MicroTCA-FAQ

10 answers to Frequently Asked Questions

This railway-demonstration showed how easy, flexible and scalable a control application can be implemented with a standard MicroTCA system

Will MicroTCA give the innovative drive to the markets of industrial automation, medical and defence? Here a combine of Frequently Asked Questions.

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The telecom market transforms and takes advantages of AdvancedTCA and MicroTCA: No longer CPCI, VME or proprietary solutions, no longer development cycles of 4 years, no longer high life cycle costs. This article targets developers and decision makers, who search for new ideas, to decrease the system costs including the costs for software development, and still providing their customer with high innovative, long life, safe and still flexible products.

Looking at the embedded market and one sees solutions based on proprietary standards as well as established ones like CPCI, VME, ETX, COMexpress, CANbus etc. The new high speed serial interfaces are PCIexpress, GigE, 10 GigE, SATA, Serial-RapidIO and Infiniband.

The telecom market takes advantage of all these high speed interfaces coming with the AdvancedTCA standard, as it defines a infrastructure utilizing these high speed links plus a management bus. The high processing density, the high power dissipation range, the high speed busses and the high availability of 99.999 percent up to 99.9999 percent attracts also interests outside of the telecom market, i.e. suppliers of silicon production facilities or manufacturers of systems used in high energy and nuclear physics. Without AdancedTCA neither the AMC nor the MicroTCA standard would exist. Commonly known mezzanines like PMCs are not hot swappable.

The consequence arising from there is that one would need to re-route an application for 8000 phone lines to another ATCA board, only to exchange a faulty telecom I/O module.

Taking the demands of the telecom market it was more than natural to incorporate hot-swap functionality and other features including high speed serial connections in the next generation of mezzanines: the Advanced Mezzanine Card (AMC). The ATCA-AMC carrier board takes care of power distribution- and conversion, management and last but not least of the data routing, too.

How was the MicroTCA standard born?

Because of the flexible sizes (single/double Compact, Mid and Fullsize) and the acceptance in the telecom market the AMC module will for sure reach higher volumes than the PMC modules ever did. This will cause a price advantage of the AMC, of which also members of other markets like to take advantage.

Small AdvancedTCA chassis with five or only two slots are available. In order to equip such a chassis with AMC modules only, a ATCA backplane and an ATCA-AMC carrier board for each slot is needed.

Obviously a better solution for the chassis and the carrier board becomes necessary. At this time MicroTCA was born, as in a MicroTCA chassis the AMC modules can be plugged directly onto the backplane.

The ATCA backplane and the ATCA-AMC carrier boards are replaced by a smaller MicroTCA backplane for up to 12 AMC and one MicroTCA Carrier Hub only. Commonly a MicroTCA system consists out of a chassis, a backplane for two up to 12 AMC slots, one or more power units (PU), one or more cooling units (CU) and one or two MicroTCA Carrier Hubs (MCH).

The standard defines backplanes in almost every possible size: from a small system of just two AMC modules up to a 19 inch chassis

	Connector Region	AMC Port #	Signal Conventions			Non-redundant MCH Fabric #	Redundant MCH #/ Fabric #
Basic Side	Common Options	0	AMC.2 1000BASE-BX			A	1/A
		1	AMC.2 1000BASE-BX				2/A
		2	AMC.3 SATA/SAS			B	1/B
		3	AMC.3 SATA/SAS			C	2/B
	Fat Pipe	4	AMC.1x4 PCI-Express	AMC.4x4 SRIO	AMC.2 10GBase-BX4	D	1/D
		5				E	1/E
		6				F	1/F
		7				G	1/G
Extended Side	Extended Fat Pipe	8		AMC.4x4 SRIO	AMC.2 10GBase-BX4		2/D
		9					2/E
		10					2/F
		11					2/G
	Extended Options	12					
		13					
		14					
		15					
		16					
		17					
		18					
		19					
		20					

AMC standard and ports

with up to 12 AMC modules of different sizes.

MicroTCA allows building small compact and price efficient systems. One has to keep in mind, that without any modifications AMC modules can be used in large AdvancedTCA chassis as well as in very compact ones-, such as MicroTCA chassis being scaled down to just two slots.

Which additional benefits beside attrative pricing does MicroTCA offer?

As described at the beginning, MicroTCA systems are available at a significant lower price than AdvancedTCA systems. But could these MicroTCA systems also be an alternative for industrial PCs, CPCI, VME and even proprietary systems?

The MicroTCA standard defines more than only the form factor, backplane, chassis, modules, connectors and the different serial busses. In consequence, the next thing to explain with a MicroTCA is the function and the software support in order to show the possible applications and the potential for cost reduction when building a system based on MicroTCA.

Not only can an application discover during bootup, which AMC modules are in the system, but also how these modules are connected to each other by the backplane. The backplane manufacturer stores the information which differential lines in the backplane are routed in a star topology from the MCH to which slot in an EEPROM.

This opens a lot of potential combinations of the serial busses such as GigE, SATA, PCIexpress, RapidIO and IPMI. Looking at the foresaid, the following questions arrise:

How can one ensure, that a non compatible AMC module causes a harm to the system?

How can one ensure, that the available power budget could cater for a newly plugged in module?

How would the AMC module get to know, which network or serial connection is provided by the backplane and how this is routed?

The MicroTCA standard already contains the answers for these and a lot of other questions to allow the development of innovative, flexible systems bases on open standards. Moroever, these systems can protect themselves and provide the means that any higher layer application can be informed about the currently existing infrastructure. The key to this flexibility is a component named MicroTCA-Carrier-Hub (MCH). Its main functions are:

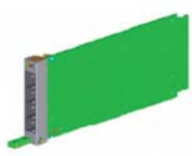
- it detects the backplane's configuration
- it is the common hub node for all serial connections in the backplane
- it manages the AMC modules in the system
- it performs checks in terms of the compatibility of the AMC modules
- it controls, which AMC module will be provided with payload power
- it tells the AMC modules which serial lines to use according to the performed compatibility checks
- it controls the power and cooling units
- it collects all sensor data like temperature etc
- it synchronises with a second redundant MCH, if installed

Would an incompatible AMC module cause the MicroTCA system to crash, if it is plugged in?

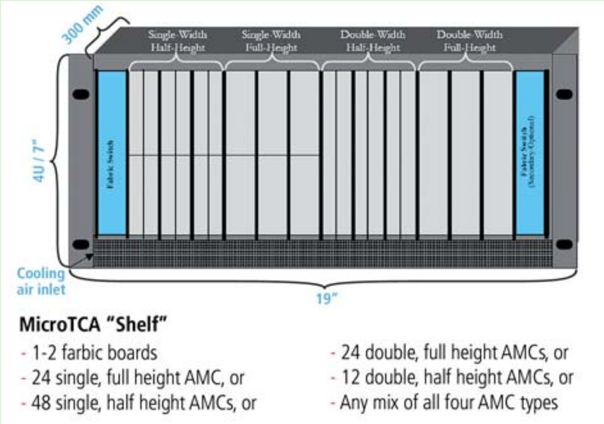
No. When an AMC module is plugged in, the power unit makes the first action. The plug in action will be detected by the power unit and it will provide the management power of 3.3 V to the management hardware (Module Management Controller MMC) of the AMC module.

The MMC announces to the MicroTCA Carrier Management Controller (MCMC) at the MCH through the IPMI bus its power requirements, supported serial interfaces, available sensors, etc. The Carrier Manager (MCMC) of the MCH forwards this information to the Shelf Manager. The Shelf Manager can be running on a General Purpose CPU at the MCH or on an AMC-CPU in another slot or outside of the MicroTCA system, i.e. on an external notebook.

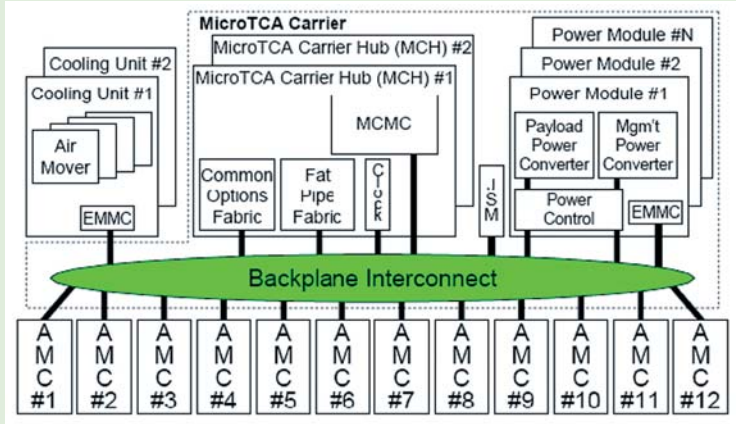
This Shelf Manager checks the information and compares it with the available power budget and the available serial interfaces. The results are reported back to the Carrier Manager MCMC at the MCH. Now the Carrier Manager knows, if the

	Compact-Size (3HP)	Mid-Size (4HP)	Full-Size (6HP)
Single modules	 73.8x13.88x181.5 mm	 73.8x18.96x181.5 mm	 73.8x28.95x181.5 mm
Double modules	 148.8x13.88x181.5 mm	 148.8x18.96x181.5 mm	 148.8x28.95x181.5 mm

AMC Form factors (source MicroTCA short form spec.)



19 inch MicroTCA chassis with AMC of different sizes (example Elma)



Building Blocks of MicroTCA

plugged in AMC module is compatible and which serial interfaces the AMC may use. Again, through IPMI the carrier manager MCMC informs the Module Management Controller MMC of the AMC module, which serial interfaces it may use during operation.

Now the Carrier Manager advises the power unit to enable the so called payload power (12 V)

to the AMC module. Eventually also the Cooling Unit gets informed to work with more power to guarantee the required environmental temperature for the new plugged in module.

Then the AMC module boots and launches its application. The information about which serial interfaces to use will be provided by the on board Module Management Controller MMC.

Will I be forced by the management software to a dedicated AMC or MicroTCA supplier?

No. The Service Availability Forum (www.saforum.org) defined standards for management software covering hot swap functions and high availability. The standards are platform independent and implementations have proven to work well i.e. for Servers, ATCA and MicroTCA systems.

With the definition of the Hardware Platform Interface (HPI) by the SAF, the user can exchange the hardware without the need to modify any software layer above. Although IPMI has been standardized long time ago, companies like Motorola, Force, Radisys, Continuous Computing etc designed their own High Availability Software as IMPI did not cover all aspects required to build such systems.

This of course made it almost impossible to exchange the chassis, the backplane or the host CPU without larger effort. Even changing just the payloads was possible with serious restrictions only. With a service software compatible to the SAF definitions, an exchange of all parts of the system is possible, giving the user much more flexibility. An open source implementation compliant with the SAF definitions is available at OpenHPI www.openhpi.org. For visualisation the open source tool OpenView is available for download, too.

By the standardisation of the management software and the flexible hardware architecture of MicroTCA the costs of development, service and upgrade can be reduced. As seen earlier, the Shelf Manager can be implemented in the MicroTCA system as well as external to it. The application specific configuration files could be located on a web host. With new available off- the-shelf hardware and own designed hardware, only these files have to be updated. This reduces even more the Total Cost of Ownership.

Is an AMC module design complicated?

No. If a customer develops a PCI-express boards as replacement for a PCI board, the main work is already done. He only has to reroute the design to an AMC form factor and add on the module a nail size micro-controller for IPMI and 4 differential lines to the AMC connector.

Implementing the IPMI software on the microcontroller as Module Management Controller MMC, the customer can use the IPMI know how provided by N.A.T.. In alternative to this commercial suppliers of hardware and software solutions are available, too. The advantage of an AMC module compared to a standard PCIexpress board is that it can be plugged in and plugged out during normal operation (hot swap).

Also the realisation of the cooling functionality is better. The service engineers and customers will like it. The power consumption may vary from just a few up to 80 Watts per slot. This means less restrictions for the selection of chipsets and other functionalise for AMC modules.

Has a MicroTCA system to be expensive?

No. If the profile of requirements of an industrial customer does not need the management functionality, the logical question arising from there is, if the costs of an MCH can be saved as well. The answer to this questions simply is that without an MCH a special slot CPU and a special backplane would needed with the consequence of all disadvantages of an proprietary system occurring. Also the advantages of such a non standard system compared to those based on CPCI, VME or an industrial computer will vanish immediately.

The charme of a standard MicroTCA system is, that MicroTCA not only can replace manageable industrial but also low end industrial computer.

As already verified, the costs of an AMC module compared to a PCIexpress board are by some cent higher only, as an additional microcontroller is needed as Module Management Controller.

How can a MicroTCA Carrier Hub (MCH) reduce the costs?

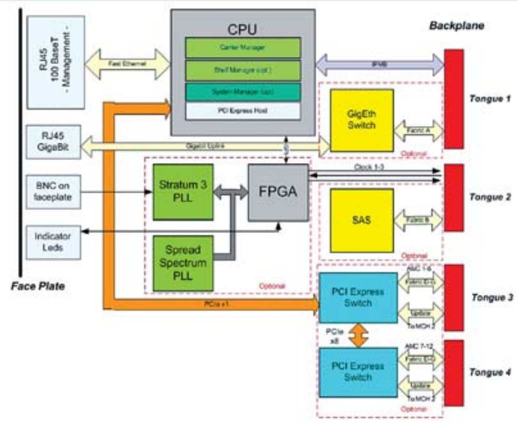
The MCH is inevitable when building a standard compliant MicroTCA system. However, it is

justified to ask, how much functionality of the MCH is needed and how much money can be saved by using a MCH at all?

By its modular design, even the MCH can be adapted to the customer needs. This will be demonstrated analysing the N.A.T. MCH as an example. For a basic working MicroTCA system only the base board of the MCH is needed (figure 5). It contains a CPU, debug

interface, Ethernet to the outside world, Uplink GigE, MCMC, IPMI interfaces to the power and cooling units, to the temperature and other sensors and to all AMC modules. On demand the CPU can work as PCI host. These are all components required for a simple MicroTCAsystem.

Together with the MCH a Shelf Manager and a System Manager running on the CPU on the MCH can be delivered. Access to these managers is possible via the HPI



MicroTCA-Carrier-Hub MCH with all options

interface provided by the openHPI implementation. In alternative to this the customer can of course decide to use his own manager instead, running on any AMC-CPU or on an external server or Notebook, which is connected by Ethernet.

This minimal system can be upgraded by a GigE switch and/or a PCI-Express Switch to 6 or to all possible 12 AMC slots. Furthermore, if a customer requires a Serial-RapidIO or any proprietary I/O bus, just the PCIexpress module on the MCH will be exchanged against the relevant module. ~~In this way the user can slowly migrate from his proprietary system to MicroTCA and already use the offthe-shelf AMC modules.~~

~~Any specific requirements to the clock synchronisation (internal or external) can be catered for by the clock input connector at the front panel. In order to cover any special requirements for telecommunication a sophisticated clock module is available with the MCH.~~ Thus, the modular concept of the *N.A.T.* MCH allows the adaption of the MCH to any customer needs and requirements.

If required, can a MicroTCA system provide redundancy?

Yes. In the case of a high available industrial application even more advantages of the MCH than already described can be used.

Inserting a second MCH, redundant AMC-CPUs and AMC-I/Os, n+1 power units and exchangeable redundant cooling units into the MicroTCA system will be all one would need for a high-availability industrial computer.

Also the configuration of a high-availability MicroTCA system is supported by the SAF and the OpenHPI software. As already explained, using this standard service software will make one's application supplier independent, enabling the system integrator to always use the hardware fitting your application best.

The described high-availability MicroTCA system reduces the costs for development of hardware and software, the costs of field service, the cost for system upgrades and the costs of adaption for a product with a long life cycle. By re-using the same modules in different configurations allows the system integrator to create products for different applications and – even more important - to scale the system up and down as needed.

Are there AMC I/O modules available for markets like Industrial Automation?

Yes. One concern often mentioned against MicroTCA is that there is not enough I/O hardware available. However, there are good news. The number of standard AMC modules available from embedded companies is constantly increasing. (See a supplier list: www.picmg.org).

Also for the users of IP modules there is an AMC-IP carrier board available from Tews TAMC100 with Support Software for VxWorks, Windows XP/XPE/2000, LynxOS, Linux and QNX6.

~~Mid~~ of 2007 there will be also an AMC-PMC carrier module delivered by N.A.T. for the PMC and PTMC users. Therefore MicroTCA systems can be built with COTS AMC modules (Pentium, Dual Core, PowerPC, DSPs, hard disk, Ethernet, Telecom WAN interfaces, ADC) and with IP and PMC modules.

For verifying own AMC module development the AMC bus analyzer Vanguard Express AMC Analyzer is available from VMEtro. It has the same user interface as the PCIexpress, VME, CPCI and PCI bus analyzer of VMEtro.

The AMC extender board NAMC-EXT from N.A.T. enables developers to make measurements of the AMC bus signals as well as management and payload voltage measurements.

How difficult is it to port a control application to MicroTCA?

At the Embedded World in February 2007 N.A.T. showed a MicroTCA system, which was realized with an Elma 12 slot MicroTCA chassis filled with a NMCH, AMCCPUs of different suppliers, a NAMC-8560-E1/T1/J1 and an AMC control module including the control application for a model railway.

The demonstration was controlled by a management user interface based on OpenHPI. And showed, that in the MicroTCA standard not only all management interfaces for cooling and power units, for temperature monitoring, hot swap function etc are defined, but also all the functions for a remote controlled, distributed and high available system. N.A.T. showed how easy, flexible and scalable a control application can be implemented with a standard MicroTCA system. A dedicated AMC control module was integrated via IPMI to the system, and all the Reed relais (position), the switches and the signal of the railway were connected to AMC.

Whenever the railway passed a Reed contact, the generated pulse triggered a sensor on the control AMC board which then generated an IPMI event. This event was received by the Carrier Manager of the MicroTCA-Carrier-Hub (MCH) board, and forwarded from there to the Shelf Manager. The event was then displayed in the control application with the respective sensor data.

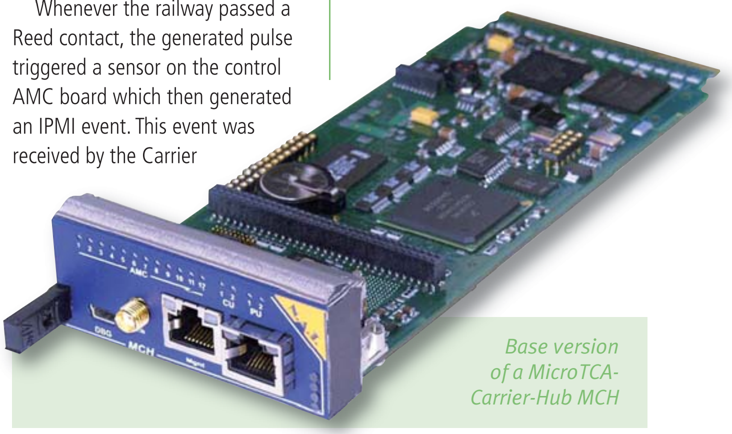
In addition to displaying of the position of the railway the control application allowed the manipulation of the railway switches and the signal which have been implemented as IPMI sensors, too. The commands for these sensors were forwarded by the System Manager through Ethernet to the Shelf Manager in the MicroTCA system and from there via IPMI to the AMC control module.

The control application of course also displayed the data and capabilities of the other AMC modules in the MicroTCA chassis and allowed reading and writing their sensors.

It was quite impressing, when AMC modules of different vendors were plugged in and out at system run-time and see them being displayed the control application.

Is MicroTCA beside the telecommunication market also interesting for industrial automation, medical and defence market?

Yes. It is quite a well known fact, that MicroTCA is a perfect fit for the telecommunication market. However, the goal of this article was to show, that MicroTCA can be seen as an innovative alternative for industrial automation, medical and defence due to its most remarkable benefits: scalability, long life cycle, extension, by standard defined



Base version of a MicroTCA-Carrier-Hub MCH management functions and possible adaptations over the whole life cycle of a project.

With the products of the embedded community interested customers can start to design their own AMC modules and to build MicroTCA systems.

Glossary

- MicroTCA µTCA Micro Telecom Computing Architecture
- MCH MicroTCA Carrier Hub
- NMCH MicroTCA Carrier Hub
- OpenHPI Open Hardware Platform Interface (HPI) www.openhpi.org
- AMC Advanced Mezzanine Card
- NAMC Advanced Mezzanine Card
- ATCA Advanced Telecom Computing Architecture
- COTS Custom off the Shelf
- MCMC MicroTCA Carrier Management Controller
- MMC Module Management Controller
- IPMI Intelligent Platform Management Interface
- IPMB Intelligent Platform Management Bus/Bridge
- IPMC Intelligent Platform Management Chassis bus/bridge
- FRU Field Replaceable Unit