LHCb Electronic upgrade
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CERN

Readout board form factor

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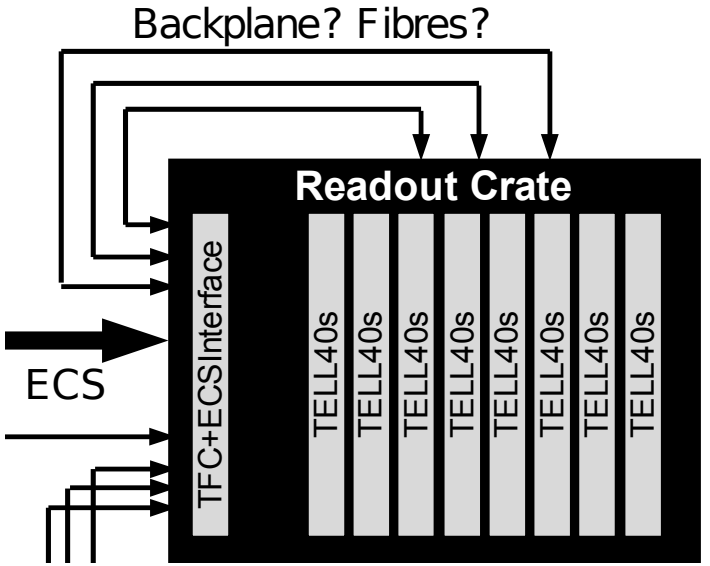
ATCA

- Standard for application with:
  - High throughput
  - High level of integration
  - High level of reliability
- A standard specifying elementary blocks for:
  - Mechanics
  - Backplane for power supplies and point-to-point high speed links
  - Control and Cooling
- Used in:
  - Telecommunication
  - Data centre (networking)
  - High energy physics (XFEL, Belle-2, ITER,...)
- The natural choice for the LHCb readout board.

Controversy

- ATCA implementation breaks the rule "Re-use existing electronics and infrastructure as much as possible" since TELL1 crates (9U VME) will be replaced by ATCA crates.

- The same functionalities can be obtained using the current TELL1 crates since time and throttle signals can be distributed using optical cables:

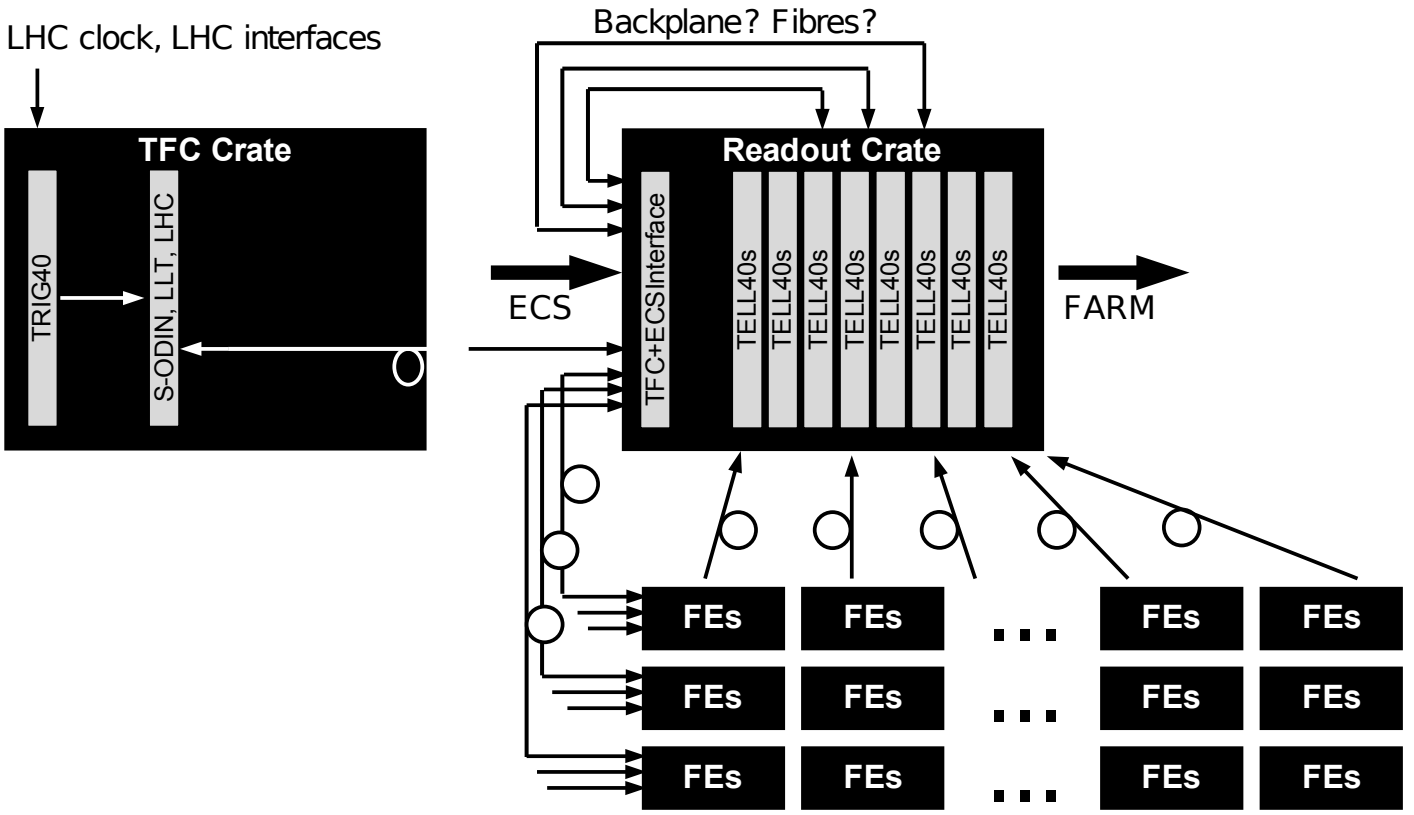


ATCA / 9U VME comparison

- Architecture
- Board
- Crate and power supplies
- Infrastructure
- Cost
- Low level controls for a crate
- Reliability
- Possibility of evolution
- Test bench for early user
- Long term maintenance

Readout Architecture

- Neutral with respect to the board form factor:



From F. Alessio, LHCb upgrade data processing mini workshop, 16 – 17 Nov, 2011

Board

- ATCA
  - 322×280 mm×mm
  - 250 Watt (FPGAs full)
  - 48 V / 5.2 A
- 9U VME
  - 400×367 mm×mm

  - Larger PCB by 8 cm in *h* and *w*
  - Additional electric/optic converter for TFC signals

Crate and power supply

- ATCA crate from Schroff
  - 14 slots
  - 200, ..., 400W per slot
  - Need: 48 V / 73 A
  - PS: 48 V / 100 A (350W)

- 9U VME crate from Wiener
  - 20 slots
  - 100 W per slot
  - Only 10 boards per crate
  - Need: 48 V / 52 A
  - PS: 3.3V/200A, 5V/100A, 48V/12A
  - Replace power supply 5 modules 48V/12A
  - 3.295 k€

From V. Bobillier

Infrastructure modifications

- ATCA
  - Crate height 13U
  - Modify the rack
  - Vertical air flow
  - Rack power dissipation 7 kW
- 9U VME
  - Crate height 11U
  - Vertical air flow
  - Rack power dissipation 5 kW

NOTE:

- LEP rack power dissipation ≤ 10kW
- General cooling should be enough

From L. Roy, LHCb upgrade electronics, 13 Oct, 2011

Crude cost estimated

- ATCA
  - 15 to 17 crates (1)
  - 8.2 k€ per crate
  - ∑crates = 120 – 140 k€
- 9U VME
  - 19 to 21 crates (1)
  - 3.3 k€ per power supply
  - 1.6 k€ / crate for optical transceivers and fibres
  - ?? due to larger PCB
  - ∑crates = 97 – 103 k€

Similar cost for the two solutions

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(1) include partitioning but depends on the ratio of TFC+ECS board with respect to TELL40 boards , The number of GBT links, the number of GBT and 10 GbE links per AMC, the load of 10 GbE links, ...

Low level control for crate

- ATCA
  - IPMI controller
  - Ethernet (distributed)
  - Switch ON/OFF crate
  - Monitor voltage, current, temperature and fan speed
  - Reset individual CCPC
  - Switch ON/OFF board
  - Off-the-shelf software from Annecy
- 9U VME
  - OPC server
  - CAN bus (daisy chain)
  - Switch ON/OFF crate
  - Monitor voltage, current and fan speed
  - Reset individual CCPC (?)

Reliability

- ACTA
  - Redundant power supply
  - Less fragile connections
  - Excellent mechanics pour insert/extract a board
  - Distributed architecture for the low level control
- 9U VME

Possibility of evolution

- ATCA

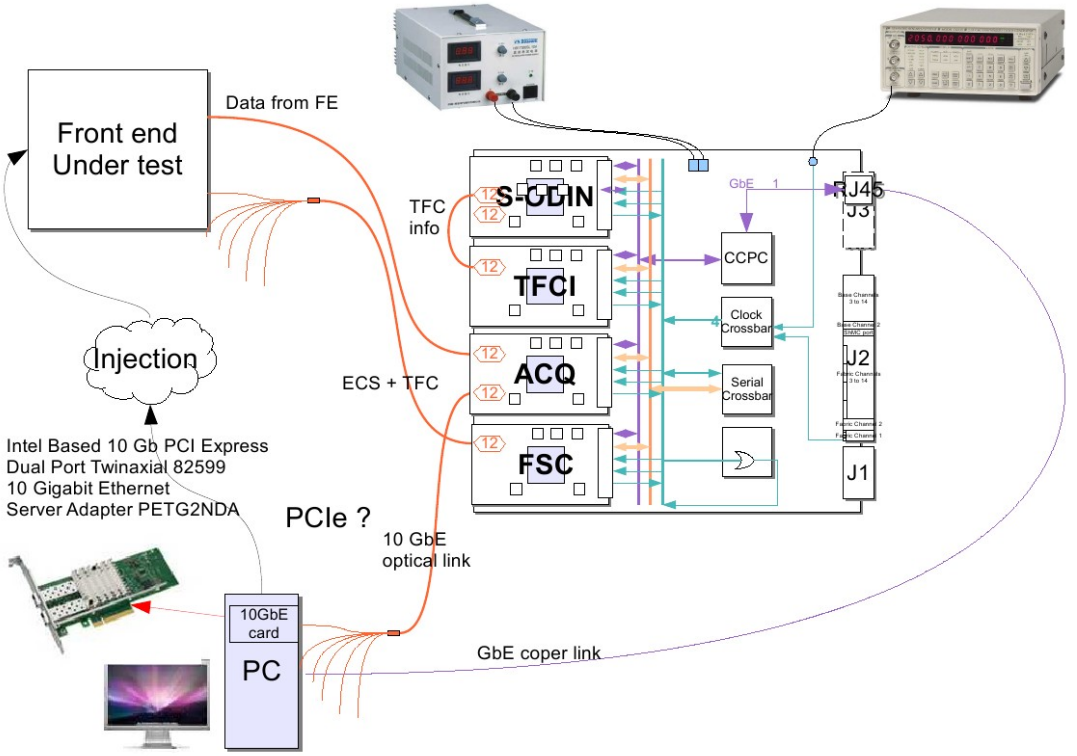
  rely on the interconnection matrix between boards via point-to-point high speed serial links embedded in the backplane and to the FPGAs *computing power*

  Allow to build unforeseen applications which might help us in the future:
  - New LLT for VELO tracking
  - Compute tracking primitive to help the tracking algorithm running in the farm

- 9U VME

Test bench for early user

- Independent of the readout board form factor.
  Require a table, power supply, big fan, PC and a clock generator.



From J.-P. Cachemiche, LHCb upgrade data processing mini workshop, 16 – 17 Nov, 2011

Long term maintenance

- ATCA
  - Contract for maintenance has to be setup by the CERN electronics pool
- 9U VME
  - Maintenance of power supplies are under contract via the CERN electronics pools
  - Contract expires in 2018 but will be renewed.

Proposal

- ATCA is better adapted to the readout board requirements.

- Propose ATCA as a baseline and 9U VME as a backup.
  The first prototype merges all together envisaged technologies:
  - Develop a readout board compliant ACTA standard
  - Buy and ATCA crate
  - Validate TFC distribution and the low level crate control

  End 2012, when the prototype is fully debug, review this choice:
  - We can modify rather quickly the board form factor when designing the preserie version.
  - Better understanding on the dimension of the readout system
  - See Evolution of CERN / POOL, Atlas, ...

- This approach allow to tests envisaged technologies up to the end. It minimizes the risk since early users will program FPGAs and are not sensitize to the board form factor.