Trigger & DAQ Development

Wesley H. Smith

U. Wisconsin – Madison

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Outline:

- **Trigger & DAQ Challenges**
- **Strategies for Experiments**
- **Tools: FPGAs, AM, xTCA, Transceivers, GPU, PCIe**

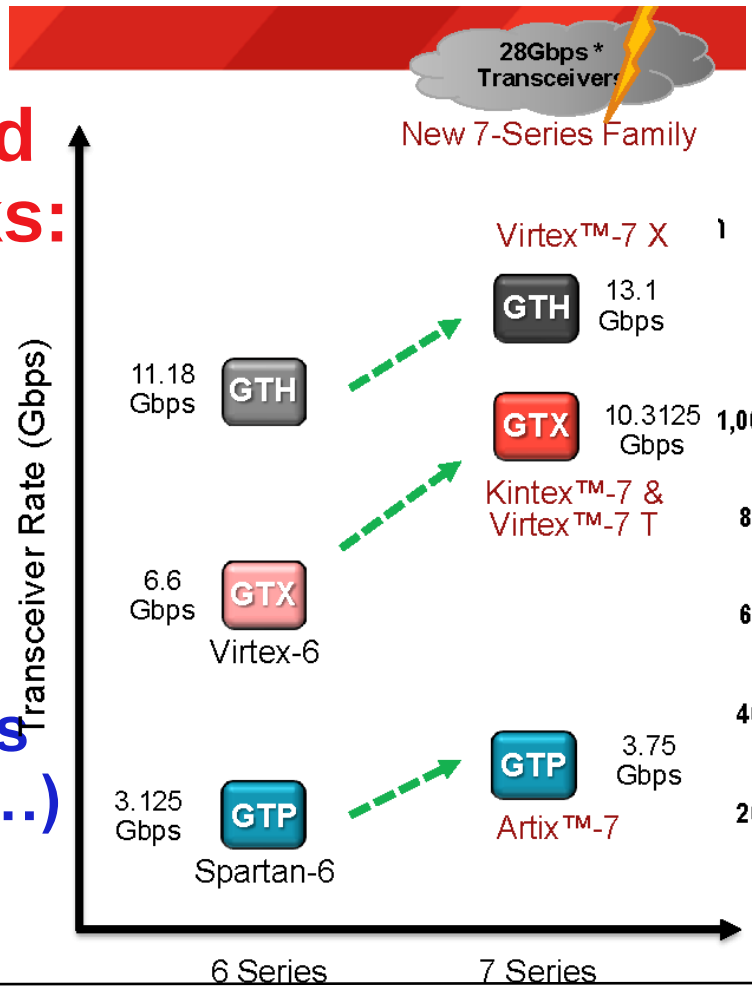
Tools for Triggers: FPGAs

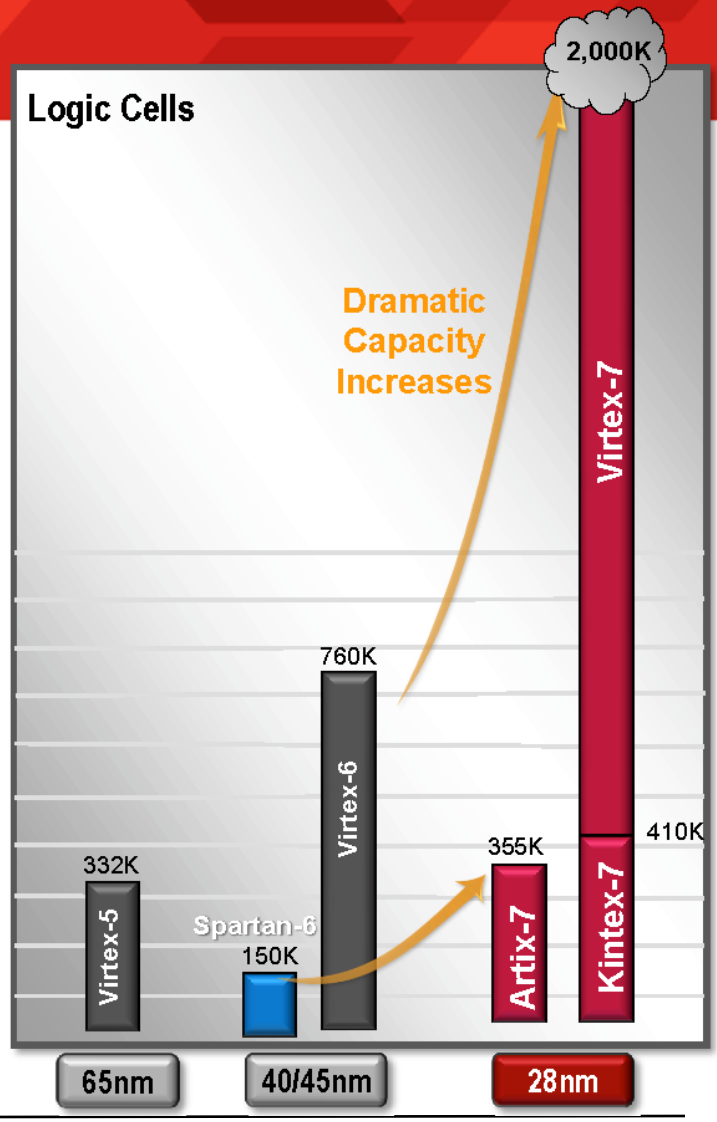
Logic Cells

- 28 nm: > 2X gains over 40 nm→

On-Chip High Speed Serial Links:

- Connect to new compact high density optical connectors (SNAP-12…)

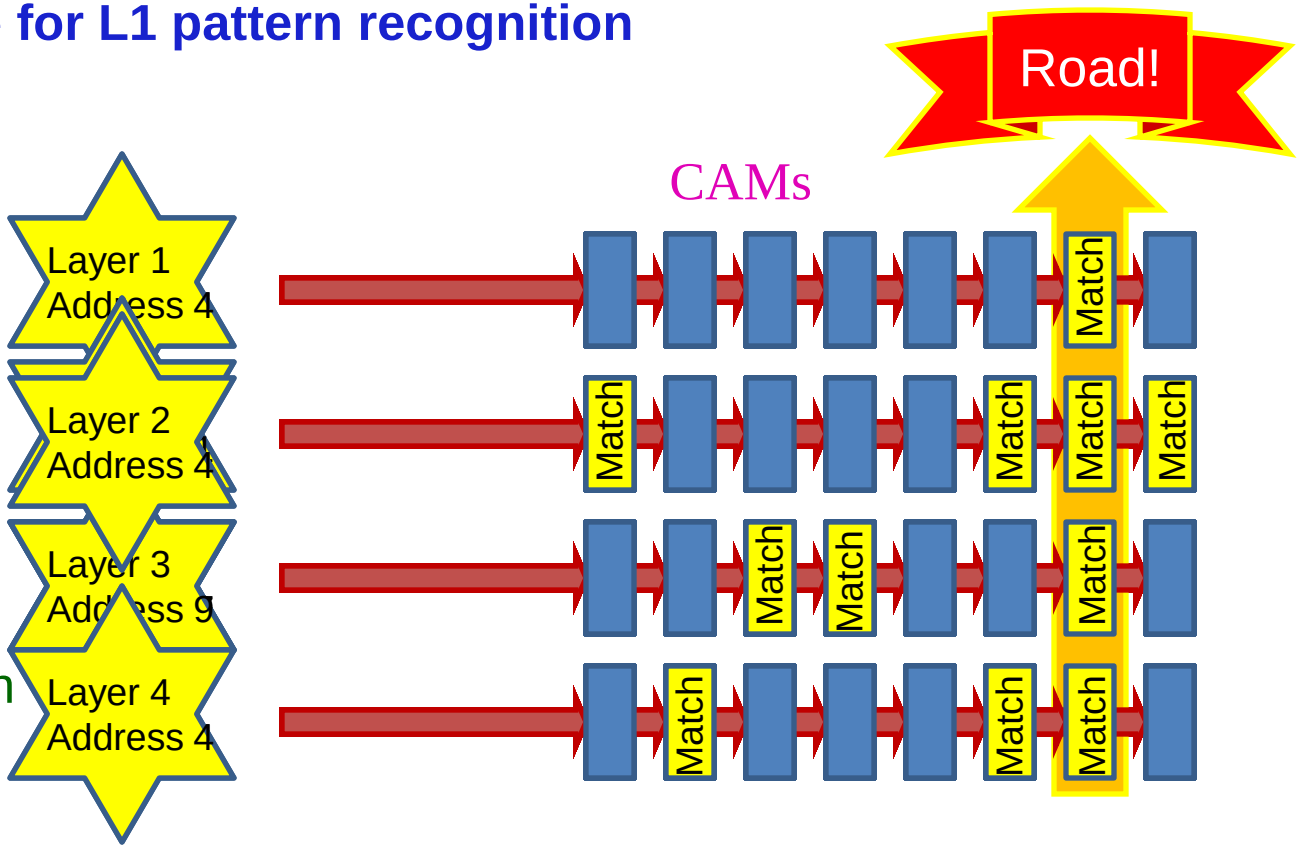




Tool for Tracking Triggers: Associative Memories

Pattern Recognition Associative Memory (PRAM)

- Based on CAM cells to match and majority logic to associate hits in different detector layers to a set of pre-determined hit patterns
- highly flexible/configurable, much less demand on detector design
- Pattern recognition finishes soon after hits arrive
- Potential candidate for L1 pattern recognition
- However: Latency
- Challenges:
  - Increase pattern density by 2 orders of magnitude
  - Increase speed x 3
  - Same Power
  - Use 3D architecture: Vertically Integrated Pattern Recognition AM - VIPRAM



Tools for Trigger/DAQ: ATCA

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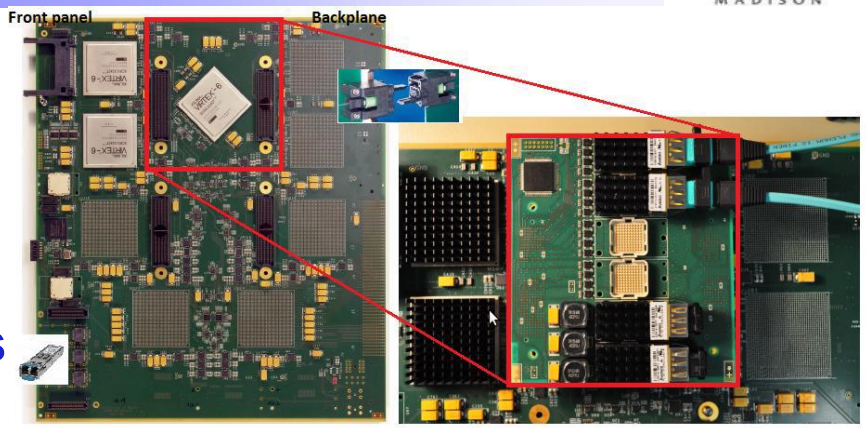
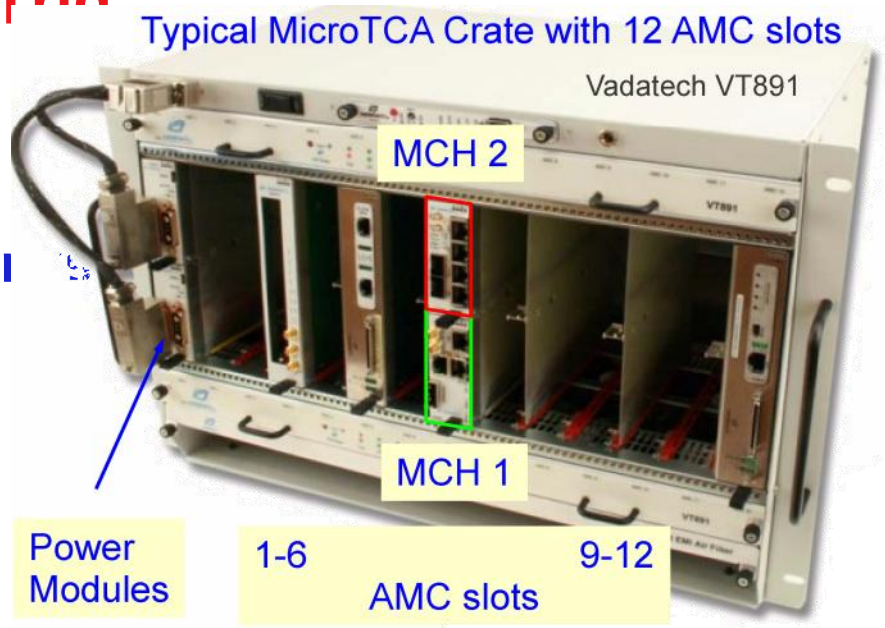
- Advanced Telecommunications Computing Architecture ATCA
- Example: ATLAS Upgrade Calorimeter Trigger Topological Processor Card
  - 12-chan. ribbon fiber optic modules
  - Backpl. opt. ribbon fiber connector
- Example: µTCA derived from AMC std. used by CMS HCAL, Trig
  - Advanced Mezzanine Card
  - Up to 12 AMC slots
    - *Processing modules*
  - 6 standard 10Gb/s point-to -point li slot to hub slots (more available)
  - Redundant power, controls,clocks
  - Each AMC can have in principle (20) 10 Gb/sec ports
  - Backplane customization is routine & inexpensive





R&D Topics: Trigger

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Increase of rate from Level-0 to HLT to read out
- Absolute rate & balance between levels

L1 complexity vs. HLT input rates
- Study the trade-offs

L1 Trigger Latency
- How much is needed & consequences on electronics

L1 Track Triggers
- Associative Memories
- Study techniques: sharpen p_T threshold, e- & μ- ID, Isolation, primary vertex for jets, multi-object triggers, possibility of pixel b-tag.
- Interplay with tracker design

Improvements to L1 Calo. & Muon Triggers
- Processing of much finer-grain, higher bandwidth information

Impact of higher bandwidth links & denser optical interconnects

New packaging & interconnect technologies
- ATCA, μTCA, RCE

Use of FPGAs in L1 Trigger

Impact of detector timing improvements (~100 ps)
- e.g. crystal calorimeters (CMS: PbWO3 has ~ 150 ps, LYSO < 100 ps)