Ideas about Optical Links for Calorimeter Trigger at SLHC

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What constraints?

- Detector:
  - Tracker: complete redesign
  - Calorimeter: Detector and front-end unchanged
  - Muons: Minimum change on detector
- Latency (from BX to L1A at front end) 5μs max.
- L1A rate ~ 200kHz max (limited by ECAL VFE)
- See http://agenda.cern.ch/fullAgenda.php?ida=a043274 (LECC '04) for more discussion

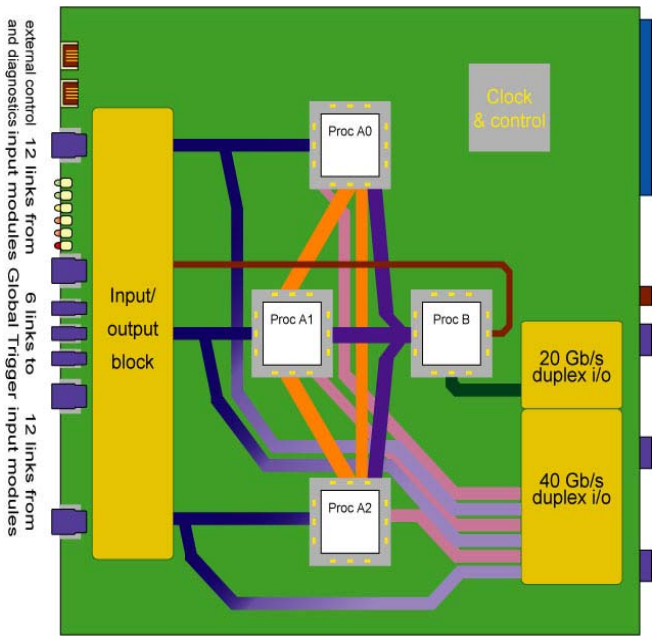
Constraints

- Trigger (apart from trigger primitives generators) not in a harsh radiation environment
  - Can use commercially available components
- Low latency is critical
  - Latency buffers cost money!
  - Could relax current fixed latency “in-order” L1 trigger, but latency will still be important

Trigger Links

- Trigger system currently uses copper links
- e.g. GCT receives data from RCT 15metre on parallel 80Mbit/s cables.
- Data flow would increase at SLHC. For many links there is a case for moving to optical.
- Can use commercial systems (e.g. XFP) where possible (but watch latency)

How? (Extrapolate GCT TPM)

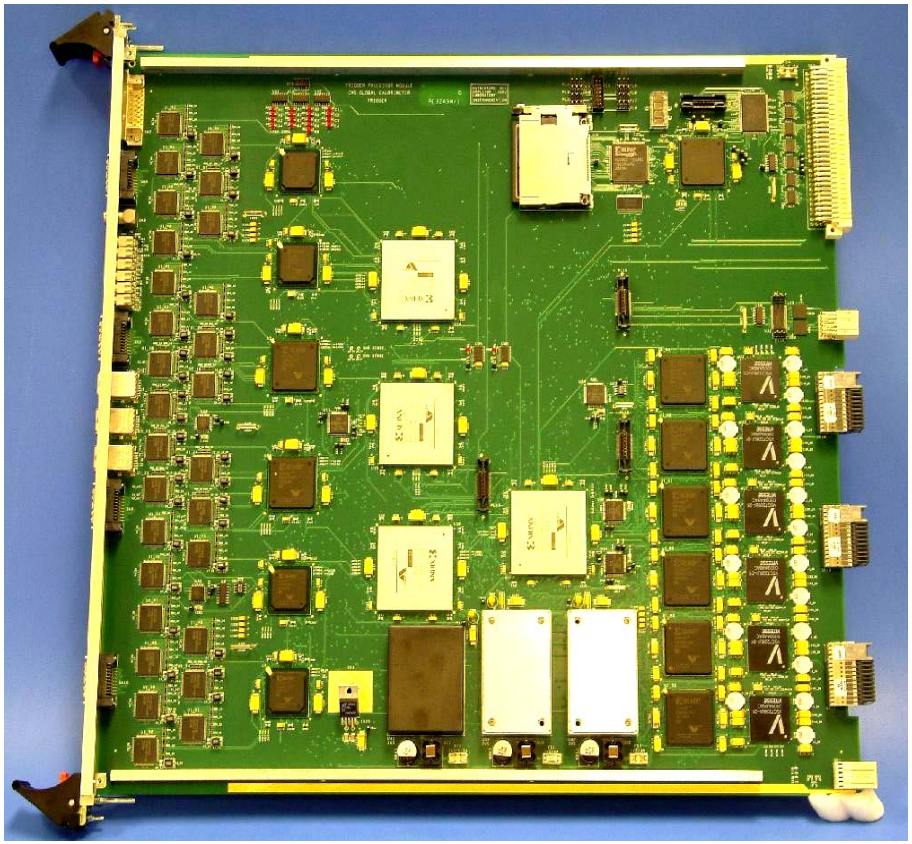


- Based on commercial components for processing and data transfer
- Four processing FPGAs, 3M gates, 14k logic cells
  - Pipelined logic and data transfers clocked at 160 MHz
- 1.44Gbit/s Front-panel I/O
  - 30 Gbit/s input data on 24 links
  - 7.5 Gbit/s output
- 3.2Gbit/s backplane
  - 60 Gbit/s in & out on 24+24 backplane links

Can we extend to a generic trigger processor for SLHC?

TPM design challenges

- Processing technology
  - Xilinx Virtex-II has been very successful
- High-speed data links
  - Serdes choice
  - Connectors and cables
  - Synchronisation
- System issues
  - Configuration
  - Control
  - Power distribution
- Firmware development and management

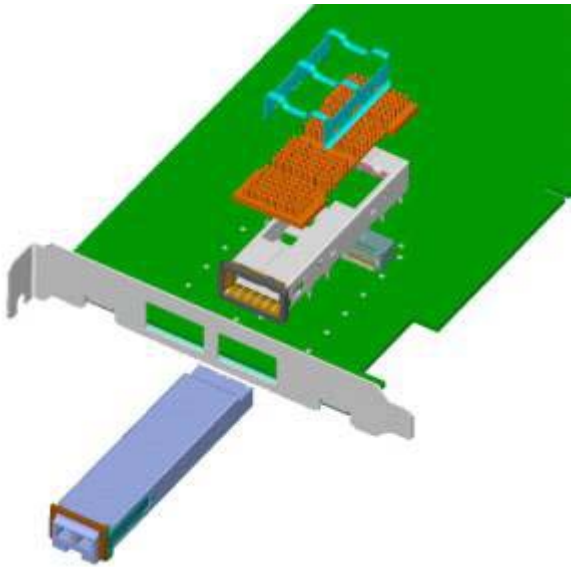


System Architecture

- GCT used a VME 9U based system:
  - Custom power
  - Custom J2/J3
- Move to a telecoms standard? E.g. Advanced TCA?
  - 8U boards
  - 6HP board pitch
  - Defined Gbit/s backplanes.

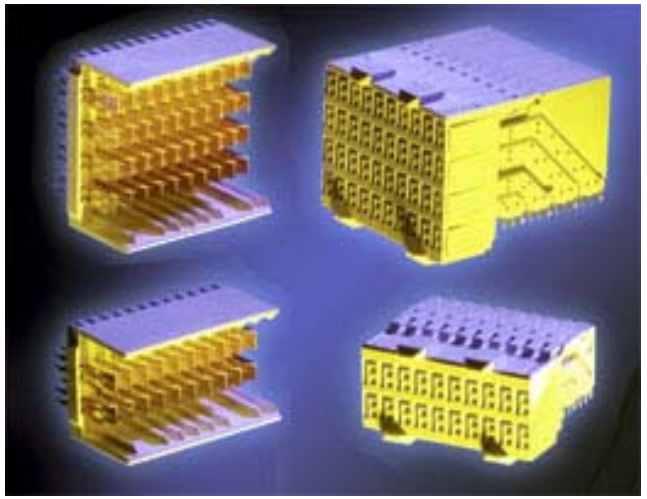
Front-Panel I/0 Extrapolation

- Use serdes inside processing devices
  - Increase density w.r.t discrete serdes
- Current TPM uses 1.44GBit/s per pa over Infiniband connectors.
- Use a pluggable system like XFP?
  - 10Gbit/s in 25mm front-panel space. (Can be double sided)
  - Standard fitting on board
    - plug in copper module for up to 1.5m
    - Fibre for inter-crate.
    - Up to 120 Gbit/s on front-panel (240Gbit/s double-sided)



Backplane I/O Extrapolation

- Currently 3.2Gbit/s per pair over Teradyne VHDM-HSD connectors. (Probably good to ~ 6Gbit/s)
- 10Gbit/s per pair over backplane with Tyco ZPack HM-ZD connectors. Up to 2Tbit/s per board
  - (c.f. Xilinx demo at SuperComm '04)
  - 9.8 Tbit/s on standard backplane. 16Tbit/s possible with custom backplane



TPM Summary

- System Platform: VME -> AdvancedTCA
- Serial I/O: 1.44GBit/s / 3.2Gbit/s -> 10Gbit/s
  - I/O per board: 9Gbit/s -> 2TBit/s
- Bus speed: 160Mbit/s.line -> 640Mbit/s.line
  - Number of high-speed lines – try not to increase to much (already 3000)
  - Clocking: system-synchronous -> source-synchronous?

Summary

- Off detector trigger electronics has the luxury of benefiting from the rise of fast serial optical links in industry
  - .... but watch latency in serializer/deserializers
- Eager to collaborate with other groups (though probably mainly as a consumer)
  - Links need increasingly sophisticated knowledge to design. Move to more “S-LINK” type projects and/or fewer varieties of cable/connectors/....