Modular data acquisition systems centered on commercial networks and compute nodes

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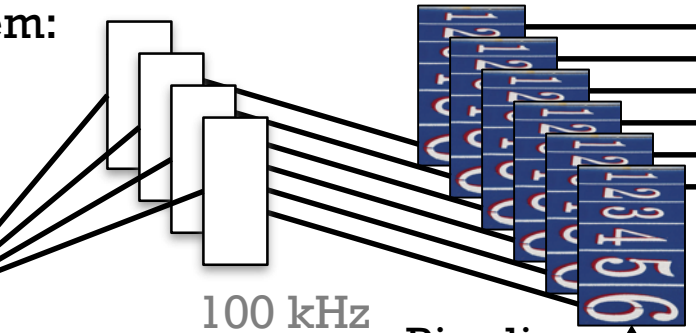
Detector Technologies

Introduction

- Two main trends in Data AcQuisition
  - Integration
  - Distribution
- Integration
  - DAQ system integrated closely to sensors and electronics
  - Even data processing is sometimes integrated
  - Compact systems
- Distribution
  - After digitization data are sent away from the sensors and dispatched to data center like compute infrastructure
  - Good approach when sensors are in a hostile environment with limited power, magnetic fields, radiation, …
- Focus on this talk is the proposal of an architecture for distributed DAQ systems.

DAQ in High Energy Physics

Readout System:
Buffering &
processing



100 kHz

Pipeline
memories

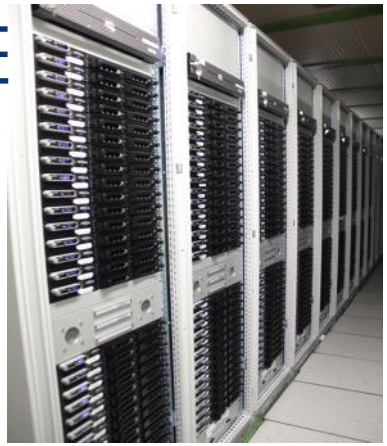
Detector

40 MHz

First hardware
selection/trigger

40 MHz -> 100 kHz

100 kHz -> 5 kHz



5 kHz

Storage

~10 GB/s

Event filter:
massive, parallel,
distributed processing of
collision data

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DAQ in High Energy Physics

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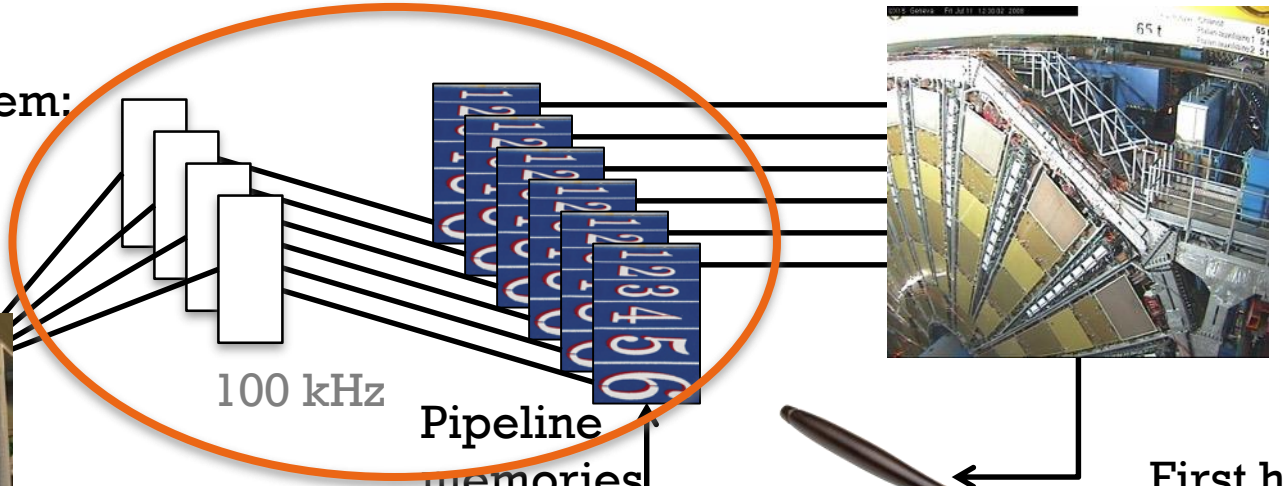

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Detector Readout

On detector digitization, temporary storage

Off detector specific systems for data pre-processing and electronics control & configuration, distribution of timing & trigger

Generic system interfacing to data processing farm:

- Translation from point-to-point links and protocols to switched network protocols
- Transition from custom electronics and firmware to software environment

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Can we skip one step?

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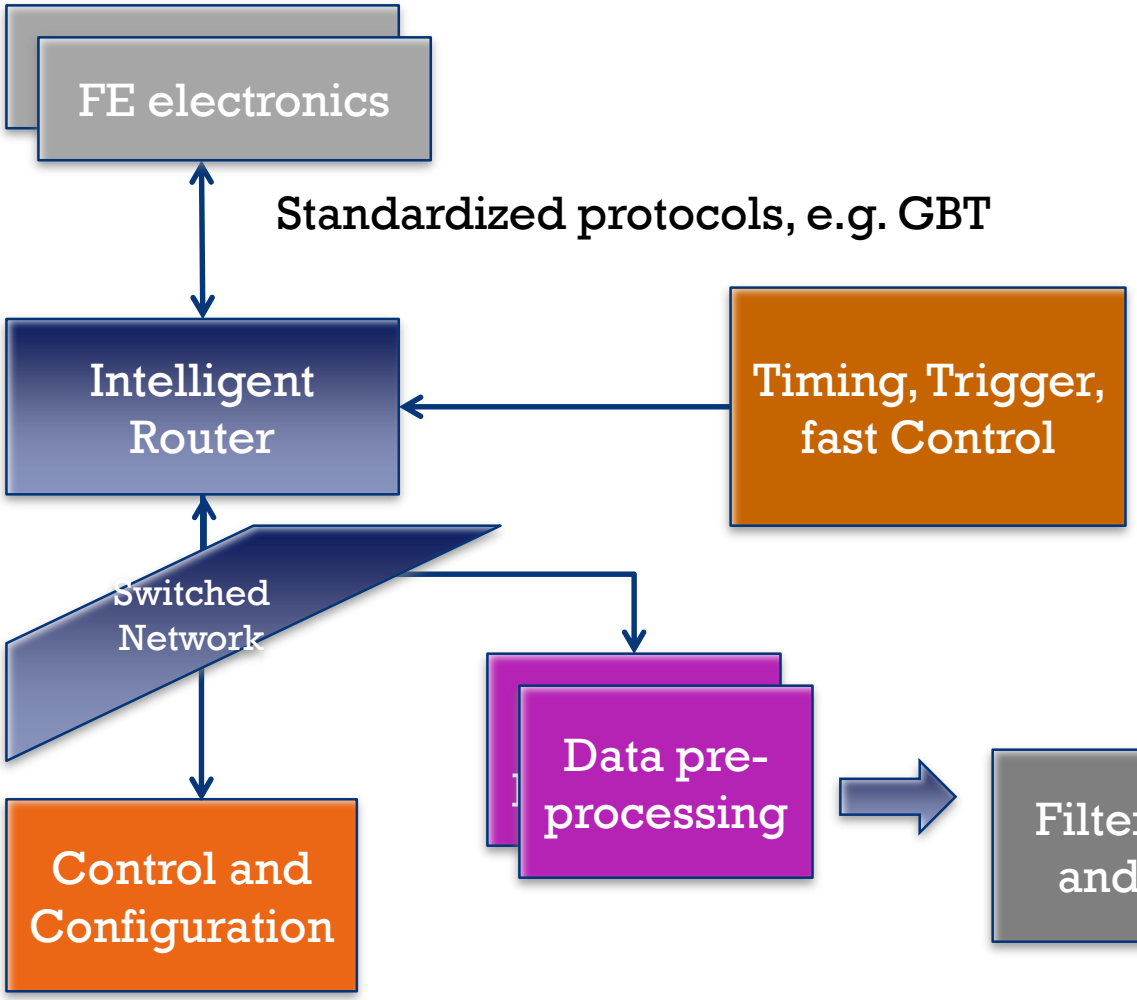
Moving the COTS boundary



Scalability:
Multiple intelligent routers can be used to match the number of links from the detector (O(10) – O (10000)).
Back-end systems and network can be designed and dimensioned to needs.

The Intelligent Router

- Several experiments are actively working in the direction mentioned
  - Implementation based on servers hosting 1-2 PCIe cards
  - PCIe cards with high number of I/O links (up to 48 duplex)
  - Host PC takes care of networking

LHCb

ATLAS

The Intelligent Router

- The intelligent router is able to receive data from the detector FE and to dispatch it for DAQ as well as control & monitoring
  - Possibility to dimension the downstream system independently of the FE
  - Possibility to introduce/change high speed network technologies without affecting the FE
- The intelligent router is able to upload configuration data and send commands to the FE
  - No need for independent links for DAQ and control
- The intelligent router acts as a distribution system for timing, trigger and fast control signals
  - No need for an independent network up to the FE

Summary and Outlook

- DAQ systems are moving into two opposite directions
  - Implement full DAQ very close to sensor
  - Move as much functionality as possible off-sensor towards computer farms
- Both approaches are valuable, depending on the conditions
- We would like to explore the architecture of distributed DAQ systems using "intelligent routers" to
  - Minimize the development of custom, detector specific electronics
  - Minimize the number of physical links to the detector
  - Allow for implementation of modular, scalable, upgradable DAQ applicable to many experiments