

ATCA Design Considerations for Telecommunication Platforms

White Paper

by Amir Janwari, Gerry Leavey and Kevin So
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Abstract

This whitepaper reviews the Advanced Telecommunications Computing Architecture (AdvancedTCA or ATCA) standard and the benefits that it delivers to Original Equipment Manufacturers (OEMs) and Carriers. ATCA addresses the market need for cost optimization at the system and infrastructure levels by enabling an ecosystem of carrier-grade off-the shelf chassis, I/O and processing blades. This paper describes some of the hardware requirements like backplane capacities and equipment protection mechanisms. Moreover, readers will learn how PMC-Sierra's PM8310 TEMUX 336 enables OEMs to address these hardware requirements effectively.

About PMC

PMC-Sierra is a leading provider of broadband communications and storage semiconductors for metro, access, fiber to the home, wireless infrastructure, storage, laser printers, and fiber access gateway equipment. PMC-Sierra offers worldwide technical and sales support, including a network of offices throughout North America, Europe, Israel and Asia. The company is publicly traded on the NASDAQ Stock Market under the PMCS symbol. For more information, visit www.pmc-sierra.com.

About the Authors

Kevin So is a Product Marketing Engineer in the Communications Product Division at PMC-Sierra and is responsible for Metro Transport and Wireless Backhaul products including Channelized SONET/SDH framers, PDH and Ethernet-over-SONET/SDH (EoS) mapping solutions. Previously, Mr. So held technical sales and R&D positions, including engineering roles with Nortel Networks Optical Components and CDMA divisions. Mr. So holds a master's degree in electrical engineering from Carleton University (Ottawa) and an undergraduate degree in electrical engineering from Queen's University (Kingston).

Gerry Leavey is a Business Development Manager and Technology Consultant at PMC-Sierra. A communications systems architect, he is PMC-Sierra's primary representative to the Open Base Station Architecture Initiative (OBSAI) organization and is a key contributor to the Reference Point 3 (RP3) interface standard. Previously, Gerry has held management and design positions with British Telecom, AT&T Network Systems, Lucent Technologies, and Toucan Technology. Gerry graduated in 1988 with a Bachelor of Electronic Engineering degree from the National University of Ireland, Galway.

Amir Janwari is currently a student enrolled in the Computer Science program at the University of Lethbridge (Alberta).

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1 About This Paper

The Advanced Telecom Computing Architecture (AdvancedTCA or ATCA) is a series of specifications for next-generation carrier-grade telecommunications equipment. ATCA delivers a standard hardware platform suitable for supporting a wide range of products, including 3G and 4G wireless network elements. It provides benefits to Original Equipment Manufacturers (OEMs) including faster system development, more flexibility, and platform cost reduction.

This paper provides a brief overview of ATCA and discusses some of the hardware requirements imposed by the standard for both board size and equipment redundancy. In this context, the paper explains how PMC-Sierra's PM8310 TEMUX 336 and PM8311 TEMUX 168 devices enable OEMs to easily meet the requirements for ATCA-based I/O modules and overcome some of the design constraints with using the architecture.

2 ATCA Overview

2.1 Background

Until recently, telecommunications vendors have successfully developed and deployed many generations of equipment based upon proprietary system platforms. Vendors accepted the additional R&D costs and increased time-to-market associated with proprietary hardware because these proprietary platforms enabled vendors to differentiate and compete at a hardware level. However, modern networks are increasingly powered by software and their value is more and more defined by the rich layers of complex software-based applications and services that are supported by the network elements. In addition, each new wave of networking innovation challenges vendors to produce new system platforms with more sophisticated enabling technologies, more flexible support of multiple protocols, and more capacity to meet the increasing traffic demands of new services – and to deliver all this much more quickly and more cost-effectively.

In response to this new operating paradigm, telecommunications vendors are investing in the development of open standards for next generation equipment. The benefits of open standardization are already well accepted in other industries: lower individual R&D costs as the total costs are shared over a wider community; shorter time-to-market; increased competition among component suppliers leading to greater innovation and downward pressure on pricing; and acceleration of the adoption of new best-in-class technologies. Harnessing these powerful forces is enabling telecommunications vendors to revolutionize the way they develop their systems and to deliver greater value to their customers. One such open platform is ATCA.

2.2 ATCA Introduction

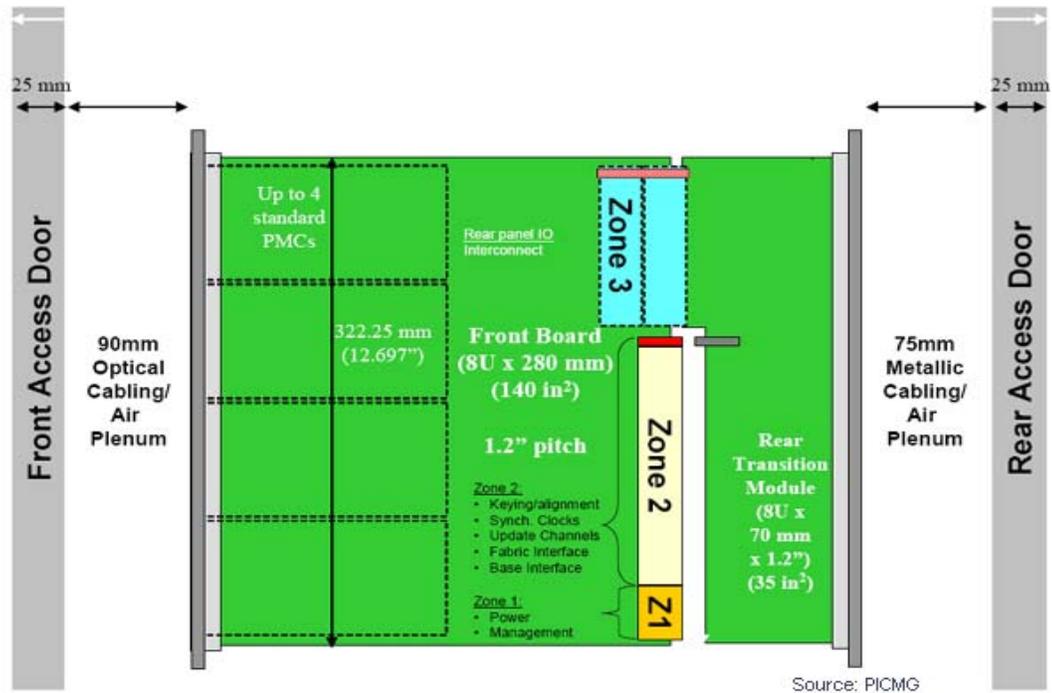
Developed by the PCI Industrial Computer Manufacturers Group (PICMG), ATCA is a series of specifications for an open, standards-based system platform. It supports the integration of plug-and-play smart I/O blades with processing server blades in a single chassis, all interconnected using standard switch fabrics. ATCA enables OEMs to develop multiple network elements on a single platform and to leverage the availability of interoperable commercial off-the-shelf (COTS) hardware and software components from an ecosystem of third-party vendors.

With more than 100 companies participating in the ecosystem, from component suppliers to application developers, ATCA has already become an accepted industry standard. It is estimated that the ATCA equipment market will grow over 50% year over year and it is poised to reach \$7.3 billion in revenues by 2012 [1]. Leading OEMs such as, Alcatel-Lucent, NEC, Nokia-Siemens Networks, and Huawei have already adopted ATCA for some of their next generation product lines. They are embracing ATCA because it enables them to shift their technical resources from research and development of proprietary hardware to focus on value-added applications and services. They can choose from a growing list of products in the ATCA-ecosystem including chassis frames, I/O blades, server blades, packet processing blades, switch fabric blades, management modules, power supplies, and standardized software modules.

2.3 ATCA Form Factor

ATCA is an open standards framework for building high-capacity, high-performance and high-availability Network Equipment-Building System (NEBS) compliant telecom shelves.

Figure 1 ATCA Form Factor



The mechanical form factor of the ATCA platform is reviewed in the PICMG 3.0 standard compliance document [2]. The basic elements of the platform are illustrated in Figure 1: the front boards which contain the electronic components; the rear transition modules (RTMs), which provide user defined I/O connectivity to the front board from the rear; the backplane, which provides connection interfaces for I/O between front boards as well as power distribution; and the subrack, which provides attachment points for the backplane and mechanical engagement for the front boards and the RTMs.

The board-to-board interconnect is separated into three major zones where different services are placed, as described in Table 1.

Table 1 ATCA Zone Features

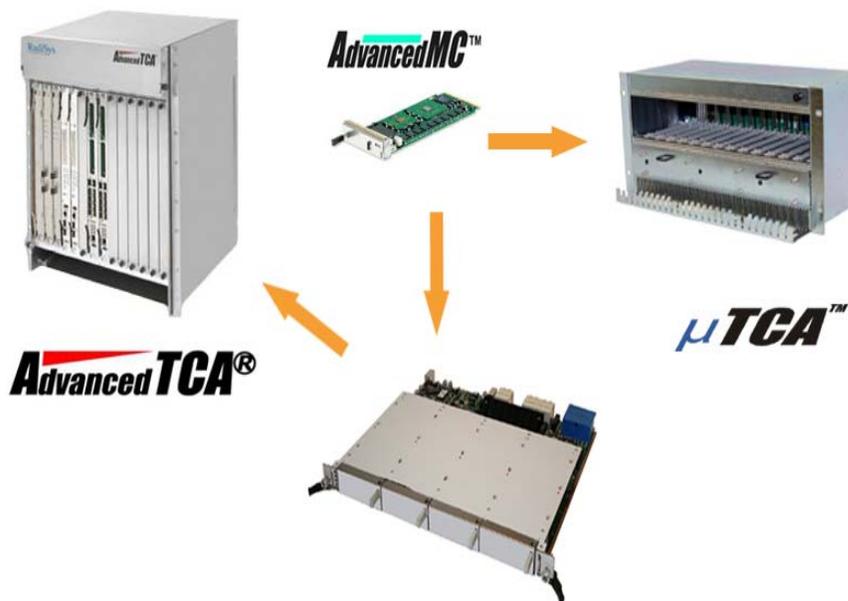
Zone 1	Zone 2	Zone 3
Power	Fabric Interface	Rear I/O
Physical Address	Base Interface	
System Management	Sync. Clocks Interface	
	Update Channels Interface	
	Keying/Alignment	

ATCA's large form factor (8U) and high-power capability (200W blade) give it the capacity to support multiple complex functions and high-density configurations. Its redundant fabric, redundant power, and hot swap capabilities reduce sensitivity to single point failure and enable service providers to manage systems with minimum disruption.

2.4 Extending ATCA with Mezzanine Cards

An Advanced Mezzanine Card (AdvancedMC or AMC) is a daughterboard that can be attached onto an ATCA Carrier Card or plugged directly into a MicroTCA (μ TCA) cabinet. AMCs provide a cost effective way to upgrade ATCA or μ TCA based equipment as carriers seek to add more functions or channels to meet changing requirements.

Figure 2 AMC and μ TCA



AMC modules augment a baseline ATCA platform by extending it with individual hot-swappable modules, providing OEMs with a versatile platform with reduced impact of component failures, and enabling service providers to scale, upgrade, provision, and repair live systems with minimal disruption to their network.

ATCA Carrier Cards can be equipped with up to eight AMC modules, which come in four sizes: half-height single-width, half-height double-width, and a full-height version of each. The field replaceable modules have escalating power limits of 20W for the smallest module to 60W for the largest module. Figure 3 shows the four different AMC module sizes.

Figure 3 AMC Board Sizes

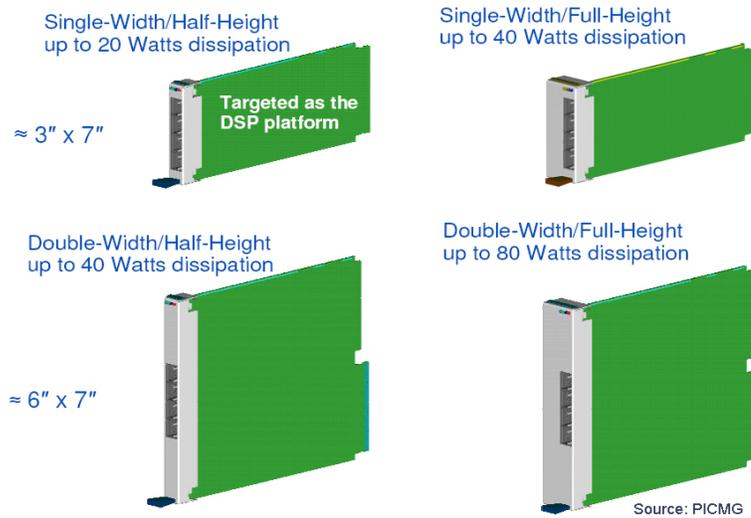
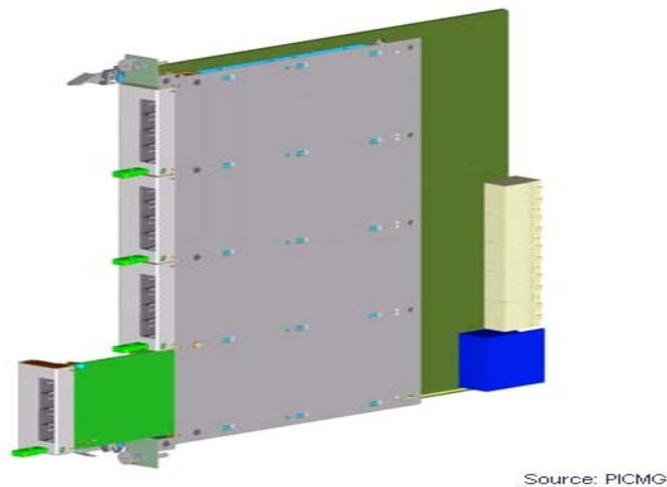


Figure 4 shows an AMC module augmented on an ATCA Carrier Card.

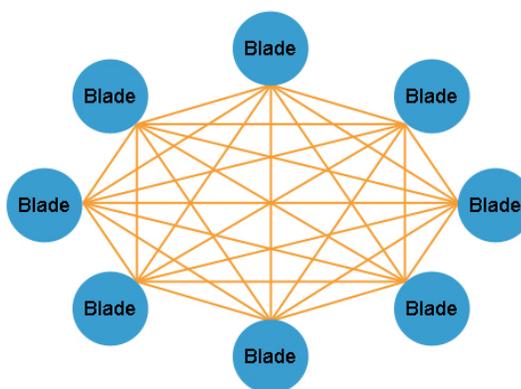
Figure 4 AMC Module on an ATCA Carrier Card



2.5 ATCA Switch Fabric

ATCA's switch fabric provides peak throughput of 10 Gbits/sec per link. The fabric supports a full mesh interconnect, enhancing availability by enabling each blade to communicate simultaneously via dedicated channels with every other blade as illustrated in Figure 5. Because it is "fabric agnostic", any switch fabric technology that supports point-to-point 100 Ω differential interconnects can be supported within an ATCA backplane, including Ethernet, InfiniBand, PCI Express, and RapidIO.

Figure 5 Full Mesh Interconnect Topology



2.6 ATCA System Availability

Network uptime is a critical issue for any telecom carrier. Unplanned network outages lead to reduced customer satisfaction, loss of sales, and breaches of customer Service Level Agreements (SLAs). Therefore, ensuring network reliability and availability to at least "Five 9s" (99.999%) is a major requirement for telecom carriers. In addition to high availability, serviceability and redundancy are also requirements for telecom carriers. To successfully satisfy these requirements, a flexible and reliable architecture is required.

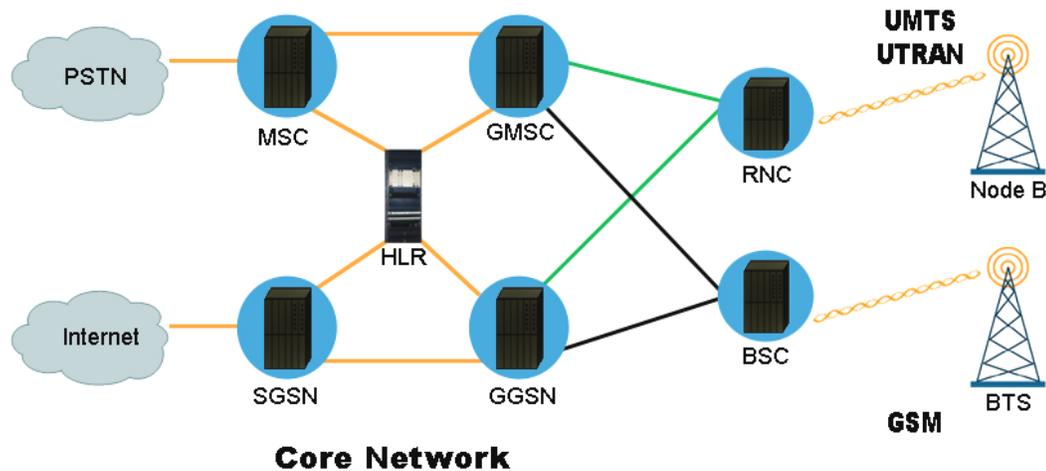
One of the design goals of ATCA is to ensure very low Mean Time to Repair (MTTR) and high Mean Time Between Failures (MTBF). Unlike some proprietary architectures, ATCA does not require active components in the backplane, which leads to low field repair costs and high uptime. Along with its hot-swap capabilities of components in the field, the architecture offers power manageability by allowing for a redundant shelf Field Replaceable Unit (FRU), managed by a Shelf Management Controller (ShMC), which ensures failure of a single device does not impact the entire system. Moreover, the architecture allows for all critical components such as fans, switch fabric modules, management modules, and FRUs to be front-serviceable.

2.7 Applications of ATCA in the Wireless Network

The structure of ATCA is considered ideal for low- to medium-volume applications that are closer to the core network, as it is a cost-effective approach to create an array of application design possibilities. Due to its high availability, reliability, scalability, flexibility, and unified system management approach, ATCA is considered ideal for core wireless platforms. Common wireless network elements where ATCA has been implemented include Radio Network Controllers (RNC), Base Station Controllers (BSC), GPRS Support Nodes (GGSN/SGSN), Mobile Station Controllers (MSC), and Gateway Mobile Switching Centers (GMSC).

In Figure 6, the blue circles denote some of the application points of ATCA-based wireless platforms.

Figure 6 Leading ATCA-based Wireless Platforms



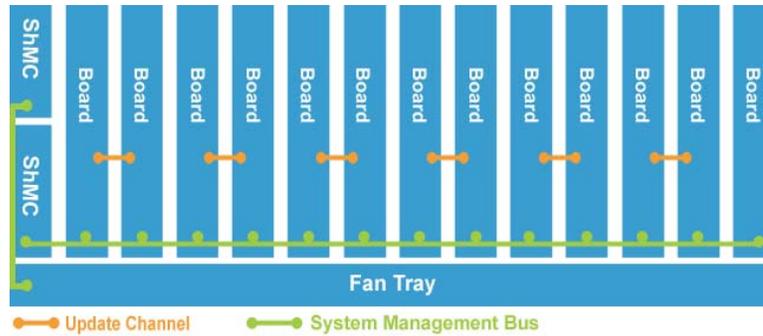
2.8 ATCA Design Challenges

ATCA and the AMC impose form factor and signal capacity constraints on the platform user. For example, with approximate dimensions of 75 mm x 180 mm, an AMC module provides little room to support expansive multi-chip solutions. In addition, the ATCA backplane affords only a limited number of signals that may be used for protection traffic to an adjacent card. One set of signals that can be used for such protection purposes is the Update Channel.

2.8.1 Update Channel

The Update Channel interface provides ten pairs of differential signals between two adjacent ATCA boards. It is expected that two like boards will use the Update Channel to share state information in redundant applications, including the passing of protection traffic.

Figure 7 Update Channel



Electronic keying is used to ensure that the Update Channel is only enabled when boards with identical capabilities are on each end of the channel. Backplanes are required to support the Update Channel but board support is optional.

3 Enabling AMC-based T/E Multiplex Cards

The PM8310 TEMUX 336 and PM8311 TEMUX 168 are the latest generation of PMC-Sierra's TEMUX family of channelized SONET/SDH framers, VT/TU mappers, DS3/E3 framers, and M13 multiplexers optimized to support the AMC modules for the ATCA architecture.

The TEMUX 336 device supports up to eight OC-3/STM-1 links, of which four links are working and four are for protection. Alternatively, the device supports up to two OC-12/STM-4 links, of which one is working and the other is for protection. The device is also capable of framing and transmitting up to 336 T1s, 252 E1s, or 12 DS3/E3 links. The TEMUX 168 device features half the density of TEMUX 336.

In addition to the SONET/SDH network interfaces, the TEMUX 336 family also features two line-side Extended Serial SONET/SDH interfaces (ESSI). These interfaces allow the TEMUX 336 family to connect to external SONET/SDH termination devices or to companion TEMUX 336 family devices in an Automatic Protection Switching (APS) scheme.

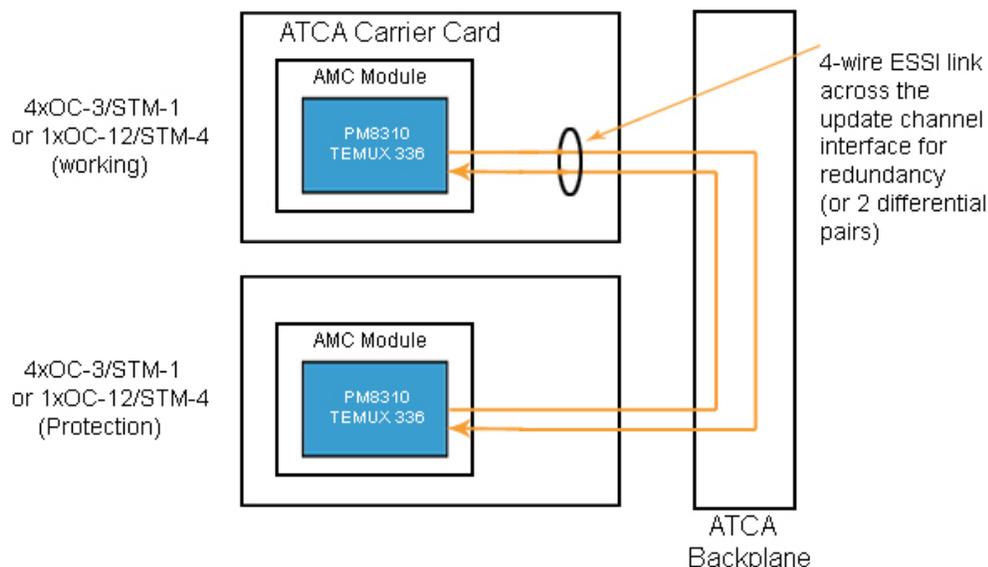
Overcoming ATCA Design Challenges

The TEMUX 336 family enables hardware designers and system architects to meet ATCA's technical challenges in the following ways:

1. **Integration:** The TEMUX 336 integrates the complete SONET/SDH front end with integrated CDR along with high-density T1/E1 framers, mappers and multiplexers in a single chip.
2. **Protection:** To meet ATCA requirements, the TEMUX 336 provides serial backplane interface that combines the traffic from all four working OC-3/STM-1 ports (or single OC-12/STM-4 port) onto only four signal wires (or 2 differential pairs), thus enabling support for equipment protection across ATCA/AMC carriers/modules using the Update Channel interface without additional multiplexing logic.
3. **Package Size:** Both the TEMUX 336 and TEMUX 168 devices have a 31x31 mm package footprint, leaving sufficient room for additional components on an AMC module.
4. **Power:** The TEMUX 336's low power consumption reduces the board power budget and overall thermal requirements, such as heat sinks and cooling fans.

Figure 8 shows a simplified diagram of an ATCA-based solution using the TEMUX 336.

Figure 8 ATCA-based Solution

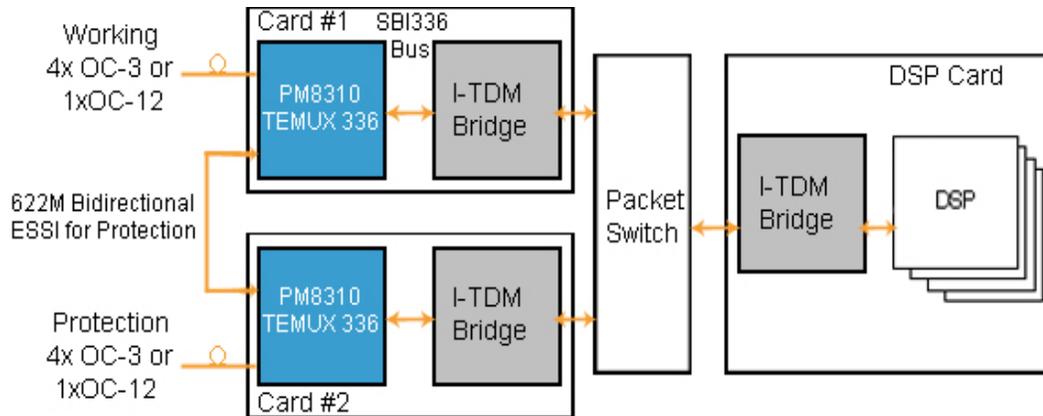


A key benefit of the TEMUX 336 is its ability to provide 1+1 equipment protection using a single 622M bi-directional ESSI link. The ESSIs allow the TEMUX 336 family to connect to companion TEMUX 336 family devices in an APS scheme.

Each bi-directional low-voltage differential signaling (LVDS) ESSI link operates at 622 Mbit/s and aggregates up to four OC-3/STM-1 connections or one OC-12/STM-4 connection. Only four signal wires (two for receive protect, two for transmit protect) are required to transport all four OC-3/STM-1 links to the companion TEMUX 336. This is vitally important for ATCA/AMC where the Update Channel (reserved for equipment redundancy) provides only a limited number of differential pairs to the adjacent protection card. The ESSI eliminates the need for additional multiplexing logic (i.e. FPGA), which increases the BOM cost and occupies more board space, to pass on traffic to the protection card.

Figure 9 shows an architecture in which two TEMUX 336 devices interface with four OC-3/STM-links. A single 622M bi-directional ESSI link is used to provide a protection path for the two devices. An internal TDM (I-TDM) bridge is used to transport the voice traffic over the packet backplane to a DSP card.

Figure 9 ATCA-based Voice Gateway



4 Conclusion

ATCA is specifically developed for the telecommunications equipment market in order to address the needs of a constantly evolving network infrastructure. This open-standards architecture brings many benefits to OEMs and Carriers:

- Promotes flexibility and innovation by providing OEMs and system integrators with an ecosystem of modular COTS components to choose from
- Reduces vendor dependency and single vendor lock-in problems by providing a broader supplier ecosystem
- Accelerates time to market for OEMs
- Eases the challenge of building and upgrading infrastructure
- Increases system efficiency and network throughput
- Reduces development time for rapid deployment of new services
- Lowers total cost of ownership

However, to meet ATCA and its specifications, components have to be carefully selected when designing a system. Factors such as equipment protection, board size, power, thermal, and capacity must be considered during the design.

PMC-Sierra's TEMUX 336 family of devices, with its high degree of integration, low power consumption, smallest footprints and serial backplane interface for equipment protection, enables OEMs to easily meet the design challenges of ATCA.

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Contacting PMC-Sierra

PMC-Sierra
100-2700 Production Way
Burnaby, BC
Canada V5A 4X1

Tel: +1 (604) 415-6000
Fax: +1 (604) 415-6200

Document Information: document@pmc-sierra.com
Corporate Information: info@pmc-sierra.com
Technical Support: apps@pmc-sierra.com
Web Site: <http://www.pmc-sierra.com>