Development of the MicroTCA Standard

Preparing the Next Generation

Kay Rehlich, DESY

7. Dec. 2021

Unofficial … subject to change

HELMHOLTZ GEMEINSCHAFT

DESY

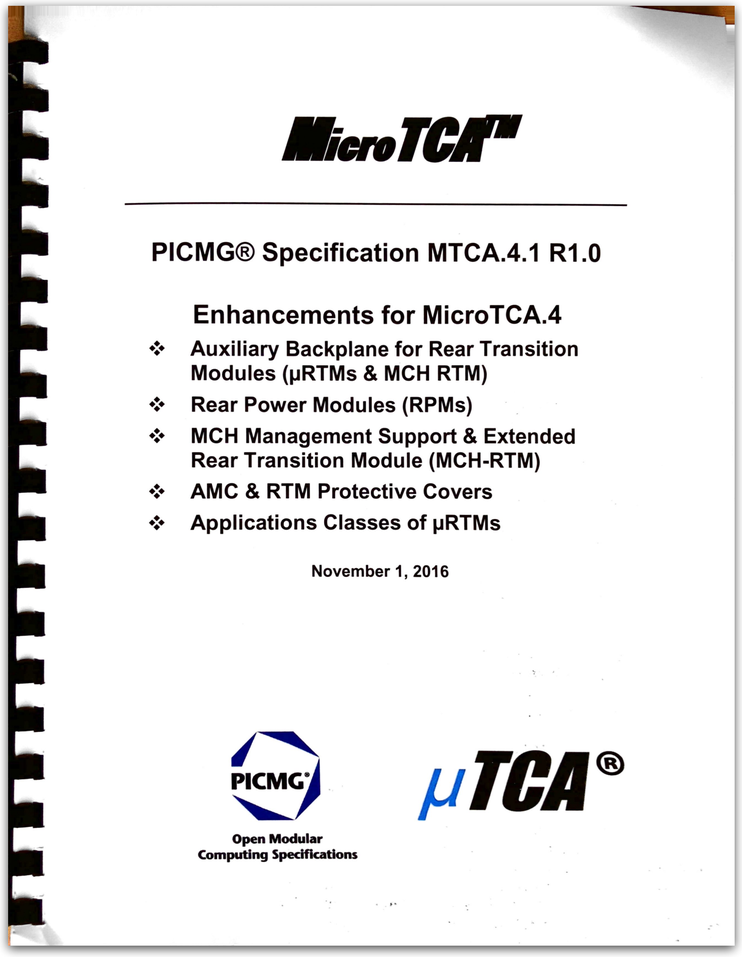
MTCA Specifications

MicroTCA.0

2006

MicroTCA.4

2011



MicroTCA.4.1

2016

… 2021 ?

Requirements for the Next Generation

- **Keep the standard alive for a long time**
  - Adapt state-of-the-art technology

- **Backward compatibility:**
  - All existing AMC modules MUST be usable
  - Must fit in with the existing eco system

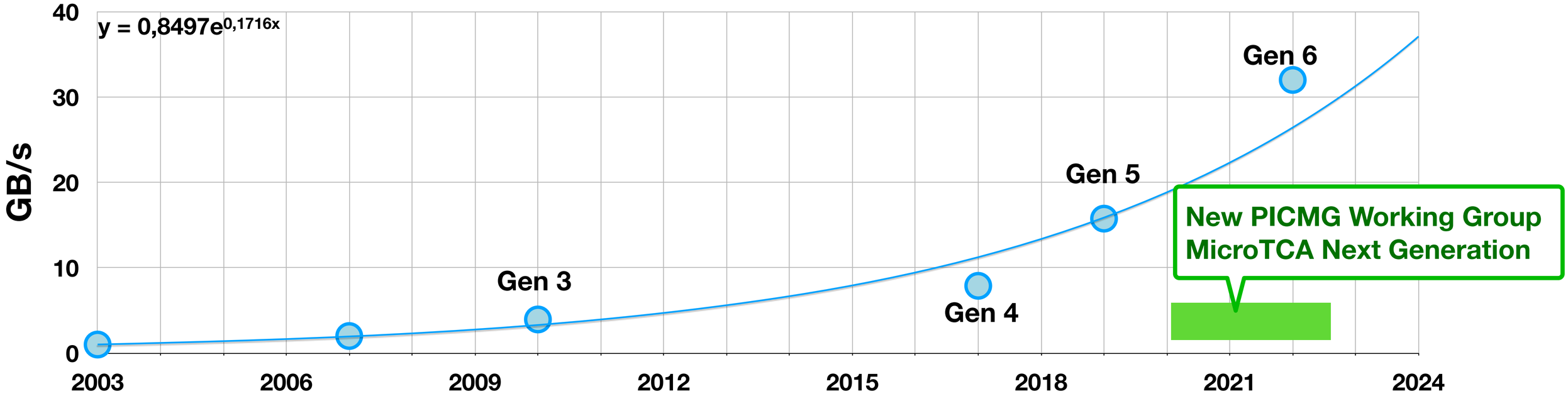
Motivation: Technology Trends

PCI Express version	Introduced	Line code	Transfer rate	Throughput (simplex)				
				×1	×2	×4	×8	×16
1.0	2003		2.5 GT/s	250 MB/s	0.50 GB/s	**1.0 GB/s**	2.0 GB/s	4.0 GB/s
2.0	2007	8b/10b	5.0 GT/s	500 MB/s	1.0 GB/s	**2.0 GB/s**	4.0 GB/s	8.0 GB/s
3.0	2010		**8.0 GT/s**	985 MB/s	1.97 GB/s	**3.9 GB/s**	7.88 GB/s	15.8 GB/s
4.0	2017	128b/130b	16.0 GT/s	1969 MB/s	3.94 GB/s	**7.9 GB/s**	15.75 GB/s	31.5 GB/s
5.0	*2019*	128b/130b	**32.0 GT/s**	3938 MB/s	7.88 GB/s	**15.8 GB/s**	31.51 GB/	63.0 GB/s

Now

Goal

Transfer Rate 4 with Lanes



Technology Trends: CPU & FPGA

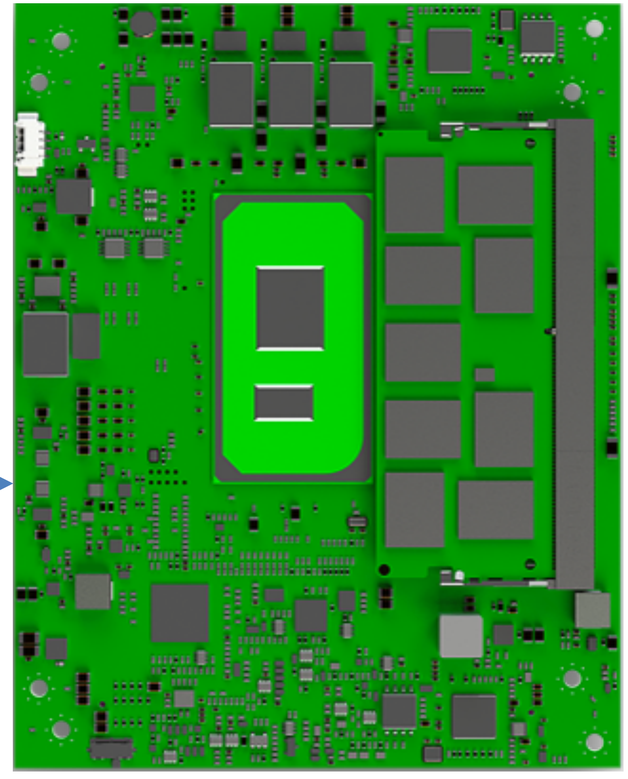
Defines the direction of technology

- Client type modules up to 200 Watt
- Up to 49 PCIe gen 5 lanes
- New PICMG standard (2021)

Today available processors:

- Intel 11th Gen: PCIe gen 4
- AMD Ryzen: PCIe Gen 4
- Apple M1: PCIe gen 4

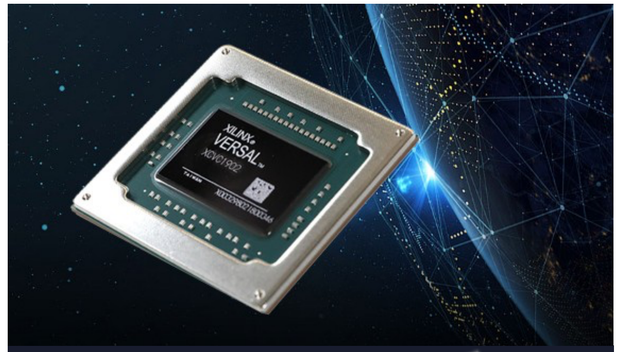
COM-HPC®



© SECO

FPGA & PCI board

- PCIe gen 4, 32 Gbps
- ≤ 225 W



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PICMG Working Group: MicroTCA Next Generation

Initial Executive Members … 14.11.2019	**ESS** **DESY** **Lodz University of Technology** **N.A.T.** **nVent**
+ Members of working group … Jan 2020	**Amphenol** **Atom Computing** **BAE Systems** **Comtel** **Concurrent Technologies** **Embeck** **IOxOS** **MicroLab** **ORNL** **Pixus Technologies** **Positronic** **powerBridge** **Samtec** **VadaTech** **Yamaichi**

Chair	**Kay Rehlich, DESY**
Editor	**Heiko Körte, N.A.T**
Secretary	**Thomas Holzapfel, powerBridge**
Hold meetings	**61**
Participants Ø	**18**

You are welcome to participate !

Challenges: Speed

- **PCIe gen 5**
  - Simulations showing promising results for 32 GT/s
  - Routing must follow rules, use high speed PCB material
- **100 G Ethernet (Fat Pipes)**
  - Simulation shows that 25 GT/s are possible
- **10 G Ethernet: Ports 0 and 1**

Sergej Dizel
nVent

- Provide PCIe x8 or x16 with **two AMC connectors**
  —> up to **factor 8 or 16 more throughput & lower latency** than today!

3.9 GB/s —> 63 GB/s

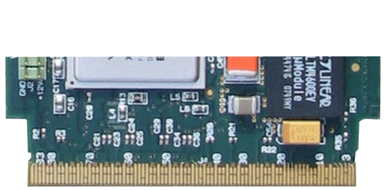
AMC Connector Options

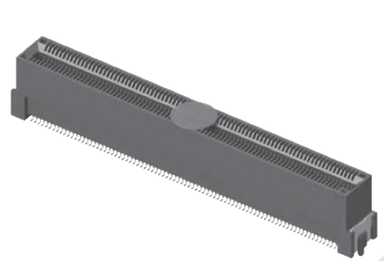
Often used Harting connector does not allow > PCIe gen 3

but remains backward compatible

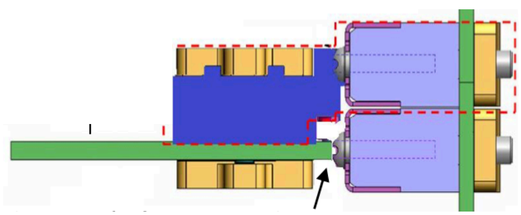
Backplane connector:
No change required

Good news: a plain AMC PCB connector is good for 32 GT/s:

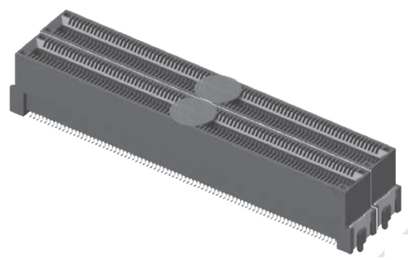




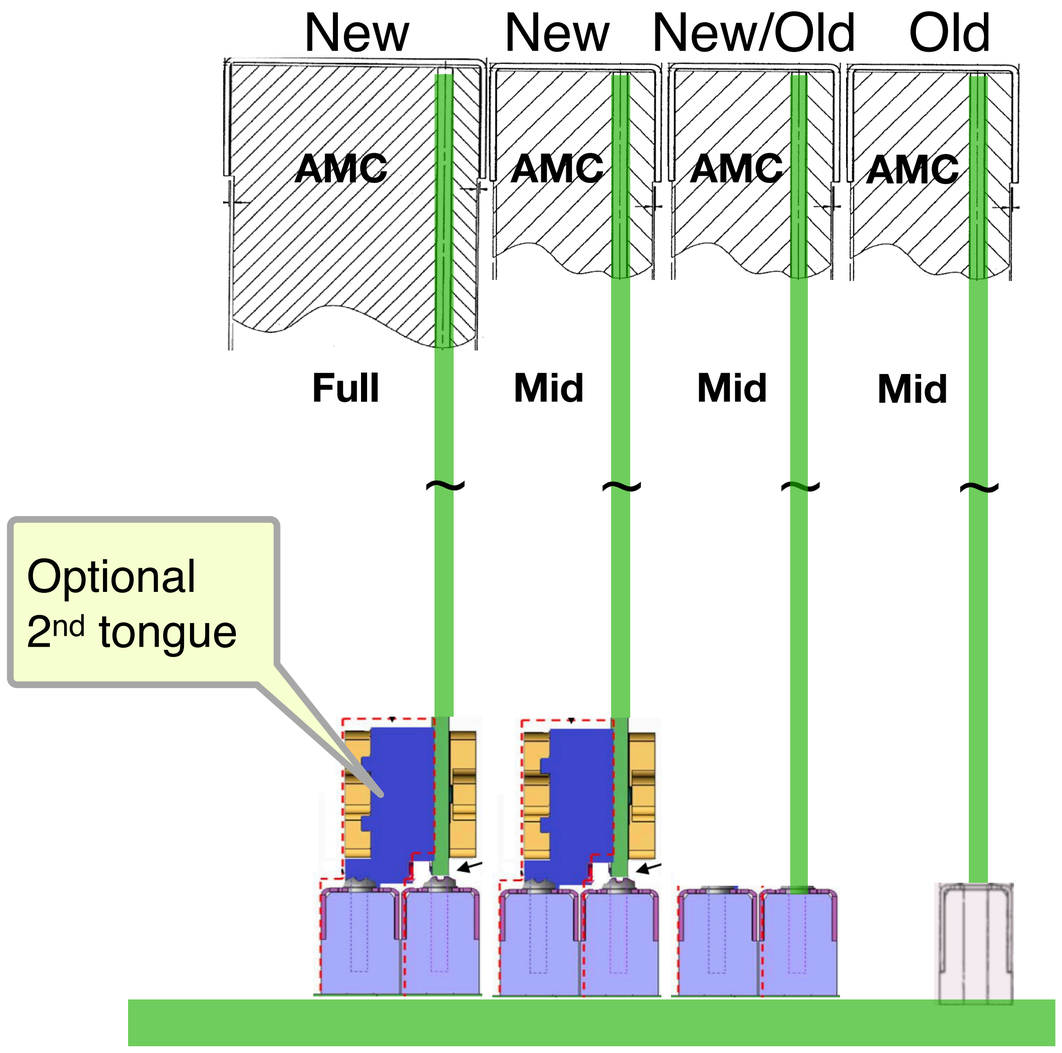
Optional second AMC connector could be used for PCIe x8 or x16 and more AMC - AMC connectivity



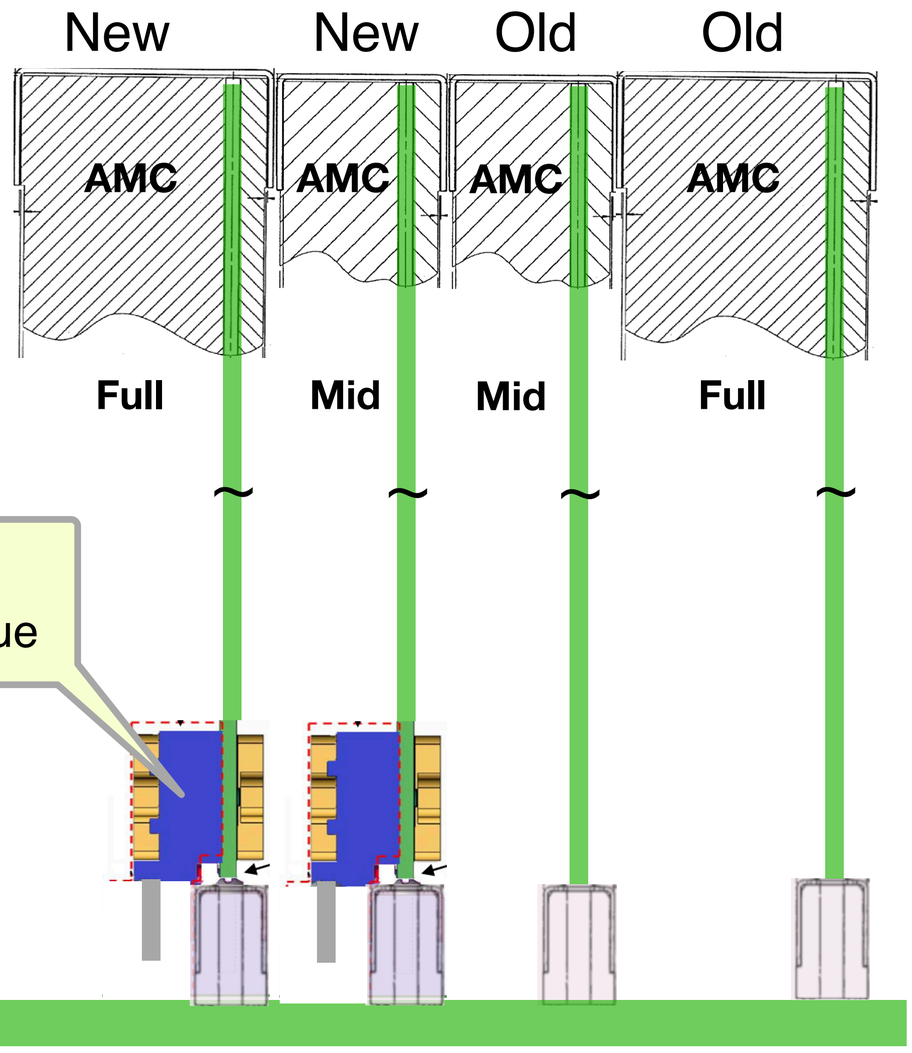
New optional 2nd connector



Full AMC Compatibility



AMC



Next Generation Backplane

‘Old’ Backplane

Old AMCs can be used in NG backplane

NG AMCs can be used in old backplane

Next Generation MCH

The existing 4 tongues **MCH limits**:

- Max 48 PCIe or Ethernet lanes

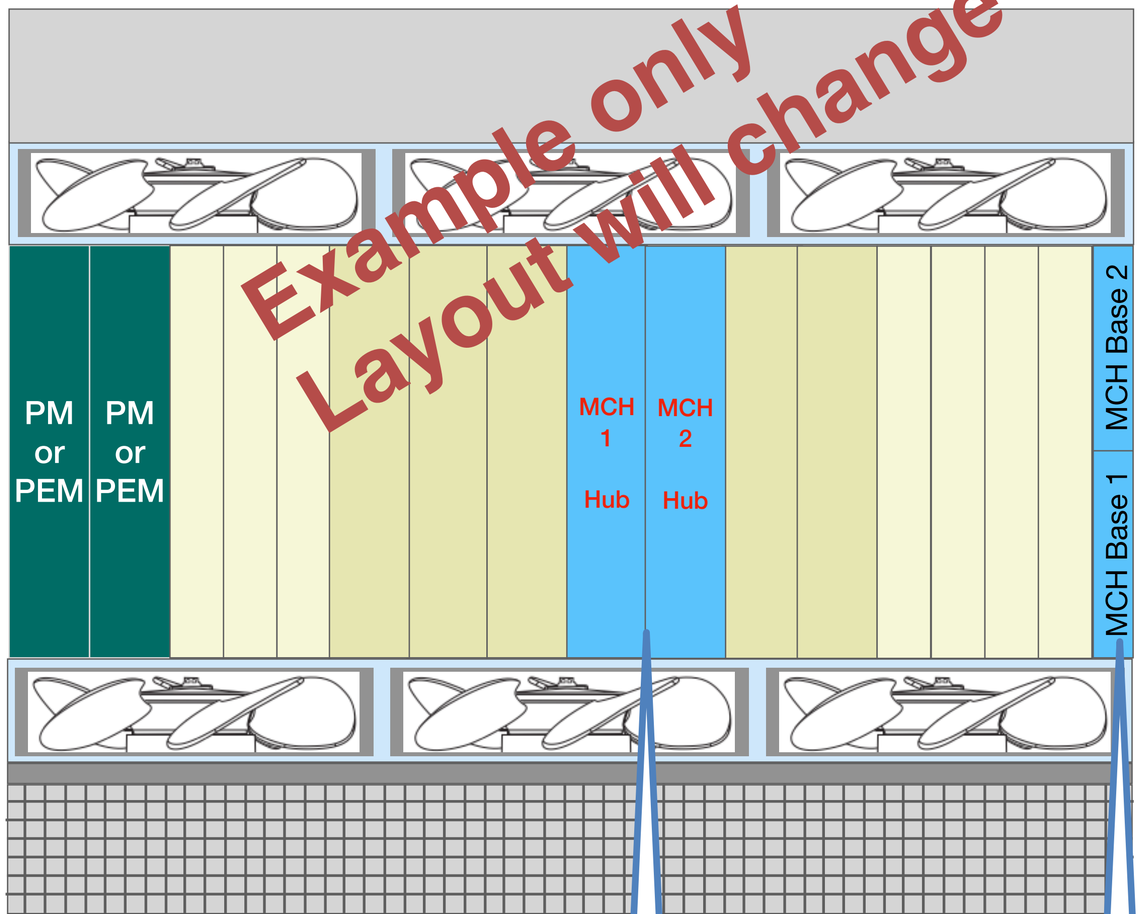
Possible solution:
“Split MCH”

- 25 Gb Ethernet and PCIe gen 5 are not supported by the connectors

Possible solution:
Improved connector

Heiko Körte
N.A.T

Split MCH Option: Base and Hub



A separate Hub has advantages:

- More fat pipes possible (e.g. PCIe x16)
- More AMC to AMC links
- Same power channel w/ Base
- Application specific designs possible
- Independent upgrade
- Better cooling for next gen switches
- **For high-end applications**

MCH Hub: in the middle of the crate to ease high speed links routing and damping

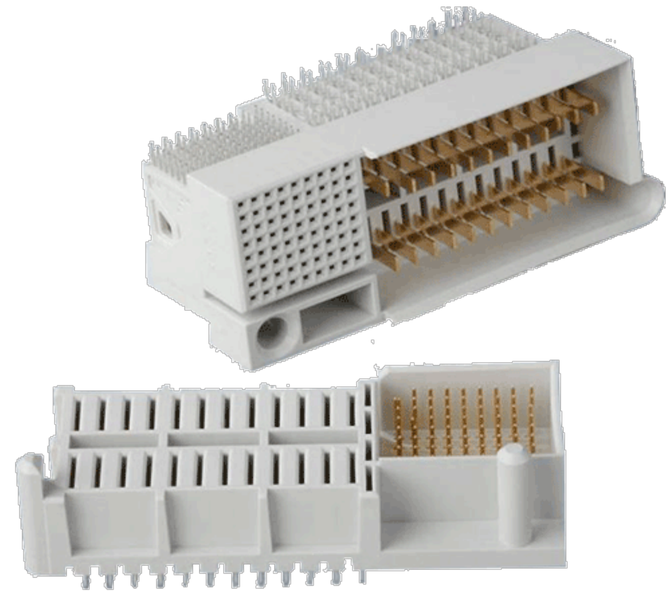
MCH Base: crate management
Ethernet hub (ports 0, 1)
Clock module

Challenges: Power

- **Challenge: 200 W per slot**
  - Limitation of AMC connector: 8 pins @ 10.8 V = 98 W
  - Limitation of Power Module connector
- **Solution:**
  - Use one more power pin on AMC
  - With optional 2nd AMC connector
  - Use 2 Power Module connectors

110 W

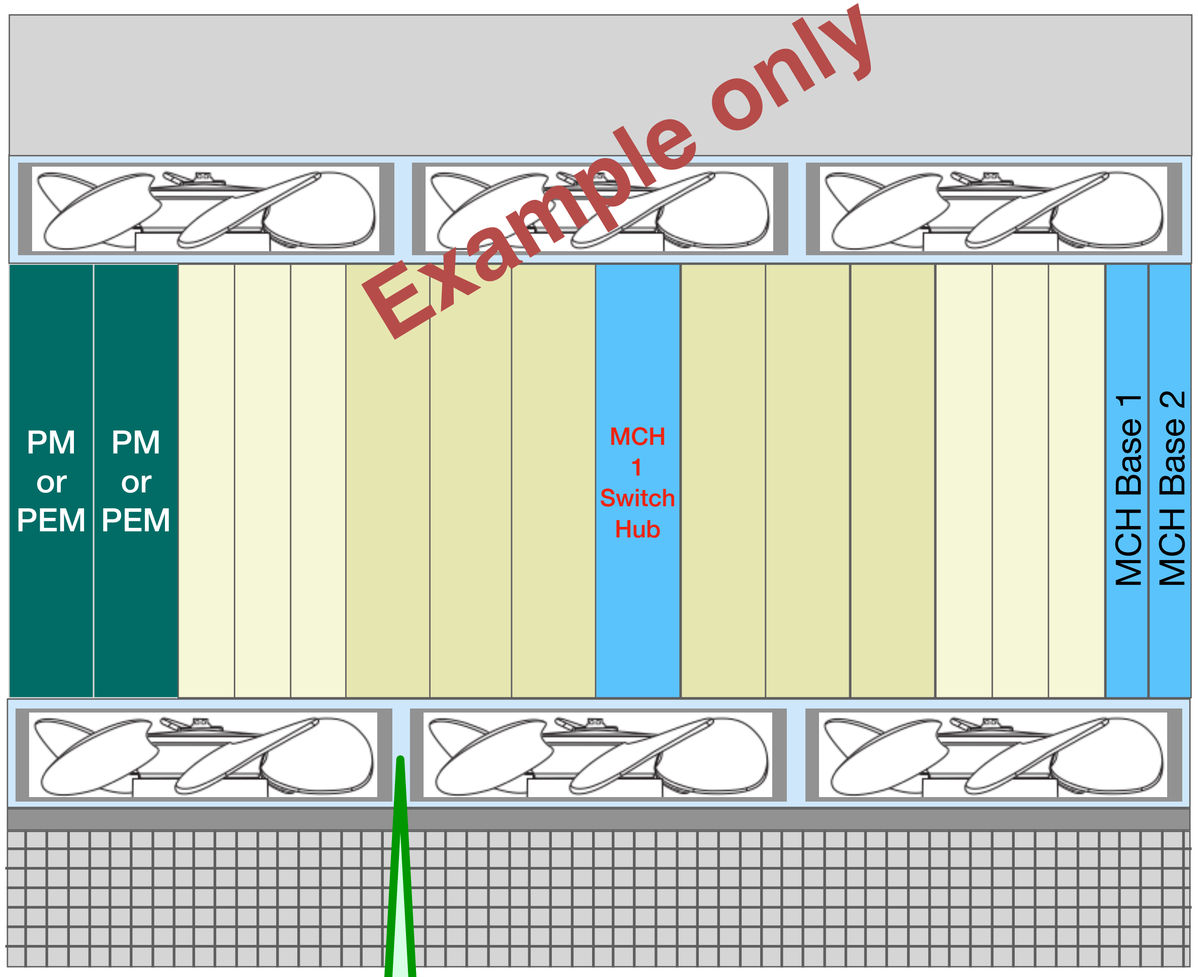
220 W



- **2 kW crate cooling**
  - Two times more airflow
  - Fans need more power
- **2 kW Power Module**
  - Might fit into the same space (GaN)

Existing Power Modules can still be used in NextGen crate to power 80 W AMCs!

Goal: max. 2000 Watt per Crate



2 kW cooling is possible:
nVent simulation result —> last workshop

	#		TE	∅ Power	Tot Power
PM	2	6	12		
AMC mid	6	4	24	70	420
AMC full	6	6	36	160	960
MCH hub	1	6	6	120	120
MCH base	2	3	6	50	100
Fan	2			200	400
Sum			**84**		**2000**

19”

“Hypothetical ” power of a full crate <= 2000 W

Conclusions

MicroTCA Next Generation

Extend MicroTCA for high-end applications

- ✦ **Allow new technologies to be used in the eco system:**
  - **10Gb Ethernet and Fat Pipes with 100Gb Ethernet and PCIe gen4 & 5**
  - **Provide more power for high speed**

Maintain the existing eco system

- ✦ **Longer lifetime of current designs by incorporating next technologies**
- ✦ **Backward compatibility with existing AMCs**
- ✦ **MicroTCA supports a wide(r) range of applications**

Thank you!

Following Talks:

- 4th Generation NAT-MCH — Heiko Körte, N.A.T
- PCIe Gen4/5 and 100G-Ethernet on mTCA platform — Sergej Dizel, nVent
- IPMI Support for FMC modules in MTCA.4 Systems — Patryk Nowak, Uni Lodz