DAQ and Online

WBS 1.3

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Introduction

- Outline
  - Organization chart
  - Structure of DAQ/Online system
  - Run IIb requirements and changes
  - Details of component upgrades
  - Cost, Effort, Risk Analysis

Organization

D0 Run IIb Project
J. Kotcher, Project Manager
R. Partridge, Deputy; V. O'Dell, Associate; W. Freeman, Assistant
M. Johnson, Technical Coordinator
C. Yoshikawa, Budget Officer; T. Erickson, Administration

Online group has excellent record of providing working network, host, and control systems, fully operational since earliest days of Run IIa commissioning

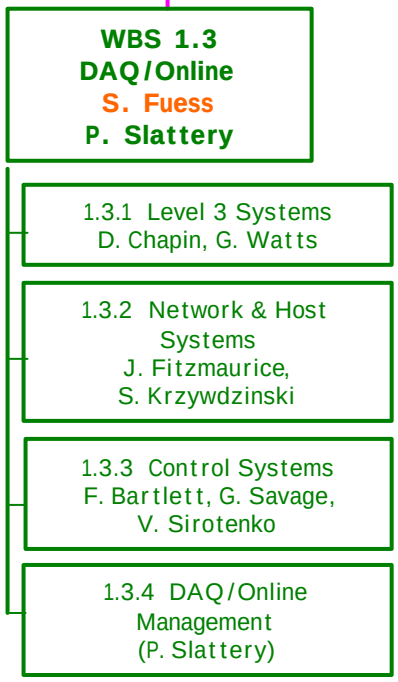
- Much credit goes to Computing Division for their contributions

In 12/2001 group reorganized to include new DAQ (readout and event building) initiative

- Successfully designed and installed state-of-the-art commodity-based DAQ system now in active use
  - kHz capable system ready for Run IIb

Online group is also represented in D0's Computing and Run IIa Operations organizational structure

- Integrated Run IIa / IIb / Computing planning

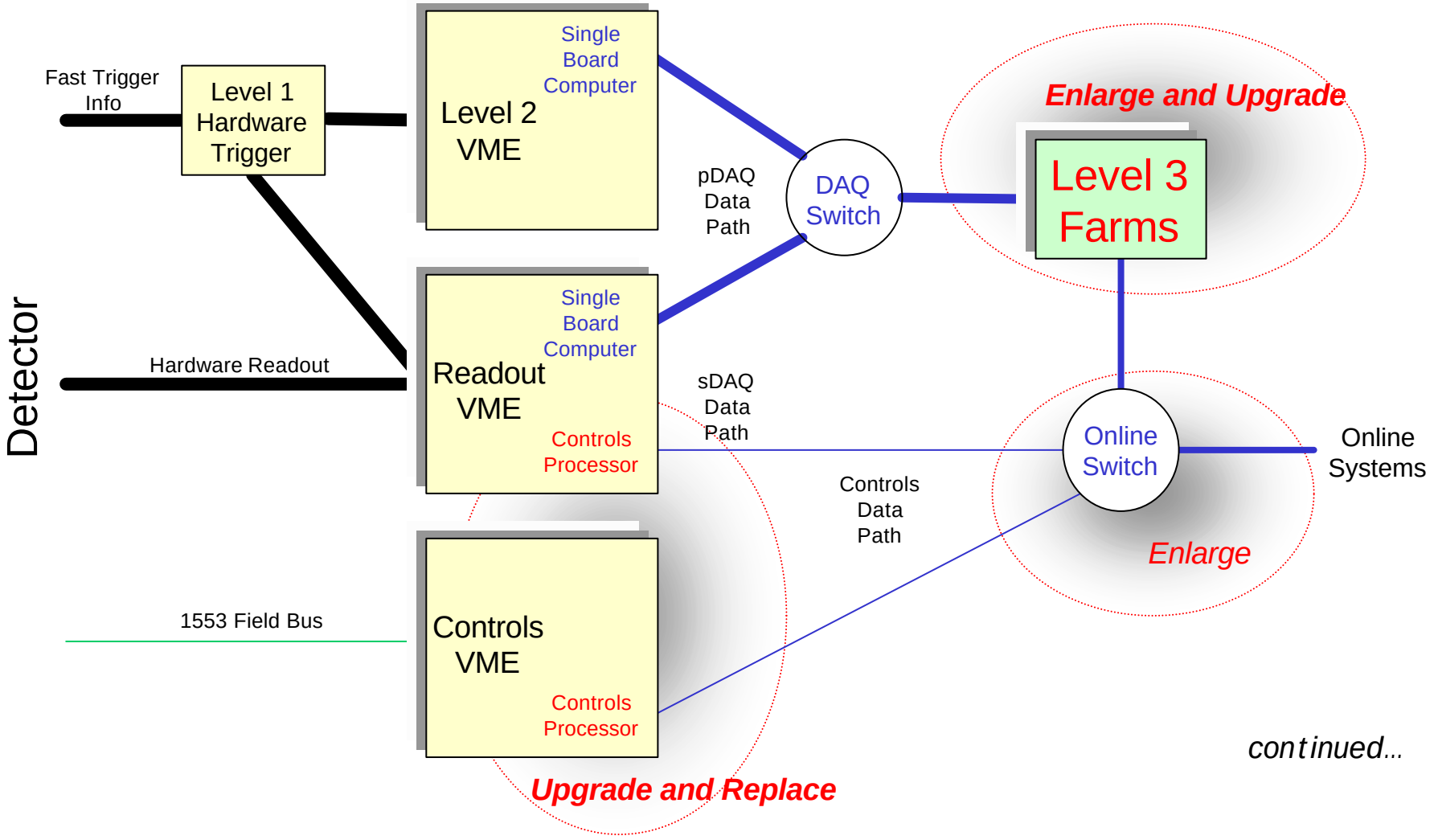


Structure of DAQ/Online

The DAQ/Online system consists of:

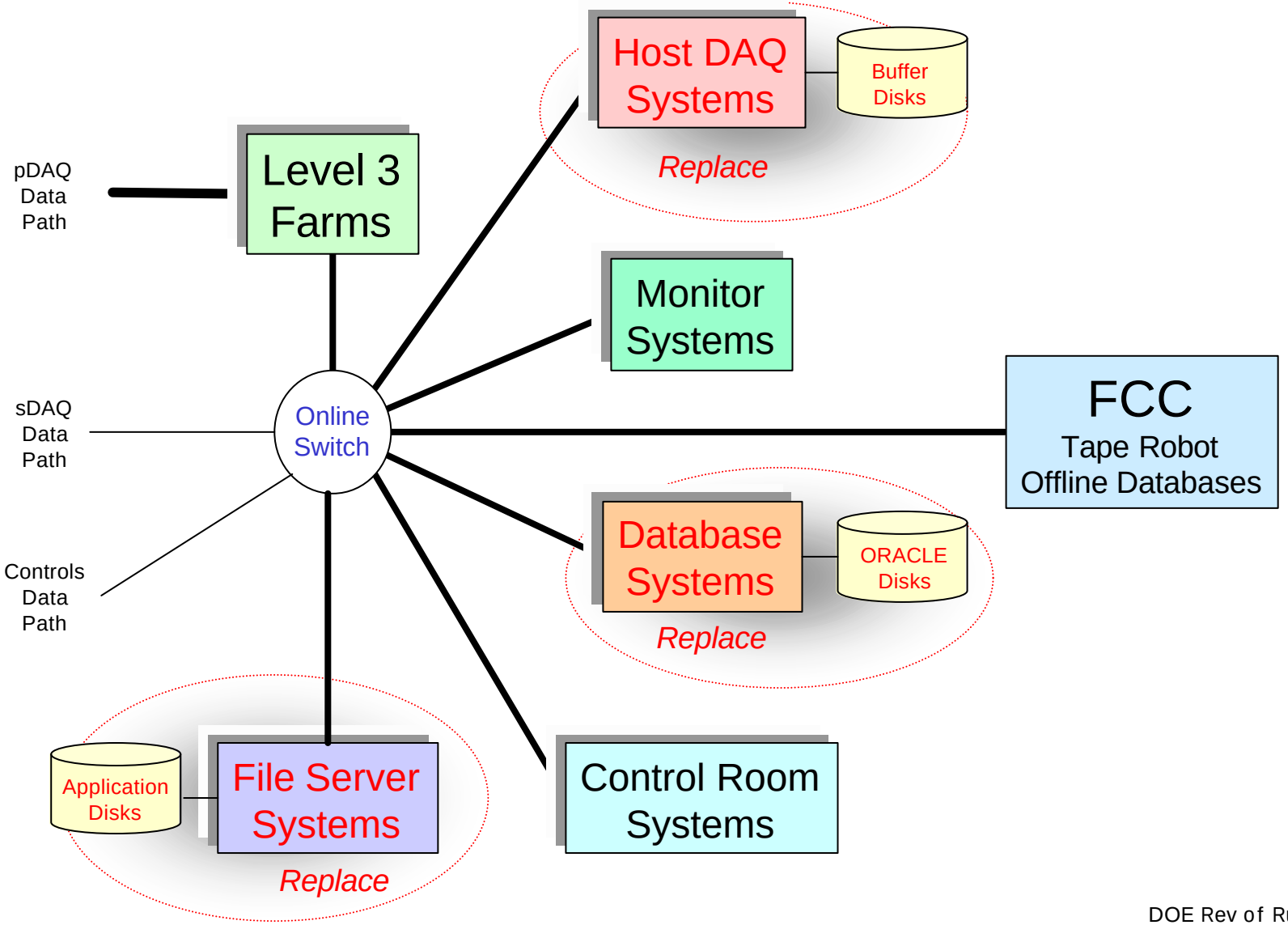
- **Event path:**
  - DAQ and Online network
  - Single Board Computers (SBCs) in VME readout crates
  - Level 3 software filter farm
  - Host systems for data transport and logging
- **Control and Monitoring:**
  - Control room systems
  - Event data monitoring systems
  - Slow control system, including VME processors
- **Infrastructure:**
  - Database servers
  - File servers
- **Software associated with the above**
  - **SOFTWARE architecture is unchanged for Run IIb**

Structure of DAQ/Online



HARDWARE <u>architecture</u> is unchanged for Run IIb
But many <u>components</u> change

Structure of DAQ/Online



Run IIb Requirements

- Maintain adequate Level 3 software trigger rejection in a more complex environment
- Provide capacity for higher peak recorded event rate (~100 Hz)
- Maintain reliable computing infrastructure

Changes for RunIIb

- **Systems to be discussed**
  - **1.3.1 Level 3 filter farm processors**
  - **1.3.2 Host systems**
    - 1.3.2.4 Storage systems
    - 1.3.2.6 DAQ hosts
    - 1.3.2.7 ORACLE database systems
    - 1.3.2.8 File servers
  - **1.3.3 Control systems**

- **Manage complete Run II effort with proper tools:**
  - **TDR includes Run IIa plans**
  - **MS Project schedule for resource allocation includes Run IIa effort**
  - **Focus on Run IIb in this talk**

Any costs shown are unburdened FY02 $

Component Details

- **Level 3**
  - **Processing time requirements:**
    - At 2×10^{31} $cm^{-2}s^{-1}$ current filter code, including global tracking, requires ~300 msec/event on 1 GHz PIII
      - Maps to 250 msec/event for single interaction, equivalent to 10 SpecInt95 secs/event
    - Extrapolation depends upon complexity of event, a function of luminosity and bunch crossing time
      - For L3 filter code, processing most dependent upon occupancy. Assume linear rise in requirements with number of interactions.
      - For 1 primary + 5 background interactions per crossing and 1 KHz L3 input rate, predicted CPU requirement is 60K SpecInt95

Component Details

- **Level 3 acquisition plan:**
  - **Purchase systems as late as possible to take advantage of Moore's law**
    - Assuming 1.6x CPU improvement per year
  - **96 nodes @ ~$2.2K = $210K, purchased in FY05**
    - Includes infrastructure (network, racks, power)
  - **Combined with Run IIa systems, this will give capacity of 70K SpecInt95**

Component Details

- **Host systems and storage**
  - **Fibre channel SAN with RAID arrays for Database and File Servers, JBOD for data buffer disks**
    - 1.3 TB RAID, 4 TB JBOD (48 hours of buffer)
    - FC fabric infrastructure, highly available systems
    - $103K with early development (FC on Linux) effort, then purchase FY04
  - **Redundant (primary/secondary) small servers (4-8 CPU)**
    - Data logging system, ORACLE database system, and File server system
    - $144K with Secondary server purchase FY04, then Primary server purchase FY05
      - –As late as possible to get best performance

Component Details

- **Control system processor upgrades**
  - **Run IIa systems include ~100 embedded VME processors for downloading, control, monitoring, and diagnostic readout of the detector**
    - Use the EPICS control system
    - Motorola 68K and PowerPC family
  - **Concerned with longevity**
    - Spares may not satisfy extended Run IIb needs
    - Replacement processors may not be available in Run IIb era
  - **~1/2 are fully loaded with present monitoring functions**
    - We wish to do more complete monitoring in Run IIb
  - **Strategy is to replace ~50% of processors with new architecture**
    - Following EPICS community advancements
    - Target those with largest processing loads
    - Remainder become spares
    - 53 nodes @ $2.8K each = $148K

Component Details

- **SiDet test stand support**
  - **1% and 10% test stands at SiDet are "micro" DAQ/Online systems**
    - Require SBC (readout) and Host/Control/Monitor Linux node
    - Require control system processor (to be supplied from operational spares)
  - **DAQ/Online group will supply experts to assist in commissioning these systems**
    - Requires small fraction of experts' time during installation and operation
    - Loaded into MS Project schedule

M&S Cost Summary

Equipment	M&S Cost	Contingency %	Contingency Cost	Total Cost
Level 3 filter nodes	**210**			**357**
Nodes, racks, power supplies, cables	210	70	147	357
Fibre Channel SAN	**60**			**90**
Hubs, cables	20	50	10	30
Fibre Channel JBOD buffer disk	40	50	20	60
RAID storage array	**43**			**65**
FC RAID controllers	10	50	5	15
Disk crates, rack	15	50	8	23
Hot-swappable disks	18	50	9	27
DAQ HOST system	**52**			**78**
Primary high-end server	32	50	16	48
Secondary mid-range server	20	50	10	30
Database System	**52**			**78**
Primary high-end server	32	50	16	48
Secondary mid-range server	20	50	10	30
File Server system	**40**			**60**
Primary mid-range server	20	50	10	30
Secondary mid-range server	20	50	10	30
Control System	**148**			**185**
Processor upgrades	148	25	37	185
Total	**605**		**308**	**913**

Unburdened FY02 K$

Contingency guidance from Project Management Plan

Effort

- **Fully resource loaded into MS Project schedule**
- **Exploiting developed expertise to meet Run IIb goals**
- **Mostly "fractions of" personnel who are otherwise dedicated to Run II operations**

- Largest components:
  - –Strategic planning (PHYSF)
  - –System installation and management (COMPF)
  - –ORACLE database migration (COMPF)
  - –Control system upgrades (PHYSF,COMPF)

- **Net technical labor cost ~$178K**

Risk Analysis

- **These elements are pointed out:**
  - **Cost**
    - Required number of Level 3 filter nodes a function of the interaction environment, detector performance, and software performance. 70% contingency to address possible need for purchase of more nodes.
    - Details of future VME processors unknown. Address risk with possible scope reduction.
  - **Schedule**
    - No significant risks
  - **Scope**
    - No significant risks
  - **Technical**
    - No significant risks

DAQ / Online Summary

- Building upon fundamentally solid hardware and software system architectures
  - We know what to do
- System constructed of commodity components by experienced group
  - We know how to do it
- Project addresses requirements for Run IIb capabilities and system longevity
  - We're ready to go!