Development of the MicroTCA Standard

Preparing the Next Generation

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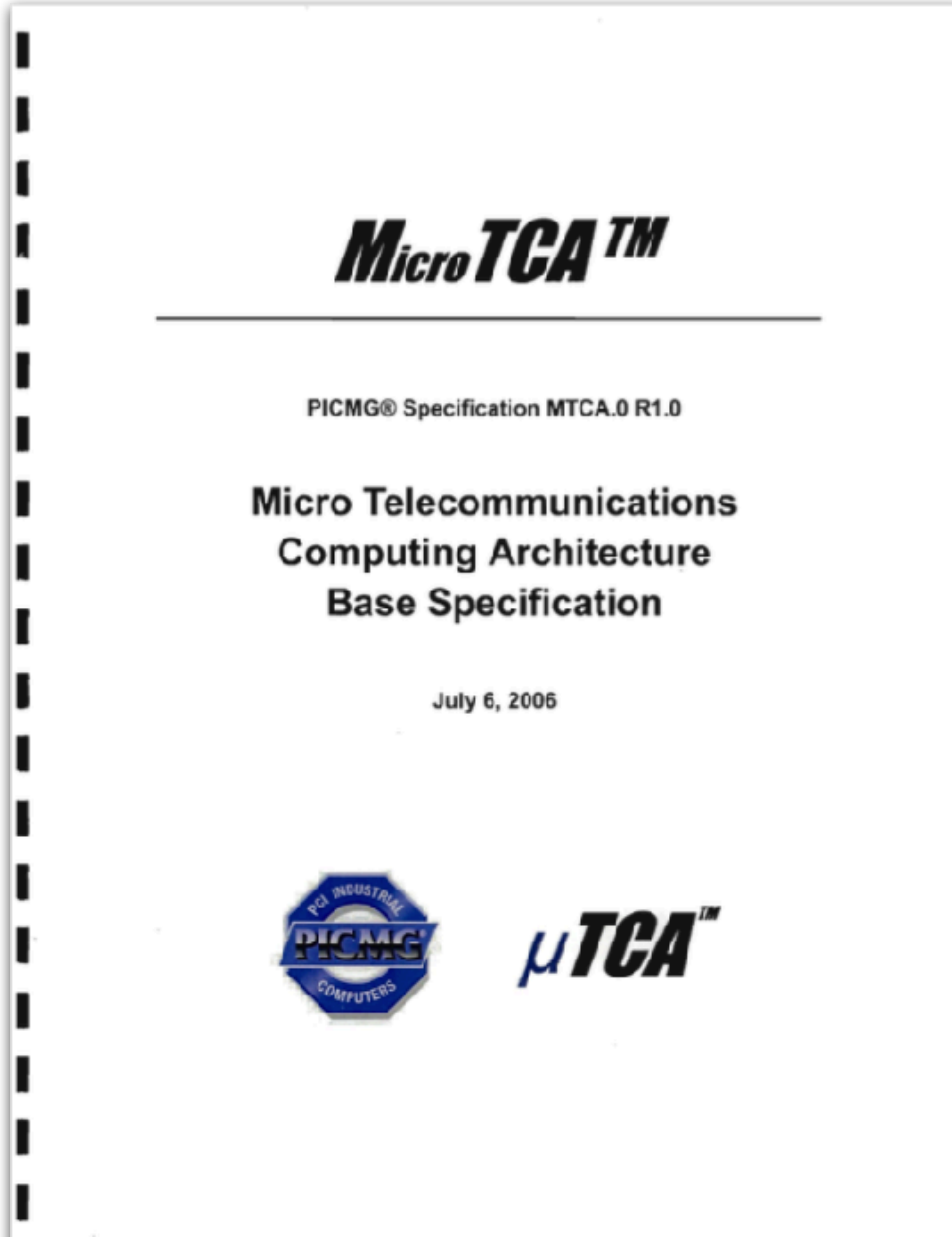
2. Dec. 2020

HELMHOLTZ GEMEINSCHAFT

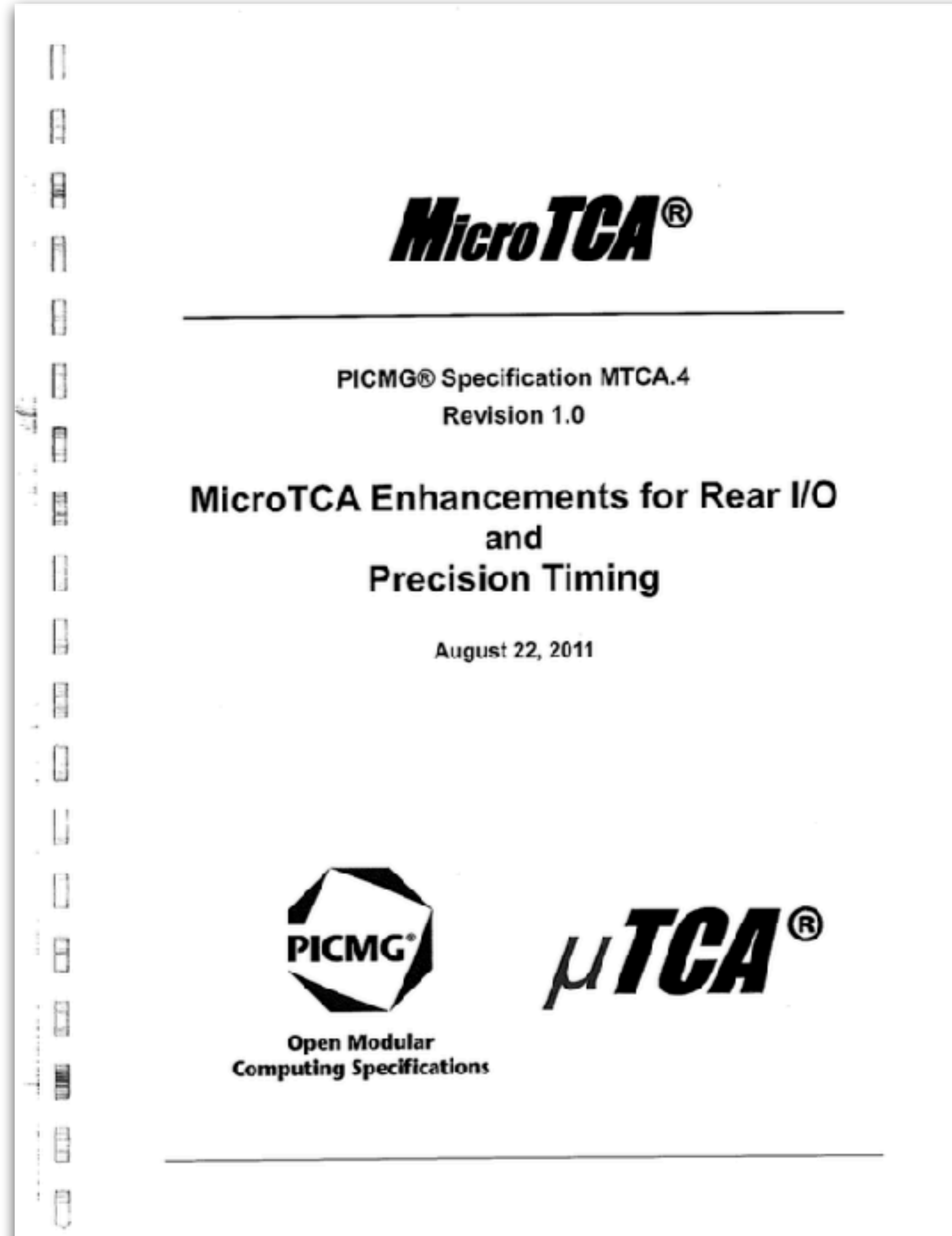
DESY

MTCA Specifications



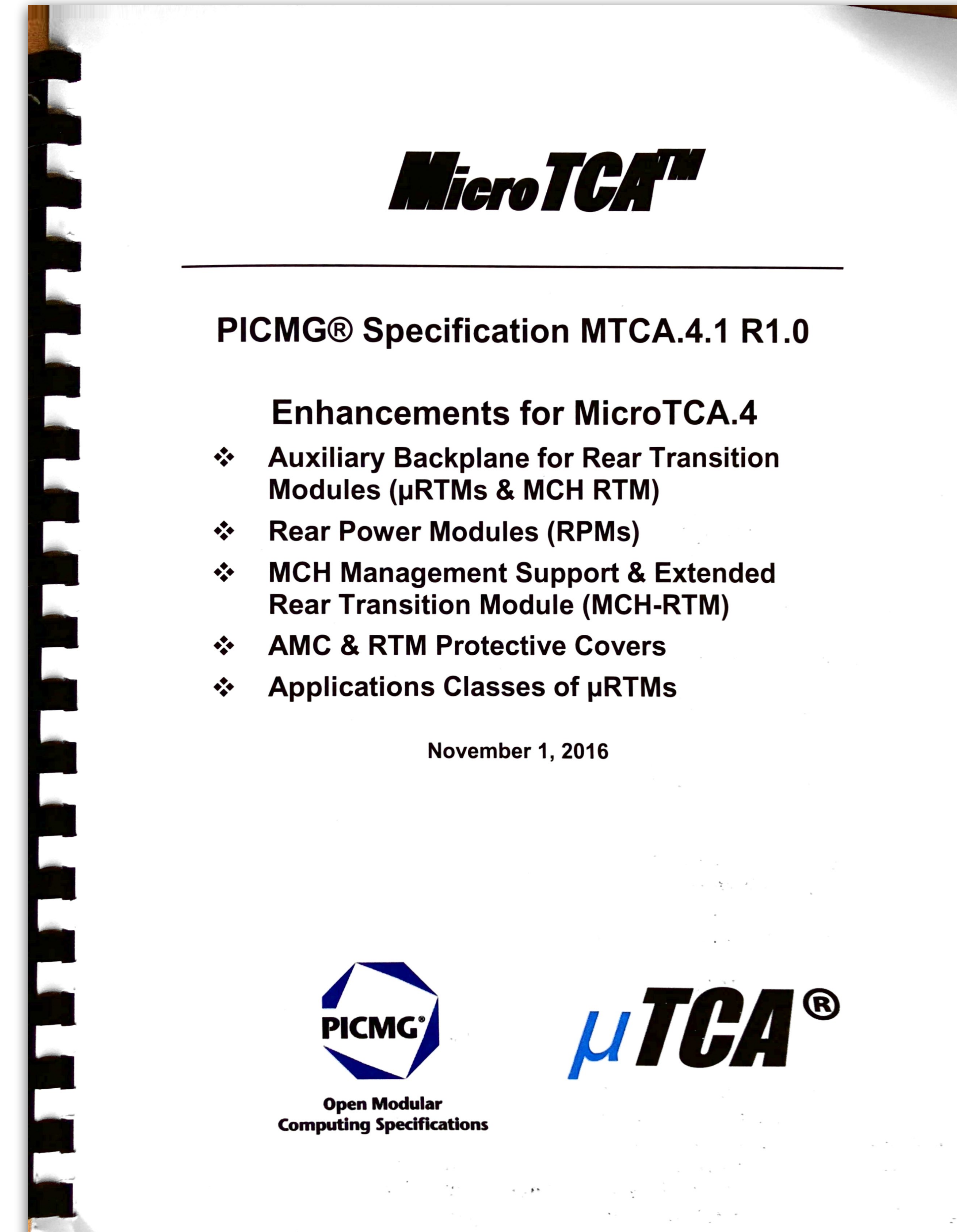
MicroTCA.0

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
  - Old power modules should be usable (with 1 kW limit)

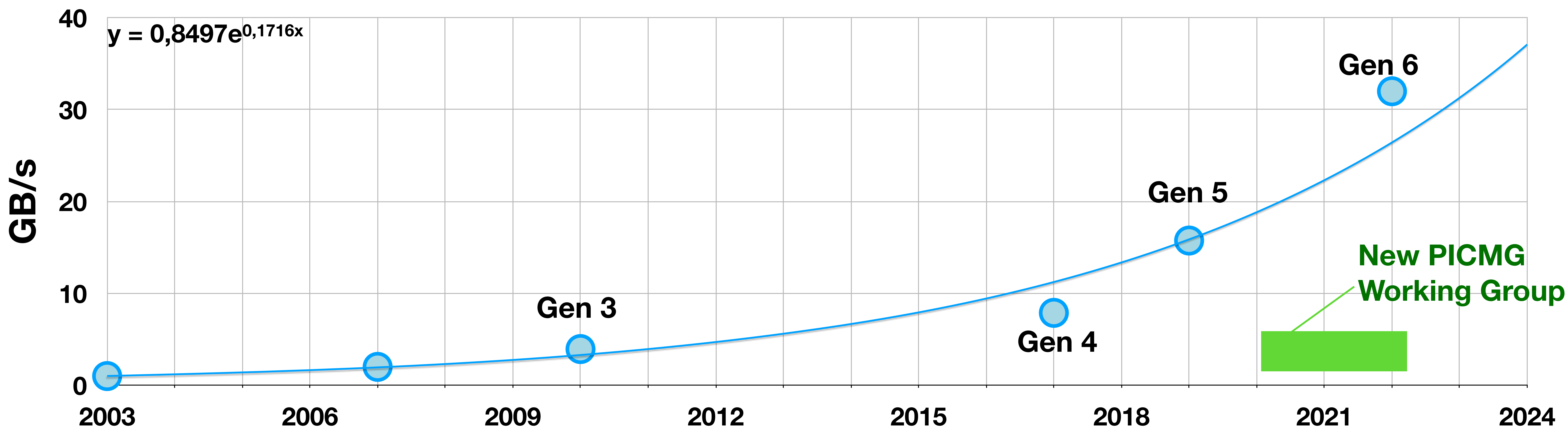
Motivation: Technology Trends

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 Lanes / Specs ready (Test specs + 1 year)



Technology Trends: CPU & FPGA

Defines the direction of technology

- Client type modules up to 200 Watt
- Up to 49 PCIe gen 5 lanes
- PICMG, to be published

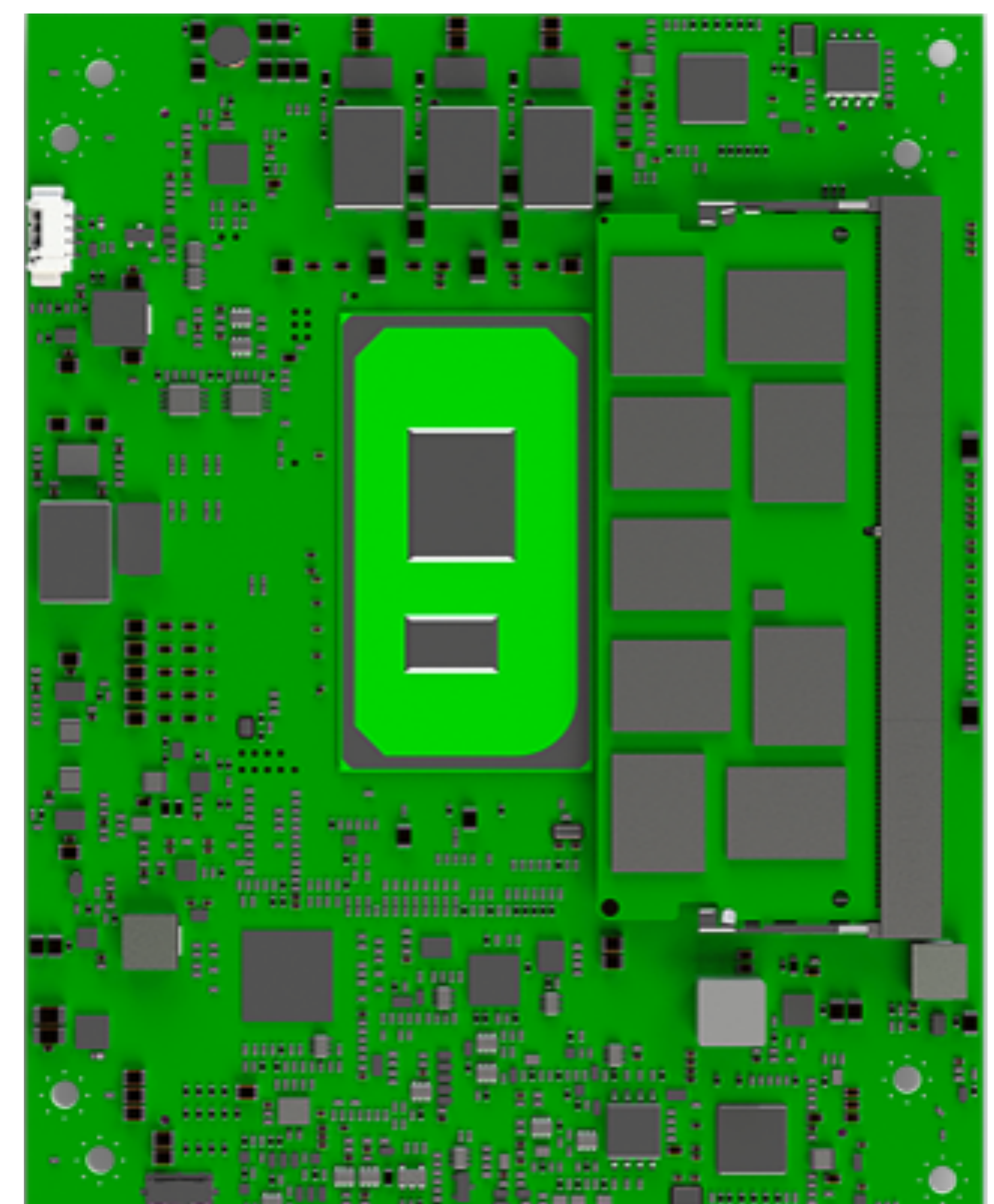
Actual design:

- Intel 11th Gen: PCIe gen 4 →

Other available processors:

- AMD Ryzen: PCIe Gen 4
- Apple M1: PCIe gen 4

COM HPC



@ SECO

FPGA & PCI board

- PCIe gen 4, 32 Gbps
- ≤ 225 W

@ Xilinx® Alveo™

PICMG Working Group

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**

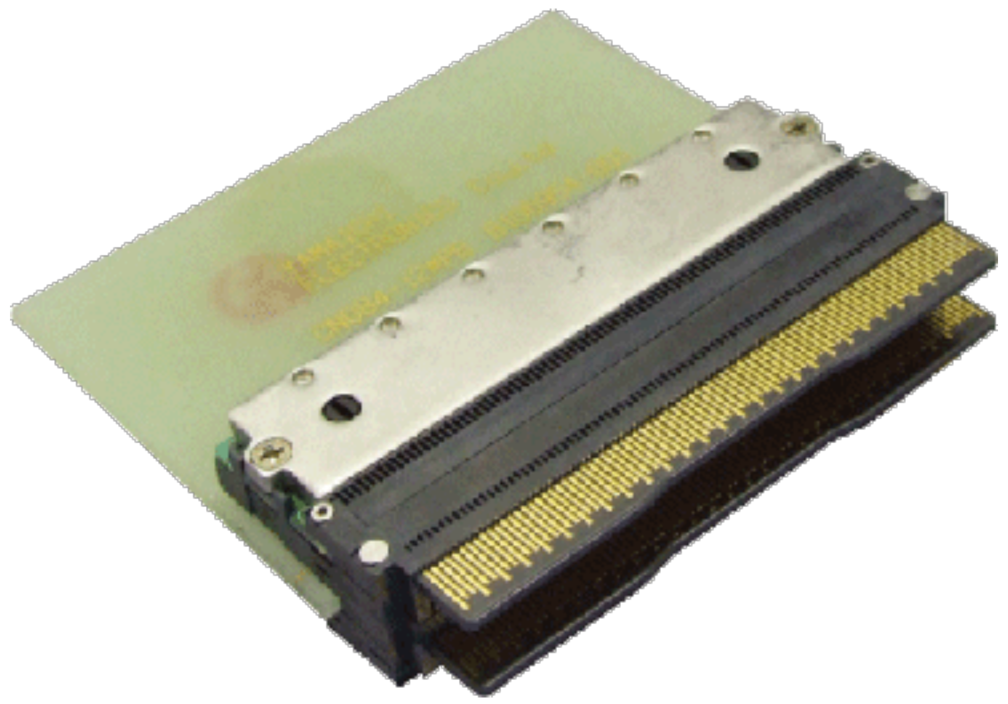
Hold meetings	**35**
Participants Ø	**18**

Challenges: Speed

- **PCIe gen 5**
  - AMC connector probably can do 32 GT/s
  - Simulation of a full channel still to be done w/ newest PCI-SIG test specs
  - Routing is not simple, high speed PCB material is required
- **100 G Ethernet**
  - Simulation shows that 25 GT/s are possible

- Main challenge is the crosstalk
- We think that PCIe gen 4 is possible
- Provide PCIe x8 or x16 with **two connectors**
  —> up to factor 8 or 16 more throughput & lower latency than today!

AMC Connector Options



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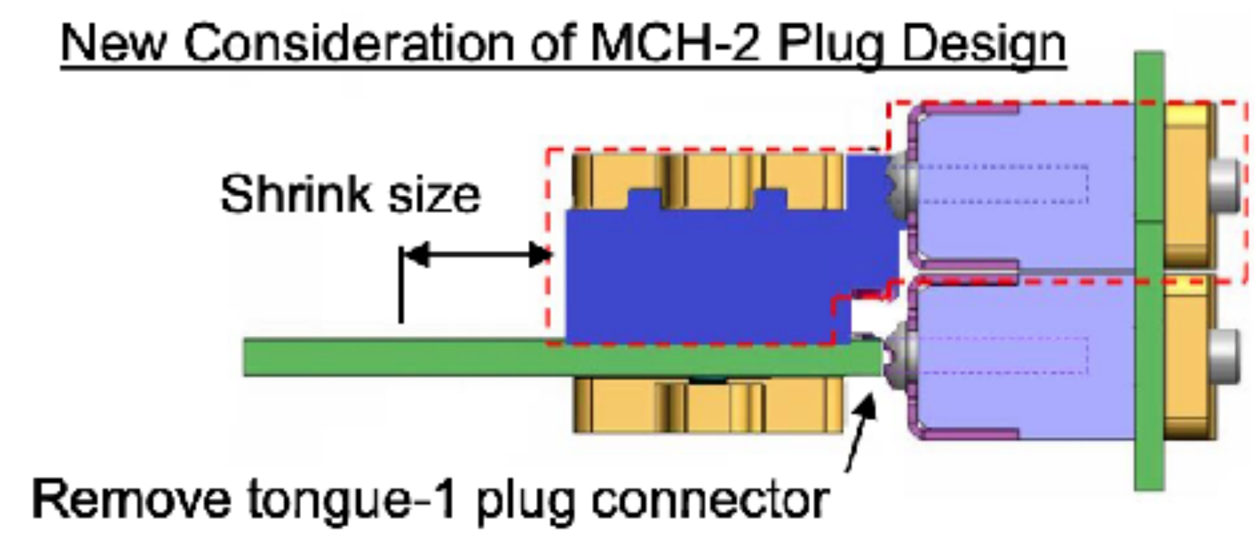

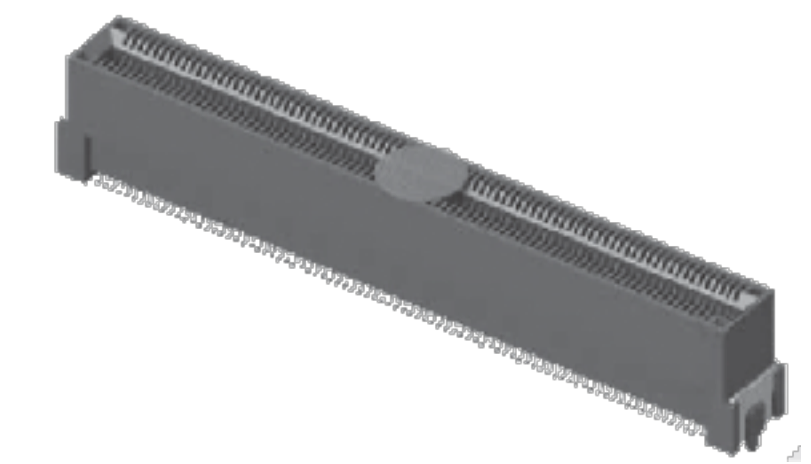

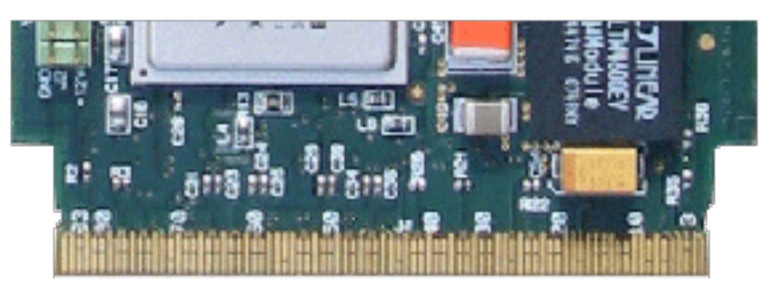

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Backplane connector:
No change required

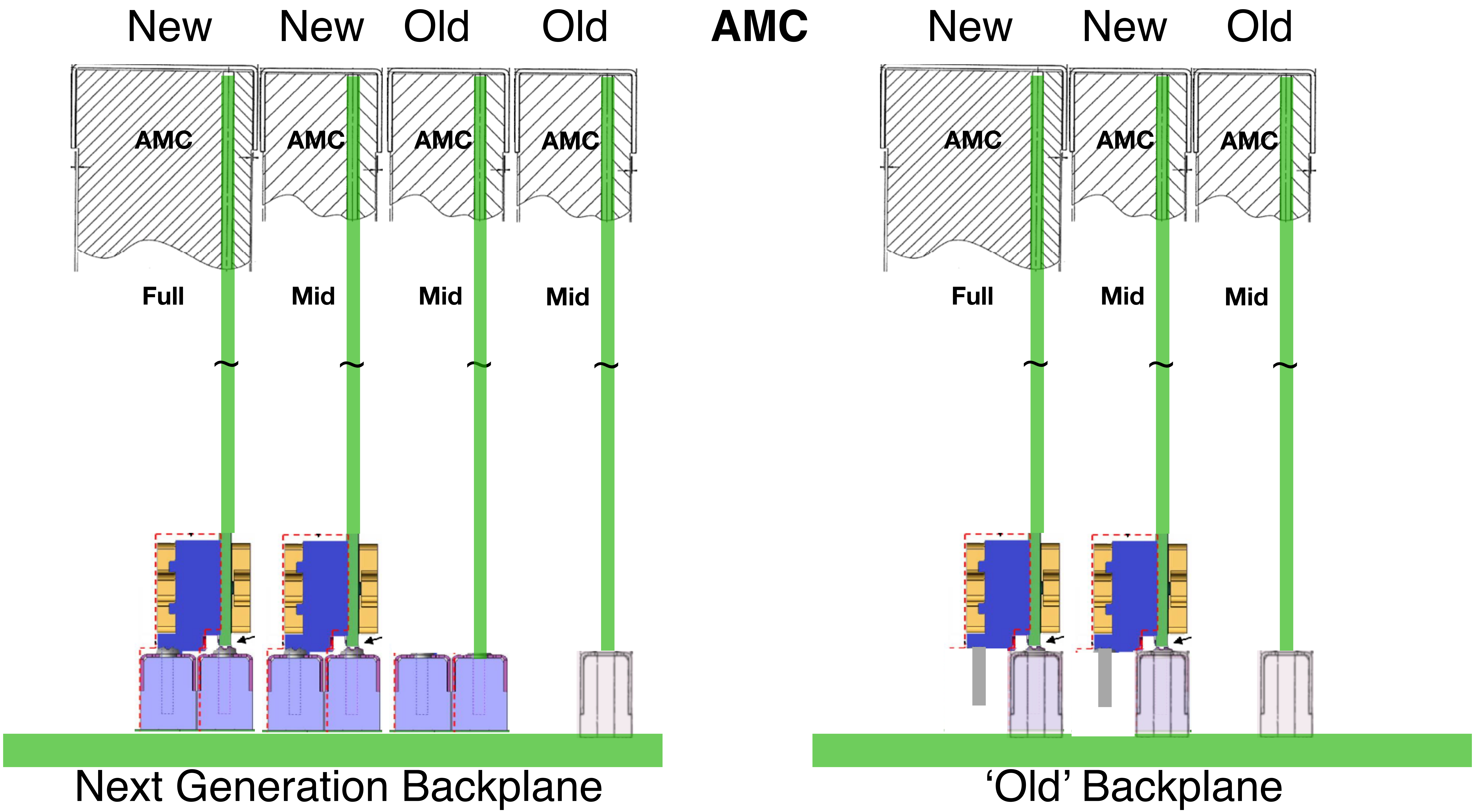
Harting connector does not allow > PCIe gen 3 (remains backward compatible)

Options for the AMC are:

- 1 PCB direct contacts
- 2 Yamaichi connector

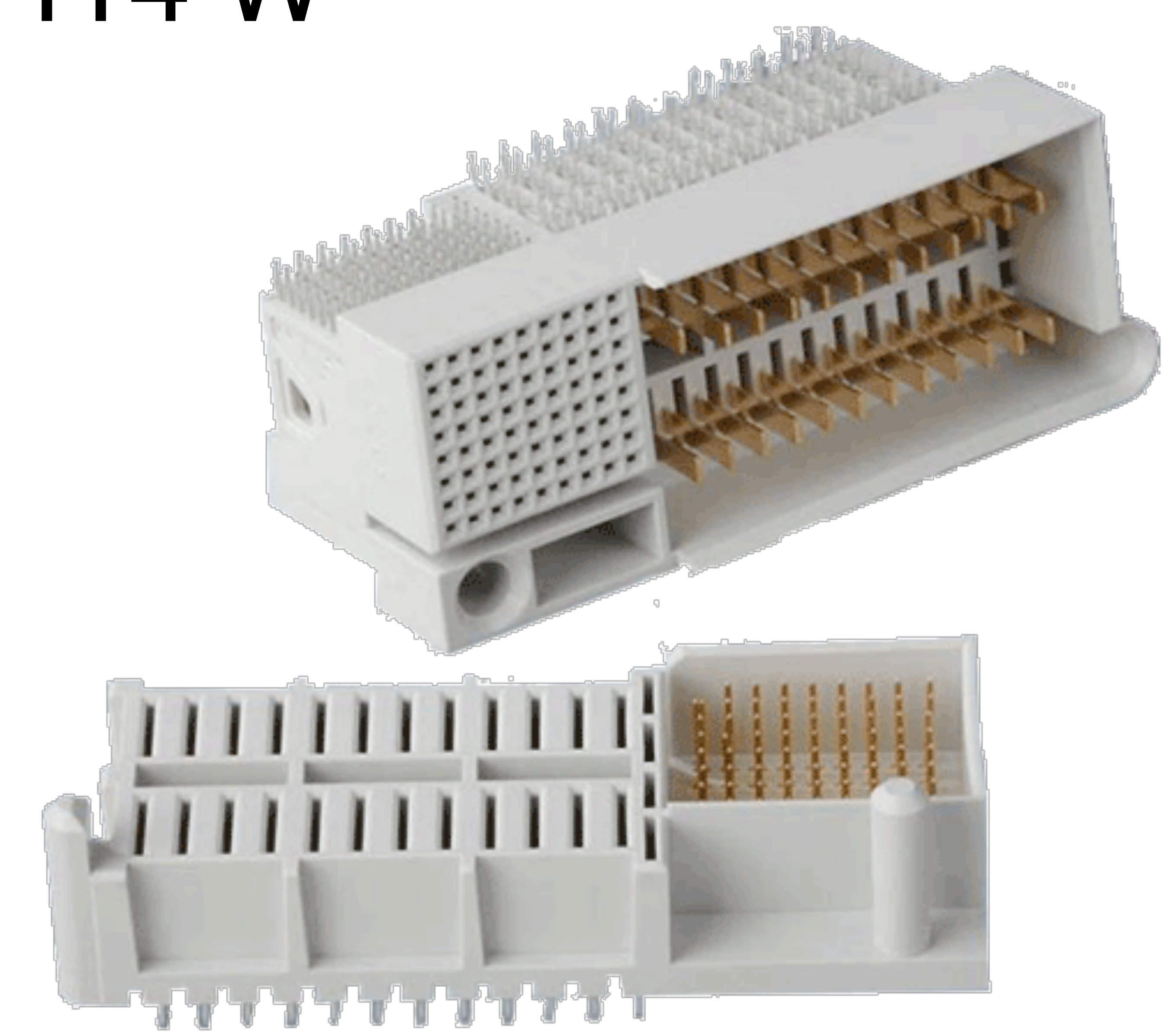
Second connector could be used for PCIe x8 or x16 and more AMC - AMC connectivity

Full AMC Compatibility



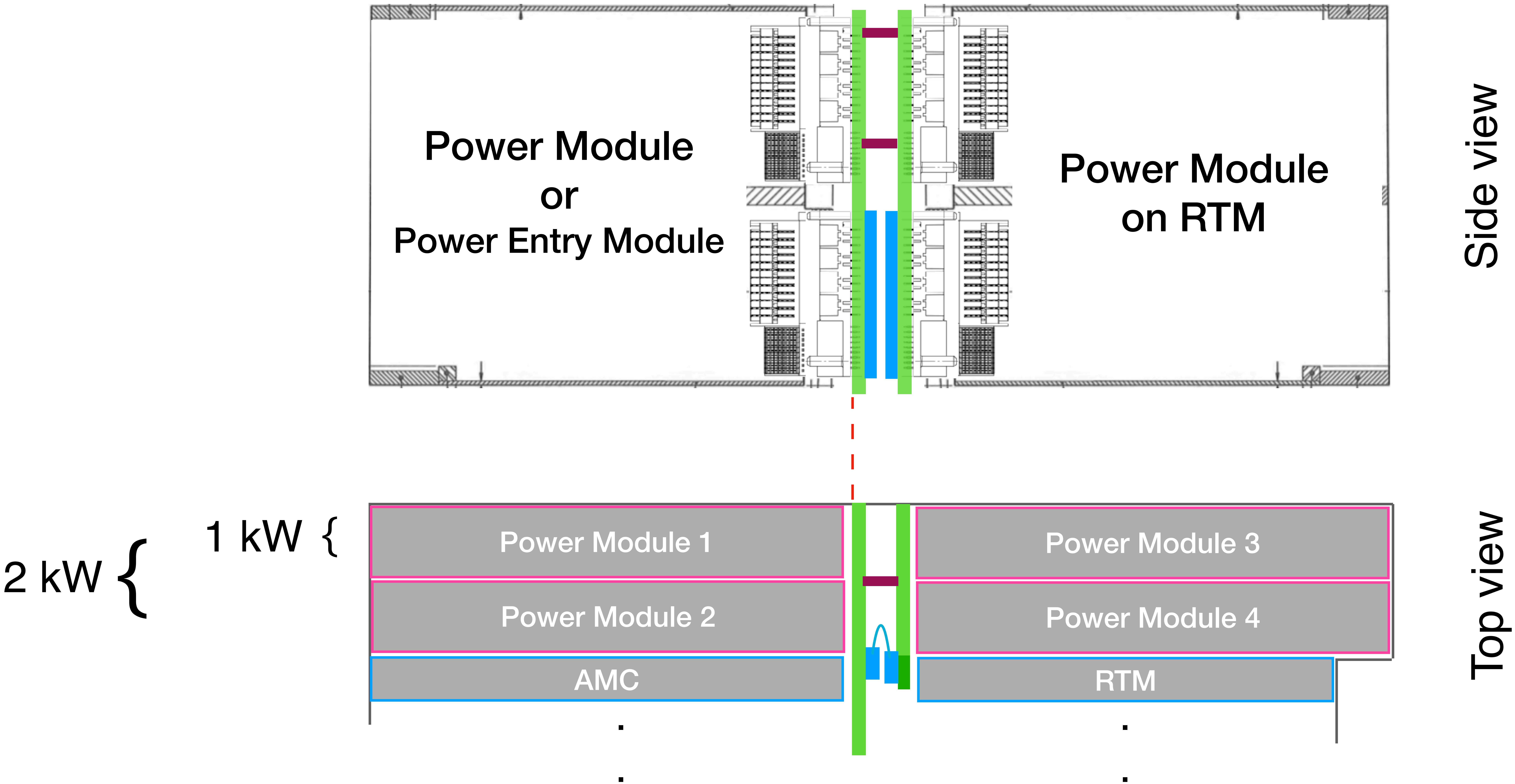
Challenges: Power

- **200 W per slot**
  - Limitation of AMC connector: 8 pins @ 10.8 V = 98 W
  - Limitation of Power Module connector: 100 W … 114 W
- **Solution:**
  - Use 9 pins on AMC + 2nd connector
  - Use 2 Power Module connectors

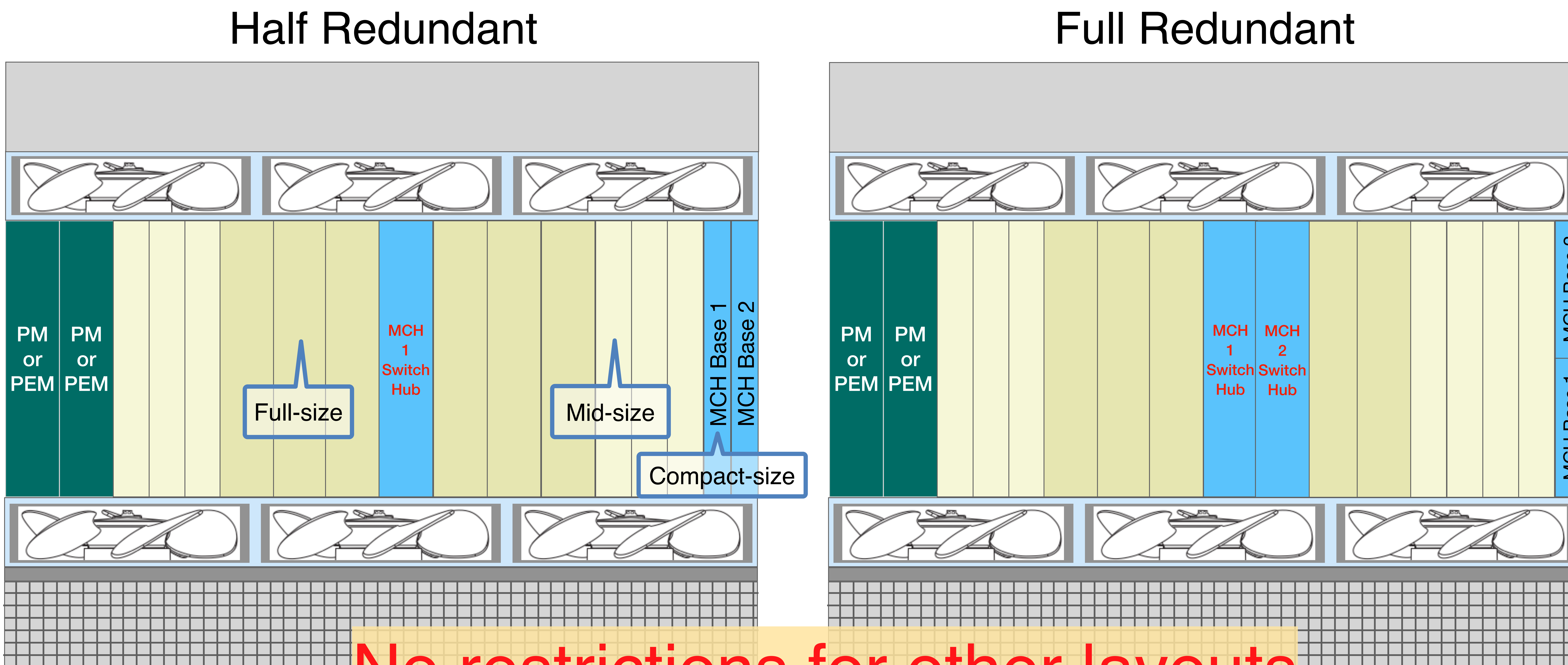


- **2 kW crate cooling**
  - Two times more airflow
  - Fans need more power
- See next talk—> Dietmar Mann (nVent)

Power Modules on Front and Rear: 2 * 2 kW

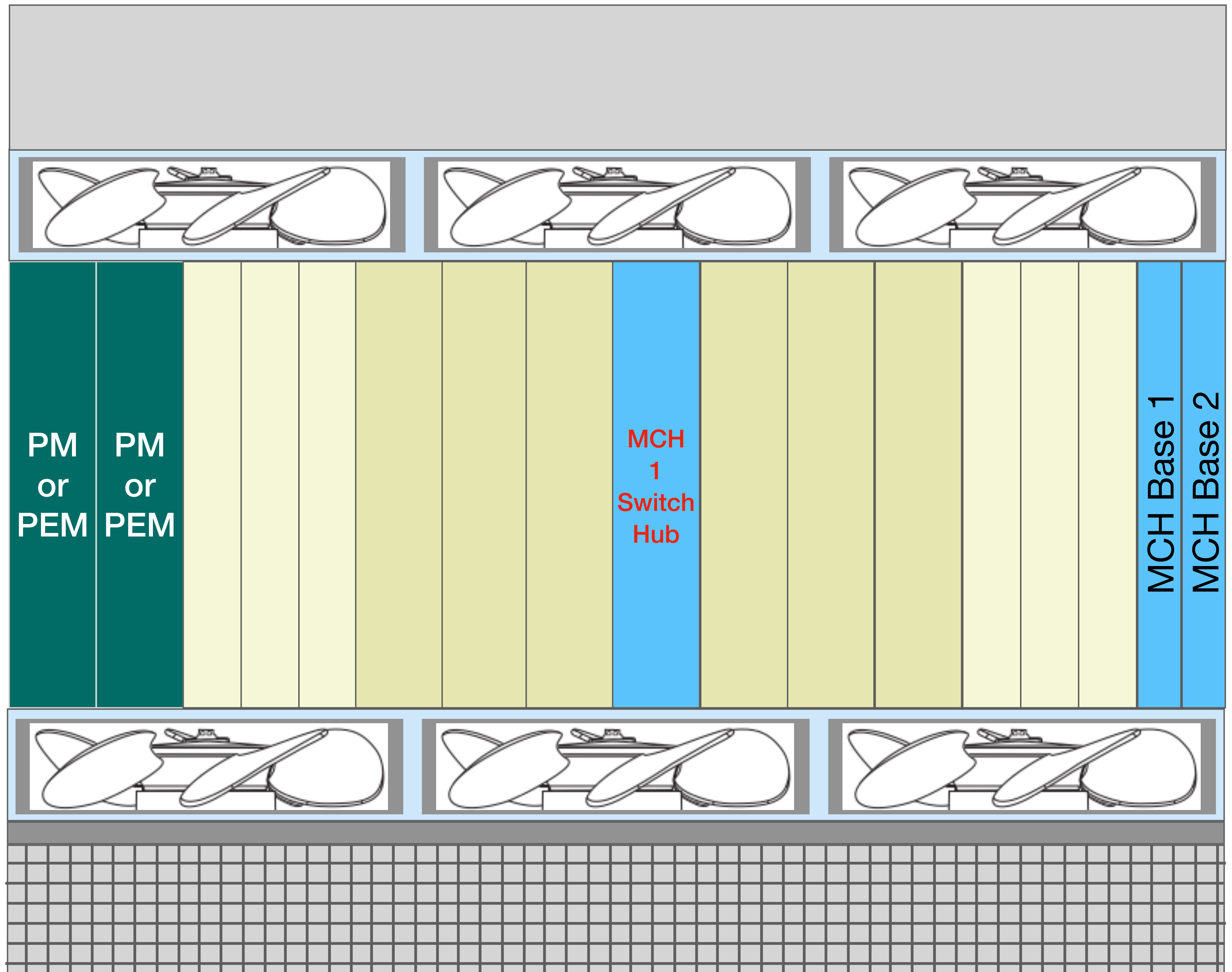


Possible Crate Layouts for 2000 Watt



No restrictions for other layouts or smaller crates

Goal: max. 2000 Watt per Crate

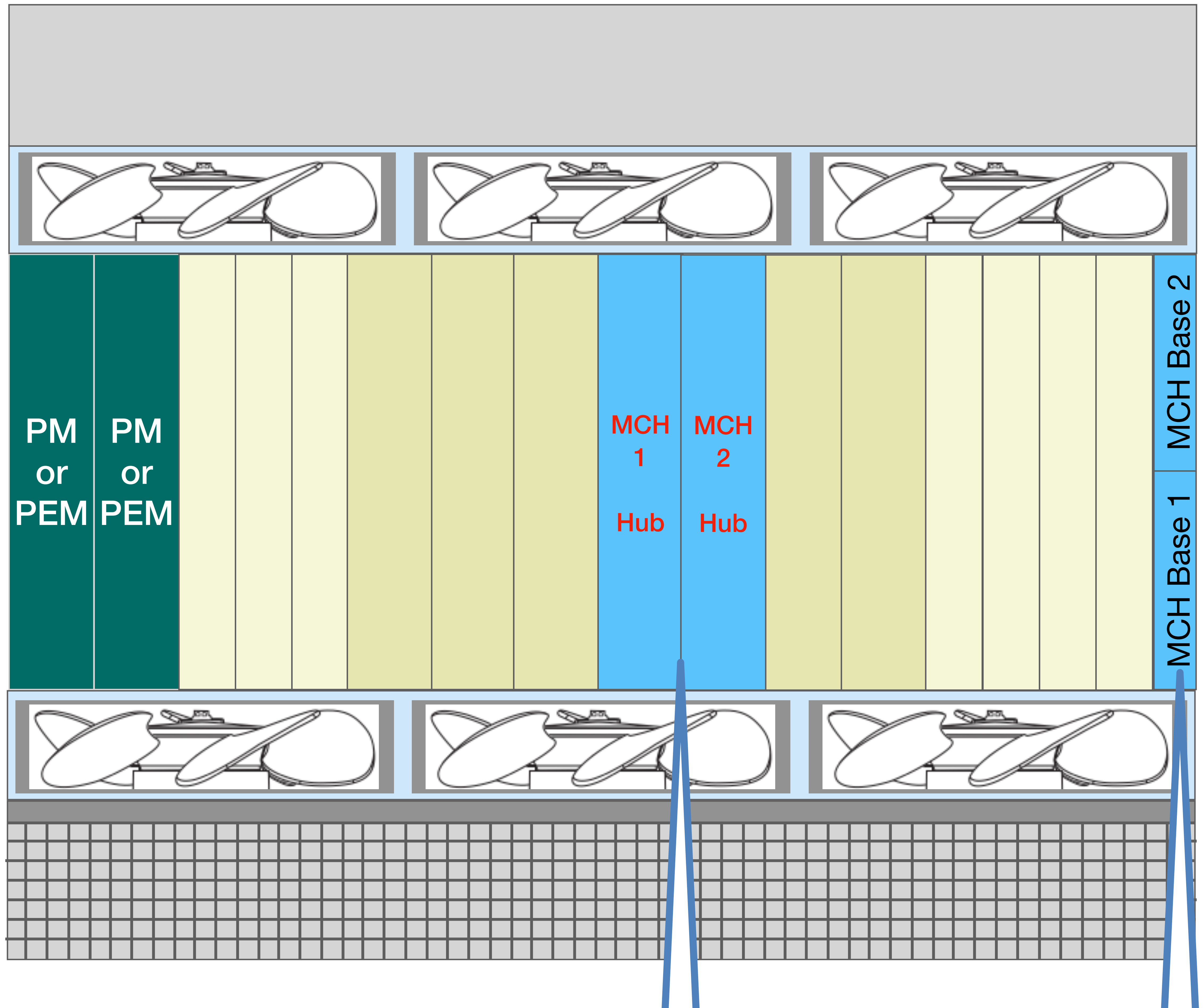


	#		TE	∅ Power	Tot Power
PM	2	6	12		
AMC mid	6	4	24	70	420
AMC full	6	6	36	160	960
MCH hub	1	6	6	120	120
MCH base	2	3	6	50	100
Fan	2			200	400
Sum			**84**		**2000**

19”

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

Split MCH: Base and Hub



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

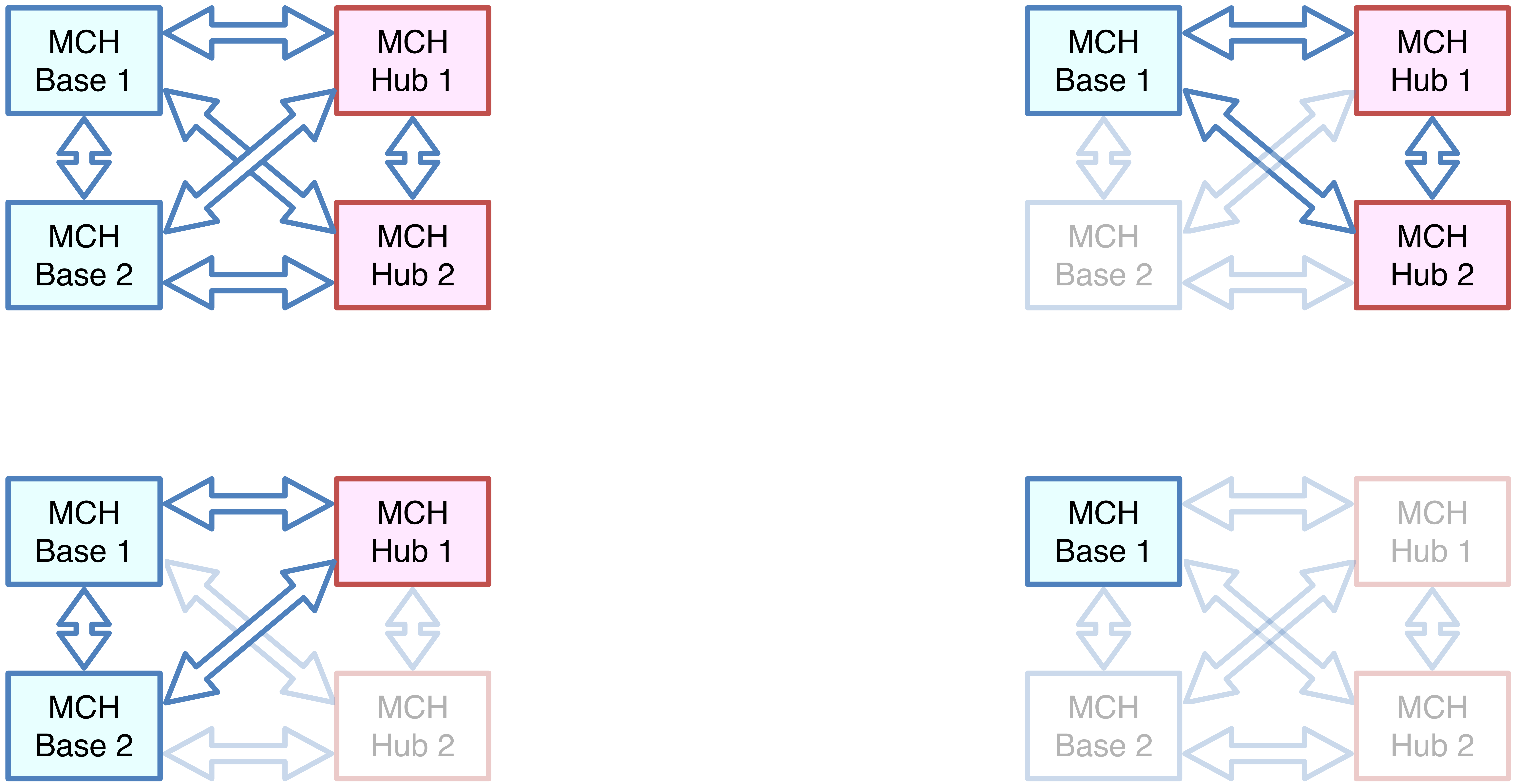
MCH Base: crate management
Ethernet hub (ports 0, 1)
Clock module

A separate Hub has advantages:

- More fat pipes possible
- Self-contained hot-swap
- Same power channel w/ Base
- Application specific designs possible
- Independent upgrade
- Better cooling for next gen switches

Split MCH Flexibility

Redundant, non-redundant and hot-swap options



Conclusions

Tough goals:

- 2 kW per crate
- 200 W max. per AMC slot
- 32 GT/s PCIe gen 5

Promising results:

- 25 GT/s simulation ok
- Solution for power (2kW/200W)
- Split MCH provides more fat pipes (e.g. PCIe lanes)

Still lots of work to be done:

- PCIe gen 5 simulation
- Find best cooling solution
- Definition of connectivity
- Definition of management
- Further items:
  - Ports 2, 3 protocols
  - FMC management
- …
- Building prototypes
- Writing specs