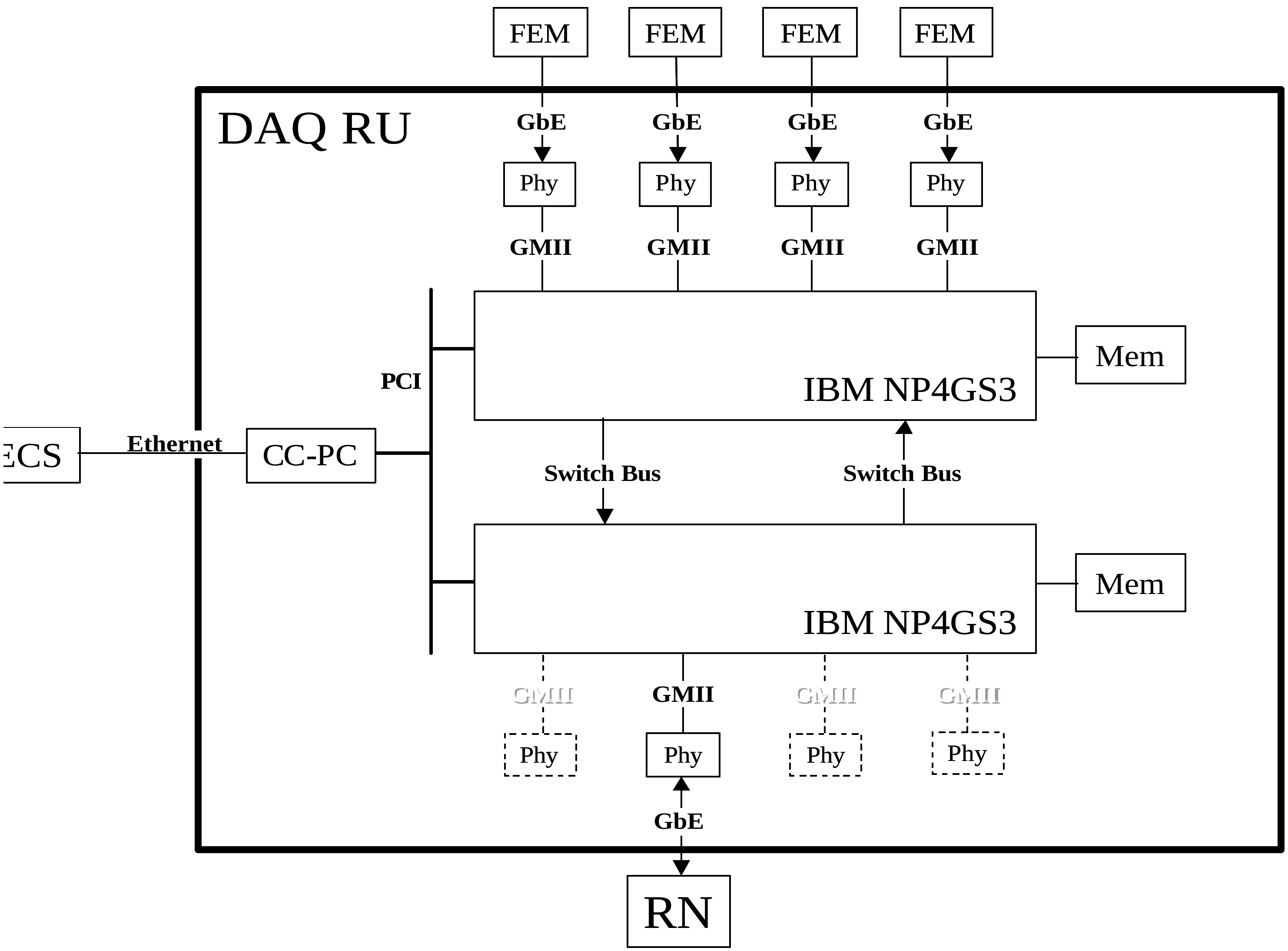
Readout Unit using Network Processors



IBM NP4GS3

- 4 x 1Gb full duplex Ethernet MACs
- 16 RISC processors @ 133 MHz
- Up-to 64 MB external RAM
- Used in routers

RU Functions

- EB and formatting
- 7.5 ?sec/event
- ~200 kHz evt rate

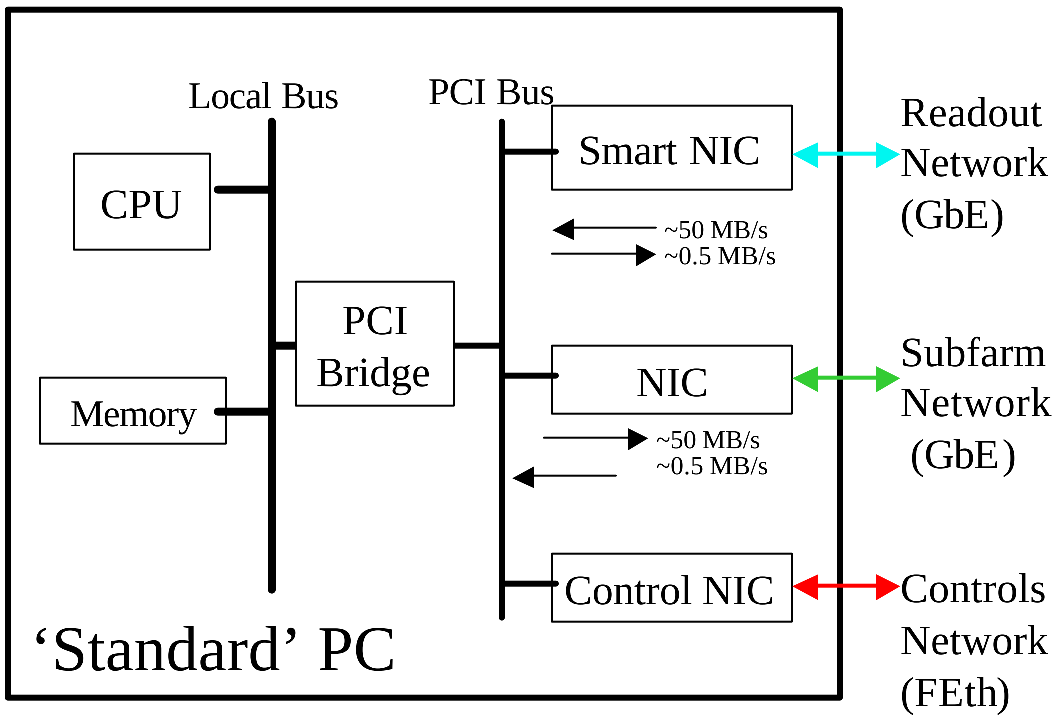
Sub Farm Controller (SFC)

Alteon Tigon 2

- Dual R4000-class processor running at 88 MHz
- Up to 2 MB memory
- GigE MAC+link-level interface
- PCI interface
- ~90 kHz event fragments/s

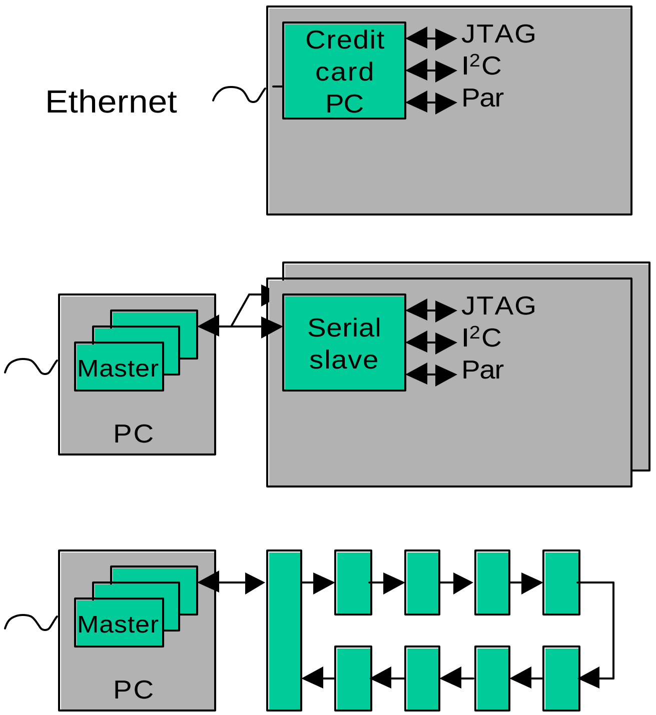
Development environment

- GNU C cross compiler with few special features to support the hardware
- Source-level remote debugger



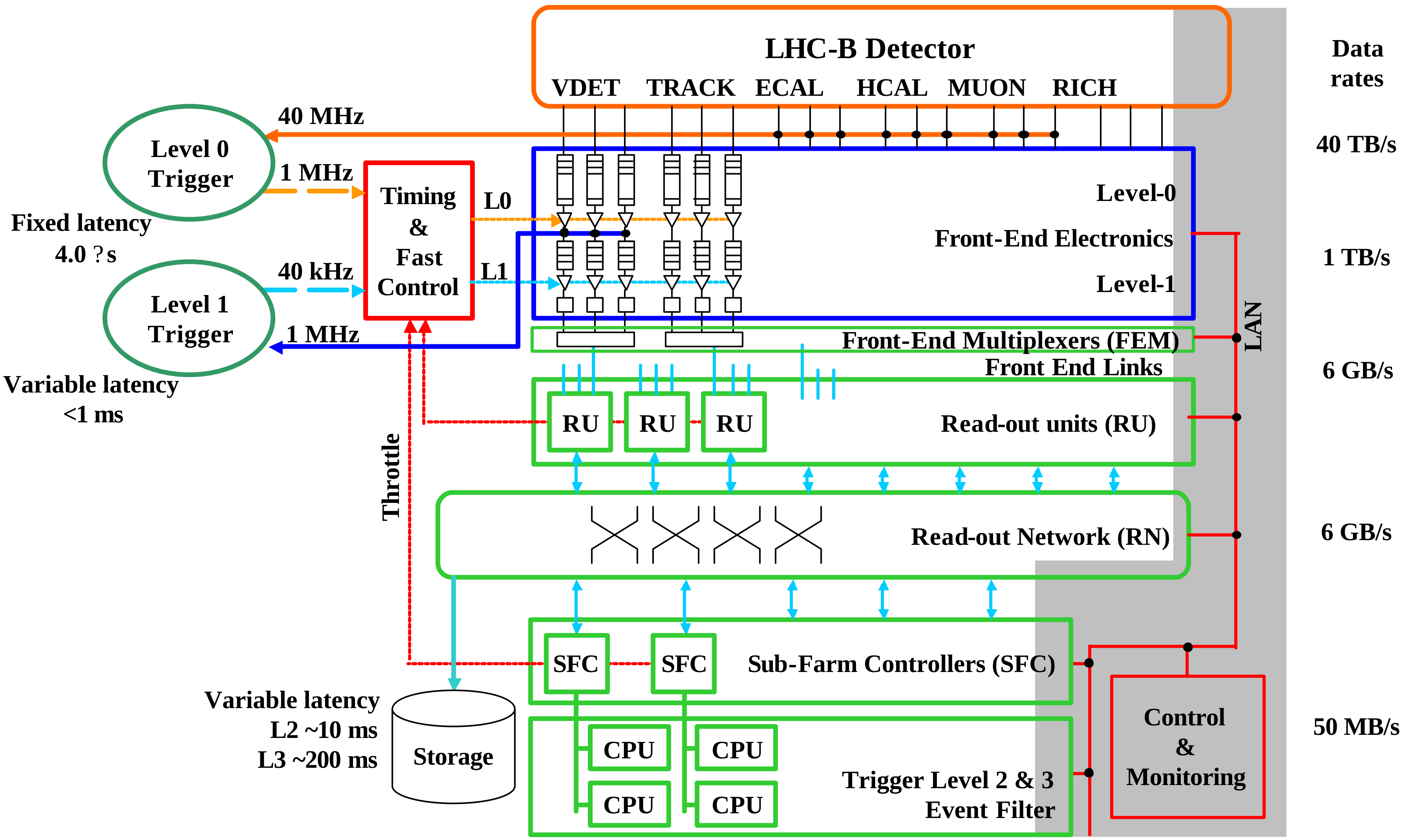
Control Interface to Electronics

- Select a reduced number of solutions to interface Front-end electronics to LHCb's control system:
  - No radiation (counting room):
    Ethernet to credit card PC on modules
  - Low level radiation (cavern):
    10Mbits/s custom serial LVDS twisted pair
    SEU immune antifuse based FPGA interface chip
  - High level radiation (inside detectors):
    CCU control system made for CMS tracker
    Radiation hard, SEU immune, bypass
- Provide support (HW and SW) for the integration of the selected solutions



Experiment Control System

Control and Monitoring



Experimental Control System

- The Experiment Control System will be used to control and monitor the operational state of the detector, of the data acquisition and of the experimental infrastructure.
- Detector controls
  - High and Low voltages
  - Crates
  - Cooling and ventilation
  - Gas systems etc.
  - Alarm generation and handling
- DAQ controls
  - RUN control
  - Setup and configuration of all readout components (FE, Trigger, DAQ, CPU Farm, Trigger algorithms,...)

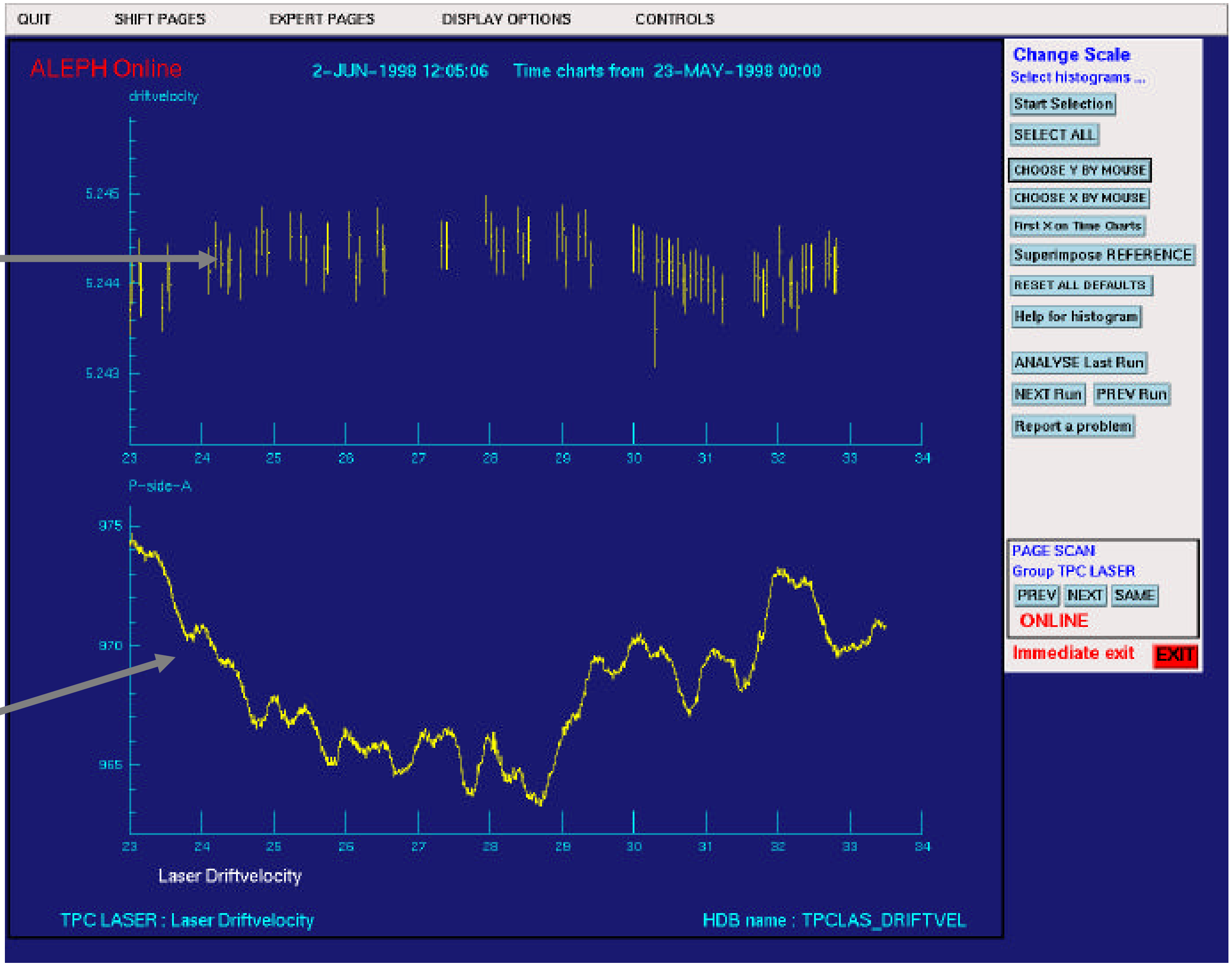
System Requirements

- Common control services across the experiment
  - System configuration services – coherent information in database
  - Distributed information system – control data archival and retrieval
  - Error reporting and alarm handling
  - Data presentation – status displays, trending tools etc.
  - Expert system to assist shift crew
- Objectives
  - Easy to operate – 2/3 shift crew to run complete experiment
  - Easy to adapt to new conditions and requirements
- Implies integration of DCS with the control of DAQ and data quality monitoring

Integrated System – trending charts

DAQ

Slow Control



Integrated system – error logger

DAQ →

Slow Control →

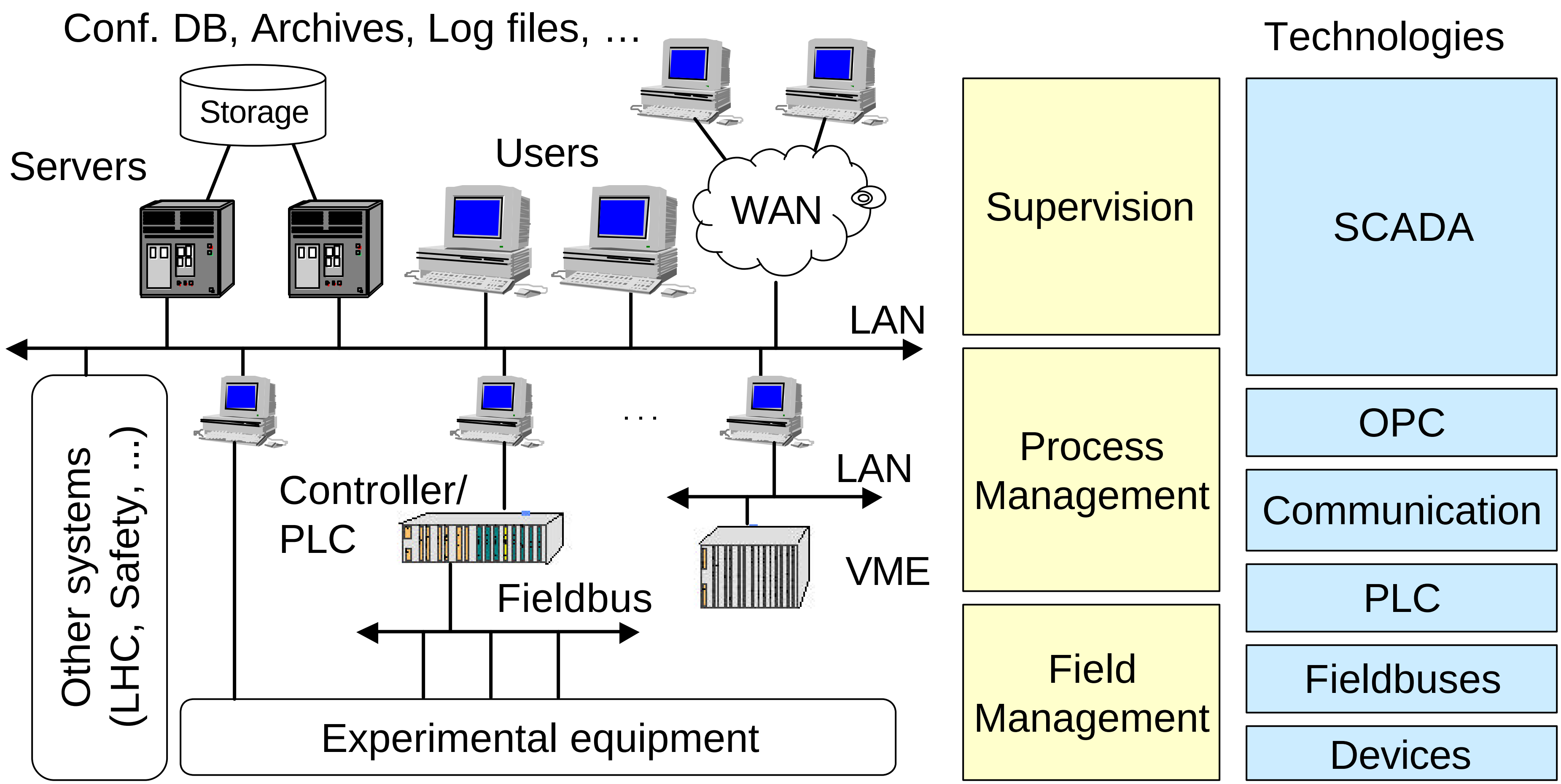
```
                 ALEPH error logger, ERRORS + MONITOR + ALARM

2-JUN 11:30 ALEP R_ALEP_0 RUNC_DAQ     ALEPH>> DAQ Error
2-JUN 11:30 ALEP TPEBAL   MISS_SOURCE  TPRP13 <1_missing_Source(s)>
2-JUN 11:30 ALEP TS       TRIGGERERROR Trigger protocol error(TMO_Wait_No_Busy)
2-JUN 11:30 TPC  SLOWCNTR SECTR_VME    VME CRATE fault in: SideA Low
```

Scale of the LHCb Control system

- Parameters
  - Detector Control: O (10^5) parameters
  - FE electronics: Few parameters x 10^6 readout channels
  - Trigger & DAQ: O(10^3) DAQ objects x O(10^2) parameters
  - Implies a high level description of control components (devices/channels)

- Infrastructure
  - 100-200 Control PCs
  - Several hundred credit-card PCs.
  - By itself a sizeable network (ethernet)

LHCb Controls Architecture



Supervisory Control And Data Acquisition

- Used virtually everywhere in industry including very large and mission critical applications
- Toolkit including:
  - Development environment
  - Set of basic SCADA functionality (e.g. HMI, Trending, Alarm Handling, Access Control, Logging/Archiving, Scripting, etc.)
  - Networking/redundancy management facilities for distributed applications
- Flexible & Open Architecture
  - Multiple communication protocols supported
  - Support for major Programmable Logic Controllers (PLCs) but not VME
  - Powerful Application Programming Interface (API)
  - Open Database Connectivity (ODBC)
  - OLE for Process Control (OPC)

Benefits/Drawbacks of SCADA

- Standard framework => homogeneous system
- Support for large distributed systems
- Buffering against technology changes, Operating Systems, platforms, etc.
- Saving of development effort (50-100 man-years)
- Stability and maturity – available immediately
- Support and maintenance, including documentation and training
- Reduction of work for the end users
- Not tailored exactly to the end application
- Risk of company going out of business
- Company's development of unwanted features
- Have to pay

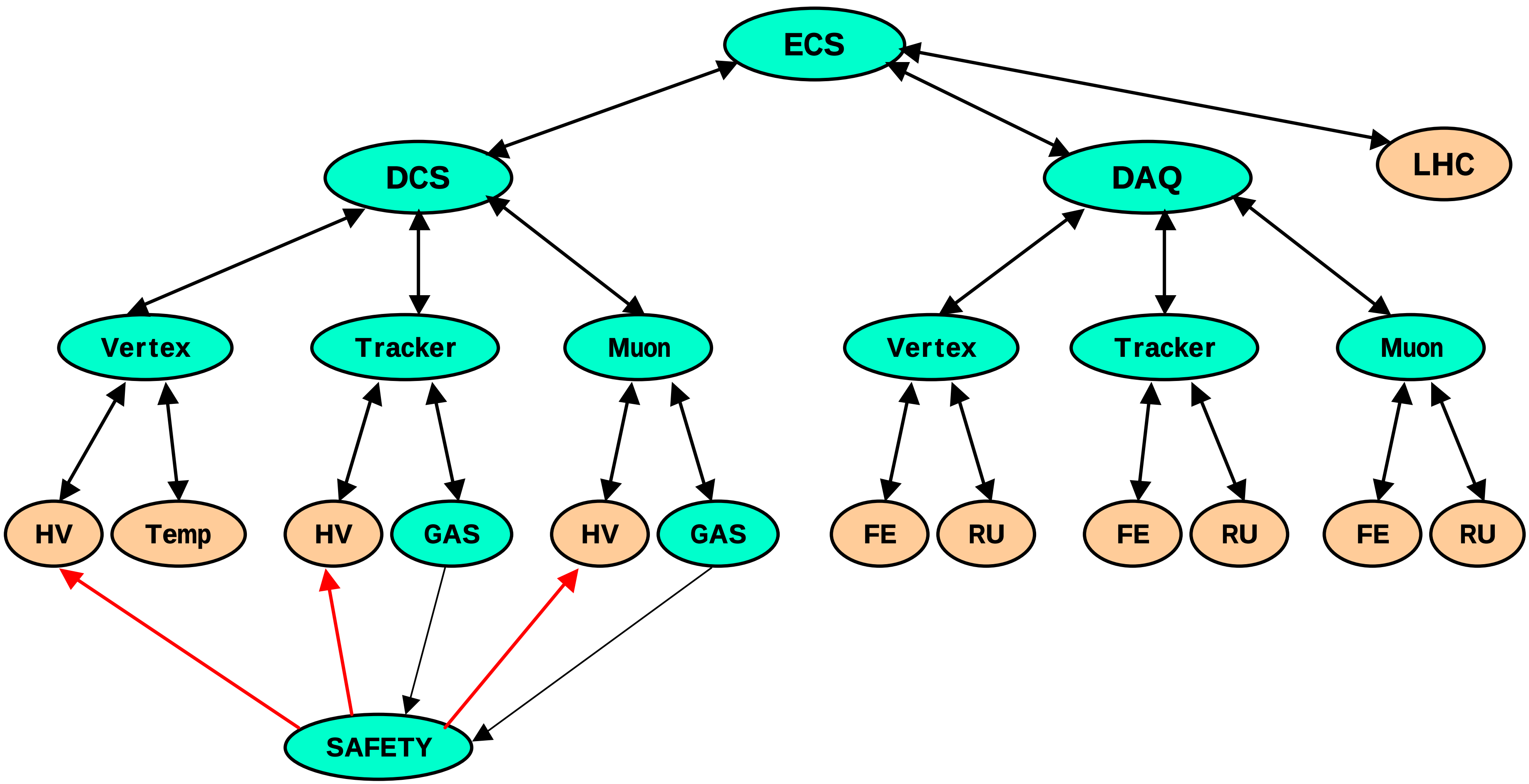
Commercial SCADA system chosen

- Major evaluation effort
  - technology survey looked at ~150 products
- PVSS II chosen from an Austrian company (ETM)
  - Device oriented, Linux and NT support
- The contract foresees:
  - Unlimited usage by members of all institutes participating in LHC experiments
  - 10 years maintenance commitment
  - Training provided by company - to be paid by institutes
  - Licenses available from CERN from October 2000
- PVSS II will be the basis for the development of the control systems for all four LHC experiments (Joint COntrols Project)

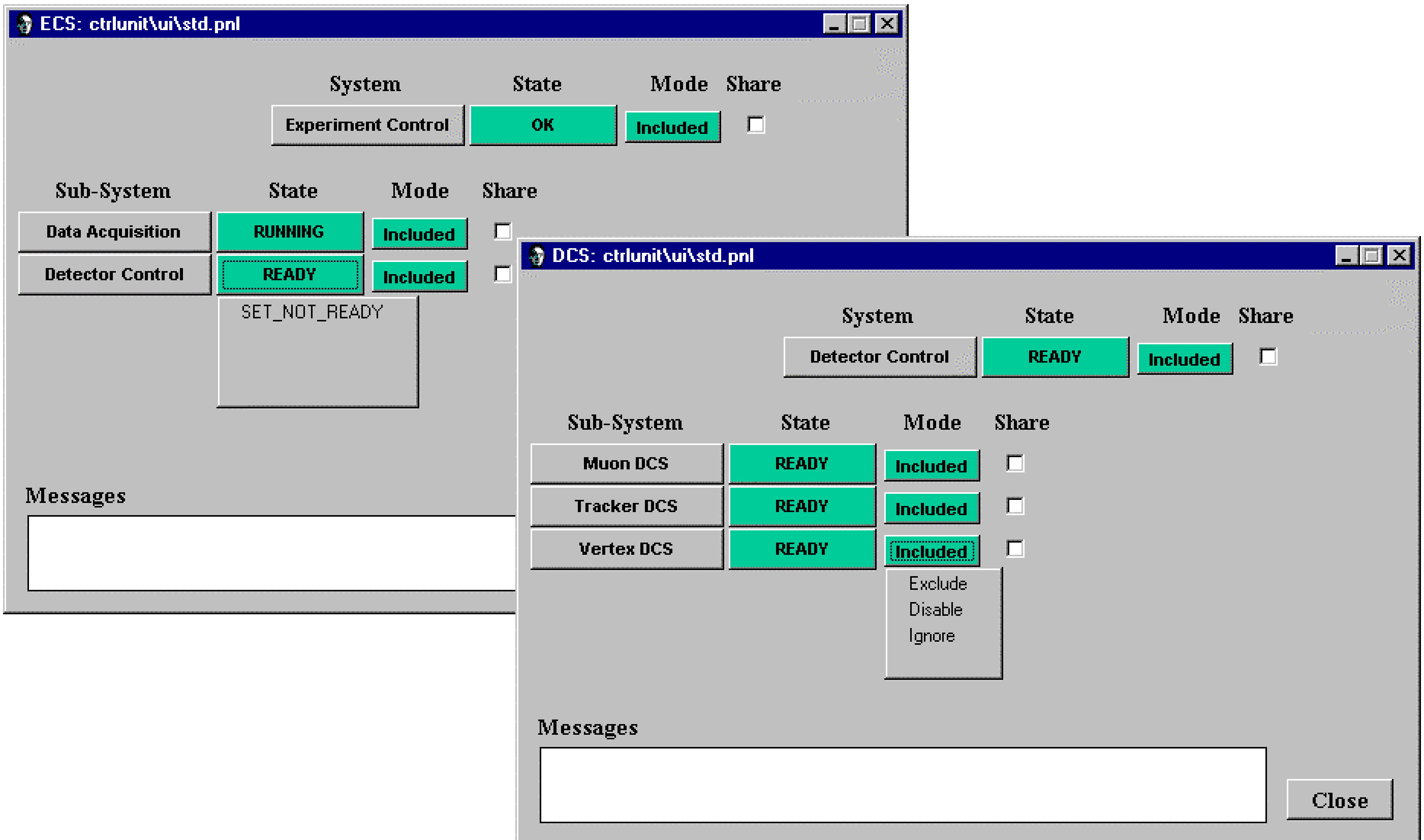
Controls Framework

- LHCb aims to distribute with the SCADA system a framework
  - Reduce to a minimum the work to be performed by the sub-detector teams
  - Ensure work can be easily integrated despite being performed in multiple locations
  - Ensure a consistent and homogeneous DCS
- Engineering tasks for framework :
  - Definition of system architecture (distribution of functionality)
  - Model standard device behaviour
  - Development of configuration tools
  - Templates, symbols libraries, e.g. power supply, rack, etc.
  - Support for system partitioning (uses FSM)
  - Guidelines on use of colours, fonts, page layout, naming, ...
  - Guidelines for alarm priority levels, access control levels, etc.
- First Prototype released end 2000

Application Architecture



Run Control



ECS: ctrlunit\ui\std.pnl
System
State
Mode
Share
Experiment Control
OK
Included
Sub-System
State
Mode
Share
Data Acquisition
RUNNING
Included
Detector Control
READY
Included
SET_NOT_READY
Messages
DCS: ctrlunit\ui\std.pnl
System
State
Mode
Share
Detector Control
READY
Included
Sub-System
State
Mode
Share
Muon DCS
READY
Included
Tracker DCS
READY
Included
Vertex DCS
READY
Included
Exclude
Disable
Ignore
Messages
Close

Summary

- Organisation has important consequences for cohesion, maintainability, manpower needed to build system
- Architecture driven development maximises common infrastructure and results in systems more resilient to change
- Software frameworks maximuse level of reuse and simplify distributed development by many application builders
- Use of industrial components (hardware and software) can reduce development effort significantly
- DAQ is designed with simplicity and maintainability in mind
- Maintain a unified approach – e.g. same basic infrastructure for detector controls and DAQ controls

Extra Slides