Introduction to MicroTCA.4

PIER Workshop 2023

Cagil Gumus
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PIER
Partnership of
Universität Hamburg and DESY

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

What is MicroTCA

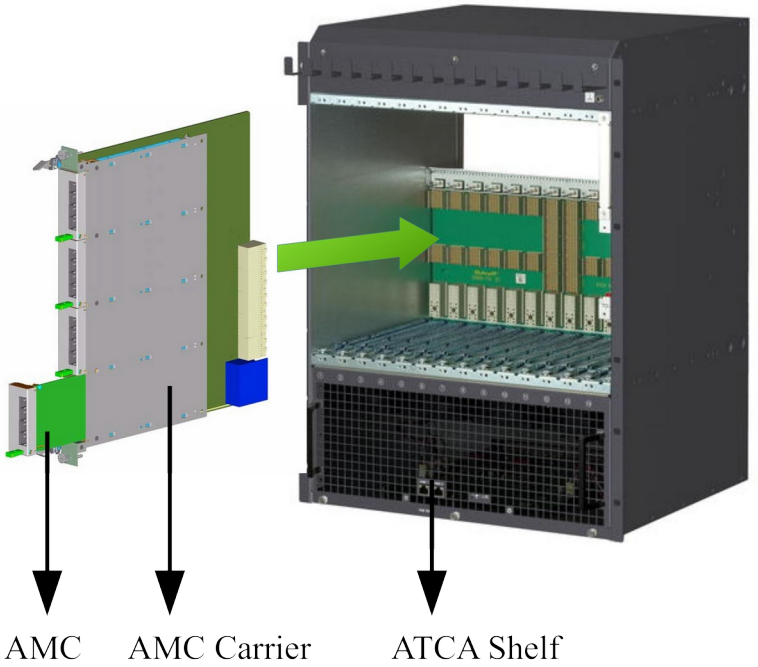
What is µTCA®

- It is an **open standard, embedded computing specification**.
- Specification is written by **PICMG** (PCI Industrial Computer Manufacturers) Group:
    - nonprofit consortium of companies and organizations
- Defines **fully** and **non-redudant** system configurations
    - Serviceability, Availability → up to 99.9999% uptime (six-nines) → 31.56 seconds downtime in a year
- **Power budgeting** and **Hot Swap** Capabilities
- Comes with complete **component and system management** that **allow failure detection** and **isolation**
    - **Reliability, availability and serviceability (RAS)** is the main focus for MicroTCA systems
- -TCA: **T**elecommunications **C**omputing **A**rchitecture

History of MicroTCA

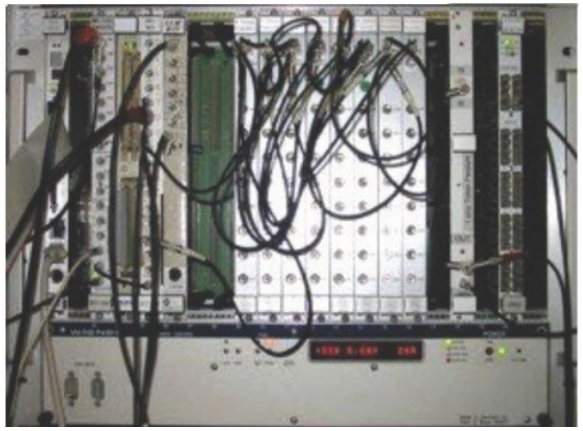
- MicroTCA has evolved from ATCA (AdvancedTCA)
- Main motivation of MicroTCA:
  - ‘Lightweight’ version of ATCA
  - Plug the AMC cards directly on a backplane
- AMC Cards can be used on both systems.
- ATCA is more power-hungry. Focuses more on telecommunication industry.
- MicroTCA can be in a smaller form factor.

ATCA Crate:

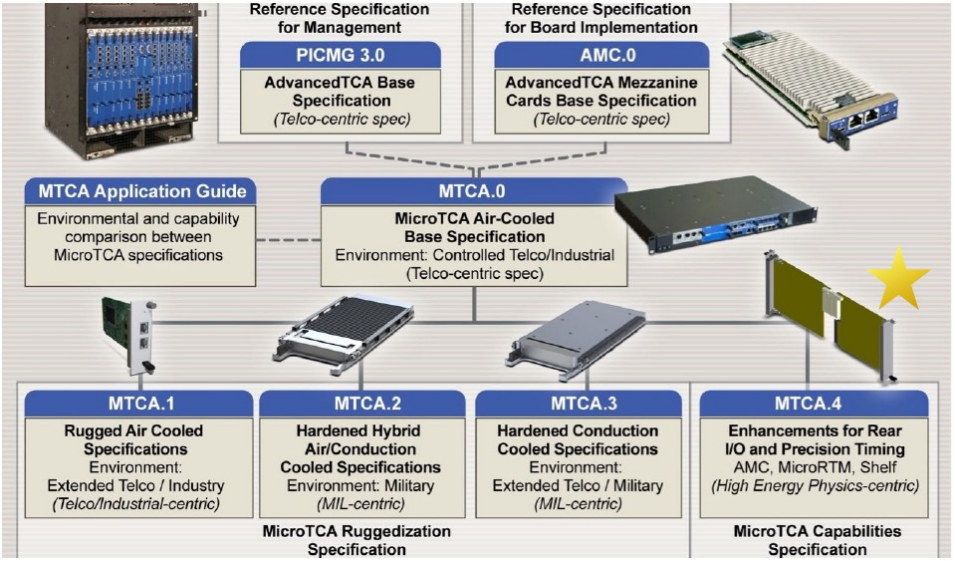


MicroTCA Crate:

Why DESY loves MicroTCA?



- DESY was designing the next gen. linear particle accelerators. (FLASH/E-XFEL)
  - Existing solution: Pizza-boxes, VME based crates..
  - Need for High Speed IO, RF signal processing, Redundancy
  - Remote maintenance capabilities needed
- Open Standard! No reliance on a particular company.
  - Make collaboration easier between different facilities
- Only missing part: Back connectivity for the MicroTCA crate → **MicroTCA.4** is born
  - Rear-Transition Module (RTM) gets introduced
  - Allocate dedicated ports for triggering/synchronization etc.
  - RF signal integrity was crucial



The building blocks of MicroTCA

MicroTCA Crates

The trade off between functionality – redundancy – reliability

1U MicroTCA.4

- Integrated eMCH
- 2x Double Mid-Size AMC slots w/ RTM
- 2x Single Mid-Size AMC slots
- Integrated 400W PSU
- No redudant part

3U MicroTCA.4

- 4x Double Mid-Size AMC slots w/ RTM
- 1x Double Mid-size AMC slot
- 1x Double Full-size AMC Slot
- Discreete PSU
- No redudant part

5U MicroTCA.4 (Cube)

- 6x Double Mid-Size AMC slots w/ RTM
- 1x Double Full-size MCH slot
- 1x Double Full-size AMC Slot
- Discreete PSU
- No redudant part

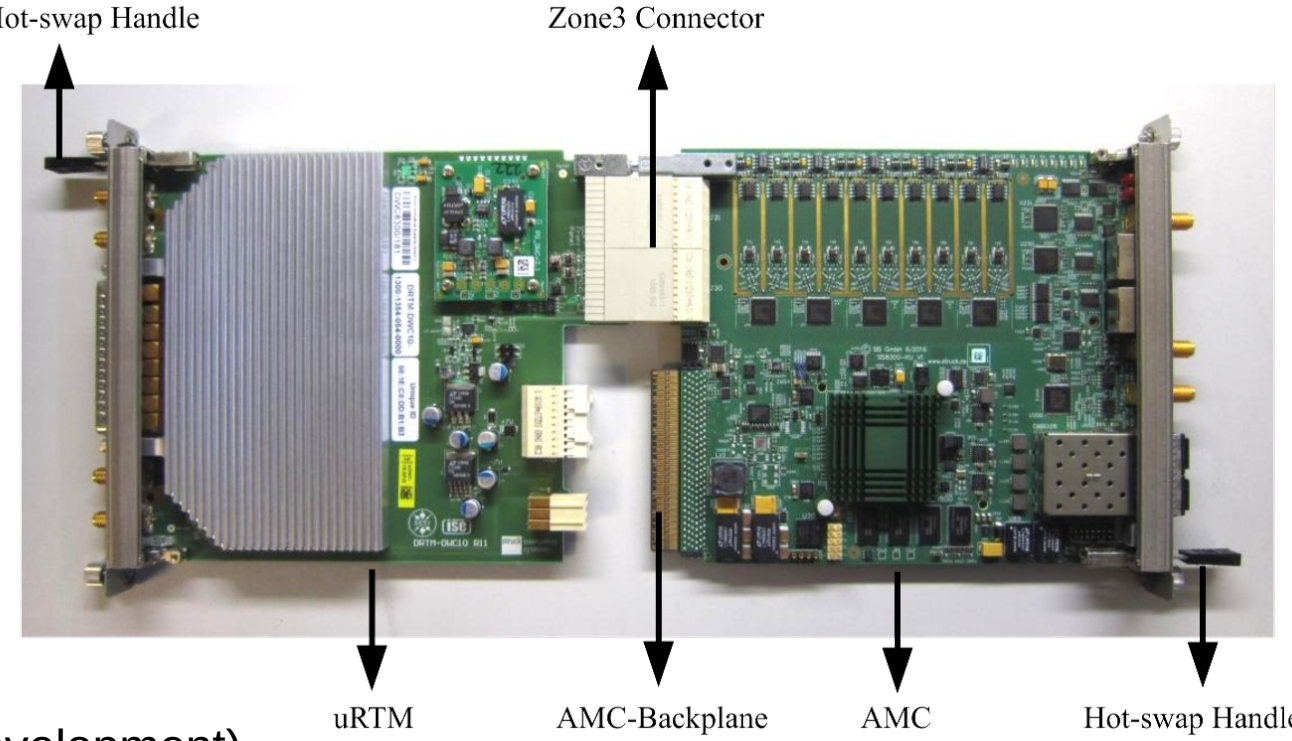
9U MicroTCA.4

- 6x Double Mid-Size AMC slots w/ RTM
- 1x Double Full-size MCH slot
- 1x Double Full-size AMC Slot
- Discreete PSU
- Redudant MCH + PM
- RF Backplane capable
- JTAG Switch Module available

AMC + RTM

AMC + RTM

- **AMC**:
  - Carries mostly the ‘digital logic’.
  - Many COTS components available
  - Can be single or double width
- **RTM**
  - Extension of the connected AMC
  - Big dependency on the application (in-house development)
  - RF Front ends, CPUs, GPIO …
- RTM is the subordinate of the AMC in terms of management
- AMC card gets connected to the crate via AMC-Backplane connector
- RTM and AMC connects through **Zone 3** connector

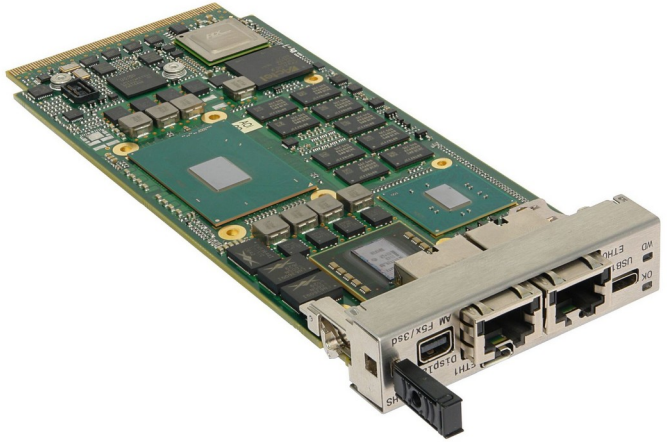


DWC8VM1 (RF Front End) + SIS8300L2 (ADC)

Power Limit: AMC + RTM < 80W

AMC Examples

- A/D & D/A Converters
- CPU
- FMC Carriers
- Timing Boards
- GPUs
- Storage (eg. SSD via SATA)
- Network Interface
- ...



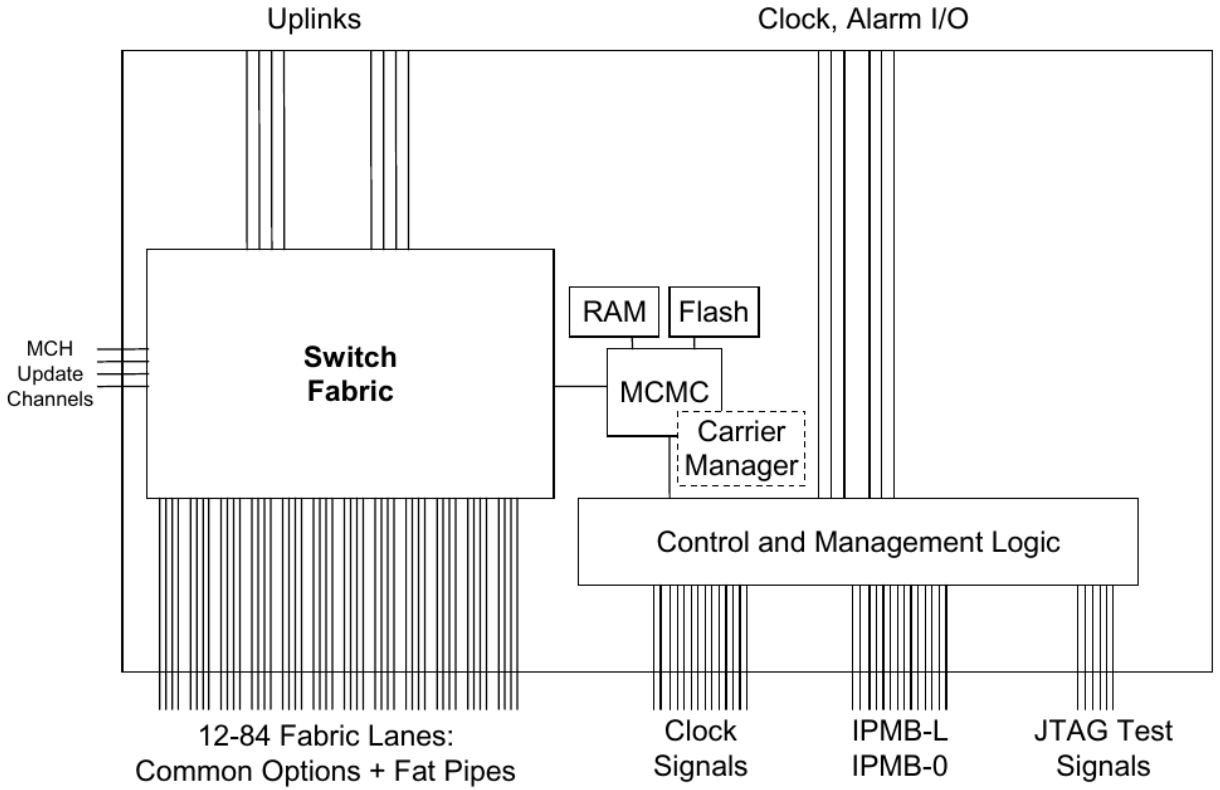
Concurrent AMC-CPU

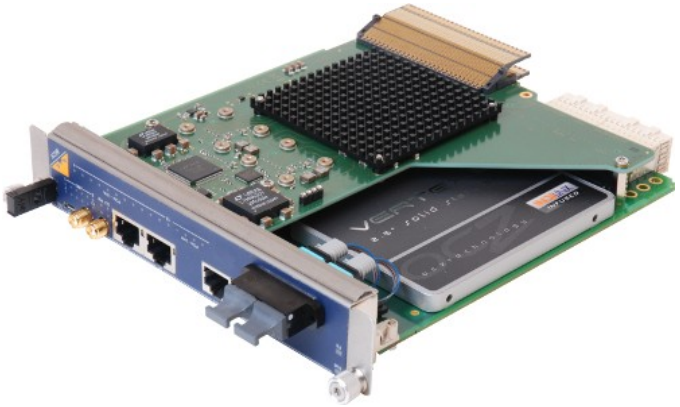
DAMC-FMC2ZUP from MicroTCA Technology Lab

MCH

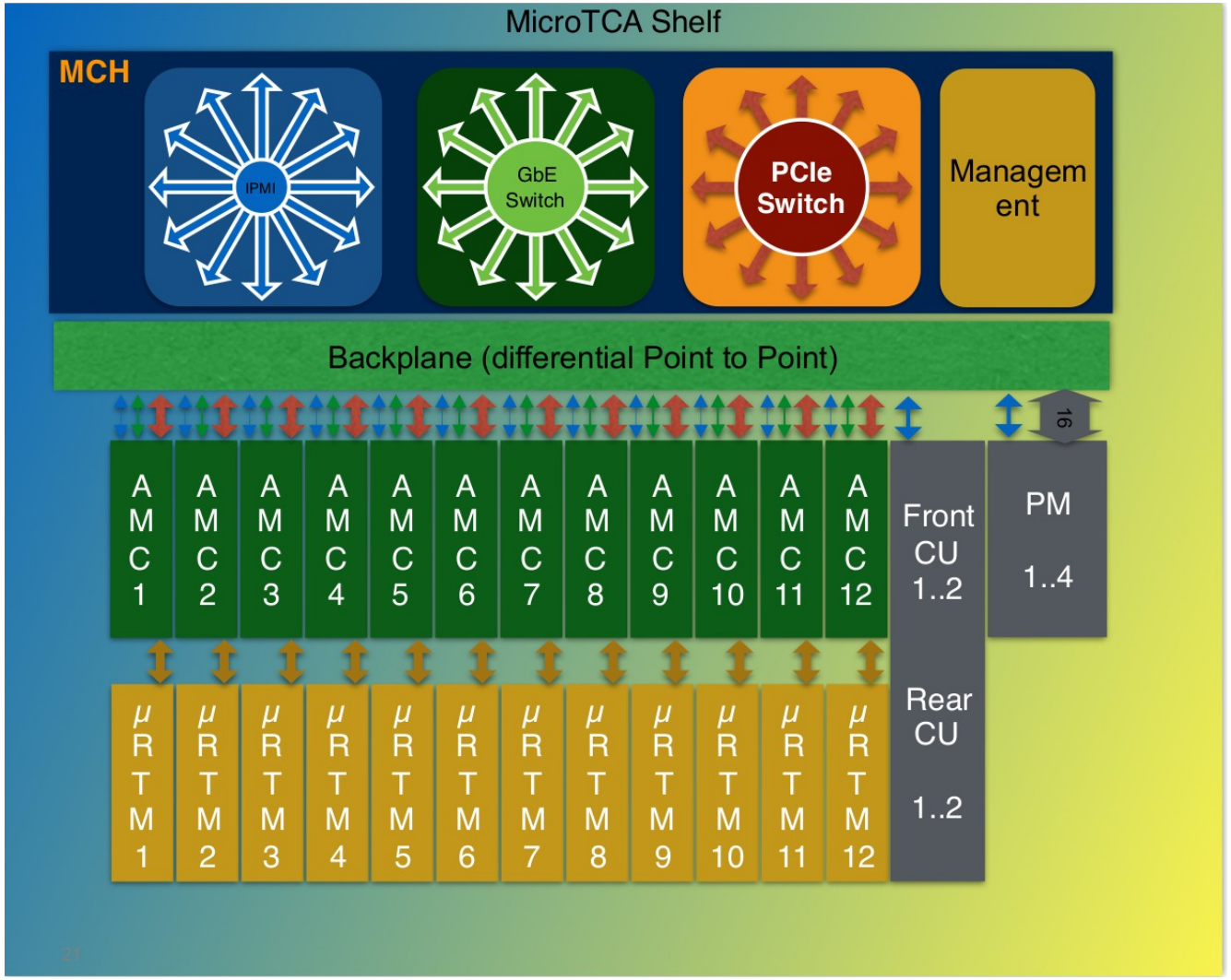
MicroTCA Carrier Hub (MCH)

- Main **authority** of the crate
- Bare minimum functionality;
  - **Switch Fabric**
  - **Remote Control and Management Logic**
- Additional functionalities;
  - Provide clocking functionality
  - Fat Pipe Switch (PCIe)
  - JTAG Connectivity to the backplane
- Can be ‘embedded’ inside the backplane. (Seen on smaller crates)
- Zone 3 Connectivity exists. (eg. MCH-RTM used as CPU)





Putting Everything Together

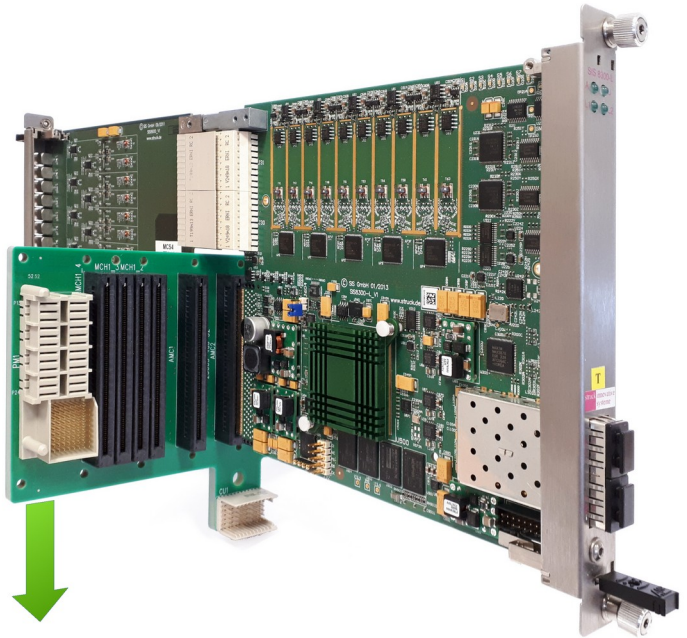


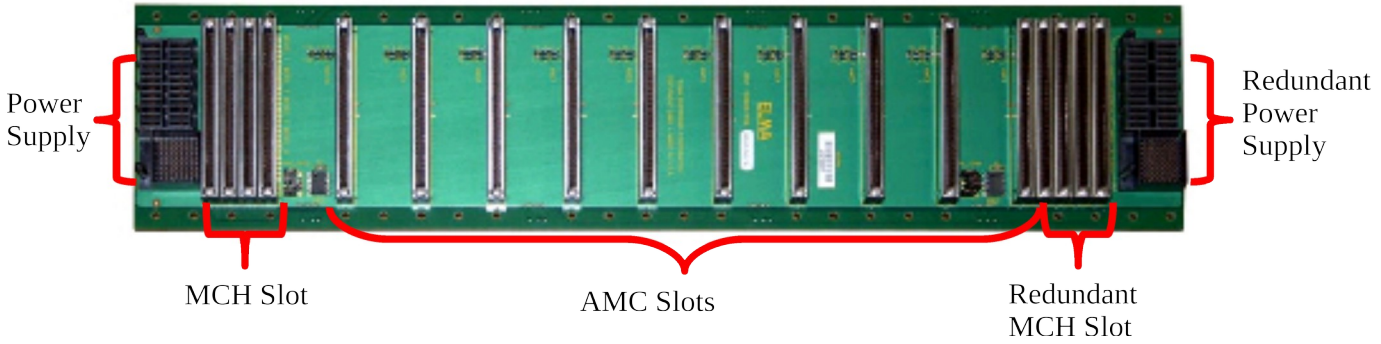
‘The Naked View’

AMC-Backplane

The AMC-Backplane

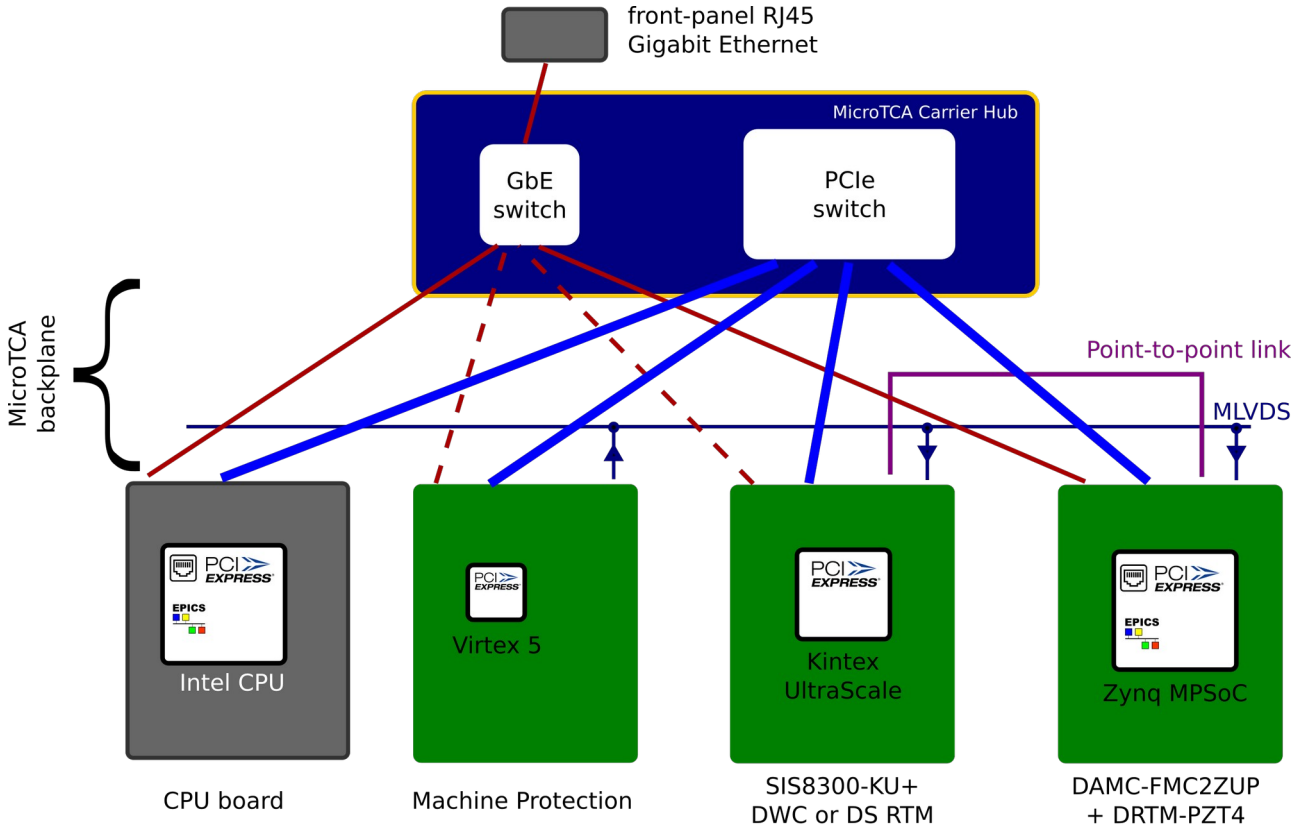
- Strict definition of how each port can be used.
  - It is important for interoperability!
- Protocols that can be seen on AMC-Backplane
  - Management (IPMI)
  - PCIe / SRIO / 10/40GbE
  - Point-to-Point Links (using FPGA Transceivers
  - Timing/Synchronization Mesh Topology (MLVDS)
  - JTAG / Clocks etc.





‘Typical’ Application using MicroTCA.4

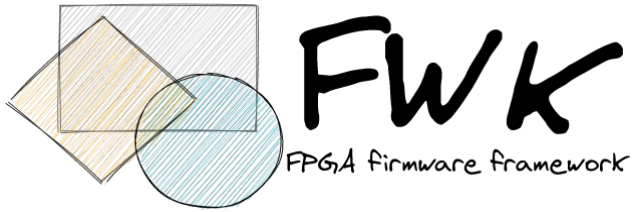
- Fast Feedback:
  - RF
  - Movement control (Motor / Piezo)
  - Laser Synchronization
- Data Acquisition
  - DAQ systems for RF, Camera,
  - Diagnostic systems
- Machine Protection systems
- Timing
- Data Aggregation
- ...



Usually FPGAs (inside the AMCs) are used for fast control, CPUs are used for slow monitoring/control

How DESY can help you with MicroTCA

- DESY has been supporting MicroTCA ecosystem:
  - MicroTCA Workshop
  - HW/FW/SW development
  - Training (Contact: Me!)
- We (MSK Group of DESY) are developing open-source tools that meant to be used with MicroTCA systems because we believe in Public Money, Public Code
- Open-source FPGA Framework and BSPs
  - https://gitlab.desy.de/fpgafw
- Open-source C++ Framework for software
  - https://github.com/ChimeraTK



Thank you

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