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MAY 2005 • Volume 9 Number 4

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INSIDE
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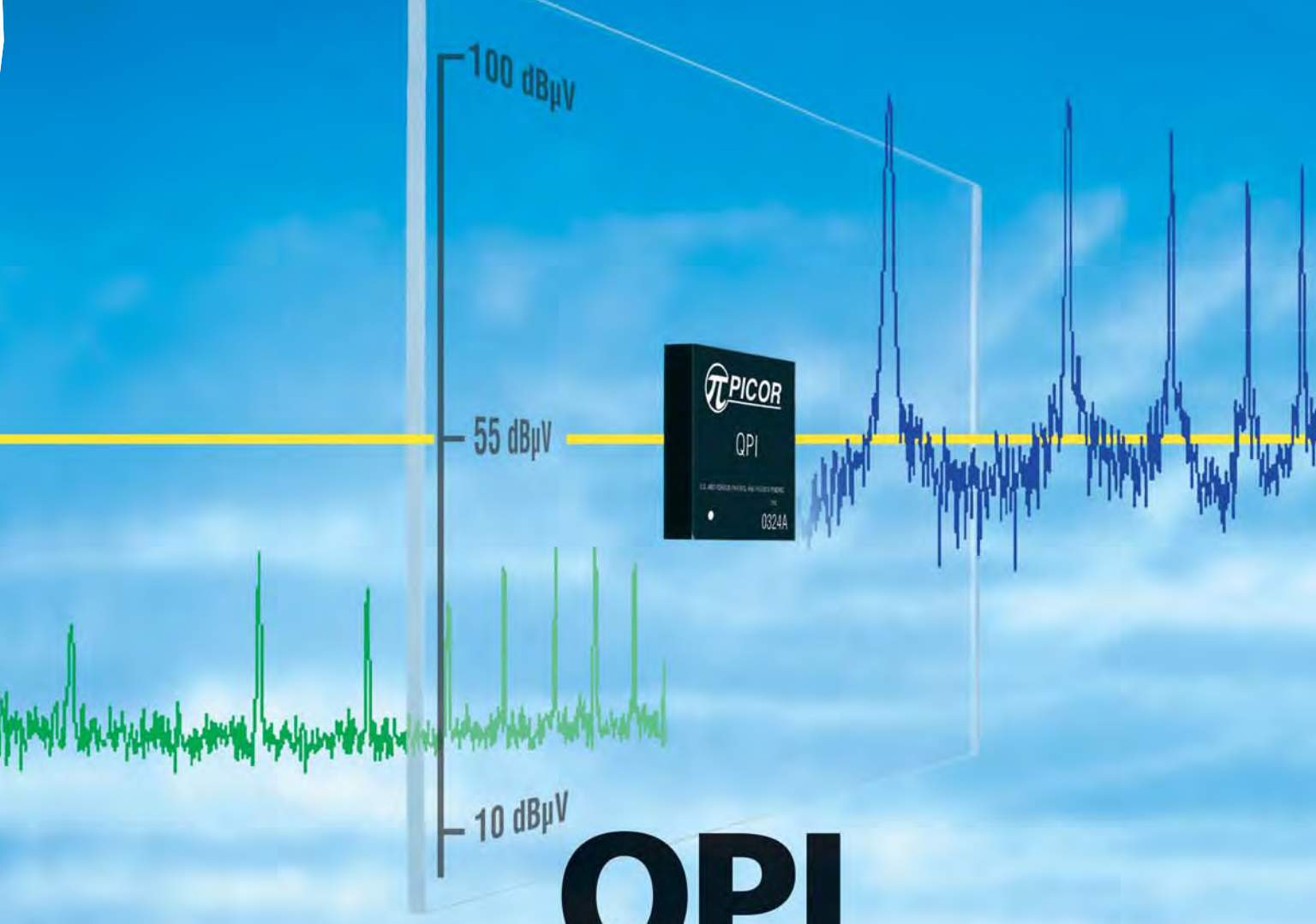

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VOLUME 9 • NUMBER 4
MAY 2005

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EVENTS

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ISSN #1098-7622 ONLINE ISSN #1550-0381
Publication Agreement Number: 40048627
Canada return address: WDS, Station A, PO Box 54, Windsor, ON N9A 615

CompactPCI and AdvancedTCA Systems is published nine times a year by OpenSystems Publishing LLC., 30233 Jefferson Ave., St. Clair Shores, MI 48082. Subscriptions are free, upon request in writing, to persons dealing with or considering *CompactPCI and AdvancedTCA Systems*. For others inside the US and Canada, subscriptions are $45/year. For 1st class delivery outside the US and Canada, subscriptions are $90/year (advance payment in US funds required).

POSTMASTER: Send address changes to *CompactPCI and AdvancedTCA Systems*
13253 La Montana, Ste 207, Fountain Hills, AZ 85268

By Joe Pavlat
Editorial Director

Climbing the application ladder

Today's sophisticated computer systems are a complex combination of hardware elements, operating system, and applications software. Often additional hardware and software in the form of system management or High Availability (HA) control of redundant resources is present. Assembling all of these elements and integrating them is arguably the biggest task facing system designers. In the past, developers often custom designed or modified all of these parts for each end application. Large systems could take years to reach the market. Product upgrades and improvements without major redesign are often limited with a custom-architected design, as there usually isn't very much extra computing power or additional I/O capability. This approach often minimizes component reuse of chassis, boards, and software, which adds to overall product development costs, decreased manufacturing efficiency, and large spares pools.

Standards based design methodologies have improved the situation somewhat. Open hardware standards have become increasingly popular and are suitable for simple applications (PC/104) and very sophisticated big systems (AdvancedTCA). Software standards including Linux in its various forms, among them Carrier Grade Linux, have followed a parallel path, although historically software and hardware standards have interacted little outside the personal computer arena.

However, this is beginning to change, with new industry alliances and partnerships being created to marry off-the-shelf hardware with off-the-shelf software and middleware. This approach will simplify the design process by delivering partially integrated hardware/software combinations that are ready to add the customer's end application software.

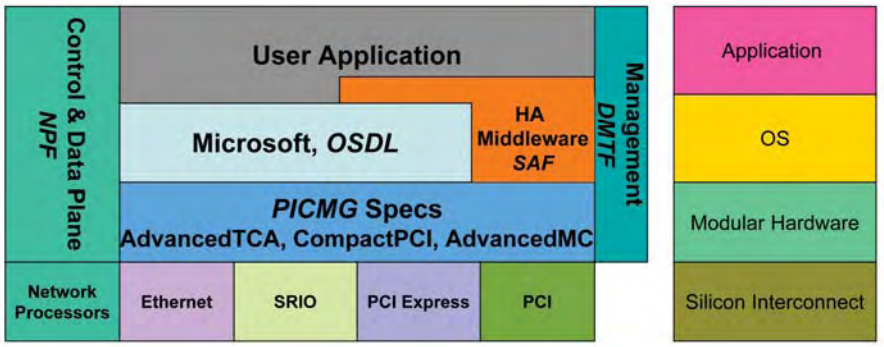

Figure 1

One group leading this effort is the Service Availability Forum, known as SAF (www.saforum.org). As noted in this issue's *Software Corner* by Technology Editor Curt Schwaderer, SAF focuses on HA middleware that resides between the hardware and the end application. The Hardware Platform Interface (HPI) is an open standard that separates the system hardware from management middleware and makes them independent of each other. SAF and PICMG, the organization that developed the AdvancedTCA Specification (www.advancedtca.org) are working together to seamlessly integrate SAF middleware with the AdvancedTCA platform in a standard fashion via the HPI. A number of companies, including GoAhead Software, Augmentix Corporation, Intel, MontaVista, and UXComm have already developed commercially available HPI-compliant products. SAF has also created another standard, known as the Application Interface Specification (AIS) that standardizes the interface between the end application and SAF-compliant HA middleware.

Alliances like the one between SAF and PICMG are creating real value for system designers by creating off-the-shelf hardware and software building blocks that work together in a standardized way. By allowing the OEM to concentrate on the end application, a number of key benefits occur, including lowered development costs, increased flexibility and reuse, quicker time to market, and lower total cost of ownership.

This is a good beginning to helping OEMs lower the development cost of what is generally the most expensive part of system development – software. There are additional pieces of the puzzle that need to be added, including operating system integration and management software integration. Discussions with the Open Source Development Labs (OSDL), which concentrates on Linux, the Distributed Management Task Force (DMTF), and other standards organizations are taking place to help pull the entire platform picture together and to accelerate the adoption of standards based platforms and software building blocks. More information on OSDL and DMTF can be found on their respective web sites, www.dmtf.org and www.osdl.org. Figure 1 provides a graphical representation of some of the various elements and shows how they interrelate.

Joe Pavlat
Editorial Director

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For more info, go to:
www.adlinktech.com/products

2U Rackmount Chassis with 1U ATX Power Supply

The cPCIS-6230R/64 is a 2U-height three-slot CompactPCI chassis. It is equipped with a PICMG 2.1 hot-swap compliant 64-bit 6U CompactPCI backplane with P3 and P5 rear I/O. It supports one dual-slot system board and two peripheral slots. The cPCIS-6230R/64 also features a built-in 300W AC-input power supply, slim type EIDE CD-ROM, floppy drive, and internal space for drive bays for one 2.5" HDD and one 3.5" HDD.

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cPCI-6842
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- 32-bit/33MHz CompactPCI
- One 32-bit/33MHz PMC site
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- Hot-swappable CompactFlash socket
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Service Availability Forum continues to drive carrier grade building block standards

By Curt Schwaderer

Communications technologies have and will continue to further evolve into multiservice networks. Three main driving technologies: landline, Internet, and mobile communications, are converging into a fully interoperable, multiservice network, providing voice, video, and other multimedia services from handset to television screen.

Further, countless millions (likely even billions) of dollars are spent annually writing proprietary software for custom-built carrier grade equipment. Management solutions have difficulty integrating with and managing these custom-built systems. The communications industry has reached a point where it is absolutely critical for systems to be highly reliable and much more cost effective.

Historically, communications systems were built from completely custom pieces by both network equipment and service providers. Custom, high reliability components are very costly to develop and maintain however. Therefore, standards such as CompactPCI and AdvancedTCA form a hardware platform foundation for high reliability convergence communications systems. However, challenges, including interoperability of applications and management of these systems, still exist. The Service Availability Forum (SA Forum) focuses on these challenges.

Standard building block form factors such as CompactPCI and AdvancedTCA are critical in the move to Commercial Off-the-Shelf (COTS) high reliability systems. The SA Forum and the hardware interface as well as the software Application Programming Interface (API) standards they create are an equally critical part of the evolution towards high reliability, commercial building block, convergence communications systems.

In this column, we will take a look at the SA Forum, its members, and what they are working on, and offer an overview of SA Forum specifications available for download.

SA Forum charter

The SA Forum website states, "The Service Availability Forum specifications enable the implementation of carrier grade systems and services built with COTS building blocks, for the benefit of telecom service providers/operators, network equipment providers, and independent software vendors."

The focus is on software APIs revolving around application, management, and hardware platform interoperability. The assumption here is that if developers write the APIs relating to hardware interface, management, and applications robustly and completely with rigorous conformance and testing criteria, platforms meeting SA Forum standards will inherently provide the reliability carrier grade, high reliability networks demand.

The service availability solution not only encompasses High Availability (HA) requirements of 99.999 percent availability, but also strict service continuity requirements. That is, there shall be no loss of service during fault management actions.

Primary/backup redundancy also figures into the service availability specifications. The platform and management programming interfaces incorporate the concept of primary/backup redundancy. APIs abstract redundancy to allow application operation during failover.

SA Forum specifications overview

Figure 1 shows the SA Forum reference architecture and places the service availability interfaces within the architecture.

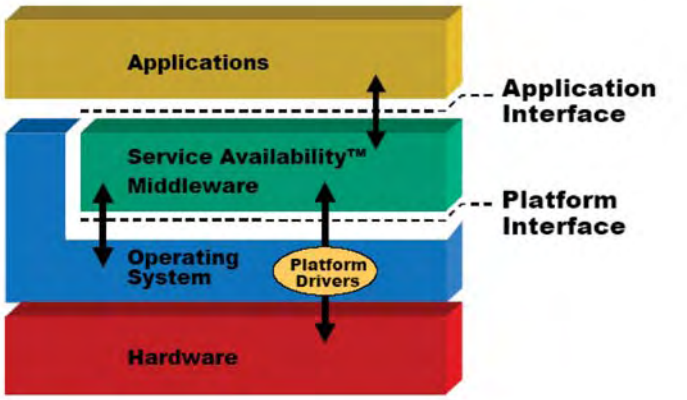

Figure 1

The reference architecture interfaces define the flow of information between objects defined in the architecture. While there is one specific service availability middleware entity in the reference architecture, this component performs the management function for service availability. The other objects in the architecture are expected to be able to provide the information required across each service availability interface defined in the reference architecture.

The reference architecture and interface standards of the SA Forum target circuit and packet switched networks, wireless networks, and cable-telephony networks. So, the interfaces are truly defined to support the convergence network of the future.

SA Forum registered products

In order to be realized in deployed solutions, the SA Forum requires support from a variety of vendors, suppliers, and customers in the communications industry. Component and board manufacturers need to build platforms that can provide statistics and managed interfaces for redundancy, hot-plug, and hardware failover. Operating system providers must offer extensions to the operating system for SA Forum interfaces in addition to mak-

ing the internal operating system software inherently reliable. Systems and applications providers must utilize the SA Forum interfaces to create innovative, highly available network applications that can generate significant revenue streams for network operators and service providers.

Operating systems serve as an especially critical reliability component within the HA software environment. The operating system is the software foundation of any communications system component sporting a CPU. Operating systems that use a memory management unit in the CPU and maintain user and system state to minimize damage that can be done by accidental or malicious corruption by applications are critical to the HA environment.

Process model operating systems are better equipped for keeping reliability and maintainability in this kind of environment. These systems track and monitor memory allocated to processes. If any process attempts to access memory outside its allocated memory, the operating system isolates the attempt, then contains and isolates the process, limiting the damage done to the offending process's domain. Threads that model only operating systems, or applications that make use of threads, open the door to memory corruption in the environment. Threads that have access to all system resources have the ability to compromise the service availability environment at its core, rendering the system vulnerable. For this reason, application writers must use protected execution domains, along with process model operating systems, to ensure the reliability of the SA Forum compliant system.

Five companies currently have SA Forum registered products on the SA Forum website:

Augmentix has a spectrum of products available that are compliant with the latest SA Forum standards. Customers can purchase the Hardware Platform Interface (HPI) software alone, software with hardware platform components, or the entire SA Forum-compliant platform, ready for application development. Augmentix has an off-the-shelf HPI software solution suite that conforms to the B.01.01 SA Forum HPI specification. A Server Availability Management Processor card (A+SAMP) provides plug-in management and service availability functions for systems with a PCI interface. One compelling feature of this management card is its ability to provide *lights out* management whereby the card has the ability to manage the host system even upon failure or power loss to the system. The A+SAMP includes an Augmentix service availability software package as a bundled management solution. Finally, Augmentix offers complete repackaged service availability servers based on the Dell PowerEdge server product line. These innovative products provide the ability for equipment providers and network operators alike to deploy SA Forum solutions today. For more information, visit www.augmentix.com.

GoAhead Software has an implementation of the Service Availability middleware shown in the reference architecture of Figure 1 called *SelfReliant 7500 Advanced Suite.* This suite is compliant with the SA Forum B.01.01 specification and implements an HPI management console, with database management and replication services. For more information, visit www.goahead.com.

Intel is offering carrier grade rack-mount servers. One of these servers, the Intel TSRLT2, is a NEBS-3 and ETSI certified carrier grade rack server. The system comes with floppy and CD-ROM drives, redundant, hot-plug power supplies, USB, PS/2, and video connectors, as well as slots for PCI cards and SCSI drives. Status lights on the front panel provide indications for service availability and Telco Alarm management, both audible and visible alarms. Visit www.intel.com/design/cgservers/telecom/tsrlt2/ for a more detailed look at this HA server.

MontaVista has released version 3.1 of their Carrier Grade Linux package. This implements the functions of the operating system block of the SA Forum reference architecture. System serviceability features such as kernel resource monitoring, field-safe application debugger, and runtime application patcher provide operating system functions that support the goals of the service availability environment. In addition to these kernel extensions the operating system also supports SA Forum features such as cluster membership services, application availability management framework, and a checkpointing service. For more information, visit www.mvista.com.

UXComm is a company that specializes in data center automation products. They have a product called AutonomIQ Distributed Element Management (DEM) that specifically relates to the SA Forum and the HPI specification. The DEM product is one in a suite that provides hierarchical management and control from the hardware platform itself through the IT infrastructure in order to efficiently manage and automate data center activities. The DEM product provides discovery, monitor, and control functions using a policy based management framework for bladed environments. It provides web and command line interface interaction that can pull widely distributed information to build *system specific dash-*

boards for monitoring this information. For more information, visit www.uxcomm.com.

SA Forum: What's next?

It appears that the SA Forum has significant momentum and real products available that implement the specifications from hardware platforms, operating system, service availability middleware as well as bundling solutions. Some of the companies providing these solutions have applications focused on the management and control of these functions. But where are the rest of the applications that will drive revenue generation and additional service offerings for network operators? With the SA forum foundation complete, the successful proliferation of SA Forum standards will depend on the emergence of applications that conform to the SA Forum application interface. Aside from focused management offerings, applications using the SA Forum standards were noticeably absent. Now that the foundation is set and SA Forum compliant server products are available, I would expect member companies such as Oracle, IBM, and MySQL to start to announce application-level product offerings that fit into the SA Forum reference architecture.

Additional information on the SA Forum can be found at www.saforum.org.

SA Forum members

The SA Forum member list includes a mixture of platform and software manufacturers. The membership includes:

Artesyn Technologies	MySQL AB
Augmentix Corporation	NEC
Clovis Solutions	Nokia
Continuous Computing	Nortel Networks
Ericsson	NTT
Fujitsu Limited	Oracle Corporation
Fujitsu Siemens Computers	OSA Technologies
GNP	Phoenix Technologies
GoAhead Software	RadiSys
Hewlett-Packard	Siemens
IBM	Solid Information Technology
Intel	Sun Microsystems
Kontron	TietoEnator
Lucent Technologies	UXComm
MontaVista Software	Veritas Software
Motorola	Wind River Systems

For further information, contact Curt by e-mail at cschwaderer@opensystems-publishing.com.

Lead-free and waste prevention requirements in the European Union: Cleaner products at lower cost

By Hermann Strass

This is the second of two columns on the Restriction of the use of certain Hazardous Substances (RoHS) and the Waste from Electric and Electronic Equipment WEEE (directive 2002/96/EC). Please visit www.compactpci-systems.com/columns/Technology_in_Europe/ to read the first column, which appeared in the April 2005 CompactPCI and AdvancedTCA Systems.

Fujitsu-Siemens Computers (FSC) is meeting lead-free and waste prevention requirements in cost critical mass production on a big scale (with lower cost than current production), not just in isolated partial solutions in experimental set-ups, for its PC and AdvancedTCA production in Augsburg, Germany and other places. FSC is typically placed into position four on the list of worldwide PC producers and number one in Europe. Several production lines for PC and workstation motherboards at the FSC factory in Augsburg, Germany have been converted to lead-free production in an around-the-clock (three shifts per day) operation (Figure 1). Green computers from this factory are not more expensive than traditionally produced equipment.

AdvancedTCA products from FSC will be lead-free and green (RoHS and WEEE compliant) when they appear on the market during the second half of 2005. FSC made this possible by recycling computers beginning in 1988. The company is currently exceeding WEEE requirements significantly with consequential savings in overall production costs. FSC designs products with the goal of recycling up to 98 percent of the materials. For example, FSC has jointly developed with Toray (a leading chemical company in Japan) a plastic material for the housing of Notebook PCs (such as FMV-BIBLO NB80K) that is made almost completely from plant (organic) material. The material is flame-retardant, suitable for mass production, and dramatically reduces the amount of petroleum and CO2 used in its production. The SCENIC C620 desktop PC now uses the new lead-free chipset i915GV from Intel, which combined with other measures, reduces the lead content of the motherboard from 12 grams to 1 gram.

Several series of desktop PCs (SCENIC) and workstations (CELSIUS) are already available in compliance with RoHS and WEEE directives. Large corporations, insurance companies, banks, health, and government authorities already write compliance to RoHS and WEEE into their request for quotes. FSC computers are also halogen-free or contain lower than the tolerated amounts of bromine, chlorine, or other halogens. FSC (Siemens Nixdorf at that time) opened the world's first facility in 1996 capable of automatically detecting and classifying different plastic materials in their recycling plant.

Products are classified into three categories for recycling or disposal. These include:

- Level 1: Refurbish and reuse complete systems, possibly for customers who might need spares or replacements for EOL products to prolong the useful lifetime of well-running systems
- Level 2: Refurbish and reuse of components such as boards similar to Level 1, but not for reuse in new systems
- Level 3: Segregate components such as plastic and metal into up to 60 different groups of substances for environmentally safe disposal or reuse.

Figure 1

In 2002, more than 90 percent of the material could be recycled at FSC in Paderborn, Germany. This rate is now at 98 percent for the treatment of approximately 5,000 tons of returned electronic waste per year.

FSC develops and produces their own PC motherboards and designs and produces almost all their PCs in house, mostly in Augsburg, Germany. During the design phase, the requirements for lead-free production and easy recycling are considered. Four automatic production lines are already producing lead-free PC motherboards. Other lines are converted as they depreciate. FSC started this expensive conversion process (approximately $500,000 per line) a long time ago. Actually, green motherboards and other Printed Circuit Boards (PCBs) are colored

blue rather than green. By tradition practically all PCBs worldwide (made mostly from FR-4 plastic material) have been colored green. Coloring environmentally green boards blue allows for easy differentiation between traditional and green material at recycling time, saving chemical analysis costs.

The current plans of FSC are to be compliant with EU directives by December 31, 2005 for all business products and by March 31, 2006 for all consumer products, long before the legal requirement dates. AdvancedTCA products will be compliant right at production start.

The FSC products are complying with numerous requirements such as Energy Star, Blue Angel, Nordic Swan TCO, and others. The FSC factory in Augsburg, Germany has won the Best Factory, Industrial Excellence Award 2003 and they are certified to ISO 14001 (environment-friendly production).

Logistic challenges

Most chip manufacturers still do not list any information on lead or other hazardous content on their data sheets. This makes it very time consuming to establish and maintain a bill of materials that contains only lead-free components. Documentation, such as component libraries, must be available and accurate along the supply chain from the basic components to the finished products. During a transitional period, there will be two of everything, lead-based and lead-free. Some distributors and resellers have already updated their product databases to identify lead-free components in their catalogs. However, there is no standardized way of doing this. Supply chain management has to take care of alternate sources, different delivery times and channels, product shelf life, and proper documentation, as proof of compliance.

FSC has already improved their logistics. For example, material flow has improved significantly. They are now developing self-organizing flow algorithms based on ant and wasp behavior in a research project together with scientists from the University of Stuttgart and the Neural Computation Centre at Siemens Corporate Technology. Experimental results show a 44 percent reduction in delivery delays.

The transition to RoHS and WEEE compliance should be taken as an opportunity to clean up and streamline business processes and establish less complicated management procedures.

Economic effect

Currently, about six million metric tons of electric/electronic waste have to be properly disposed of in the EU at a very high cost to the user. Significantly reducing this amount will result in comparable cost savings. Therefore, not using hazardous substances will make it much cheaper to dispose such waste, eliminating the high cost of extracting these hazardous substances.

Using the FSC situation again as an example, they have calculated an overall savings of more than 4.5 million EURO per year by eliminating the weight and cost of packaging, reducing the relative cost of recycling. As mentioned, the cost of lead-free soldering and optimized assembly is cost neutral in comparison to legacy lead-based production.

Obtaining favorable results demands examining and streamlining the entire production and product life cycles. Individual actions just disrupt smooth operation and might actually have an overall negative effect.

Fast-growing waste mountains

With the high population density in Europe, there is the issue of fast-growing waste mountains. For example, the population density per square kilometer is

466 in Holland, 244 in the United Kingdom, and 29 in the United States. This means that the United States would need more than 15 times its current population to be as densely populated as Holland. This is why waste reduction by way of recycling or nonhazardous disposal is several times more important in Europe (or Japan) than in the United States, Canada, or other less densely populated countries.

In 1998, approximately six million metric tons of electric and electronic waste had to be disposed of in the EU. Growth rates for electronic waste are estimated at 5 to 10 percent annually. The EU wants to get to a recycling rate of 75 percent by end of 2006. FSC products are already approaching a rate of 98 percent.

The US Agency for Toxic Substances and Disease Registry (ATSDR), Centers for Disease Control and Prevention (CDC), Environmental Protection Agency, Occupational Safety and Health Administration (OSHA), and others warn about the specific health problems in the central nervous system (especially in children) caused by lead. The ATSDR lists lead as the most toxic of all environmental substances on a list of 275 substances that they examined.

The Association Connecting Electronics Industries board of directors claims that soldering components to boards uses only two percent of the world's lead. It references studies that indicate lead poses no health danger in their industry. However, it also states support for lead-free activities.

Most lead is used in car batteries. Car batteries are already 100 percent recycled in practically all industrialized countries. Microscopic lead particles in the food we eat or in fumes around soldering operations, in dust from leaded paint, or smoke from cars using leaded gasoline, is slow and painful in harming or killing people.

Modern day chemical analysis and research on corpses from the late Middle Ages show that a significant proportion of these people died of lead poisoning or suffered from it as a result of *plumbing*. Plumbum is the Latin name for lead and the chemical element symbol is Pb. Plumbing, such as water pipes made from lead, were for a long time practically the only way of getting water directly into European houses, which improved hygienic conditions for those who could afford it. Our ancestors did have at least some knowledge about lead being a hazardous substance. The former Republic of Venice locked up their worst criminals in *lead chambers* for extremely severe punishment (lead harms the central nervous system). World famous Giacomo Casanova managed to escape from the lead chambers of Venice telling the world about his fortunes and misfortunes in his memoirs and other books.

Lead as a piece of metal may not be very toxic, but it is very toxic in the form of microscopic parts, such as dust or debris from leaded paint or in fumes during soldering or as exhausted particles from leaded gasoline. As with many substances they are very active (good or bad) on a microscopic scale. Divalent lead (Pb +2) is considered to be quite active. Just counting the tons of materials used does not provide much useful information. Lead accumulates through the food chain and in human bodies year after year. Therefore, even small doses become dangerous after some time. Lead is a chemical element. It is highly persistent, for example, it does not decompose (rot, dissolve) as many organic substances do, into non- or less-toxic substances. Blue mussels are generally considered to have an especially high concentration of lead. Statistics by US health authorities show that the accumulation of lead in children's bodies dropped from 88 percent to 4.4 percent after the introduction of lead-free (unleaded) gasoline. Lead, while it was used in gasoline, was only a very tiny fraction in weight or volume in the gasoline as used for the family car. The transition level between harmless and harmful is set at 10 micrograms per decilitre (μg/dL) for children and 45 μg/dL for adults.

Lead-free progress

Boeing and other companies in the Aerospace Industries Association (AIA) have set up the Lead-free Aerospace Electronics Working Group (LAEWG) to propose a unified, industry-wide approach for the transition to lead-free production. LAEWG's purpose is to develop and implement actionable, deliverable items that enable the aerospace industry to accommodate the global transition to lead-free electronics. In turn, the deliverable items address issues that are unique to and within the control of the aerospace industry. Other organizations are encouraged to participate and share the results of their work.

Air Liquide, Houston (USA), offers electromagnetic pumps for lead-free soldering equipment because this variant shows significantly less corrosion than rotating or piston-based pumps as proven by research from Rahn-Tec, Canada.

Tundra Semiconductors (Canada), a world leader in interface and communication chips for AdvancedTCA, CompactPCI, VMEbus, and other interface standards, started offering in August, 2004 lead-free variants and green packaging for most of their chips. A list of lead-free chips on their website www.tundra.com shows the current status of lead-free and green products (product codes Y and V, respectively). Tundra quotes compliance for their lead-free parts with EU and Japanese requirements and specifically with the IPC/JEDEC J-STD-020B specification, Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices. Tundra recommends a tin/silver/copper alloy for lead-free soldering.

Celestica (Canada), one of the leading contract manufacturers worldwide, has an ongoing plan for conversion to RoHS and WEEE compliance that started in 1998. They also provide Electronic Manufacturing Services (EMS) consulting for their customers.

Xilinx (USA) started delivering lead-free products as early as 2002 for the European and Japanese markets compliant with the RoHS directive. They have delivered well in excess of 1.5 million lead-free chips.

Japan has laws about Promoting Green Purchasing, Promotion of Effective Utilization of Resources, Pollutant Release and Transfer Register (PRTR), and others. Companies such as NEC or Sony produce all their consumer products for the Japanese market in compliance with these laws.

JVC, Panasonic, and Thomson are working on a joint project to collect electronic waste in accordance with WEEE regula-

tions in Germany and other EU countries. This is to ensure that a system of return and recycling of waste can be established where community waste disposal centers or industry-wide collection systems are not available or not economic.

The Canadian Standards Association has issued a number of standards on environmental management, anaerobic biodegradability of plastic materials, green procurement, and many others.

Lead-free solder is available in the electronics/computer section of electronics stores such as Radio Shack, at prices of around $5 for a 56 gram (approximately 2 ounces) reel. There is no information about its long-term quality or suitability in specific applications. Scientific proof does not exist for traditional leaded solder either.

Manufacturers, distributors, and resellers selling or trading in the EU need to comply with WEEE by August 2005 and RoHS by July 2006. Therefore it is not necessary to quote their commitment. However, some have announced early compliance and support for their customers during the transition period. For example BuS Elektronik, (Germany), a medium-sized EMS, started soldering and assembling lead-free boards in 2002. They introduced reflow and selective lead-free soldering in 2003 and lead-free wave soldering in 2004.

Summary

It is important to start very early to have adequate time for experimenting and fine tuning. Doing just lead-free alone will not solve the issue. Getting the logistics right might very well be the more time consuming and costly part of the transition to lead-free and green operation.

Compliance to RoHS, WEEE, and similar Japanese legal requirements can be done both from a technology standpoint and economically. It reduces the amount of hazardous substances for everybody and reduces the size of the waste mountains significantly. In Japan, some consumer products have been produced lead-free for some years.

Numerous websites cover just about every aspect of lead free and green with focus on technical, political, or economic issues. Some entry points are listed at the end of this column as starting points for your own research.

For more information, contact Hermann at hstrass@opensystems-publishing.com.

For more information on environmental-related topics, visit:

RoHS Directive
http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_037/l_03720030213en00190023.pdf

WEEE Directive
http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_037/l_03720030213en00240038.pdf

General information on lead-free and waste reduction
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www.cdc.gov/nceh/lead/lead.htm
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www.jedec.org
www.leadfree.org
www.osha.gov/SLTC/lead/index.html
www.tintechnology.biz/soldertec/soldertec.aspx

Finer grain fabric structures continue to evolve with the introduction of MicroTCA

By Mike Franco

The original concept for MicroTCA was very simple: Advanced Mezzanine Card (AMC) modules in a backplane. The idea of AMC modules in a backplane is appealing because custom blades can be quickly developed from an assortment of AMC modules and can be combined to create almost any desired blade function. These AMC modules would be installed in a generic carrier or what is sometimes called a dumb carrier, with dumb meaning that primary compute power does not reside on the Conventional Carrier, as has been the practice for sometime. The Cutaway Carrier exists to maximize the size and utility of the module payload.

MicroTCA extends this concept with what the MicroTCA Subcommittee calls the Virtual Carrier, as show in Figure 1. In MicroTCA the Virtual Carrier can support up to 12 AMC modules of any form factor. This means that up to six times as much circuitry can be supported with a single VC Manager. And since the VC Manager has a 60 lane fabric switch, the boundary of the Virtual Carriers can have very substantial overlap, which creates the potential for enormous powerful and complex processing functions.

Virtual Carriers have another important advantage over AMC Carriers in that they can provide redundancy that is otherwise not possible. As AMC modules do not have redundant I/O as do AdvancedTCA Front Boards, other means are employed to achieve 6-nines reliability.

A few MicroTCA features

MicroTCA features include:

- 300 mm equipment practice with exhaust into an included rear channel
- Optional redundant configurations
- Support of all AMC form factors
- Optional configurations include hot swappable Virtual Carrier assemblies
- Support of true Full-Height AMC Modules, Extended- Height for full length of the module

MicroTCA benefits

MicroTCA is viewed as a way to greatly expand the scope of supportable applications while dramatically reducing cost. MicroTCA configurations will span implementation from as few as one or two AMC modules to frames with many hundreds of modules. These applications will diversify in numerous ways from MicroTCA's origins in such areas as telecom/enterprise to grid computing, Wi-Fi and Wi-Max, medical, industrial, and all the way into consumer products. This is because of technical capabilities of AMC modules and MicroTCA to be sure, but more importantly because of the value proposition that MicroTCA offers.

Reduced product cost

MicroTCA calls for standardized modules that are functionally interchangeable elements, helping to reduce product cost.

MicroTCA scalability substantially increases the range of MicroTCA applications, facilitating several orders of magnitude increase in production volume for AMC modules and hence substantially reduced cost.

MicroTCA dramatically reduces the cost of common elements (overhead). Compared with fully equipped AdvancedTCA Shelves, MicroTCA eliminates fabric boards and ShMC. Carrier boards canbe constructed more economically as a non-stacked individual FRU and can carry 50 percent more modules, which can be up to four times larger than in AdvancedTCA.

Expanded market

MicroTCA suits 300 mm and 600 mm equipment practice applications. Developers can also implement it in 75 mm, 150 mm, and 300 mm subrack configurations as well as in a 300 mm double rack utilizing front and rear access. One of the most important configurations is the partial shelf or cube configuration (see Figure 2).

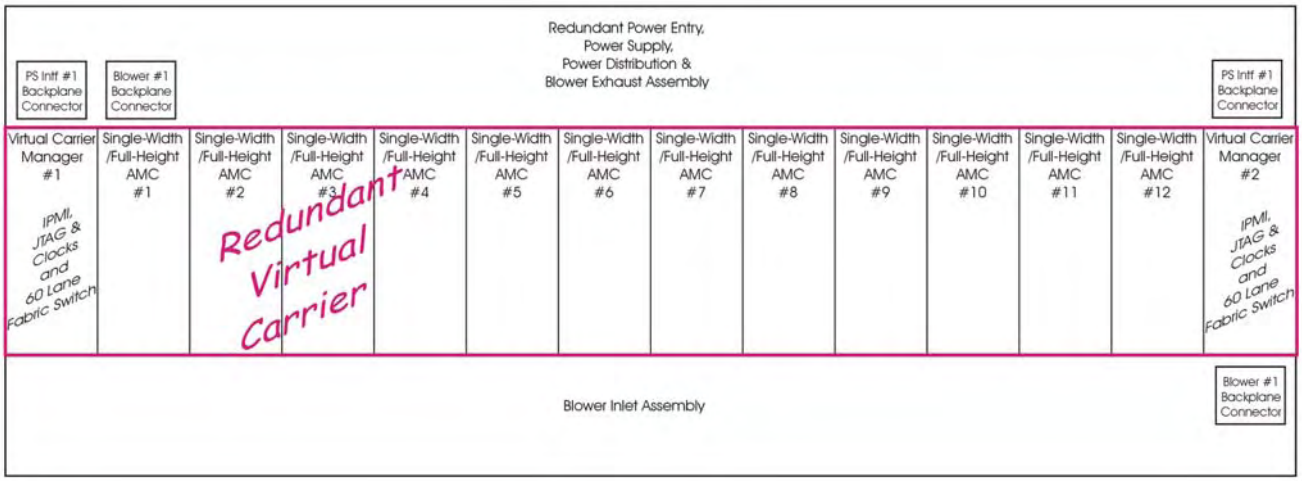

Figure 1

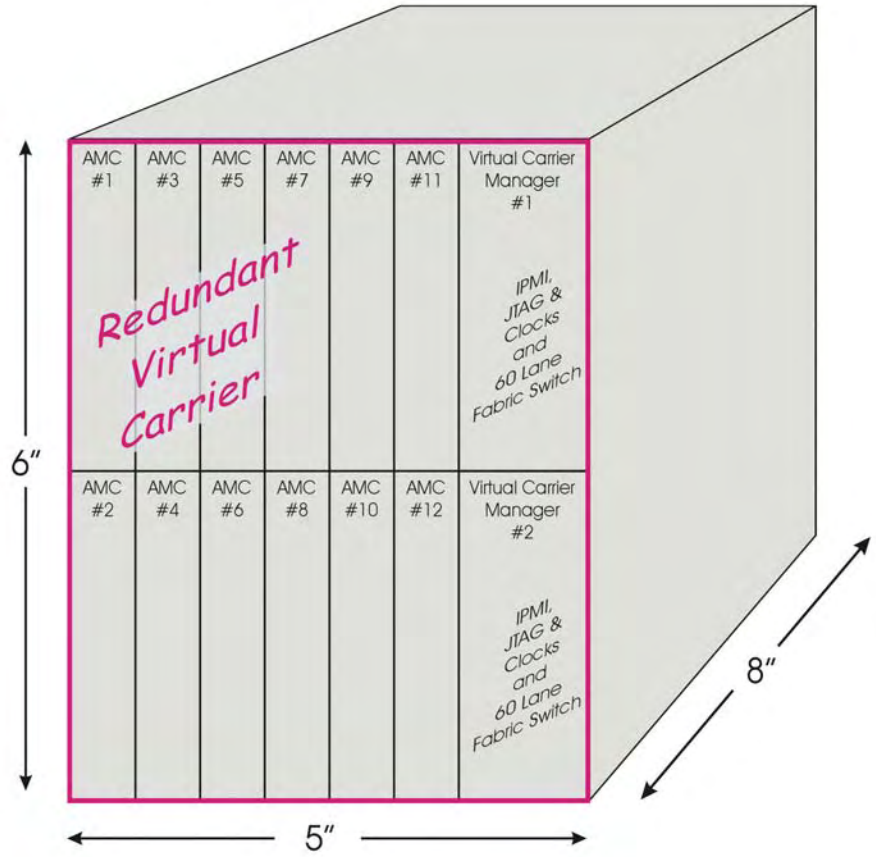

Figure 2

Faster time to market
Making products of standardized *Lego Blocks* shrinks development time by reducing the number of unique elements and their level of complexity.

Lower cost to upgrade
For example, say a developer has a new feature upgrade to a previously deployed system, which the developer would like to upgrade, but it requires a processor with additional processing capacity. Swapping out an AMC processor rather than swapping out a complete front board is far more cost effective. This is especially true because the front board integrates many other functions in an attempt to lower product cost.

Reduced impact of a failure
For example, a failed AMC line card might take out 4 T1 channels instead of an AdvancedTCA front board taking out 36 channels.

Reduced provisioning cost
Capacity can be more accurately right sized, if the T1s are added in groups of 4, 8, or 9, as with MicroTCA, instead of in groups of 36.

Reduced cost of spares provisioning
For instance in the T1 example cited earlier, regardless of the number of channels required, the spares required are probably one or two modules, not an entire 36 channel front board. This concept extends not only to the number of online spares, but to the number on the shelf as well.

Reduced time to repair or replace
As standardized function modules emerge, so too will standardized online functional tests that can evolve into a new generation of continuous background testing consuming a small portion of the channel capacity. These tests can be made to provide far more extensive coverage due to the nature of serial fabric topology. But the ability to refine and keep refining this test strategy relies on the limited number of standardized modules that will be required to implement any system. These modules will have a consistent function, enabling these tests to be readily be propagated to all modules of similar function.

MicroTCA basic elements

Virtual Carrier
The Virtual Carrier concept helps designers understand what the required functions to support AMC modules are:

- IPMI system management
- Fabric switch with up to 60 lanes of capacity

- Clock management and distribution (optional)
- JTAG interface and test (optional)

Virtual Carrier Manager (VC Mgr)

The Virtual Carrier Manager is targeted at providing all of the support needed for 12 AMC modules. The VC Mgr uses Carrier IPMC-like connections as defined in the AMC spec on the module side and ShMC (Shelf Management Controller) interface directly to the System Management via an in-band network connection as defined in the AdvancedTCA specification. This obviates the need for a separate Shelf Management Controller.

The VC Mgr also provides up to 60 lanes of Fabric Switch connectivity. This is intended to provide either Common Options Control Interface and the Fat Pipes Interface connections for 12 modules or may be configured as Common Options Control Interface to up to 60 AMC modules. Various configurations will exist supporting PCI Express, Ethernet, and others, which may be configurable on a port-by-port basis.

In addition the VC Mgr may provide clock management for Clocks 1, 2, and 3. Clock 1 is distributed by a radial bidirectional bus, while Clocks 2 and 3 are distributed by two bidirectional parallel buses.

Extensive JTAG support is planned so that remote diagnostics may optionally be done via the in-band management system. While this is optional, systems can include JTAG test engines that can individually test any system element.

MicroTCA backplanes

While there are hundreds of potential backplanes and midplane potential configurations, it is certain that some standard configurations will exist such as in Figure 1.

MicroTCA subracks

The subracks, like the backplanes potentially, could include hundreds of configurations, but unlike backplanes almost all subracks and shelves will be able to be assembled from standard components.

MicroTCA connectors

There are at least two new connectors being planned, a vertical entry backplane connector for AMC modules and a VC Mgr connector. The VC Mgr connector is quite challenging with about 650 pins including hundreds of differential pairs expected to support data rates to at least 10 Gbps.

Power interface and distribution

The MicroTCA power system has three components, the power entry module, power supply, and the power interface as shown in Figure 3. The power entry mod-

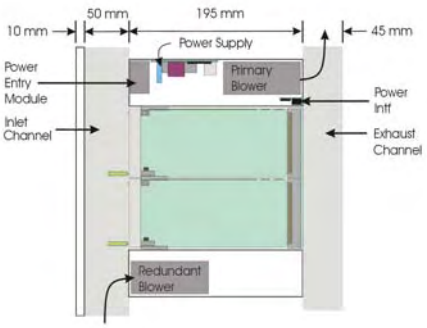

Figure 3

ule and power supply are consistent with the AdvancedTCA requirements.

There are multiple instantiations of Figure 4-2 in the AMC specification. The power interface distributes individual power feeds to each MicroTCA component. It also provides for redundant power system connection. Figures 4 through 7 show various MicroTCA configurations.

It's important to note that the efforts described in this column reflect one person's perception of the current thinking of the group, which is sure to evolve and change as the Subcommittee's work progresses.

The goal of the MicroTCA Subcommittee is to have running prototypes of at least two configurations at SUPERCOMM in the PICMG booth. Spec completion is scheduled for December with ratification expected in early 2006.

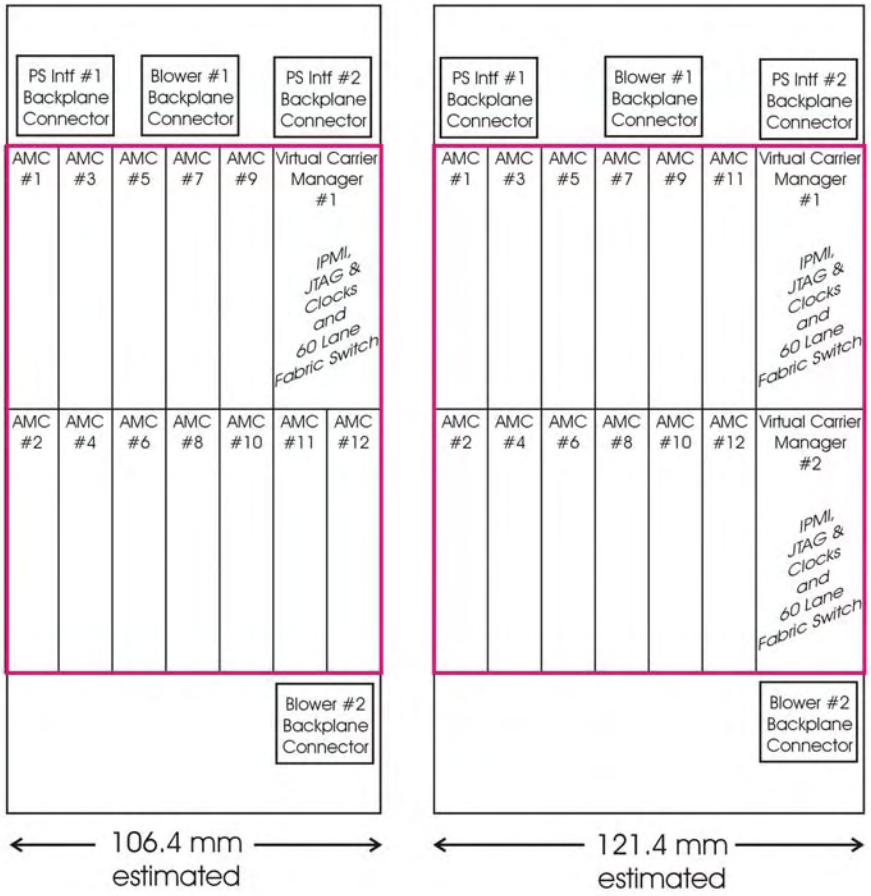

Figure 4

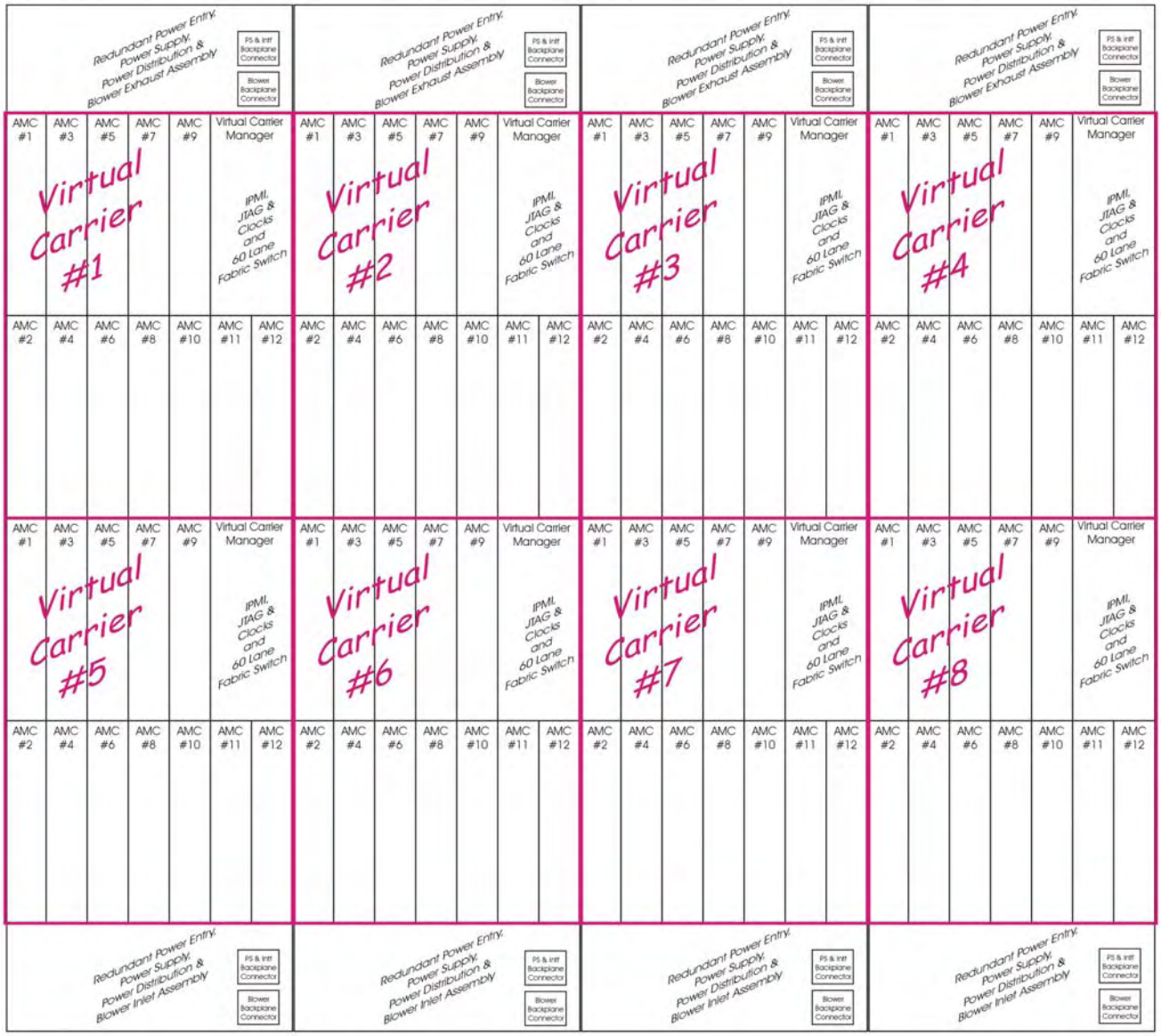

Figure 5

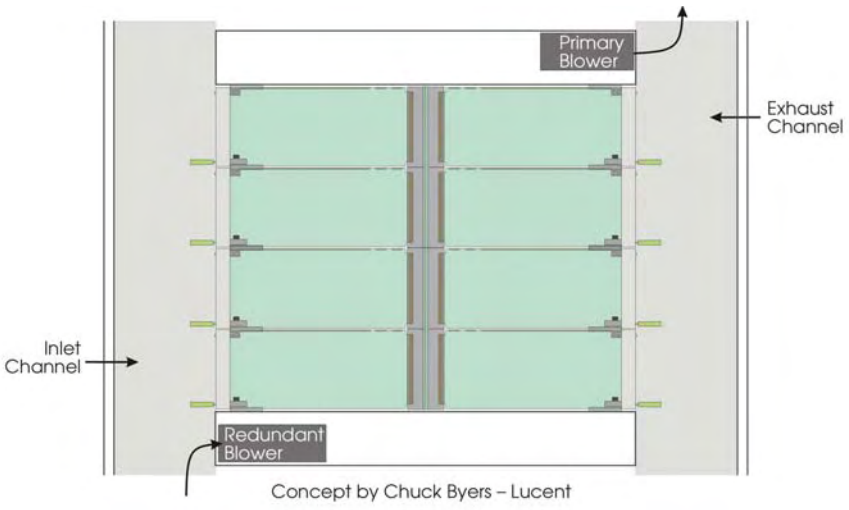

Figure 6

Mike Franco *is the chairman of MicroTCA PICMG Subcommittee and was draft editor of the PICMG AMC.0 specification, author of the mechanical, power, and thermal sections, and chairman of the AMC Connector Workgroup. The PICMG AMC spec work began while Mike served as Director of Advanced Technologies at Artesyn Communication Products. Mike is an entrepreneur, having founded and been executive officer of several companies in the medical-image networking and telecommunications industries. Currently he is president/CEO of Signal Stream Technologies, LLC, a telecommunications marketing and technology-consulting services company. Mike is currently serving as an advisor to CorEdge Networks.*

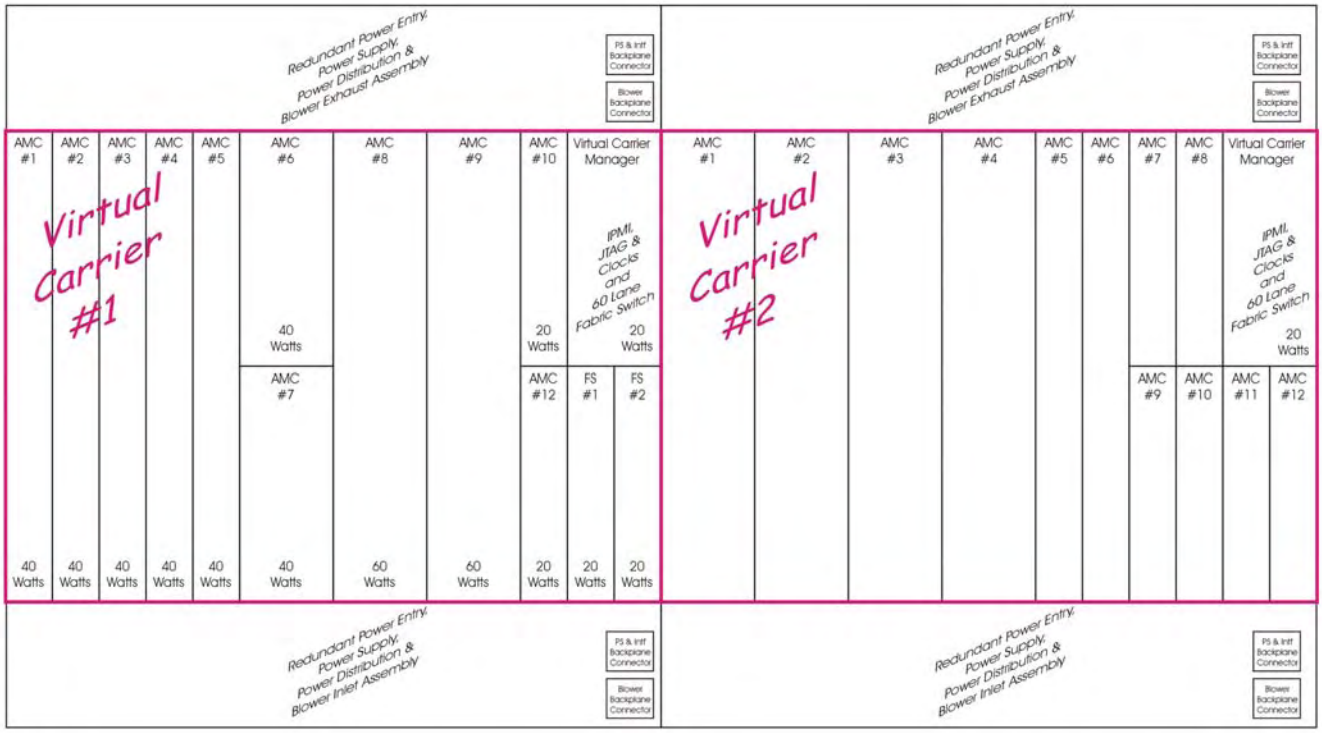

Figure 7

For further information, contact Mike at:

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E-mail: mjfranco@charter.net

Advanced Mezzanine Card (AdvancedMC) interconnect strategy

By Lawson Guthrie and Mark Summers

This is the third in a series of articles describing Advanced Mezzanine Card, the industry's next-generation mezzanine standard. This article summarizes the general interconnect strategy for AdvancedMC. For more information on the PICMG AMC.0 specification, see Lawson's and Mark's earlier articles in CompactPCI and AdvancedTCA Systems *on* AdvancedMC Design Goals *and* AdvancedMC Theory of Operations.

The PICMG AMC.0 specification defines the base requirements for a new mezzanine standard optimized for serial interfaces and the AdvancedTCA form factor. These requirements include definitions of mechanical, power, thermal, interconnect, and management functions. It is important to note, however, that PICMG AMC.0 does not include guidelines that define the use of specific protocols such as PCI Express, Advanced Switching (AS), and Gigabit Ethernet. For protocol-specific implementation guidance, the industry is defining subsidiary specifications guided by the general interconnect design goals presented in PICMG AMC.0.

The value of such a general interconnect mapping strategy is to maximize compatibility and interoperability between different AdvancedMC implementations to enable greater market acceptance of the specification. This article outlines AdvancedMC's interconnect design goals and provides an overview of AdvancedMC subsidiary specifications for various protocols.

AdvancedMC interconnect design goals

The AdvancedMC interconnect strategy was developed to meet four major design goals:

- Define specific regions of the connector for signal assignment. Figure 1 illustrates how mapping the AdvancedMC connector defines primary regions for both the basic connector (eight duplex ports) and extended connector (21 duplex ports).
- Optimize port assignments to support the most common usage models on the basic connector with eight ports. Devices that require higher throughput would utilize the additional ports provided by the extended connector.
- Eliminate the redundant definition of common options that are applicable across multiple subsidiary specifications. Common options, such as storage and control ports, are to be defined once and subsequently referenced by other subsidiary specifications.
- Encourage the combination of multiple protocols as defined in any of the connector regions, so long as the ports are mutually exclusive. The industry is encouraged to combine nonconflicting ports from any subsidiary specifications and from any of the three AdvancedMC connector regions.

These interconnect design goals provide governing principles and objectives to help define the AdvancedMC interconnect strategy. Additional guidance was also provided to AdvancedMC subsidiary committees to encourage compatibility and interoperability during the definition of specific protocol implementations.

Mapping the AdvancedMC connector regions

As shown in Figure 1, the basic and extended AdvancedMC connectors define regions on the connector for signal assignment in support of the four design goals listed in this article. This mapping provides standardized definitions of how clocks and ports are to be assigned to support a variety of applications and data path connections.

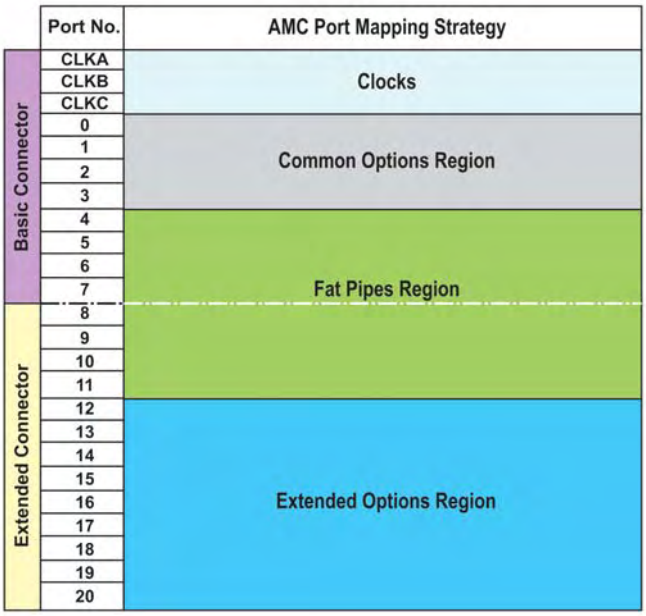

Figure 1

Clocks region

The clocks region provides three differential pairs for clock distribution for applications that require the exchange of synchronous timing information between modules or between multiple boards in a shelf. This allows modules to source clocks to the system when a module provides a network interface function, or to receive timing information from another carrier board or module within the system. The three synchronization clock signals are CLK1, CLK2, and CLK3. A differential pair supports each signal.

Common options region

The common options region is defined to support the essential interfaces that are common across multiple fat pipe implementations. A fat pipe, so called because a larger diameter pipe will carry more fluid at a greater rate than a smaller one, is a data transmission circuit or network that can carry large amounts of data without significantly degrading transmission speed.

This strategy helps to ensure a standardized means of defining common options across multiple fat pipe subsidiary specifications, while avoiding redundancy. Each common interface is defined only once, and it can be used in conjunction with other fat pipe interfaces or used independently.

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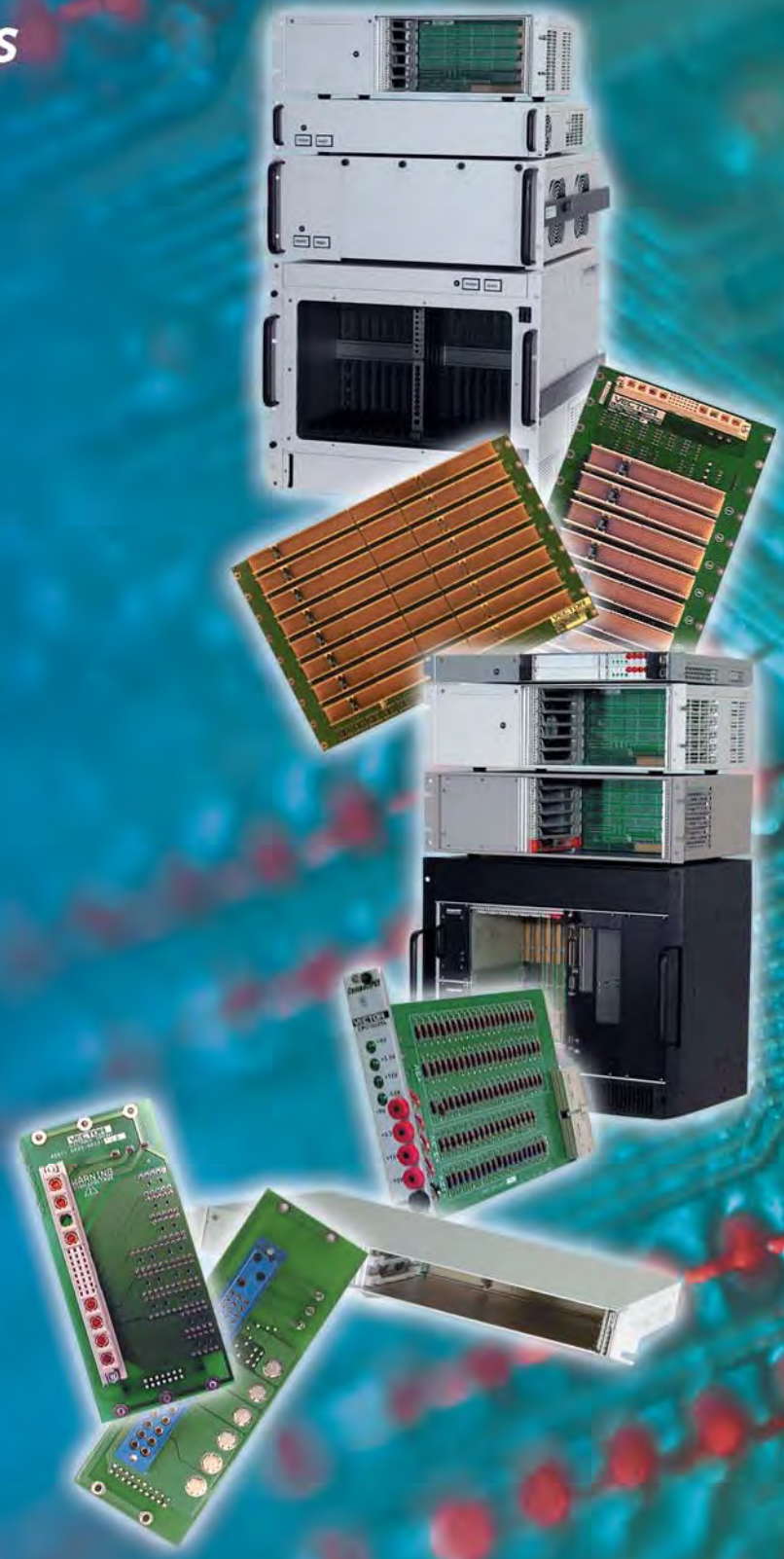

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The common options region is defined as Ports 0-3 to ensure their availability on a basic connector. Control path interfaces are defined for general use on Ports 0-1. Storage interfaces are defined for use on Ports 2-3. The extended options region is to be used when additional ports are needed, in ascending order starting from Port 12.

Fat pipes region

The fat pipes region is defined to support large amounts of data. The AdvancedMC fat pipes region is defined to support data path connections such as PCI Express, AS, XAUI, and Serial RapidIO (SRIO).

For first-priority usage, the fat pipes region reserves eight contiguous ports (Ports 4-11) for data transmission. The first four ports are defined on the basic connector (Ports 4-7), and the remaining four ports are on the extended connector (Ports 8-11). If more than eight ports are needed, the remaining 11 ports on the extended connector may be used, for a total of 17 ports.

Extended options region

The extended options region is loosely defined but recommended for use for RTM support. It is also recommended for use as an extension of both the common options and fat pipes regions when additional ports are needed.

The RTM definition is to be defined in descending order, starting with Port 20. This minimizes conflict with extensions from the common options and fat pipes regions, which will assign ports starting from Port 12 in ascending order.

Non-LVDS interface guidance

Support for non-LVDS (Low Voltage Differential SCSI) interfaces will typically require most, if not all, of the pin assignments on an AdvancedMC connector. As a general rule, non-LVDS interfaces are encouraged to begin definition in the extended options region in descending order, starting from Port 20. This preserves use of the common options and fat pipes regions to the extent possible.

AdvancedMC subsidiary specifications

Based on the AdvancedMC interconnect design goals outlined previously, four PICMG subcommittees have been formed to define the initial wave of AdvancedMC subsidiary specifications.

PICMG AMC.1 – PCI Express and Advanced Switching
AMC.1 defines support in both the common options and fat pipes regions.

- In the common options region a PCI Express control port is defined with a x1 Link width on Port 1.
- In the Fat Pipes Region, x1, x2, x4, and x8 Link widths are defined for both PCI Express and AS.

While a x16 link width is possible using the extended options region, the subcommittee determined x8 links to be sufficient. The Gen1 PCI Express line-rate of 2.5 Gbps in each direction equates to 20 Gbps per mezzanine. Support for Gen2 PCI Express at an anticipated 5 Gbps line rate has also been defined.

AMC.1 released simultaneously with AMC.0 in January, 2005.

PICMG AMC.2 – Gigabit Ethernet and XAUI
AdvancedMC.2 defines the implementation of Gigabit Ethernet and 10 Gb, four-lane XAUI Ethernet (XAUI) interfaces on an AMC.0 module and carrier board. Similar to AMC.1, AMC.2 defines support in both the common options and fat pipes regions.

- In the common options region, a 1 Gigabit Ethernet or 2 Gigabit Ethernet Serializer/Deserializer (SERDES) connection can be defined as a Control Port via Ports 0 and 1.
- The fat pipes region can support:
  – One to four Gigabit Ethernet SERDES ports, utilizing Ports 4-7 of the basic connector.
  – One or two 10 Gb, four-lane, XAUI Ethernet ports on Ports 4-7 and 8-11.

PICMG expects to ratify AMC.2 in the second quarter of 2005.

PICMG AMC.3 – Storage protocols
AMC.3 defines the implementation of storage protocols such as Serial Attached SCSI, Serial ATA, and Fibre Channel (FC). The primary ports dedicated to these protocols are Ports 2 and 3.

AMC.3 is expected to be ratified by PICMG in the first quarter of 2005.

PICMG AMC.4 – Serial RapidIO
At press time, AMC.4 was still in the formative stage. AMC.4 may define both the common options and fat pipes regions for SRIO.

Anticipated subsidiary specifications

Additional protocols were explored by the AMC.0 subcommittee to verify their support and compatibility with the interconnect design goals, including SPI-4.2, RP3, TFI-5, and UTOPIA II. While preliminary layouts confirmed that these protocols are supportable, there are no current plans or subcommittees actively defining these interfaces.

Summary

A general interconnect mapping strategy for AdvancedMC maximizes compatibility and interoperability between various AdvancedMC implementations and is intended to facilitate acceptance of the specification. This port-mapping strategy enables flexible combinations of protocols to work cohesively together. For example, the protocols of AMC.1 and AMC.4 can both be mapped onto an AdvancedMC. This combination of protocols greatly expands the number of potential usage models, facilitating market acceptance of this new series of standards by the telecommunications industry.

Lawson Guthrie *is a strategic initiatives manager in Intel's Communications Infrastructure Group. He currently serves as secretary of the AMC.0 base specification and AMC.2 (GbE) subsidiary specification, as well as chair of the AMC.1 (PCI Express and Advanced Switching) subsidiary specification. Lawson has held various positions in strategic marketing over his 17-year career, focused on technology definition for network operating systems, desktop management, and telecommunications.*

Mark Summers *is a technical marketing engineer in the Intel Embedded Architecture Division developing new markets for Intel products and technologies. As chairman of the PICMG AMC.0 subcommittee, Mark is focused on assuring a successful industry specification that will be readily adopted by industry. During his 20 years of technical experience (as employee of Motorola and Intel) spanning commercial, industrial, and military electronics markets he has been issued 22 US Patents and has authored numerous technical journals.*

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ADVANCEDTCA CONNECTORS

This newly developed architecture and system layout allows manufacturers of telecom equipment a new standard for designing systems. ATCA stands for ***Advanced Telecommunications Computing Architecture***.

The basic structure is utilizing a modular concept. Application of this new structured approach allows various module designs that are compatible in layout and mechanical installation.

The PICMG Group created the PICMG 3.0 Standard. This Standard specifies the mechanical details with regards to input/output, voltage, current and connection parameters. Control, backplane layout and system architecture are part of the standard.

CONEC developed unique socket press fit contacts for this series of connectors. The socket contact utilizes high reliability screw machine components combined with stamped and formed press fit zone. CONEC has developed a new family of connector products that adhere to this new Standard. Products such as plugs and sockets, high power and signal contacts, have been developed.

This new connector series ia available with press fit and through hole contact types.

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Improve design quality through early, focused verification testing

By Kathy Breda and John Crossin

Human nature is a constant thorn in our sides. If only it was easier to do the right thing all the time instead of what is easiest. We know that we should watch what we eat, exercise, not drink too much, and think before we act, but very few of us consistently follow these guidelines.

Since engineers are humans too they often succumb to the perils of ease. Some may gamble that by implementing a design specification, along with a healthy dose of hard-knocks experience, that the finished product will have a reasonable probability of success. The downside of the risk can be catastrophic to a product line and a company. Missing a market window, trailing revenue goals, redistributing resources to fix a problem, and holding off potential customers can wreak havoc with any company's resources and leave a trail of unhappy customers and employees.

Early design validation

The odds can be tipped in favor of a successful design by shifting design validation from the end to the beginning of the development cycle. Validation is only useful if you have the time in the development cycle to understand and integrate the results into the design. It is often very costly to make substantive changes late in a design cycle, so amendments are often avoided. Change in behavior can be hard work, and it does not help that performing complete design validation is a detailed, methodical, and time-consuming task.

The answer to this challenge is to utilize design methodologies and tools to hybridize and focus verification and *what-if* analyses early in the design cycles, without hindering the development schedule. Industry standards such as AdvancedTCA and various design tools, such as AdvancedTCA analysis products, can assist engineers' early design validation activities. This article will focus on the utilization of these types of solutions.

The big picture

As companies vie to develop new products quickly, the constant tradeoff between the time and cost of innovative internal design, versus the need for verified quality and reliability, continues to be a problem.

New specifications such as AdvancedTCA have attempted to address this situation by defining such things as physical and electrical requirements for enclosures, logic modules, and backplanes. Adoption of these specifications allows companies who specialize in chassis or logic card design to concentrate on their core competencies and begin development without having to wait for the other components to be readily available. The result is that products can be available for sales sooner at a reduced development cost. In addition, full compliance to the current and future versions of standards allows products to be available for sale longer. All of these benefits should yield a greater financial return for the development effort.

However, before these products can be released they need to undergo extensive evaluation to insure that the intended specifications and regulatory requirements are met. This is time consuming and technically challenging since it can be like solving an equation with too many undefined variables.

For example, the enclosure developers must verify the thermal and signal integrity characteristics of their product before the product can be released. This includes all possible combinations of components and fault conditions. Conditions such as power dissipation per slot, effects due to unused slots, and number and type of air movers must be evaluated. Since few companies develop all the components required for a complete system, there is often a problem of how to insure verification for the early adopters.

To address this problem the early developers have a few choices. Simulation analysis may be undertaken as one alternative. For example, CFD analysis may be performed to insure that the chassis provides adequate cooling for all the fault conditions and component choices. In order for CFD to be utilized for a new design, system models must be created and verified. Validation of these models generally requires creating prototypes for all the components. This is time consuming and redirects engineering resources from the primary goal of getting the product completed and released. While this may be a reasonable possibility for an enterprise that has made this investment, it is cost and time prohibitive for companies who do not have the tools, expertise, or funding to complete such a rigorous program.

Signal integrity analysis can be even more difficult than thermal analysis. While tools are also available, the level of expertise required to obtain valid results is quite high. Simulation models must be created and verified, interconnect characteristics understood, material choices, layout, and fabrication rules must all be considered and blended for optimum design choices. There are many signal integrity tools available. However, these tools are complex to use and require considerable experience to prevent solutions that *appear* correct yet are not an exact representation of the actual system. In the end, it comes down to understanding whether the input and output is correct and what to do with the results. Again this is usually beyond the capabilities of many specialized companies because signal integrity analysis is not a core competency of most product development teams. Adding this capability to the development program is

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expensive and adds risk to releasing the product on a predictable schedule.

Focus on the essential design parameters

Since there are many analyses alternatives and no silver bullet, early design verification can succeed if analyses are focused on crucial design parameters. Accounting uses an *acid test* ratio to quickly verify a company's viability. Engineers can perform a similar series of tests on their products early on by focusing on key areas such as:

- Thermal and power dissipation
- Skew and connectivity (Time Domain Reflectometry, or TDR)
- Signal impedance (Time Domain Transmission, or TDT)

This allows early insight into the component and system characteristics, focuses design efforts, and helps insure that the products will operate as intended and meet the required design specification requirements, such as AdvancedTCA.

For example, the AdvancedTCA specification requires dissipation of 200 watts per slot under all airflow conditions. Understanding all the requirements and combinations of slot population and fan failures can be a daunting exercise. Creating and running the permutation of combinations in a simulation program requires a significant investment of an engineer's time. Instead, using an off-the-shelf thermal and power analysis blade, such as Fulcrum9's AdvancedTCA ThermalBlade, as a stand-in for an AdvancedTCA logic card to mimic typical logic module heat dissipation, airflow, and component heights, enables an *acid test* for operability and specification compliance. For example:

- Baseline fans may be turned on and off.
- Power and thermal dissipation can be adjusted to simulate differing conditions.
- Measurements can be taken.

Using the resulting data engineers can verify the margin of thermal capacity, airflow resistance, and the thermal profile of their intended chassis as a function of power and fan blower type. In any slot, they can detect on-card hot spots and thermal eddy points where component temperature limits might be exceeded. This type of testing provides engineers with the benefits of early design verification as well as the advantage of what-if analyses. The focus on key design parameters, such as those already discussed, enables engineers to make thoughtful, concise design decisions and revisions without damaging budget and schedule.

In a different example, an engineer may need to verify whether a backplane meets the AdvancedTCA matched delay requirement (otherwise known as skew) of 17 ps within a channel. This is just one of the many requirements a product must adhere to if it is to be considered AdvancedTCA compliant. Assuming logic cards for the system are not readily available, a designer can either wait until they are fabricated, or

develop a stand-in test card that has exacting signal integrity to insure the measurements taken will be for the device under test and not the test equipment or connector system. This may not be feasible due to engineering resource capabilities or the time and funding involved in such a development. However, by using an off-the-shelf test card, such as Fulcrum9's Tx/Rx SignalBlade, as a stand-in for the missing logic cards, an acid test for operability and specification compliance can be performed. By performing TDT through the stand-in logic cards that populate the backplane slots, measurement delay of transmit or receive channels can be performed and analyzed to provide the match delay results. In addition, measuring the propagation properties of the channels on the backplane (through the stand-in logic cards) yields a good, basic understanding of the backplane's signal fidelity. An engineer can drill down a bit further using the Fulcrum9 Tx/Rx SignalBlade to understand if the backplane was constructed properly and if any discontinuities or faults exist on the board by performing TDR, analyzing signals through connector pins as they relate to layers of etch. This type of what-if analysis can prevent the fabrication of faulty systems and save a company from a costly mistake. Through focusing on essential areas of interest, an engineer can verify key parameters early in a product's design cycle.

Summary

The prime focus of every development company is to get their product into the market as quickly yet reliably and inexpensively as possible. By changing design habits and performing design verification early in the design as well as focusing on the verification of the most significant design features, the chances of a successful product launch increase dramatically.

Kathy Breda *brings more than 20 years of business and product development experience to the electronics industry.*

For the past decade Kathy was the Director of Business Development for North East Systems Associates, Inc. (NESA), a high performance Signal Integrity design firm, serving clients worldwide. Her experience spans sales, management, marketing, and technical product development.

A graduate of the University of Massachusetts, Kathy holds a BA degree in Business Administration with a concentration in marketing and economics.

John Crossin *brings more than 25 years of diverse business and financial experience to the electronics industry. He has held senior positions with rapid growth private and publicly held firms alike, and has served as a technical and financial advisor with numerous early stage and established companies.*

A veteran of the high technology startup environment, John was one of the founding members at both Argon Networks (later acquired by UniSphere Solutions) and Alliant Computer Systems. At Argon and Alliant as well as at Bay Networks (Wellfleet Communications), Cereva Networks, and DEC, John has had executive level responsibility across the business and technical spectrum.

A graduate of Rennsselaer Polytechnic Institute and Worcester Polytechnic Institute, he holds Master degrees in both engineering and management. He is also a Registered Professional Engineer.

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Legacy telecom hits the 21st century: TDM circuits on AdvancedTCA switch fabrics

By R. Brough Turner

AdvancedTCA has gained substantial traction in the telecommunications industry because it's extremely scalable and it fully supports telecom approaches to power, cooling, packaging, reliability, management, and serviceability. The only thing it hasn't done well, at least so far, is support traditional Time Division Multiplexed (TDM) circuit switching. From the beginning, AdvancedTCA was focused on meeting the needs of the evolving telecommunication industry by, for example, supporting the move to packets and taking advantage of emerging high-speed serial interconnects and next generation silicon.

Substantial TDM legacy

But TDM has not gone away. In fact, for voice traffic, the conversion to Voice over IP (VoIP) has barely begun. IP-PBX sales began to take off in 2003 and consumer VoIP (Vonage, ATT CallAdvantage, Skype) has gotten considerable publicity over the past 12 months, but penetration rates are tiny in the context of more than 1 billion fixed and 1.7 billion mobile telephones in the world today. And globally, the mobile phone industry is adding several hundred million new subscribers each year. Some of these new users get packet-based access to data services, but they all get voice services, and virtually all these new mobile voice services use traditional circuit-switching technology. Yes, the conversion to Voice over Packet will happen, but it will take decades, during which the new VoIP infrastructure will have to interwork with traditional TDM networks and TDM devices.

Of course this need was not lost on AdvancedTCA working groups. The AdvancedTCA base specification includes a full set of redundant TDM clocks. These clocks are also available on Advanced Mezzanine Cards (AMCs) and are being incorporated into the evolving MicroTCA specification. In each case, the assumption has been that TDM interface modules convert incoming TDM signals to packet protocols so TDM can be transported over the native switch fabric (Ethernet, StarFabric, and other switch fabrics) in the AdvancedTCA chassis. But available packet protocols couldn't meet all the requirements for legacy TDM support.

VoIP protocols such as RTP/UDP/IP emulate individual phone calls over the Wide Area Network (WAN). As such they introduce substantial latencies, for example, 5 ms, 10 ms, 20 ms for basic packetization, and three times that or more, on an end-to-end basis. Furthermore, schemes for multiplexing multiple VoIP streams have always been an afterthought, not widely standardized.

There are also two competing WAN protocols called TDM over IP (TDMoIP) and Psuedo Wire Emulation Edge-to-Edge (PWE3). But both of these were designed for edge-to-edge over a WAN. As such they include sophisticated clock recovery schemes, but no switching. For TDM on an AdvancedTCA backplane, we don't need clock recovery as we already have robust clock signals, but we do need switching for many applications. So work on TDM transport has been ongoing within PICMG since late 2003, and the solution is now available.

Internal TDM

In March 2005, PICMG announced final ratification of the Internal TDM specification (PICMG SFP.1), a.k.a. I-TDM. This is a TDM-over-Packet standard optimized for AdvancedTCA and similar packet backplane applications. Indeed, I-TDM provides more capability than classic TDM buses like the H.110 bus used with CompactPCI. And while early focus has been on I-TDM over Ethernet, I-TDM is transportable on a wide variety of AdvancedTCA recognized switch fabrics.

The AdvancedTCA requirements for I-TDM are:

- Dense TDM interconnection between modules
- Low latency TDM switching (500 μsec desirable; < 1.6 ms mandatory)
- High capacity (much greater than H.110; OC-12's worth per module desirable)
- Efficient (support high call rate and high switching rates)
- Easy to interface to general purpose CPUs

The sidebar gives an I-TDM overview. The next two sections show system examples where I-TDM solves fundamental implementation issues and subsequent sections present I-TDM protocol details.

Wireless backhaul optimizer

In mobile networks, a mobile switching center handles traffic for hundreds or thousands of cell sites. The links between the radios at these cell sites and the central switching facility use TDM or ATM protocols carried on T1/E1 facilities, typically leased from the local incumbent carrier at

SIDEBAR

I-TDM Overview

- High capacity: Approximately 10K DS0s per module
  – 100Ks of DS0s per shelf
- Low latency: 1 ms and 125 msec packet rates
- Low overhead: Up to 512 DS0s per packet
- Software friendly: 64-bit aligned fields
- TDM switching via grooming
  – Easy grooming of DS0 channels within packet flows
- Options for multi-DS0 *bonded* channels and transport to CAS signaling

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considerable expense. Backhaul optimizers reduce the required bandwidth using lossless compression. Figure 1 shows the blades in the central site equipment shelf that handles hundreds of backhaul links. A key issue is latency. Mobile telephony already involves substantial delay, which you can observe by calling mobile-to-mobile to a friend in the same room. Even a few milliseconds of additional delay can impact voice quality.

At the Central Office, multiple T1 or E1 trunks are delivered to the optimizer over redundant OC-3 optical facilities. One OC-3 pair faces the cell sites while the other OC-3 pair faces the central equipment. The 6+1 redundant AccessGate 1000 cards shown in Figure 1 are protocol processors capable of handling compression for several hundred bidirectional DS0 equivalents. Since the basic increment is either E1 or T1, I-TDM is used to carry multiple E1/T1 payloads between the optical interfaces and the media cards. The connections at the bottom of the figure show the active I-TDM flows. These packet flows are physically carried over the backplane Ethernet fabric (shown at the top of the figure). The entire system is TDM-centric. I-TDM provides the equivalent of a TDM bus and switch fabric but with less cost and substantially greater scale than traditional TDM bus implementations.

Media processing platform

Figure 2 shows an enhanced services platform that includes both the applications processor(s) and the media processing components to support multiple applications like voice mail, interactive voice response, conferencing, and delivery of other audio content to fixed and mobile telephones. For systems of a few hundred channels or less, all media services can be provided with software running on a general purpose processor. At higher densities, special purpose DSP blades provide better performance per watt and per slot. In either case, with VoIP protocols, each media stream has its own packet flow of 50, 100, or 200 packets per second, so several hundred media flows require tens of thousands of packets per second. Processing full RTP/UDP/IP headers at such packet rates can consume more than half the MIPS of a general purpose processor and add substantially to the requirements on a DSP blade.

When providing media services into a TDM network, it makes even less sense to convert the TDM signals to VoIP protocols within the chassis. A much more efficient approach is to use I-TDM within the AdvancedTCA chassis. With I-TDM at a 1 millisecond packet rate, a single packet flow of 1,000 packets per second handles hundreds of media channels and the processing overhead for the 64-bit aligned I-TDM headers is significantly less than that required for VoIP protocols. As a result, processing overhead at the media processor is reduced from 50 percent of CPU MIPS to perhaps 2-4 percent of CPU MIPS.

At the line interface, conversion from TDM (T1/E1/OCx) to I-TDM has roughly the same hardware complexity as an H.110 bus interface. Conversion from VoIP protocols to I-TDM protocols has similar complexity. So even in a purely VoIP system, it can be advantageous to convert VoIP protocols to I-TDM at the line interface so as to make more efficient use of media processor resources.

I-TDM on a range of AdvancedTCA fabrics

I-TDM is simple protocol that can be implemented on top of a variety of switch fabrics. The principal things I-TDM needs from a Layer 2 protocol are a flow ID and timestamps. When these are not available, a shim layer called System Fabric Plane (SFP) is available to fill the gap. In partic-

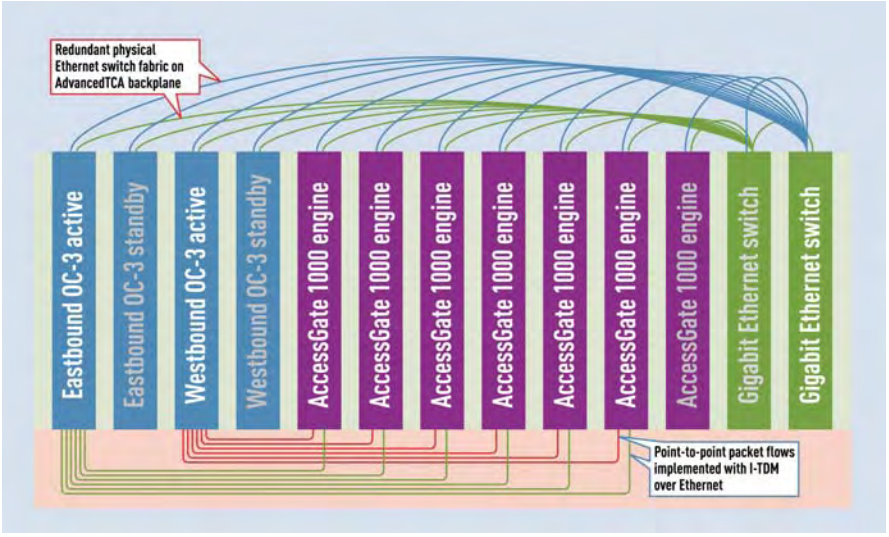

Figure 1

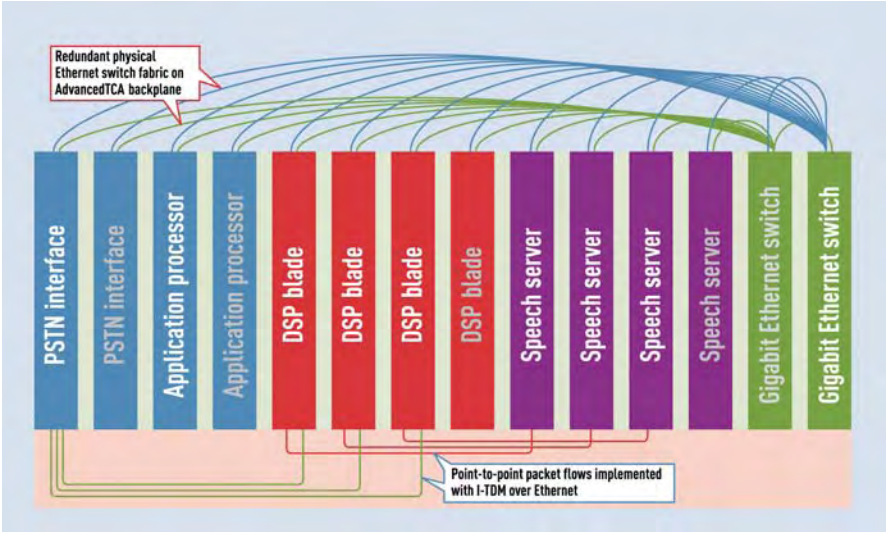

Figure 2

ular, Gigabit Ethernet is the most widely used AdvancedTCA switch fabric and the first target for I-TDM. As Ethernet headers do not include timestamps or a flow ID, SFP is used.

For PCI Express Advanced Switching Interface (ASI), an adaption layer that supports flow IDs and timestamps is already available in the form of Peripheral Interface 2 (PI 2). The Serial RapidIO case is still to be determined. See Figure 3.

I-TDM protocol details

Figure 4 shows the relative arrangement of headers for I-TDM over the SFP shim over Ethernet. Notice that header fields are 64-bit aligned for easy manipulation in software on general purpose processors. SFP timestamps are in 5 μsec increments. The flow ID identifies the destination as well as the payload type (control or data), the payload format, and the packet rate.

Within I-TDM, there are two basic payload formats, one used to emulate low-latency TDM transport and switching at a nominal 125 μsec packet rate and one focused on media processing that uses a nominal 1 ms packet rate. The 1 ms packet format is required while the 125 μsec packet format is optional. Figure 5 shows the internal packet organization for 1 ms I-TDM packets. This is ideal for media processing and most other purposes, except TDM switching. In this format, the 16-bit channel ID identifies a specific destination, for example a specific DSP on a media processing board containing multiple DSPs.

Figure 6 shows the internal packet organization for 125 μsec I-TDM packets. In the 125 μsec payload format, individual channels are identified by their location within the packet. A 64-bit channel management structure, sent once per packet, manages up to 512 bytes (DS0s) per packet flow. Each channel management command must be acknowledged and activated before additional commands can be sent, so updating 512 DS0s can take as much as 512 ms. On the other hand, a bonded

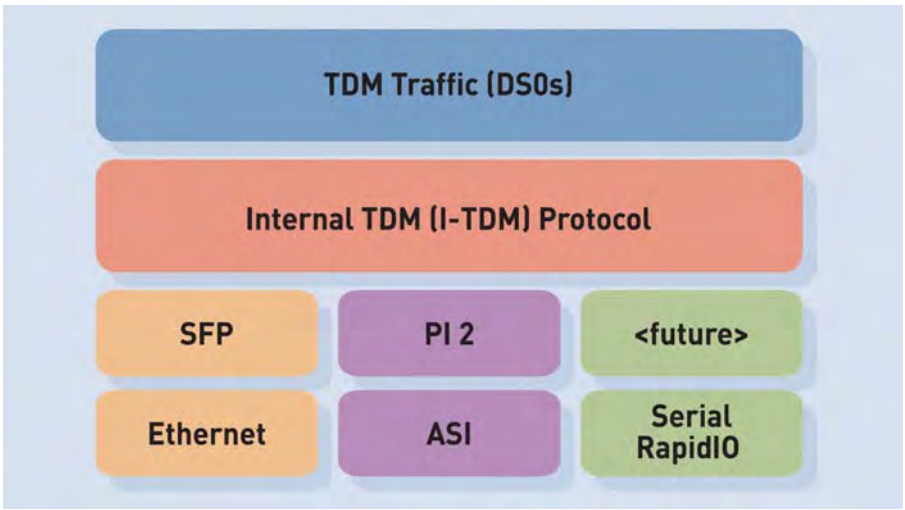

Figure 3

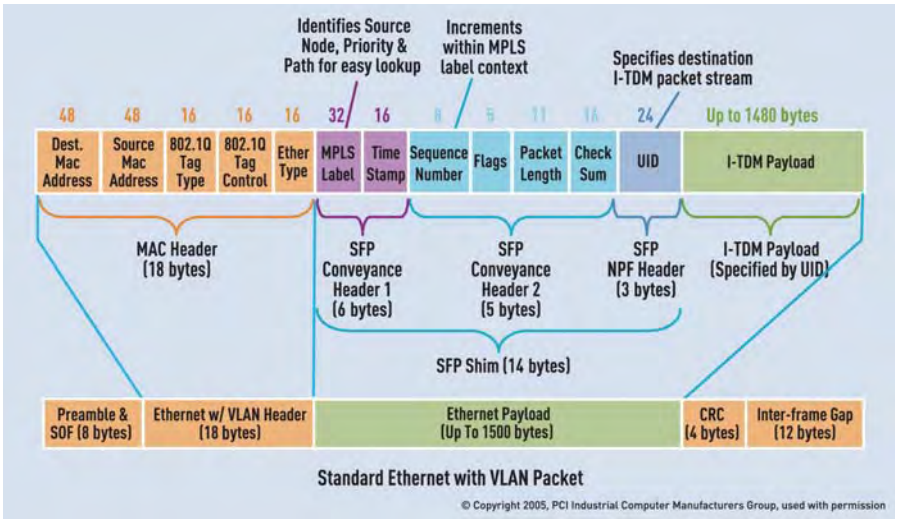

Figure 4

group of 24 or 30 channels can be established with one command, so systems like that of Figure 1 are able to establish a complete mapping of multiple E1s in just a few milliseconds.

Because channel identification is based on position, the endpoints must maintain state information. When there are no new commands, the channel management structure is used for a cyclic reaffirmation protocol so endpoints can confirm their synchronization.

I-TDM grooming

With multiple DS0s per packet flow and active media processing that includes new calls arriving and old calls ending, it is inevitable that individual DS0 channels within a packet flow will get fragmented and the data structure will develop gaps where active calls have terminated. To handle this, I-TDM includes a grooming function that allows easy reallocation of TDM channels within one or more I-TDM packet flows. The source node is responsible for bandwidth optimization. As channels are reassigned, the destination node reacts accordingly.

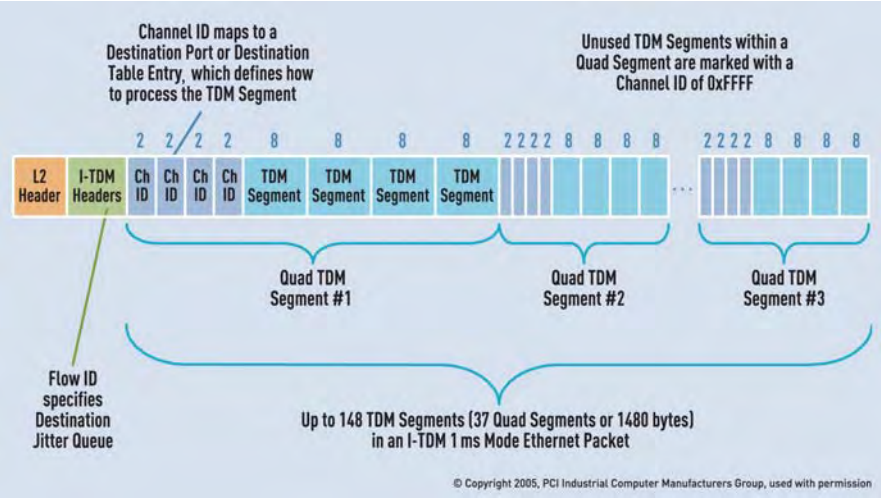

Figure 5

I-TDM call control

Nodes within an AdvancedTCA system are typically autonomous, that is they are loosely coupled with other nodes using well defined protocols over a packet-based

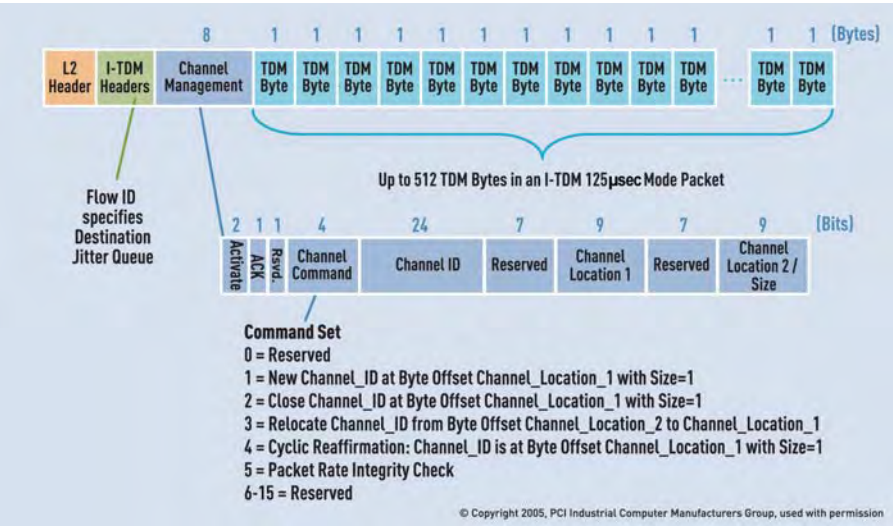

Figure 6

control fabric or a control VLAN running on top of a shared control and data fabric. Establishing and clearing I-TDM connections between autonomous nodes is done using standard call control stacks, preferably Session Initiation Protocol (SIP). This may be by direct interaction of the two endpoint nodes or it may be done with SIP 3rd party call control if a separate application processor needs to directly control connections between modules.

In a practical implementation, there may be a lower level software interface, for example, a device driver for an I-TDM chip or a device driver for the operating system on a general purpose processor. Due to the variety of potential operating environments, the interface to such a driver has not been standardized. On the other hand, the multiplexing of channels into a single packet is completely specified and is handled by the chip, firmware or device driver implementing I-TDM. In other words, at the SIP layer, connections look like point-to-point TDM links, not multiplexed TDM packets. This allows SIP to simply connect channels (DS0s or bonded groups of DS0s). The lower layers completely manage the multiplexing of many channels into a single packet, hidden from the SIP layer.

I-TDM status

The I-TDM specifications grew out of work that had been going on within specific companies between 2000 and 2003. A PICMG work group was formed in December 2003 to pursue standardization of both the I-TDM and the SFP protocols. The work was substantially completed in late 2004 and formally adopted by PICMG in March 2005. At this time there are pre-standard implementations that are commercially available and proprietary implementations of the standard but, as yet, no off-the-shelf I-TDM components or interoperability tests.

I-TDM provides a standard solution for a critical need, so it appears likely to gain widespread adoption – and not just within the AdvancedTCA community! With legacy TDM systems likely to persist for decades, I-TDM provides a convenient path to leverage modern switch fabrics and modern processors in any context that needs to support legacy telecom. We expect to see I-TDM demos in the latter part of 2005 and widespread deployments in 2006.

R. Brough Turner *is SVP, CTO, and co-founder of NMS Communications, where he oversees the evolution of NMS's technology and product architectures and works on business strategy and new market development. Brough has broad business experience, but focuses on engineering, technology, and products. Besides AdvancedTCA, his current interests include mobile video, multimodal applications, and wireless infrastructure.*

Brough writes and is quoted widely on telecommunications topics in both trade and general business publications, and he is a frequent speaker at telecom industry events around the world. He holds a BSEE from the Massachusetts Institute of Technology.

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Remote, reliable firmware upgrade on PICMG board management controllers

By Mark Overgaard

Intelligent Field Replaceable Units (FRUs) in AdvancedTCA and CompactPCI/CompactTCA include a management controller (an IPM Controller, in AdvancedTCA specification terms) that provides a shelf or chassis manager visibility to inventory data, sensor readings, and similar platform management information. The stringent minimum requirements for these board management subsystems include compliance with the hundreds of pages of requirements in the relevant PICMG and Intelligent Platform Management Interface (IPMI) specifications. Also required is active interoperability testing, including at the AdvancedTCA/AdvancedMC Interoperability Workshops (AIWs) that PICMG organizes several times a year.

In addition to these minimum requirements, firmware in highly available systems must be reliably upgradeable without a physical visit to the equipment. Reliable upgrade typically implies that a separate copy of the upgraded firmware is downloaded to the controller in such a way that the original firmware is preserved. If anything goes wrong at any time during the upgrade process, the original firmware can be restored and the IPM Controller can go back to using it while the difficulties in the upgrade are sorted out.

This article describes how these requirements can be met in off-the-shelf PICMG board management building blocks, such as the IPM Sentry Board Management Reference (BMR) solutions from Pigeon Point Systems.

The IPM Sentry solutions are widely used to reduce the effort to build compliant and interoperable IPM Controllers on boards governed by PICMG specifications. Using an off-the-shelf solution for the IPM Controllers allows board developers to focus their often scarce development resources on the value-add portions of their boards. There are two BMR variants used in new AdvancedTCA designs: BMR-AVR-ATCA (based on Atmel AVR microcontrollers) and the newly available BMR-H8S-ATCA (based on Renesas H8S microcontrollers). These IPM Sentry reference designs are used as examples in this article.

The focus here is on AdvancedTCA IPM Controllers, but similar considerations apply to CompactPCI/CompactTCA IPM Controllers. In addition, though the emphasis here is on IPM Controllers on full-sized boards, firmware upgrading is just as applicable to the IPM Controllers on any other intelligent FRUs, such as fan trays or power entry modules. This discussion also applies to the Carrier IPM Controllers (Carrier IPMCs) and Module Management Controllers (MMCs) on carriers and hot-swappable modules based on the just adopted Advanced Mezzanine Card (AMC) Base Specification, PICMG AMC.0.

Firmware upgrade interfaces

Figure 1 shows the key interfaces of an AdvancedTCA board that are relevant to firmware upgrades for the IPM Controller:

- IPMB-0, the dual-redundant Intelligent Platform Management Bus that links all intelligent FRUs in a shelf to the shelf manager: This standardized interface is present on all IPM Controllers and is accessible (typically over Ethernet) via the shelf manager. Given these properties, this interface is very attractive for remote firmware upgrades.
- Payload Interface to the *payload* or primary function of an AdvancedTCA board, which may include one or more powerful general purpose processors based on the Pentium, PowerPC, or SPARC architectures: This interface is implementation-dependent in AdvancedTCA (and uses UART-based serial ports in the IPM Sentry BMR designs, for instance). Nevertheless, some developers prefer to have a payload processor retrieve firmware upgrade images over one of AdvancedTCA's high-speed interfaces (the Ethernet based Base or SERDES based Fabric Interfaces) and supervise the upgrade process.
- Serial Debug Interface intended for debug or craft person interactions with the IPM Controller: This interface is present on most IPM Controllers, but is completely unaddressed by the AdvancedTCA specification. On IPM Sentry BMR designs, this is a UART-based interface that uses the same Serial Interface Protocol Lite (SIPL) protocol as the Payload Interface. Typically, this interface is not easily accessible on a remote basis, so most firmware upgrades using this interface require a person to be present at the equipment.

The main IPM Controller block in Figure 1 is not drawn to scale, but the inset shows the approximate scaled footprint of the BMR-AVR-ATCA implementation on an AdvancedTCA board.

Overall upgrade process

The Intelligent Platform Management Interface (IPMI) specification, on which the PICMG platform management architecture is based, reserves a set of command codes for firmware upgrades, but does not define any specific command code points or associated semantics. Therefore, the firmware upgrade protocol by which commands using these codes implement an upgrade is currently specific to the developer of the IPM Controller firmware. It would clearly be attractive to have a universal upgrade protocol for all PICMG-governed IPM Controllers. Standardizing such a protocol is a candidate activity in the recently launched effort to update the AdvancedTCA specification.

The standardized protocol would likely emphasize upgrades via IPMB-0, the only fully standardized interface to a PICMG IPM Controller. Upgrade protocol packets would be forwarded from, and corresponding responses forwarded back to, an upgrade facility that either resides with or remotely accesses the shelf manager. Remotely originated upgrade commands could be issued via the shelf manager using the *Send Message with response tracking* forwarding facility defined by IPMI. Figure 2 shows this process. Figure 2 also shows how upgrade protocol

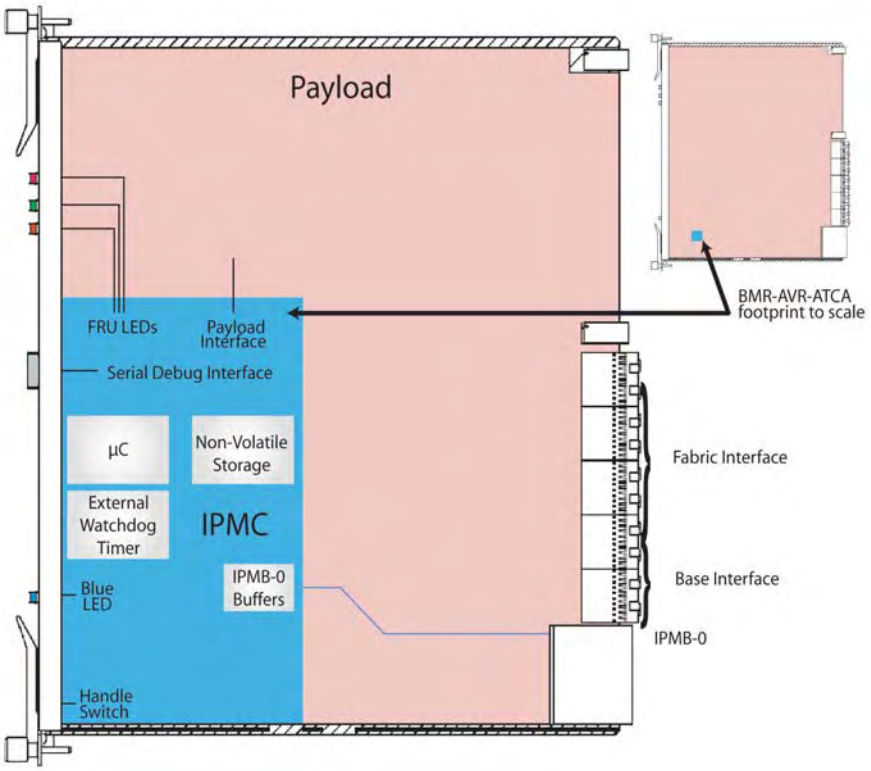

Figure 1

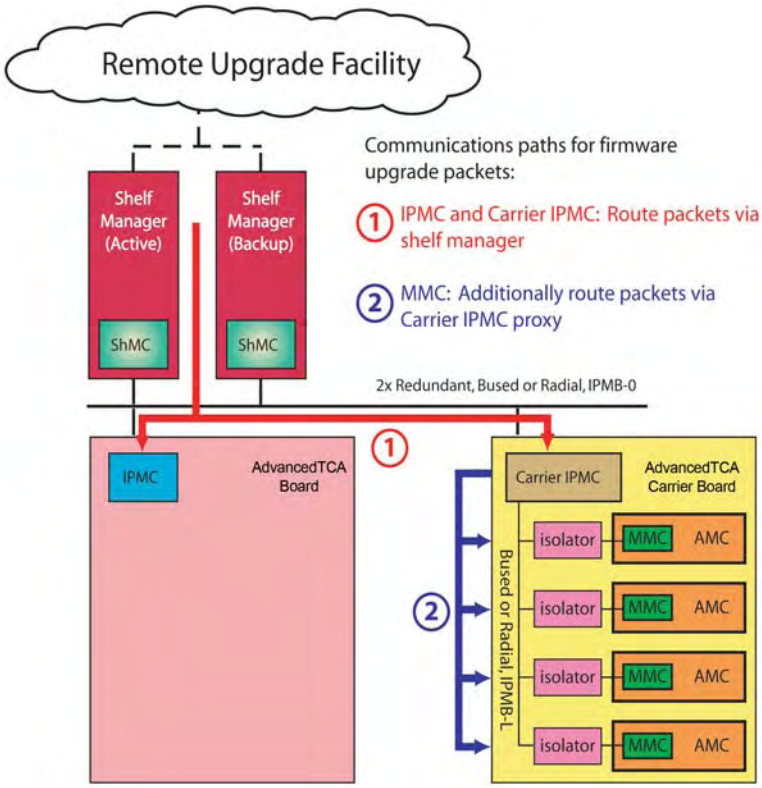

Figure 2

packets can reach the MMC on an AMC, using the Carrier IPMC as a proxy and leveraging IPMI's *Send Message with response tracking* mechanism for each packet. For remotely originated packets, the Carrier IPMC would act as a second level proxy, following the shelf manager's first level proxy role.

A standardized upgrade facility might also include a format for the upgrade images that are passed to the IPM Controllers being upgraded. Figure 3 shows the format used in the IPM Sentry upgrade facility. It is intentionally designed to be useable as a standardized format. The first three bytes contain an organization identifier (see www.iana.org) to identify the group responsible for the syntax and semantics of the image, followed by a version number for that definition. After this header, the image format is a sequence of N individual images (say for the master and slave AVRs, N=2 in a BMR-AVR-ATCA based IPM Controller). The current IPM Sentry format uses the Pigeon Point Systems identifier in the header. A PICMG-defined format could use the PICMG identifier, just like the PICMG-defined IPMI command extensions do.

With a standardized image format, creation of the image would be the only step specific to vendor or development tool. The upgrade facility of Figure 2 could then deliver that image to an IPM Controller via the shelf manager.

The IPM Sentry BMR firmware upgrade process uses the `mkupgimg` and `upgradefw` utilities to create and download (respectively) the upgrade images.

Storing active/backup firmware copies on IPM controller

A key requirement of reliable firmware upgrade is the storage of two copies of the firmware: one for active use and one as a backup. During the BMR upgrade process, the current firmware is copied to the backup region. Next, the upgrade protocol copies a new firmware image into the active region. If the upgrade process fails or the new firmware image becomes corrupted for any reason, copying the backup copy into the active region restores normal operation. Subsequently, the upgrade process can be retried if necessary. One example of a problem that can occur during the upgrade process is a power failure.

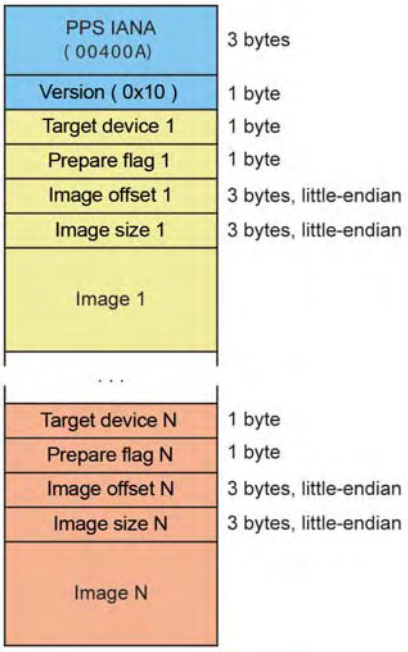

Figure 3

Figure 4 shows how the available Flash memory is allocated for these purposes on the BMR-AVR-ATCA and BMR-H8S-ATCA IPM Controllers. For the BMR-AVR design, the IPM Controller contains two AVR controllers: the master and slave AVRs. The master AVR stores backup copies of both its own and the slave AVR's firmware. The master and slave AVRs assumed in the figure are the ATmega128, with 128 Kbytes of Flash, and the ATmega8, with 8 Kbytes of Flash, respectively. The H8S/2168 controller assumed in the figure has 256 Kbytes of user Flash.

Upgrade protocol

In the absence of a standardized protocol, this article uses the IPM Sentry BMR upgrade protocol to show how reliable remote upgrades can be implemented. A key concept of this protocol is that an IPM Controller is either in upgrade mode or in normal operations mode. If in upgrade mode, the IPM Controller suspends its normal operation and focuses solely on executing the upgrade protocol. Any other commands received in upgrade mode yield the IPMI-defined response: Device in Firmware Update Mode.

The key IPMI commands in this protocol are:

- Firmware upgrade status: Allows an upgrade utility or other entity to query an IPM Controller about its upgrade status (that is, whether it is in upgrade mode).

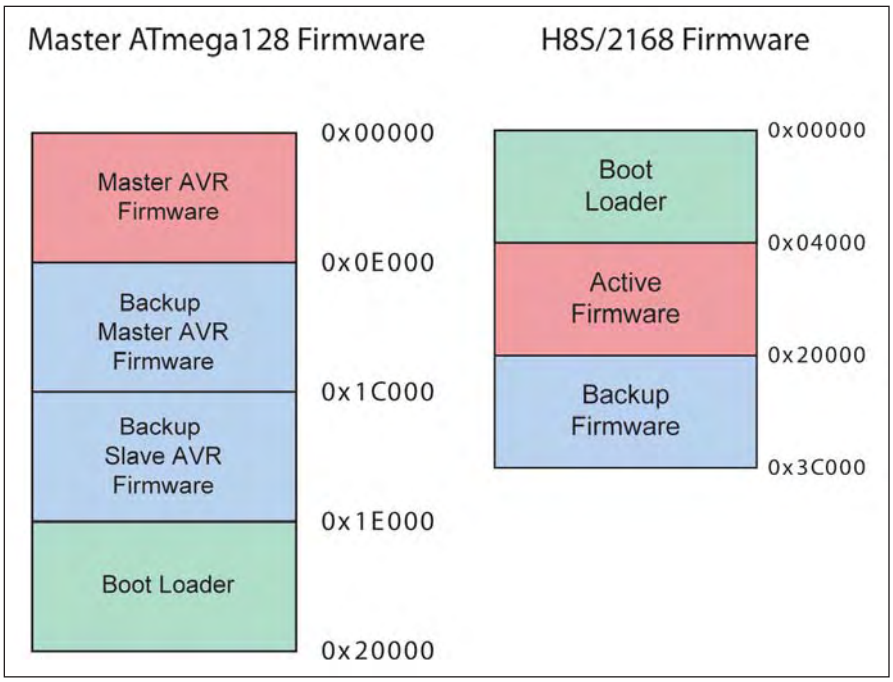

Figure 4

- Firmware upgrade start: Switches the IPM Controller to upgrade mode.
- Firmware upgrade prepare: Prepares the IPM Controller for upgrading, including copying the current firmware image to the backup region in Flash.
- Firmware upgrade write: Programs a portion of the new image.
- Firmware upgrade complete: Finalizes the new image, exits upgrade mode, and boots the newly programmed firmware.
- Firmware upgrade restore backup: Causes the boot loader to restore the firmware from the backup image.
- Firmware upgrade backup revision: Returns the revision of the backup firmware image(s) currently stored in the IPM Controller.

Putting it all together

Provisions for reliable remote upgrades of PICMG management controllers are only a small part of producing the compliant and interoperable controllers on which the rapidly growing AdvancedTCA ecosystem depends. Between the base specifications for AdvancedTCA and AMC, there are 230 pages of platform management recommendations and requirements in addition to the IPMI specification's 430 pages. Thoroughly understanding and developing compliant implementations of these requirements is a serious engineering effort.

Another critical part of producing viable management controllers is testing, to be sure that compliant but independently implemented controllers can interoperate successfully. Crucial for such testing are the PICMG-organized AIWs. These events, held several times a year, bring together dozens of PICMG members for systematic interoperability testing, guided by dozens of test plans covering different functional areas of the AdvancedTCA and AMC specifications.

For board developers who want to focus their engineering efforts on the unique value adds of their boards, versus dealing with all the challenges noted earlier on the microcontroller front, an off-the-shelf management solution can be a significant win. The IPM Sentry family of Board Management Reference solutions provides comprehensive design specifications, tested schematics, ready-to-use bench top implementations, highly configurable firmware source code, and integrated firmware development tools.

It would clearly be attractive to have a universal upgrade protocol for all PICMG-governed IPM Controllers.

Mark Overgaard *founded Pigeon Point Systems (PPS) in 1997 to focus on products and services supporting the adoption of open modular platforms to replace proprietary architectures, with an initial focus on the telecommunications market and CompactPCI. He is a leader in the technical subcommittees of PICMG (including the management aspects of AdvancedTCA and the corresponding CompactTCA specification, now in development). The current PPS product focus is the IPM Sentry line of platform management components, including AdvancedTCA shelf and board-level management components. Previously Mark was vice president of engineering at Lynx Real-Time Systems (a UNIX-compatible RTOS supplier) and TeleSoft (a major supplier of embedded development solutions for Ada). He earned an M.S. in Computer Science from UC San Diego and a B.S. in Physics from Geneva College.*

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Power management for AdvancedTCA

By Rob Hilkes

Seldom has a standard for system interconnect and chassis design been more enthusiastically adopted than AdvancedTCA. The AdvancedTCA standard has been embraced by most major communications infrastructure equipment manufacturers as the chosen platform architecture for new products. Although the standard was only completed in December 2003, AdvancedTCA equipment is operational in live applications and various board-level and rack-level products are available from multiple vendors.

Compared with its predecessor CompactPCI, AdvancedTCA boards more than double in size from under 60 square inches to 140 square inches. The power allocation per board also scales fourfold, from 50 W to 200 W. This generous increase in real estate and power budget means that far more functionality and performance can be packed onto a single AdvancedTCA blade than was ever possible in CompactPCI or other open standard architectures. The amount of traffic that can be moved around an AdvancedTCA system – what the customer ultimately cares about – is measured in thousands of Gbps compared to tens of Gbps in previous standards.

This dramatic performance improvement brings with it an accompanying challenge for power designers: Whereas with earlier standards multiple voltages were readily available from the system backplane, in AdvancedTCA power distribution is based on dual -48 V feeds, and all power conversion is performed locally on the board. Designers with little or no experience designing telecom-compliant power subsystems face a significant challenge because of the increased complexity of the power system. Furthermore, elements of the power system must communicate with higher level system management entities to negotiate initialization and to report status.

AdvancedTCA requirements

Figure 1 shows a typical power delivery architecture for a Field Replaceable Unit (FRU) in an AdvancedTCA system. There may be four different lengths of backplane connector associated with power delivery from dual -48 V feeds. Also, power delivery for management power and payload power are separated. This partitioning enables an FRU to meet the AdvancedTCA requirement that board level power may not exceed 10 W until proper negotiation has occurred between the board and system level management. This 10 W

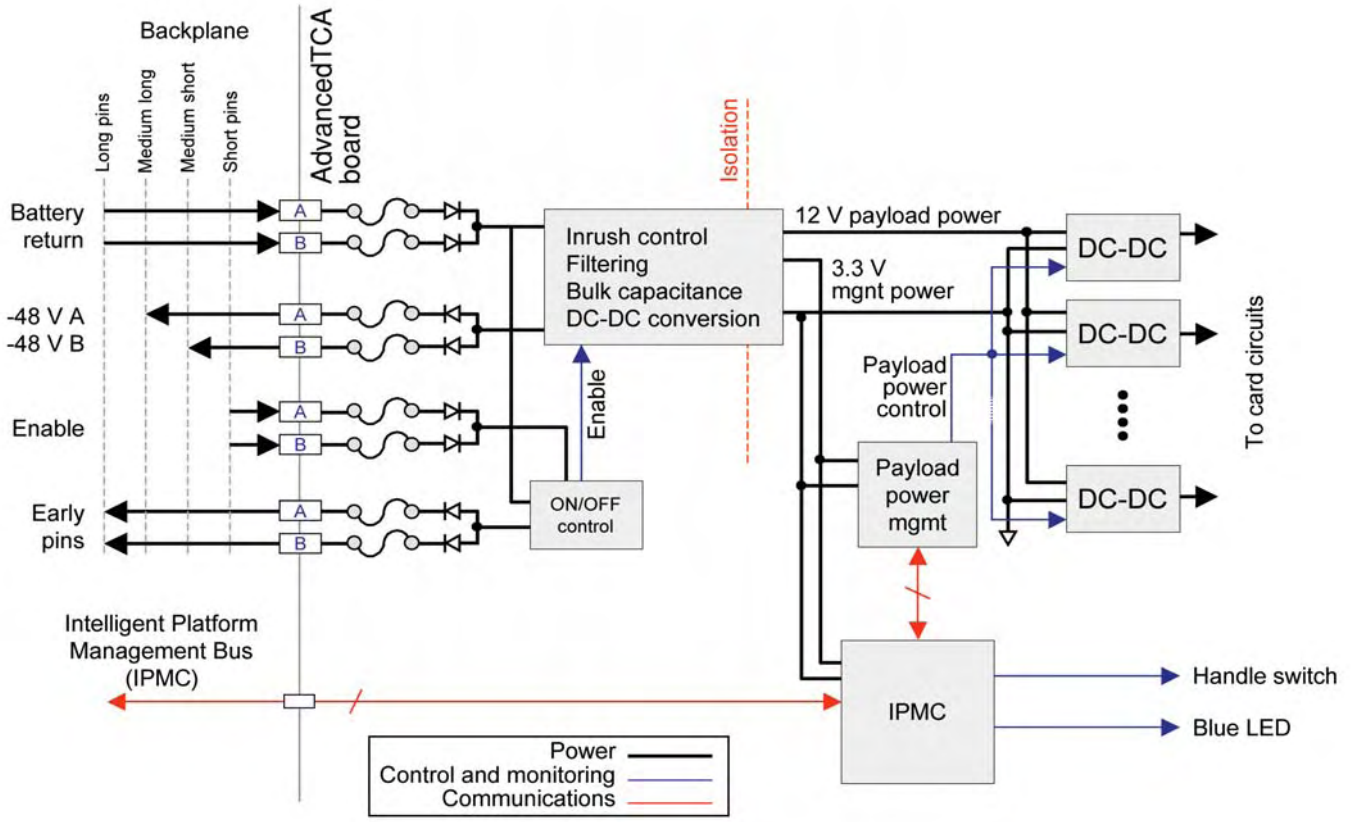

Figure 1

supplies board level power management circuitry for the negotiation process.

Inrush

When an AdvancedTCA board is plugged into the system backplane its current consumption must not exceed the profile shown in Figure 2.

ORing diodes and fuses

Figure 1 shows ORing diodes and fuses on all -48 V feeds and all return feeds. The Early and Enable pins in Figure 1 are optionally used for precharging bulk capacitance and a hard wired enable function respectively. In practice, most AdvancedTCA boards will use an intelligent inrush device that alleviates the requirement for these pins.

Bleed resistor

AdvancedTCA boards also require a bleed function that will safely discharge a board's stored energy to less than -60 V and less than 20 J within one second of removal from the backplane in order to protect service personnel from possible shock. This function may be implemented with a simple bleed resistor across the FRU's bulk capacitance, but may also use other circuit schemes.

Management power consumption requirement

One of the most stringent AdvancedTCA power requirements is that it must not consume greater than 10 W until the board level Intelligent Platform Management Controller (IPMC) has successfully negotiated startup rights from system management. This negotiation takes place over the backplane via the Intelligent Platform Management Bus (IPMB), using the Intelligent Platform Management Interface (IPMI) protocol. IPMI is well defined, and has been used for years in server architectures. The IPMB is built on a dual I2C physical topology.

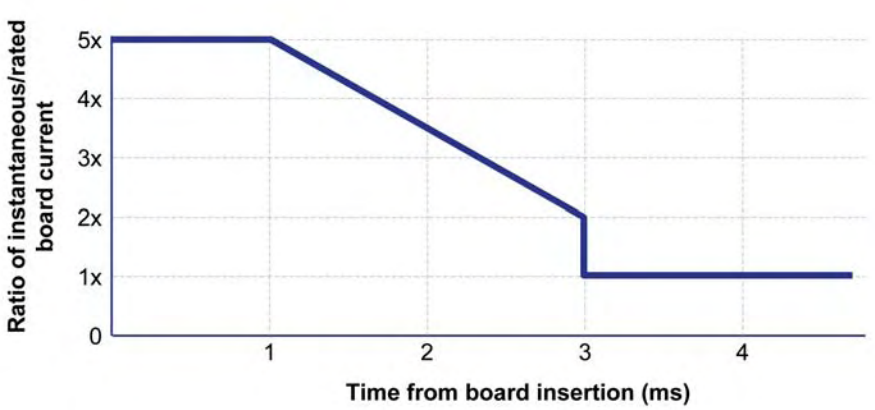

Figure 2

AdvancedTCA implementation using PS-1006 and PS-2406

Figure 3 shows two Potentia devices used to implement an AdvancedTCA FRU power architecture: The PS-1006 Inrush Controller and Primary Side Monitor with PI-Link Interface and the PS-2406 Power Subsystem Controller. This board design meets all the requirements for inrush control and power negotiation as outlined in the AdvancedTCA specification 3.0. Additional beneficial features are provided that further enhance board level availability.

The application in Figure 3 only uses four of the eight available power feeds on the backplane. The -48 V long pins are not used for bulk capacitor precharging because the PS-1006 properly limits current based on a configurable minimum startup voltage, and seat pin functions. The bleed resistor, normally connected across the bulk capacitor, is also not shown.

In the application shown in Figure 3, a single 12 V brick (12 V bus converter) is

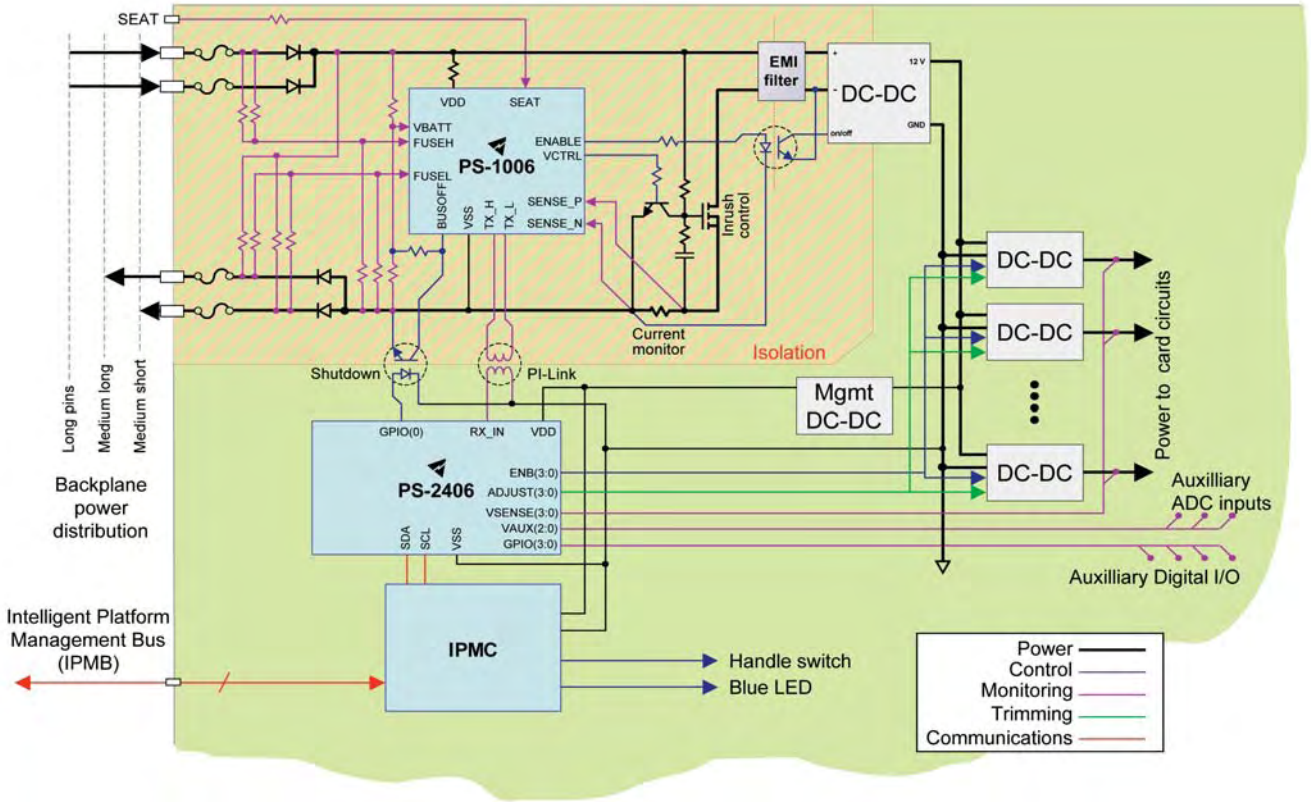

Figure 3

used to convert -48 V power down to 12 V for use as both management power and payload power. Management power is delivered via a small Point-of-Load (POL) converter that runs off the 12 V intermediate bus. This small power supply is sufficient to provide power to the IPMC, the PS-2406, and LEDs as required by the AdvancedTCA specification.

POL power converters are also used to power payload devices. These are held in the off state until the PS-2406 is instructed by the IPMC to initiate the startup sequence.

The power converter topology shown in Figure 3 requires only one isolated DC-DC converter, minimizing board real estate and cost. Upon completion of the inrush event, the 12 V intermediate power bus turns on without IPMC negotiation, providing management power via a small 3.3 V POL power converter. The 12 V bus converters have become sufficiently efficient that the AdvancedTCA 10 W management power requirement can easily be met.

The configuration shown in Figure 3 provides the following features:

- Primary voltage and current measurement
- Fuse status monitoring
- Circuit breaker function
- Primary side undervoltage (UV), overvoltage (OV), and brownout detection
- Sequencing and fault handling on up to four power rails
- Primary side shutdown initiated by PS-2406

Primary voltage and current measurement

Although not a specific AdvancedTCA requirement, the ability to actually measure primary side voltage and current provides significant benefits in high availability systems. The PS-1006 has an on-chip 10-bit ADC which accurately measures up to two voltages as well as current through the inrush resistor. This data is transmitted via the proprietary Potentia PI-Link interface. PI-Link uses a simple transformer interface to send primary side data into registers in the secondary side PS-2406 device, where it is accessible by the IPMC. Knowledge of card level voltage and current (and through derivation, power) provides useful status information to system management for power budgeting and for trend analysis and reporting.

Fuse status monitoring

Although there is no specific AdvancedTCA requirement to monitor fuse status, it is highly beneficial in order to prevent unnecessary system downtime. Fuses are an area where a hidden, silent fault can exist on a board. The failed fuse is only discovered when the relative potential on the power feeds shifts such that the feed with the failed fuse becomes active.

The PS-2406 reports fuse status to the IPMC on all four fuses, meaning that hidden faults can be alerted to system management before they result in downtime.

Circuit breaker function

The PS-1006 provides a circuit breaker function, used to shut off power to a board when the overall current exceeds a specified value for longer than the circuit breaker time. This feature can prevent dangerous faults from causing further component damage.

Primary side UV, OV, and brownout detection

To further protect board components from supply faults, the PS-1006 includes OV and UV protection features. When the input -48 V feed falls below the UV threshold the PS-1006 shuts off the 12 V DC-DC converter. The PS-1006 may also be configured to turn off the DC-DC converter in the event of an OV condition. A third threshold, called brownout, is used to provide an indication to the IPMC that the input feed is too low, and unless action is taken the PS-1006 will turn off the DC-DC converter if the input feed falls further (to the UV threshold). This brownout feature is useful because system management can take action to avoid a UV fault by reducing the load. Conversely, the IPMC can take action to gracefully shut down an FRU based on a brownout warning, before the power is shut off by the PS-1006.

Sequencing and fault handling on up to four power rails

Once the IPMC has successfully negotiated the startup sequence, the PS-2406 provides extensive sequencing, trimming, and fault handling for multiple POL power converters. Like all Potentia power management devices, every managed power rail can have multiple fault and warning thresholds and time delays. Potentia power subsystem controllers provide thorough power supply management.

Primary side shutdown initiated by PS-2406

Occasionally, a POL power converter will fail such that its output is internally shorted to its input and it cannot be turned off. This is a dangerous condition from which the only means of recovery is to shut off the isolated DC-DC converter that powers the intermediate bus. The PS-2406 includes a feature that will signal to the PS-1006 to latch off the intermediate bus when it cannot safely shut down all secondary side POL converters.

Summary

AdvancedTCA brings many benefits to equipment users, including performance levels and system availability unprecedented in standards based system architectures. Proper AdvancedTCA power design can be a daunting challenge, especially for designers with little prior experience in high availability -48 V systems. Using the PS-1006 Inrush Controller and Primary Side Monitor with PI-Link Interface, and the PS-2406 Power Subsystem Controller from Potentia Semiconductor will help the power system designer to meet AdvancedTCA requirements.

Rob Hilkes *is director of product line management and brings more than 15 years of semiconductor experience to Potentia Semiconductor. Prior to joining Potentia, Rob was director of product management at Tundra Semiconductor Corporation. He has also worked with MOSAID Semiconductor, Rob Gennum Corporation, and NCR Corporation. Rob holds a Bachelor of Applied Science in Electrical Engineering from the University of Waterloo.*

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Introduction to VoIP product guide

By Ian Colville

Ian covers several trends from a computer telephony perspective. This article looks at next generation and the market drivers forcing change. Services and content appear to be the key to profitability.

It is clear that next generation networks and fixed mobile convergence will provide new opportunities for application developers and systems integrators. What are the prospects?

A key message is that carriers and service providers won't be shedding their responsibilities for users of existing systems. The old shall interwork with the new – and there will remain a need to integrate legacy users for some considerable time to come.

Host Media Processing (HMP) gathers pace, with live implementations evidencing real world acceptance of this software-only alternative to digital signal processor hardware. Additionally, AdvancedTCA and CompactTCA developments will provide the computer telephony industry with new tools to work with.

The challenge to the computer telephony community is, "get your thinking caps on!"

When sitting down to write this introduction, I was reminded of a quote by Walt Disney, which goes something like, "It's always fun to do the impossible." Not because of writing this, I hasten to add, but in thinking about the task facing the communications industry, that is, how to make the vision of Next Generation Networks (NGN) using VoIP into a widespread, wholly accepted reality.

The sheer size of this undertaking was brought into stark relief recently, whilst attending the 21st Century Communications World Forum in London. Just a brief look at some of the conference topics addressed gives a feel for the scale and complexity of the job ahead:

- Migrating to the 21st century network
- The business case for IP
- Services provisioning, control, and management in an IP world
- Delivering IP QoS in a real-time environment
- IP network security

Undoubtedly then, there is a challenge ahead, but one we all relish – to provide the products and services that will enable the creation of a global NGN and ensure that it becomes a platform for the profitable delivery of services.

Many vendors will have a part to play, whether they are supplying AdvancedTCA processor blades to a Tier 1 Telecommunications Equipment Manufacturer (TEM) or, like Aculab, they provide Computer Telephony (CT) developers and systems integrators with open standards building block technologies for Telco or enterprise solutions.

The explosion in mobile telephony and wireless services, and the upgrading of mobile networks from 2G and 2.5G to 3G networks is creating new opportunities. For fixed line telcos providing voice minutes, the loss of revenues to mobile operators, coupled with other competitive factors like price erosion, has led to a massive rethink.

The evidence is there by virtue of what British Telecom (BT) is planning to achieve with the implementation of its 21st Century Network. Public announcements aside, BT is making no bones about it; it is going all out to change over to an NGN in what is as close to a big bang as is feasible, rather than following the transitory approach favored by some of its European competitors. Where BT leads, others will follow – can this be true?

The prospect for the CT industry is nothing but good news. Following on from the post dot.com hiatus (after the gold rush you might say) market recovery is clearly underway and the realization of an NGN will create a demand for new applications and services. Indeed, a central tenet of BT's plans is for an ecosystem of suppliers and service providers to evolve. Services and content are seen to be the key to profitability, with differentiation in ways other than competing on price for voice minutes.

This ecosystem should emerge to take advantage of an open environment where developing, launching, and delivering new services – both long term and *short life* products – is rapid. All this will give CT developers, systems integrators, and solutions providers a golden opportunity to offer new and innovative solutions.

Customers buy services, not technology

Another recent observation is the amount of attention paid to SIP, as opposed to H.323, which just doesn't seem to figure at all. However, a few words of caution are necessary as in: "It's not yet a mature, carrier class technology." Once again, the theme is opportunity. As SIP grows up, it will need a new change of clothes every once in a while, and therein lies another challenge – make it work, and then improve on it.

Protocol conversion is as relevant today as it was during the emergence of ISDN PRI. The need to interconnect incompatible networks around the world remains, but the key difference lies in the conversions required. For example, where one might have thought of protocol conversion between Q.931 and CAS flavors now think of media gateway interconnection to SIP-based IP networks.

Notwithstanding the move to such IP networks, no network operator is going to *switch off* their existing customers just because they have implemented a brand new MPLS infrastructure at the core. There will remain a need to interconnect with (and to provide services and applications to) users of legacy CPE/PBXs for some considerable time to come.

Step up to the gateway vendors and introduce yourselves

According to a recent Insight Research report, media and signaling gateways, enterprise gateways, groomers, and protocol converters will become a keystone in the network architecture. These products will allow operators to continue to support legacy interfaces, such as DASS2 in the UK, VN3 in France, or TS014 in Australia. The question is not: "How to kill Bill," but rather how to continue to provide existing services to him and retain him as a customer as the PSTN evolves toward NGN.

TEMs and Network Equipment Providers (NEPs) need to provide media servers for enhanced voice services such as network announcements, conferencing, Interactive Voice Response (IVR), transcoding, and messaging. CT developers and integrators of high performance communications solutions are seeking these same media processing resources in their role as solutions providers within the CT market landscape.

Additionally, speech technologies, including Automatic Speech Recognition (ASR) and Text-To-Speech (TTS), are becoming more and more mainstream. Their role in the delivery of new service products designed for delivery on the NGN is a surety, I would suggest. Therefore, integration with ASR and TTS products is a key strategy for CT building block manufacturers. Board vendors, therefore, are tasked with providing an increasing mix of capabilities that are easy to integrate and available on a single platform – combining circuit switched digital network access and IP connectivity – for Telco grade solutions.

HMP is a recent addition to the armory of CT application developers. HMP resources are identical to the more familiar term of DSP resources such as play, record, and DTMF tone detection used to build media servers and integrated messaging platforms. The key difference is where these resources run, namely on a server's host processor rather than on DSPs on a dedicated computer telephony card.

The power of today's host processors makes it feasible to run some of the basic speech functions, like record and playback, on the same server as the application. This concept is especially attractive for applications that do not involve live conversations between users and where calls are arriving via IP transport; minor latency inherent in host processing will not cause any noticeable effect and no dedicated telephony

hardware is required to connect to a telecommunications network.

An Aculab customer, Capricode, based in Finland, recently developed an HMP based, IP unified messaging solution to complement the Cisco CallManager. The solution is flexible, and it is easy to introduce new value-added features, tailoring the solution for individual customers, which is just the ticket for NGN deployment.

With regard to AdvancedTCA and, indeed CompactTCA, in terms of adoption by the CT industry, it may well be a question of timing. The return on investment from the development cycle is a key consideration and the incorporation of new technology may not be high on the agenda – unless there is a customer demand.

Looking around at the capabilities of AdvancedTCA hardware available today reveals a distinct lack of the kind of functionality that *telephony boards* provide. Perhaps this reflects CT's current status, and time will tell. Media servers, conferencing platforms, and integrated or unified messaging solutions may well pull through the development of AdvancedTCA telephony or media processing boards. Alternatively, the advancement of HMP may well see these functions performed on AdvancedTCA mezzanine cards within an Athlon or Pentium processor farm.

Conclusion

From a computer telephony perspective, application developers and systems integrators have several interesting and exciting trends to capitalize upon.

In particular, next generation networks and the market drivers forcing change upon incumbent telcos and service providers will provide new opportunities – for new applications, products, and content services. However, understandably carriers and service providers will be conscious of their responsibilities to users of existing enterprise systems and the need will remain to integrate legacy systems, via gateway products, for some considerable time to come.

Excitingly, the popularity of host media processing, a software only alternative to digital signal processor hardware in an IP environment, is on the increase, with live implementations evidencing its real world acceptance. AdvancedTCA and CompactTCA developments will surely provide the CT industry with new tools. And finally, we should not expect a step change, we should help to create one; the challenge to the CT community is: "Get your thinking caps on!"

Ian Colville *is a Product Manager at Aculab and his role includes support for the company's global sales force. He has broad industry knowledge gained during a number of years employed in a variety of management roles by a major telecommunications manufacturer. Ian's industry experience spans marketing, sales, customer service, and project management.*

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	AdvancedTCA	CompactPCI	PCI	PICMG 2.16	Software
Motorola					www.motorola.com/computers
CompactPCI Configurable Systems		•		•	
PVRB672				•	
WTRB500				•	
NMS Communications					www.nmscommunications.com
CG 6500C		•		•	•
CG 6500C1		•		•	•
MG 7000A	•	•			
Octasic					www.octasic.com
OCT9600 Series		•			
Performance Technologies					www.pt.com
MTN4100 PTMC Mezzanine Card		•			•
MTN4300 Media Gateway Module		•			•
SEGway 1200 Link Replacement		•			•
SEGway 2200 IP-Edge		•			•
RGB Spectrum					www.rgb.com
Open aXs					•
SBE					www.sbei.com
wanPTMC-C24TE1				•	
Signalogic					www.signalogic.com
SigMGSS-cPCI		•	•	•	•
Syndeo Corporation					www.syndeocorp.com
Syion 426		•			•
TietoEnator					www.tietoenator.com
AdvancedTCA Signaling Blade	•				
Voiceboard					www.voiceboard.com
CS38		•		•	•
DSP20SW-PVD					•
DSP41SW-PVD					•
MediaPro MGW		•			•
PTMC41		•		•	•
PTMC41-DSP/12			•	•	•
SuperSpan CS Series				•	•
VM128 Monitoring					•
VS32-VoIP					•
VS34-VoIP					•
VoicePump					www.voicepump.com
VoicePump-6000					•

Server blades: Where are we now and where are we heading?

By Lance A. Leventhal

Blades became a billion-dollar market in 2004 (according to IDC), with the potential to reach $9 billion by 2008. As Senator Everett Dirksen once put it, "A billion here, a billion there, and pretty soon you're talking about real money." Blades are also a major topic in most surveys of IT, telecom, and data center managers. We will soon reach the time when all major installations will have blades. Of course, there are many problems yet to be solved. We need better tools to manage, boot, configure, assign, monitor, and track blades. Automation is absolutely essential, since no one will want to handle them individually or examine their status one-by-one. Most installations are small today (typically under 100 blades), but numbers will grow. We can expect that thousands and even millions of blades will become commonplace, judging from the rapid growth in demand and numbers of other servers. Scalability will quickly become a major issue, since solutions that work well for a few blades may not handle large numbers.

Everything must be scalable, including:

- Management tools
- Interfaces
- Storage
- Network connections
- Repair and upgrading methods
- Power
- Cooling

We must be ready to handle the numbers that will come faster than we can imagine. Research that has dealt with large numbers of processing elements or network nodes may well apply here as well.

Software will eventually be the major obstacle. Obviously, users want it to be inexpensive, easy to use, and simple to integrate with other software. Oh, and expansible to handle increased numbers and types of elements, capable of managing storage and peripherals, and accessible over a network. Did I mention that the vendor should provide installation and training – and be large enough and competitive enough to be around for a while? The major OEMs must form alliances that ensure software will run on their blades, and the smaller vendors must join forces with them. System managers need a unified approach rather than hundreds of separate screens with different features and functionality.

Of course, users also want interchangeable standards. They want to buy whatever is best (or cheapest), combine old equipment with new, and not worry about a vendor dropping a product line, being acquired or merged, or deciding to focus on other areas. So far, the major OEMs (Dell, HP, IBM, Sun) have been loath to comply, fearing competition from copycat manufacturers with low labor costs.

Data centers already face problems in handling blades. Crowding more units into smaller spaces leads to serious cooling and power distribution issues. Older centers may have to be retrofitted with extra equipment, and new centers must have much greater capabilities. Designers will have to be aware of standards such as

Network Equipment Building Standards (NEBS), Telecommunications Industry Association (TIA), and American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

There is no question that blades are here to stay. Lower costs, smaller sizes, greater modularity, and simpler maintenance and expansion all make the concept an obvious choice. But we will obviously need to solve challenges in software, interconnect, management, and facility planning to get the most advantage from them.

Lance A. Leventhal *is the Technical Editor of the Blade Systems Alliance and Program Chairperson of the Server Blade Summit.*

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BLADES: NETWORK PROCESSOR, SERVER, STORAGE, SWITCH, TRANSITION

COMPANY NAME/ MODEL NUMBER	AdvancedTCA	CompactPCI	PICMG 2.16
Network processor blades			
ACT/Technico www.acttechnico.com			
RaidStor		•	•
ADLINK Technology www.adlinktech.com			
cPCI-6240-2		•	•
Advantech www.advantech.com			
SF-420		•	
Artesyn Communication www.artesyncp.com			
Katana750v		•	•
Continuous Computing www.ccpu.com			
PACKETblade BC10	•		
GarrettCom www.garrettcom.com			
Magnum Blade DS12		•	
Interphase www.interphase.com			
iNAV 4000 Network Processor Blade	•	•	•
iNAV Series		•	
Motorola www.motorola.com/computers			
5385		•	•
CPIP5365		•	•
Performance Technologies www.pt.com			
FlexNAT NAT/LSNAT Module		•	•
FlexTunnel IP Tunnel Routing Module		•	•
Spectrum Signal Processing www.spectrumsignal.com			
aXs.1110		•	
Voiceboard www.voiceboard.com			
TDM to Packet Processor		•	•
Server blades			
ADLINK Technology www.adlinktech.com			
Blade Server		•	
cPCI-6760D		•	
cPCIS-3100BLS		•	•
cPCIS-3120BS		•	•
cPCIS-3300BLS		•	
cPCIS-6400BS		•	•
Hewlett Packard www.hp.com			
bc1100		•	•

COMPANY NAME/ MODEL NUMBER	AdvancedTCA	CompactPCI	PICMG 2.16
Sun Microsystems www.sun.com			
Netra cp2300		•	•
Storage blades			
Adtron www.adtron.com			
EA8R Bladepak	•		
EA8R RAID5 iSCSI ATCA			•
IC6C		•	
IC6HB		•	
IC6MB		•	
SC3		•	
SC6F		•	
SC6H		•	
SC6M		•	
JMR Electronics www.jmr.com			
StorBlade		•	
Switch blades			
Apcon www.apcon.com			
Intellapatch 16		•	
Continuous Computing www.ccpu.com			
COREblade FM10	•		
Diversified Technology www.dtims.com			
ATS-1136	•		
ATS-1460	•		
DSS Networks www.dssnetworks.com			
CPCI 2.16 8261		•	•
RadiSys www.radisys.com			
Promentum ATCA-2100	•		
Voiceboard www.voiceboard.com			
MediaPro SuperSpan SS7		•	•
SwitchBlade		•	
Transition blades			
Performance Technologies www.pt.com			
RTM4808		•	•
ZT 4804		•	
ZT 4806		•	
ZT 4807e		•	•

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By Chad Lumsden

www.compactpci-systems.com/products

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ENCLOSURE

ELMA Electronic

Website: www.elma.com
Model: Type 32 Enhanced **RSC No:** 20843
An enhanced version of Elma's Type 32 enclosure • The unit was reconstructed for a unique aesthetic appearance • Reinforced metal base for EMC shielding • Comes with a sheet metal base that is a mounting chassis and shielding provision in one • The shielded base is compatible with Elma's new and existing Type 32 enclosures • Offers a way to shield existing chassis, without any redesign • The metal base has Elma's patented gasketing spoons built-in for superior EMC shielding • The feet of the chassis have an Italian design • Two depth extrusions run along each side of the enclosure, providing a more finished look • The front bezel runs along the front edges of the Type 32, blocking out unsightly edges • The material was modified in the Type 32 Enhanced from a sinoplast to painted aluminum skins, which allow a wide range

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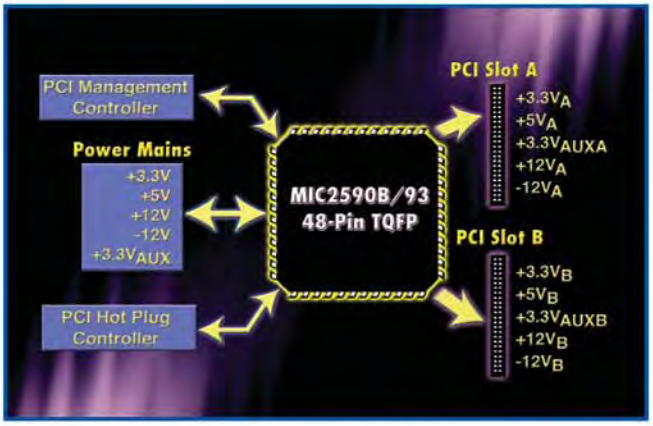
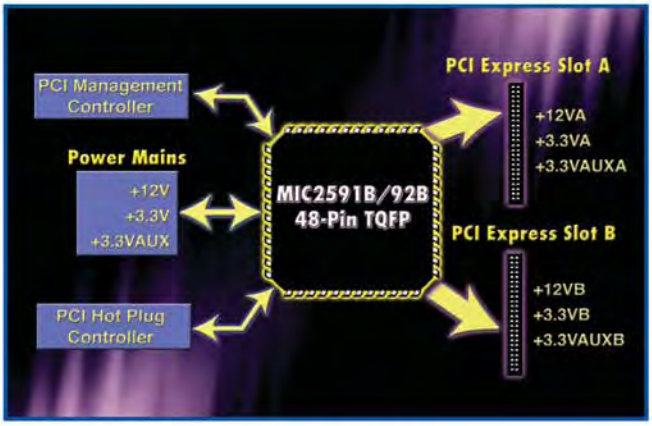


PCI v2.x and PCI-X 1.0b/2.0
MIC2590B/MIC2593



PCI Express
MIC2591B/MIC2592B

Micrel MIC259x family of multi-rail, dual-slot hot-swap controllers lowers overall system cost for implementing power controllers in PC board space conscious applications such as mid- and high-end enterprise server platforms. Micrel offers system design engineers one of four solution-optimized products that address dual-slot PCI v2.x, PCI-X 1.0b/2.0, or PCI Express power control requirements. For sophisticated power control and fault monitoring/reporting, all products incorporate an SMBus interface where the MIC2590B and the MIC2591B incorporate additional circuitry to support the Integrated Platform Management Interface (pursuant to IPMI v1.0).

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  - MIC2591B/92B: +3.3VAUX
- Integrated high-side gate driver circuits for external MOSFETs
  - MIC2590B/93: +5V and +3V
  - MIC2591B/92B: +12V and +3V
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Website: www.radstone.com
Model: IMP2A **RSC No:** 20218
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RSC 20218

PROCESSOR: POWERQUICC

MEN Micro

Website: www.menmicro.com
Model: EM03A **RSC No:** 20061
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PROCESSOR: XEON

Kontron

Website: www.kontron.com
Model: AT8001 **RSC No:** 20052
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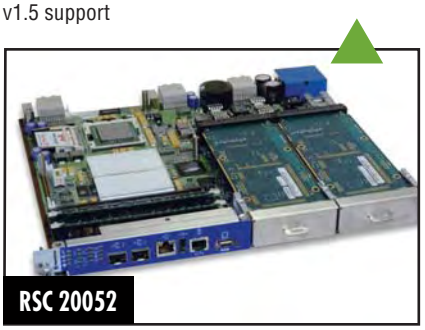
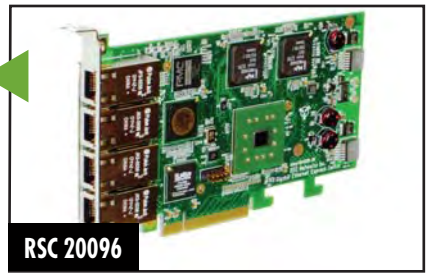

RSC 20052

ROUTERS/SWITCHES

DSS Networks

Website: www.dssnetworks.com
Model: 6468 Gig PCI-E Switch **RSC No:** 20096
8 port hybrid switch/interface card • 4 ports routed to RJ-45's • 4 port x8 PCI Express host bus interface • Hardware switching in Broadcom BCM5388 • Uses 12V and 3.3V power from PCI Express connector • Onboard regulators for step-down voltages • 7W total board power consumption • 0°C to +70°C ambient temperature • Supports Tornado 2.2/VxWorks 55.5, Linux 2.4, 2.6 • Management features include frame generator and performance statistics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5	SBE	Linux On Demand
63	SBS	PowerPC Single Board Computers
302	SBS	PMC/AdvancedMC
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21	SMA	CompactMAX CPU1.2
37	Sundance	SMT3000, SMT300, SMT7008
39	Sundance	SMT791, SMT787, SMT795
41	Sundance	SMT6050, Diamond RTOS, GDD600 & GDD8000
31002	TeraChip	ATCA Switch Fabric
7	Vadatech	Board Level Solutions
26	Vector	CompactPCI System Components
3	Vicor	QPI EMI Shield
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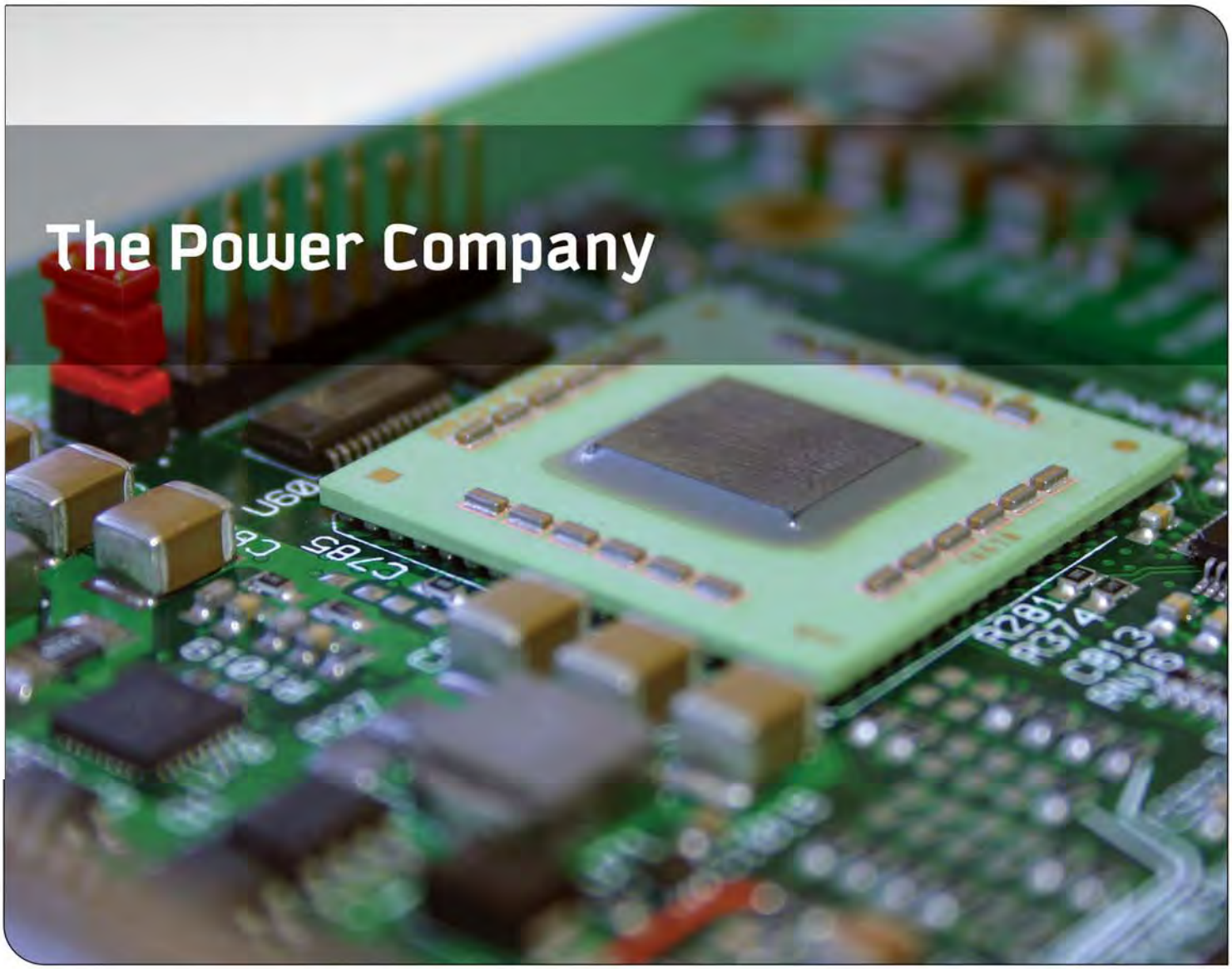

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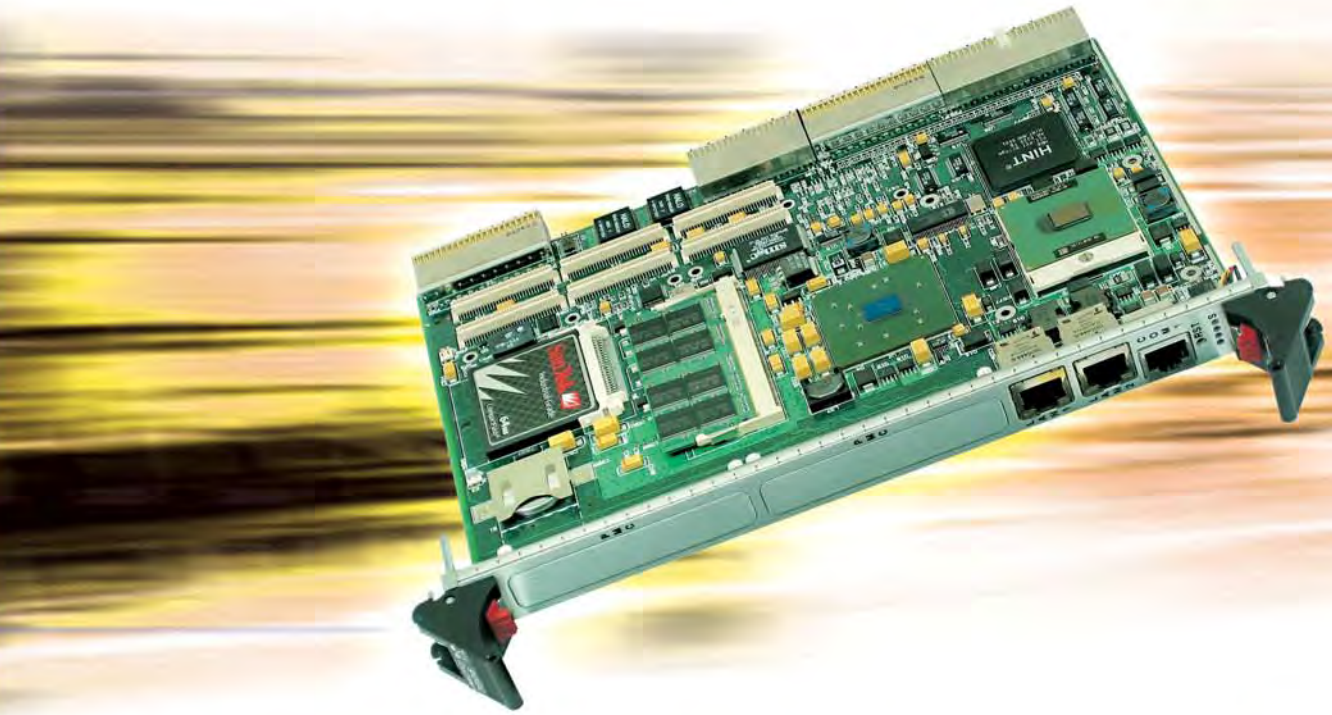

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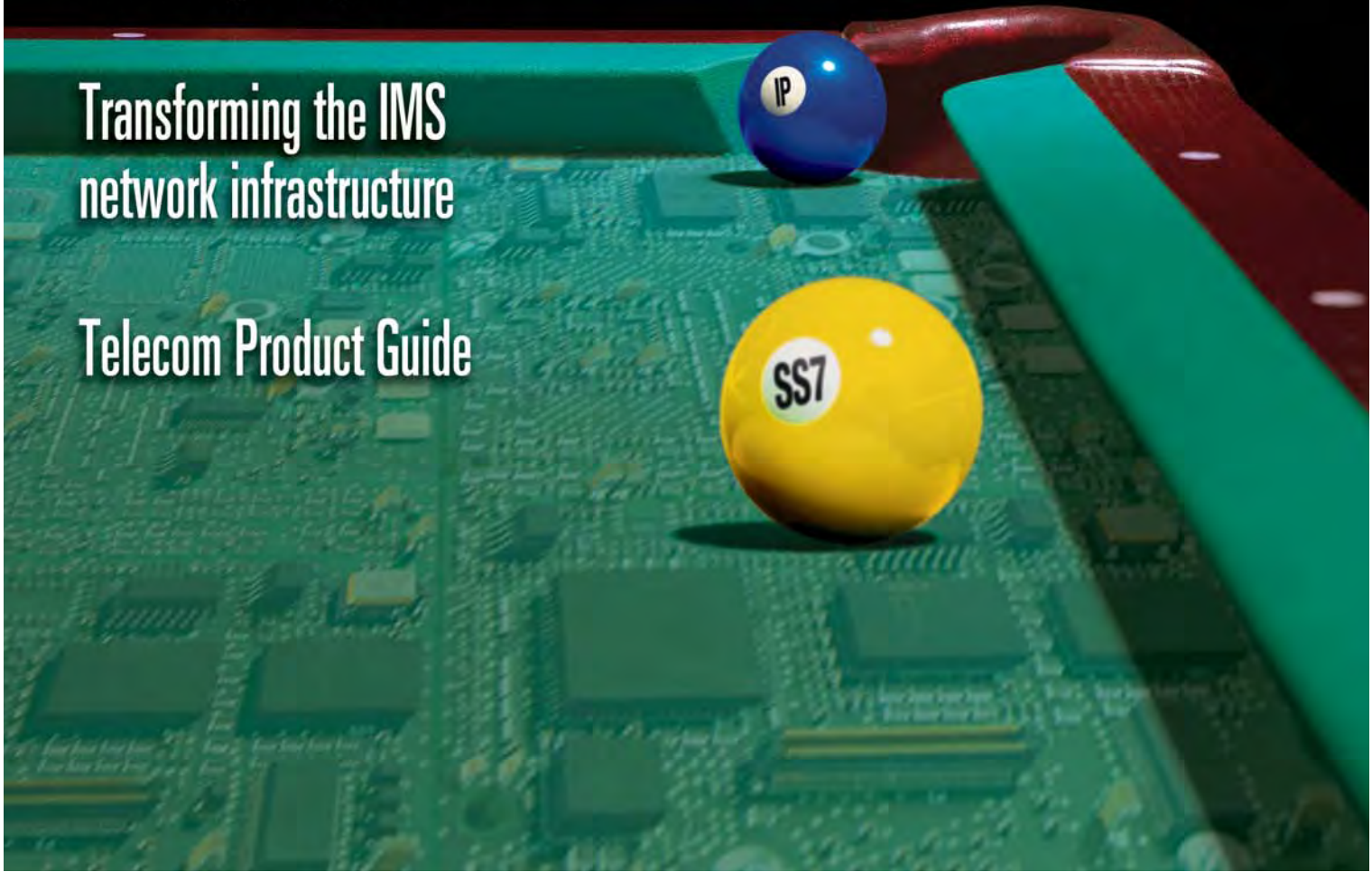
Telecom Product Guide



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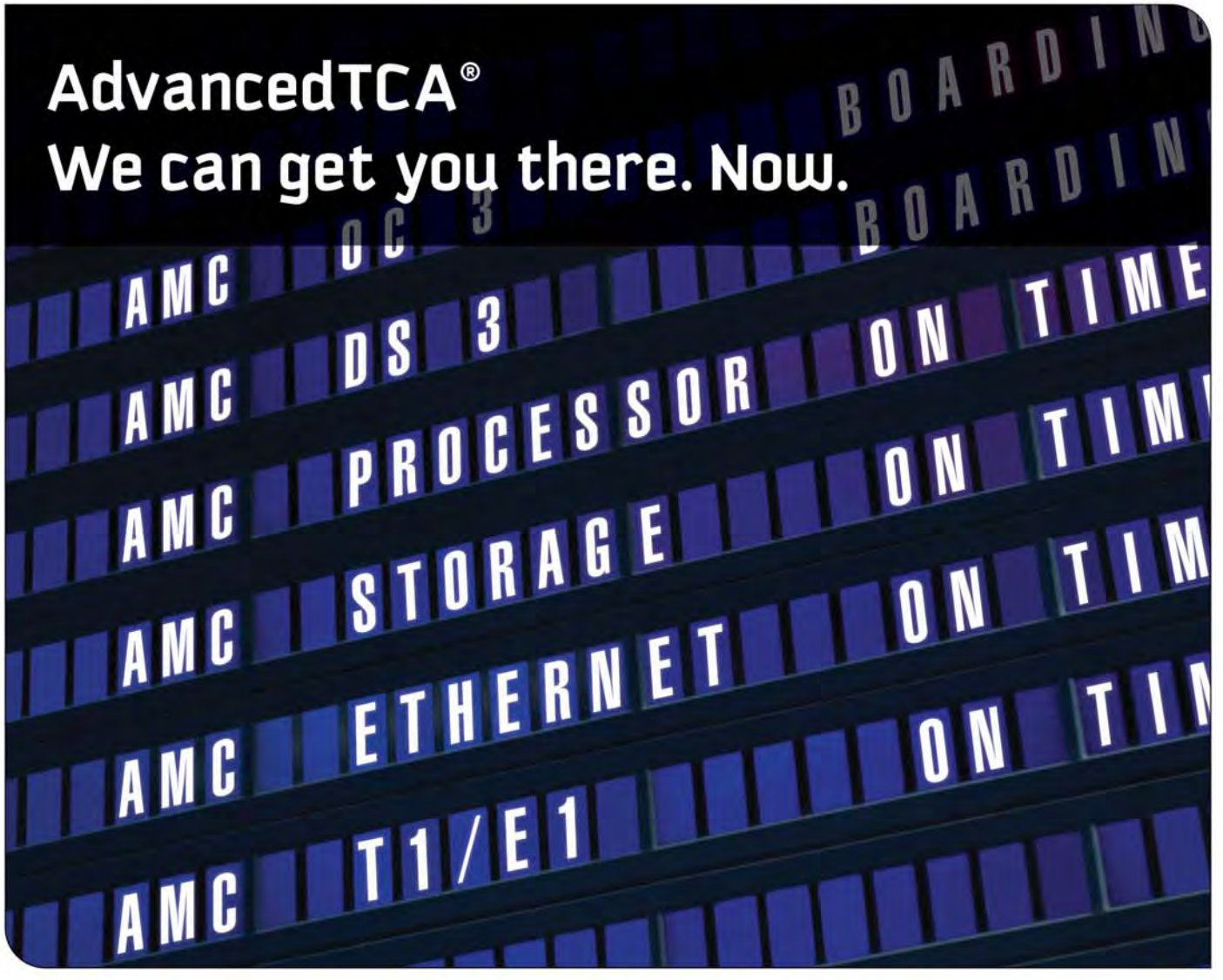

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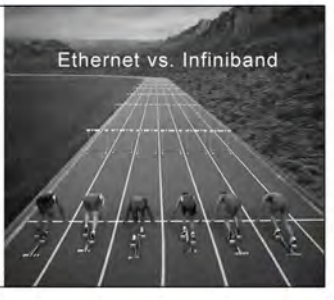

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AdvancedTCA platforms bridge SS7 and IP signaling networks

By Jim Darroch

AdvancedTCA is an important new standard for building telecom systems. Signaling is a very important telecom application. In this article Jim provides a brief introduction to both technologies and explains the advantages of using AdvancedTCA to develop next generation devices. This article will also cover the integration of traditional Public Switched Telephone Network (PSTN) with VoIP and, in particular, a technology called SIGnaling TRANsport (SIGTRAN).

With the economy rebounding, major carriers are migrating their existing circuit-switched Time Division Multiplexed (TDM) networks to IP packet networks and rolling out new VoIP, data, and other multimedia services. But with cost containment still a top priority, carriers are adopting hybrid solutions that meld the PSTN and packet networks rather than replacing TDM networks wholesale. This approach leverages TDM infrastructure and applications while laying the groundwork for all-IP networks.

Open platforms like AdvancedTCA provide an ideal framework for quickly deploying High Availability (HA) telecom and datacom systems that bridge the PSTN and IP networks. Open AdvancedTCA platforms make it easier to outsource network access, control, and media processing. This strategy enables TEMs to reduce time to market and focus engineering resources on valued-added applications and services. Outsourcing and utilizing off-the-shelf AdvancedTCA technology also reduces cost by enabling TEMs to capitalize on increased competition and economies of scale.

SS7 migrates to IP networks

Signaling is a perfect example of a hybrid technology tailor made for open AdvancedTCA platforms. IP based signaling is clearly the wave of the future. But the interim solution, SIGTRAN, bridges SS7 and IP signaling networks in a way that enables service providers to deploy efficient IP signaling while still maintaining compatibility with existing SS7 networks and leveraging SS7 infrastructure.

The principal signaling protocol used for wire line and mobile communications in the PSTN is SS7, which facilitates call setup, tear down, and routing through the PSTN. SS7 also enables enhanced transaction based services such as:

- Toll-free calling
- Caller ID
- 911
- Follow-me number portability

SS7 services are usually deployed over a dedicated network of 56 kbps or 64 kbps TDM lines, though carriers also utilize high-speed T1 (1.5 MBps) and even OC-3 (155 MBps) optical lines.

Until recently, the processing demand on legacy SS7 nodes has been remarkably light. Because signaling only takes place at the start and end of a call, many voice circuits can share a signaling link. Moreover, SS7 is a fairly efficient protocol, which enables a single SS7 link (56 kbps or 64 kbps) to service thousands of calls. A surprisingly small number of nodes implemented in relatively inexpensive rack-mounted systems, each containing a handful of T1 line cards, processing elements, and a management interface can serve a metropolitan area.

While SS7 remains viable, increased use of phones, faxes, modems, and toll-free/managed rate numbers, together with new services such as Local Number Portability (LNP) and Short Message Service (SMS), have generated exponential signaling traffic growth, straining the system. And higher VoIP and cellular service use, although using IP in the network core, require SS7 for wireline phone, modem, and fax delivery.

Signaling equipment can handle a far greater number of calls within the same footprint. One way to do this is to upgrade the existing SS7 network with higher speed links. A more efficient, scalable, and cost-effective approach, however, is to utilize packet networks to carry the signaling traffic. IP networks carry 50 percent more signaling (and other) traffic for a given bandwidth, and handle rerouting and recovery more flexibly, making them more reliable than single redundant SS7 networks.

SCTP provides real-time transport alternative to TCP

One of the biggest challenges in moving SS7 signaling to IP networks is maintaining compatibility with SS7 and enabling service providers to protect their SS7 application code investment while enjoying IP's increased efficiency and reliability. SIGTRAN, a set of standards defined by the International Engineering Task Force (IETF), is designed to reliably transport the SS7 signaling protocol over an IP network.

IP wasn't designed from the ground up to be used as the backbone for signaling transport. In fact, the Transmission Control Protocol (TCP), which provides transport for IP, is not well suited at all for transporting time-sensitive signaling data. In particular, TCP's byte-streamed protocol, while ideal for delivering large unstructured pieces of data like files, is ultra sensitive to delays caused by network errors such as loss of bytes, messages, or sequence violations. When errors occur, TCP holds up delivery of all signaling data within the offending stream until the correct sequence is restored. If that stream contains signaling information for multiple connections, then lost, corrupted, or out-of-order signaling data for one connection will delay all connections until the error is corrected.

To use an IP network as a transport for SS7 messages, the IETF created a new

transport protocol for SIGTRAN to replace TCP (Figure 1). The Stream Control Transmission Protocol (SCTP), multistreaming capability enables a single IP connection to be separated into multiple logical streams, each assigned to a particular application or resource. Data corruption specific to any particular stream affects only that logical stream, not the rest of the streams sharing that physical connection.

Sitting above the SCTP transport layer are User Adaptation layers such as M2UA that replace equivalent SS7 layers such as MTP2 (SS7's data link layer). Together SCTP and the User Adaptation layers provide an IP-friendly platform that enables higher-level SS7 software layers such as MTP3, ISUP, and SCCP to run unmodified over IP-based SIGTRAN networks. Signaling gateways such as Artesyn's SpiderWareSG bridge SS7 and SIGTRAN networks provide a transparent connection between the SS7 network's MTP2 layer and the equivalent SIGTRAN M2UA layer. This seamless connection enables existing SS7 applications to be used across either traditional TDM or IP transport infrastructure.

Anatomy of an AdvancedTCA signaling platform

AdvancedTCA provides an ideal platform for building modular, high density, carrier grade signaling systems. AdvancedTCA's large size and high-speed switched fabric gives telecom OEMs the bandwidth and form factor they need to service a large number of calls on each blade. AdvancedTCA's redundant components include switched fabric, power supplies, fans, and management controller.

These redundant components, in concert with hot swappability and integrated Intelligent Peripheral Management Interface (IPMI) system management, enhance availability by minimizing the impact of component failures and enabling systems to be monitored, repaired, and upgraded in the field without disrupting service.

An AdvancedTCA SIGTRAN Signaling Gateway (SG) can be implemented as a standalone entity, or combined with a Media Gateway Controller (MGC) in the same chassis or shelf. The SG, in turn, may be integrated into a variety of systems that require signaling, including Signal Transfer Points, Service Control Points, Base Station Controllers, Home Location Registers, Softswitches, and Visitor Location Registers.

SG and MGC platforms can be implemented using a single AdvancedTCA chassis. The SG is implemented as a cluster of redundant hot swappable AdvancedTCA blades. It runs the SIGTRAN and SS7 stacks, taking TDM signaling information from the SS7 world and passing it on (and vice versa) to the IP world in a SIGTRAN format. The MGC, which actually terminates the calls and forms the bridge between IP and SS7, is implemented as a pair of separate blades. The MGC utilizes an ATM or Ethernet interface to access an upstream IP network. Chassis management assures that new blades are provisioned and made available to the application as they are added to the system.

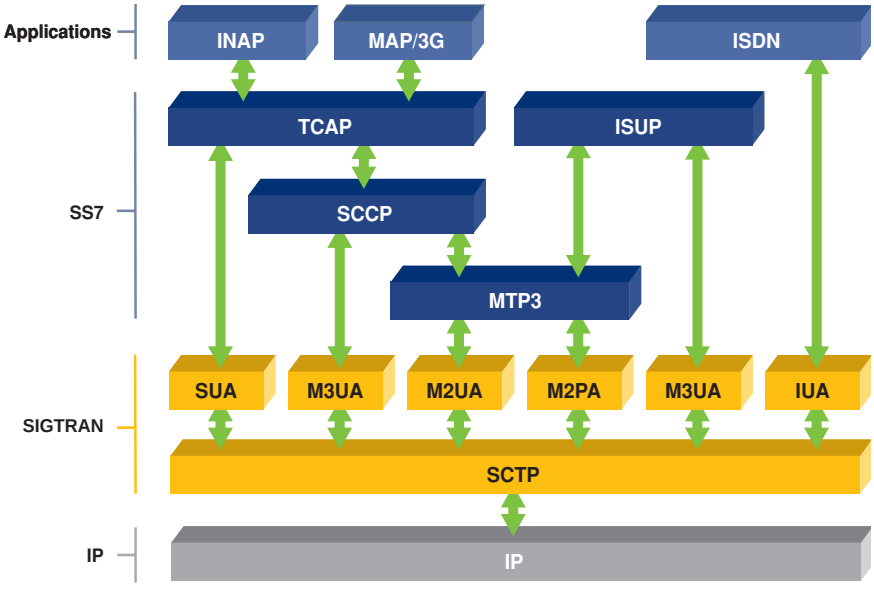

Figure 1

Artesyn's Katana blades, available in both PICMG 2.16 (CompactPCI Packet Switching Backplane) and AdvancedTCA form factors, can be used to implement both the SG and MGC functions. Artesyn's PICMG 2.1 based dual-processor SpiderWareSG, for example, runs both the SS7 and SIGTRAN protocol stacks, supporting up to 64 SS7/SIGTRAN channels (SS7 to SIGTRAN and SIGTRAN to SS7). The AdvancedTCA based KatanaPPB, shown in Figure 2, on the other hand, features six PowerPC MPC7447A processors, giving it the raw processing power needed to host high-density control, signaling, and packet processing applications, including SGs, MGCs, wireless base stations, and Softswitches.

Figure 2

Open architecture systems utilizing off-the-shelf blades like Katana make it easy for TEMs to outsource basic control, signaling, and media processing functionality and build systems that integrate the PSTN with emerging IP networks. These systems take less time to develop and cost less to manufacture, upgrade, and service. For service providers on a tight budget, the open architecture approach is the clear wave of the future.

Jim Darroch *is currently the Protocol Development Manager with Artesyn Communication Products (ACP) and has been with the company since 1996. Previous positions with ACP include software architect and project manager, working with X.25, ISDN, Frame Relay, SS7, and SIGTRAN. Before joining ACP, Jim spent four years at HP as a senior software engineer and technical architect working on a distributed surveillance system for SS7 networks. Jim holds a B.Sc. (Hons) in Computer Science from Strathclyde University and lives in Edinburgh, Scotland.*

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Transforming the IMS network infrastructure

By Sven Freudenfeld

AdvancedTCA and AdvancedMC provide cost-efficiency and long-term savings for network operators looking to deploy multimedia services in IP Multimedia Subsystem (IMS) networks.

Telecom Equipment Manufacturers (TEMs) are continually on the hunt for better economies of scale and faster time-to-revenue when rolling out new network solutions. Open standard modular communication platforms are giving TEMs a major leg up in accelerating roadmap implementations. And the reasons for following this new direction are becoming loud and clear today to both TEMs and their carrier and network operator clients.

Working with open standard, modular platforms based on the two standardized specifications developed by PICMG, Advanced Telecom Computing Architecture (AdvancedTCA) and Advanced Mezzanine Card (AMC), provides carriers the unprecedented flexibility to swap in and out new wireless services with drastically lower costs and with no loss of service. TEMs gain major development savings and quicker turnaround of new product launches.

What's the open standard?

AdvancedTCA is a fast emerging model for carrier grade systems to be built on standardized hardware as defined by PICMG. AMC extends the value of AdvancedTCA at the mezzanine level. And as a hot-swappable, Field Replaceable Unit (FRU), the AMC module opens up a whole host of design opportunities and can be used for any number of processing and I/O line card applications. AMC modules communicate via high-performance serial interconnects such as Gigabit Ethernet and PCI Express (PCIe) and may be designed with an *AMC everywhere* approach, where AMCs and AdvancedTCA boards such as AdvancedTCA carrier boards, CPU, and hub boards combine to create a powerful tool for designing new platforms.

The first version of this AMC specification has already been ratified, with additional iterations soon to follow for various types of connections. AMC supports 21 lanes of serial data traffic, which can be mapped to ports on the backplane. One lane is made of one differential pair in each direction (Tx and Rx).

The ancillary benefits include easy manageability through IPMI, High Availability, low power ultra dense processing, and lower operating costs. Equipment consolidation also reduces real estate needs by combining content, billing, and transport applications

With the current growth in the wireless market, AdvancedTCA/AMC has quickly become an interesting answer to port new network elements away from costly proprietary platforms. Nearly the full spectrum of the wireless infrastructure is affected – from Radio Network Controllers (RNC) and Gateway GPRS Support Nodes (xGSN) to Mobile Station Controllers (MSCs), and HLR servers.

Another exciting area for AdvancedTCA/AMC is the range of IMS network application and multimedia servers As this market segment matures, open modular platforms can overcome many infrastructure challenges. Initially developed by the Third Generation Partnership Project (3GPP) for wireless applications, As a standards based service platform, IMS adheres to IP/SIP and requires properly addressing several technical demands before deployment, making AdvancedTCA a promising infrastructure solution. Recently the International Telecommunication Union (ITU) has adopted principles of IMS as the foundation for its Next Generation Network (NGN) Project for wireline applications, increasing the momentum.

IMS infrastructure and business challenges

Carriers are expecting to increase revenue with multimedia applications, with new protocols and with services such as Multimedia Broadcast Multicast Services (MBMS), Multimedia Messaging Services (MMS), and Packet Switched Streaming (PSS) already opening doors for new applications.

To implement this, however, an increasing number of resources are needed for continual network deployment, keeping both CAPEX and OPEX costs too high, and placing a severe burden to be first on the market with new services. This *first-come-first-serve* scenario is what is driving TEMs to meet these new business requirements, as the industry moves towards an all IP infrastructure for next generation networks.

Today, each service requires its own separate platform, which is costly and often translates into interoperability and OS issues. Maintaining any level of redundancy requires additional platforms for load balancing, and as the number of new platforms increases so does the complexity with respect to manageability (OAM&P). Plus, with more server elements deployed, TEMs risk the loss of revenue during maintenance periods. The less real estate available, the more carriers risk giving up one service to make room for another.

Porting AdvancedTCA/AMC to IMS network elements

Figure 1 shows a sample configuration of an IMS multimedia network ported onto an AdvancedTCA/AMC platform. Further redundancy can be addressed by duplicating cards 1-6 on one chassis and cards 9-14 on a second chassis, connecting the chassis via a GbE interface. As the OSS and BSS are SNMP compliant, AdvancedTCA-built platforms also need to be SNMP compliant to support multimedia services, which communicate to the

Digital Rights Management (DRM) application within the network. This applies as well to user interactions for MBMS applications with Home Subscriber Service. The IMS network requires:

- GbE, which interfaces with the IP-based network infrastructure
- SAN interfaces for content storage and HLR and VLR information
- Processing interfaces for encoding/decoding/transcoding (DSP)
- ATM and TDM transporting network interfaces

Cellular subscribers' multimedia service options are numerous, built on server-to-user, user-to-user, or multi-user applications. In light of the traditional network deployment of dedicated servers per application, now TEMs can offer advanced equipment that consolidates the various content, billing, and transport applications on far fewer platforms.

For example, a 12U AdvancedTCA chassis that features 14 server board slots may be configured to support any combination of applications such as streaming audio/video (PSS, MMS, MBMS), SMS, DRM for digital rights management, security/firewall, billing, ringtone, and mobile gaming applications, and transcoding (interoperability compliance of any file format to any file format, such as AMR, AMR-WB, AMR-WB+, AAC, AAC+, VMR-WB Codec, MPEG-4, MPEG-2, and JPEG).

An open modular AdvancedTCA/AMC system is ideal for storing multimedia content. As hard drives could be made to fit on an AMC, each module could hold 80 GB at the very least, which gives a capacity of over 5 Terabytes on only one AdvancedTCA chassis. Delivering the content poses multiple delivery challenges. The wide range of 3G handset manufacturers means supporting a wide range of protocols and standards. Interoperability plays an important role in the deployment of the 3G infrastructure for basic telephony functions such as the transcoding function for speech, and for encoding and decoding, VAD/DTX, and echo cancellation in the Base Station Transceiver System (BTS).

Audio, video, pictures can be encoded in various formats that the SIP and H.323 network infrastructure supports, with storage in SAN over several different networks. Content transcoding is an important part of next generation services deployment and requires high processing resources (MIPS) for quality operation. Further configurations may support VoIP (SIP, H.323, MGCP), voice mail, IVR, mobile commerce, Push To Talk (PTT), and Video on Demand (VoD) services.

Faster ROI, reduced OPEX, and more service innovation

The high return on investment becomes immediately clear when the platform real estate required for all these applications essentially shrinks by two-thirds compared to deploying the same applications on single, dedicated platforms.

Standardization enabling telecom friendliness also makes AdvancedTCA and AdvancedMC appealing. System scalabil-

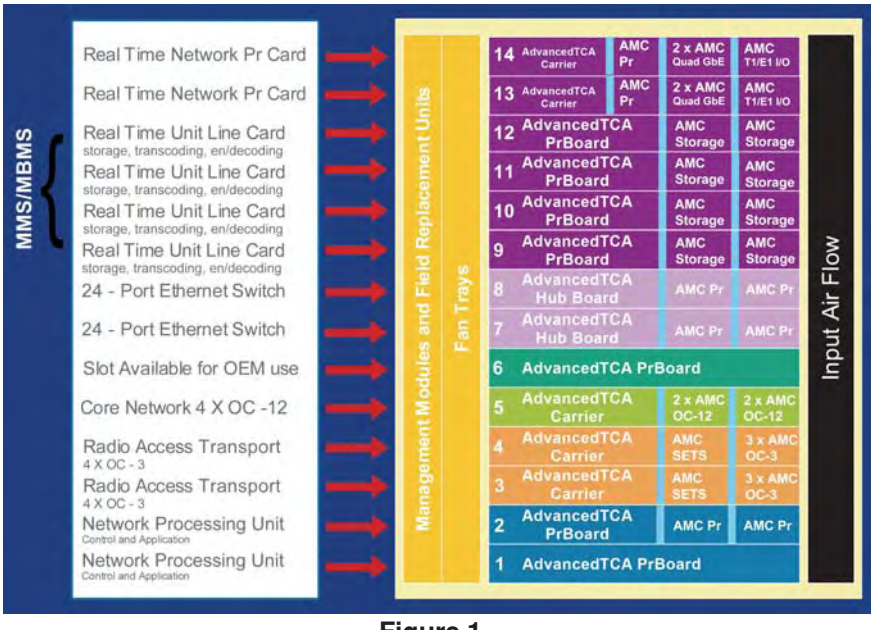

Figure 1

ity enables shelf capacity up to 2.5 Tbps, 5-nines service availability, multiprotocol support for interfaces up to 40 Gbps, a robust power infrastructure, large cooling capacity, and high processing capacities for such operations as transcoding (MIPS).

Open modular systems' high levels of modularity and configurability make integrating multiple functions and new features fairly simple. The ability to host large pools of DSPs, NPs, processors, and storage makes these systems suitable throughout any network, from access to transport segments, enabling a healthy, dynamic, multivendor, interoperable ecosystem.

Depending on the application being deployed, TEMs can expect to go to market twice as fast with a significant reduction in CAPEX and OPEX costs. Any amount of CAPEX will mean a significant amount of savings in a very short time and virtually immediate ROI. This allows carriers to invest in open platforms with a long-term IMS strategy for growth, which will support completely seamless adaptability at the networking equipment level for years.

Sven Freudenfeld *is responsible for North American Business Development for Kontron's AdvancedTCA and AdvancedMC modular solutions. Sven possess more than 20 years experience with voice, data, and wireless communications, having worked extensively with Nortel Networks, Sanmina-SCI, and Deutsche Telekom.*

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