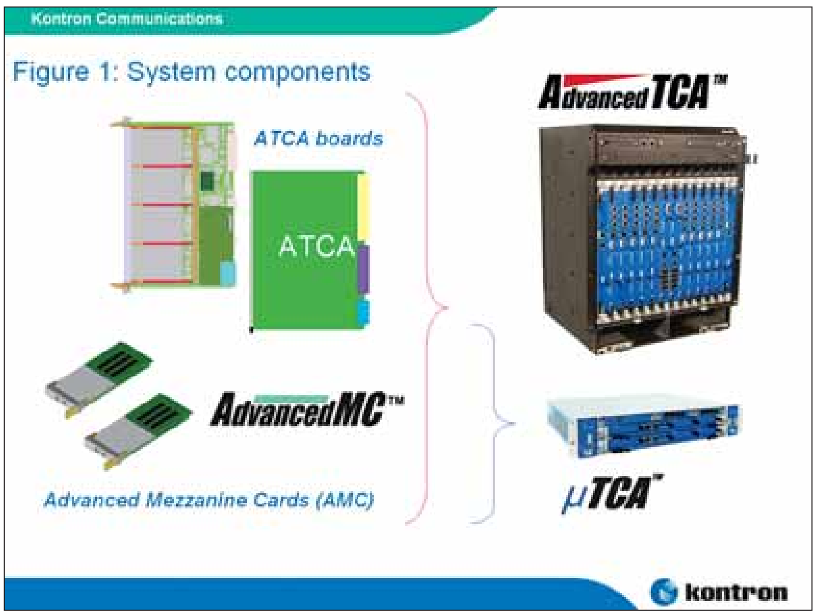
AdvancedMC systems
for industrial applications

*by **Dr. Stephan Rupp**, Kontron*

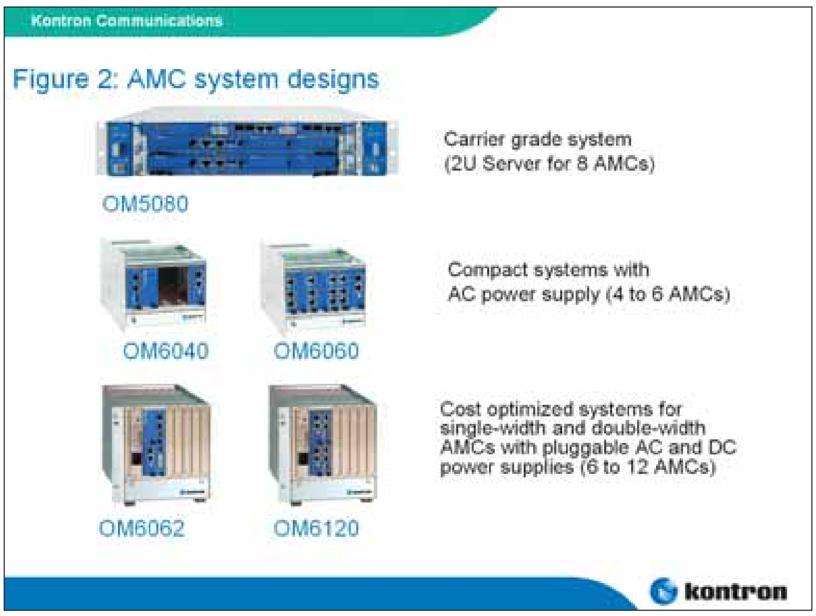
Following the success of CompactPCI there is now a further PICMG standard that has already established itself on the market - Advanced Mezzanine Cards (AMC). In contrast to the parallel bus systems of VME and CPCI, AdvancedMC is based on serial interfaces and supports different transport systems such as, for example, PCI-Express, Gigabit Ethernet, 10 Gigabit Ethernet, Serial Rapid I/O and SAS (Serial Attached SCSI)/SATA (Serial ATA).
Using the MicroTCA standard (Micro-Telecom Computing Architecture) it is possible build systems based on AMCs that can be used beyond the telecommunication industry. AMCs offer everything needed for creating industrial multi-processor systems. According to the MicroTCA specification, however, the systems would be more complex due to high redundancy and application specific configurations needed in the telecommunications industry. By dispensing with the unnecessary, telecom-specific components it is possible to significantly reduce the costs for industrial applications.

What are the origins of AdvancedMC?
AMC is an industrial standard from the PICMG and part of the AdvancedTCA (Advanced Telecom Computing Architecture) specification. It differs from parallel bus systems such as CompactPCI and VME by using serial interfaces in the backplane and controlling the operation of all hardware components via IPMI (Intelligent Platform Management Interface). ATCA supports a large number of options: The basis specification (PICMG 3.0) lays the foundations, i.e. the mechanics, IPMI, different topologies and the physical characteristics of the cables. Sub-specifications determine how special transport systems are to be used: Ethernet (PICMG 3.1), Infiniband (PICMG 3.2), Star Fabric (PICMG 3.3), PCI-Express (PICMG 3.4) and Serial RapidIO (PICMG 3.5). This ensures that the standard remains open for future extensions. Several protocols can be implemented simultaneously in a single chassis. Electronic keying checks the compatibility of newly inserted cards which eliminates the possibility of electronic faults that can occur when a board is accidentally inserted into the wrong slot. When the keying is positive, the card is logged into the system and ready to go. System specialization occurs during the configuration process.
The “T” in ATCA stands for Telecom. The specification therefore contains requirements that are important for operating telecommunication systems. As well as operational safety requirements (operation, radiation, heat, noise, fire, vibration and shock), the most important requirement is reliability. Telecommunication systems must have 99.999% availability which equates to a downtime of around 5 minutes per year. This level of availability requires systems with built in redundancy to prevent single points of failure. The basis specification therefore includes requirements for high-available system designs, such as the use of system components in duplicate, two power supplies and separate control and user planes. Telecommunication systems need to process a massive number of transactions with a low latency period and high throughput. Another requirement from the telecommunication sector is clock synchronization in the backplane.

System components and standards
What are the building blocks of ATCA and AMC systems? The main parts are the chassis which come in different designs, the ATCA boards and the Advanced Mezzanine Cards (AMC). The chassis already contain 1-2 shelf managers for operating the ATCA boards and AMCs as well as the fans and



ATCA/AMC system components: The Chassis are different. They already contain 1-2 shelf managers for operating the ATCA boards and AMC as well as the fans and power supply.

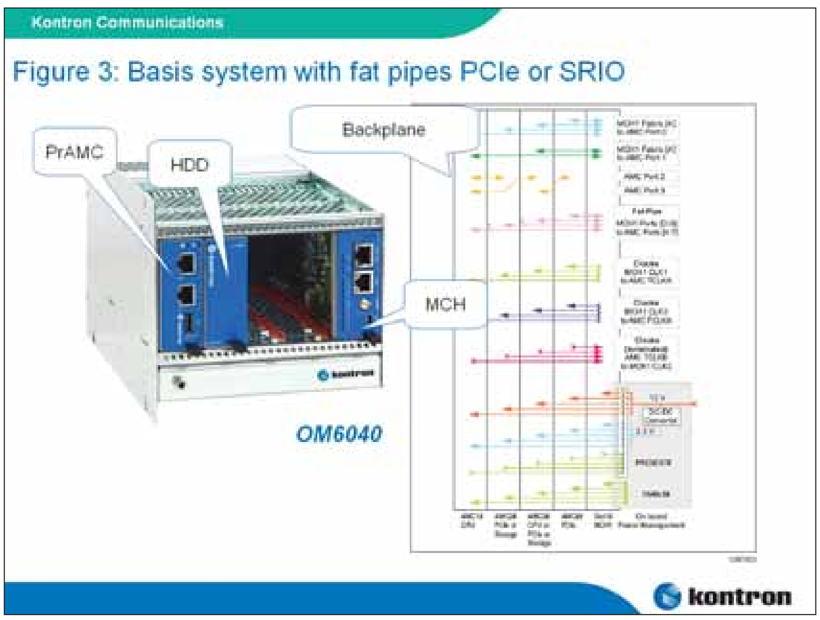


Different designs according to the application area: E.g. the OM5080 2U server in 19 inch format for 8 AMCs, the compact OM6040 and OM6060 systems for 4-6 AMCs, and the second generation OM6062 family of systems available as single-width or double width systems. The OM6120 supports up to 12 AMCs in single-width format.

power supply. ATCA offers a wide range of functionality thanks to the form factor of the ATCA board (8U x 160 mm x 12 inches) with a power consumption of up to 200 watts and the AMC specification that enables the smallest field replaceable hot swap units to be connected to ATCA boards.
The PICMG standards for AdvancedMC are similar to the ATCA standard. AMC.0 provides the basis specification and further specifications describe the use of different transport systems (AMC.1 PCI-Express, AMC.2 Gigabit Ethernet and AMC.3 interfaces for storage media).
There is a further standard for systems that have AMCs directly connected to the backplane, i.e. MicroTCA, for which version 1.0 of the MicroTCA.0 basis specification was published in July 2006. MicroTCA defines the use of up to 12 AMCs in a single system together with the use of shelf management, power management and switch functions. The AMCs remain unchanged. The required additional functions are contained in specific MicroTCA components, i.e. the MicroTCA Carrier Hub (MCH), power module and cooling units.

Basic system architecture

The system management and network (Ethernet) functions are part of the basic architecture of every AMC system. Every AMC is connected to a manager that checks the system configuration and activates the power supply only once the check has been successfully completed. It also adjusts the fans in accordance with the required energy consumption and environmental temperature. These functions are known as E-keying and power management and are the responsibility of the MCH. The MCH can also deactivate the feed voltage of the AMCs when an AMC needs to be removed or replaced whilst the system is running. External interfaces such as SNMP are also part of the management function.
The MCH is connected with the AMC, fans and power supply via the I2C bus and the IPMB protocol. Each AMC also has an IPMI controller with a separate power supply (3.3 volt) so that system management is independent of the AMCs' feed voltage. The MCH individually switches the 12 volt feed voltage for each AMC.
AMCs usually have 1-2 Ethernet connections connected to an Ethernet switch that is also part of the MCH. This enables AMCs to communicate with each other within the system as well as with the outside world via the external Ethernet ports of the MCH.
Management and Ethernet are not the only transport systems in an AMC system. The standard has space for further serial interfaces on the backplane that can be implemented either as point-to-point connections between the AMC or as radial connections to a fabric switch. The fabric is also usually implemented on the MCH. For AMCs and MCHs there is a convention for assigning the ports for the components. The backplane maps the port assignments between the AMC and MCH.
Compared with parallel bus systems the backplane of an AMC system is therefore not fixed, but instead depends upon the respective application. The standard only provides options for assigning the AMC and MCH ports. But there are conventions for assigning these ports. One popular approach is the Scope Alliance port mapping. The lower ports on the AMC and MCH (clocks and common options) are part of the basis system (management, clock signals and Ethernet). Ports 2 and 3 are reserved for storage media.
In addition there are the fat pipes and extended options for PCI Express (ports 4-7), Gigabit Ethernet or Serial Rapid I/O (from port 8). It makes sense to separate PCI Express from Gigabit Ethernet or Serial Rapid I/O when both systems are to be used at the same time. When implementing either PCI Express or Serial Rapid IO, using AMC ports 4-7 enables the same backplane and the same chassis to be used.



Standard AMC systems for industrial applications: The management concept remains (E-keying, power management, hot swapping and external administrative interfaces).

Additional capacity with PCIe, SRIO and 10GbE

Just like PC systems, processor AMCs can be connected with peripheral AMCs via PCI Express (PCIe). The AMC standard defines a clock line (fabric clock or CLK3) for operating PCI Express as well as data lines for PCI Express with 1 - 4 serial connections. In the simplest case, the PCI Express connections are implemented as point-to-point connections on the backplane. As an alternative to point-to-point connections the PCI Express connections can be routed to the MCH and from there to the AMC slots. In this case the MCH needs to have a PCI Express switch.
The AMC standard offers further optional ports for additional connections between the AMCs in a single system. This includes further Ethernet connections (1 Gigabit Ethernet per AMC port or 10 Gigabit Ethernet with four AMC ports) and Serial Rapid I/O (SRIO, also with 10 Gigabits per second for four AMC ports) or 10 Gigabit Ethernet (10 GbE currently via combination of 4 ports). The additional capacity is implemented via the MCH and is most likely needed for processor communication in a multi-processor system. Depending on the system configuration, one or more MCHs with an Ethernet switch or SRIO switch could be used.
Whereas Ethernet usually requires a switch for the basis system or for additional capacity, PCIe can run as a periphery bus directly via the backplane, including PCIe clocks. As usual for CompactPCI, there is a CPU slot for the PCIe connection. When it comes to PCIe, the four neighboring slots are for periphery cards. This specialization is, however, only valid for PCIe. Since the basis system already offers Ethernet, a processor can be placed on every slot. The slots can be connected to each other via the Ethernet network.

Cost savings for industrial applications

As standards in the telecommunication sector the AMC and MicroTCA specifications are very stable and offer a reliable and long-lasting basis for systems. The areas of application, however, go well beyond traditional telecommunication applications. Industrial applications include those requiring high processing power such as image processing, control and medical diagnostics as well as data capture and data processing with high throughput. How can you cost-efficiently implement these applications without the telecommunication specific components?
An important criterion for AMC systems is the use of standard AMCs. The management concept can be kept (E-keying, power management, hot swapping of AMCs as well as external administrative interfaces). But unlike telecommunication systems, industrial systems can take advantage of the following cost-cutting measures:

- *No redundant components in the system.*
- *No MicroTCA power module: an active backplane handles the switching when AMC cards are inserted or removed. It also controls the fans.*
- *Cubic design for six AMCs or twelve AMCs simplifies cooling.*
- *PCI Express lanes and clock signals on the backplane instead of a PCI switch.*
- *Operation without MCH when Ethernet is not needed.*
- *MCH reduced to management and Ethernet (Basis version: unmanaged switch).*
- *Double-width format enables complete CPU including graphics and hard drive on an AMC.*
- *Double-width format enables reuse of CompactPCI.*
- *Pluggable power supplies for different supply voltages and performances.*

These measures reduce the costs of implementing AMC systems for industrial applications. AMCs are a particularly solid and future proof-solution, especially for applications that require several processors. The first systems for industrial use are already on the market.

Streamlined for industrial applications

Removing the unnecessary telecom components from AMC or MicroTCA systems such as redundancy, the MicroTCA power module or the MCH, generates a cost-effective, robust and powerful computer for industrial applications. These solutions are of particular interest to industrial applications that require multiple processors, such as industrial image processing. They are also ideal for medical diagnostics.

About the author

Dr. Stephan Rupp is business development manager at Kontron in Kaufbeuren, Germany. He was previously with Alcatel, responsible for systems integration, business development and intelligent networks. Before that, he developed digital radiography systems for Philips Medical Systems. Stephan Rupp is also engaged in education as a lecturer and author of specialist publications.
Phone: +49 (8341) 803 425
Fax: +49 (8341) 803 40 425
Stephan.Rupp@kontron.com