# MTCA / ATCA Technology

Brief Introduction

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# AGENDA

**XTCA Technology Evolution**

- Parallel to Serial data transmission
- Why is xTCA ?

**AdvancedTCA**

- Basic form-factor
- Key features (brief introduction)

**MicroTCA**

- Basic form-factor
- MTCA Technology Evolution
- Key features
  - Backplane topology
  - Rear data transmission
  - Shelf Management (remote control)
  - Thermal Management
  - EMC Shielding
  - LLRF Support





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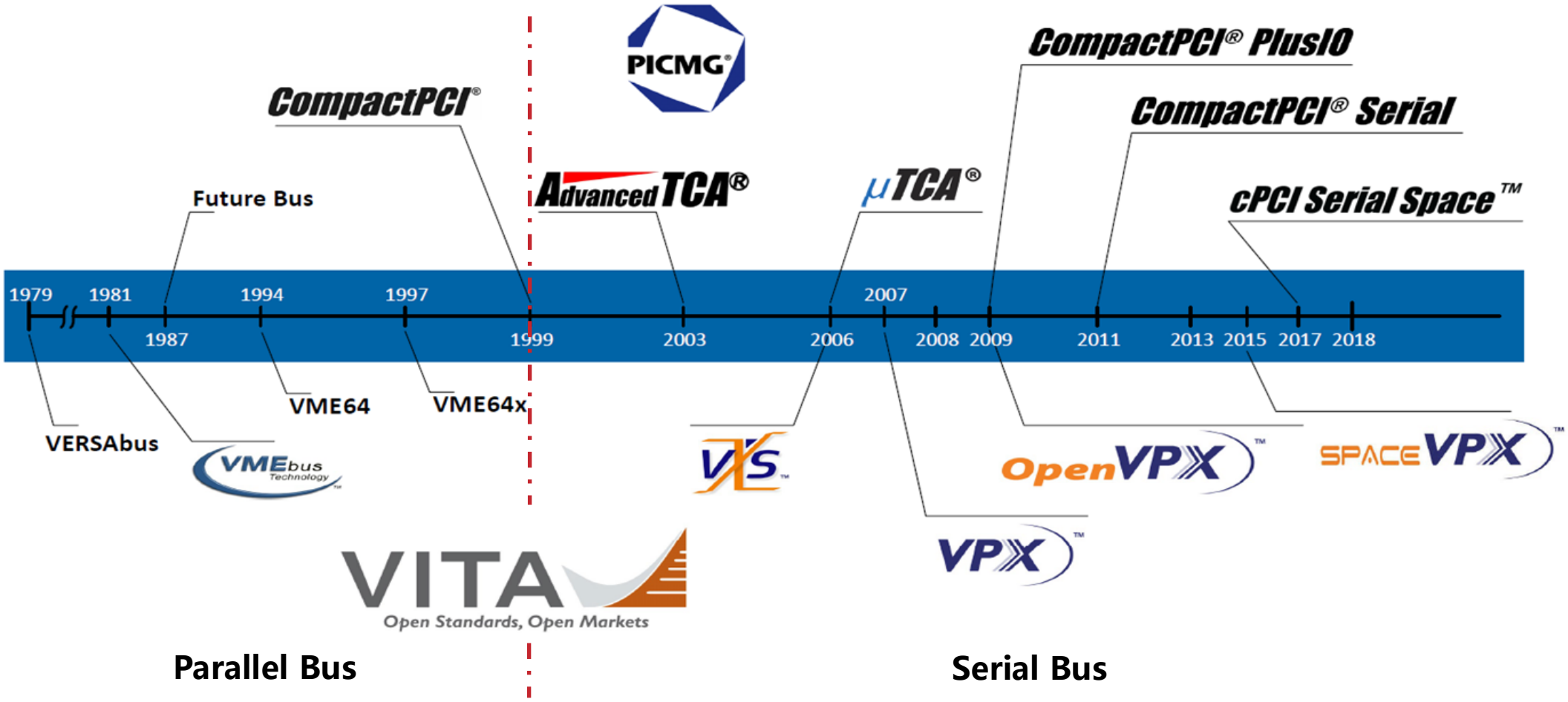
# xTCA Technology Evolution

# Parallel to Serial data transmission

PCIE, Ethernet, USB, SATA… … all belong to serial data transmission




**Serial data transmission is deployed since 2000's**





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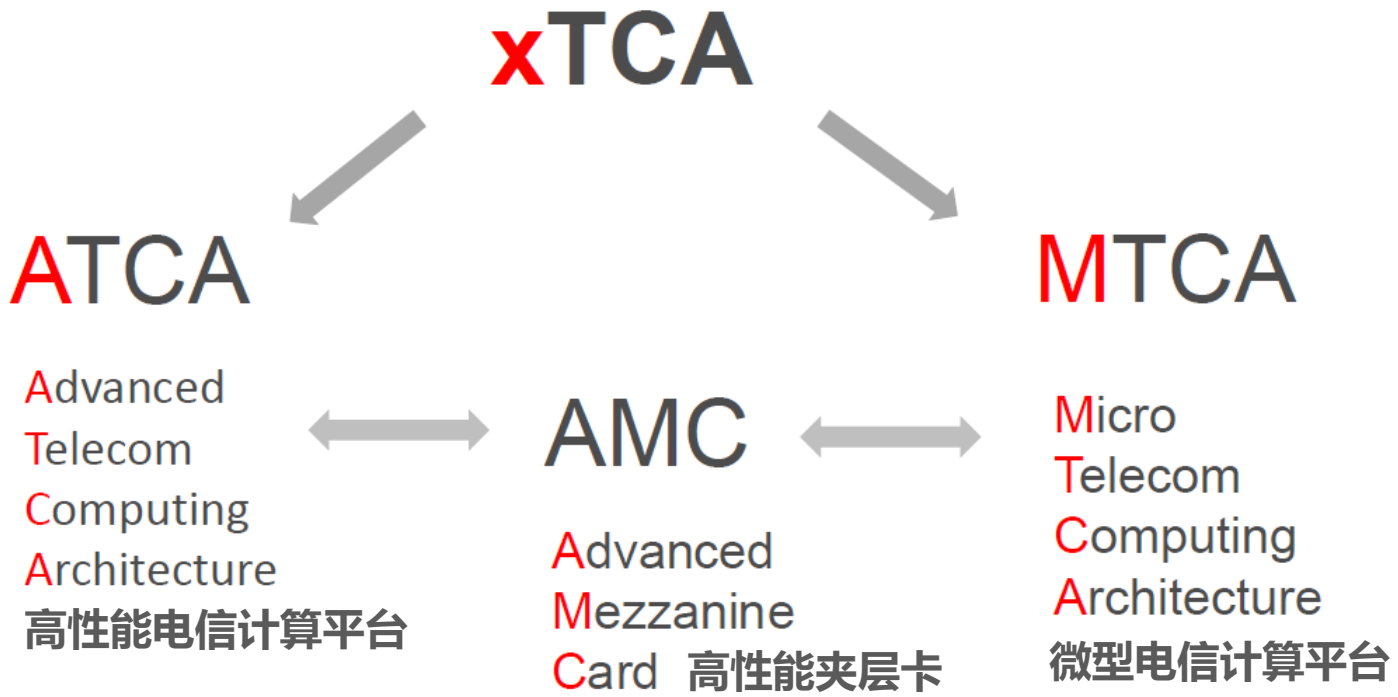
# What is xTCA ?




**PICMG 3.0**
AdvancedTCA Base Specification

**PICMG 3.1**
Ethernet/Fiber Channel Over PICMG 3.0

**PICMG 3.2**
InfiniBand Over PICMG 3.0

**PICMG 3.3**
StarFabric/Advanced Switching for AdvancedTCA Systems

**PICMG 3.4**
PCI Express and Advanced Switching for AdvancedTCA Systems

**PICMG 3.5**
Serial RapidIO for AdvancedTCA Systems

**AMC.0**
Advanced Mezzanine Card Base Specification

**AMC.1**
PCI-Express & Advanced Switching

**AMC.2**
1Gb / 10Gb Enet XAUI

**AMC.3**
Storage ( SATA / FC )

**AMC.4**
Serial RapidIO

**MTCA.0**
Micro Telecommunication Computing Architect Base Specification

**MTCA.1**
Air Cooled Rugged MicroTCA Specification

**MTCA.2**
Hardened Air Cooled MicroTCA Specification

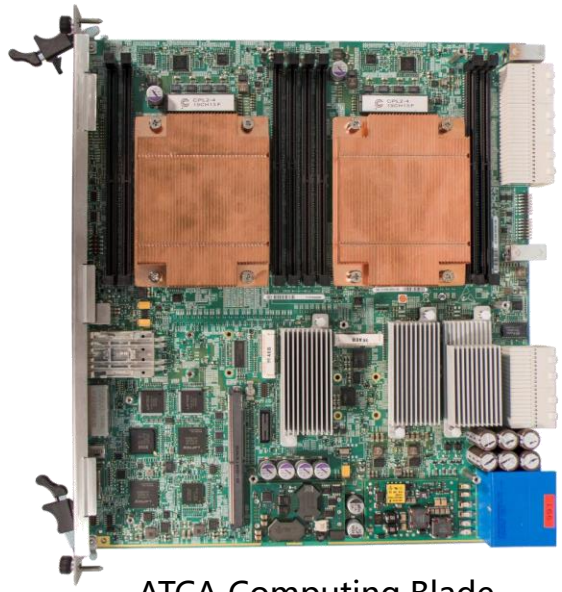
**MTCA.3**
Hardened Conduction Cooled MicroTCA Specification

**MTCA.4**
MicroTCA Ehnancement for RearIO and Precison Time

**xTCA has a big set of standard Matrix**

# Why is xTCA ?

| | Activities |
|---|---|
| **Market Condition** | ▪ Product/market is getting mature, ECO system is established, customers have more choices in the market |
| **Major Application** | ▪ **Telecom :** Small-scale and decentralized deployment, it is mostly located at switching node or edge of the network (such as firewall, load balancing).<br>▪ **A&D:** Battlefield command/communications systems<br>▪ **Video conference and surveillance**: High-definition video transcoding and real-time processing<br>▪ **Advanced Physics:** Beam Control, Timing, LLRF, Data acquisition |
| **Characteristic** | ▪ System standards in accordance with telecom grade, rigorous and comprehensive<br>▪ Small form-factor but complete functional<br>▪ **Reliability :** Up to 99.999%, all key components support HW redundant<br>▪ **Availability:** Most of component are COTS in market<br>▪ **Maintainability:** Most components are FRU, support remote HW management |



ATCA Computing Blade

MTCA MCH

MTCA MCH

**xTCA is most appropriate for the application requiring high reliability / performance and small form-factor**





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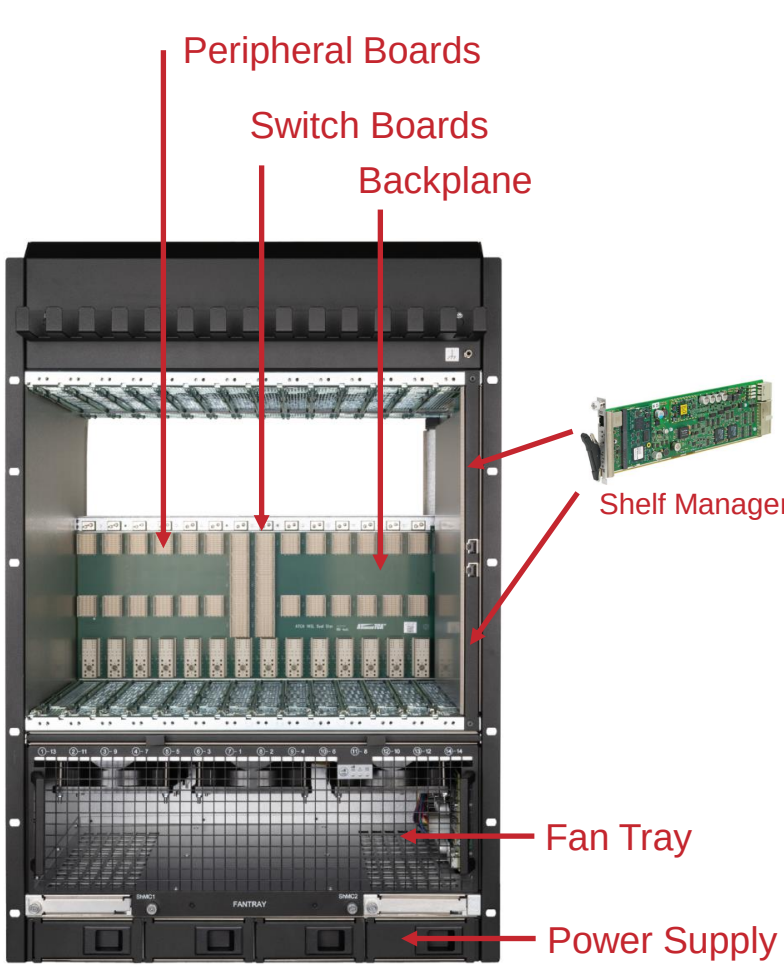
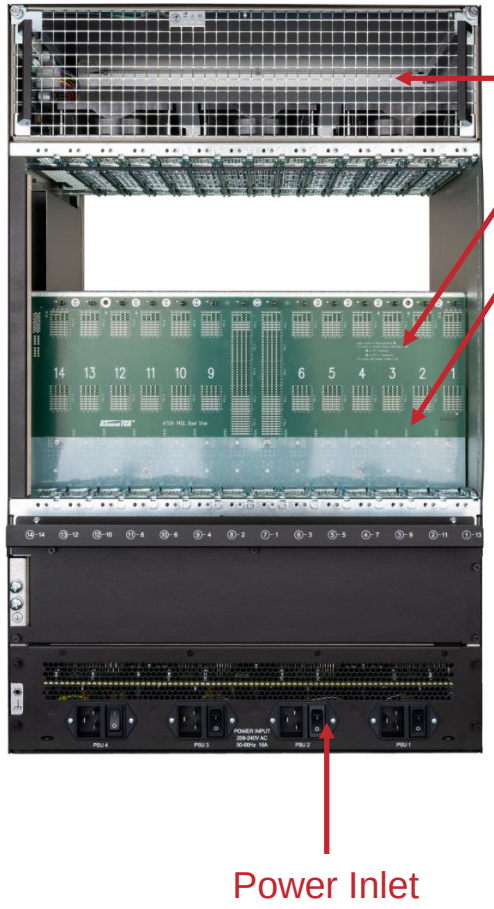
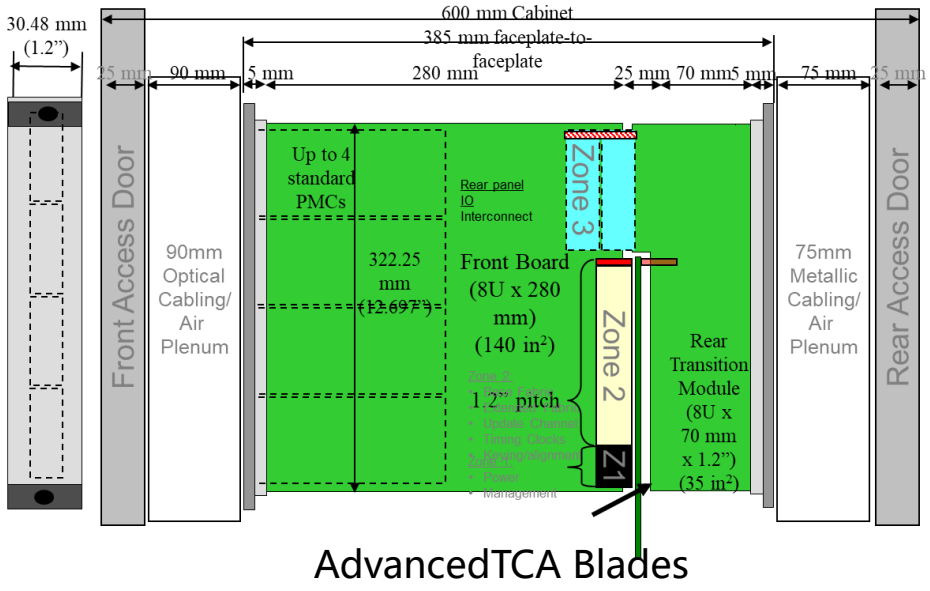
# AdvancedTCA

# AdvancedTCA Form-Factor and Components



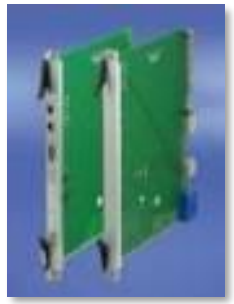

**Mandatory Redundant Design**

# Key Features

- **ADVANCEDTCA …RELEASED IN 2002,  ESPECIALLY FOR TELECOM CENTRAL OFFICE (PICMG 3.0)**

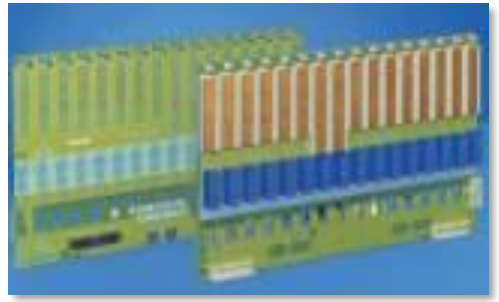
Shelf Manager

AdvancedTCA Chassis



ATCA Front Blades

AMC Carrier



ATCA Backplane

- Serial data communication ✸
- Multi protocol capability (PCI Express, Ethernet, Rapid I/O, Infiniband, Star Fabric) ✸
- Multi processor capability with operating system Linux & Windows ✸
- Dual-Star, Dual-dual Star, Full-Mesh Topology ✸
- High availability (95 = 99,999 %) with redundancy and full hot swap ✸
- Powerful shelf management, support remote monitoring and automatic failure correction ✸
- 400 W / 50 W, 100G backplane (between 2 boards per direction)
- Larger board dimensions (>2x  size) compared to all 6U open standards (eg. CPCI & VME)

✸ MTCA also support

**High reliability,**

# MicroTCA

# MicroTCA Form-Factor and Components

**MTCA basic idea**

- MTCA is to have a shelf that contains just AMC modules
- Backplane directly accepts AMC modules
- AMCs are interchangeable between ATCA and MTCA
- 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

AdvancedTCA®

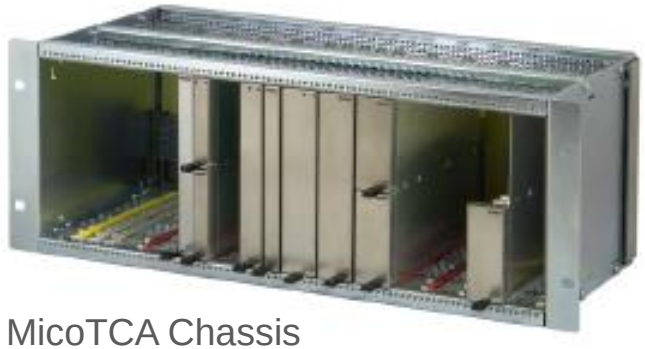
Advanced Mezzanine Card

AMC Carrier

AdvancedTCA Chassis

μTCA™

Advanced Mezzanine Card



MicoTCA Chassis

**AMC is core components, MiroTCA is chassis platform**





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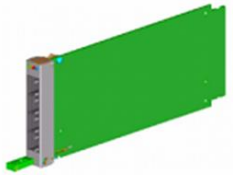
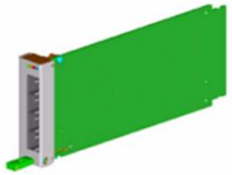
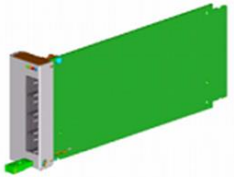
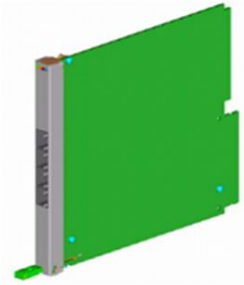
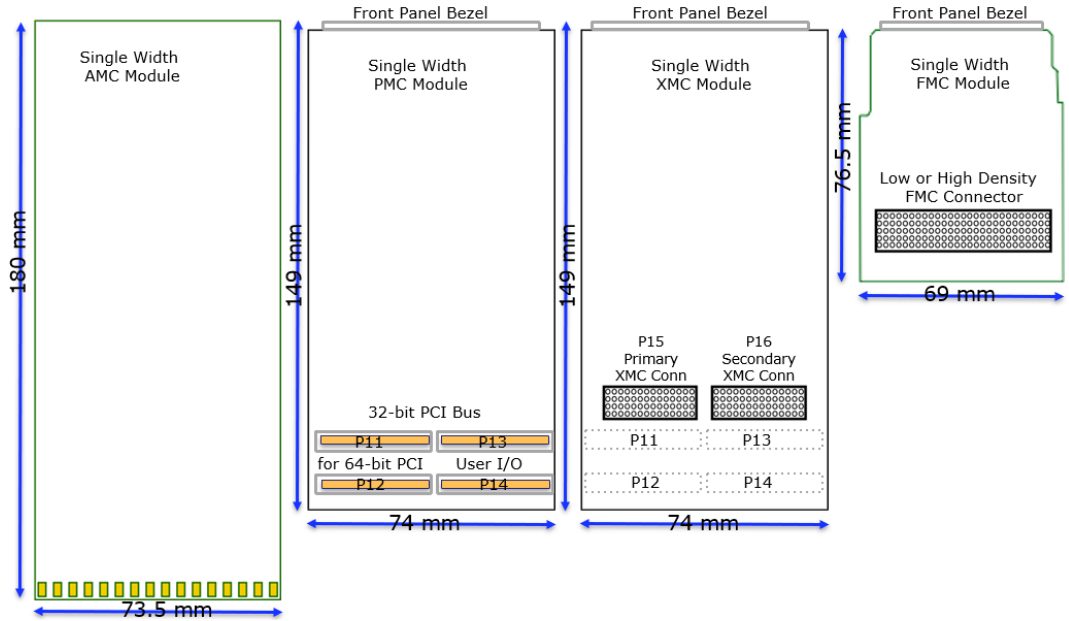
# MicroTCA Form-Factor and Components

| | Compact-Size (3HP) | Mid-Size (4HP) | Full-Size (6HP) |
|---|---|---|---|
| Single modules |  73.8x13.88x181.5mm |  73.8x18.96x181.5mm |  73.8x28.95x181.5mm |
| Double modules |  148.8x13.88x181.5mm |  148. 8x18.96x181.5mm |  148. 8x28.95x181.5mm |

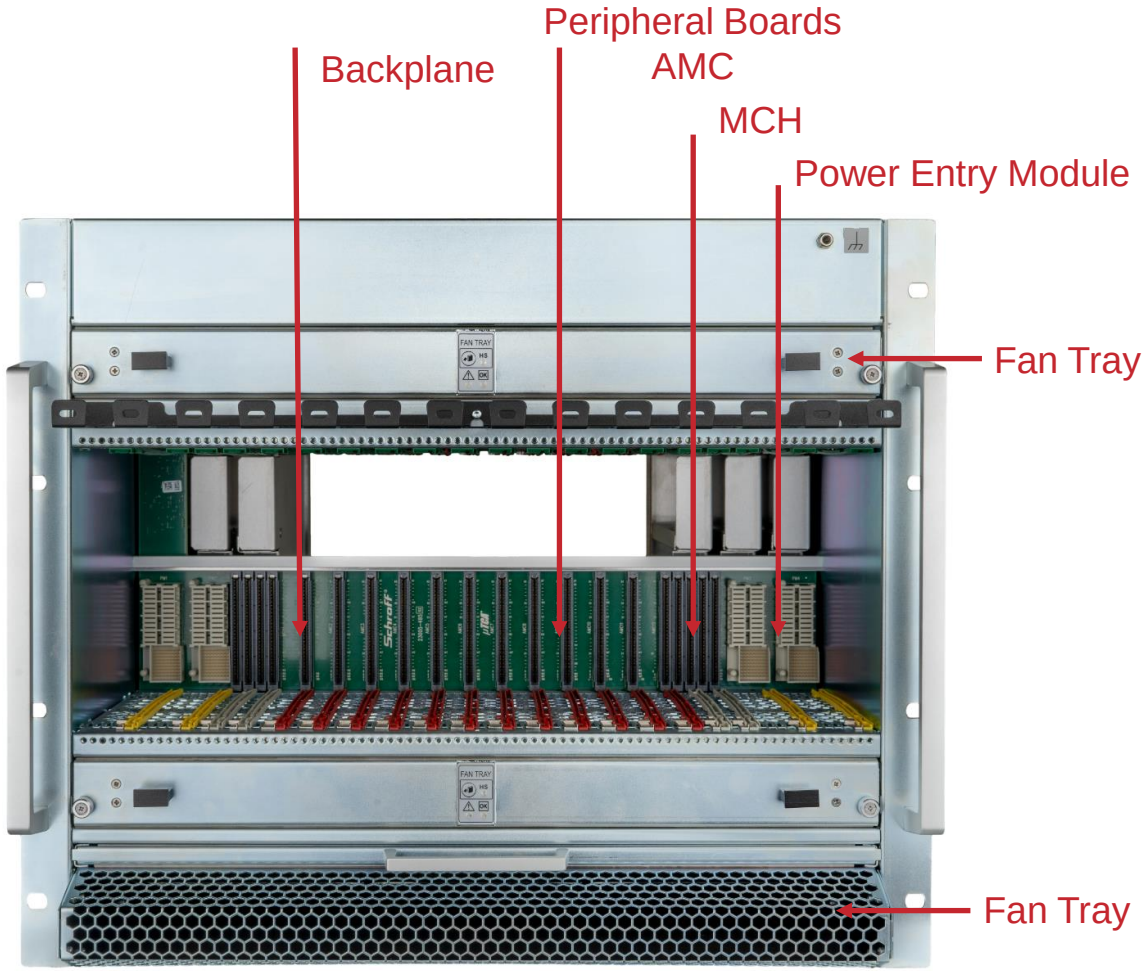
AMC has 6 Sizes

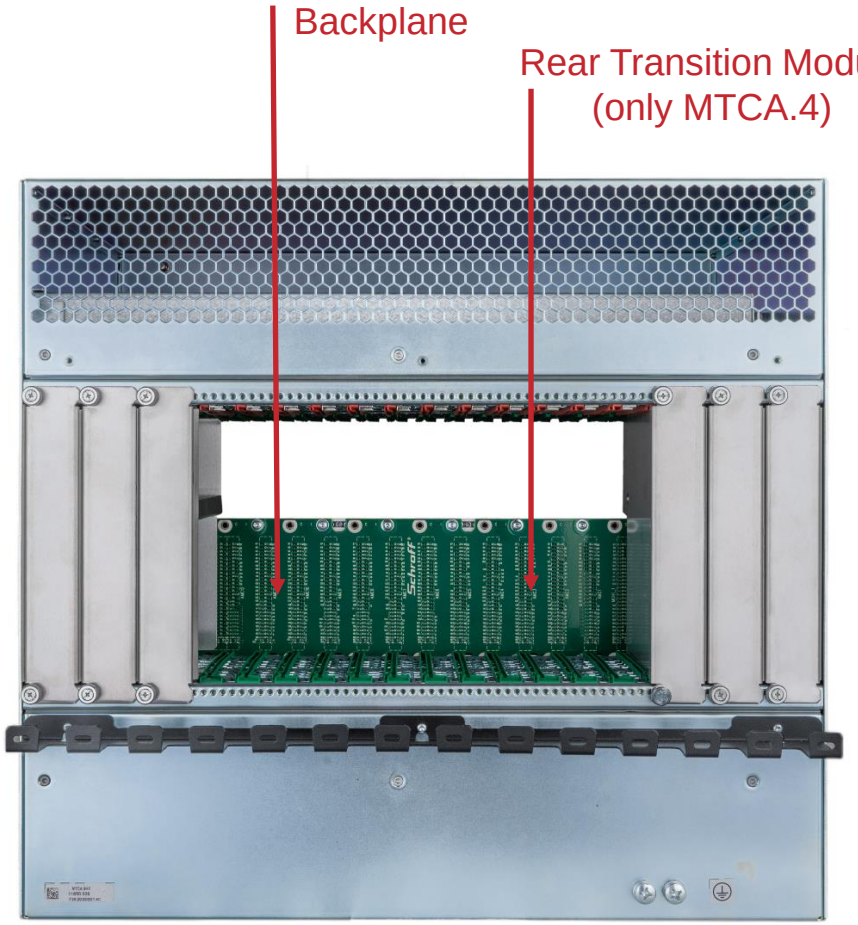



AMC vs PMC / XMC / FMC

**AMC support 6 different sizes**

# MicroTCA Form-Factor and Components




**Mandatory Redundant Design**

# MTCA Technology Evolution

## MTCA consists of .0 / .1 / .2 / .3 /.4 standard

- MTCA.0 released in 2006
  - Design for Telecom edge / access network
  - New standard platform, new board form factor (75/150 mm x 180 mm)
  - AdvancedMC interchangeable between AdvancedTCA and MicroTCA
  - No rear I/O, power input and all modules will be inserted from the front side
  - Topologies: Single-Star, Dual-Star
  - 40 G Backplane (40 Gb/s between 2 boards per direction)
  - High availability (99.999 %) with full redundancy
  - Defines a powerful Carrier- and Shelf management
  - Defines 80 W per slot (in NEBS environment)


MTCA.0

- MTCA.1 released in 2009
  - Design for industrial use
  - MicroTCA for higher shock and vibration levels (IEC 61587-1 DL3, ANSI/VITA 47 V2)
  - Extended temperature ranges

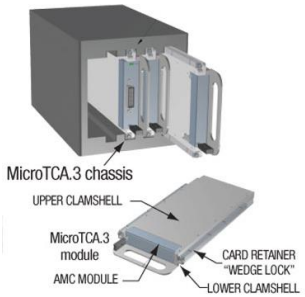
| | | | |
|---|---|---|---|
| MicroTCA.0: | 5 °C | to | +55 °C |
| MicroTCA.1 XT1L: | -40 °C | to | +55 °C, |
| XT1: | -40 °C | to | +70 °C |

MTCA.1

- MTCA.2 released in 2012
  - Design for Telecom Outdoor and Military Air, Land and Sea application
  - Hardened MicroTCA
  - Clamshell System similar to MicroTCA.3
  - Conduction Cooling, Heat path: From the hot spots though thermal paste to clamshell and through Card-LOK to the chassis


MTCA.2

- MTCA.3 released in 2010
  - Design for Telecom Outdoor and Military Air, Land and Sea application
  - Support harden conduction cooling
  - Adds a clamshell around a standard AMC board
  - Conduction Cooling: , heat path: From the hot spots though thermal paste to clamshell and through Card-LOK to the chassis




MTCA.3

**.0 Basic Standard / .1 .2 .3 support rugged application**

# MTCA Technology Evolution

## MTCA.4 is released on 2011

AD / DA Blade

AMC Carrier

Power Module

19” MTCA.4 Chassis

Desk-Top MTCA.4 chassis

- Originally created for the High Energy Physics community
  - The Physics community has made the decision to use ATCA and MicroTCA (Today is using VME
- Additional rear I/O area for specialized AdvancedMC devices and a rear transition module, called a MicroRTM
- Precision timing and synchronization (PS level)
- Allow swapping of front modules while rear modules are engaged

Tritium-Neutrino-Experiment KATRIN

# MICROTCA.4 KEY FEATURES – BPL topology

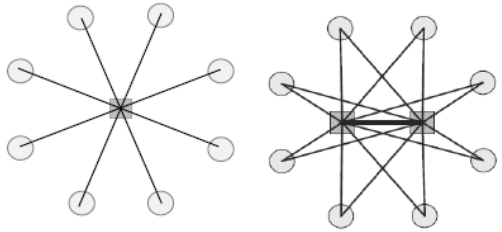
Several types of data protocols (formats) that are transmitted over the platform, each defined by its own specification

- AMC.1 PCI Express / Advanced Switching
- AMC.2 Ethernet
- AMC.3 Storage (SATA… )
- AMC.4 Serial Rapid I/O

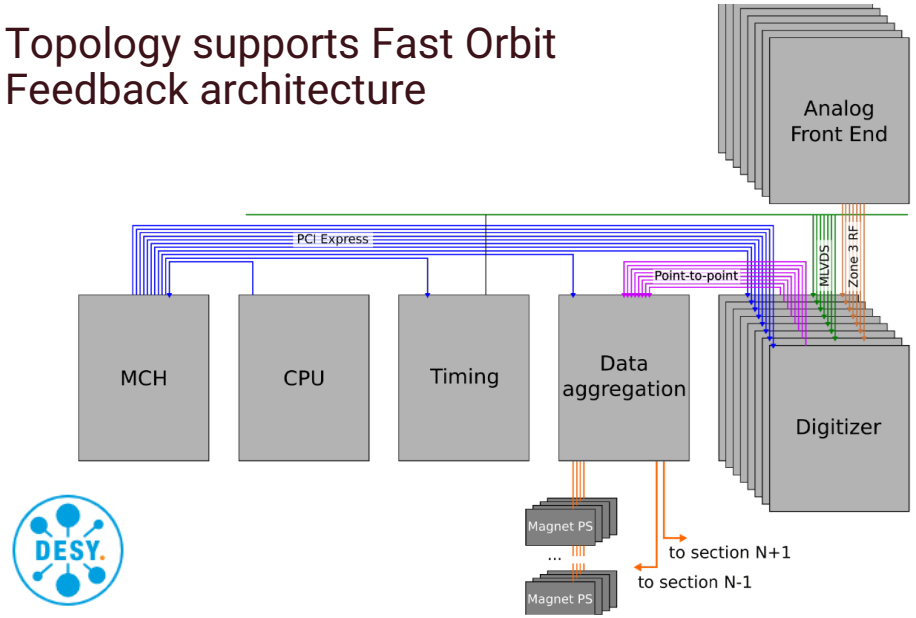
Each MTCA.4 BPL is a combination of AMC specs and topologies.

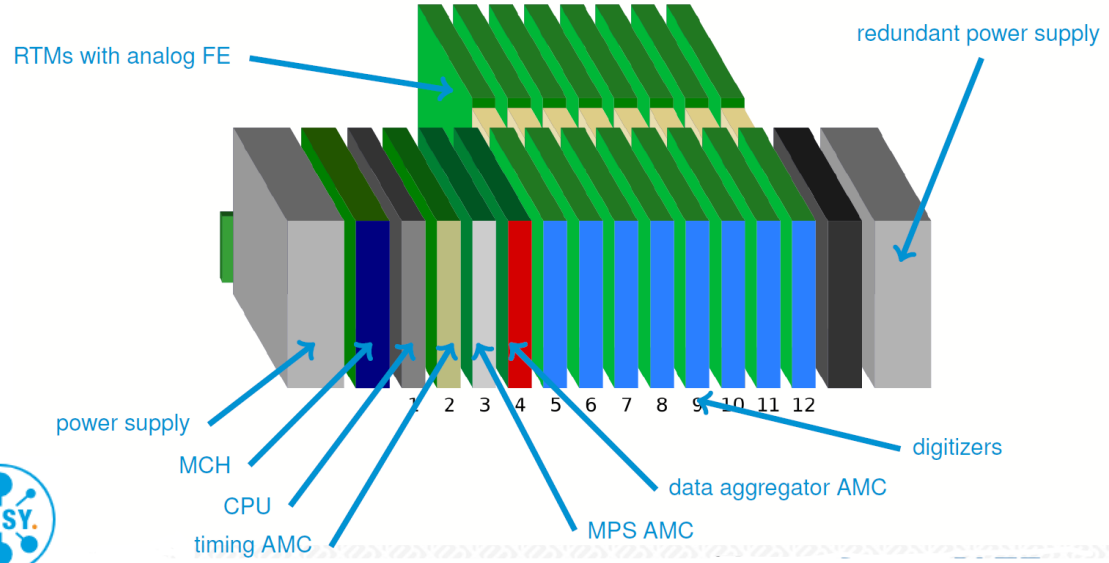
BPL topology

- Single Star - Dual Star … …



Topology supports Fast Orbit Feedback architecture




**Each MTCA.4 BPL is a combition of AMC specs and topologies**

# MICROTCA.4 KEY FEATURES – BPL topology

**Crate** 11850-026

- Standard MTCA.4 Backplane Topology

**Crate** 11850-027

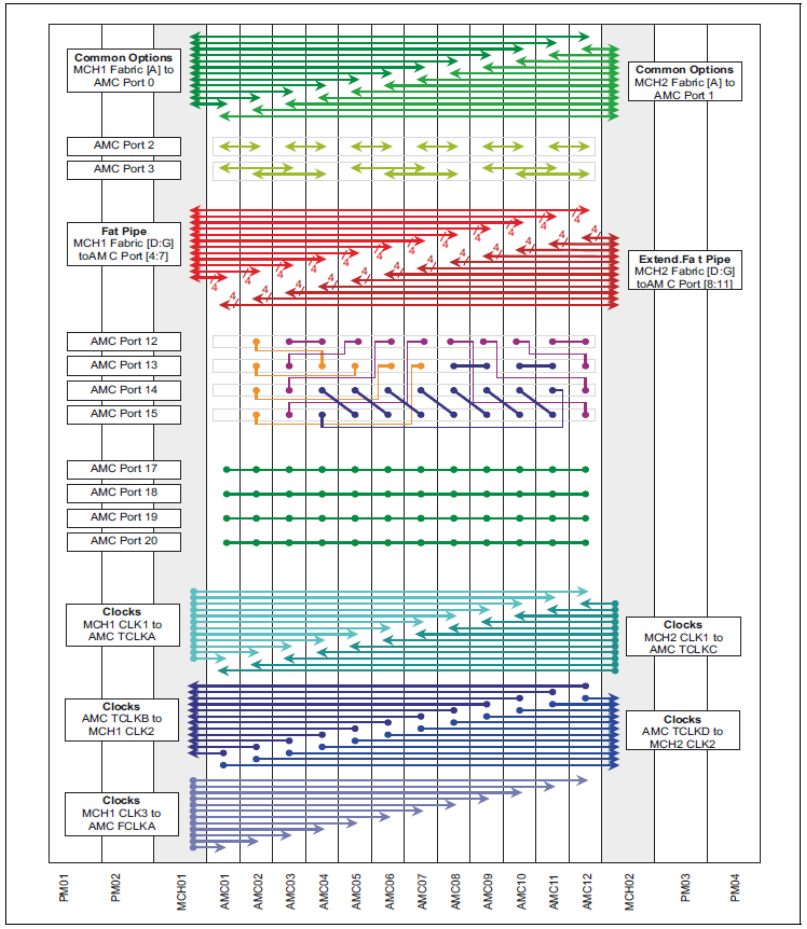
- Standard MTCA.4 Backplane Topology + JSM + White Rabbit support

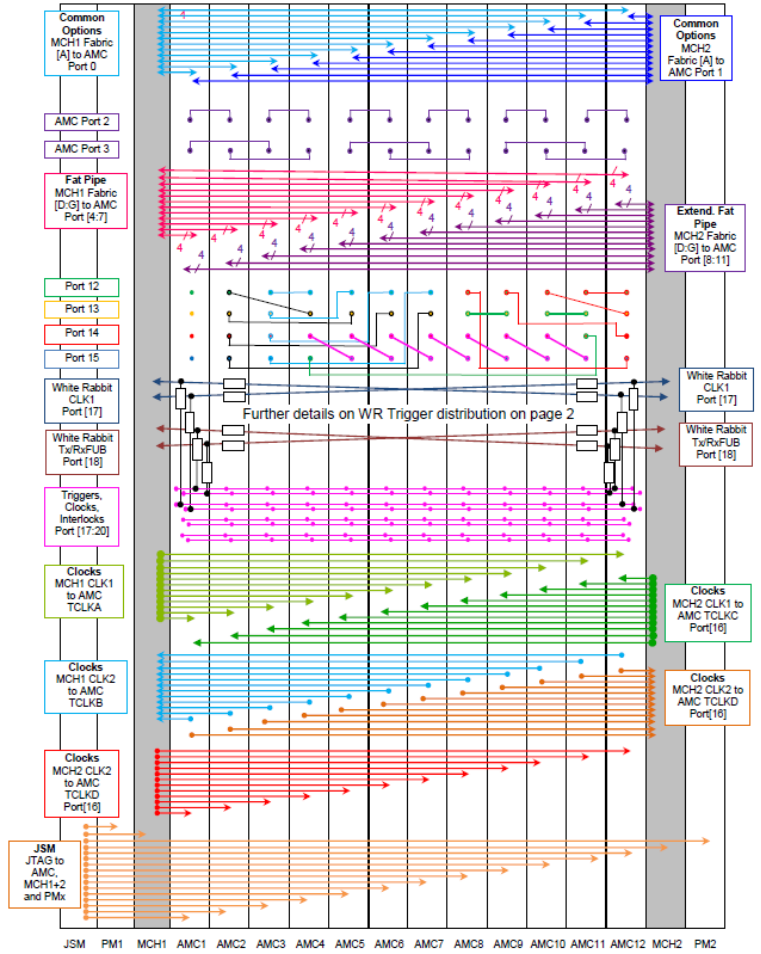
**Crate** 11850-028

- Standard MTCA.4 Backplane Topology + JSM without White Rabbit

**Crate** 11850-030

- Dual-Star Topology on port 8 to 15 + JSM + White Rabbit support




**Each MTCA.4 BPL is a combition of AMC specs and topologies**





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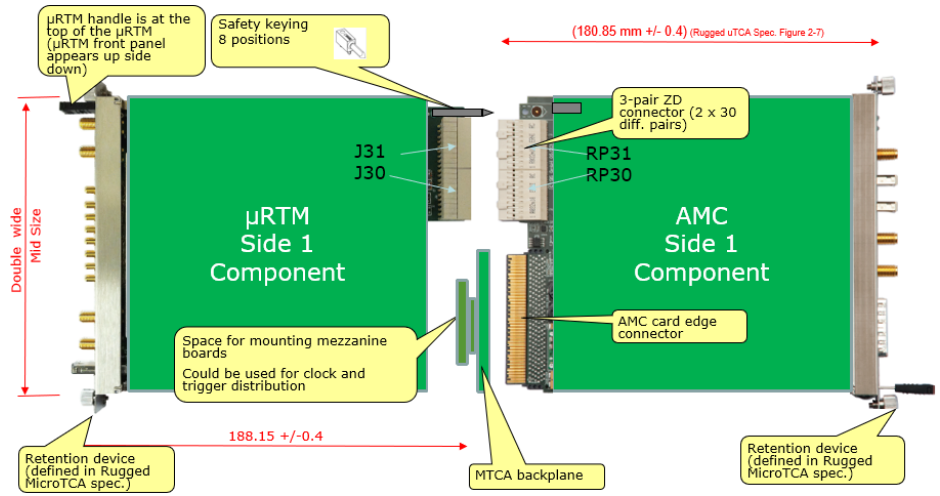
# MICROTCA.4 KEY FEATURES – Rear data transition

## RTM … REAR TRANSITION MODULE

- Used to provide e.g. connectivity to input/output devices (I/O).
- Advantages:
  - All the cabling can typically remain the same for years, while active boards in the front can be changed over the years due to changed requirements or newer technology, e.g.:
  - faster or more powerful processors
  - larger storage capabilities
- In µTCA.4, RTM boards get directly connected with its corresponding front Board (µTCA.4 or ATCA). Direct mating with the front Board give the board designer the opportunity to chose the most appropriate connector for his purpose without influencing the Backplane design.

  Traditionally, MTCA.4 RTM unable to communicate directly, but this signal / data block is removed by MTCA.4 .1



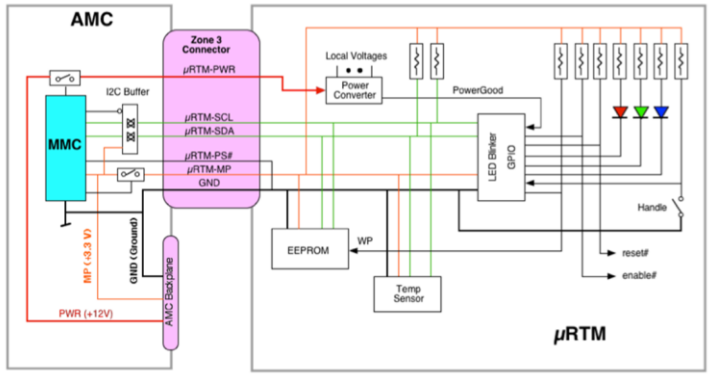

µTCA.4 RTM concept

**µRTM-MP:** Management Power for the EEPROM Temp. Sensor and I/O Expander

**µRTM-PWR:** Payload power for the RTM

**µRTM-PS#:** RTM Presence signal grounded on the RTM

**µRTM-SCL/SDR:** I²C bus coming from the AMC MMC going to RTM




µTCA.4 RTM Management

**RTM – Expand and Enable constant I/O connection**

# MICROTCA.4 KEY FEATURES – Hardware management

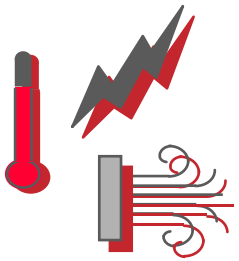
## WHAT IS THE HARDWARE MANAGEMENT ?

Delivering some or all of the functionality below: locally and remotely, uniformly, across heterogeneous HW/SW platforms, even when their main CPUs are down, in support of the primary computing and other applications on those platforms

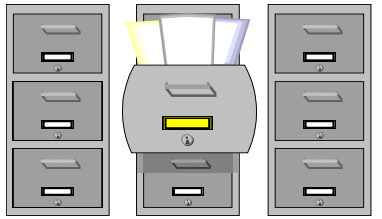
**Advantages**

- Guarantee 7x24hrs remote monitoring / record, automatic failure correction **by MMC**
- Precise power control to up to 16 channels **by EMMC**
- Precise fan speed control, ensure lower crate vibration, acoustic, power consumption，radiation and longer fan life **by EMMC**

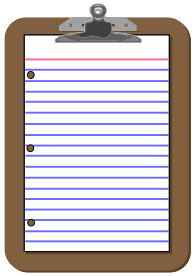
Monitoring



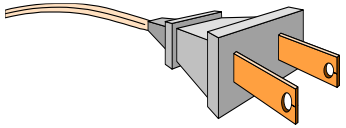
Logging



Inventory



Power Control



Alert

Recovery

**7x24hrs remote monitoring / record, automatic failure correction**





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# MICROTCA.4 KEY FEATURES – Hardware management

## Terms and Acronyms

**MCH** MicroTCA Carrier Hub
- This is the complete module you can buy from a vendor

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

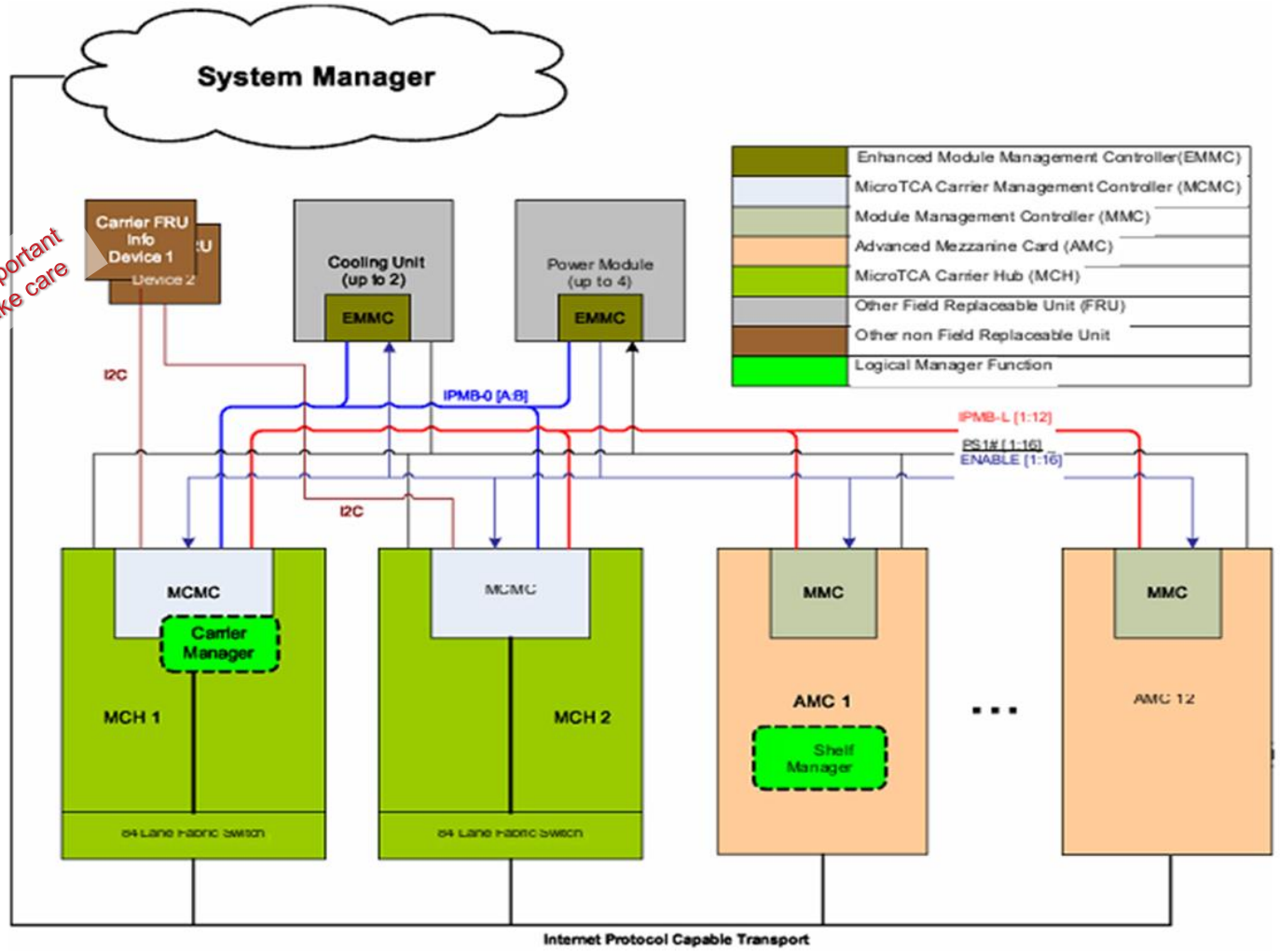
**MMC** Module Management Controller
- This is the physical IPMI controller on an AMC

**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

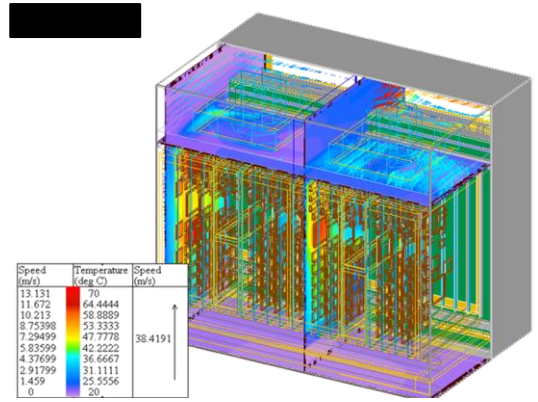
MMC is the most important part you have to take care



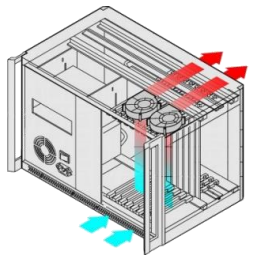
# MICROTCA.4 KEY FEATURES – Cooling

## MTCA.4 apply forced air-cooling

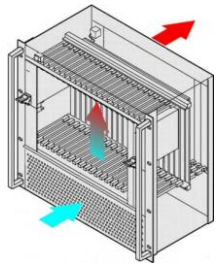
- Forced air cooling will be realized differently depending on the system:
  - very cost sensitive systems with small power consumption may just use a bottom to top cooling
  - In a lot of environments bottom front to top rear cooling is preferred as with that there are clearly defined cold and warm areas in the cabinet.
  - Side to Side cooling is very common for Systems with a horizontal boar arrangement.
  - Push-Pull Cooling concepts are very common for High Power / High Availability Systems



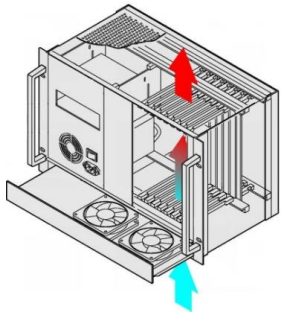

Most of full-config MTCA.4 crates use push/pull cooling concept



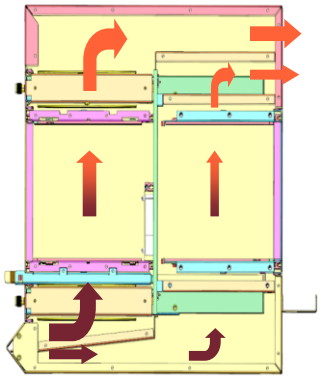
Pull Concept



Push Concept



Bottom to Top forced cooling: Very common for cost sensitive systems



Systems with a cooling concept "Bottom Front to Top Rear" guarantee clearly defined areas in the cabinet and avoid headaches due to chaotic airflow.

Schroff MTCA.4 Crates with push/pull cooling

# MICROTCA.4 KEY FEATURES – Cooling

## How to make sure you system working properly in desired operation temperature ?

- Determine AMC power consumption, environment temperature and ΔT
- Determine operation scenario ( Normal,
- Determine crate desired MTBF

– The cooling capability of a crate is very much dependent on the environmental temperature

– AMC slot 1: 24.3 m3/h
  - cooling capability (at ΔT=12k) ~ 88 Watts
  - cooling capability (at ΔT=25k) ~ 184 Watts
– RTM slot 7: 12.1 m3/h
  - cooling capability (at ΔT=12k) ~ 44 Watts
  - cooling capability (at ΔT=25k) ~ 92 Watts

MTCA.4 Power Measurement Result

**Device: 11850-026 MTCA 9U 84HP 12SL REAR IO**

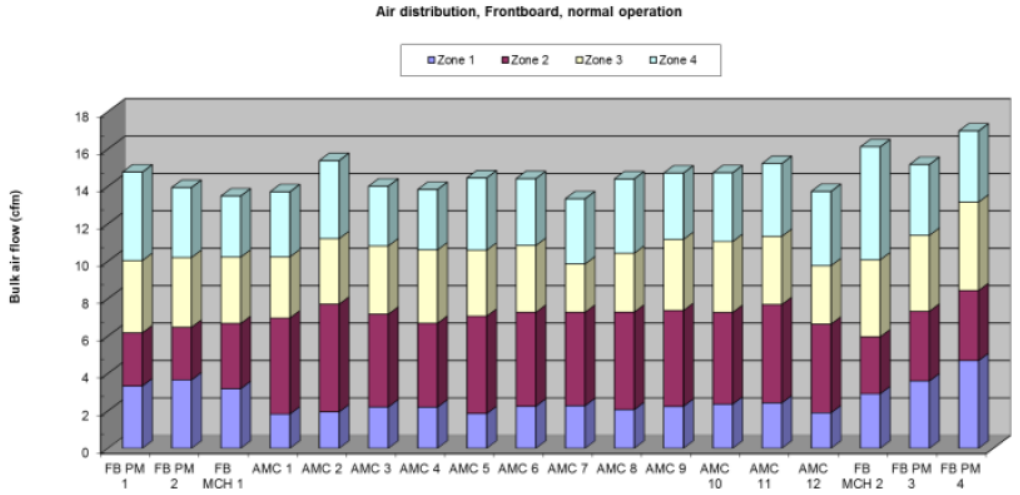
General calculation informations:

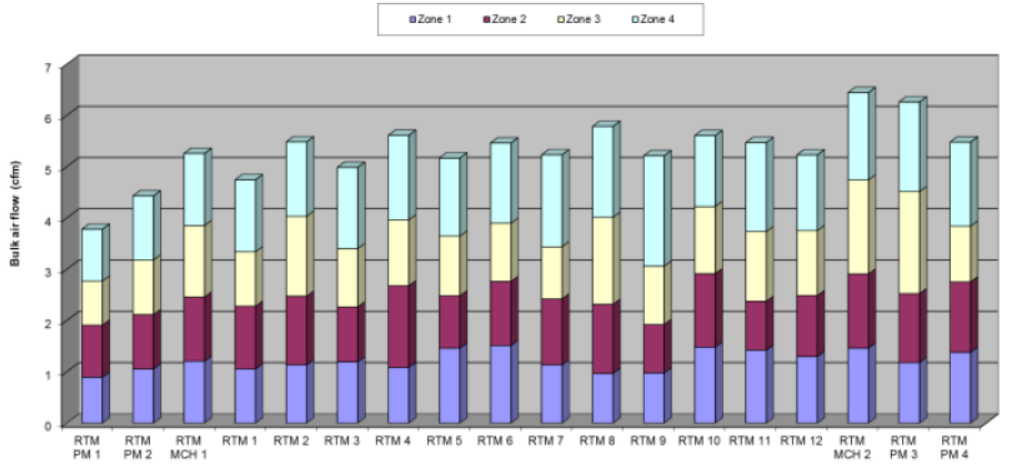
Telcordia SR-332 Issue 2, September 2006
Ground Benign
25°C mean component environment temperature
continous operation 8760 hours a year
Methode „parts count"
Quality Level = Level II
mean stress values
failure rate of mechanical components is negligible
Results at K:\PDSAS\R_and_D\1_Daten\MTBF

**Results:**

| | |
|---|---|
| **Failure rate** | |
| parts count | |
| Failure rate[FIT]: | 17569,7 |
| MTBF [hours]: | 56916,2 |
| MTBF [years]: | 6,5 |
| **Availability** | **MDT = 100h** |
| Failure rate[FIT]: | 1055,73 |
| MTBF [hours]: | 947 211 |
| MTBF [years]: | 108 |

MTCA.4 Crates MTBF

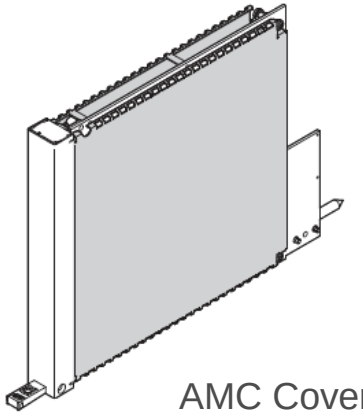


# MICROTCA.4 KEY FEATURES – EMC shielding

**System EMC shielding depends on product design from cards to cabinets,**

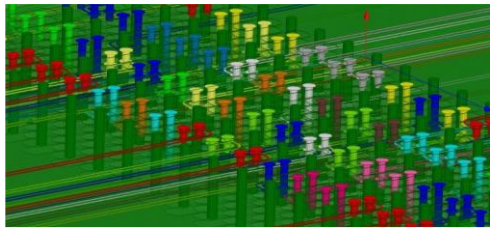
**It is three layers of protection**



AMC Cover

Air Perforation


Air-Water Cooling Platform with EMC shielding



BPL layout

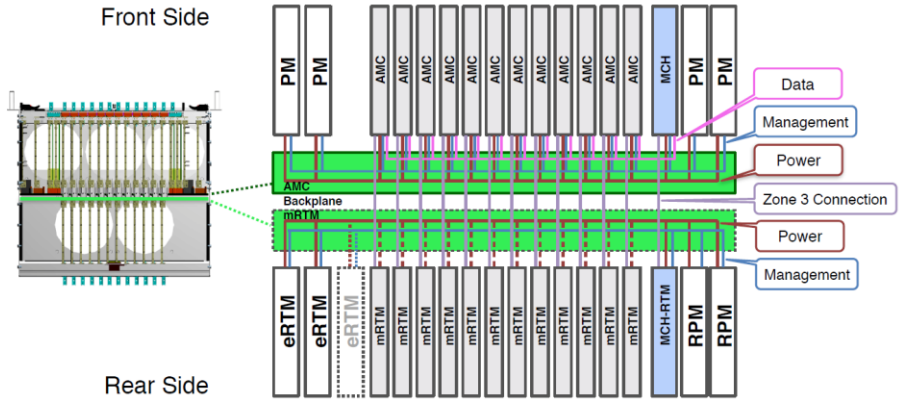
EMC Gasket

**Three layers of EMC protection**

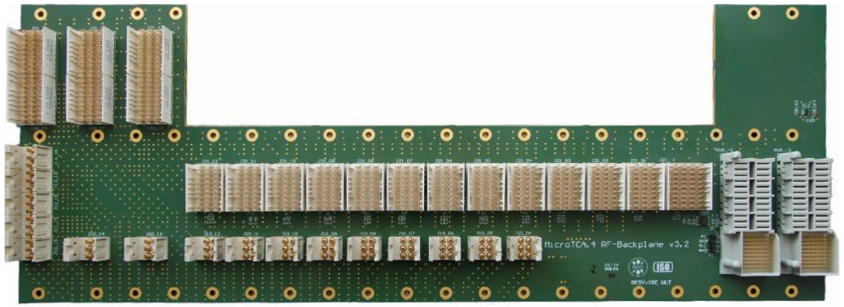
# MICROTCA.4 KEY FEATURES – RF-Backplane

## RF backplane realize RTM direct data communication regardless of MTCA BPL

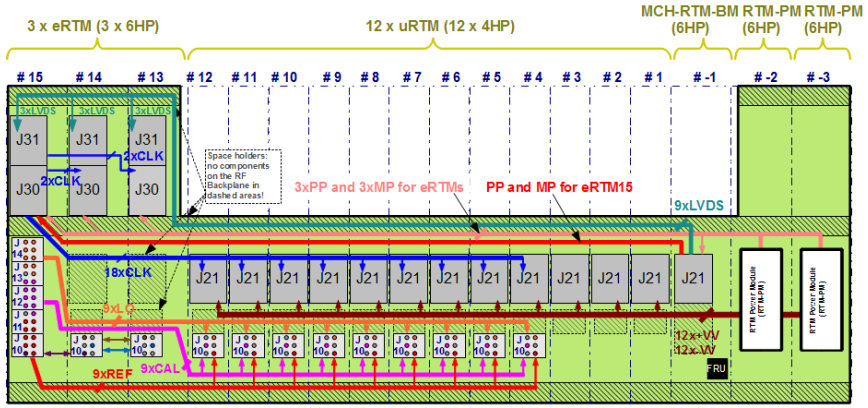
- Radio Frequency Backplane (RF-backplane) offer optional capability extension for MTCA.4 chassis
- Interconnection of high-precision RF and clock signals among RTMs and newly defined eRTMs
- Support up to 12 RTMs, 3 eRTMs, 1 MCH-RTMs and 2 RTM-PMs
- High-frequency signals distribution in range of DC to 6GHz (27 signal ended channels, star topology
- Can be mounted in selected commercially 9U 12 Slots chassis (e.g. Schroff.. )




RF-Backplane Physical Sample



RF-Backplane Physical Sample




RF-Backplane Topology

**Three layers of EMC protection**

# Thank You

nVent Schroff

YouTube.com/nVentSCHROFF

schroff.nvent.com