Recent ATCA development for LHCb

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Outline

- **AMC40 board**

    Optical interface

- **ATCA40 board**

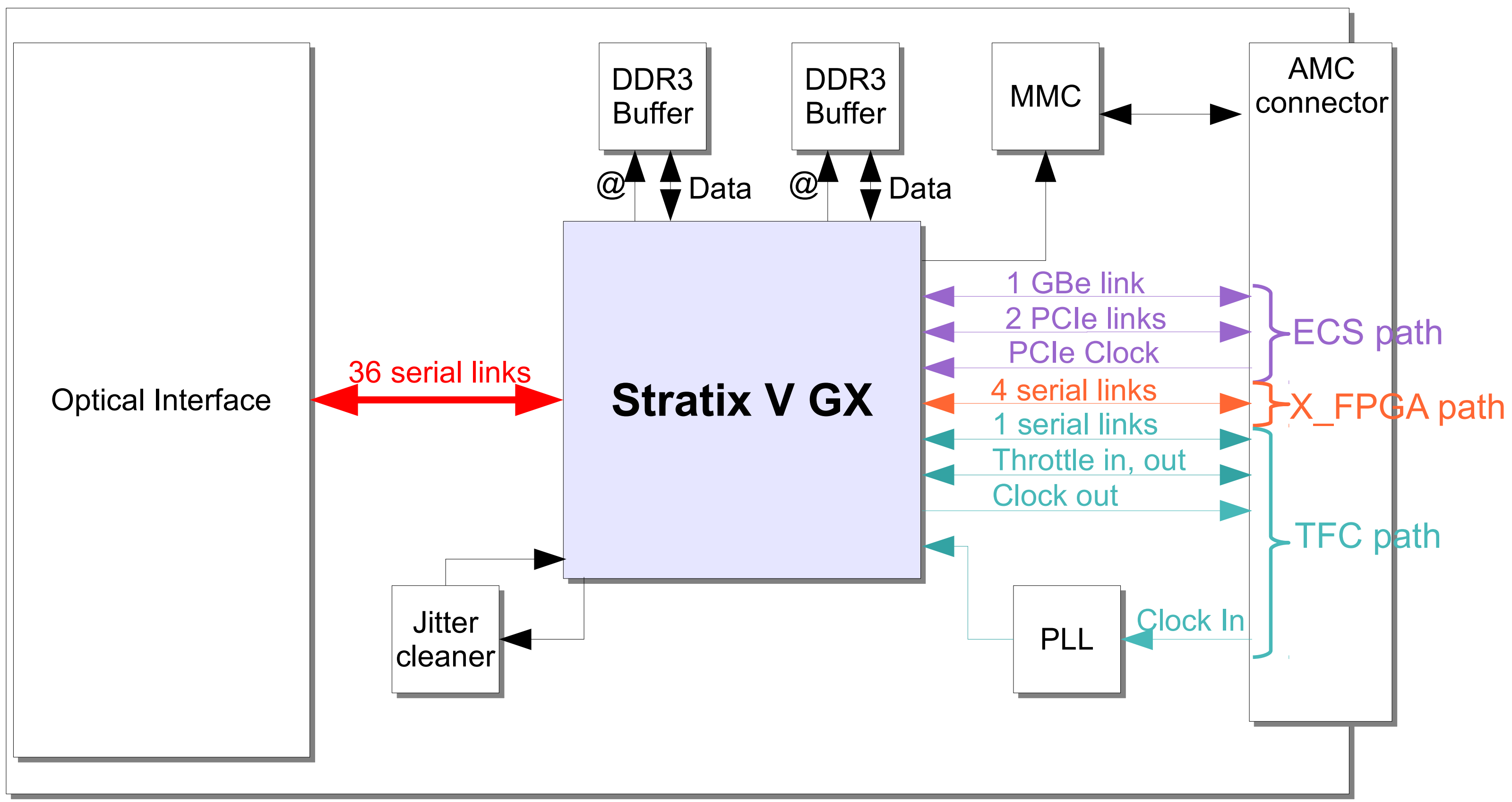
    ECS management
    Commutation functions
    IPMI management

- **Crate level**

    Backplane connections
    Power consumption and cooling
    Chosen crate

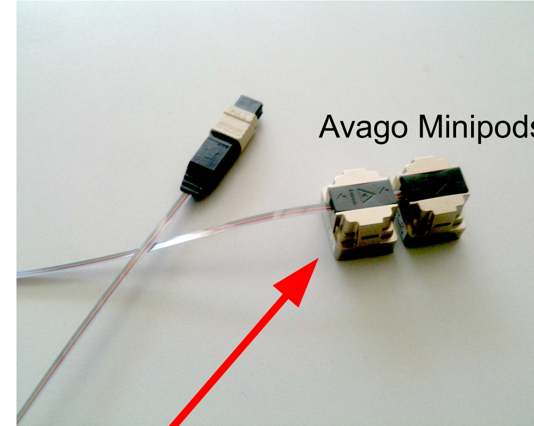
- **Debugging a board**

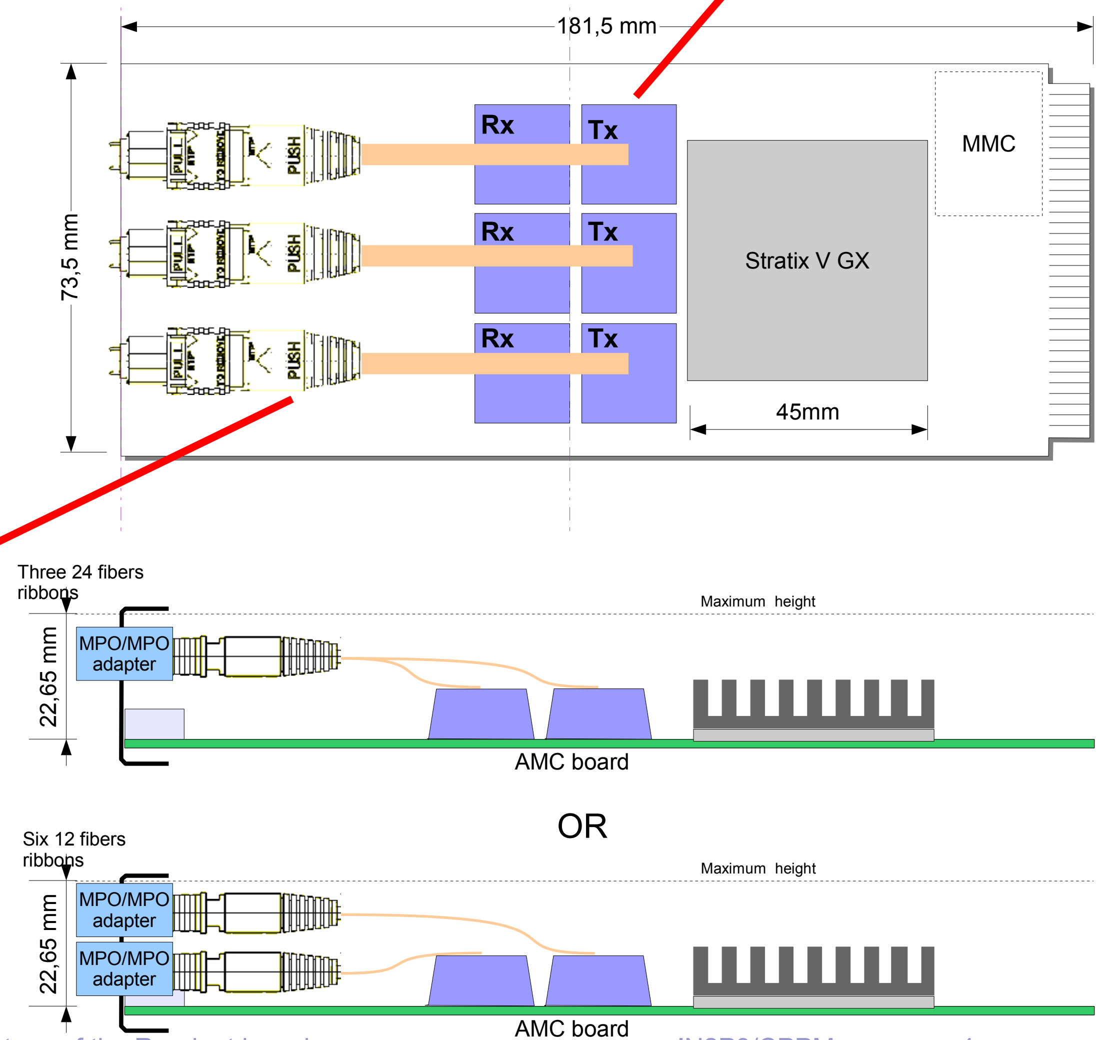
AMC40 daughter board



Optical interface

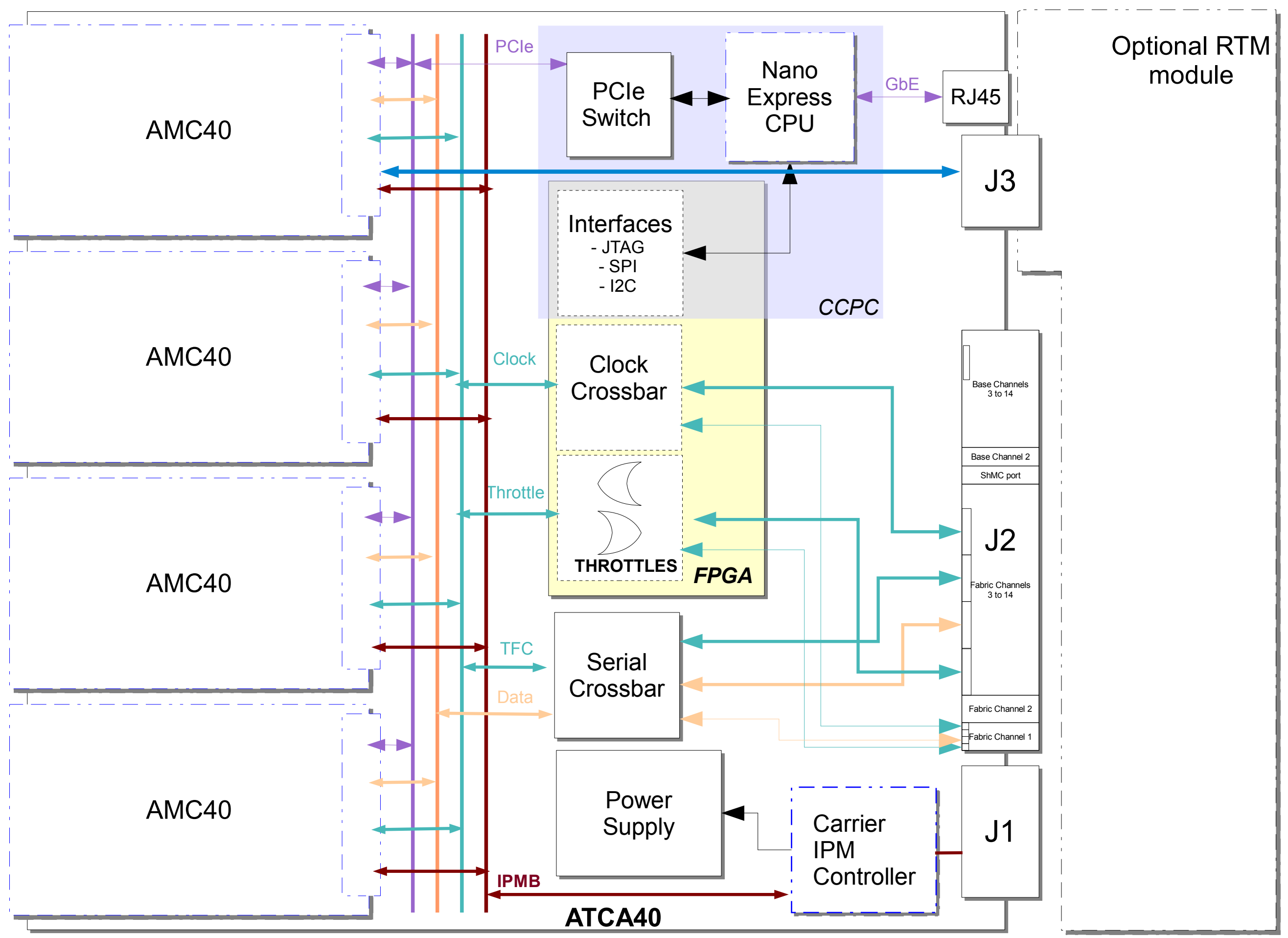
36 inputs AND 36 outputs at 10 Gbps

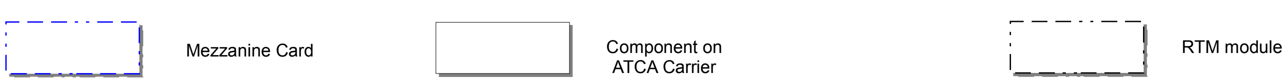




MPO/ Prizm patchcord

ATCA40 board

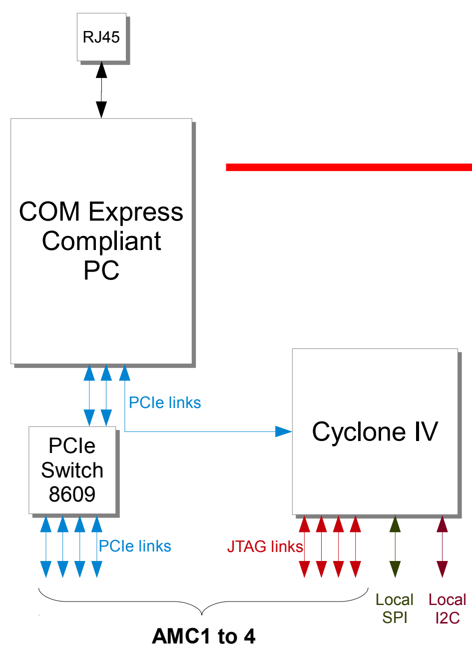


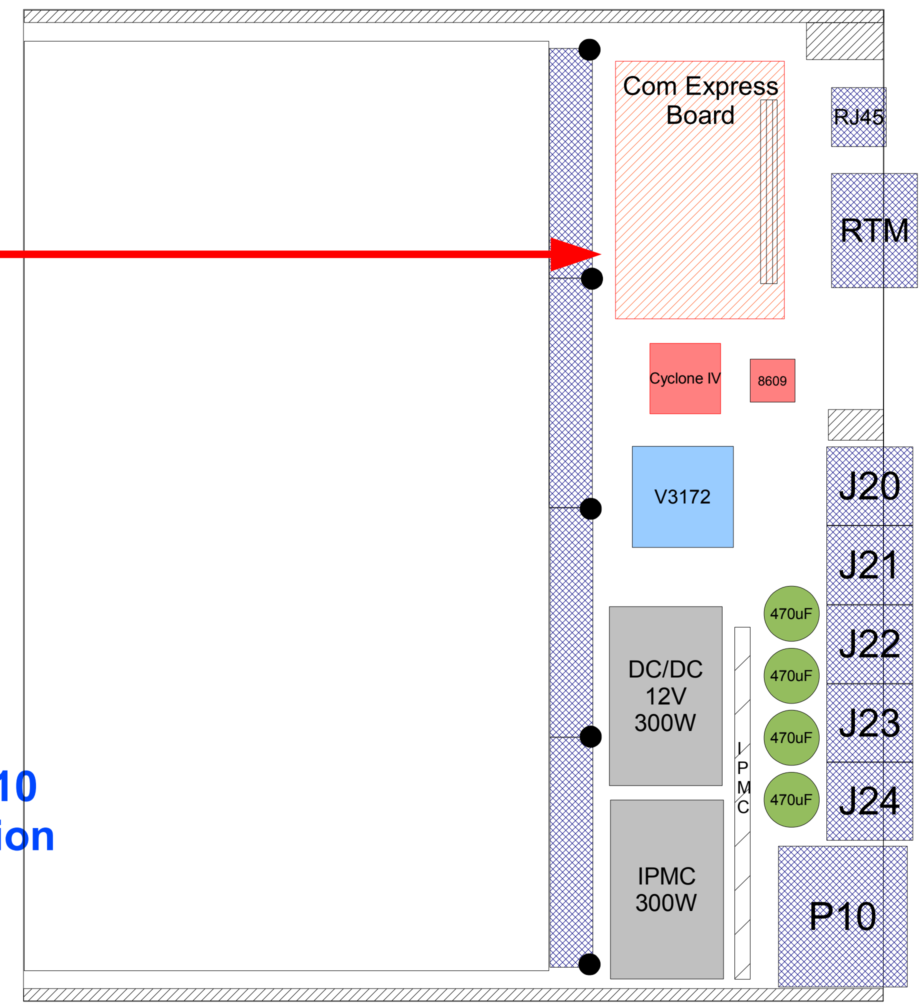


ECS management

Standard COM express connector type 10:

Currently ATOM core at 1 GHz
CCPC board can be upgraded





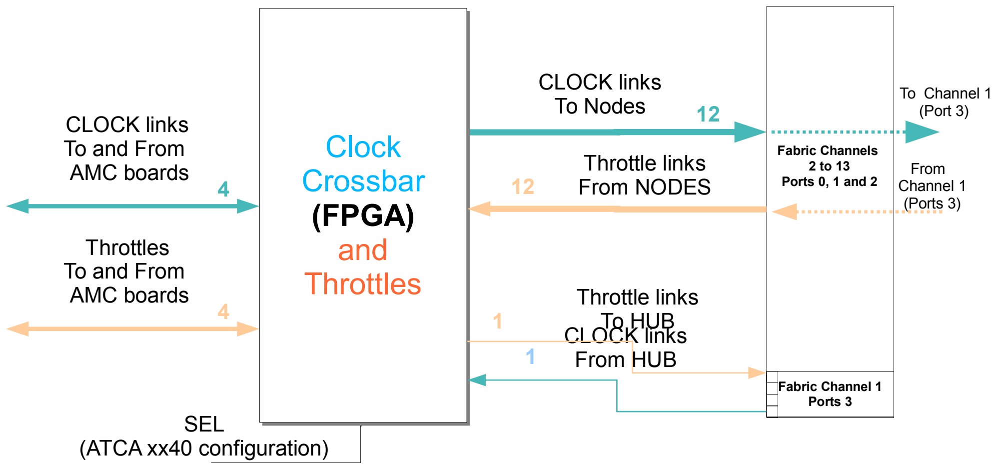
Reuse of developments made by Rio for Tell10
same components but different implementation

Commutation functions

Programmable crossbars

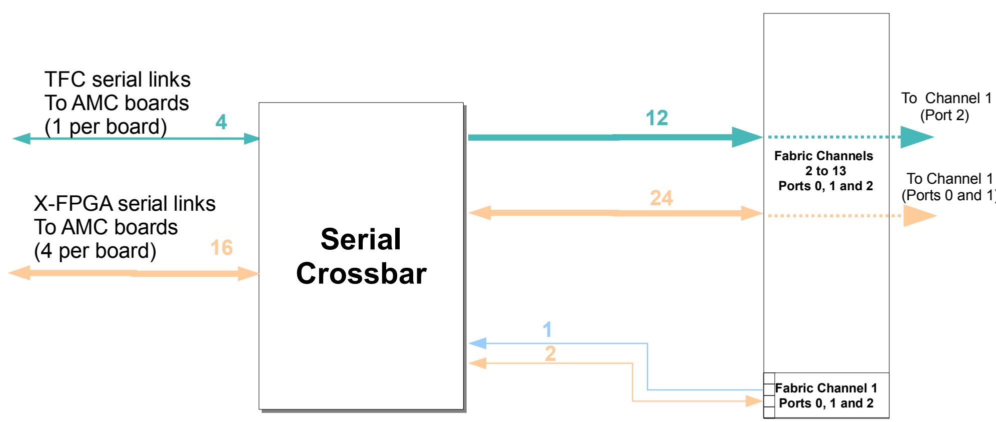
LVDS links:

- Clock broadcast
- AMC40 to AMC40 clock routing
- Oring of throttles

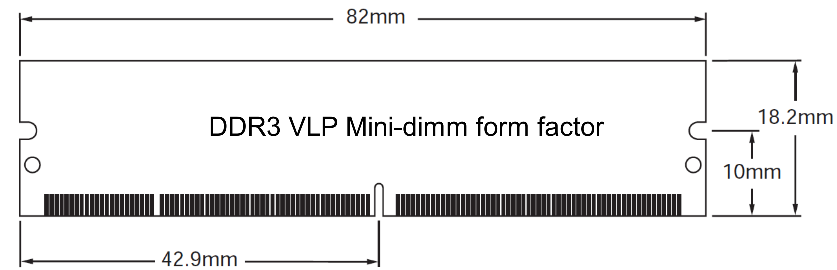


Multigigabits Serial links:

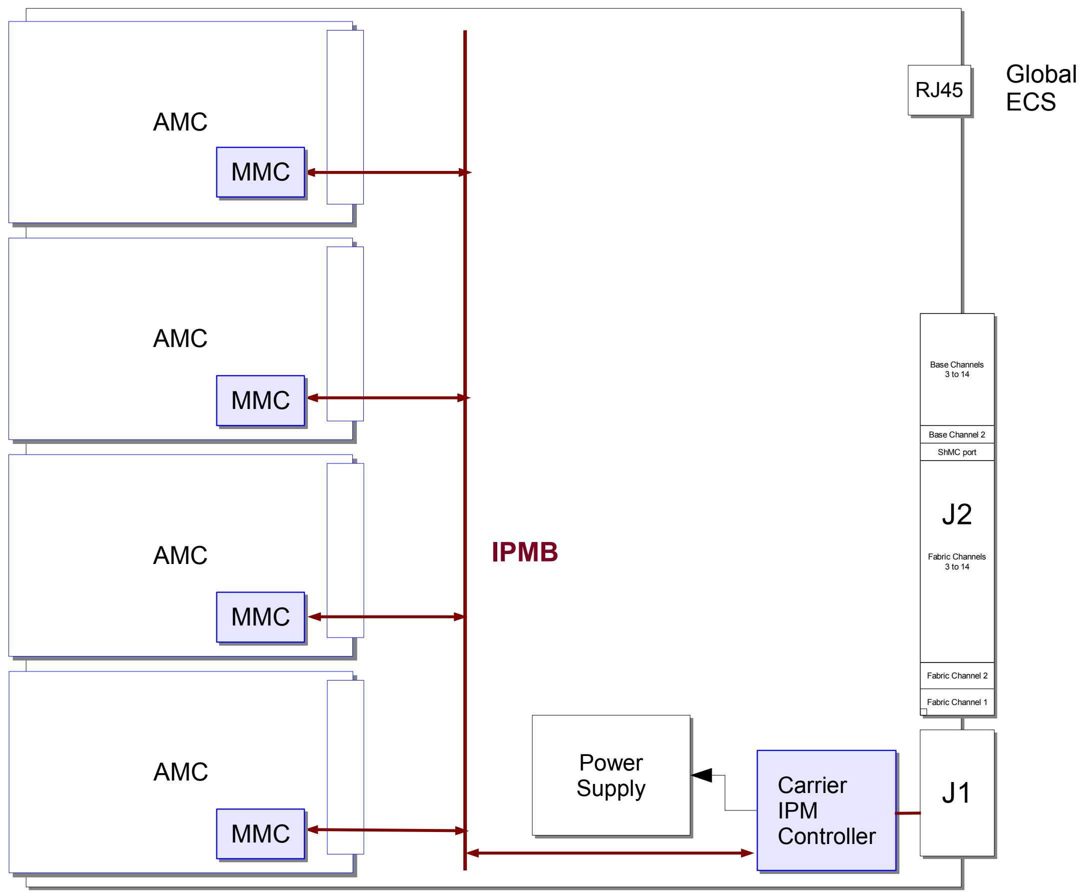
- TFC information broadcast
- AMC40 to AMC40 communication
- ATC40 to ATC40 communication



IPMI management

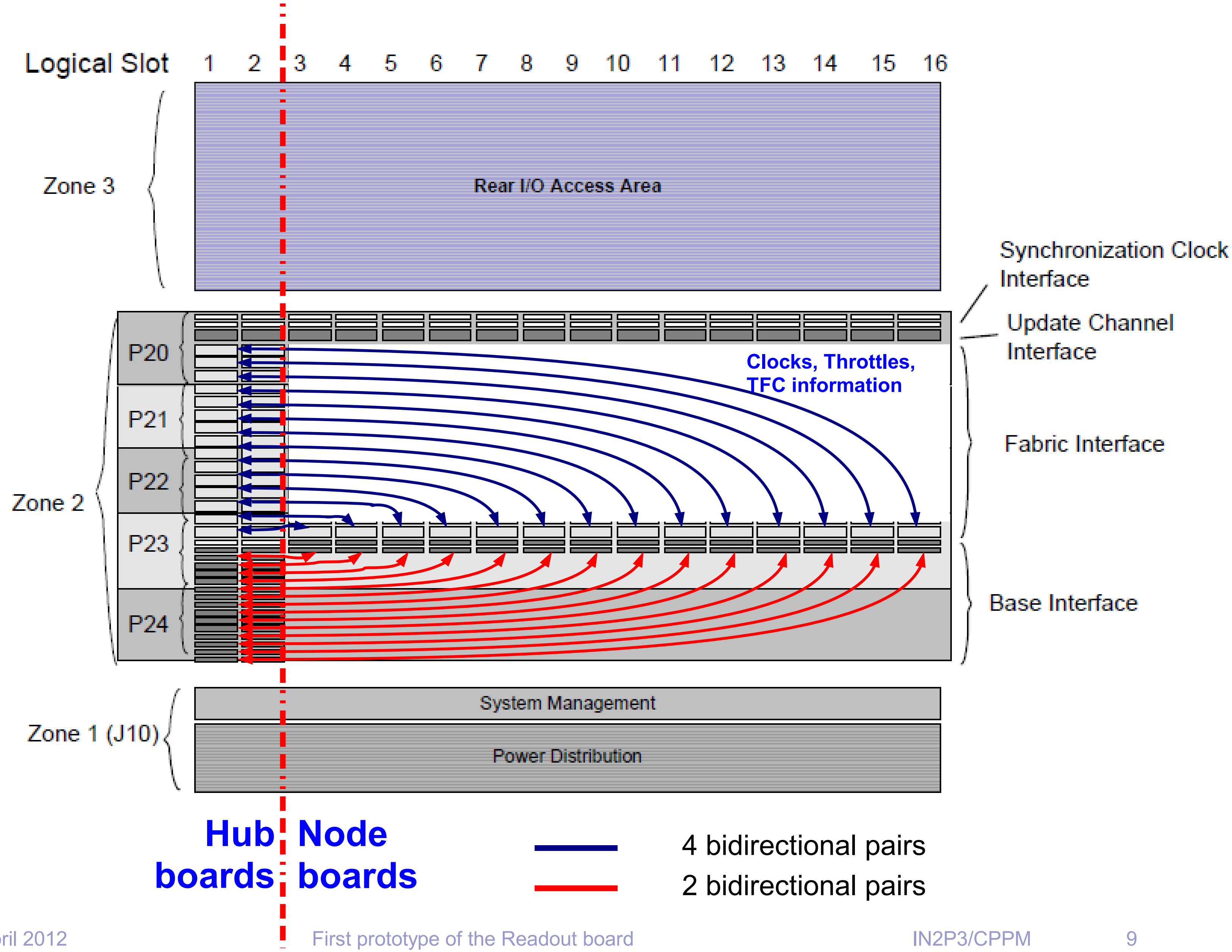


Implemented on mezzanine



Will be based on a development made by LAPP Annecy for ATLAS

Backplane connections



Power management and cooling

Power consumption above ATCA specification (200W per board)

Device	Power in W	Total power (η=80%) in W
VSC3172	19	23,8
VSC3441	1,9	2,4
Cyclone IV	6,5	8,1
DDR3	0,6	0,8
Crédit Card PC	6,2	7,8
IPMC	1,7	2,1
MMC*4	3,3	4,1
AMC*4	166	207,5
ATCA40 power		**256,5**
Maximum Crate power		**3591,0**

But compatible with existing cooling system

See study « LHC rack cooling measurements »
http://cdsweb.cern.ch/record/38031/files/epess-2003-014.pdf

The results of the project indicate that the system is suitable: using 2U high heat exchangers, 10kW of power may be dissipated within the rack with less than 2% losses to the surroundings.

Crate

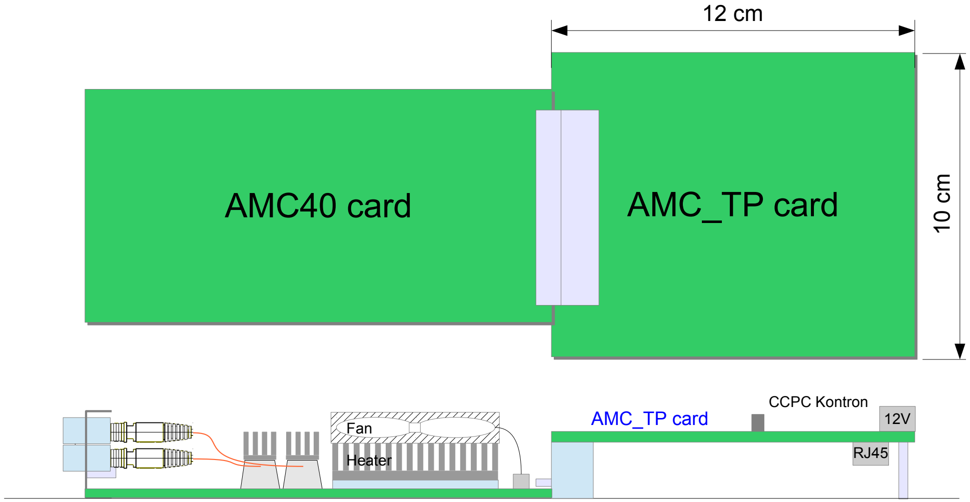
Schroff crate

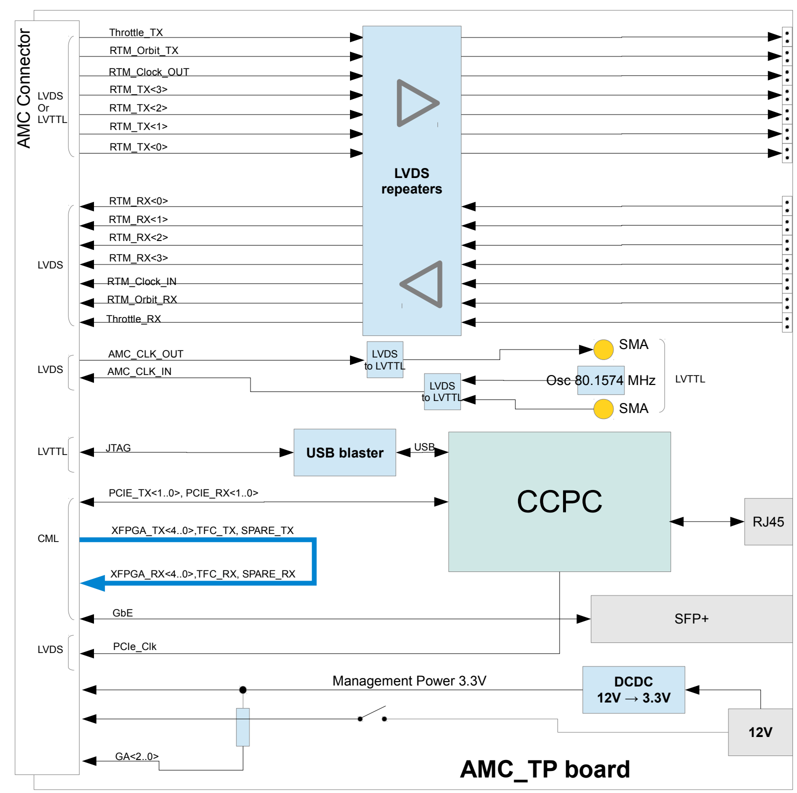
- power dissipation :
  300 W per board
- Front to back cooling
- Needs external
  Power converters
- Pigeon Point shelf manager

Debugging an AMC40 board

Only needs :

- A 12 V power supply
- A control PC

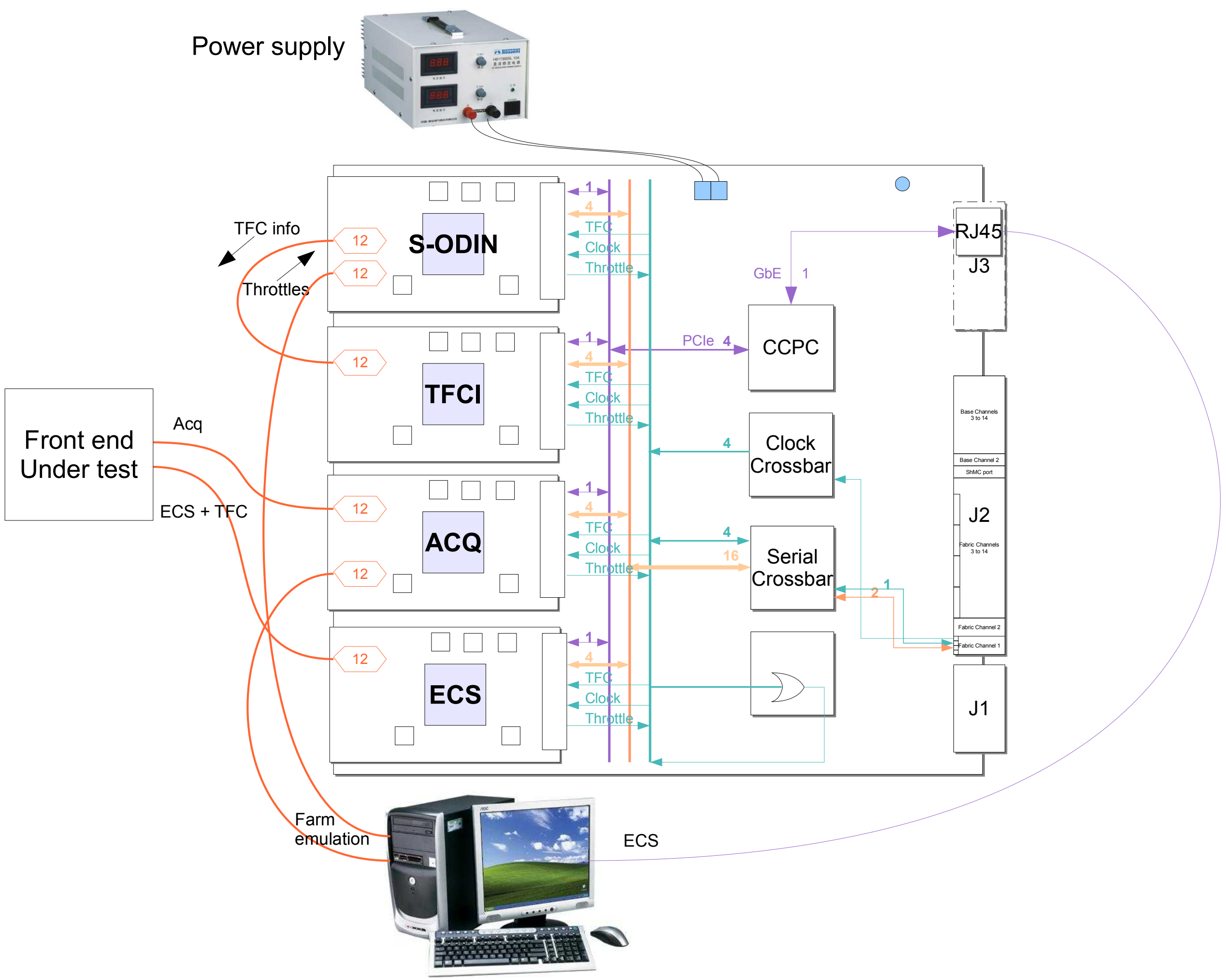




Emulating a system

Only needs :

- A power supply
- A control PC



Conclusion

Schedule

- AMC40 board available mid-May
- ATCA40 boards schematics completed at the end of the month
- Complete prototype ready around July 2012

Proof of feasibility of «LHCb readout on ATCA » by end of year

Extra

Optical budget

Minipods or Micropods
Min Tx OMA = -2.4 dBm
Input Optical Power Sensitivity = -10.4 dBm

Table 5.1 Tracker-grade Versatile Link power budget

FE → BE   BE → FE

	MM_VTx_Rx	MM_Tx_VRx	SM_VTx_Rx	SM_Tx_VRx
Min. Tx OMA	-5.2 dBm	-1.6 dBm	-5.2 dBm	-3.6 dBm
Max. Rx sensitivity	-11.1 dBm	-13.1 dBm	-12.6 dBm	-15.4 dBm
Power budget	**5.9 dB**	**11.5 dB**	**7.4 dB**	**11.8 dB**
Fiber attenuation	0.6 dB	0.6 dB	0.1 dB	0.1 dB
Insertion loss	1.5 dB	1.5 dB	2.0 dB	2.0 dB
Link penalties	1.0 dB	1.0 dB	1.5 dB	1.5 dB
Tx radiation penalty	0 dB	-	0 dB	-
Rx radiation penalty	-	5.4 dB	-	5.4 dB
Fiber radiation penalty	1.0 dB	1.0 dB	1.0 dB	1.0 dB
Margin[1]	**1.8 dB**	**2.0 dB**	**2.8 dB**	**1.8 dB**

Note 1: Error coding scheme, for example, the GBT coding can result in in an additional 2-3 dB gain in margin.

Table 5.2 Calorimeter-grade Versatile Link power budget

	MM_VTx_Rx	MM_Tx_VRx	SM_VTx_Rx	SM_Tx_VRx
Min. Tx OMA	-5.2 dBm	-3.2 dBm	-5.2 dBm	-5.2 dBm
Max. Rx sensitivity	-11.1 dBm	-13.1 dBm	-12.6 dBm	-15.4 dBm
Power budget	**5.9 dB**	**9.9 dB**	**7.4 dB**	**10.2 dB**
Fiber attenuation	0.6 dB	0.6 dB	0.1 dB	0.1 dB
Insertion loss	1.5 dB	1.5 dB	2.0 dB	2.0 dB
Link penalties	1.0 dB	1.0 dB	1.5 dB	1.5 dB
Tx radiation penalty	0 dB	-	0 dB	-
Rx radiation penalty	-	2.5 dB	-	2.5 dB
Fiber radiation penalty	0.1 dB	0.1 dB	0 dB	0 dB
Margin[1]	**2.7 dB**	**4.2 dB**	**3.8 dB**	**4.1 dB**

Estimated margin For LHCb   **2.0 dB**   **5.0 dB**

500 kGy, 2 x 10^{15} n/cm2

- Tracker-grade back-end transmit power must be boosted to compensate radiation penalties

10 kGy, 5 x 10^{14} n/cm2

- Calorimeter-grade power budget compatible with COTS component specs

LHCb ?
Current worst case in VELO: 3.9 x 10^{12} n/cm^2
Extrapolation to upgrade : 3.9 x 10^{13} n/cm^2
→ **much below CMS calorimeter grade**

Overall architecture