

MTCA.4 TUTORIAL BASICS INTRODUCTION IN XTCA

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KIT, KARLSRUHE

Rüdiger Cölln

Pentair Technical Solutions GmbH

ruediger.coelln@pentair.com

AGENDA

- What is xTCA?
- Specifications Overview
- ATCA Features
- AMC Features
- MTCA Family
- MTCA.0 Features
- MTCA.4
 - Initial Requirements
 - Mechanical Features
 - Module sizes
 - Management extensions compared to MTCA.0
 - Keying
 - Hot Swap Transition States
 - Backplane
 - Cooling
 - Redundancy

WHO WE ARE

ELECTRONICS
PROTECTION

Schroff



INDOOR AND
OUTDOOR
CABINETS



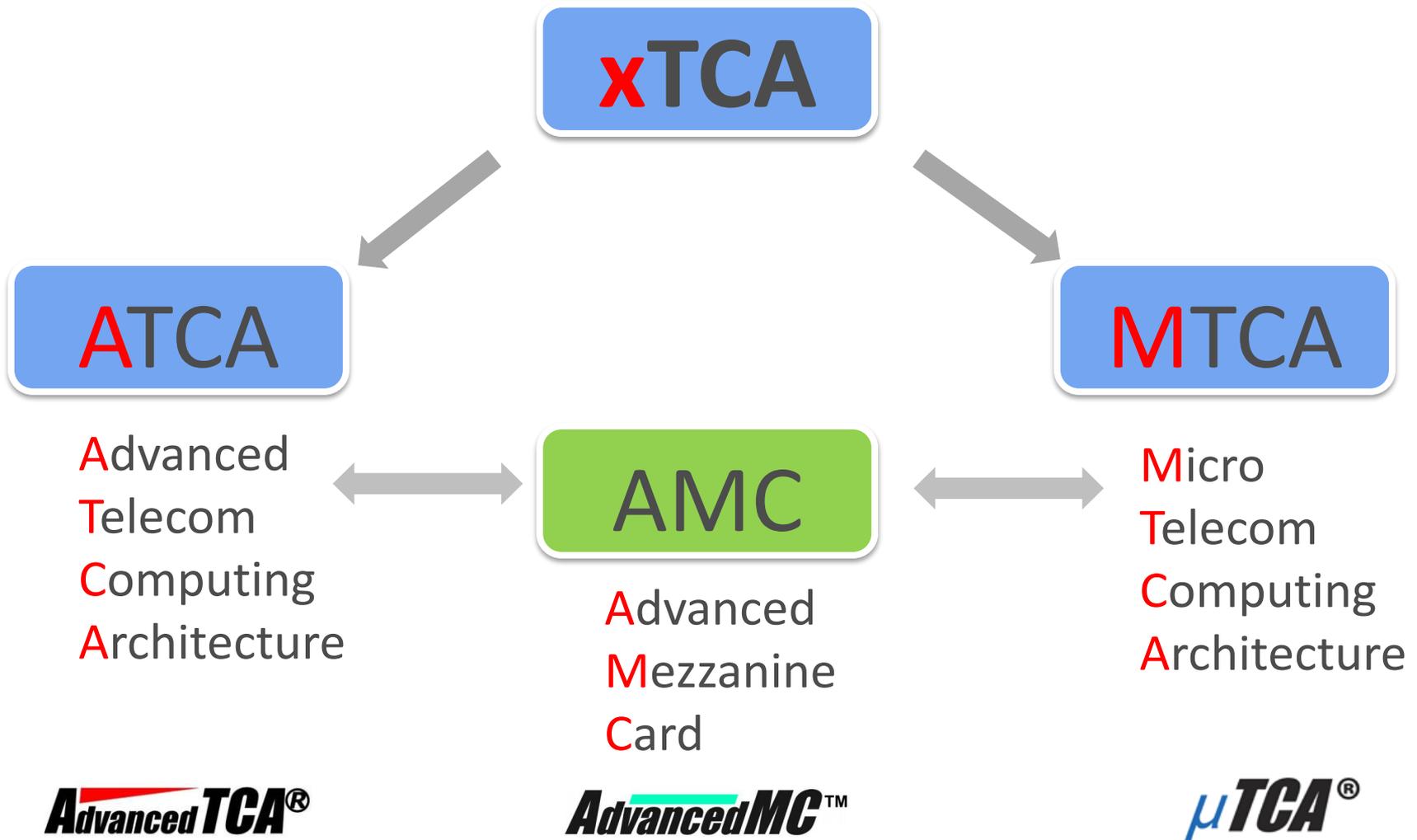
ELECTRONIC
SUBRACKS,
CASES AND
ACCESSORIES



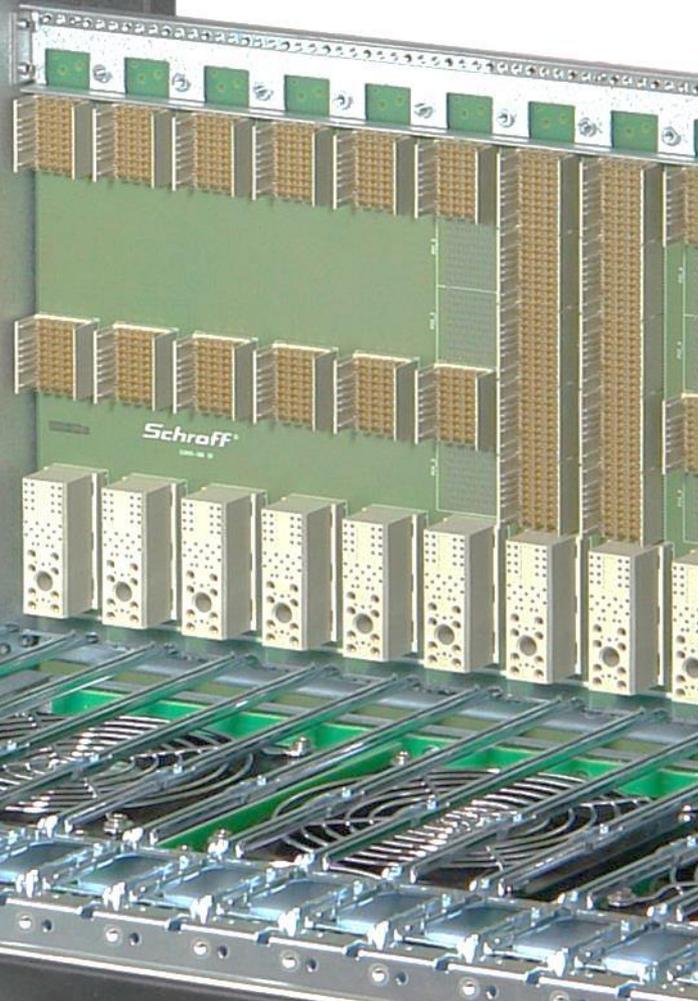
- Leader in providing high-quality protection solutions for a wide variety of electronic design challenge
- Large selection of standard 19" products, plus the broadest array of modification options and customization capabilities
- Offering world-leading electronic packaging components and systems – within 19" and beyond



WHAT IS xTCA?



ATCA

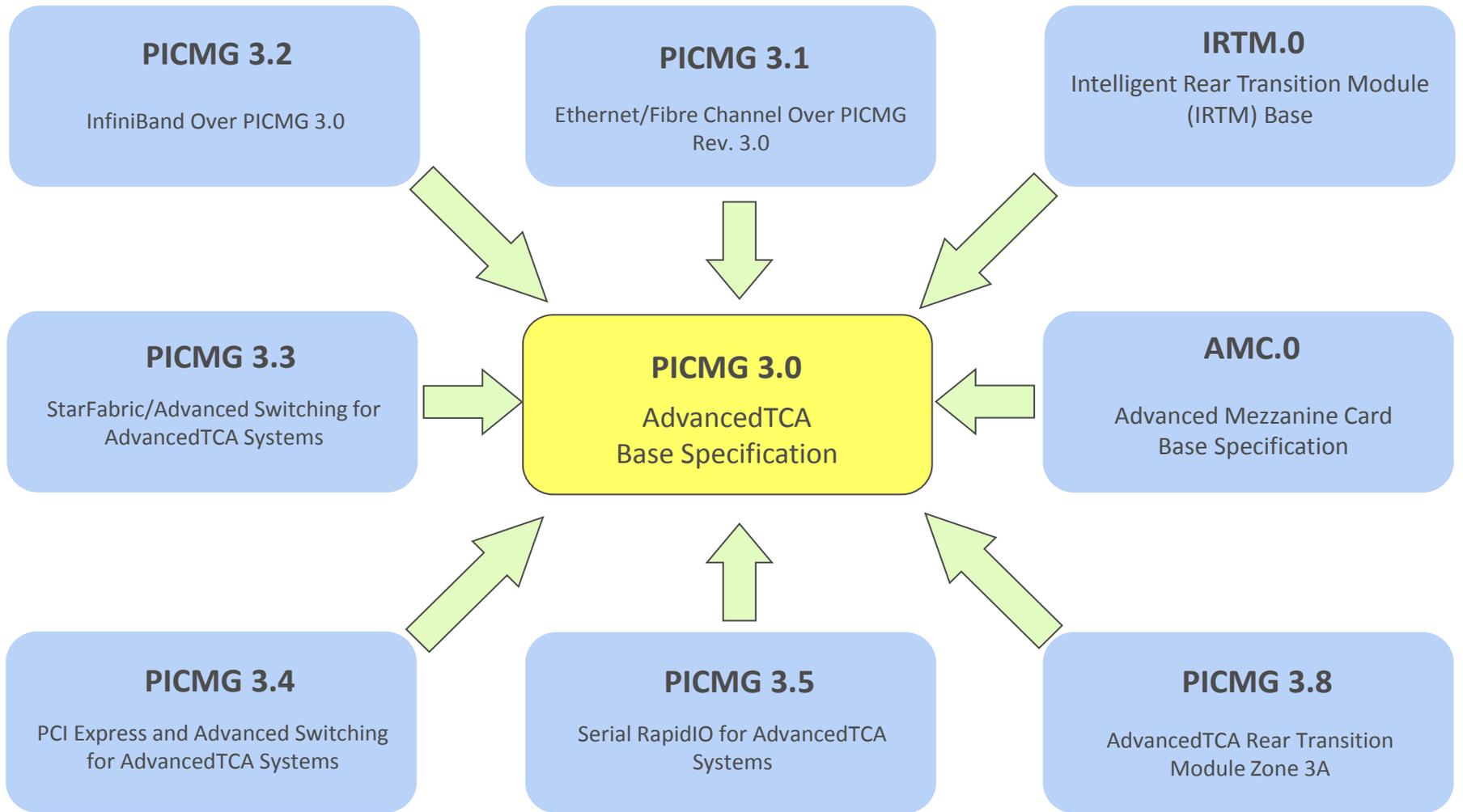


OVERVIEW



- Introduced in 2002
- Sponsored by the PCI Industrial Computer Manufacturers Group (PICMG)
- Specification initially targeted to the Telco Industry
- HA features of interest to many other “up time” critical systems!
- System Availability 99.999% (~5 min/yr)!
- Management, monitoring and control!
- Port data rate up to 100 Gb/s (4 x 25Gb/s)
- System throughput to 24 Tb/s (16 Slot, full mesh)!

ATCA SPECIFICATION FAMILY



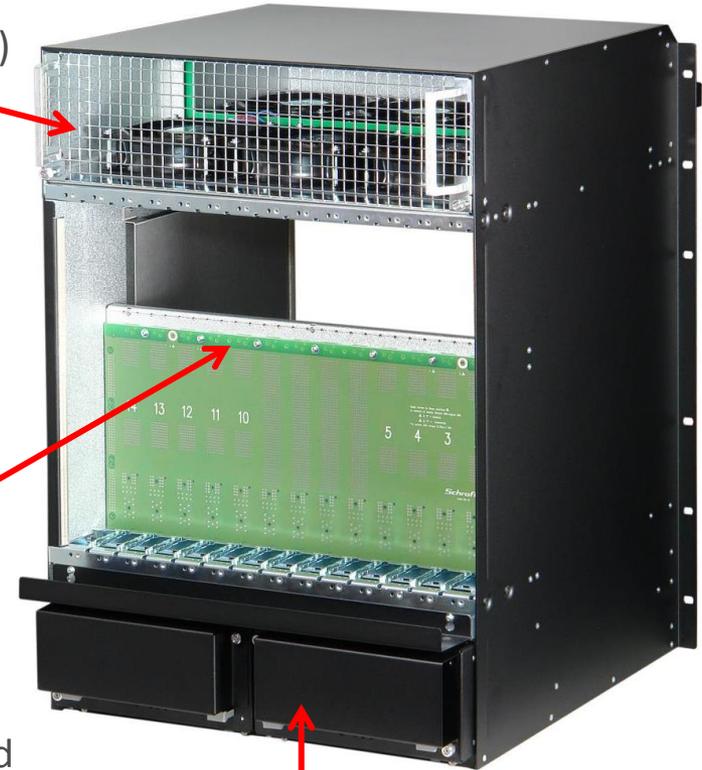
ATCA CRATE ELEMENTS

Front View



Dual redundant Shelf Managers

Rear View



Redundant Fan Tray (Pull)

Backplane

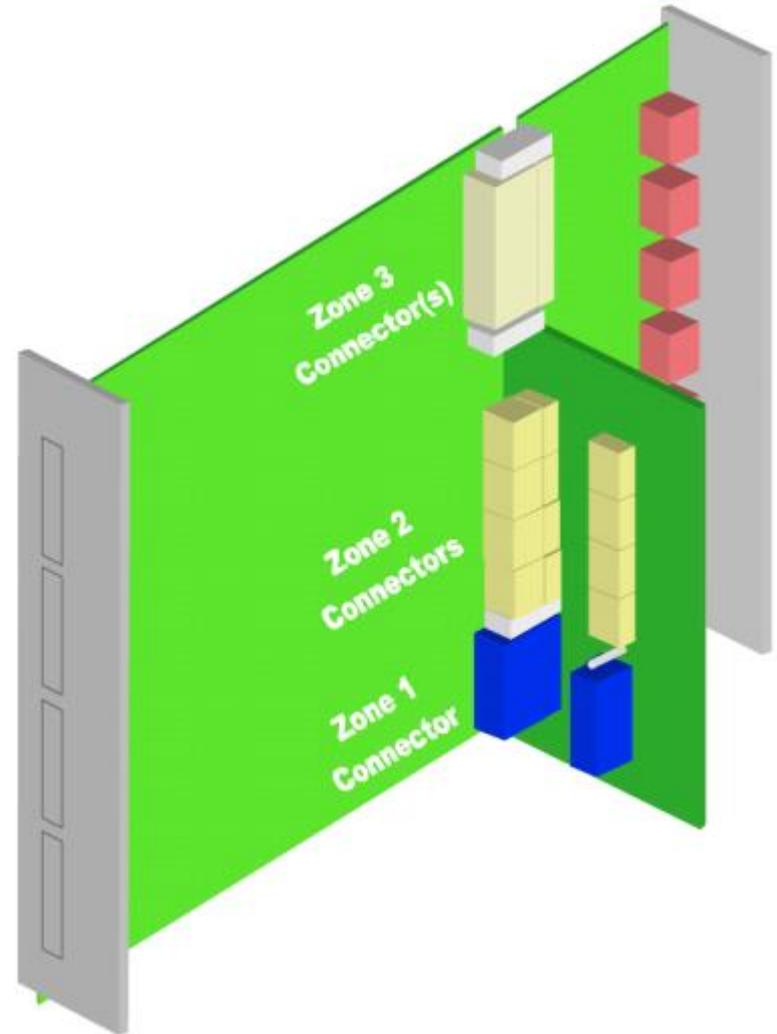
Redundant Fan Tray (Push) with Alarm Board

Power Entry Module (PEM)

ATCA CRATE ELEMENTS

Board size and connectors

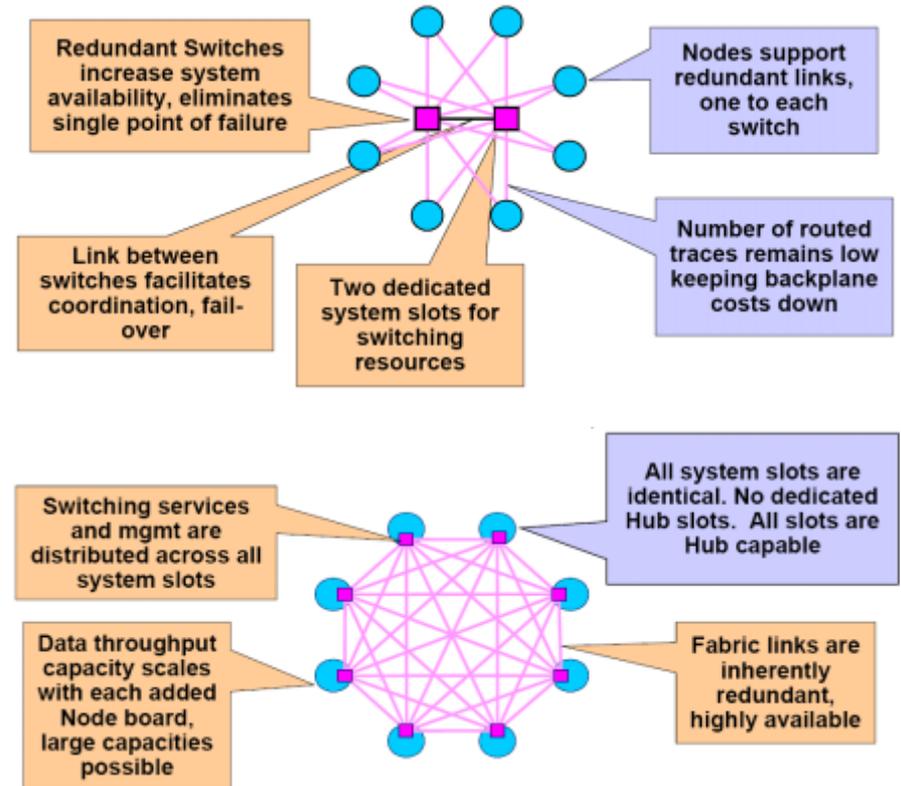
- Front board size 8U x 280 mm
- Rear board (RTM) size 8U x 70 mm
Connects directly to front board
- Board width 6HP (1.2")
- Alignment/Key pins
- Zone 1: Management and Power
- Zone 2: Base Interface and Fabric Interface
- Zone 3: Interface to RTM



ATCA INTERFACES

Zone 2 Backplane Interfaces

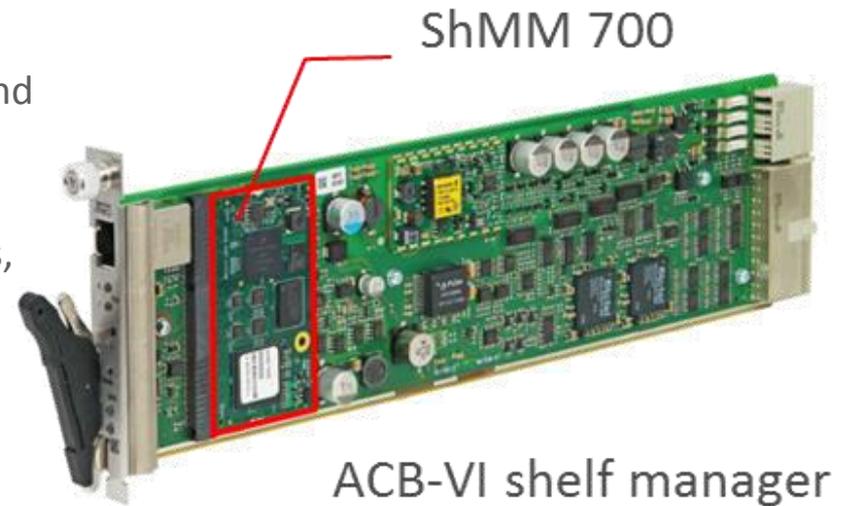
- Base Interface
 - 10/100/1000 BASE-T Ethernet
 - Always Dual Star topology
- Fabric Interface
 - Star topology
 - Mesh topology
- Clock Interface
 - Three dedicated clock interfaces
- Update Channel
 - Direct connection between two slots



ATCA MANAGEMENT

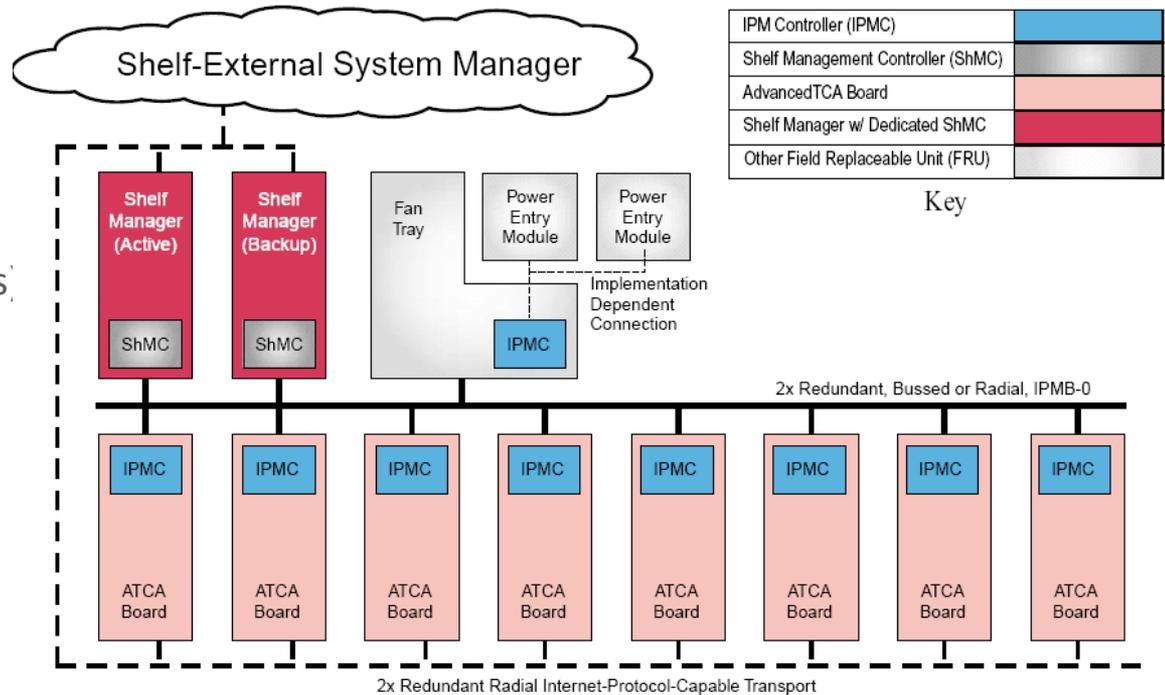
ATCA Shelf Management purpose

- Monitor & control low-level aspects of ATCA boards and other Field Replaceable Units within a shelf
- Watch over basic health of the shelf, report anomalies, take corrective action when needed
- Retrieve inventory information & sensor readings
- Receive event reports and failure notifications from boards and other intelligent FRUs
- Manage power, cooling & interconnect resources in the shelf (electronic keying)
- Management Protocol IPMI (I2C-bus on backplane)



ATCA MANAGEMENT

- Dedicated Shelf Management Controller (ShMC)
- ATCA Boards with IPMC
- Protocol IPMI (Physical layer I²C-Bus)
- Intelligent and Managed FRUs
- Bused or Radial IPMB



AMC

AMC MODULES

- Initially developed as function extension for ATCA Boards
- Fully integrated into the ATCA IPMI management structure
- Plugged into a so called ATCA Carrier
- Hot Swap capability

AdvancedMC™



AMC Modules



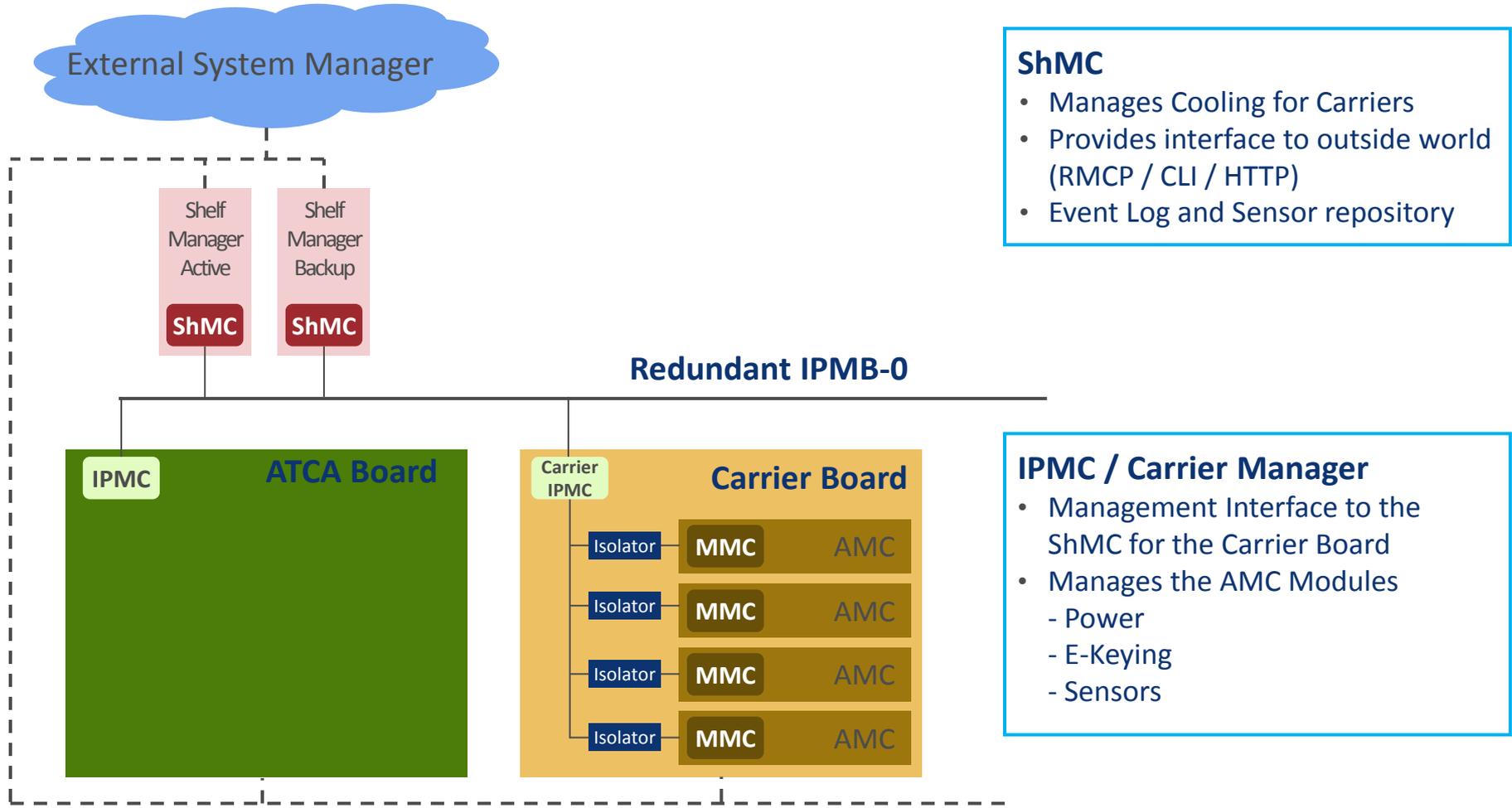
Carrier Blade



Carrier Blade in an
ATCA chassis

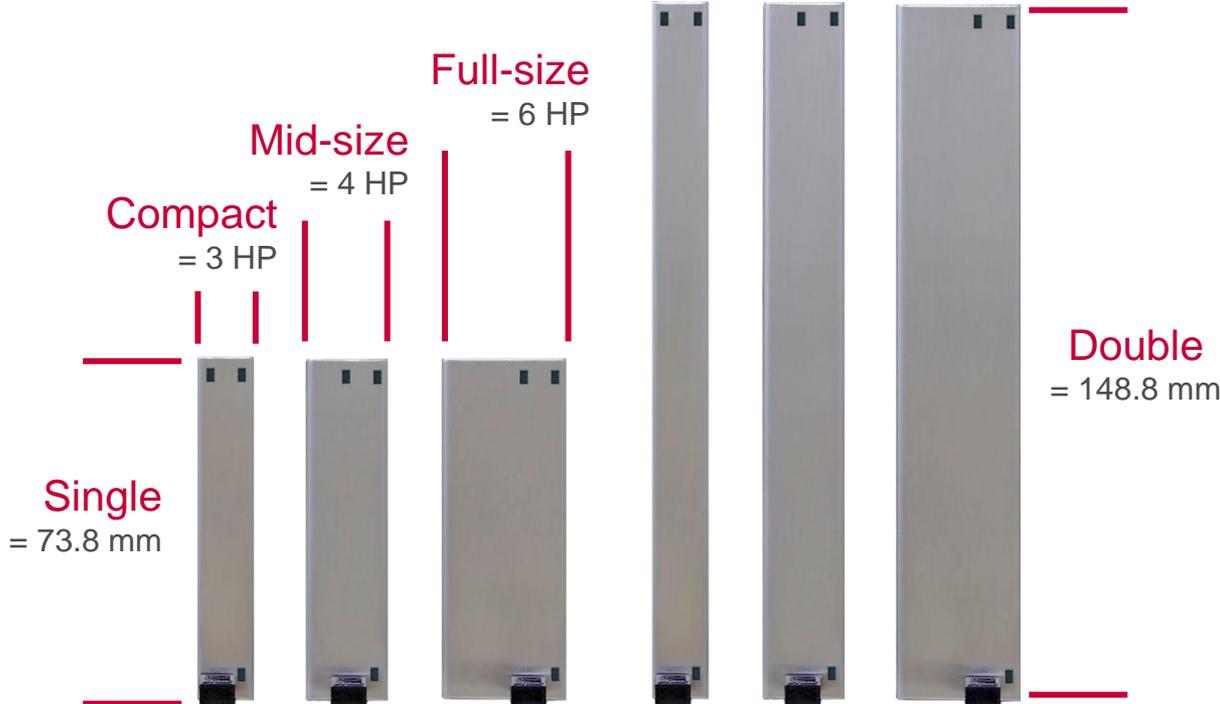
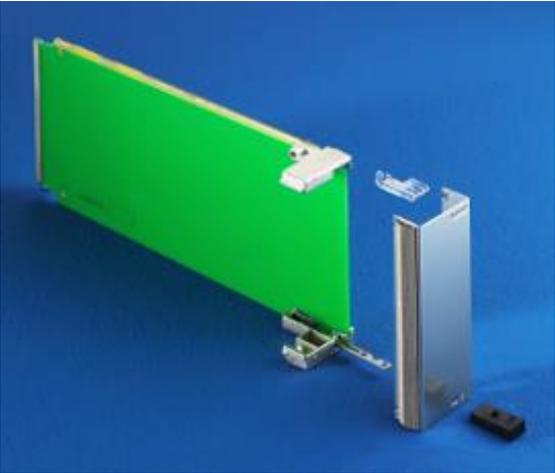
AMC MODULES

Carrier IPMC represents the MMC on the AMC as a FRU to the Shelf Manager



AMC MODULES

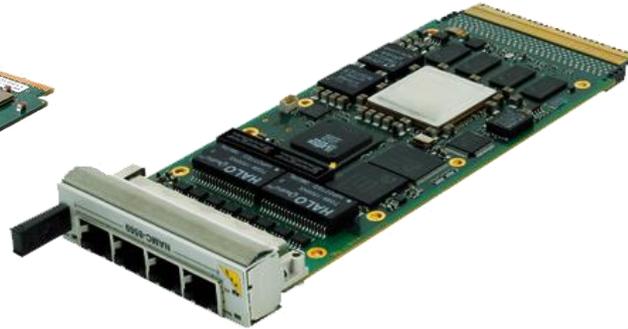
AMC Module Sizes



AMC MODULES



Media Processing AMC



Line Interface module



RF interface card for software defined radio



Processor AMC



Processor AMC



**Integrated AMC based on TI
DSP + Xilinx FPGA**

MTCA

Micro Telecom Computing Architecture

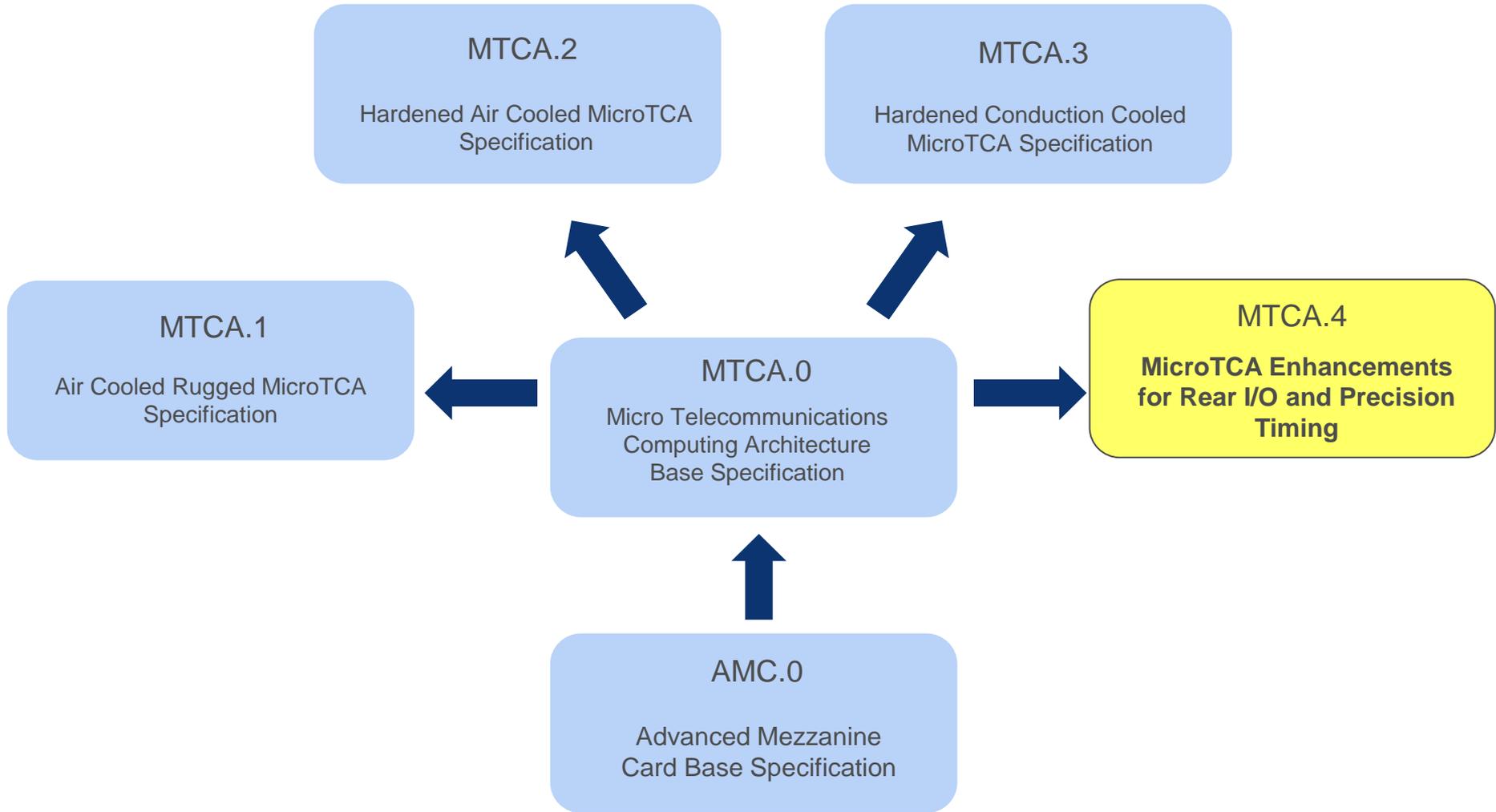
MicroTCA[®] | FEATURES

- Similar feature set as ATCA
 - Extremely high data transmission, 10 Gb/s per port & 40 Gb/s per link
 - AdvancedMC interchangeable between AdvancedTCA and MicroTCA
 - Protocols: 10GBaseT Ethernet, PCI e, Serial Rapid I/O, SAS, and S-ATA.
 - Fully redundant or non-redundant systems available
 - Hot-swap capability ensures uninterrupted operation
 - Shelf and carrier management
 - Allow administration and monitoring of system resources
 - Board protection via electronic coding (e-keying)
- Small form factor (compared to ATCA, CPCI or VME)



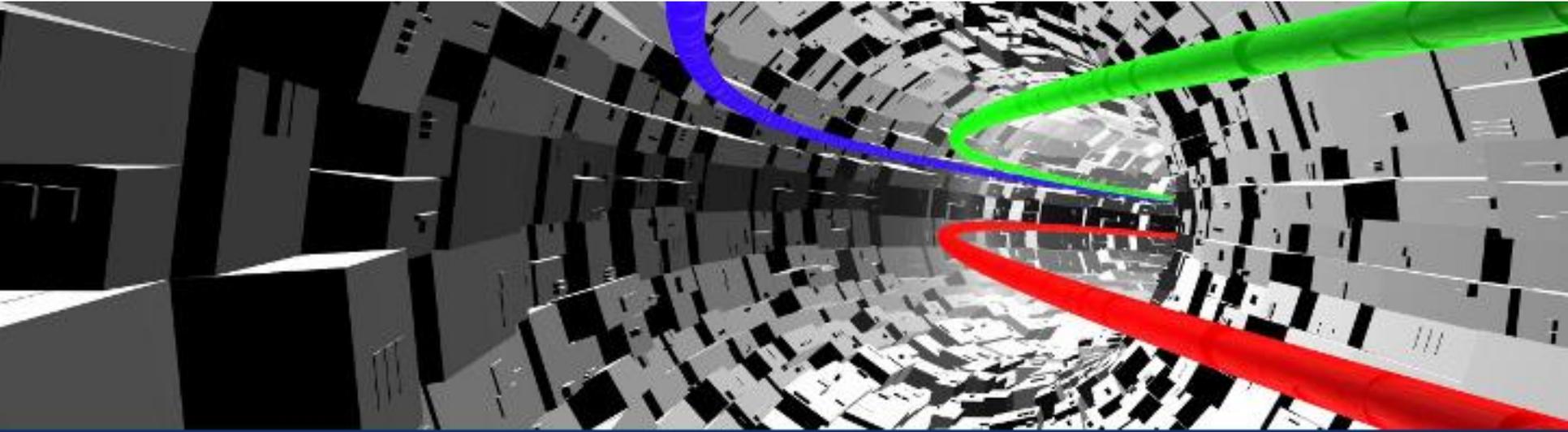
μTCA[®]

MTCA SPECIFICATION TREE



MTCA - TERMS AND ACRONYMS

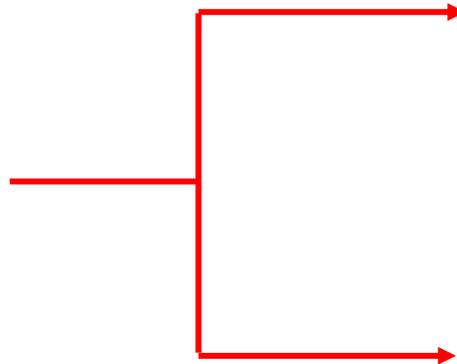
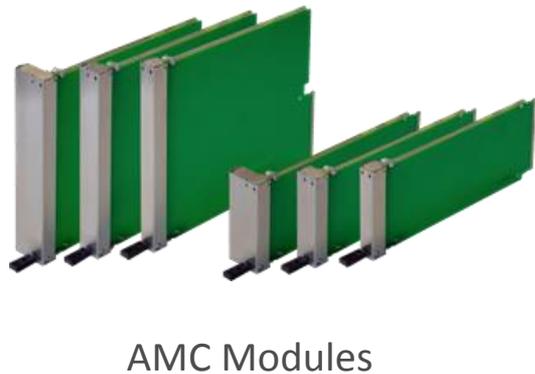
- **MCH** MicroTCA Carrier Hub
 - This is a complete module for the system management and Ethernet hub
 - **MCMC** MicroTCA Carrier Management Controller
 - This is the physical IPMI controller on the MCH
 - **MMC** Module Management Controller
 - This is the physical IPMI controller on an AMC
 - **EMMC** Enhanced MicroTCA Carrier Management Controller
 - This is the physical IPMI controller on a Cooling Unit and on Power Module
 - **IPMB-0** Intelligent Platform Management Bus 0
 - Logical IPMB, physically divided into redundant IPMB-A and IPMB-B
 - **IPMB-L** IPMB-Local
 - IPMI link between MCH and AMCs
-



MTCA.0

MTCA.0

- The basic idea of MTCA is to have a shelf that contains just AMC modules
- AMCs are interchangeable between ATCA and MTCA
- Backplane directly accepts AMC modules
- The infrastructure of a ATCA Carrier was adapted into the MTCA shelf (power, management, switching)
- No rear I/O, power input and all outputs to the front



ATCA Shelf



MTCA Shelf

MTCA.0

- As MicroTCA does not use a Carrier board, the power, management, clock distribution and switching functionality must be realized onto another device
- New Module: MCH (**MTCA Carrier Hub**)
 - IPMI management
 - clock distribution / generation
 - Switching functionality
 - JTAG slave / master
 - Redundant MCHs
- New Module: Power Module
 - 12V Payload Power
 - 3.3V Management Power
 - Redundant power modules
- Special MTCA Shelf Slots for these new modules



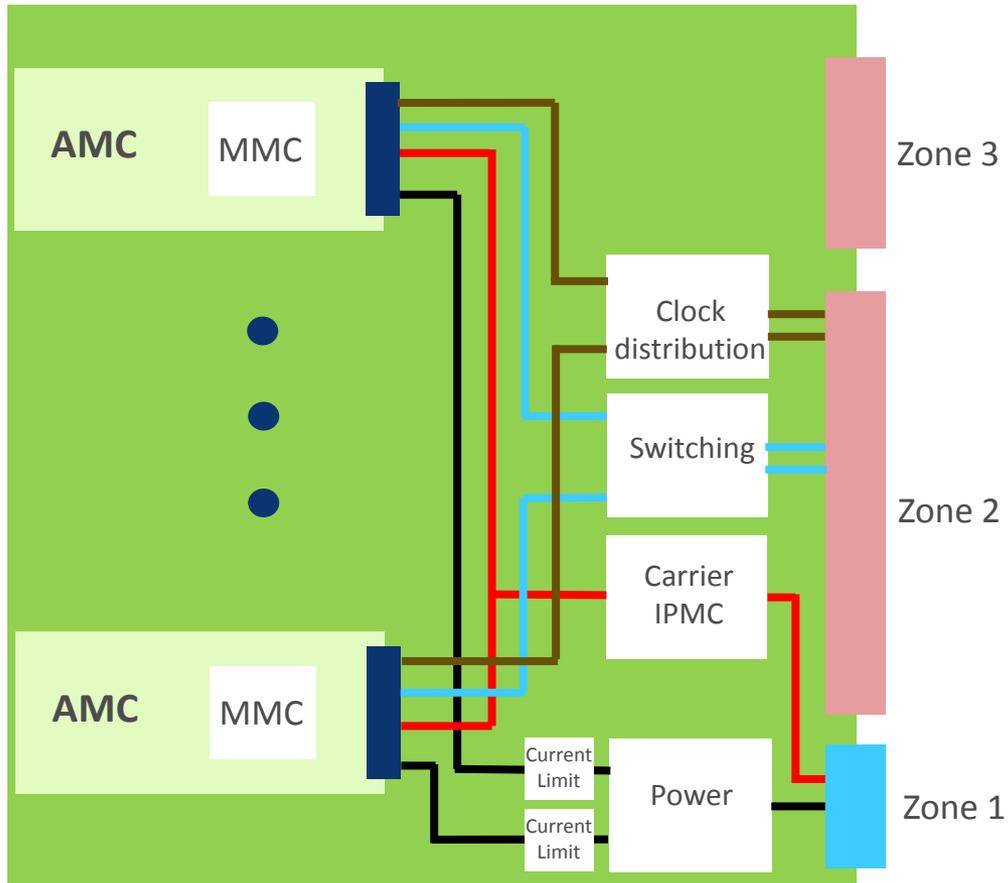
NAT MCH with Clock and Fabric options



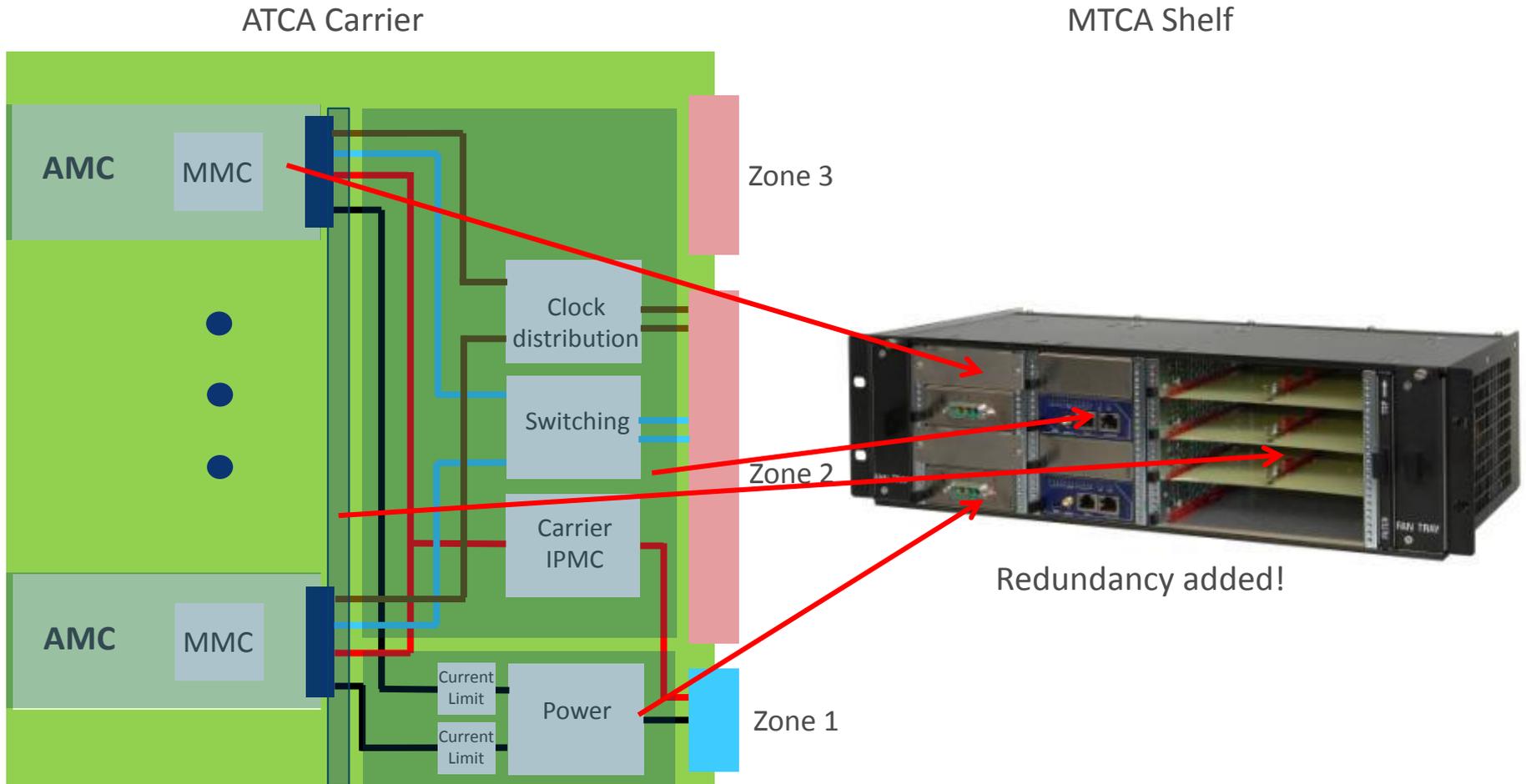
NAT-PM-AC600 600W AC input PM

MTCA.0

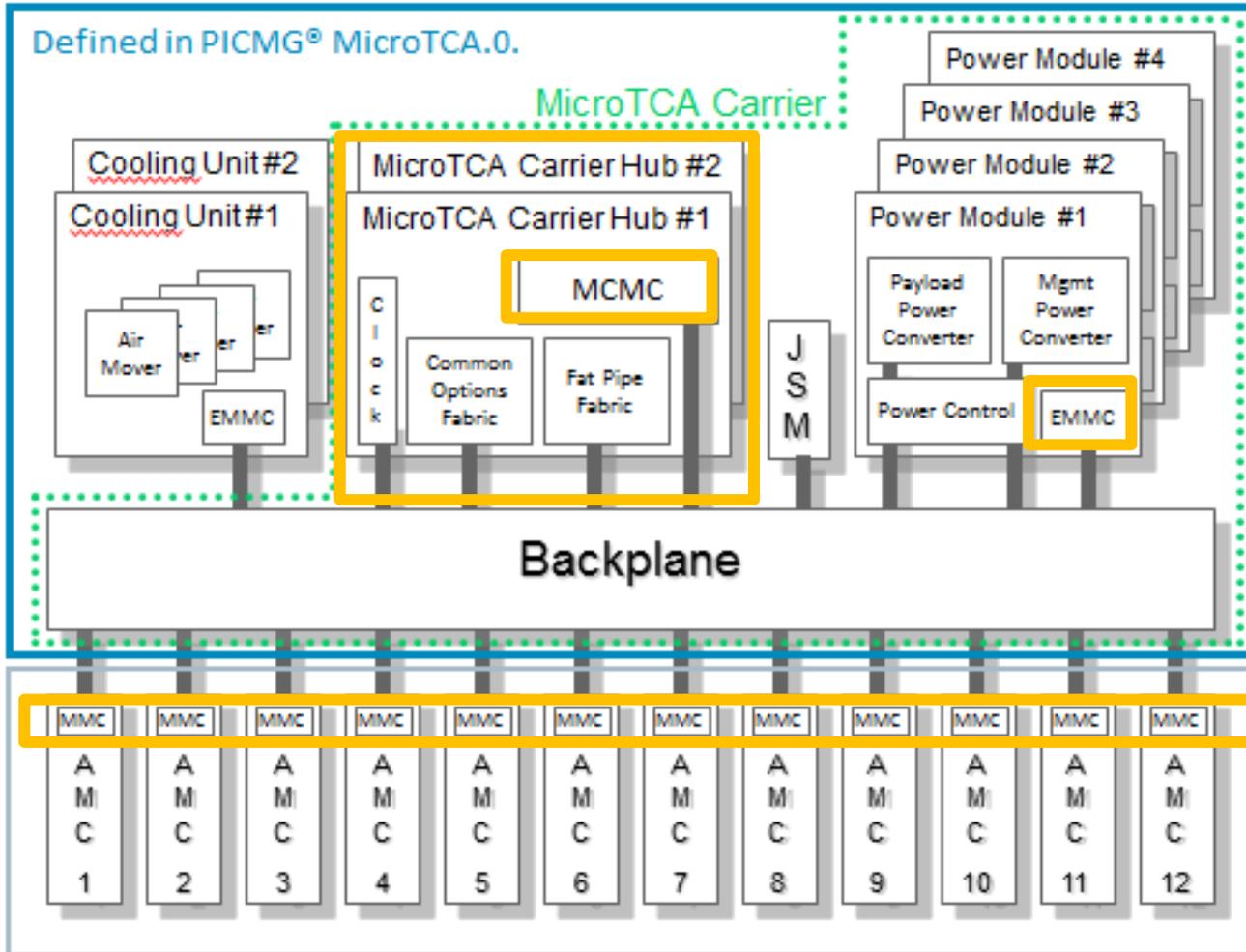
ATCA Carrier Board



MTCA.0



MTCA.0 - BLOCKDIAGRAM

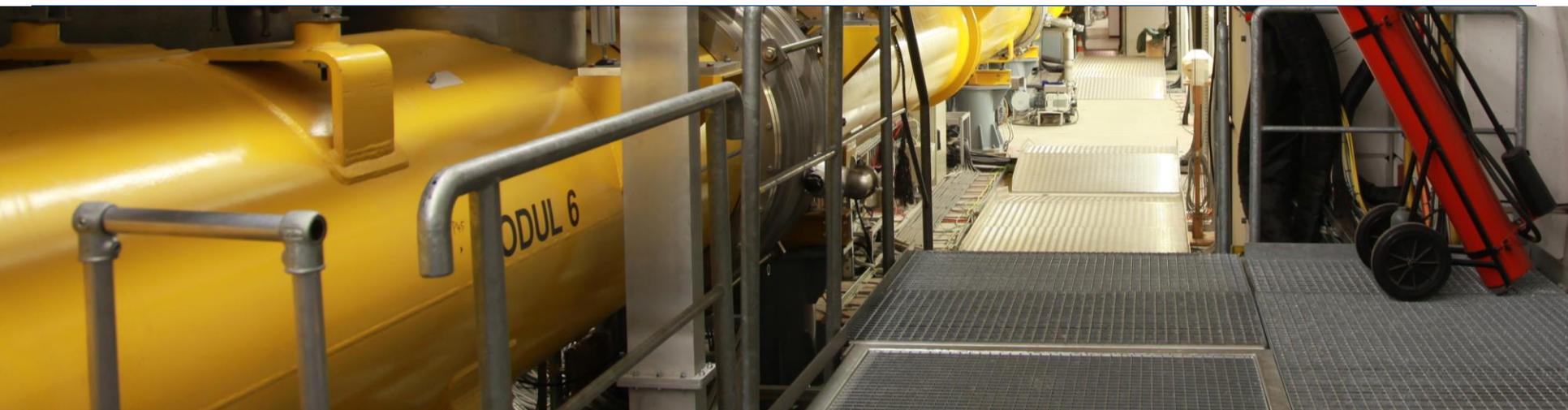


- MCH** MicroTCA Carrier Hub
- (1) Power & Cooling
 - (2) Electronic Keying & Hot-Swap for AMCs
 - (3) External management interfaces (over Terminal or Network)

MCMC MicroTCA Carrier Management Controller. This is the physical IPMI controller on the MCH

MMC Module Management Controller. This is the physical IPMI controller on an AMC

EMMC Enhanced Module Management Controller. This is the physical IPMI controller on a Cooling Unit and on Power Module



MTCA.4

MTCA.4

Why were extensions needed to the existing MicroTCA specifications?

- **No Rear Transition Module (RTM) defined for MicroTCA**
 - Physics applications typically require a large number of I/O cables. It makes sense to connect them to the rear of the chassis

- **Special clock and trigger topology**
 - MicroTCA.0 specifies 3 Clocks and AMC.0 R2.0 specifies 4 Telecom and 1 Fabric Clock on the AMC Module. Physics applications typically need additional Clocks and Triggers

- **Sophisticated requirements for the clock and trigger accuracy**
 - MicroTCA / AMC defines typical telecom clock signals corresponding to PCIe values. Trigger signals are not specified

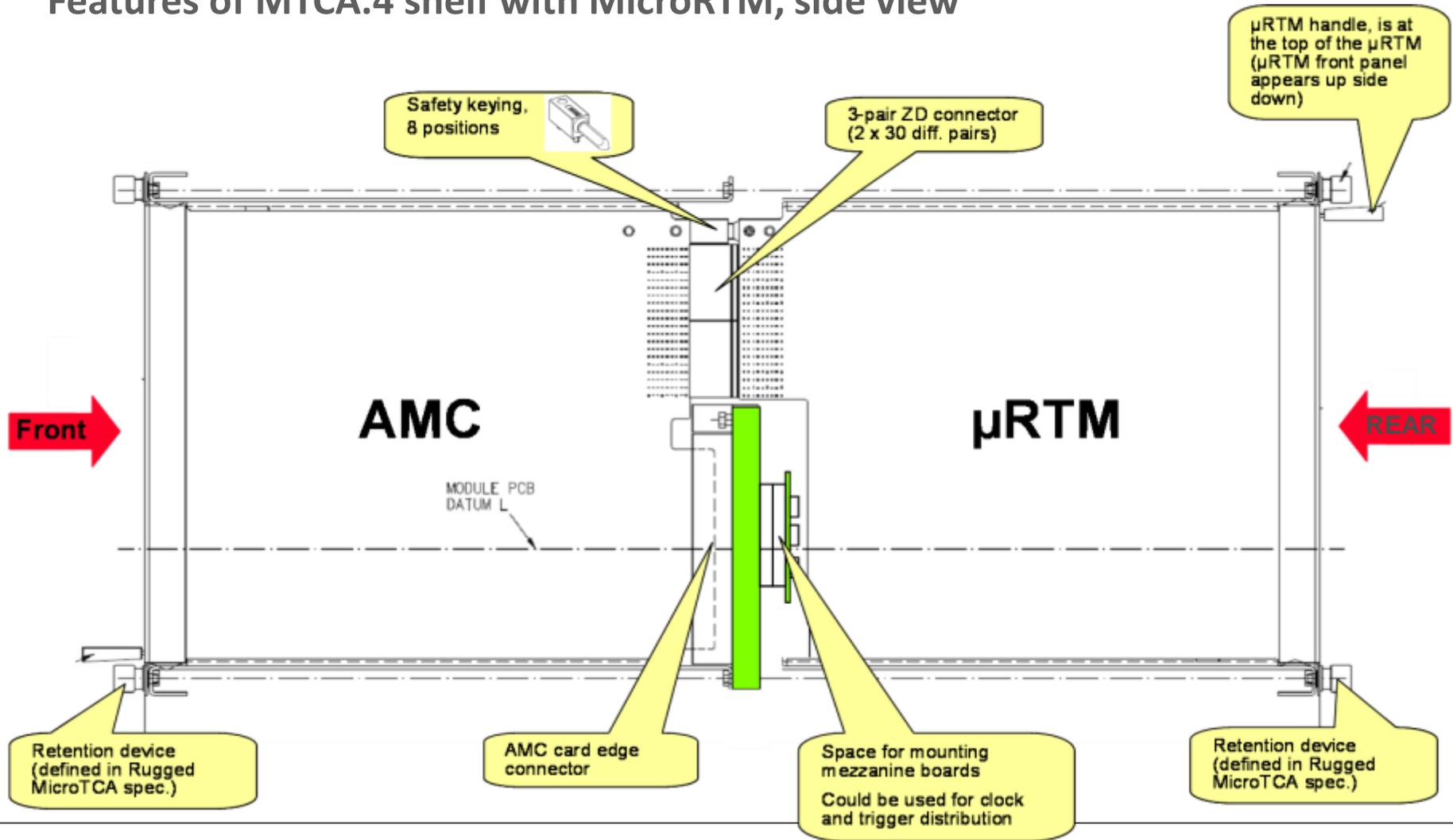
MTCA.4

Requirements for mechanics and sizes

- **AMC Module size: Double, Mid-size**
 - Allows for the max number of 12 AMCs in a 19" wide shelf
- **Large MicroRTM real estate**
 - MicroRTM size approximately the size of the AMC (doubles depth of existing uTCA chassis)
- **Use front panel mechanics based on Rugged MicroTCA (MTCA.1)**
 - Need to mechanically attach a module to avoid it being pushed-out by the corresponding module
 - Use Rugged MicroTCA retention device
- **Reuse existing AMC front panels for the MicroRTM**
- **Allowing mounting of mezzanine modules on the rear of the backplane**
- **Optional zone 3 backplane**

MTCA.4

Features of MTCA.4 shelf with MicroRTM, side view



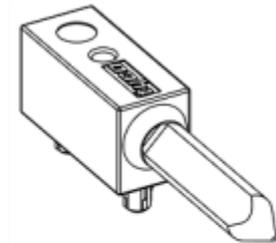
MTCA.4

Alignment and Keying

- mechanical keying prevents a module from being inserted which is not electrically compatible and could cause damage
- Eight keying positions are implemented that define the electrical interface

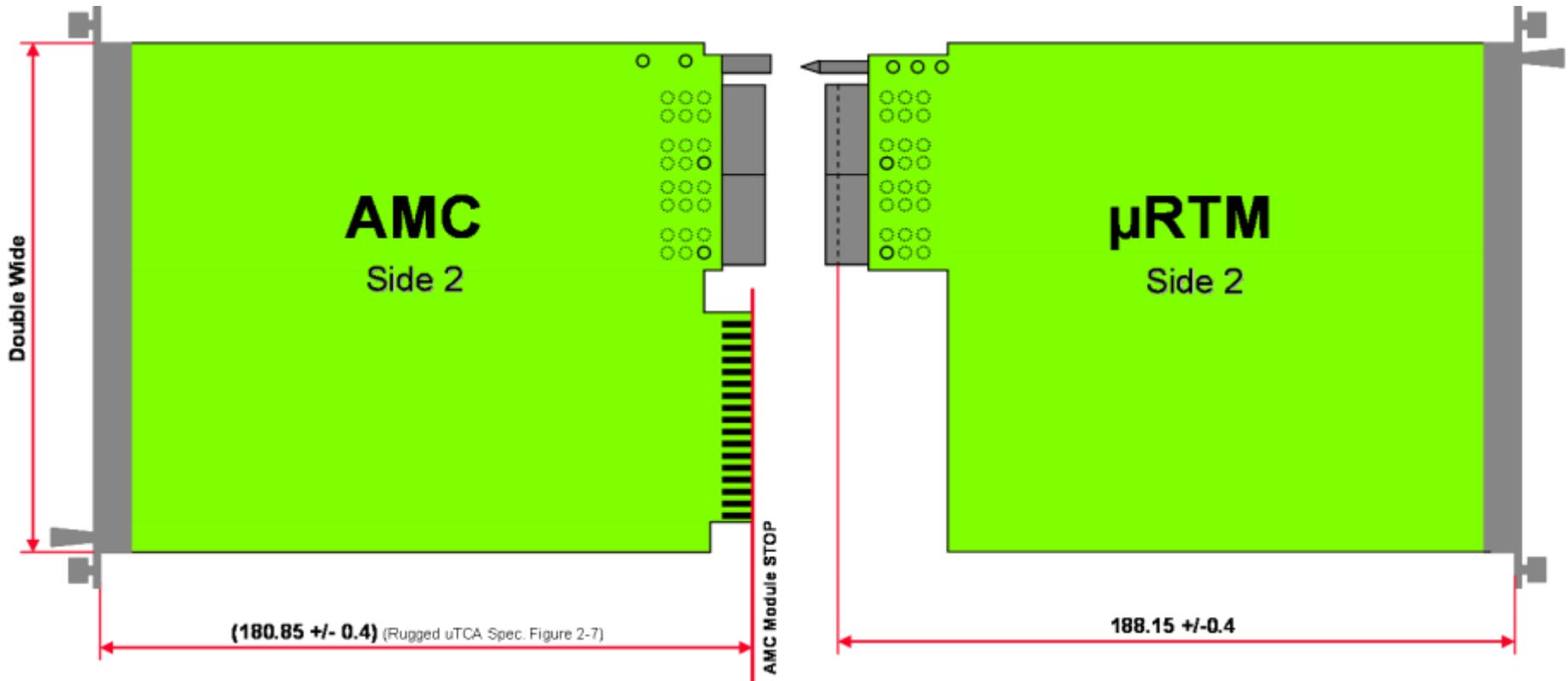
| N | A Rotation in degrees | View into rear of AMC | View into rear of μ RTM |
|---|-----------------------------|--------------------------|--------------------------------|
| | | Receptacle | Post |
| 1 | 0 | | |
| 2 | 45 | | |
| 3 | 90 | | |
| 4 | 135 | | |
| 5 | 180 | | |
| 6 | 225 | | |
| 7 | 270 | | |
| 8 | 315 | | |
| 0 | NA | | |

| N | Data Signal in Volts |
|---|----------------------|
| 1 | LVDS |
| 2 | 0 - ± 1 |
| 3 | $>\pm 1 - \pm 3.3$ |
| 4 | $>\pm 3.3 - \pm 10$ |
| 5 | $>\pm 10$ |
| 6 | Reserved |
| 7 | Reserved |
| 8 | Reserved |



MTCA.4

Module Sizes



MTCA MANAGEMENT

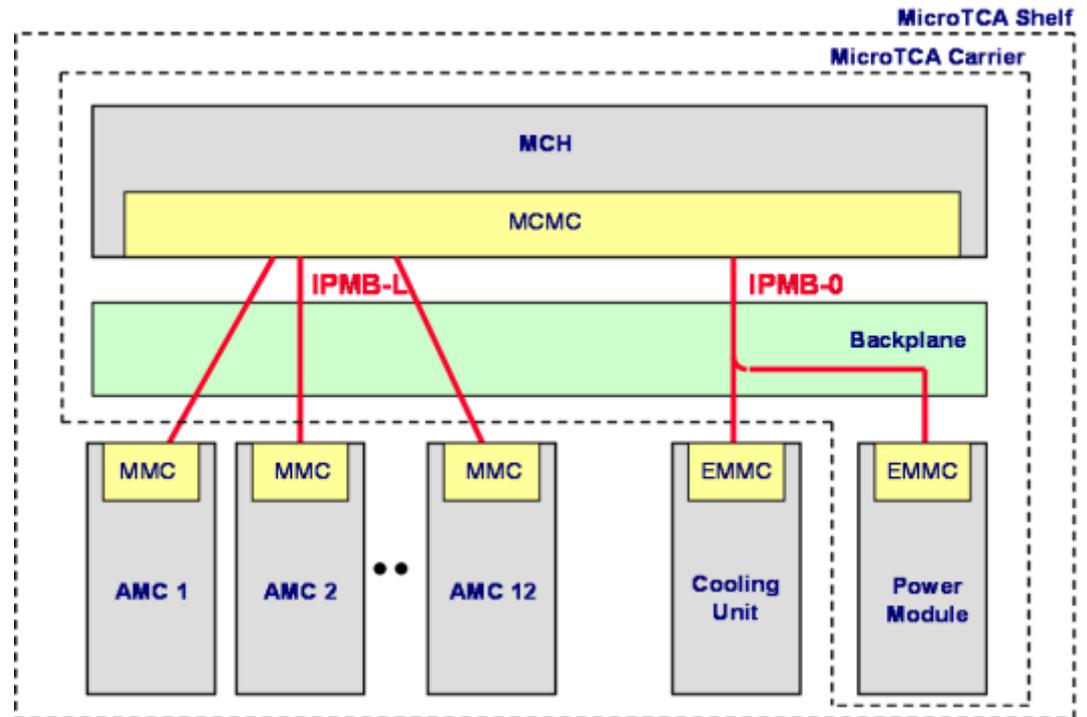
Management defined in AMC.0 / MTCA.0

- **IPMB-L**

- Connects the MCMC on the MCH to the MMC on the AMC Modules
- Radial architecture

- **IPMB-0**

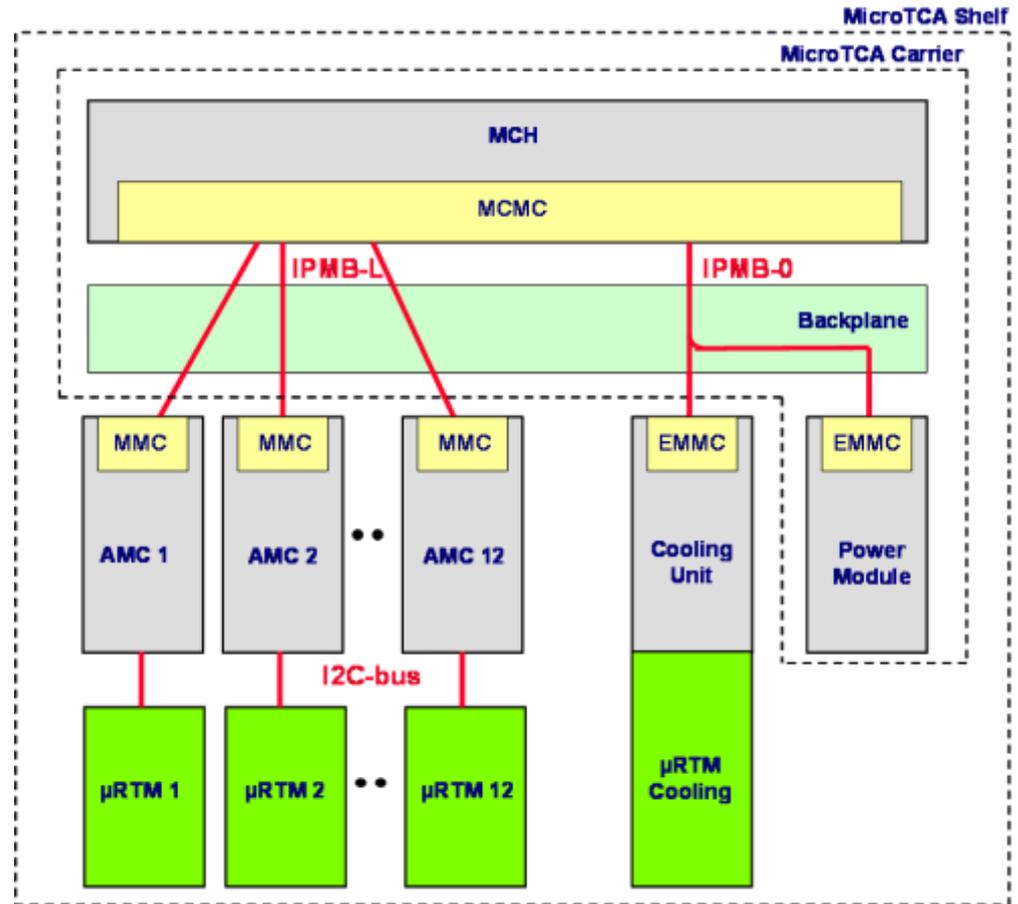
- Connects the MCMC on the MCH to the EMMC on the PM and CU
- Bused architecture



MTCA.4

Management extensions in MTCA.4

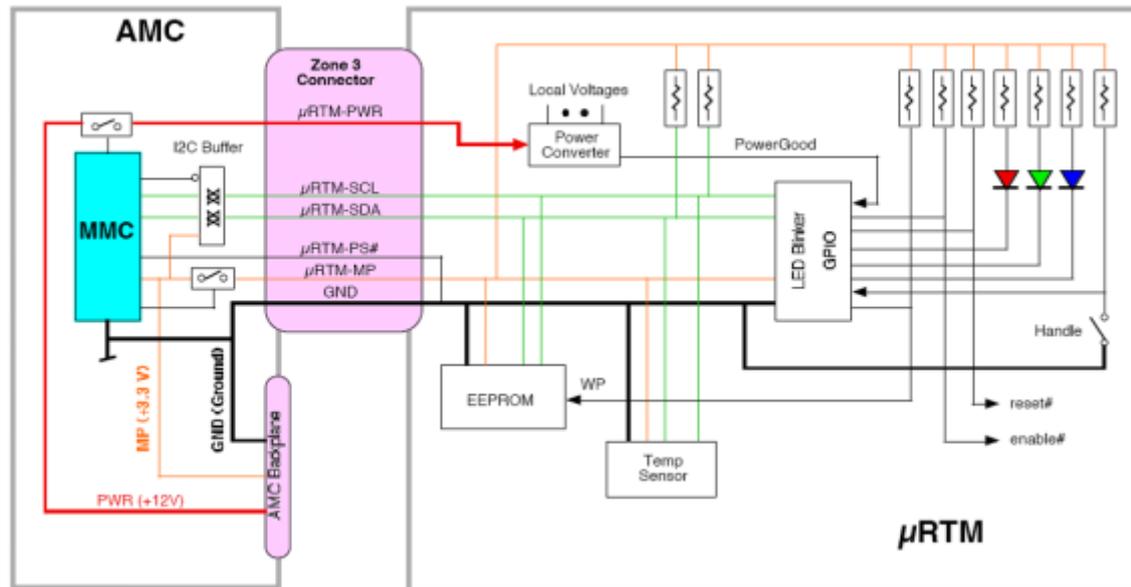
- **IPMB-L**
 - Connects the MCMC on the MCH to the MMC on the AMC Modules
 - Radial architecture
- **IPMB-0**
 - Connects the MCMC on the MCH to the EMMC on the PM and CU
 - Bused architecture
- **I2C-Bus**
 - Connects the AMC to the μ RTM
 - The μ RTM is treated as managed FRU of the AMC



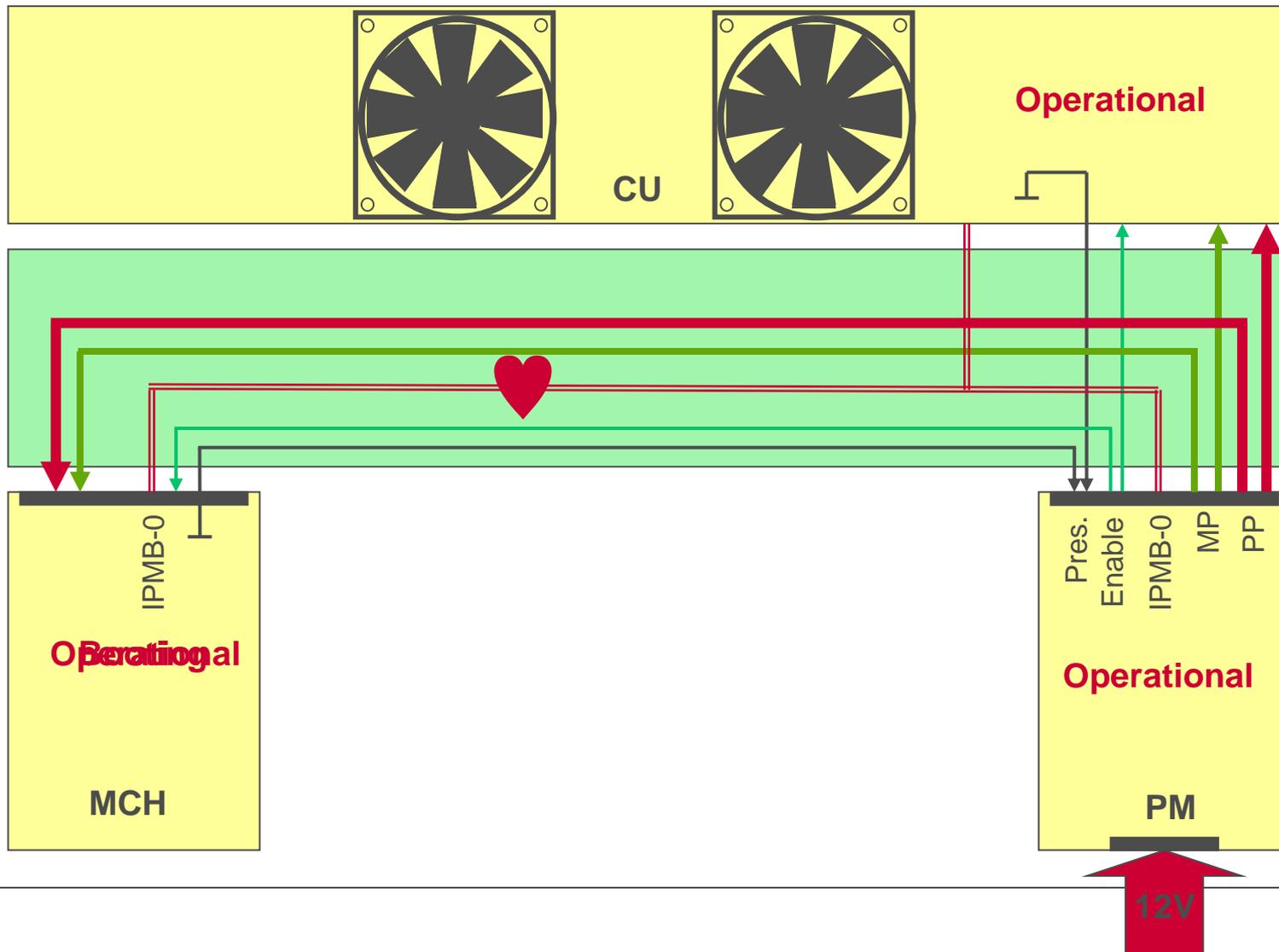
MTCA.4

MicroRTM Management

- A management interface is defined on the lower zone 3 connector
- Management and power signals:
 - μ RTM-MP: Management Power for the EEPROM, Temp. Sensor and I/O Expander
 - μ RTM-PWR: Payload power for the RTM
 - μ RTM-PS#: RTM Presence signal, grounded on the RTM
 - μ RTM-SCL/SDR: I²C bus coming from the AMC MMC going to the RTM

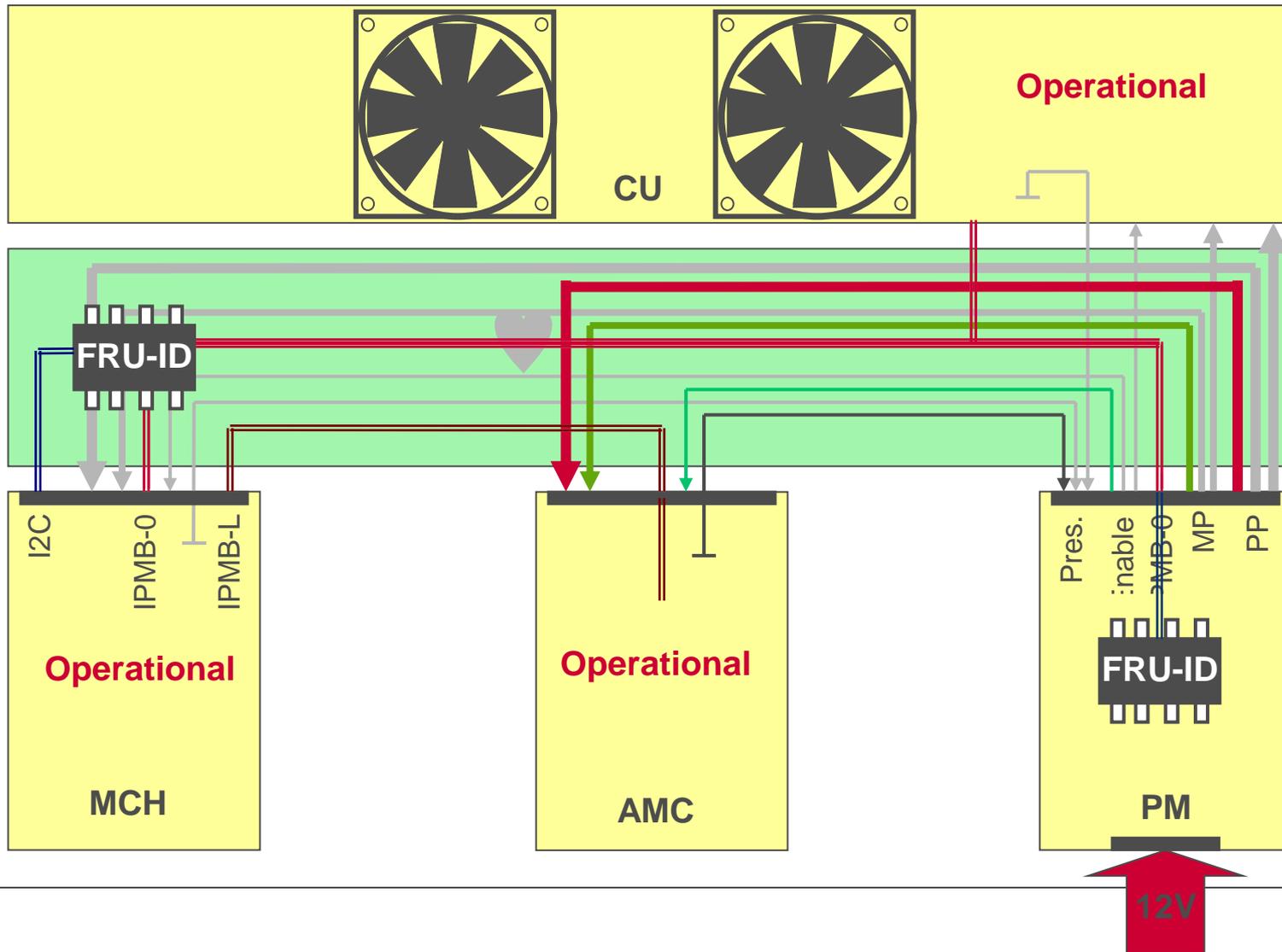


POWERING UP A MTCA SHELF



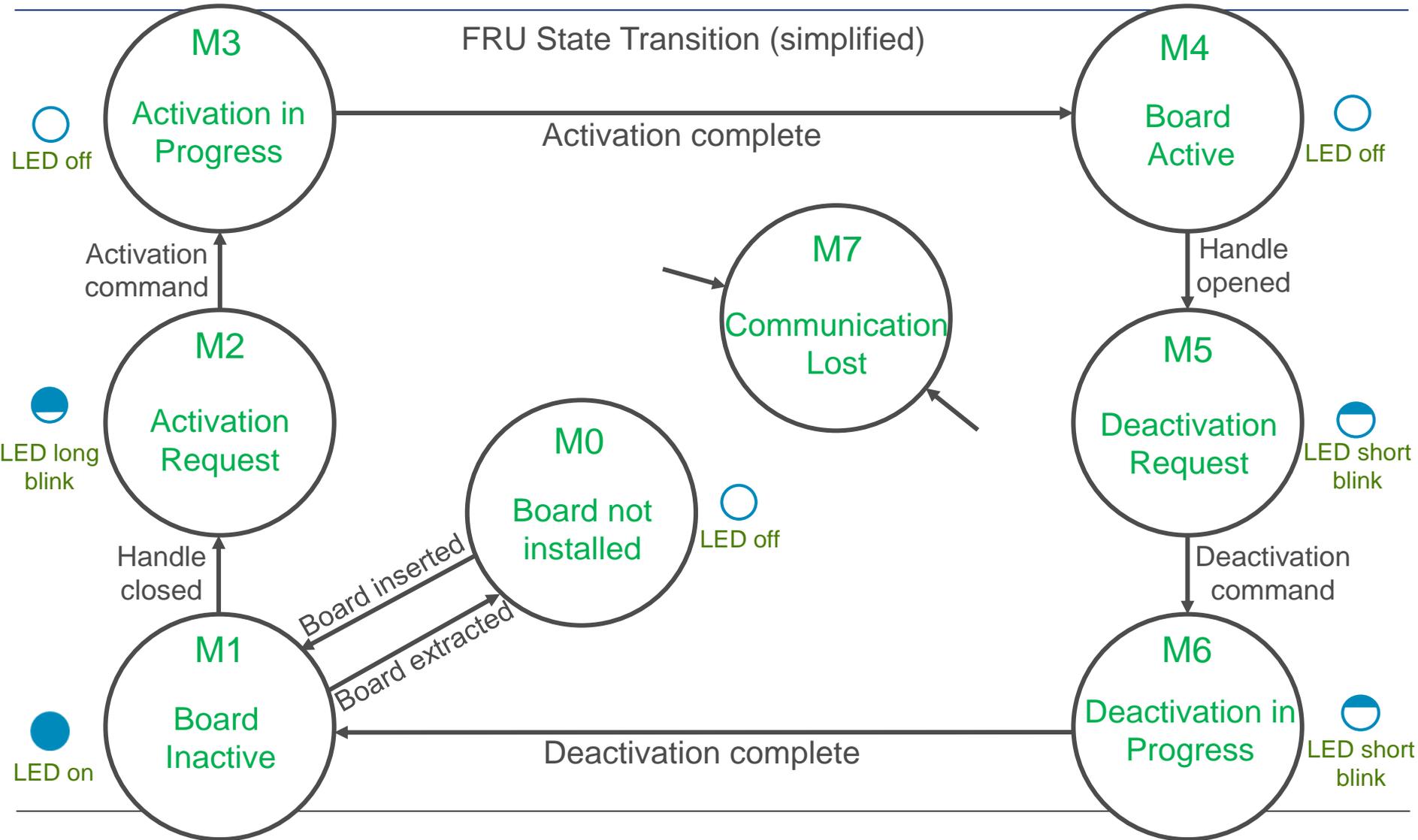
X

POWERING UP A MTCA SHELF

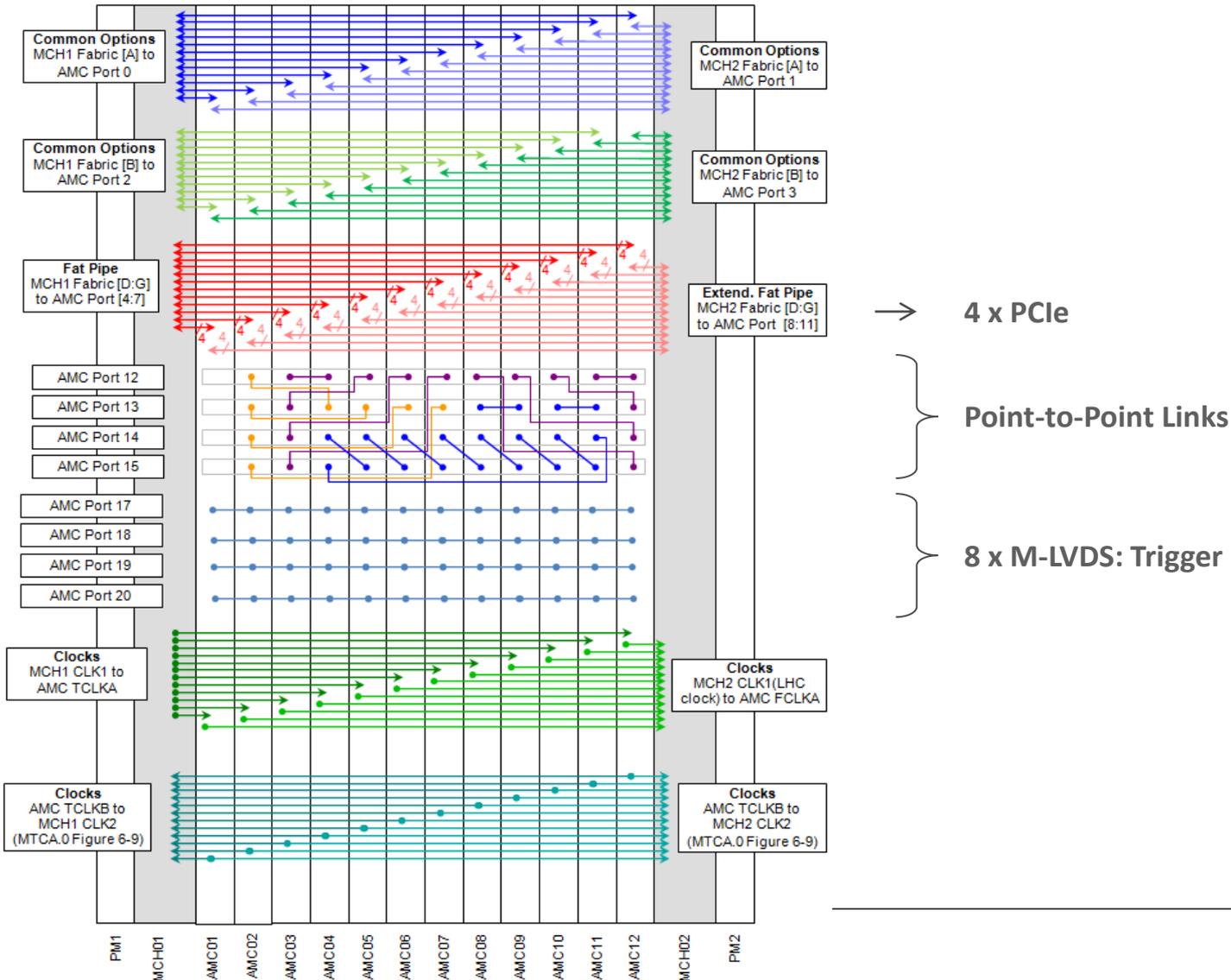


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MTCA.4 – HOT SWAP STATES



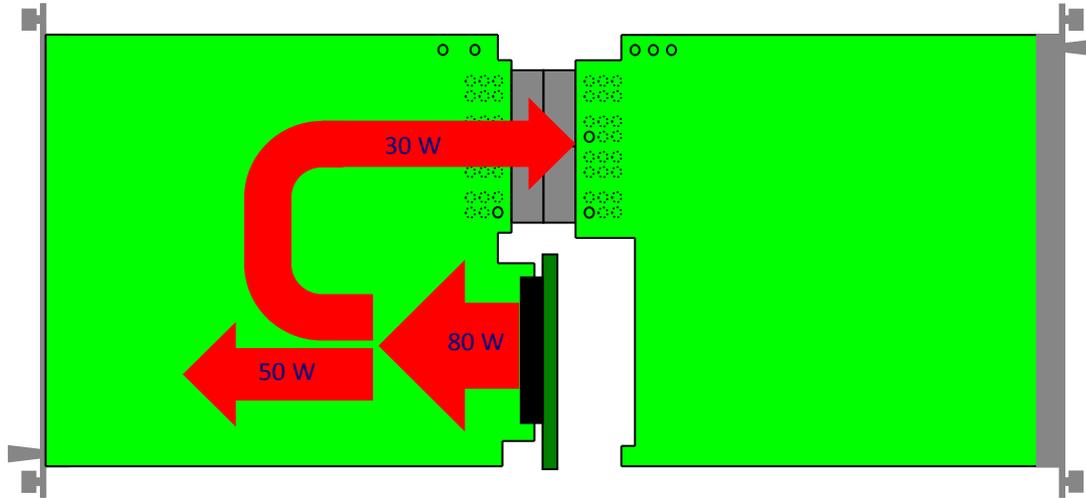
MTCA.4 – 12-SLOT BACKPLANE



MTCA.4

Front board and MicroRTM power distribution

- The total power for a slot (front board and RTM) is supplied through the front board AMC connector
- The MicroRTM power is supplied from the front board through the Zone 3 connectors
- Total available power for a slot is 80 Watts, the MicroRTM power is limited to 30 Watts
- The power required by the MicroRTM is subtracted from the power for the front board

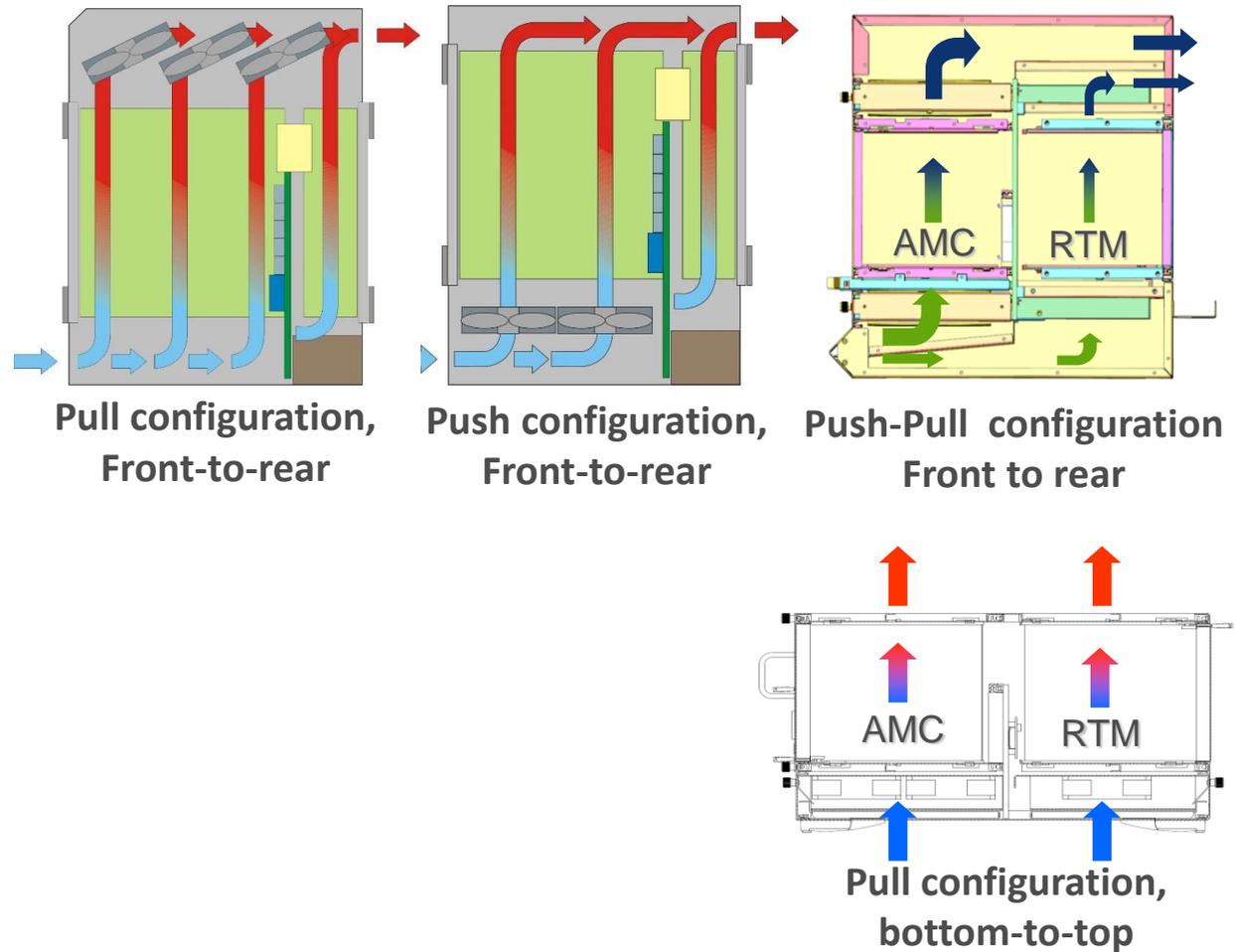


MTCA.4 – COOLING CONCEPTS

Vertical boards

The cooling concept depends on the installation situation of the chassis:

- Front-to-rear air flow
- Side-to-side air flow
- Bottom-to-top air flow
- Front-to-side air flow

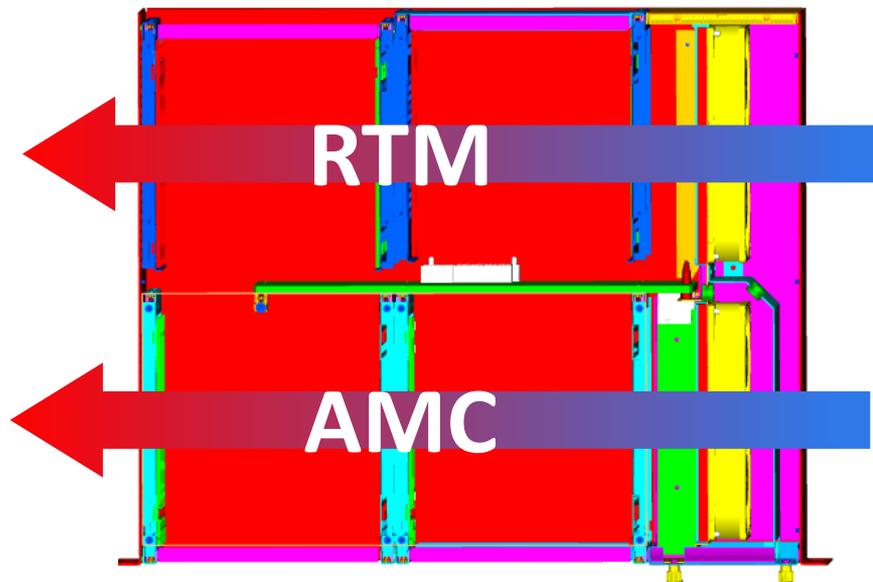


Fan configuration:

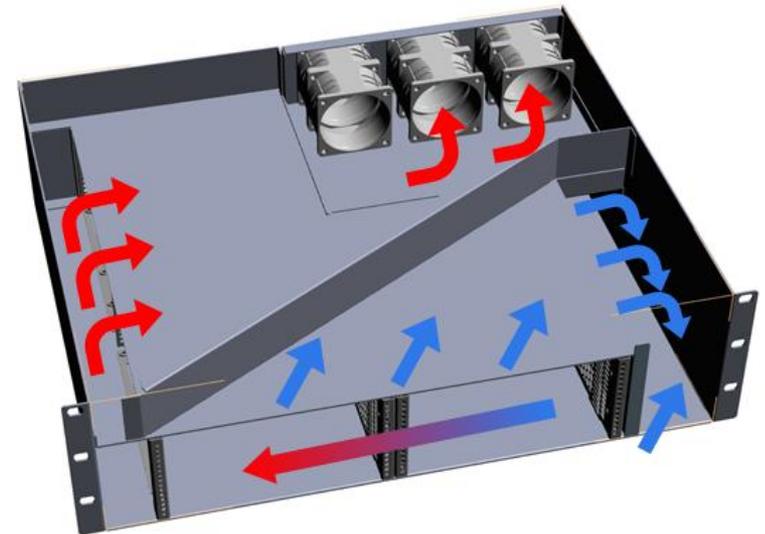
- Push
- Pull
- Push-pull

MTCA.4 – COOLING CONCEPTS

Horizontal boards



Push configuration
Side-to-side



Pull configuration
Front-to-back

MTCA.4

Air flow measurements in MTCA.4 Shelves

- One of the most critical issues in a shelf is cooling of the installed modules
- A reliable method to define the cooling capability of a shelf is to measure the volumetric air flow in m^3/h or cfm
- Measured Air flow values:
 - Bulk air flow value for the total shelf air flow
 - Individual air flow per slot
- Cooling capacity can be calculated based on the Air Flow and desired temperature differential between air intake and air exhaust

MTCA.4

- Bulk air flow measurements in wind tunnel:

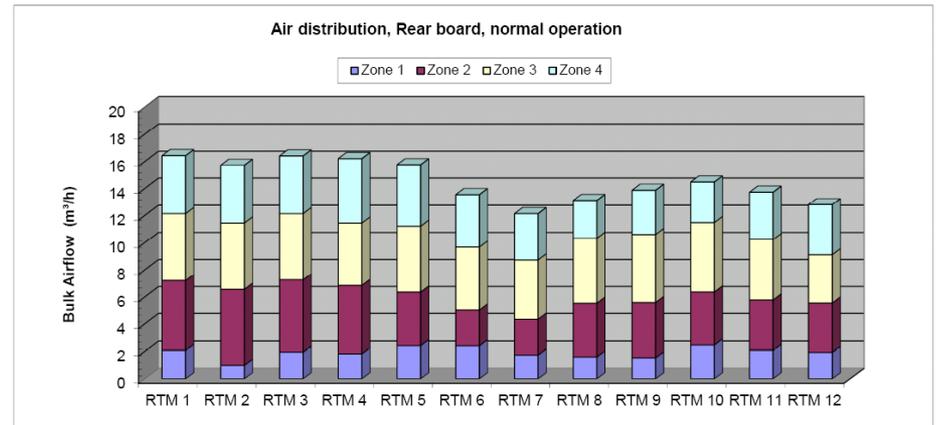
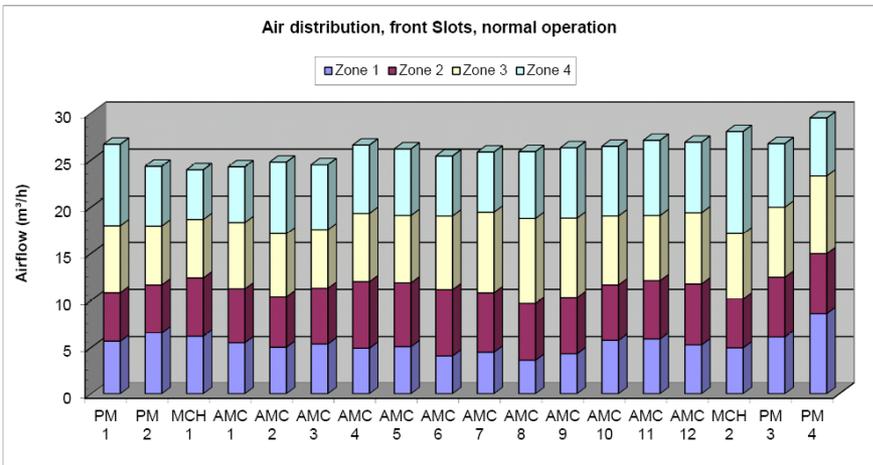


- Per slot air flow measured with air flow measurement boards and Flow Impedance Boards (similar to cp-ta in ATCA)



MTCA.4

- Test results:
Bulk air flow measured in wind tunnel = 635 m³/h
Sum of per slot air flow (front and rear) = 644 m³/h



- Cooling capability approximation: $Power = Air\ Flow * \Delta T / 3.3$
AMC slot 1: 24.3 m³/h => cooling capability (at $\Delta T=12k$) ~ 88 Watts
RTM slot 7: 12.1 m³/h => cooling capability (at $\Delta T=12k$) ~ 44 Watts

MTCA.4

How can MTCA.4 improve the reliability of the system?

- Prediction of failures (e.g. a fan does normally not fail instantly)
- Monitoring of every temperature sensor on every module and FRU
- Isolation of faulty modules(e.g. powering down over-heated modules)
- Power management
- Redundancy

MTCA.4

Redundancy

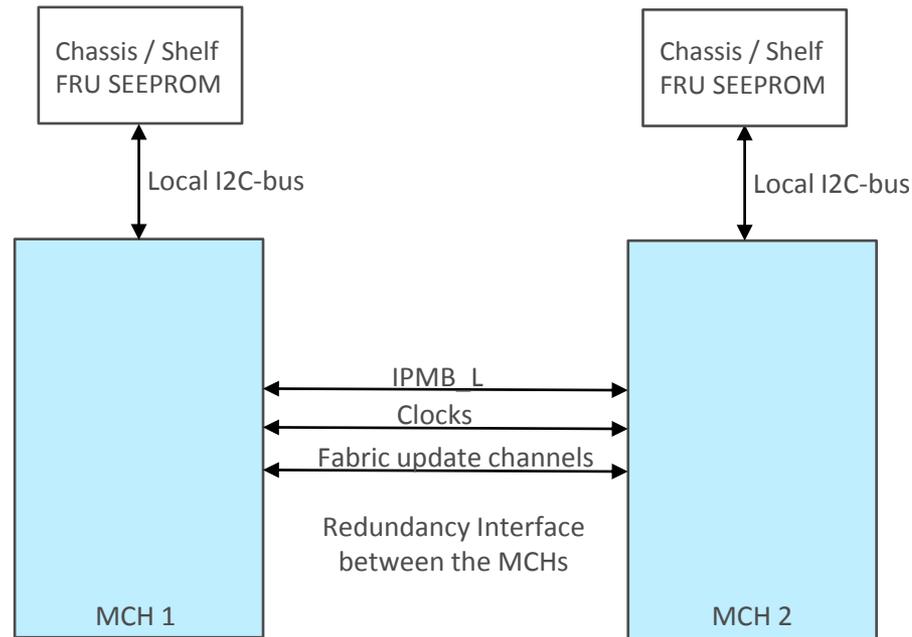
- For high availability applications all modules are redundant:
- 2 x MCH
- 4 x Power Module
- 2 x Cooling Unit
- IPMB-0:
One logical bus divided into two physical busses: IPMB-A and IPMB-B



MTCA.4 - REDUNDANCY

MCH Redundancy

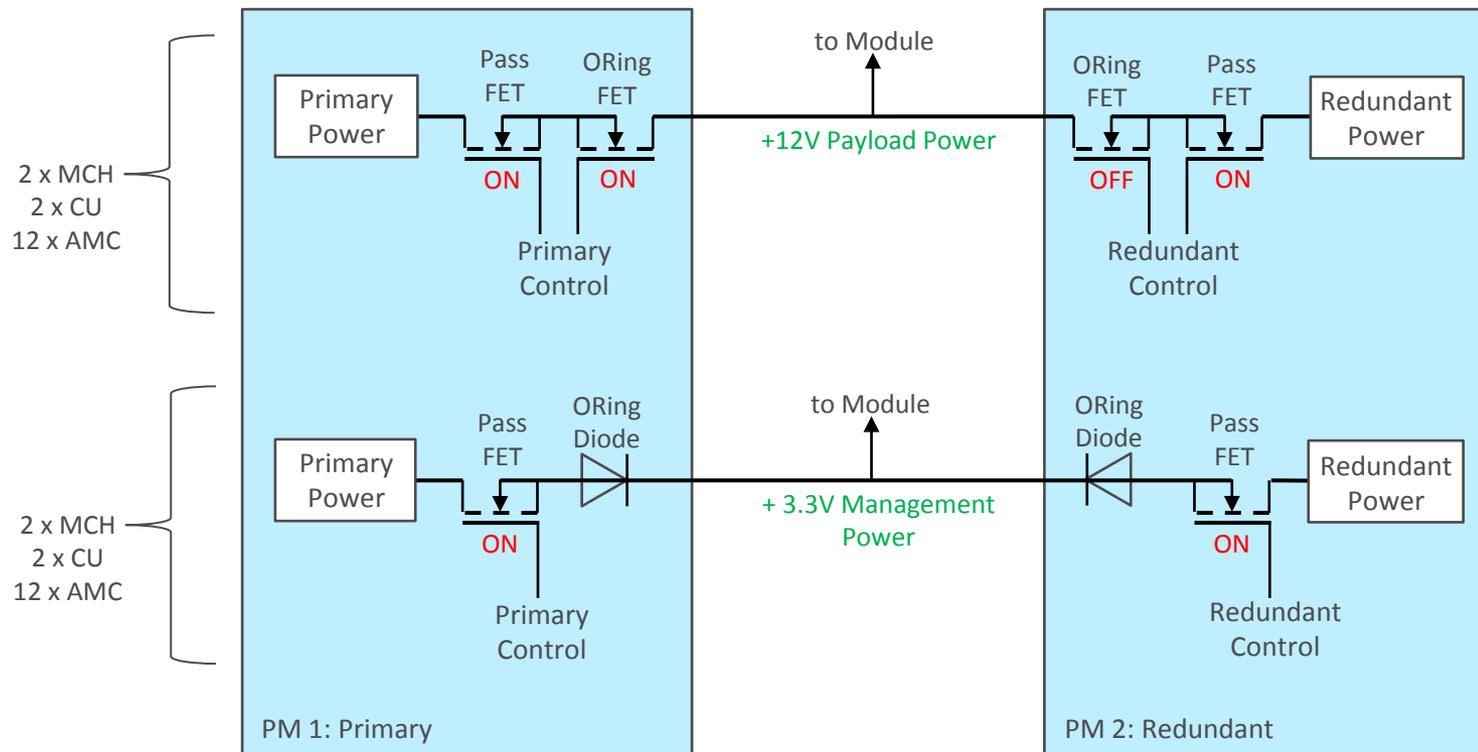
- Two MCH: One is Master, One is Redundant
- Redundant chassis / shelf FRU Information SEEPROM
- Redundancy Interface between the two MCH
- Redundancy defined in chassis / shelf FRU information



MTCA.4 - REDUNDANCY

Power Module Redundancy

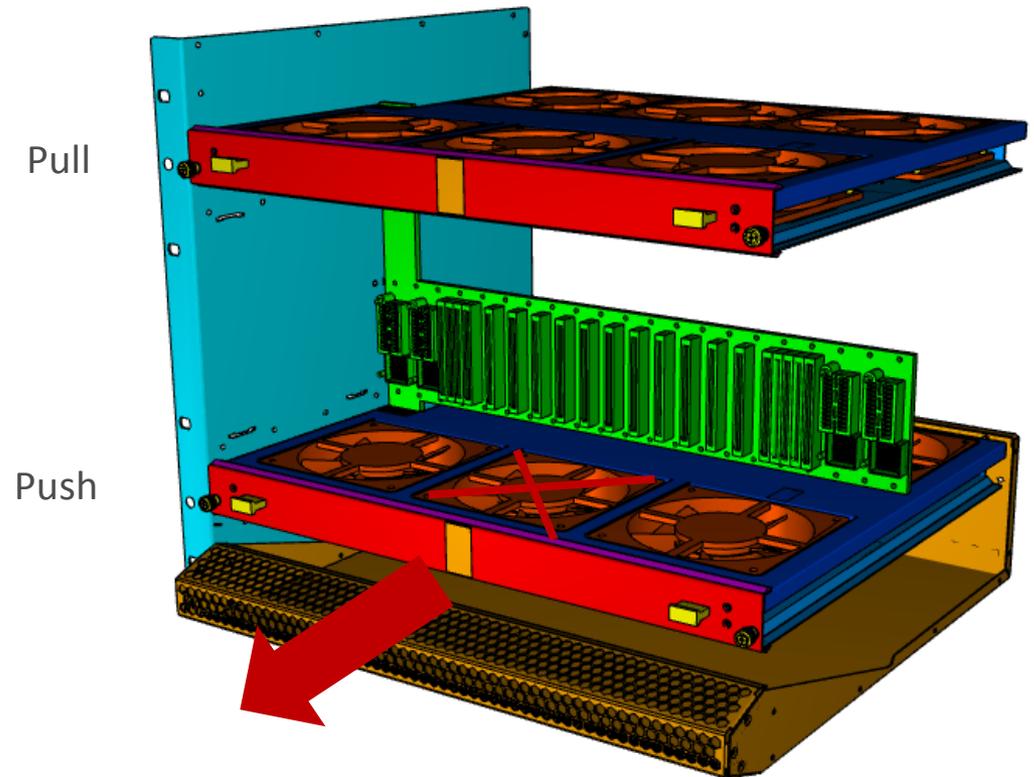
- Up to 4 Power Modules per chassis
- Redundancy mode defined in shelf FRU file
- Individual power channel to each module and FRU



MTCA.4 - REDUNDANCY

Cooling Unit Redundancy

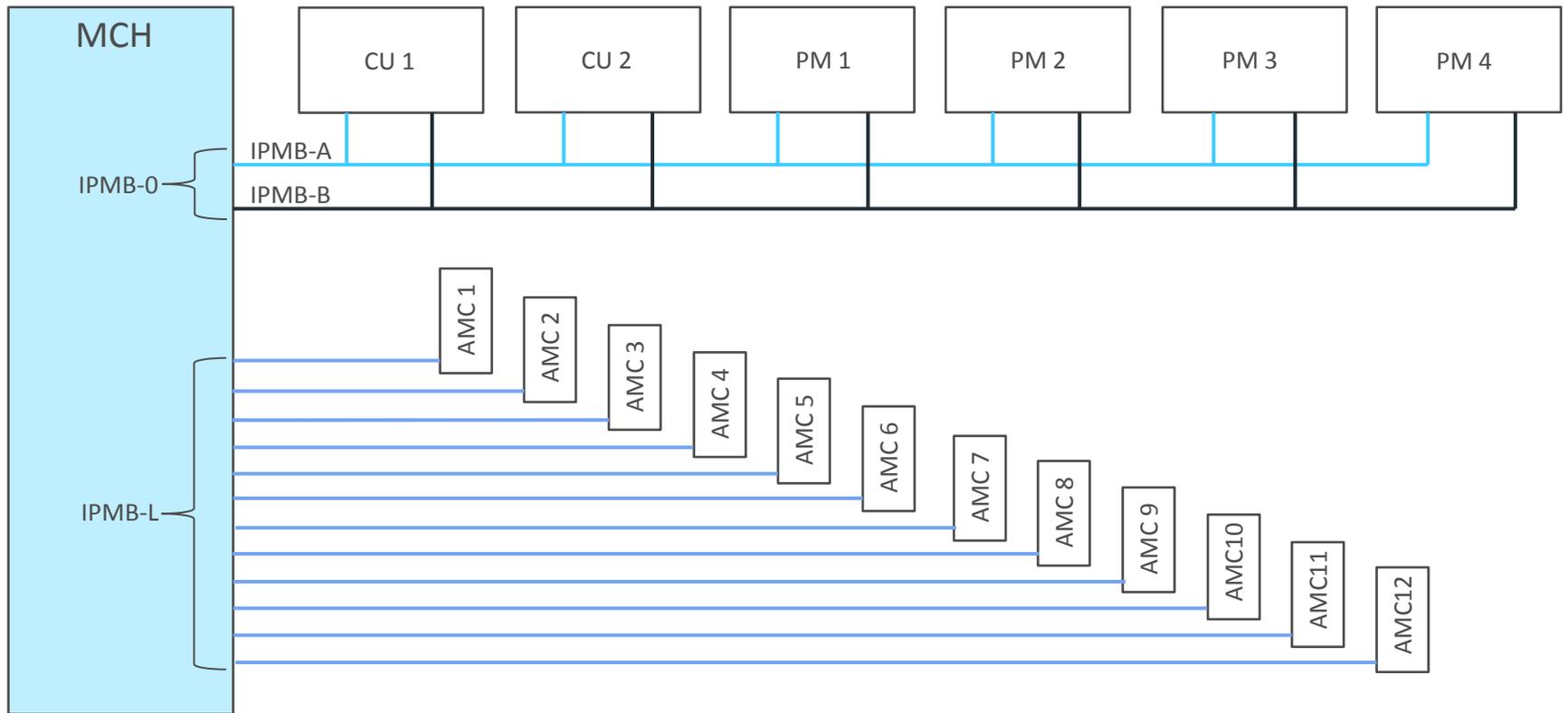
- Redundant Cooling Units in push-pull configuration
- Scenario 1: fan failure
- Scenario 2: Cooling Unit replacement



MTCA.4 - REDUNDANCY

IPMB redundancy

- Individual IPMB-L to each AMC
- Redundant logical IPMB-0 to PMs and CUs

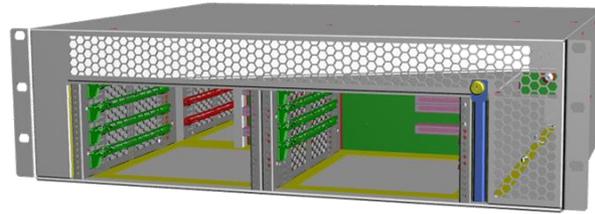


MTCA.4

MTCA.4 Chassis types

Various different MTCA.4 chassis available now:

- Laboratory use
- Fully redundant
- Compact sizes
- Small form factors (MTCA.0)

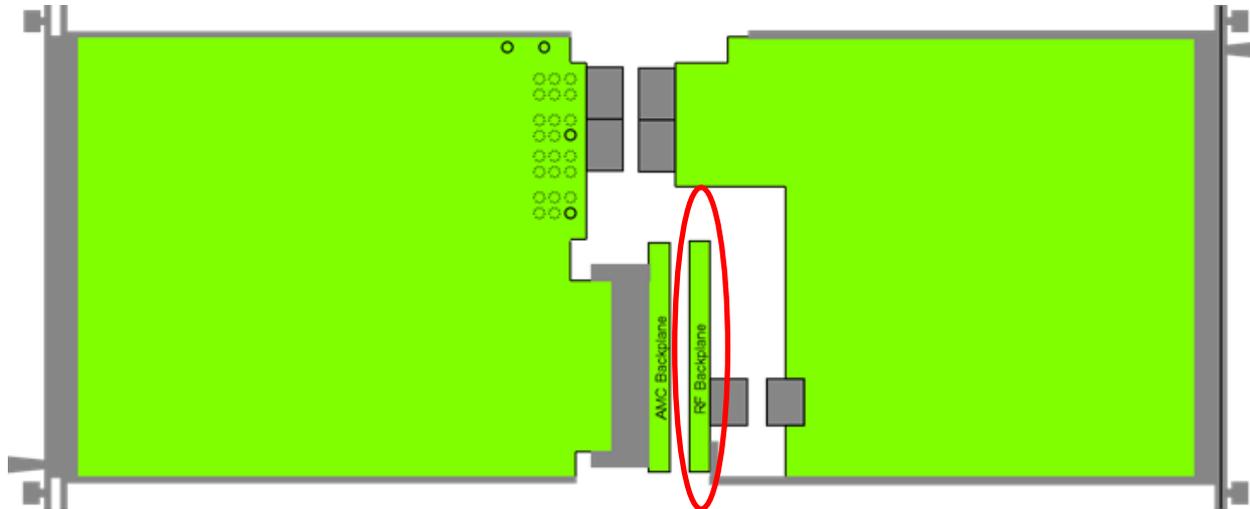
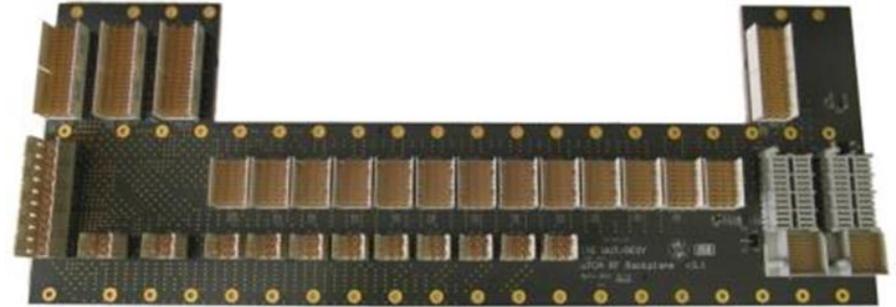


MTCA.4

LLRF Backplane

Definition of a RTM Auxiliary Backplane

- Based on the LLRF backplane developed at DESY
- Optional connector usage



MTCA.4

Standardization continues: AMC Covers

Protective mechanical cover for AMC and RTM modules

- Protective cover to mechanically protect components
- For Side A and Side B
- Designed for Double Mid- and Double Full Size modules



MTCA.4

PICMG MTCA-IW → Interoperability Workshop

- Module and shelf manufacturers test the interoperability of their products
- Test matrix defines „who tests with who“
- Last TCA-IW was held at Vadatech / USA in October 2014.
 - MTCA.4 Chassis manufacturers
 - MTCA.4 AMC manufacturers
 - MTCA.4 PM manufacturers
 - MTCA.4 MCH manufacturers



MicroTCA®

TELCO ALARMS

ALARM SILENCE

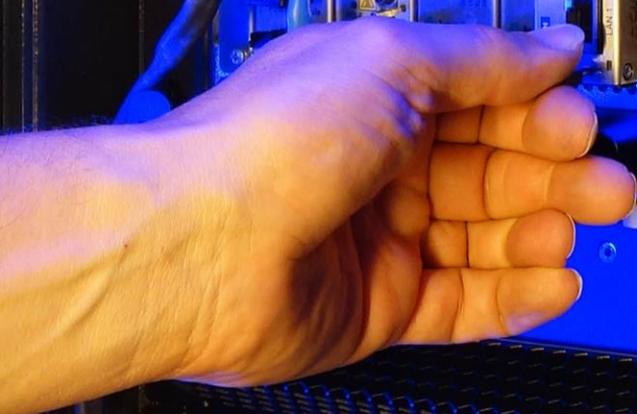
MINOR

MAJOR

CRITICAL

FAN TRAY

HS



FAN TRAY

HS

THANK YOU

Pentair Technical Solutions GmbH
Rüdiger Cölln
Product Marketing Systems Europe

Tel. +49 7082 794-300
Mobil: +49 151 61301663
Mail: ruediger.coelln@pentair.com

