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VITA TECHNOLOGIES

SPRING 2013 / VOLUME 31 NUMBER 1

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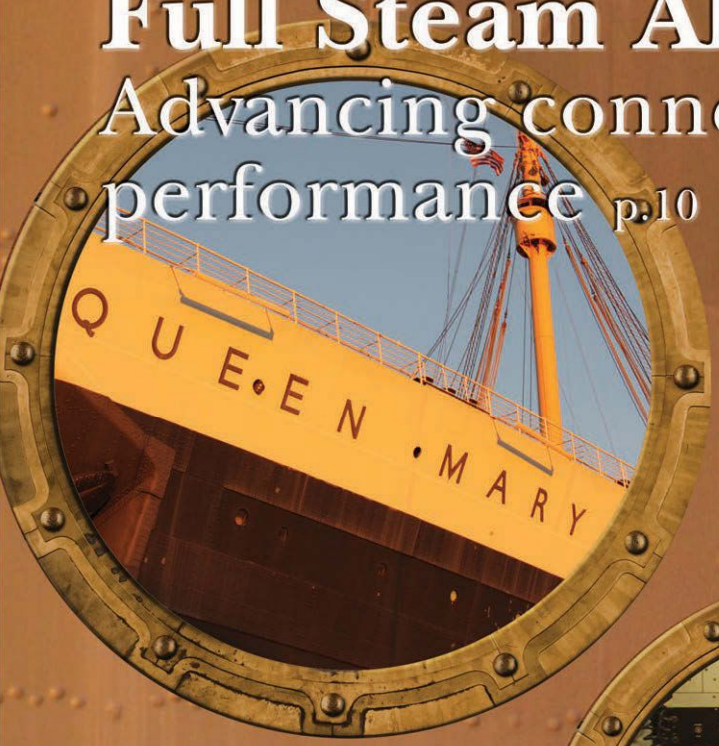
Full Steam Ahead: Advancing connector performance p.10



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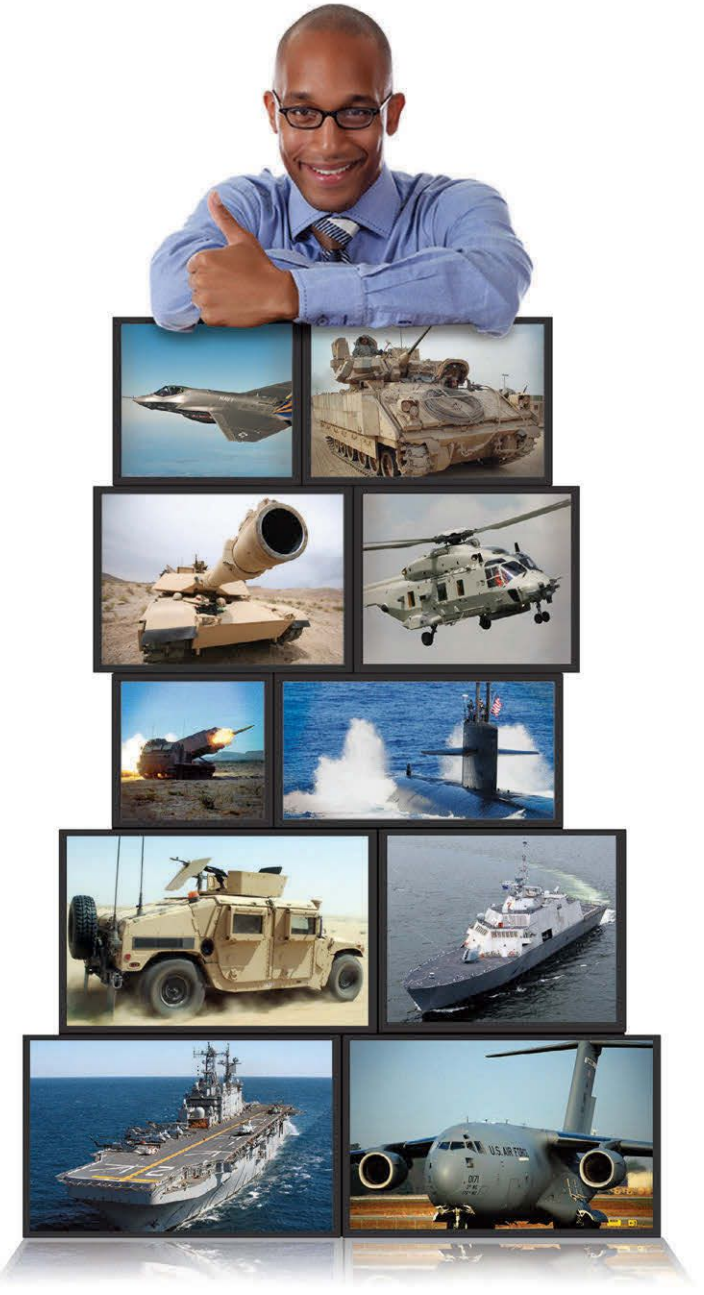

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Connect this: Analyzing connector trends, challenges, and solutions for advancing performance

By Jerry Gipper

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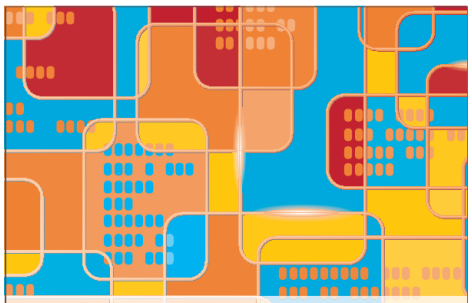

Operating systems running critical embedded systems

By Jerry Gipper

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Stacked up: Standardizing mezzanine modules

By Jerry Gipper

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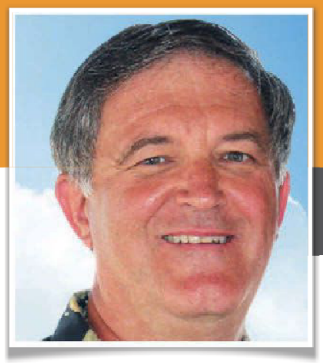
On the cover

At Embedded Tech Trends January 21-22, hosted by Editorial Director Jerry Gipper, 15 companies discussed embedded computing technology in action and the state of the industry aboard the Queen Mary in Long Beach, CA. VITA Technologies is kicking off 2013 with a look ahead at the future of critical embedded systems, including connector advances for performance, operating system developments, and mezzanine module standardization efforts. Photos by Jerry Gipper.

Advertiser Index



Editor's Foreword

By Jerry Gipper

@VitaTechnology jgipper@opensystemsmedia.com

Out and about

International CES

I started out the year with my annual trek to Las Vegas to attend the ultimate consumer electronics show, International CES. This event continues to grow, with this year's being the largest yet. In two full days, I was only able to work my way through about half of the 1.92 million square feet of exhibit space, visiting many of the more than 3,250 exhibitors at CES. Since the consumer space is the single largest influence on the electronics industry, it is always interesting to me to watch new trends emerging and study how consumer electronics impact VITA technologies.

"Connected" was the overriding theme as devices are becoming more intelligent and connected via Wi-Fi to home networks that then extend to the rest of the world. In home appliances, ZigBee is becoming the common local mesh with an outlet to Wi-Fi.

High-definition television technology is not holding still, moving up to 4K and 8K resolutions that might see some of their first implementations in embedded computing because the content for consumers is going to be a while in development. The obstacles to distribution and content development are greater than they were for the first generation of HD.

Communications networks are already struggling to keep up, so the added bandwidth demanded by higher-resolution video is going to require some major technology shifts. This bodes well for the bandwidth demand of critical embedded computing such as signal processing and high-performance computing that will benefit from bigger and faster data pipes.

Embedded Tech Trends

Yours truly hosted Embedded Tech Trends in January, where 15 leading companies of the embedded computing industry gathered with 13 editors and analysts to meet aboard the Queen Mary in Long Beach, CA. Industry thought leaders led discussions on a wide range of topics during the two-day event with the focus on "embedded computing technology in action."

Topics covered during the two-day event included analysts' viewpoints of the industry, government research programs, solid state drives, FPGA technology, Size, Weight, and Power (SWaP), test instrument architectures, High-Performance Embedded Computing (HPEC), signal and image processing, the Intel Intelligent Systems Framework (ISF), and embedded technologies in action. Each topic included presentations from the sponsors followed by questions from the media.

Bob Hult, Bishop & Associates, presented market data from the connector industry's perspective. Developing trends in the connector markets are an early indicator to the board and system suppliers as to what direction they can expect their markets to go. Bob is seeing an increasing need for support of higher data rates and interest in fiber optic connectors, supporting the notion that optical interconnections are on the cusp of having a major impact on the industry.

The liveliest debate of Embedded Tech Trends was during the presentation on the Intel ISF by RJ McLaren of Kontron. This new initiative from Intel defines a set of interoperable solutions designed to address connecting, managing, and securing devices in a consistent and scalable manner. It is still unclear to me what this actually means and you could tell from the questions, there is still much to learn.

SWaP was a major topic of discussion as the suppliers struggle to optimize these parameters of computing systems while still delivering on high performance. HPEC and signal processing presentations highlighted the advances being made that enable smaller and faster computing platforms. Supplies are addressing both small form factor products on one end of the spectrum and HPEC computers using VPX and AdvancedTCA on the other end. With the switch fabric architectures used in the HPEC computers, it is amazing to see the levels of performance that can be delivered by today's computing technology.

In general, the sponsors were cautiously optimistic about growth for 2013. Since government defense spending heavily influences the industry, they are closely monitoring the budget discussions around the world to see which direction spending will go. They all realize that at best, it will be slowed down so there is an intense desire to seek out new applications for their technology.

All of the material presented at this year's event has been posted on the VITA website (www.vita.com). This is a very intense two-day event, so be sure to put Embedded Tech Trends on your calendar for 2014 to help you stay on top of the latest trends in the industry.

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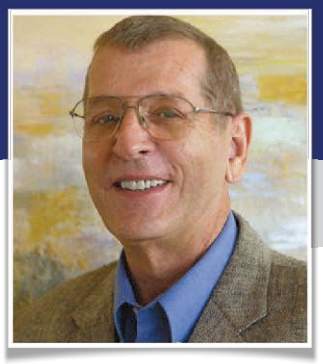

VITA News

By Ray Alderman

exec@vita.com

The changing landscape of 2013

2012 is behind us, and it was bumpy for our industry in the last two quarters. In reaction to market conditions, a number of embedded companies reduced their headcounts. Decreased demand in many markets due to a number of factors make for uncertain times ahead, but some new prospects have shifted into focus.

Industrial

The business conditions in the industrial board markets deteriorated in 2012, particularly in Europe. Demand for manufacturing systems and upgrades are on hold, awaiting clarity on the world economic environment. Gross World Product (GWP) growth declined to an estimated 3 percent last year, after being near 4 percent in previous years. While this reduction in world demand for consumer products surely contributed to the decline in the demand for industrial systems, there's another element to consider: We have become very efficient at manufacturing around the globe. We have automated our factories with advanced computing technology to the extent that capacity now exceeds market requirements. The future in the industrial markets will be focused on making those systems even more efficient.

Telecom

The amount of data going through the telecom networks continues to increase at dramatic rates. That means that telecom service providers must install more equipment to handle the data volumes. The remaining telecom board vendors had a tough year in 2012, so where did that new equipment come from? Probably Taiwan and China, in the guise of commodity PC-based boards and systems. Smartphone sales are increasing dramatically, further increasing the data going through the networks. Telecom board vendors must drive down their costs to remain in this market, or develop newer capabilities like boards that can do deep-packet inspection or other functions that commodity boards don't have the horsepower to accomplish. Telecom will be the toughest market for board vendors in 2013.

Medical

The medical equipment markets have moved to China and India in the past few years. The U.S. and Europe have already outfitted their hospitals and clinics with adequate diagnostic capabilities, but undeveloped nations are nowhere near the saturation point. New Obamacare taxes on medical equipment sales in the U.S. will depress demand here until the capabilities of the new equipment designs offer a significant economic reason to buy.

Figure 1 | Ray Alderman launched Embedded Tech Trends in January with his thoughts on the state of the industry for critical embedded systems.

Military

Even with the "fiscal cliff" deal in congress, the MIL markets remain deeply uncertain about budgets for 2013. We won't know which programs will be cut and which will be funded and at what level until March. But the best bets are in Unmanned Aerial Vehicles (UAVs), intelligence systems (SIGINT, RADAR, SONAR, Electronic Warfare, Communications Intelligence), and upgrades to existing platforms.

Shifting gears

There are two technology shifts that may offer opportunities to all the basic board markets. First is the shift away from PC-based processors (Intel) to cellphone-based processors (ARM). The Android operating system and the low cost (and great performance) of the ARM chips offer a compelling reason to move away from PC-based technologies, especially on small form factor and motherboard products in industrial and military markets (in low-level applications).

The second shift is the incredible advancements in sensor technology. Just recently, a new sensor capable of detecting certain molecules in the air at concentrations of a few Parts Per Billion (PPB) was announced. We have advanced image sensors that have amazing resolution both in the normal light spectrum and infrared. These new technologies have great benefits to many industrial and military applications.

So, in spite of the uncertainty present in our markets, there are opportunities to explore. I would bet on the sensor advancements as the next big market driver for 2013 and beyond.

VITA Standards Organization

Open Standards, Open Markets

Editor's note: This update is based on the January VSO meeting. Upcoming meetings are held bi-monthly through 2013. Visit the VITA website (www.vita.com) for details on upcoming VSO meetings.

VITA Standards Update

By Jerry Gipper

jgipper@opensystemsmedia.com

VITA Standards Organization gets onboard: VITA 46.0, 46.1 complete five-year review; several new developments underway

For current VITA specifications: opsy.st/vitaspecifications

VSO ANSI accreditation

Accredited as an Standards Development Organization (SDO) by ANSI, the VITA Standards Organization (VSO) meets every two months to address embedded bus and board industry standards issues.

VSO study and working group activities

Standards within the VSO may be initiated by a study group and developed by a working group. A study group requires the sponsorship of one VITA member, and a working group requires sponsorship of at least three VITA members.

VITA 38: Intelligent Platform Management Interface (IPMI) with VME

Objective: This specification is based on the PICMG 2.9 System Management specification and describes the additional requirements for implementing IPMI in a VME system. IPMI describes a hardware independent interface between chassis sensors and the operating system. IPMI is particularly useful for managing servers and High Availability systems.

Status: ANSI/VITA 38-2003 (R2008) is under public review to move to a stabilized maintenance status.

VITA 46.0, VPX Base Specification

Objective: Commonly known as VPX, this specification family defines entirely new high-speed connectors in part to carry mappings for popular switched serial fabrics including Gigabit Ethernet, PCI Express, Serial RapidIO, InfiniBand, and Aurora. It also defines a new increased power envelope including a 48 V profile and additional cooling methods.

The base standard does not address the possible serial fabric configurations available in systems, which utilize the standard.

Status: ANSI/VITA 46.0-2007 completed its five-year review. Revisions have been made and comments close in January.

VITA 46.1, VPX: VMEbus Signal Mapping

Objective: This specification supplements the VITA 46 base specification with the definition for the VMEbus signals as mapped to a VITA 46 connector.

Status: ANSI/VITA 46.1-2007 completed its five-year review. The current specification was reaffirmed and submitted to ANSI on 1/8/2013.

VITA 46.6, VPX: Gigabit Ethernet Control Plane Signal Mapping

Objective: This specification supplements the VITA 46 base specification with the definition for the Gigabit Ethernet signals as mapped to a VITA 46 connector.

Status: VITA 46.6 is a new specification. Public review closed in January.

VITA 58.1, Line Replaceable Integrated Electronics Chassis Draft Standard, Liquid-cooled Chassis

Objective: The intent of this standard is to provide a line replaceable chassis, which accommodates VITA 46, VITA 48, and IEEE 1101 format plug-in boards. It also provides an upgrade path for older ARINC 404A, ARINC 600 applications. The modularity of the LRU sizing is based on those standards while adapting them to the VITA/IEEE board formats. The VITA 58 family of specifications is intended to address variations in envelope, cooling method, connectors, coolant couplings, and, in general, mechanical and electrical interface requirements. It is arranged as follows:

VITA 58.0 General specification for Line Replaceable Integrated Electronics Chassis

VITA 58.1 Liquid-flow-through-cooled enclosure

Status: VITA 58.1 is a new specification. Public review closed in January.

ANSI/VITA 66.2, VPX: Optical Interconnect On VPX - ARINC 801

Objective: The objective of this standard is to define an optical interconnect using the ARINC 801-style contact for use in VITA 46 plug-in modules and backplanes.

Status: VITA 66.2 is a new specification. Balloting has closed and public review comments are under consideration.

Copies of all specifications reaching ANSI recognition are available from the VITA website. For a list of current VITA specs and their status, go to: www.vita.com/home/Specification/Specifications.html.

ESMexpress (VITA 59: RSE) brings new life to cost-effective COMs

By Barbara Schmitz

Although based on a concept that has been around for several decades, Computers-On-Modules (COMs) have lacked the robustness and standardization since their inception that would enable wide proliferation of these cost-effective computing modules into embedded systems.

With no set standard for design, pin-out, component compatibility or technological upgrades, and several manufacturers developing their own "secret sauce" to implement them, COMs never provided the intended commonality and lowered development costs among board manufacturers. Nor did they initially possess the structure to withstand rugged environments, which are becoming more commonplace in a wide variety of embedded computing applications.

First steps to mass deployment

The COM concept incorporates a complete computer on a mezzanine card with a CPU board that requires customization only on the carrier board as a standard feature. It was initially developed to provide "standard" time- and cost-saving benefits.

Yet, with no committee really steering the ship when COMs were first developed, each manufacturer seemed to be making customized solutions that really did not fit in with other available designs. In fact, some reports claim there are more than 50 "standard" COM designs among embedded computing manufacturers. The compatibility benefits were never fully realized, but the concept itself was a good one.

Additionally, the initial COM concept contended with some common industry design problems, most notably heat generation and lack of ruggedization. As embedded technology made its way into an increasing number of mobile, rugged, and harsh environments, COMs needed an update in order to be used effectively in the growing embedded arena.

Initiated in 2008, the ESMexpress standard, known as VITA 59: Rugged System-on-module Express (RSE), began the process of bringing all COM design elements under one umbrella to enable true realization of the concept's compatibility features. ESMexpress utilizes the same 125 mm x 95 mm board size as the previous COM Express form factor.

Common industry design considerations are also a part of the new standard, currently slated for completion in 2013. The CPU roadmaps of different manufacturers – Intel and Freescale, for example – have been brought into account. And, with the reinstitution of VITA 59: RSE for completion this year, compatibility with COM Express has been added for even more flexibility in COM-based application development. For extremely compact situations, a subset concept has been developed as well: ESMini, measuring 95 mm x 55 mm. While not officially part of VITA 59: RSE, ESMini still provides the same rugged performance as the upcoming standard.

Considering the design environment

Both COM types are resistant against temperature, shock, vibration, and EMC influences and have to function reliably and according to the relevant standards in life-critical applications or applications that entail high costs in case of failure. These include applications in ground transport or airborne equipment, mobile computers of any kind in transportation, avionics or medical engineering, as well as outdoor computers and critical industrial control equipment.

On ESMexpress, the signals are led to two 120-pin connectors and exclusively defined for modern serial buses like PCI Express, Ethernet, SATA, USB, etc. The pin assignment is fixed without options in order to guarantee 100 percent interchangeability between the modules. This means that legacy I/O that might be required as well as additional modularity can be implemented using FPGAs on the carrier board.

For ESMini, both the form factor and the pin assignment is variable. Thanks to this flexibility, components with different sizes can be used, and additional individual I/O in the onboard FPGA can be realized beside the serial I/O.

The most important feature of ESMexpress and ESMini is the fanless cooling concept designed for a power dissipation of up to 35 W. The electronics are completely sealed in an aluminum enclosure. If the power dissipation of the COM requires additional cooling, the housing is either connected to an external heat transfer device (conduction) or combined with a heat sink for heat dissipation (convection). The dissipated heat can also be led from the cover via the frame to a carrier board that supports conduction cooling. At the same time, the closed aluminum enclosure offers optimum EMC protection. As the module is mounted on the carrier board, all six sides are hermetically sealed. The connector of both COMs, qualified for MIL and railway applications, supports differential signals with up to 8 GHz and is specified for -55 °C to +125 °C.

Standardization on the horizon

The cost-effectiveness and design simplicity of COMs is finally ready to be fully realized with the upcoming VITA standardization, as well as through the support of several industry manufacturers.

It is these types of innovations that will keep embedded computing at the forefront of the technology landscape, as more opportunities are created for companies to employ ruggedized, efficient, standardized computing concepts.

***Barbara Schmitz** is CMO at MEN Mikro Elektronik.*

Connect this: Analyzing connector trends, challenges, and solutions for advancing performance

By Jerry Gipper

Connectors drive many of the key decisions in standards used in open architecture embedded computing platforms as many types of connectors are used in a typical critical embedded system (such as backplane connectors, mezzanine connectors, I/O connectors, and specialty connectors). They also hold the key to realizing advancing system capabilities, and in this regard they have run into problems. This feature discusses the trends, challenges, and future of connectors for critical embedded systems.

At Embedded Tech Trends 2013, Marc Couture, director of product management at Mercury Systems, made this declaration: "We need to speed up without degradation. The connector is the key to unlocking speed!" Marc commented that current advances in connector and backplane technology will get the industry to 8 Gbaud and beyond, but that much more is needed from the connector suppliers for the next-generation fabric interconnects such as PCIe Gen 3, InfiniBand QDR, or 40 Gigabit Ethernet. Marc's thoughts are reflected throughout the industry as system designers struggle to find that perfect connector.

It is impossible to build a computing platform without connectors. Chips, boards, and systems simply need to be connected in some fashion (Figure 1). But, as Marc mentioned, the connector is the key to speed, and unfortunately they have struggled to keep up with the advancements in processor and chipset bandwidth.

According to Ken Fleck, Fleck Research, the worldwide production of connectors in 2012 was $40 billion. Bob Hult, Bishop & Associates, has a slightly higher number of $47 billion. Both saw a slight decline in sales from 2011 to 2012 of 4.1 percent and 2.6 percent respectively. Bob is forecasting 2013 to see a 4.2 percent growth to $49.1 billion while Ken is forecasting continued decline of 3.7 percent to $38.7 billion. Ken is basing his predictions on the continued sluggish economies around the world, the new U.S. tax on medical devices, and the cuts in U.S. defense spending that will impact demand in 2013.

Influences across industries

At the 2012 Fleck Connection Conference in December, Ken pointed out several industries and platforms that are creating the most demand and currently have the greatest influence on the connector industry (Table 1). VITA technology suppliers must follow the trends and technologies of these industries and platforms because they are driving the innovation and cost curve of connectors that may possibly have a place in future open architecture specifications. Fortunately, these industries have many of the same problems with connector technologies experienced by critical embedded systems. Consequently, the solutions for these industries can carry over to other industries and apply to critical embedded systems.

Challenges for connector suppliers

Several challenges are influencing the designs of next generation connectors. In separate presentations at the Fleck Connection Congress in December and

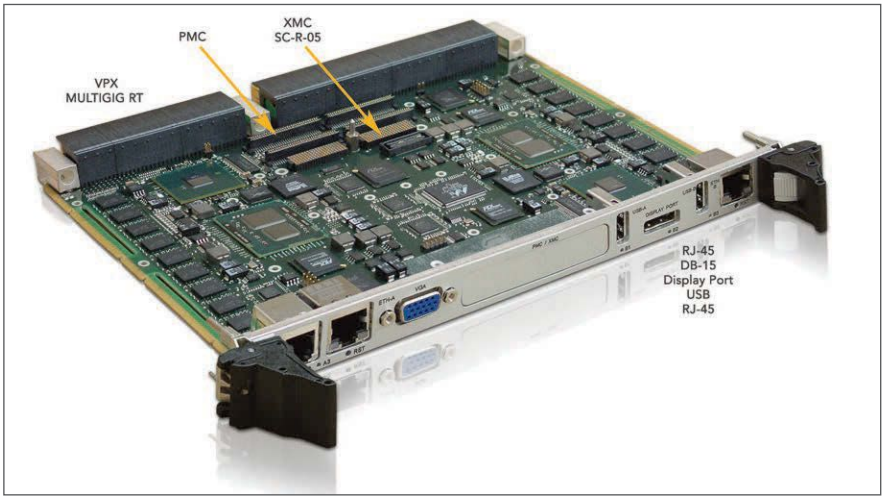

Figure 1 | A variety of connectors are on a typical board.

Embedded Tech Trends 2013, Fleck Research, Intersil, Bishop & Associates, and TE Connectivity discussed similar challenges to the connector industry (Table 2). All three agree that bandwidth is the single biggest concern for connector suppliers. Followed closely by demand for smaller and lighter connectors for increasingly mobile platforms. All of this while still cognizant of cost sensitivity.

Matthew McAlonis, development engineering manager at TE Connectivity, mentioned the connector needs for critical systems from the connector supplier perspective. He listed several needs that his design teams address during the development of connectors. Many of these needs directly address the challenges; for instance, optimizing the weight of connectors has a direct impact on the SWaP requirements faced by system architects (Figure 2). Though the gain may be small, it is very additive with the use of many connectors in a typical platform. A few grams here and there add up very quickly in a large system.

"The most important design concern for connectors in critical embedded computing is always electrical performance – this could be signal integrity in a high-data-rate connector or conductivity in a power connector," commented Greg Powers, market development manager at TE Connectivity. "The immediate secondary concern is mechanical performance in the environment, including shock, vibration, temperature, durability, etc. Connectors are truly electro-mechanical systems" (Figure 3).

- Provide Electrical Stability
- Meet Mechanical Envelope
- Error Proof
- Provide Manufacturable Solution
- Provide Mechanical Stability
- Provide Thermal Management
- Environmentally Sealed
- Safe to Use
- Provide Mating Assurance
- Meets Materials Compatibility Requirements

Figure 2 | Connector needs for critical systems.

Application	Developments
Medical electronics	Driven by electro surgical equipment, EKG, oxygen monitors, insulin pumps, CAT scan, ultrasound, MRI, and more.
Automotive electronics	Driving forces include smart connector modules utilized in seat controllers, power window lifters, sun roof openers, powered mirrors, climate control systems and door-locking systems, among others. Leading designs include CAN and MOST networks.
Solar power	Global Photovoltaic (PV) solar installations in 2012 increased by 39.3 percent. Deployment of solar systems will continue to grow and drive demand.
Wind power	The U.S. surpassed Germany last year as the world's number one wind-powered nation, with more than 25,000 megawatts in place. Wind could supply 20 percent of America's electricity needs by 2030, up from less than 1 percent now.
Next generation tanker	Boeing has clinched a fiercely contested contract to supply the U.S. Air Force with refueling aircraft, beating rival EADS, the European aerospace and defense company, to win the $35 billion prize. Over the life of the program, connectors and cable assemblies are projected to account for $2.430 billion.
Commercial aircraft	Commercial aircraft including wide body, narrow body, business jets, and regional aircraft accounted for $478 million in connectors and cable assemblies in 2011 with high growth forecasted to $863 million in 5 years. The Airbus 380 is projected to roll out more than 200 aircraft through 2019. The Boeing 787 is forecasted to produce 1,173 aircraft through 2019. Over the next 19 years, Airbus is expected to produce 25,850 aircraft and Boeing is expected to produce 30,900 aircraft.
4G/LTE and Base stations	LTE is destined to become the dominant wireless airlink providing downlink peak rates of 1,000 Mbps and uplink rate of 50 Mbps. Likewise, 142,000 new base stations were installed worldwide in 2011. LTE devices reached 67 million units in 2012 and are projected to reach $36 billion by 2015
Tablets and netbooks	Tablet sales increased 256 percent in 2011, reaching 72.7 million units.
Smart phones	Smartphone usage is projected to increase worldwide from 472 million units in 2011 to 981 million units by 2015.
Source: Fleck Research, Fleck Connection Congress 2012	

Table 1 | Industries and platforms influencing connector technology.

Fleck Research	Bishop & Associates	Intersil	TE Connectivity
• High bandwidth • High speed • Serial interconnects	• Increasing data rates • Increasing interest in fiber optics	Higher bandwidth	• High-speed migration • Footprint layouts
Fine pitch	SWaP	• Thinner and lighter • Reduced power	SWaP
	Cost sensitivity (COTS)	Reduced cost	
	Standards driven, e.g. VPX		Commercial-off-the-Shelf/Standards
	Environmental resistance		Increasing reliability

Table 2 | Analysts project similar top challenges to the connector.

The future is active

At the Fleck Connection Congress, Intersil's Gourgen Oganessyan, elaborated on active cable interconnects as a way to address many of the challenges. In active cables, small silicon ICs are embedded in each end. The silicon restores signals that have been attenuated over the length of the cable. Active copper-based cables can be used for the lowest cost and lowest power applications while active optical fiber-based cables are ideal for the longest distances. Data centers are already embracing active cables to overcome limitations of existing solutions. The consumer market is more cost sensitive and thus more hesitant to use active cables, but the driving need for ultra-thin product profiles and I/O density are making active cables the only option.

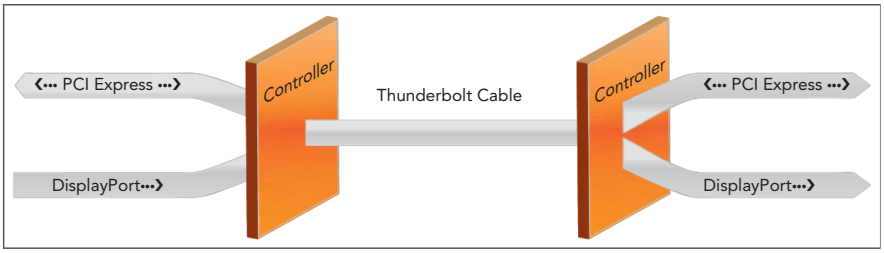

Figure 3 | The Thunderbolt cable is an example of active cable interconnect technology that addresses many challenges of critical system connector needs.

Apple and Intel are promoting Thunderbolt as a revolutionary I/O technology that supports high-resolution displays and high-performance data devices through a single, compact port. It sets new standards for speed, flexibility, and simplicity. Thunderbolt is designed to address the performance and density challenges faced by many computing devices. More and more consumer devices from PCs to peripherals are embracing Thunderbolt technology. There are still cost and power impediments that are slowing adoption, but many of these consumer device designers are left with no other choice. Thunderbolt technology will continue to evolve, making it a better solution. These same issues are facing critical embedded computing platforms, and they are also left with no other choice.

While Thunderbolt is one of the first consumer technologies to go active, others are on the way. PCIe OCuLink, VERA DP 1.2, and HDMI 2 are developing active interconnect options to extend their own roadmaps to the next generation.

Though it has been discussed for many years, optical interconnects are finally showing up in board-level product announcements. Several sections of the VITA 66 VPX fiber optic interconnect specification are complete and suppliers have real products. More work is needed to address the optical backplane, but this is the first wave of what is expected to grow quickly in the near future.

Looking even further into the future, connector suppliers are studying ways to integrate the board connection into the cable to additional reduce the impact that the physical connector has on signals as they pass from the PWB to the connector and on to the transport medium, whether it be copper or optical.

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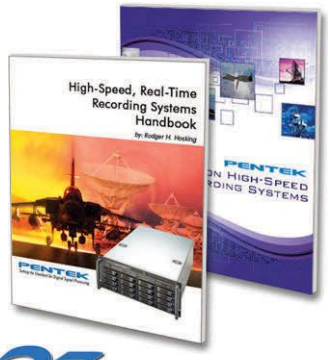

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Operating system developments impact critical systems

By Jerry Gipper

Software architects designing critical embedded systems have tough choices to make when selecting an operating system. Decisions can be both simplified and complicated with new framework and platform initiatives coming into being.

Operating systems that control critical embedded systems have many stringent requirements that they must be able to address in order for them to be considered for deployment. There will always be debate about the best operating systems to deploy in critical applications. However, improvements in real-time operating capabilities in Windows and Linux have opened up the door to options in addition to traditional Real-Time Operating Systems (RTOSs).

Requirements to deploy

Most of the requirements to deploy a critical system are based on the real-time response of the system to the processes they monitor and control. The top requirements are related to:

- **Memory protection –** A misbehaved thread can corrupt the kernel's own code or internal data structures causing all types of bad behaviors to the system.
- **Fault tolerance and high availability –** Even the best software has latent bugs. As applications become more complex and perform more functions, the number of bugs in fielded systems continues to rise. System designers must, therefore, plan for failures and employ fault recovery techniques.
- **Mandatory vs. discretionary access control –** Mandatory access control provides guarantees to the access of a device or file. Discretionary access controls are only as effective as the applications using them, and these applications must be assumed to have bugs in them.
- **Guaranteed resource availability: space domain and time domain –** A critical process cannot, as a result of malicious or careless execution of another process, run out of memory resources or deadlock due to priority conflicts that block resources.
- **Schedulability –** Meeting hard deadlines is especially important, and missing a deadline can be a critical fault; the access to system services must be deterministic.
- **Interrupt latency –** Some interrupts are higher priority and require a faster response time than others; how long it takes to respond is critical.
- **Bounded execution times –** Just as response time is critical, how long a task takes to execute is also important.
- **Priority inversion –** A lower task can block a higher priority task; predictably resolving the block is a must.
- **Security –** Everything is becoming connected, so trusted computing is more important than ever to prevent malicious attacks.

Adding decisions when adding cores

Today's multicore processors add an additional layer of complexity that can hinder or enhance the capability of a critical embedded system. In many cases, multiple operating systems may be used within the same computing system. These can be in completely isolated physical computing elements or on the same processor subsystem under the management of a software hypervisor that controls the necessary operating systems. For example, an RTOS that is optimized for characteristics such as memory footprint, performance, and real-time capabilities, runs in one partition and/or core. While Linux, with

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SNMP v1/v2/v3	Web Server	CLI/MIBway	Learning Bridge
VRRP	Web Svcs-Interop/SEC	DCOM	CAN/OPC

Base Middleware**

TIPC MIPC	Distributed Shared Memory	USB 1.1, 2.0
dosFs	Flash Support (TrueFFS)	Highly Reliable FS
IPv4/IPv6 Network Stack		PPP

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VxWorks/VxWorks Multiprocessing (SMP/AMP)

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* Included in VxWorks industry-specific platforms
** Included in all VxWorks platforms

Figure 1 | Wind River's VxWorks platform bundles key functionality.

the advantage of industry-standard user interface technology and robust support of IT capabilities over a network, runs on another partition and/or core. Each operating system is chosen for its advantages and they work together to provide a complete operating environment. Much is being done with hypervisor-enabled configurations but we are still in the early years of taking advantage of all that multicore processors and hypervisors have to offer in addressing performance needs of critical embedded systems.

Today's landscape

The landscape of operating system choices that can address the requirements for real-time critical embedded applications has changed extensively over the past decade. Many of the RTOS choices from years past have disappeared or retreated to very specialized niches.

What was once dominated by more than 30 choices of RTOSs and an occasional UNIX implementation has now boiled down to Wind River VxWorks, Linux (from many distributions), and Microsoft Embedded Windows. Microsoft has closed the gap by adding more real-time functionality to Windows. UNIX was always popular for select applications, and now Linux, with real-time support since release 2.6, has filled the UNIX void.

A look at the VITA technology companies that develop computer boards capable of running an operating system shows that virtually all of them offer Microsoft Embedded Windows, a Linux variant, and VxWorks on nearly all of their new platforms. The Microsoft Embedded Windows usage is driven by the fact that nearly all the hardware vendors now embrace Intel Architecture processors. Linux has earned its status as a solid choice through the efforts of many that added the necessary real-time capability to the operating system. VxWorks holds strong as the most widely supported RTOS across many processors and in applications of all types. While still widely chosen for new projects and widely deployed, Green Hills Software's Integrity, LynuxWorks' LynxOS, and QNX's Netrino are not as frequently mentioned by these board and system suppliers.

Software development platforms

Software development platform strategies are popular with all of the leading operating system suppliers. Software development platforms are an excellent way to accelerate the software design process. A well-supported software development platform brings all of the key elements needed by the software team to design, develop, test, and deploy a critical embedded system.

Windows Embedded comes in several platform configurations suitable for specific applications: Standard, Server, POSReady, Enterprise, Handheld, Compact, Automotive, and Device Manager. Each of these platform packages has software specifically included to address the needs of the intended target applications.

Wind River has a long list of platforms based on VxWorks with new platforms being defined as markets emerge (Figure 1). Wind River platforms exist for automotive devices, consumer devices, industrial devices, medical devices, gateways, network equipment, infotainment, and military equipment.

Linux has many distributions, many of them from suppliers that have bundled platforms for specific applications. The Wind River Intelligent Device Platform is an example of a complete software development environment for jump-starting machine-to-machine (M2M) device development. Based on Wind River Linux, Intelligent Device Platform includes ready-to-use components built exclusively for M2M applications.

Intelligent systems smartly influence critical systems

The term "intelligent systems" has emerged as a common way to describe devices of many types with embedded processors. Since 2011, Microsoft's Windows Embedded business has been laying the foundation for an entirely new category within the traditional embedded market — solutions known as intelligent systems that can extend enterprise software and cloud services out to everyday devices.

Intel is driving to simplify the deployment of the Internet of Things and to that end, has introduced the Intel Intelligent Systems Framework, a set of interoperable solutions designed to address connecting, managing, and securing devices in a consistent and scalable manner.

The Intelligent Systems Framework enables OEMs to shift their investments from achieving interoperability to unlocking the value of data. Intel defines intelligent systems to be:

- **Connected –** Simplify device connectivity for wireless and wired networks, speeding time-to-market and reducing expense for device manufacturers
- **Managed –** Deliver pre-integrated and supported management software from best-in-class Independent Software Vendors (ISVs), making it much easier to manage remote connected devices
- **Secure –** Provide powerful and customizable security capabilities for protecting devices and their data

These intelligent system initiatives by Microsoft and Intel are providing benefit to architects of critical embedded systems in the form of better integration of hardware and software components necessary to develop a larger and more complex system. The suppliers are being asked to look at the "big picture," from the operating system to the application, ensuring a robust set of software elements that are interoperable and reduce development time.

The changing future of operating system choice

Platforms and frameworks are changing the process of selecting an operating system. The detailed definitions of platforms and frameworks are eliminating many of the important decisions for the system architect to design application-specific devices. To get to market quickly, architects have to look closely at these "bundles." This frees up the system developer to focus on the end results by eliminating basic decisions on interoperability and integration challenges. In many ways, making an operating system choice is no longer necessary as it will be defined by the platform architectures specified by industry suppliers.

VPX versus VME: The Power to Create More Powerful Systems

By Jerry Hovdestad, Director COTS Engineering, Behlman Electronics

VME has been around since the 1980s and will continue to be used on various programs. As VPX technology grows, it is gradually replacing VMEbus in applications requiring very-high-speed switched fabric data transfer. The need for power supplies to keep up with the demands of such continuously evolving technology has always been a system design limitation, with power ceilings stalled for some time at 400-600 watts. This gating factor was due, at least in part, to the difficulty of cooling the high-density power supply cards essential for compliant profiles.

Network topologies based on the OpenVPX architecture enable multiple processors and multiple network switches to communicate efficiently and reduce R&D cost and risk. VPX is also highly compatible with VMEbus, and gives VMEbus users access to the high-speed switch fabric.

Two facts are undeniable:

1. If you have an OpenVPX™ system, you need a compliant power supply.
2. If you need higher power ranges, they are now available.

Behlman currently offers three VP*Xtra*™ high-power, high-efficiency, 6U power supply cards designed to support "OpenVPX Systems." All the cards are designed to be compliant with ANSI VITA 62, which was released in June 2012.

Heat problems solved by Behlman's *Xtra-Cooling*™ technology.

Behlman's engineering breakthrough – *Xtra-Cooling*™ technology – has been achieved by unique card-edge conduction cooling that enables these power supplies to operate at full power up to a maximum rail temperature of 71°C. All cards are designed in accordance with VITA 46 Requirements, VITA 47 Environmental Considerations, and VITA 48 REDI, and are for use in VITA 65, Interoperability Specifications for VPX Systems.

Late in 2012, Behlman broke through the VPX power ceiling with its VP*Xtra*™ 1000CD Power Supply. This unit is a high-power 12 V card that delivers a full 1000 watts of power at a typical efficiency of 91%. It is designed to be used in systems that require 12 V primary power. Multiple cards can be paralleled to deliver higher power to support as much current as modern backplanes require. This card also has a 3.3 V auxiliary output for system housekeeping functions. The input to the card is 28 VDC in accordance with MIL-STD-704 and MIL-STD-1275.

Behlman also offers the multiple output power card VP*Xtra*™1000CM, for systems that require additional +5 V power as well as +12 V, 3.3 V, and ± 12 V AUX power. This card will produce up to 700 W of power at a typical efficiency of 88%, and can also run on +28 VDC.

The outputs of all Behlman cards can be paralleled with similar voltages of other cards to increase total system capability.

For systems that have an AC input, Behlman offers the VP*Xtra*™1500. This card will take up to three phases of 115 VAC, from 47 to 440 Hz, in accordance with MIL-STD-704 and produce 1500 W of DC to drive our CD and CM models. The VP*Xtra*™1500 has power factor correction and an efficiency of 92%. This high efficiency allows the card to be used at up to full power if the chassis cooling can handle the 130 W slot dissipation.

All Behlman VP*Xtra*™ power cards are designed for a 1.0" pitch and have card ejectors, which facilitate both insertion and extraction. Mechanically, they are designed to meet the shock, vibration, and humidity requirements of MIL-STD-810. Over-voltage, over-current, and over-temperature protections are included in the design. Circuitry is conformal coated for optimal humidity performance. They are also designed to meet the applicable sections of MIL-STD-461 for conducted emissions, conducted susceptibility, and radiated susceptibility. In accordance with MIL-HDBK-217F Notice 2, MTBFs are 336,000 for VP*Xtra*™1000CM, 277,000 hours for VP*Xtra*™1000CM, and 209,000 hours for VP*Xtra*™1500.

All units incorporate Behlman's *Xtra-Reliable*™ design and *Xtra-Rugged*™ construction. They are designed and manufactured to meet MIL-STD-810 for shock, vibration, and humidity, and MIL-STD-461 for EMI.

Complete specifications and data sheets for Behlman VP*Xtra*™ Power Supplies are immediately available at www.behlmanvpx.com.

About Behlman

Behlman Electronics Inc., a subsidiary of Orbit International Corp., manufactures and sells high-quality standard, modified standard, custom, and COTS power solutions, including AC power supplies, frequency converters, inverters, DC-DC, AC-DC, DC-AC, uninterruptible power supplies, and the highest output 6U VPX power supplies available today.

Orbit International Corp., (orbitintl.com), based in Hauppauge, New York, is involved in the manufacture of customized electronic components and subsystems for military and nonmilitary government applications.

For more information contact:
Behlman Electronics Inc., 80 Cabot Court, Hauppauge, New York 11788 USA; TEL: +1 631 435-0410; FAX: +1 631 951-4341; sales@behlman.com; behlman.com.

Stacked up: Standardizing mezzanine modules

By Jerry Gipper

Mezzanine modules are an important design element to many board form factors. They grew out of a necessity to gain more board real estate or to incorporate modular flexibility to the original form factor. In the early days, few, if any, standards for mezzanines existed. However, over time, standards emerged to make it easier to incorporate mezzanines into designs.

Ecosystems for various mezzanine form factors exist at various levels, making some more popular than others. Companies still continue to develop proprietary mezzanines to meet specific requirements, and this is expected to continue as long as board-level components exist.

Fortunately, the members of VITA recognized the need for mezzanine standards early in the emerging board industry. By the late 1980s, discussions started to standardize a few different mezzanine form factors. First to emerge were S-bus and PCI Mezzanine Cards (PMCs). S-bus was driven by Sun Microsystems while the PMC form factor evolved out of an IEEE effort. While neither was a VITA standard, PMC went on to become a widely used mezzanine for 6U cards for VME, VPX, CompactPCI, and other form factors.

The first mezzanine standard to go through the VITA/ANSI process was the IndustryPack. Developed by GreenSpring Computers, it was chosen by the Motorola Computer Group as the expansion mezzanine for its MVME162 SBC. The move to make IndustryPacks a standard was joined by Acromag and the VITA 4 IP Module effort was launched. Since then, no fewer than eight mezzanine standards have gone through the VITA/ANSI process to become accredited specifications.

Today, most carrier boards use one of the XMC-type modules. While IP Modules and M-Modules still remain, new designs using them are not common. The widespread us of switched fabrics makes XMC the most popular module for use on many new products.

Further work continues on new specifications as the needs of the industry change and technology advances. The perfect mezzanine remains ever elusive!

Specification	Common name	Description	Status
ANSI/VITA 4.0-1995 (S2011)	IP Module	IP Modules provide a convenient method of implementing a wide range of I/O, control, interface, slave processor, analog, and digital functions. IP modules, about the size of a traditional business card, mount parallel with a host carrier board, which provides host processor or primary bus interfacing, as well as mechanical means for connecting the IP module's I/O to the outside world. Typical carriers include standalone processors, DSP-based carriers, as well as desktop buses and VME-based boards. This specification includes mechanical, host bus electrical, and logical definition of I/O space, memory space, identification space, interrupts, DMA, and reset functions. Two physical sizes, two fixed clock rates, and multiple data width sizes to 32-bits are defined.	ANSI Stabilized
ANSI/VITA 12-1997 (S2012)	M-Module	This specification defines minimum mechanical and electrical characteristics of M-Modules, a method of implementing modular circuit boards with specific functions that can be used to add functionality to other larger printed circuit boards. For special requirements, a third row can be added to the base board connection.	ANSI Stabilized
ANSI/VITA 20-2001 (R2011)	Conduction-cooled PMC	The conduction-cooled PMC specification defines the methodology and implementation details to allow the creation of conduction-cooled PMC modules to ensure electrical and physical compatibility with various host card modules onto which conduction-cooled PMCs are mounted.	ANSI Ratified
ANSI/VITA 32-2003 (R2009)	Processor PMC	Processor PMC cards are used where modular attachment of a processor is desired. These processor PMC cards may be used in conjunction with PMC I/O cards, traditional PCI cards, or with directly attached PCI components. As such, Processor PMCs increase the modularity of a computer system and thus complement, rather than compete with, the existing family of PMC cards. Processor PMC cards are expected to electrically operate with existing carrier boards (or mother-boards); that is, while the carrier may be redesigned to take advantage of the enhanced functions that are offered by this standard, such a redesign should not be a requirement to ensure proper operation. Indeed, Processor PMCs shall be specifically enabled to operate as master/host CPUs; otherwise, such cards revert to traditional PMC modes, operating as intelligent slave/target pro-cessor boards when that support is required within PMC and Processor PMC designs. The complete physical (mechanical) and the environmental layers are retained as specified in the IEEE 1386 Common Mezzanine Card (CMC).	ANSI Ratified
ANSI/VITA 39-2003 (R2009)	PCI-X for PMC	The PCI-X specification adds support for PCI-X to PMCs and Processor PMCs. The complete physical (mechanical) and the environmental layers are retained as specified in the IEEE 1386 CMC ("Common Mezzanine Card").	ANSI Ratified
ANSI/VITA 42.0-2008	XMC	Switched Mezzanine Cards (XMCs) follow the same concept of PMCs but with support for open, standardized switched serial fabric technologies commonly used in current-generation board archi-tectures. The specification enables selection of a variety of fabric interconnects. XMC preserves the standard PMC form factor, remaining compatible with the existing PMC technology. PMC, XMC, or dual-mode mezzanine cards are supported. Included in the specification is a standard for optional conduction cooling. Several dot-specifications exist to define how alternate protocol layers are to be supported. Currently released specifications define: › Parallel RapidIO Protocol Layer (ANSI/VITA 42.1-2006) › Serial RapidIO Protocol Layer (ANSI/VITA 42.2-2006) › PCI Express Protocol Layer (ANSI/VITA 42.3-2006) › 10 GbE Protocol Layer (ANSI/VITA 42.6-2009)	ANSI Ratified
ANSI/VITA 57.1-2008	FMC	FMC stands for FPGA Mezzanine Card, an I/O mezzanine module, that shall connect to, but is not limited to, 3U and 6U form factor cards. This mezzanine module is in a smaller form factor when compared to PMC/XMC modules, and assumes that it will be connected to a FPGA device or other device with reconfigurable I/O capability. This standard describes FMC I/O modules and introduces an electromechanical standard that creates a low overhead bridge. This is between the front panel I/O, on the mezzanine module, and an FPGA processing device on the carrier card, which accepts the mezzanine module.	ANSI Ratified
ANSI/VITA 61.0-2010	XMC 2.0	This standard, based on VITA 42.0 XMC, defines an open standard for supporting high-speed, switched interconnect protocols on an existing, widely deployed form factor, but utilizes an alternate, rugge-dized, high-speed mezzanine interconnector known as VITA 61 XMC 2.0.	ANSI Ratified

Table 1 | Summary of active VITA technology mezzanine specifications.

Embedded Tech Trends 2013 high-flying design wins

Anyone remotely familiar with the critical embedded computing industry knows that suppliers thrive on design wins. They are the first step in filling the orders pipeline, and provide a good look into the health of the organization. Companies incentivize their sales teams to get key design wins that can assure business for years to follow. As important as design wins are, it is hard to brag about them. For many reasons, most of which could tip the competition, design wins are rarely talked about.

At Embedded Tech Trends 2013, several of the sponsors were able to talk about programs where they have been successful. Let's take a quick look at some of those programs where VITA technology has been deployed.

Aitech (www.rugged.com) was the first company to supply – and internally radiation-qualify – multiple VMEbus products for use on the International Space Station (ISS). With the first having been installed in 1995, more than 100 Aitech SBCs and PMCs on the ISS are still in use today, and more programs are in the pipeline to be added to the ISS.

Mercury Systems, Inc. (www.mrcy.com) pointed out several programs using their technology. Mercury Systems platforms can be found in sensor processing solutions for the F-35 and P-8 MMA radars, Raytheon's Advanced Distributed Aperture System (ADAS), Gorgon Stare Electro-Optical (EO)/Infrared (IR) Sensors, Joint Counter-Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW) program, Navy Aegis combat system radar, Patriot missile system radar, Navy's Surface Electronic Warfare Improvement Program (SEWIP) electronic warfare systems, and many other programs.

4DSP LLC (www.4dsp.com) products have found homes in airline industry programs used for strain and temperature measurements, embedded structural health monitoring, real-time 3D shape rendering, and composite materials characterization and quantification.

ADLINK Technology Inc. (www.adlink.com) highlighted a remote sonar system towed by a naval vessel to detect other vessels and objects under water. The rugged design is suitable for operation in underwater environments. Its compact size and ultra low power consumption fit in the limited space of the towed unit. They also mentioned a sniper detection system used to determine position and distance by a microphone array deployed on vehicles moving up to 60 mph. The rugged design is suitable for operation in ground vehicle environments.

Pentek (www.pentek.com) signal processing products have found homes in U.S. Navy Signals Intelligence (SIGINT) systems. Pentek products score high with the Navy acquisition system: reducing development time, and acquisition and maintenance costs. The open architecture standards used in these products enable easier new technology insertion so that the latest technology is available to key Navy programs.

CES – Creative Electronic Systems (www.ces.ch) develops scalable systems, using COTS principles, with modular functional units. These modules are widely used in commercial, military, and unmanned aerial vehicles for test, simulation, airborne mission, and primary flight computer systems.

Curtiss-Wright's mission computer subsystem continues to power smart flight training

Curtiss-Wright Controls Defense Solutions (www.cwcontrols.com) recently received a follow-on contract from Pilatus Aircraft Ltd to provide a fully integrated open architecture-based mission computer subsystem for use in its PC-21 NextGen Trainer aircraft. Over the lifetime of this PC-21 program, this contract is valued at more than $11 million. Under the contract, Curtiss-Wright will provide Pilatus with its rugged MPMC-9350 processing subsystem. Shipments under the new contract began in October 2012, and are scheduled to continue through August 2014.

"We are very proud that Pilatus Aircraft Ltd has extended its ongoing partnership with Curtiss-Wright by selecting our fully integrated off-the-shelf subsystem technology for use in their industry-leading trainer aircraft," said Tom Quinly, President of Curtiss-Wright Controls Defense Solutions.

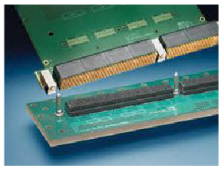
The Pilatus Aircraft PC-21 is a next-generation turboprop trainer that provides an unmatched level of advanced technology, configuration flexibility, and lifecycle cost savings. With an intelligent avionics system that can be modified to suit the student pilot's phase of training, the PC-21 is significantly less costly than jet aircraft training alternatives.

The Curtiss-Wright MPMC-9350 provides the PC-21 aircraft with a mission computer that supplies processing for pilot and co-pilot multi-function display symbology and mapping as well as radar simulation. The MPMC-9350 is a rugged integrated system solution that accommodates the highest power 3U VPX or CompactPCI cards in the embedded computing market within a five-slot forced-air enclosure. The MPMC-9350 is designed to meet the harsh environments of many military computing applications. Circuit cards installed in the system enclosure are isolated from external environmental conditions such as humidity, dust, and sand.

VT Primetime Choices

Embedded Tech Trends brought some interesting new products. The VITA technology suppliers are picking up the pace to drive new products into the market in 2013. Expect to see many more innovative products in the coming months.

MULTIGIG RT 2-R connector enhances VPX stability



Innovation does not stand still. TE recently collaborated with Mercury Systems to develop and test a new MULTIGIG RT 2-R connector for use in the most challenging environments, even beyond requirements of the VITA 46 VPX standard. "The MULTIGIG RT 2-R connectors and ruggedized guide hardware are valuable new additions to TE's portfolio of interconnects for VPX and custom embedded computing solutions," said Mike Walmsley, Product Manager, TE Connectivity, Global Aerospace, Defense & Marine.

This rugged, lightweight, and high-speed board-to-board interconnect is compliant to VITA 46, including backward compatibility with all existing VITA 46 daughter cards. The new connector system features the modularity and flexibility of the field-proven MULTIGIG RT 2 connector products, but with a new quad-redundant contact structure designed for extreme vibration levels. Ruggedized guide hardware is also available to increase the stability of the daughter card-to-backplane interface under shock and vibration.

TE Connectivity (TE) | www.te.com
vita-technologies.com/p370748

Flexible XMC, VPX modules BLAST off

Flexibility at the board level is the secret to fast time-to-market. The FM780 and VP780 from 4DSP are two highly configurable modules with advanced Digital Signal Processing (DSP) capabilities and multiple I/O options targeted at applications requiring programmable implementations of complex FPGA algorithms.

The FM780 is XMC (VITA 42.3) compliant with a PCI Express Gen 2 interconnect while the VP780 (pictured) is 3U VPX form factor (VITA 46) compliant. Both modules provide an FMC (FPGA Mezzanine Card, VITA 57) site and two 4DSP BLAST (Board Level Application Scalable Technology) locations that are closely coupled to the onboard Xilinx Virtex-7 FPGA and 2 GB of DDR3 SDRAM.

4DSP LLC | www.4dsp.com
vita-technologies.com/p370869

SWaP Reductions for HPEC

High-performance embedded computing platforms benefit from reductions in (SWaP). Emerson Network Power has crafted a fanless enclosure designed to minimize SWaP for military, aerospace, commercial, and other (HPEC) applications.

The Emerson Network Power VPX3000 includes a configurable I/O Adapter Board (IAB) that routes I/O from the payload blades to the front of the enclosure. The IAB is designed to mate with Emerson Network Power's iVPX7225 processor blade, based on the Intel 3rd generation Core mobile chipset.

Two Data Plane Fat Pipes from each slot are connected in a full mesh configuration. Two Control Plane Ultra Thin Pipes from each slot are routed to the IAB as 1000Base-T interfaces. USB 2.0 and DisplayPort interfaces are also routed to the IAB.

Emerson Network Power
EmersonNetworkPower.com/EmbeddedComputing
www.vita-technologies.com/p37868

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X-ES

Extreme Engineering Solutions

608.833.1155 www.xes-inc.com

READY TO UPGRADE?

SMALL PACKAGE, HIGH PERFORMANCE 3U MILITARY ATR CHASSIS

CM Computers latest line of compact COTS ATR enclosures incorporate all proprietary technologies, advanced features and well established mechanical and electrical solutions developed during the past 20 years.

These military ATRs benift from improved thermal dissipation and have been designed for cost effective 3U high power military systems and UAVs.

Three 5-slot 3U chassis cooling techniques are available to suit all applications. All models (S/HES/FAC) integrate the same enhanced PSU and Backplane electronics.

PSU OPTIONS

	Vin Options		Backplane DC				Suggested BUS		
	28VDC	OTHER†	+5VDC	3.3VDC	+12VDC	-12VDC	VME64	cPCI	VPX
A-475W	•		40A	22A	8A	8A	•		
A-575W		•	40A	22A	12A	12A	•		
B-450W	•		20A	45A	8A	8A	•	•	•
B-550W		•	20A	45A	12A	12A	•	•	•
C-475W	•		20A	22A	16A	8A			•
C-575W		•	20A	22A	21A	12A			•

† 48 VDC / 270 VDC / Autorange 90-264 VAC @ 47-880Hz / 200 VAC-3Ph @ 47-880Hz

True COTS capabilities

- Contaminant-free enclosure (S+HES Models)
- VPX, VME64 & cPCI ready (1" Pitch)
- Accepts Conduction & Air-cooled 3U Modules
- Flexible Top & Bottom I/O wiring
- In-line EMI/EMC MIL-STD-461E Filter
- Operating Temperature -40°C to +85°C
- Up to +85 Watts per slot
- Integrated Temperature Supervisory Unit
- Dramatically increases Payload MTBF by 4x
- 20°C less than Conventional 3U ATRs
- Maintenance free Operation in service
- Extensive set of Front Panel user Indicators
- Integrated Rear fans Finger Guards
- Stand alone Low Weight solution
- Internal Card-cage airflow recirculation
- Independent Fan & Power Supply input voltage
- Customizable to specific requirements
- Low Profile Mounting Tray with quick release

The leading ATR chassis manufacturer in Europe & the USA

All our chassis products are delivered **Tested and Certified** by independent authorized Labs per **MIL-STD-461E & MIL-STD-810G** for immediate deployment in US Navy & US Air Force military UAVs, Fighters & Helicopters.

Contact **info@cmcomputer.com** to request our new Chassis Catalog.

4 HEAT EXCHANGERS

3U

UP TO 575 WATTS

CM-ATR-3U/FAC

CM-ATR-3U/HES

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