modules. With the XMC expansion board, the expanded I/O configuration also provides AC97 audio, a third Gigabit Ethernet port and two multiprotocol serial ports. A TC2D64 configuration is also available with an optional three-slot PMC carrier card.

Themis Computer, Fremont, CA. (510) 252-0870. [www.themis.com].

Products

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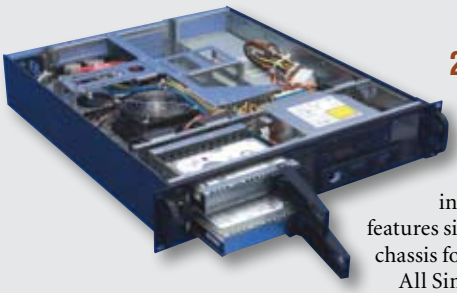
www.cotsjournalonline.com/getconnected



20-Inch 2U Chassis for Trenton 32 Gbyte Boards

The days when military system developers did everything themselves are long gone. They'd much rather find building blocks to piece together the solution the need, as long as they meet the program requirements. Single Board Systems (SBS), a division of DXL Enterprises, now provides 2U MIL/COTS chassis designed for secure installation of Trenton Technology's 32 Gbyte SHBs (system host boards) in 19-inch racks. Built in adherence with PICMG 1.3 / SHB Express industry standards, the SBS214 chassis is only 20 inches deep, and features six fans, a power supply, CD/DVD and floppy drives, and other standard peripheral hardware in a slim 2U chassis for vertical or horizontal mounting in space-constrained shipboard applications.

All Single Board Systems SBS214 chassis are provided complete with Trenton extended memory (32 Gbyte) SHB cards built to customer specifications to provide the best fit for server-class or graphics-class for PICMG 1.3 applications. Each SBS214 chassis features three 80 mm, 34CFM removable system fans, one 60 mm, 20 CFM exhaust fan, and two 60 mm, 20 CFM memory cooling fans. A 500W power supply is supplied standard and redundant power is available optionally. In addition to the CD/DVD and floppy drives, the chassis has three SATA hard drive removable carriers and two front mounted USBs.

DXL Enterprises, Mahwah, NJ. (202) 891-8718. [www.dxl.com].

1.8-Inch Micro-SATA SSDs Target Rugged Laptops

The military much prefers solid state drives over rotating disks. SSD are not only inherently more rugged, they also are much easier to erase secure data from when needed. Super Talent Technology has released a new line of 1.8-inch Micro-SATA SSDs. 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). Prices range from $299 to $679 depending on capacity.

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

Rugged Embedded PCs Provide Three GbE Links

Low-power computing has become a much sought after requirement in the military, and heat dissipation becomes an ever greater challenge. Feeding such needs, MPL has rolled out three new models of its PIP embedded PC family. The new products, called PIP11-E, PIP10-E and PIP9-E, are based on low-power Pentium-M or Celeron-M CPUs from Intel's Embedded program, which guarantees long-term availability. The CPUs are soldered on board and therefore offer the highest ruggedness and best reliability. Integrated on-board are numerous features like three independent Gbit Ethernet ports, four serial ports, multiple USB 2.0 ports and much more.

The rugged PCs are available with 512 Mbytes of ECC protected SDRAM memory soldered on board. A socket is available where additional ECC or standard DDR RAM modules of up to 1 Gbyte can be installed for a total of up to 1.5 Gbytes of RAM. The new models are extremely flexible and easy to expand over PC/104, PC/104-Plus, PMC or PCI. Further MPL offers various add-on options and several housings (MIL and open frame) for all needs. The PIPs are powered with a single power supply between 8 and 28 VDC—optionally up to 48 VDC for mobile applications.

MPL, Dättwil, Switzerland. +41 56 483 34 34. [www.mpl.ch].

PCIe XMC Card Sports ADCs, DACs and FPGAs

Thanks to the magic of chip and board level integration, the days when each and every sensor channel required a separate board are long gone. With that in mind, Innovative Integration offers the X3-Servo module that features 12 simultaneously sampling A/D and DACs with a user-programmable FPGA computing core. Low-latency SAR A/D and fast-settling DACs support real-time military servo control applications. The programmable input range and high input impedance allow interfacing directly to many sensors, while the output is capable of directly driving many transducers. Front panel digital I/O can also be used as PWM or process controls.

Clock and trigger controls include support for consistent servo loop timing, counted frames, software triggering and external triggering. The sample rate clock is either an external clock or onboard programmable PLL clock source. Data acquisition control, signal processing, buffering and system interface functions are implemented in a Xilinx Spartan3A FPGA, 1M gate device. Two 1Mx16 memories are used for data buffering and FPGA computing memory. The X3-Servo XMC board quantity one pricing is $2,995.

Innovative Integration, Simi Valley, CA. (805) 578-4261. [www.innovative-dsp.com].

Battery Family Serves UAV Power Back-Up Needs

UAVs need reliable back-up power in the event of catastrophic main engine failures. They require battery packs to power the UAV's recovery system that enables navigation and control systems to continue operating so the damaged craft can glide to a safe landing away from enemy territory. The power management solution must deliver high energy density and capacity while also offering the ability to withstand extreme environments. Reduced battery size and weight leave more room for the payload of sensors, cameras, communications equipment and so on. With all that in mind, Tadiran offers its TLM Series of high-power lithium batteries that are suited to serve as the battery packs that power emergency recovery systems on UAVs.

The TLM-1550HP high-power lithium AA-size batteries deliver 2W-hours of energy with an open circuit voltage of 4.0V and are capable of handling pulses of up to 15A, and 5A maximum continuous current at 3.2V. The batteries can be easily combined in series or parallel to create custom battery packs in virtually any shape or size. Smaller cells, including sub-1/2 AA and 2/3 AA sizes, are also available. TLM-1550HP cells provide up to 20 years of service life, and can be periodically tested, enabling system readiness to be confirmed without fully discharging the battery. These cells are safe, rugged, and capable of withstanding extreme temperatures from -40° to +85°C. The cells feature fast activation, with instantaneous voltage after prolonged storage. Moreover, no squibs are needed to start the battery and they require no thermal insulation.

Unlike reserve and thermal batteries, TLM-1550HP cells do not generate excessive amounts of heat, which saves space and reduces weight by minimizing mechanical and thermal design considerations. The cells feature a glass-to-metal hermetical seal instead of a crimped elastomer gasket. Aside from UAV applications, TLM-1550HP cells are also found in other military and aerospace applications, including rockets and missiles, smart ammunition, mines, jammers, unattended ground sensors, sonobuoys, listening devices, weapon sights, artillery fuses, trajectory correction add-on kits, proximity fuses for bombs, aircraft ejector seats, and in sensors for dispersed munitions.

Tadiran, Port Washington, NY. (516) 621-4980. [www.tadiranbat.com].

Rugged Box-Level System Targets Avionics

Stand-alone rugged box systems have entrenched themselves as a major product category in the military embedded marketplace. Kontron's latest offering along those lines is the Kontron MEC-PPC-AV1, a completely rugged Modular Embedded Computer (MEC) specifically targeted toward avionics applications. The Kontron MEC-PPC-AV1 is a low-cost 3U CompactPCI rugged subsystem designed to exceed requirements through its compact dimensions, low-power dissipation and real-time software with a very large I/O offering.

The Kontron MEC-PPC-AV1 is targeted toward the avionics market because of its ATR footprint dimensions, 28 VDC power supply, lightweight structure in aluminum, conduction-cooled dissipation, MIL-STD-1553 links, MIL-C-38999 connectors and a very low power consumption of less than 17W. The Kontron MEC-PPC-AV1 hosts a Kontron 3U CompactPCI Single-Slot PowerEngineC7 Embedded Computer, a low-power dissipation and high-performance processor board already embedded in major avionics programs. The PPC-AV1 offers a large range of I/Os such as Ethernet, general-purpose I/Os, serial lines and MIL-STD-1553 links thanks to the Kontron CPMC-1553-R PCI Mezzanine. The Kontron CPMC-1553-R is a redundant MIL-STD-1553B interface with two channels. The PMC module has a 32-bit, 33 MHz PCI interface and a parallel 8-bit TTL I/O port.

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

Frequency/Phase Converter Targets Mobile Military Apps

When it comes to power conditioning, the military system needs something that's lightweight and compact but with flexible capabilities. Along just those lines, Falcon Electric has introduced its new lightweight ED-FPC Series Frequency and Phase Converters that provide reliable computer-grade power for sensitive equipment. The new rackmount ED-FPC Series, ranging from 3 to 5 kVA, boasts a weight of less than 80 pounds and a compact 7-inch (4U) high rackmount form factor.

Due to its light weight and small size, the ED-FPC is an ideal COTS solution delivering computer-grade power for use in aircraft, ground-based and mobile systems, such as a HMMWV. Furthermore, to accommodate fixed, mobile and aircraft installations, the ED-FPC is designed to meet the shock and vibration requirements of RTCA/DO160, Zone A and the Munson Road Test. It has a three-phase input that accepts a wide 45-450 Hz input frequency range. Having a single-phase 120 VAC, 50, 60 or 400 Hz output, the ED-FPC eliminates phase imbalance problems associated with powering large single-phase equipment from a three-phase generator source. The ED-FPC also eliminates line-side voltage transients, surges, sags and frequency stability problems. Available now, the ED-FPC Series Frequency and Phase Converters list pricing starts at $16,450 for the 3kVA model.

Falcon Electric. Irwindale, CA.
(800) 842-6940. [www.falconups.com].

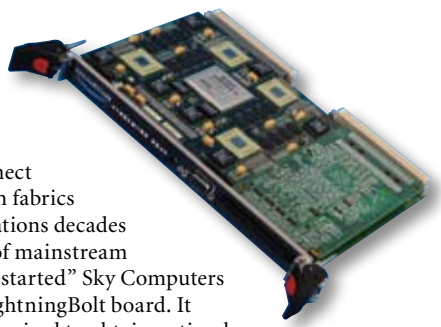
Software Radio PMC Offers Beamforming, Power Meter

Real-time software radio, beamforming, signal-intelligence and radar systems all have something in common. They're all hungry for an integrated solution—and that solution does conversion, processing and beamforming all the better. Pentek does exactly that with its Model 7152, a quad 200 MHz, 16-bit A/D digitizer with a 32-channel digital down converter (DDC) configured in a PMC format. The 7152 features 32 power meters that continuously measure the individual average power output of each of the 32 DDC channels. In addition, 32 threshold detectors automatically send an interrupt to the processor if the average power level of any DDC falls below or exceeds a programmable threshold.

The built-in power meters and threshold detectors offload these tasks from a downstream processor and present average power measurements for each channel in easy-to-read registers. A second set of new features makes the module ideal for beamforming applications. By adjusting the phase offset and weighting of the individual channels, followed by summation, the antenna can be "steered," rotating the azimuth angle to enhance receptivity in a particular direction. The 7152 PMC module is also available in a variety of additional form factors. The 7152 PMC module is priced at $14,500 for the hardware.

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

6U VME PowerPC Board Has SKY Channel Links



Sky Channel, along with a handful of other interconnect technologies, brought switch fabrics to high-end military applications decades before fabrics became part of mainstream computing. The recently "restarted" Sky Computers has rolled out its new 6U LightningBolt board. It provides all the resources required to obtain optimal performance from Sky's compute and I/O modules. It is configured with one compute module of four MPC7448 processors. Data is transferred throughout the LightningBolt over the SKYchannel Packet Bus at 320 Mbytes/s. Data moves transparently through the SKYchannel P2 interface to other boards in a SKYchannel chassis. System control is handled by the System Processor, which performs I/O and operating system tasks that would otherwise burden the compute processors.

A full VME64 interface provides communication to the host and other off-board communication. The application runs on the processors resident on the compute module. Front-panel I/O expansion modules may be added to the LightningBolt for maximum I/O performance. LightningBolt uses the 1.2 GHz PowerPC MPC7448 microprocessor and the ANSI/VITA standard SKYchannel interconnect fabric, delivering optimal computing and I/O performance. The new LightningBolt embedded computers are 100 percent compatible with Sky's previous SKYbolt family of products.

Sky Computers, Chelmsford, MA.
(978)-259-2420. [www.skycomputers.com].

MicroTCA Chassis Is Ripe for Military Comms

MicroTCA is starting to gain some traction among military system designers. Applications that are networking or communications based are first among those. With that in mind, Carlo Gavazzi Computing Solutions has launched its new 650 Series MicroTCA chassis. The 650 Series is engineered to be an economical connectivity solution. Thanks to an innovative power supply configuration, the 650 Series is available for half the cost of comparable products.

The 650 Series, offered in a 2U 19-inch rackmount configuration, features a single 6HP MicroTCA Carrier Hub and a 12-node backplane. The backplane supports a range of customizable configurations for full- and half-height Advanced Mezzanine Card (AMC) slots. Designed to include a low-cost power supply, the 650 Series offers a single fixed, rear-mount MicroTCA power controller. The forced evacuation and pressurization cooling design manages temperature with eight fans for up to 40W per AMC slot. The 650 Series MicroTCA chassis is available starting at $2,500.

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

300W/600W Power Supplies Give 300% Peak Power

Motors and pump subsystems are critical parts of a variety of military systems from vehicles to aircraft to ships. The power supplies for those systems need high peak currents. Feeding that need is Lambda's new series of 300W and 600W power supplies that deliver up to 300% peak output power. The AC-DC single-output HWS300P and HWS600P series are ideal for powering systems that demands high peak currents, ultra-reliability and extended field-life. Units are available in three nominal output voltages, including 24, 36 and 48V.

The HWS300P and HWS600P series accept a wide range of input voltages—from 85 VAC to 265 VAC—and comply with the SEMI F47 (with 200VAC line or higher). Remote on/off and DC good signals, and overvoltage/overcurrent protections, are standard. The power supplies have a high-quality internal fan and can be operated in a -10° to +70°C ambient. The 300- and 600-watt units come in a compact footprint—respectively 2.4 x 3.23 x 6.5 and 3.94 x 3.23 x 6.5 inches—making them suitable for mounting in a 2U rack. The new Lambda power supplies meet Class B EMI standards (radiated and conducted), are CE marked, and are safety-approved to UL/CSA/EN60950-1 and EN50178 specifications. The HWS300P and HWS600P series are available now, priced from $214 each in 100 unit quantities.

Lambda, San Diego, CA. (619) 575-4400. [www.lambdapower.com].

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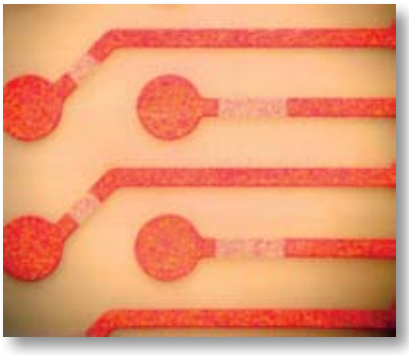

Trace Technology Shrinks Resistor Power, Footprint

Shrinking size, weight and power has become a top priority in a variety of military system designs. Attacking that issue at the board trace level, Ohmega Technologies has introduced its OhmegaPly Orbit product, a 10 ohm per square sheet resistivity thin film material. Orbit allows termination resistors to be built within traces and eliminates the requirement for designing a resistor footprint and placing them within the circuit layout. Orbit resistors can be placed on any circuit layer of a multilayer printed circuit board, but is especially suited for internal circuit layers. Orbit provides smaller resistor footprints and tighter finished resistor tolerances.

Orbit is processed like the other OhmegaPly products using conventional subtractive printed circuit equipment and techniques. Since the resistors are built within the trace, any board shop with the capability of building controlled impedance traces can build Orbit resistors. Orbit is offered at a 3 percent material tolerance. This allows finished resistor tolerances of 5-10 percent. This is critical since the ability to trim resistor elements of 5 mils and smaller widths becomes problematic. Orbit also has higher power dissipation than higher sheet resistivity products with power dissipation over 25 percent greater than OhmegaPly 25 ohm per square product. This is also crucial for the formation of very small resistor elements that can handle the rated power requirements.

Ohmega Technologies, Culver City, CA. (310)559-4400. [www.ohmega.com].

4-Channel, 32 MHz Wave Generators Feature Small Size

Applications such as radar and military software radios depend on complex wave generation to meet development and test needs. Highland Technology releases two new members of its T340 series of embedded complex waveform generators. Smaller than a paperback, the T346 and T344 feature four output channels capable of generating standard and arbitrary waveforms from microHz to 32 MHz, and four additional internal channels usable as modulation and summing sources. Channels can also be pulse/PWM and Gaussian noise sources, and can be summed with or modulate one another in any combination. Modulations include AM, FM, PM and PWM. Waveforms include sine, triangle, sawtooth, Gaussian noise and precision pulse/PWM outputs. The T344 version is a four-channel ARB without modulations.

Four additional waveform generators are provided internally as modulation/summing sources. Channel-channel modulation capability allows generation of sweeps, chirps, I/Q and constellations, and calibrated jitter, and simulation of a wide range of radar, communications, power, encoders, and electro-mechanical systems.

Highland Technology, San Francisco, CA. (415) 551-1700. [www.highlandtechnology.com].

Low-Power Atom CPU Climbs Aboard cPCI

It took a while for CompactPCI to stake out its place in defense applications, but now it's entrenched as a significant alternative in this market. A 3U CompactPCI SBC called the "CoolOne" (CC40x) from General Micro systems, is a conduction-cooled board with a typical operating power consumption of 3.5W/5W maximum. Because CoolOne is based on the Intel Atom processor, the board achieves low power in an exceptionally lightweight, conduction-cooled package.

The Atom processor operates at up to 1.6 GHz with 512 Kbytes of L2 Cache. With (up to) a 533 MHz front side bus, the board delivers as much as 1 Gbyte of 533 MHz DDR-2 SDRAM. Performance is further ensured by up to 16 Gbytes of bootable flash memory via CompactFlash, six USB 2.0 ports, two Serial ports with RS-232/422 support and two 8-bit Secure Digital I/O or MMC ports for custom I/O. CoolOne is available in a full rugged extended temperature (-40° to +85°C) version for critical environment applications. With its onboard heaters, CoolOne can operate at temperatures below -40°C. Pricing for the conduction-cooled version starts at $3,110 in quantity 100.

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

Scan Converter PMC Card Supports High Res Radar

Radar system development represents an extremely active segment of the military realm. Supporting that need, Curtiss-Wright Controls Embedded Computing, has announced the Eagle-2, a new high-resolution radar video scan-converter card. This compact PMC mezzanine module delivers enhanced scan conversion performance and support for high-resolution screen displays and eases the integration of advanced radar scan conversion functionality into VME, VPX and CompactPCI and PC-based systems. The Eagle-2 supports the simultaneous scan-conversion of multiple radar sources into PPI, A-Scan, or B-Scan formats at display resolutions up to 2560 x 1600, including 2048 x 2048 to address the growing demand for large-screen displays.

Eagle-2 delivers field-proven, high-performance radar scan conversion based on the industry-leading White-Powell algorithm. The card supports both forward and reverse scan-conversion to ensure that all single point targets are displayed and that no holes or spokes appear in the displayed image, even when zooming-in at long range. High-resolution (up to 2560x1600/2048x2048) and standard resolution (up to 1920 x 1200) versions are available. The card is available in both air-cooled L0 and L100 ruggedization levels. Pricing for the Eagle-2 starts at $10,200.

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

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Fax: (613) 599-7777 **Web:** www.cwcembedded.com

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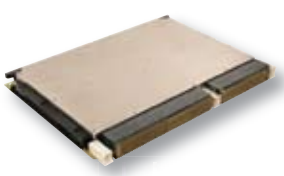
VPX NAS Network Attached Storage Card



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Phone: (602) 438-5720 **E-mail:** EmbeddedComputingSales@emerson.com
Web: www.EmersonNetworkPower.com/EmbeddedComputing

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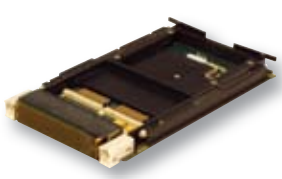

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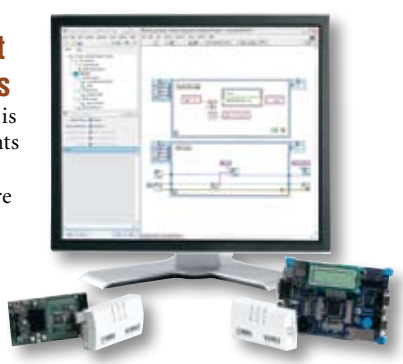
COM Express Module Targets Advanced Graphics

The COM Express form factor has come to dominate the "bus-less" embedded computer space, and military system designers are giving it a try. Adlink's latest COM Express board features the Intel Core 2 Duo processor and Intel GM965 chipset. Called the Express-MC800, this COM.0-compliant design enables high-end graphic tasks and computer-intensive applications. The Express-MC800 enables military system developers to run sophisticated applications, such as video processing, biometrics, and data analysis and visualization.

The Express-MC800 COM Express module offers the combination of the Intel Core2 Duo processor family (up to 2.2 GHz) and the Intel GM965 chipset with integrated X3100 GPU. The latter provides exceptional flexibility for embedded applications by offering the 32-bit 3D graphics engine of the X3100 GPU and a system bus of up to 800 MHz for up to 20 percent faster data transfer rates over the previous system bus generation. I/O options include support for five PCI Express x1 lanes, one PCI Express x16 lane, four PCI slots, one IDE port, three SATA ports and up to eight USB 2.0 ports. The Express-MC800 provides two SODIMM sockets for up to 4 Gbytes of 533/667 MHz DDR2 memory. The Express-MC800 can also be configured with the Intel Celeron M processor for low-power applications.

Adlink, Irvine, CA. (949) 423-2354. [www.adlinktech.com].

Graphical Development Tool Targets ARM Chips



The portable/mobile segment is one of the most dynamic segments of today's military system arena. The low-power ARM architecture is a favorite in that space. An extension of LabVIEW, the popular graphical system design platform from National Instruments, now directly targets the ARM 7, ARM 9 and Cortex-M3 microcontroller families. The module is the first product in an ongoing collaboration between the companies that combines the ease of use of LabVIEW with the performance of ARM microcontrollers.

Using the new module, engineers can create military embedded applications in LabVIEW and deploy them to more than 260 microcontrollers created from microprocessor IP licensed by ARM and manufactured by the world's leading semiconductor companies including Analog Devices, Atmel, Luminary Micro, NXP, Freescale Semiconductor, Intel and Texas Instruments. The LabVIEW Embedded Module for ARM Microcontrollers features LabVIEW drivers that make it possible for domain experts to graphically program all components of the ARM microcontroller including the analog and digital I/O. National Instruments offers a development kit that includes a choice of an MCB2370 evaluation board with an ARM 7 family-based NXP processor or a Stellaris LM3S8962 with a Cortex-M3 processor-based Luminary Micro processor. Pricing starts at $8,999.

National Instruments, Austin, TX. (800) 258-7022. [www.ni.com].

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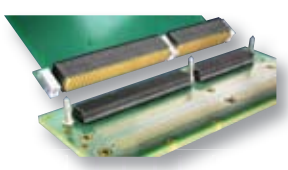

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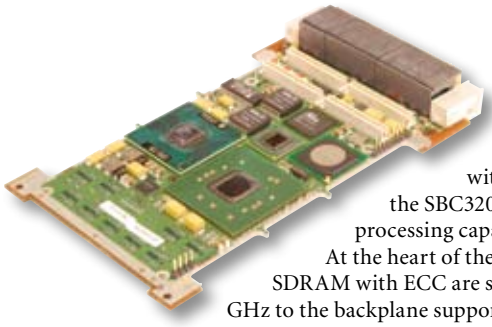


3U VPX SBC Suited for Space-Constrained Apps

Designed specifically with military needs in mind, the VPX form factor is rapidly carving out territory and mindshare among program decision makers. The SBC320 from GE Fanuc Intelligent Platforms is a 3U VPX single board computer that features Core2 Duo processing technology combined with a server-class memory controller. Available in five air- and conduction-cooled ruggedization levels, the SBC320 is designed for demanding space-constrained embedded computing applications where leading-edge processing capability is coupled with low heat dissipation.

At the heart of the SBC320 is an Intel Core2 Duo L7400 low-voltage processor running at 1.5 GHz. Up to 2 Gbytes of DDR2 SDRAM with ECC are supported along with 128 Mbytes of user flash memory. Two 4-lane PCI Express ports running at 2.5 GHz to the backplane support the high levels of system throughput enabled by the serial switched fabric VPX architecture, while maximum connectivity is delivered via two USB 2.0 ports, two SATA 150 ports, two 10/100/1000BaseT Gigabit Ethernet ports, two UART (RS232) ports and an XMC-compliant PMC site. Covers for the SBC320 are optionally available to allow 2-level maintenance.

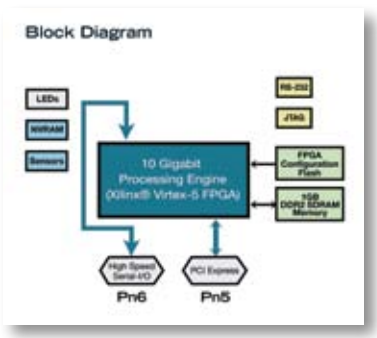
GE Fanuc Intelligent Platforms, Charlotteville, VA. (800) 368-2738. [www.gefanuc.com].

Atom Z500 COM Express Boasts "Micro" Form Factor

The Intel Atom line of processors has emerged quickly as the processor of choice for ultra-low-power embedded computing platforms, and military applications like small UAVs and mobile devices are expected to reap the rewards. Advantech's SOM-5775A is a COM Express module designed with the Intel Atom processor Z500 series that takes advantage of all the benefits of the Atom platform in the new COM Express "Micro" form factor. The Micro form factor performs the same functions as traditional COM Express modules but with a smaller board size of only 3.74 x 3.74 inch.

The Intel Atom Z500 series processor is not only a fraction of the size, the thermal design and 45 nm manufacturing process uses 10X less power (under 10W total) yet still provides great performance. SOM-5775 supports DDR2 memory up to 1 Gbyte, 10/100 Mbps Ethernet, 8 USB 2.0 ports and PCIe interface. In addition, the integrated graphic engine supports CRT and 24-bit LCD display modes. Advantech's System On Module (SOM) series is backwardly compatible with existing hardware and software systems. Advantech's own Secure and Unified Smart Interface (SUSI) API library speeds software development, and global logistics and support streamline the product development process.

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



Dual-channel 10 GbE XMC Ready for Rough Duties

The military has become sold on the idea of using Ethernet not only as network technology but also as fabric interconnect. The V1120 from AdvancedIO is the first in a family of conduction-cooled XMC products for 10GbE connectivity and packet processing that addresses emerging requirements for open-standard, extremely high-bandwidth networking and point-to-point connectivity in high-performance real-time systems in harsh environments. The card uses a Xilinx Virtex-5 FPGA to optimize its performance and provide the functionality and flexibility required by high-performance real-time processing and recording applications. To accommodate large line-rate bursts of incoming sensor data, the V1120 can buffer up to 115,000 jumbo-frame Ethernet packets in its onboard SDRAM memory. Additional interface signals are provided to facilitate precise time synchronization and other application-specific functionality that requires deterministic, low latency access to the packets.

The V1120 facilitates stable, rapid deployment of 10GbE technology into high-performance, real-time, sensor data flow applications such as signal intelligence, radar and high-speed record/playback. Boasting two 10GbE interfaces in a conduction-cooled package, the V1120 is designed for an extended temperature range of -40° to 85°C. Upcoming members of the V1100 family will address different rugged requirements and options.

Advanced IO Systems Vancouver, BC.
(604) 331-1600. [www.AdvancedIO.com].

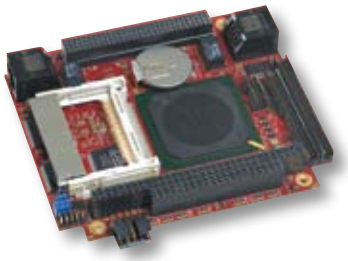
VME NAS RAID Blade Offers High Availability

As defense systems continue the trend toward greater reliance on computing and the need for denser storage, ACT/Technico's latest offering is a single-slot 6U network attached storage (NAS) blade that provides the same automatic, transparent data replication and re-sync of traditional box-level RAID storage modules in a more compact footprint. The VME RAIDStor provides network access for up to 18 slots (up to 1/2 Terabyte per slot) in a 19-inch chassis. The SATA-based VME RAIDStor is suitable for use throughout many industries in a number of high-availability, data-intensive applications including network-centric military environments.

The blade can be configured in a single-star topology where the VME RAIDStor is connected to one network, or in dual-star where two networks are present, providing completely redundant network paths as well as port failover services and enabled or disabled with a single command for continuous system availability. Dual PMC-mounted solid state flash SATA drives and an extended temperature range of -40° to +85°C enable the VME RAIDStor to operate effectively in rugged environments. A 1 GHz Freescale processor provides 512 Mbytes of DDR-ECC memory, 64 Mbytes of NOR-based flash memory and 128 Kbytes of SRAM. Pricing starts at $6,500 for air-cooled with rotating drives.

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

PC/104-Plus SBC Supports Fanless Operation



Fans aren't welcome in many defense applications. They represent a single point of failure that is too risky to accommodate. Using an efficient AMD LX 800 processor that provides very low power consumption without sacrificing performance, a new PC/104-Plus SBC achieves the benefits of fanless operation (no moving parts), soldered-on system memory and extended temperature operation (-40° to +85°C). The Cougar from VersaLogic delivers 800 MHz-equivalent performance while drawing less than 5W of power. Standard onboard features include 256 Mbytes of soldered-on SDRAM, dual 10/100 Ethernet, four USB 2.0 ports, IDE interface and three COM ports. A CompactFlash socket provides reliable, high-capacity onboard storage, with no moving parts. Flexible options for keyboard, mouse, external storage and other devices are provided via USB ports.

The board includes integrated SVGA and LVDS flat-panel support with MMX & 3DNow! for video-intensive applications. The PC/104-Plus interface supports both ISA and PCI add-on modules. Standard pass-through connectors allow the board to be used either above or below other PC/104 modules. It may also be used as a CPU module for a larger system by plugging it into a proprietary base board that includes specific user I/O circuitry. Pricing starts around $795 in OEM quantities.

VersaLogic, Eugene, OR. (541) 485-8675. [www.versalogic.com].

Tool Enables Reliable Real-Time Messaging

Lossy networks—those that have uncertain or sporadic connectivity—are common in a variety of applications, such as defense and unmanned vehicles. There is support for lossy networks in the RTI Data Distribution Service 4.3 rev from Real-Time Innovations. Most distributed systems today rely on messaging middleware that uses the Transmission Control Protocol (TCP) for inter-application and inter-node communication. TCP has characteristics that make it undesirable for use in real-time applications where the underlying network itself is not reliable. RTI provides a built-in transport that is Internet Protocol (IP)-based and employs the User Datagram Protocol (UDP). RTI also provides a completely tunable reliability model to optimize transport utilization over transient, high-delay, bandwidth-limited and lossy networks.

One of the many ways the RTI reliability model provides higher utilization of low bandwidth networks is that it allows the frequency of heartbeats and acknowledgements to be fine-tuned. The RTI reliability model is completely configurable, enabling developers to achieve the appropriate balance of determinism and reliability even in the presence of bandwidth-limited, high-latency and lossy transports. The use of UDP in conjunction with the RTI reliability model supports features not available with TCP, such as multicast, for extremely efficient data distribution. Group (OMG) Data Distribution Service for Real-Time Systems (DDS) is standard.

Real-Time Innovations, Sunnyvale, CA. (408) 990-7400. [www.rti.com].

COTS View

RoHS Two Years Later

Ensuring Reliability in Spite of RoHS and WEEE

The EU directives RoHS and WEEE opened up a host of challenges for the military market. There is a lot that suppliers of boards and systems to the defense market need to do to continue to meet the reliability demands in this new era of lead-free components.

Doug Patterson, VP Worldwide Sales and Marketing
Aitech Defense Systems

Now that the European Union's RoHS (Restriction of Hazardous Substances) and WEEE (Waste Electrical and Electronic Equipment) directives are in place, it's vital to understand the challenges involved in ensuring that boards and components meet the defense industry's stringent reliability standards. The relationship between using pure tin solders and component lead finishes (greater than 97% Sn (tin) and the occurrence of tin whiskers is well known and thoroughly documented. Figure 1 shows an example of the tin whiskering effect on an SOIC leadframe after three years of ambient storage. The challenge is to continue to produce high-reliability, mission-critical and defense-related products with a tin/lead (SnPb) manufacturing process while still ensuring the reliability of those products in the extreme application environments so commonly found in the military and aerospace markets.

In response to the EU's directives, many companies have conducted research over the past several years into the potential of offering a commercial-grade lead-free (Pb-free) product—without using pure tin—in compliance with WEEE and RoHS. Table 1 describes the three major Pb-free areas manufacturers should now be focusing on to provide reliable electronic boards and subsystems for critical embedded, defense and aerospace systems.

Looking toward the future, companies must monitor the several industry standards groups addressing the impact of Pb-free, including the Lead-Free Electronics in Aerospace Project (LEAP). This is an international working group and collation of high-reliability companies from the aerospace industry, along with AIA, ARINC, CALCE, DoD and the FAA. As new research becomes available, companies must evaluate and determine the applicability of new technologies to their products to ensure the continued delivery of the highest reliability products and technologies that their customers and warfighters deserve. ▮▮

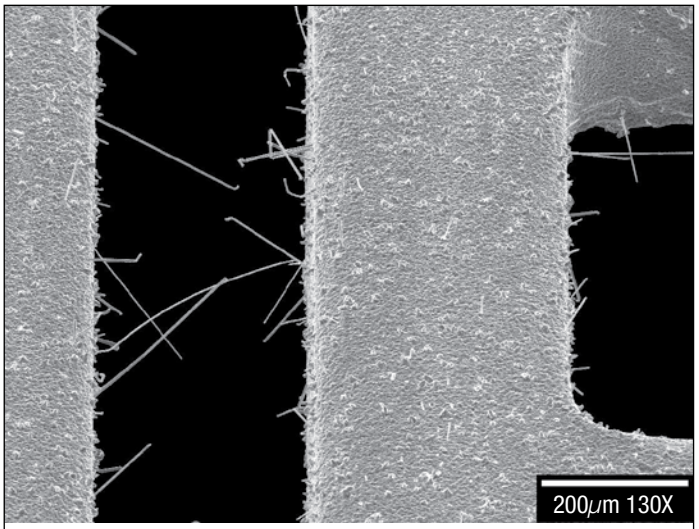


Figure 1

Shown here are tin whiskers growing on a matte tin-plated copper leadframe commonly used in the manufacture of 28-pin small outline integrated circuit (SOIC) leadframe after three years of ambient storage. (Photo Courtesy of State University New York at Buffalo).

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RoHS: What Board and Sub-System Suppliers to the Military Should Be Doing About It

Components

Work closely with component suppliers to create a controlled environment that ensures the proper usage and identification of SnPb and Pb-free components in engineering CAD and MRP parts databases.

Employ a comprehensive component obsolescence management system that tracks product and process change notices.

Conduct weekly obsolescence reviews, institute traceable mitigation practices and monitor at all manufacturing sites.

Work closely with purchasing personnel to control and prevent the potential flow of counterfeit components into the controlled work environment—from incoming inspection to the manufacturing floor.

Reliability

Institute an active solder joint reliability (SJR) program that assesses different technologies including the reliability of SnPb re-balled parts. Companies need to stay involved with industry activities that address the controlled introduction and mitigation practices of Pb-free in defense and aerospace applications. Areas of control include:

- Project Management
- Tin Whiskering
- Re-balling
- Solder Dipping
- New Solder Flux Cleaning Practices

Select Pb-free finishes have been used on numerous passive components over the past 10 years and have proven to be reliable. Therefore, proactive steps are needed to ensure that component lead finishes deemed incompatible with a SnPb manufacturing process are not utilized.

Manufacturing Process

Continually evaluate process changes needed to support SnPb and Pb-free finish PWBs (printed wire boards). This entails profile development for the reflow oven and process changes needed to clearly segregate and identify various levels of Pb-free products on the production floor.

Complex rework and second stage assembly as well as the rework processes must also be carefully monitored to determine which parts or processes must be altered, or added, to accommodate Pb-free manufacturing.

Table 1

Described here are the three major Pb-free areas manufacturers should now be focusing on to provide reliable electronic boards and subsystems for critical embedded, defense and aerospace systems.

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Coming Next Month

- *Military-Specific I/O.* Tried and true I/O schemes, such as MIL-STD-1553 and ARINC 429, remain popular for pure control applications. But they're bandwidth-limited by today's standards. A slew of multipurpose communications protocols provide options to suit emerging needs. Articles in this section compare today's crop of I/O schemes relevant to military users.
- *High-Performance Processor Boards.* Compute-density has become the watchword in many segments of military system design. More and more programs are pushing for as much computer processing muscle as can possibility fit into a board-level solution. Feeding such needs, embedded computer vendors are crafting single board computer products based on the newest crop of multicore microprocessors, along with interconnect technologies capable of keeping pace. The section examines the latest trends in high-performance SBCs in a variety of form factors, including VME, VPX, VXS, ATCA, Compact PCI, PrPMC and others.
- *USB and the PC as Military Test Platforms.* Fading fast are the days when complex military electronics systems required large racks on boards to implement test platforms for them. Now the same test functions can be done on the PC using USB, PCI Express data acquisition and test modules. This section looks at the boards and software solutions driving this trend.
- *Processor PMCs and XMCs.* Processors and memory face shorter life cycles than the rest of a system—like custom I/O, storage interfaces and comm links. Processor PMCs—and their newer fabric-based XMCs—accommodate that trend nicely, enabling military system integrators to swap out just the computing core and leave the base board unchanged. This Tech Focus section updates readers on these trends and provides a product album of representative PrPMC and PrXMC products.

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Editorial

Jeff Child, Editor-in-Chief

Who Cares What's Inside the Box?

Summer is the time of year when the *COTS Journal* staff—and the staffs of our sister publications—get together for our annual Summer Editorial Meeting. It's an important get-together because it's when we discuss, debate and plan out what topics we'll be concentrating on in the year ahead. This involves the tricky task of predicting what will be important in six to eighteen months from now. I'm always frankly more shocked that we're actually pretty spot on with our predictions than I would be if we were way off.

In the process of looking at the year ahead, one thing that struck me is the rising importance of the product category that I've coined the "stand-alone rugged box." In many ways it's moved to the center spot of the military embedded computing industry—the spot once held by single board computers (SBCs). I guess another way to say that is that rugged box systems have become a second center of gravity alongside SBC's center of gravity. Not too long ago, the SBC was sort of the driver of the military embedded computing market. The major vendors rolled out new SBC products—in VME, cPCI and other form factors—every couple months, and the peripheral, mezzanine and I/O products rode that wave, being sure to be compatible with whatever form factor or bus architecture the SBC vendors were supporting. That trend continues, but now integrated rugged box systems have started to move to the foreground as the indicator of where the industry is "at."

I came up with the term "stand-alone rugged box" because there wasn't really a consistent name associated with this new emerging trend. Another challenge is that they're available in a variety of shapes, sizes and capabilities. They typically comprise a set of modular embedded boards housed in a rugged enclosure that has its own power supply and interface ports to link to a variety of user terminals. This idea in the embedded computer market, offering a more complete system solution, is nothing new. In fact, the trend has been gaining momentum for almost a decade now—although mostly they were "custom" offerings for specific customers. The term "custom" gets a lot of leeway here, because in the military embedded computing market, some degree of customization has always gone on—whether you're talking about boards or system boxes. What's changed, however, is that in the past couple years the concept has really become a kind of staple in this market—although there are a handful of companies, Octagon Systems, Parvus, Quantum 3D, Rave Computer, RTD Embedded Technologies, that were doing this long before the traditional board vendors were.

Each month over the past couple years more embedded board vendors have joined this trend of adding stand-alone rugged box-level systems to their military market offerings. These are complete system boxes—which often support standard form factor boards inside them. Often the boards in the box are standards-based cards such as PC/104, PMC and 3U CompactPCI. But the enclosures by and large aren't in any industry standard footprint—although some standards groups have talked about defining such standards. Some vendors go a step beyond that and provide a complete, tested and enclosed computing solution that eliminates complex integration chores for their prime and sub-prime military customers.

Another twist on this rugged box trend is rugged box-level systems that offer complete environmental control including advanced cooling technologies. SprayCool has a product along those lines called the SprayCool 9-slot enclosure. And while it's not a complete stand-alone box itself, SprayCool has begun partnering with board vendors like Sky Computers and others to team up to provide a more integrated box-level solution. The SprayCool-9 is capable of accepting a wide range of card types within the same chassis, simplifying the technology refresh cycle.

With the importance of the rugged system box trend in mind, we've made sure that our coverage over the coming year gives the topic full justice. That doesn't mean we'll be slighting the board-level technologies. Board-level systems remain tremendously important—and active—especially in the areas of tech upgrades and tech refresh where board-level products shine. We'll be weaving together the "two centers of gravity" of our market that are SBCs and rugged box-level systems as we cover I/O technologies, processing trends, power supply challenges, cooling techniques and more.

Looking forward, as new military programs opt for complete box-level systems—and as some older programs shift from a slot-card scheme to a box-level implementation—I'm wondering if we'll eventually get to a point were military program decision makers start to not care what's in the box. Certainly, they'll always have functionality, reliability and maintainability requirements that the boxes must meet. But as to whether they'll care if it's VME, CompactPCI, PC/104 or PMCs inside? Well, that won't happen overnight, but the trend seems to be moving in that direction. ▮▮

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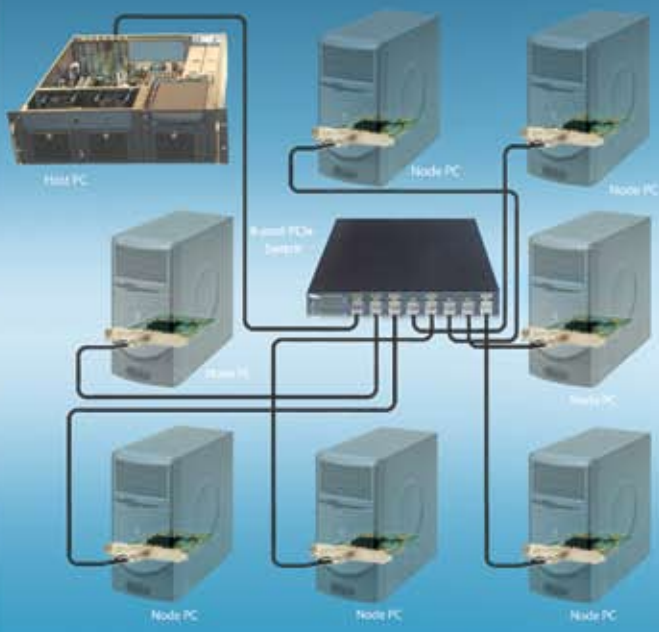

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