The DØ Level 3
Data Acquistion System

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Outline
System Overview
Performance
Running Experience
Future Plans

CHEP
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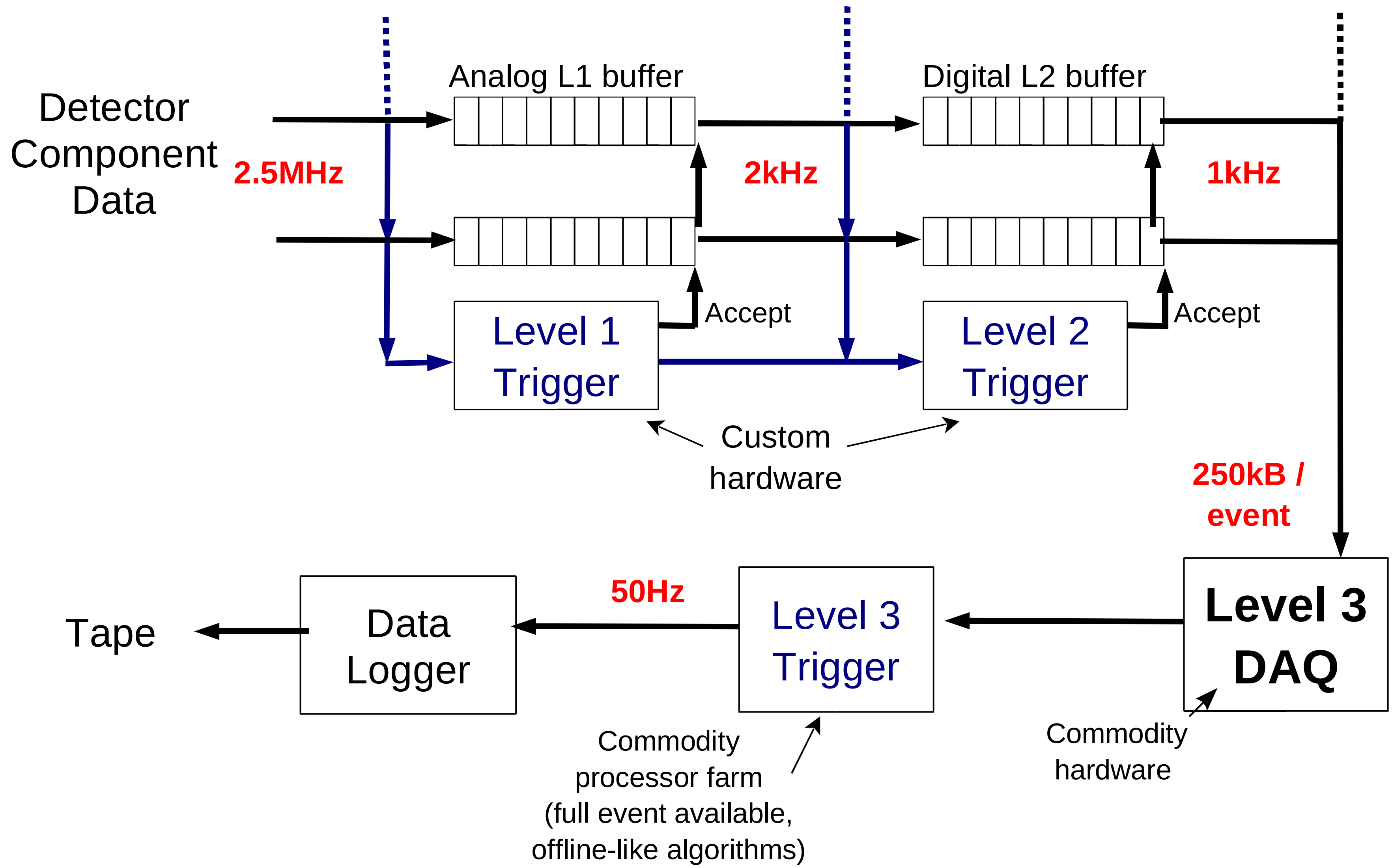
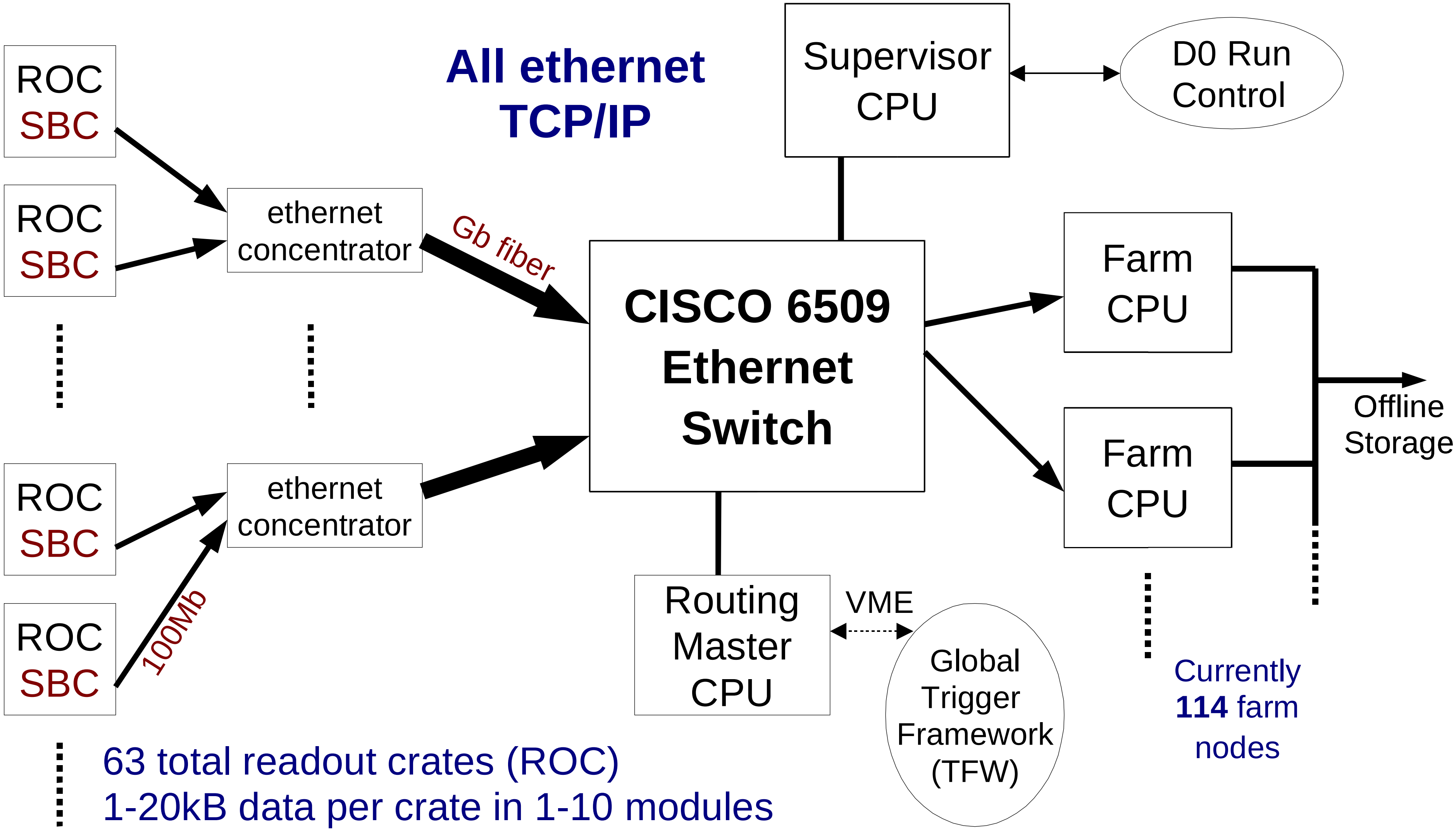
D0 Data Acquisition System



L3DAQ: Commodity-Based System



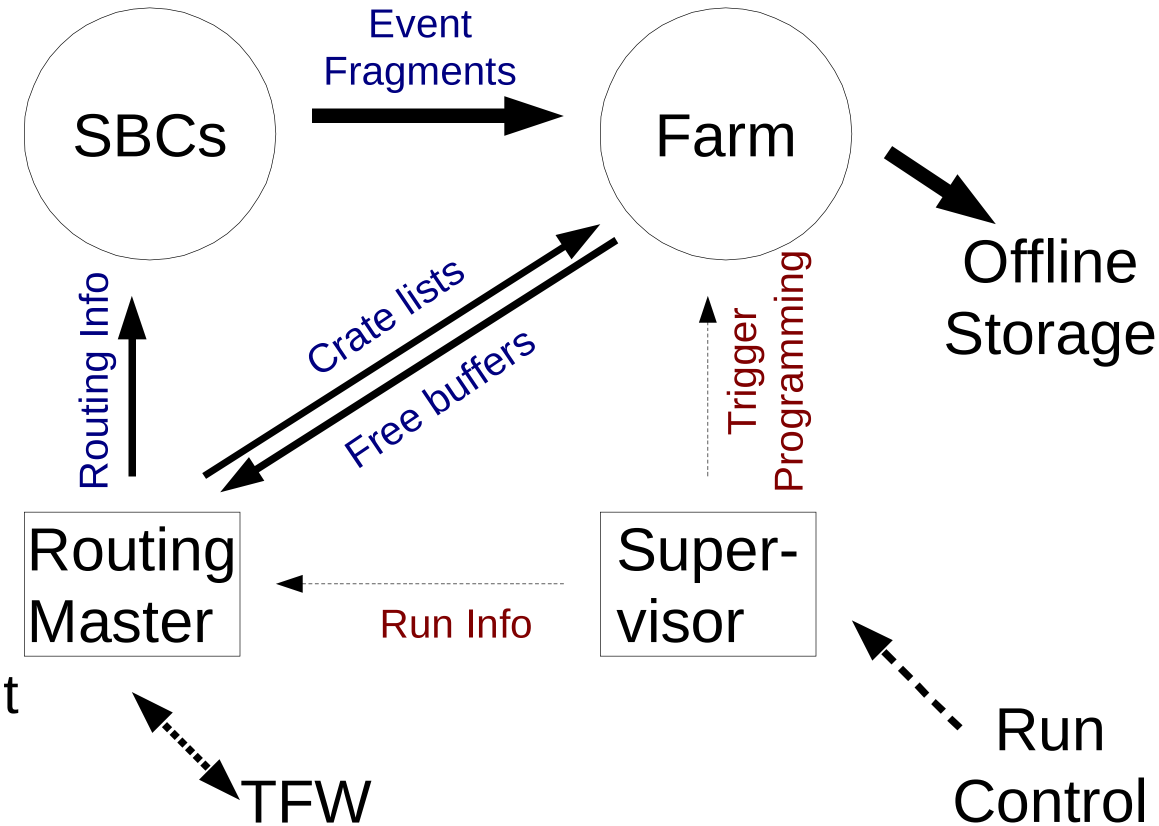
63 total readout crates (ROC)
1-20kB data per crate in 1-10 modules
One Single board VME computer (SBC) per crate

L3DAQ Operation

Partitioning
- Simultaneous runs
- choose destination node based on triggers

Flow Control
- TCP settings limit amount of data in-flight
  - avoid packet loss in switch
- Token scheme limits number of events in-flight
- Supress triggers if farm fills up

Software
- Linux
- C++
- Many shell scripts

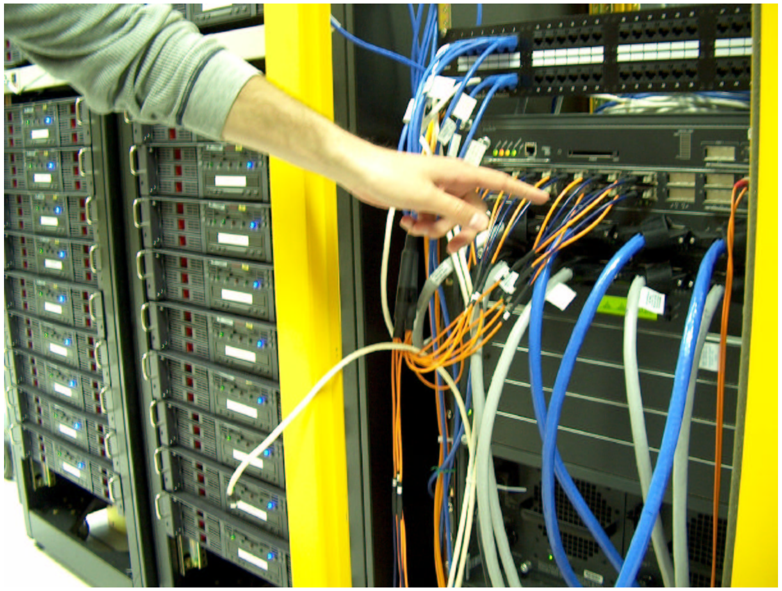


Serving the Needs of D0 since May 2002

Components

SBCs

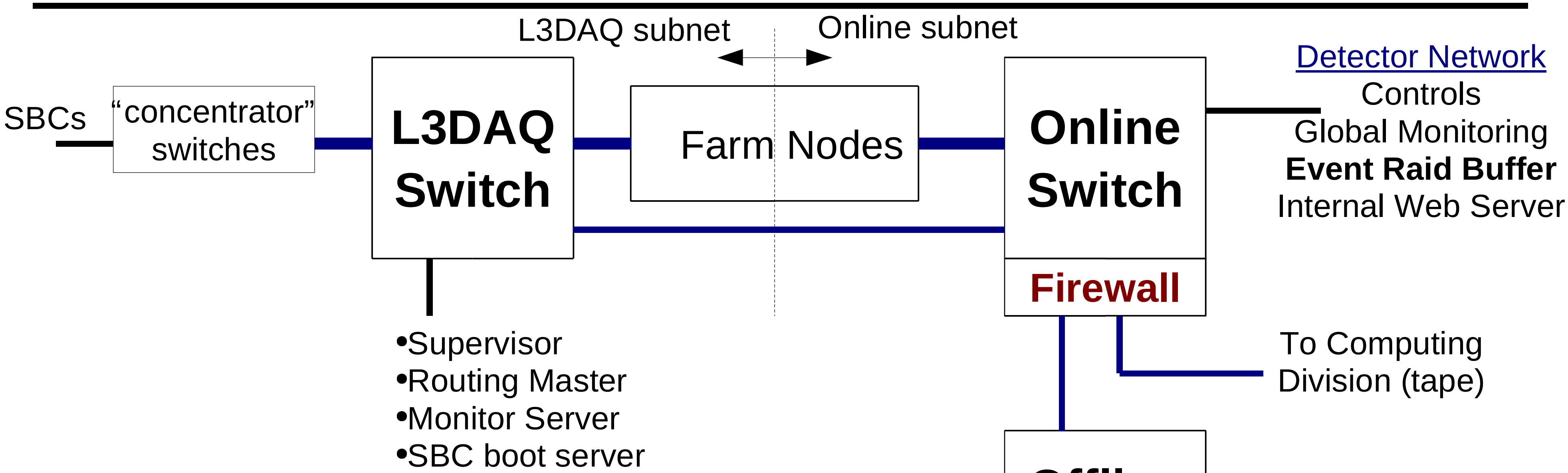
- VMIC-7750, PIII 933MHz, 128MB RAM
- 128MB CompactFlash
- VME UniverseII
- Dual 100Mb ethernet (Intel EEPRO)

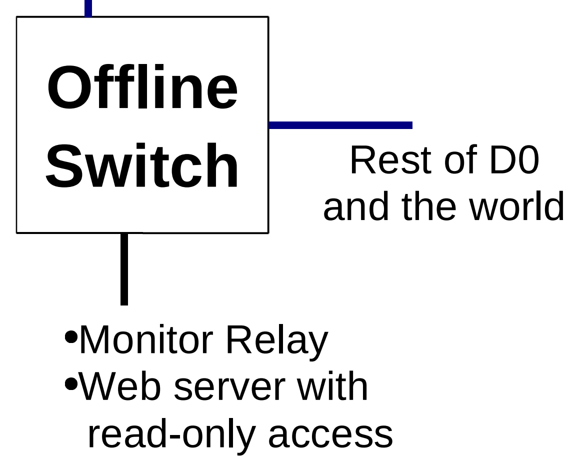


Farmnodes

- Dual Processor
  - PIII 1GHz (48)
  - AMD2000 1.6GHz (34)
  - Xeon 2.8GHz (32) NEW!
- Dual 100Mb ethernet

Network Topology





Security - Firewall

- Kerberized (or cryptocard) ssh only to Online
  - ssh port-forwarding feature is useful
- Firewall holes for
  - External monitor server relay
  - External web server
    - read-only access to some NFS disks

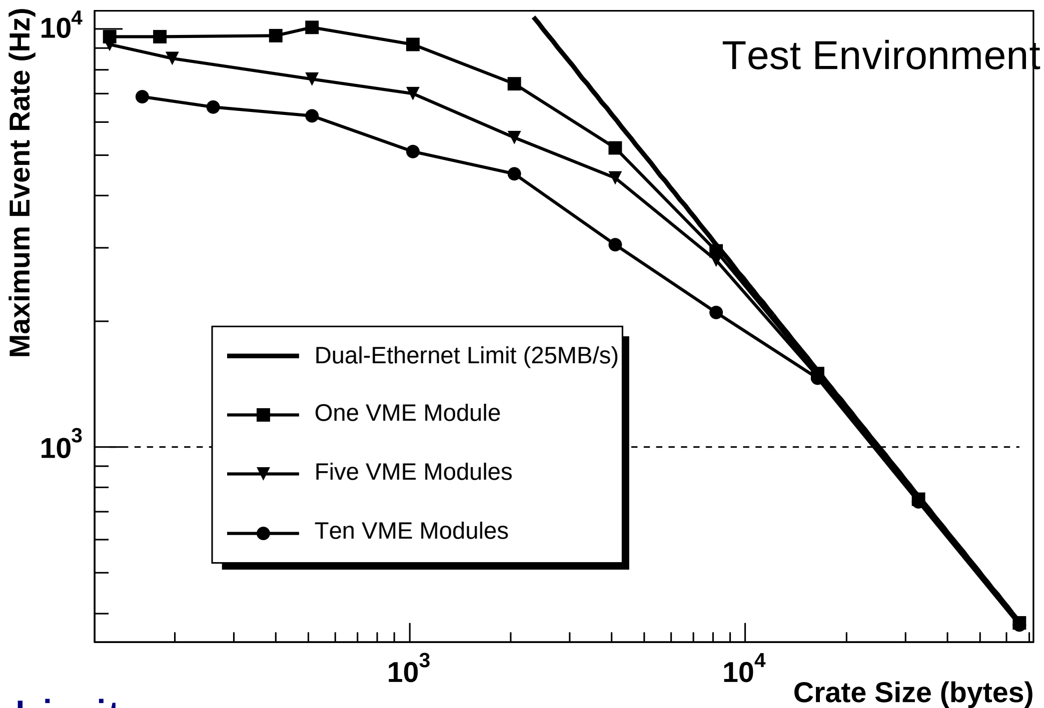
SBC Performance

SBC Operation

- Custom kernel module
  - VME reads
  - Event fragment buffering
- User-level process
  - matches route info to fragments
  - Sends to node(s)
    - no explicit data-copying

Dual ethernet operation

- On crates with large payload
- two connections from each farmnode
- Bind connection to interface
- toggle sending between connections



Limits

- Reach dual-ethernet limit for crate size > 20kB
- VME overhead is main limit for < 20kB
- CPU limited near 10kHz
  - D0 design is 1kHz

SBC Running Experience

Board quality is good

- No problems in over three years
- keyboard/video connectors – very useful

CompactFlash disk is **very** slow

- only used to store config information
- network boot and RAM disk much faster
  - NFS mounted software/log area

Some kernel/driver/EEPRO issues

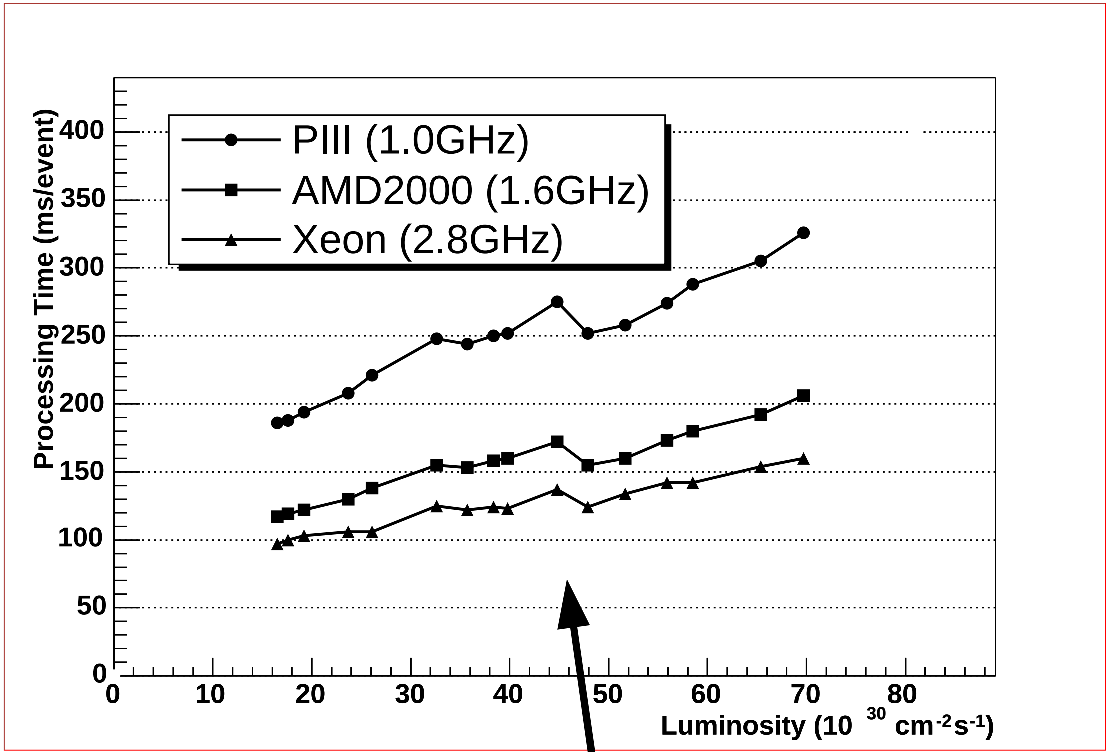
- Mysterious packet loss with some driver/kernel combos:
  - 2.4.20 and non-Intel (Becker) driver
  - 2.4.26 and Intel driver
- Using 2.4.26 and non-Intel (Becker) driver successfully

L3 Farm Performance

Relative Performance

PIII 1GHz:	**1.0**
AMD2000 1.6GHz:	**1.6**
Xeon 2.8GHz:	**2.0**

- Scaling is non-linear with GHz (or AMD rating)
- Real limit probably memory bandwidth
  - most L3 Filter data structures are larger than cache size



Track triggers prescaled

Farm Running Experience

Farm node hardware breaks often

- Typically hard drives and CPU fans
  - Hard drives fail incrementally (frustrating)
- About one machine/month requires warranty service
- Minor problems about once/week
- Correlation with age and component quality
  - AMD2000 nodes are actually worst offenders

Software must assume nodes will crash / be unavailable

- SBCs, RM, and Supervisor: robust connection handling
  - Supervisor reassigns nodes dynamically
  - Farm nodes initiate connections to RM and SBCs
- Our version and control software not as clever (later slides)

Farm Upgrade Experience

Newest group of nodes

- 32 Xeon 2.8GHz (one rack) installed 3 months ago
- Procurement time about 4 months total: desire to delivery
  - Purchase fully assembled racks with on-site service from single vendor

Fermilab Computing Division experience valuable

- Very strict vendor requirements
  - Specify cable quality, certified memory, power/heat limits
  - Require some known good subcomponents (cat5 cable)
- Most problems caught in advance
  - Site visits by vendors!
  - At least one rack fully assembled and inspected at vendor site

L3DAQ Future Plans

A few SBCs to be replaced

- Gb ethernet versions needed
  - tracking occupancies will increase crate size beyond 20kB/crate
- Evaluation SBC ordered – expect no issues
  - Tests by others (CDF) claim 40MB/s sustained

Continuous farm upgrades

- Oldest nodes (PIII 1GHz) now 3yrs old
- Plan to replace oldest set of nodes every year
  - Can react quickly to needs
    - processing needs difficult to predict long-term

Rework versioning and control software

- Easier long-term management
- Less expert involvment
- Improve reliability

Versioning and Control

Current versioning and control system

- Relatively simple shell scripts, remote shell
- Some (not enough!) web interfaces
- Active-user scheme
  - User required to check system state and correct it
    - Specific nodes/SBCs passed to control scripts
  - Many opportunities to make mistakes
    - Especially with farm node failure/recovery frequency
    - Experts modifying farm nodes for tests

Plan underway

- Implement a state-machine on each node/SBC
- User specifies desired state of entire system
  - Stored in central DB – web configurable?
- State-machine runs appropriate scripts to reach state

Versioning and Control

State-machine candidate: **cfengine**

- Common opensource software package used to keep configurations up-to-date for large clusters
  - Set links, modify config files, sync files
- Can run arbitrary scripts
  - On boot, on request, or periodically

Initial software download to farm nodes

- L3 filter software package is ~300MB (180MB gzipped)
  - Executables, libraries, calibration data
- Chained rcp or rsysnc takes several minutes to complete
- Successfully tested **BitTorrent**
  - Balanced p2p filesharing system (like kazaa, napster)
  - Takes full advantage of node-to-node bandwidth
  - Test: 180MB gzip file to 32 nodes in under 45s!

Conclusions

D0 L3 DAQ in operation since May 2002

- Commodity-based system
- Meets/exceeds current needs of D0

Upgrade paths straightforward

- Replace subset of farm every year
- Limited as-needed front-end (SBCs) replacement

Ease-of-use improvments

- Versioning and Control software replacement