MicroTCA Goes Digital Control

Micro Telecommunications Computing Architecture (MicroTCA) is a relatively new architectural specification for Information and Communications Technology (ICT) equipment, and is a complement to the Advanced Telecommunications Computing Architecture (AdvancedTCA) specification. The MicroTCA power system, which can have a significant effect on the performance, will be discussed in detail, as demonstrated at Digital Power Europe. **Per-Johan Wiberg, Ericsson Power Modules, Stockholm, Sweden**

MicroTCA, which was ratified by the PCI Industrial Computer Manufacters Group (PICMG) in 2006, is the latest generation of open-architecture platforms developed by the PICMG for ICT equipment. It builds upon the heritage of previous architectures and technology, namely AdvancedTCA (2002) and AdvancedMC, maintaining much of the same functionality, but with different system partitioning, and with optimisation for applications with lower power levels such as Customer Premises Equipment (CPE), Edge and Access equipment.

Powering Advanced TCA

AdvancedTCA carrier-boards are large planar structures operating from -48V and containing both power control/conversion circuitry and some of the load electronics (Figures 1 and 2). Additional load electronics may be packaged in Advanced Mezzanine Card (AdvancedMC) modules which are mounted to the carrier-boards. An AdvancedTCA system rack contains several of these carrier-boards. Up to 14 carrier-boards may be installed in a 13U high 19in shelf, while up to 16 carrier-boards may be used in a European Telecommunications Standards Institute (ETSI) 600mm enclosure.

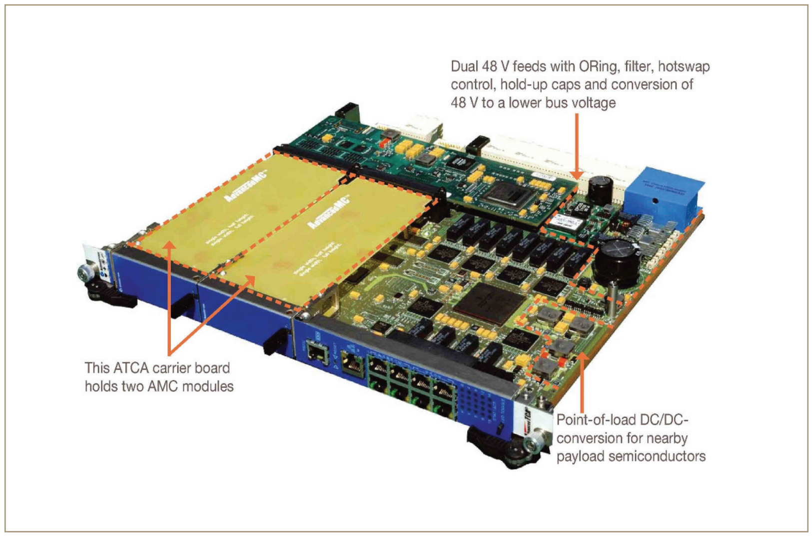

Figure 1: **AdvancedTCA carrier-board with AdvancedMC modules**

Some power conditioning takes place prior to the individual carrier-boards. AC/DC conversion and battery back-up is usually accomplished in a redundant fashion at a centralised location. The resulting -48V power is distributed to individual shelves. At the shelf level, a Power Entry Module is used to provide filtering and transient suppression.

Then the individual redundant -48V feeds are connected to the shelf backplane, which acts as an interface between the shelf level power conditioning and the power circuitry contained on each carrier-board.

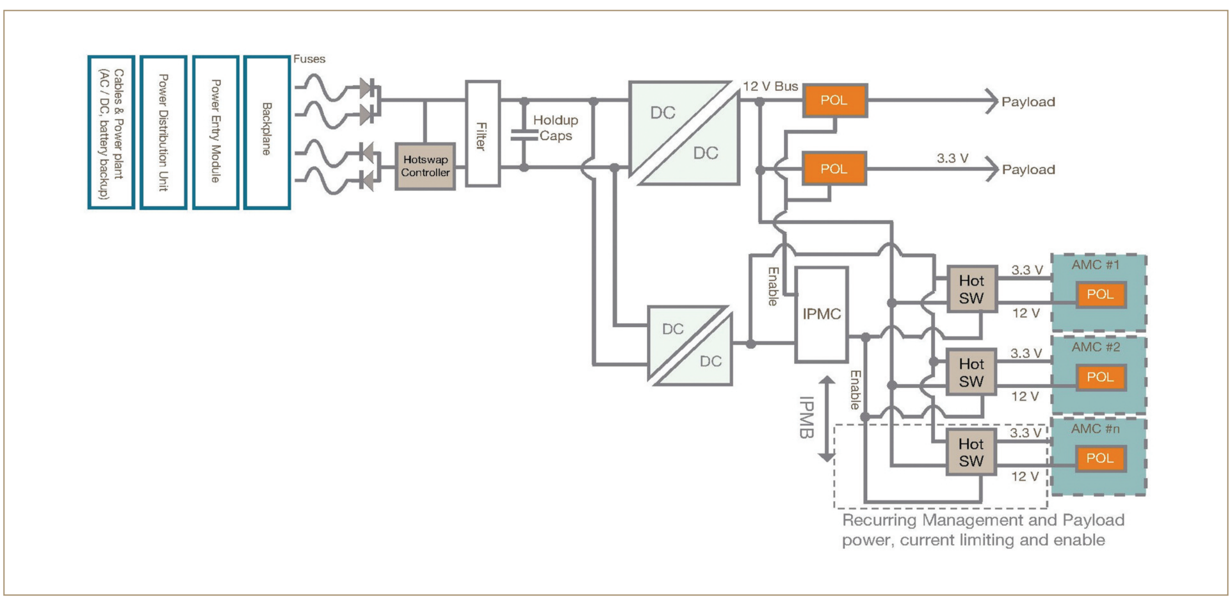

Figure 2: **Typical AdvancedTCA power system diagram**

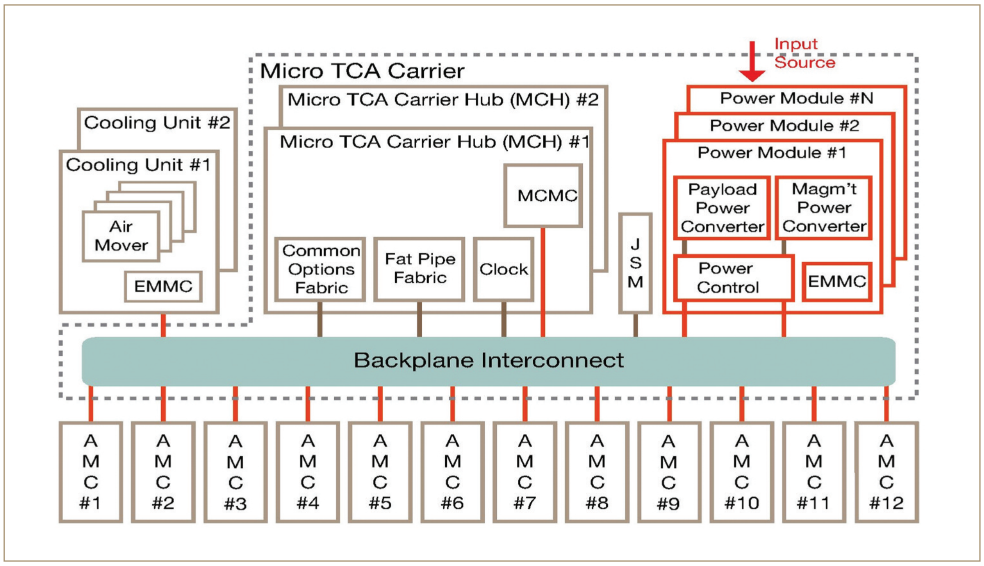

Figure 3: MicroTCA overview with parts of the power system highlighted

Each carrier board provides fusing, ORing diodes, inrush current limiting, filtering, hold-up capacitance and input voltage monitoring for the -48V input power. The result is a reliable and robust source of input power for the rest of the carrier-board power system. The remainder of the on-board power system is an example of an intermediate bus architecture (IBA). The main isolated DC/DC converter is normally selected to have an output of 12V, since there are Intermediate Bus Converter (IBC) modules available and the AdvancedMC modules require 12V as their main input voltage. The AdvancedTCA specification limits the total power consumption to a maximum of 200W per carrier-board.

The load circuitry power is referred to as 'payload' power in the AdvancedTCA specification. A carrier-board may contain payload circuitry mounted directly to its printed circuit board (PCB), in which case one or more Point of Load (POL) regulators are used to convert the 12V intermediate bus to the voltages required by the payload circuitry. Another option is to mount one or more AdvancedMC modules on the carrier-board. These modules, by definition, will require 12V as their payload power voltage. Any required POL regulation will be accomplished within the AdvancedMC module.

Another function that must be provided on each carrier-board is power control via an Intelligent Platform Management Controller (IPMC). The specification requires that the control circuitry be active and in communication with shelf-level management to negotiate power-up rights before a maximum of 10W of power is used. This requirement could be accomplished by providing a separate 3.3V isolated DC/DC converter on each carrierboard that is dedicated to powering the control circuitry, both the IPMC on the carrierboard and also the management power to each AdvancedMC that may be used. By this method, individual AdvancedMC modules can receive managed power without the IPMC having powered up the full payload. In addition, the carrier-board power control must provide the functions of voltage monitoring, current limiting, power sequencing and hot-swap control for each AdvancedMC location on the board.

Thus, each carrier-board requires a high degree of power conditioning and control functionality, both for input power and for payload power located on either the carrier-board or on AdvancedMC modules. This high degree of functionality can result in an assembly shown in Figure 1. The carrier-board (280mm x 322mm) contains DC/DC conversion from -48V down to an intermediate bus voltage that provides payload power to two AdvancedMC slots. The bus voltage is also used to feed down-stream POL regulators for on-board payload circuitry.

Powering MicroTCA

With MicroTCA, all load electronics are packaged on AdvancedMC modules. These mezzanine modules are identical to those used with AdvancedTCA systems. A key feature of the MicroTCA system is the power module, which

Figure 4: Block diagram of a typical MicroTCA power module

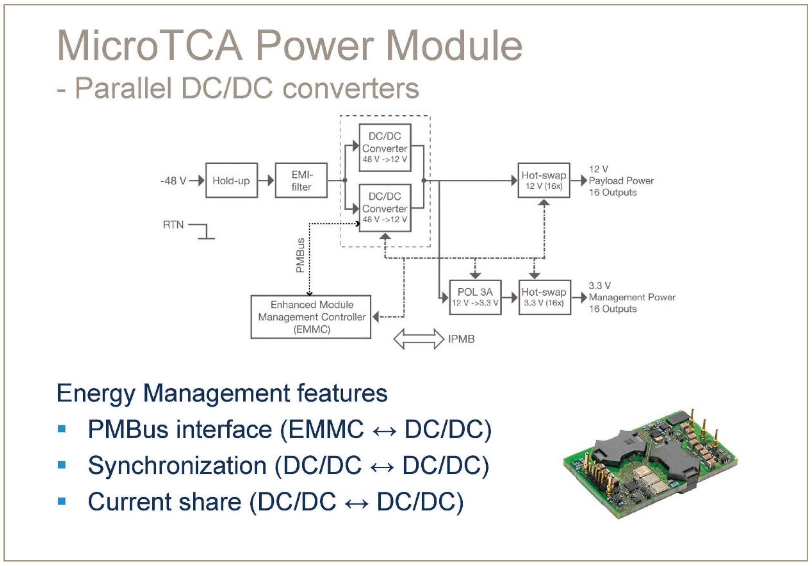

Figure 5: Evaluative-level power module with some sort of digital control aimed at telecom equipment manufacturers and system integrators

contains the majority of the power conversion and control circuitry and eliminates the need for the large planar carrier-boards of the AdvancedTCA systems. MicroTCA systems may also be packaged in 19in racks, with a 6U height considered a large system.

A minimum MicroTCA system is defined as a collection of interconnected elements consisting of at least one AdvancedMC, one MicroTCA Carrier Hub (MCH), and the interconnect, power, cooling and mechanical resources needed to support them. The system shown in Figure 3 supports up to a maximum of 12 AdvancedMC modules which contain the payload circuitry (20 to 80W). They provide the functional elements needed to implement useful system functions. Examples of AdvancedMCs that could be installed into a MicroTCA shelf include CPUs, Digital Signal Processing devices, packet processors, storage, and various sorts of I/O AdvancedMCs (including metallic and optical line units, RF devices, and interfaces to other boxes).

More power handling in modules

The MicroTCA specification provides a very clear description of the power module purpose and functionality. The power module(s) take the input supply and convert it to 12V to provide payload power to each AdvancedMC. Managed 3.3V power for AdvancedMCs is also supplied by the power subsystem. The power control logic on the power module performs sequencing, protection, and isolation functions. Power modules also include the supervisory functions necessary to manage the power subsystem. In addition to supplying payload and management power to up to 12 AdvancedMC modules, the power modules must be capable of supplying payload and management power to up to two CUs and 2 MCHs. As a consequence, many power modules are designed to provide a total of 16 output power channels, or 32 channels if payload and managed power are counted separately.

The consolidation of both power handling circuitry and system level control/ management functionality from the large AdvancedTCA carrier-board into the relatively small MicroTCA power module means that its design, performance and reliability are all crucial to the overall system (Figure 4). Most of the functionality is similar to that of an AdvancedTCA carrier-board.

With MicroTCA, there is no PEM, so ‘raw’ DC input power is supplied directly to the input connectors on the front of the power module. This means that the functionality of the PEM must be included in each power module. AdvancedTCA carrier-boards contain fuses on the -48V inputs. In the case of MicroTCA, fusing is typically done in a power distribution unit by providing fuses for each of the cables that distribute input power to the front of the power modules. Consequently, no internal fuses are normally contained within a power module. Otherwise, the front-end functions are very similar to AdvancedTCA (ORing diodes, EMI filtering, inrush current limiting and hold-up capacitance). While AdvancedTCA is specified to always contain dual redundant -48V input power feeds, MicroTCA may be configured with either a single feed or with two redundant feeds.

The power module contains a single -48 to 12V isolated DC/DC converter, similar to AdvancedTCA, but with power levels up to 600W. A POL regulator from the 12V output is used for managed power. Additional POLs within the modules are used to derive their low voltage power from the 12V payload power. The control mechanism for MicroTCA power modules is the Enhanced Module Management Controller (EMMC), which monitors and controls both management and payload power for all of the AdvancedMCs, CUs and MCHs configured in the system.

MicroTCA board for evaluation

An evaluative-level power-module (ROA 117 5078/1) is aimed at telecom equipment manufacturers and system integrators. It uses DC/DC conversion based on synchronous rectification and an FPGA for EMMC functionality and PMBus hosting. IPMB-based management components in the system interact directly with power-conversion elements via a serial bus. System-level components can use such a serial bus to undertake ‘active’ energy management to improve efficiency, and also to collect data on temperature, voltage and current. Configuration and calibration is possible during design and manufacturing due to semiconductor and firmware technology.

The 355W output power rated module features -48V input, 16 channels of 12V payload power and 16 channels of 3.3V managed power in a full-size (6HP) single-width form factor package (Figure 5). Offering reduced energy consumption, lower cost of operation, and a lower environmental impact, the modules feature high efficiency, typically 95% at half-load. The module’s single-board design offers a cost-efficient solution and good thermal performance. It is suitable for use by system integrators and telecom equipment manufacturers during evaluation and testing. The modules’ design will be enhanced based on user feedback during the fall of 2007, and it will reach general availability in Q1 2008.

Designs for other input sources and enhanced power levels will also be considered during this process.