LHCB's Experiment Control System

Clara Gaspar, September 2001
Experiment Control

- In charge of the Control and Monitoring of:
  - Detector Operations (ex Slow Controls)
    - GAS, HV, LV, temperatures...
  - Data Acquisition and Trigger
    - FE Electronics, Event building, EFF, etc.
  - Experimental Infrastructures
    - Cooling, ventilation, electricity distribution, ...
  - Interaction with the outside world
    - Magnet, accelerator system, safety system, etc.
ECS Scope

- DCS Devices (HV, LV, GAS, Temperatures, etc.)
- Detector Channels
- Trigger
- Front End Electronics
- Readout Network
- Processing/Filtering
- Storage
- Monitoring & Control

Clara Gaspar, September 2001
ECS Requirements

- Integrate the different activities
  - Such that rules can be defined (ex: Stop DAQ when DCS in Error)

- Allow Stand-alone control of sub-systems
  - For independent development and concurrent usage.

- Automation
  - Avoids human mistakes and speeds up standard procedures

- Easy to operate
  - Two to three operators (non-experts) should be able to run the experiment.

- Scalable & Flexible
  - Allow for the integration of new detectors

- Maintainable
  - Experiments run for many years
Experiment Control

Keyword: Homogeneity

A Common Approach in the design and implementation of all parts of the system:

- Facilitates inter-domain integration
- Makes it easier to use:
  - Standard features throughout the system (ex: partitioning rules)
  - Uniform Look and Feel
- Allows an easier upgrade and maintenance
- Needs less manpower
ECS design

- Integrated approach from design phase
- An Architecture
  - That can handle all aspects of the monitoring and control of the Experiment
- A framework
  - A collection of tools and mechanisms that allow the implementation of the architecture
HW Architecture

Layer Structure

Supervision

Process Management

Field Management

Technologies

Commercial

Custom

SCADA

OPC

DIM

Communication Protocols

PLC/UNICOS

VME/SLiC

Field buses & Nodes

Sensors/devices

Clara Gaspar, September 2001
Generic SW Architecture

Control Units
- T.S.
- LHC
- GAS
- DetDcs1
- ... DetDcsN
- SubSys1
- SubSys2
- ... SubSysN

Device Units
- Dev1
- Dev2
- Dev3
- ... DevN

To Devices (HW or SW)

Commands

Status & Alarms

Clara Gaspar, September 2001
The Framework

- An integrated collection of guidelines, tools and components

- Should be provided to sub-system developers in order to:
  - Allow the development of each component coherently in view of its integration in the complete system.
  - For the two types of components:
    - DCS: Control Units
    - Dev1: Device Units
Control Units

Each CU is inherently able to:

- Configure, monitor and control its children
  - Sequence & Automate operations
  - Recover errors

- Handle Alarms
  - Filter and display alarms

- Partition
  - Exclude one or more of its children

- User Interfacing
  - Present information and receive commands
Control Units (cont.)

Clara Gaspar, September 2001

PVSS II

Specific Behaviour FSM

Ownership & Partitioning FSM

Alarm Handling

Logging & Archiving

Configuration data

Operator

Parent

Commands/States

Child

Child

Child

Configuration Database

Commands/States

Configuration data

Commands/States

Commands/States

Commands/States
Run Control

- Each Control Unit (and its sub-tree)
  - Can run in stand-alone
  - Can be controlled independently (by an authorized User Interface)

- Run Control
  - Is a particular instance of a user interface:
    ➔ It is the interface to the Root of the tree
    ➔ If the tree is partitioned there can be several Run Controls.
Run Control

Messages
11-Jun-2001 16:48:46 - Run 234522 Started
Partitioning Sub-Systems

Clara Gaspar, September 2001
Sub-detector Control

System
Tracker

State
CALIBRATION

Sub-System
DCS
DAQ

State
READY
RUNNING

Run Number: 234522

Live Time: 100%

Trigger Rate:

Messages
11-Jun-2001 16:58:05 - Run 234522 Started
Device Units

- Provide the interface to the different devices

Operator

PVSS II

Configuration data

Behaviour FSM

Alarm Handling

Device Driver

Logging & Archiving

HW/SW Device

Parent

Commands/States

Settings/Readings

Commands/States

Clara Gaspar, September 2001
DCS Devices

- High Voltages, Low Voltages, etc.
  - Try to use Commercial HW
  - Fieldbuses: CAN, Profibus, WorldFip, Ethernet
  - And OPC Servers (provided by manufacturer)

- Analog & Digital IO (temperatures, humidities, etc.)
  - Same as above, or
  - ELMBs / OPC Servers

- Others:
  - PLCs / OPC Servers
  - Home made / DIM or OPC Servers
HV Device

Clara Gaspar, September 2001
In Radiation Areas

- Mainly needed I²C and JTAG
  - SPECS (ex. SPAC)
    - Serial Protocol (inspired from Atlas)
    - 10Mb/s
    - Slave is radiation tolerant
  - ELMB
    - CAN protocol (0.5Mb/s)

Clara Gaspar, September 2001
Board level electronics

■ Electronics in barracks
  ▪ Front-ends, Readout Units, Timing and Fast Control components, etc.

■ Credit Card PC's
  ▪ 66 × 85 × 12 mm³
  ▪ Pentium Compatible CPU
  ▪ Linux/DIM (no PVSS)

Ethernet

(~500+)

Clara Gaspar, September 2001
Event Filter Farm Control

- Remote Boot
  - SW download

- CPU Monitoring
  - CPU usage, memory, IO, etc.

- Processes
  (trigger algorithms)
  - Configure
  - Monitor
  - Start/Stop
CPU Monitoring Using PVSS II

![Diagram of CPU monitoring software interface](image-url)
The Monitoring of the Control System itself is very similar to the Monitoring of the CPUs in the Event Filter Farm:

- Controls PCs, Credit Card PC’s, etc:
  - Remote Boot & SW download
  - CPU Monitoring
    - CPU usage, memory, IO, etc.
  - Processes (controls processes: PVSS, etc.)
    - Configure, Monitor, Start/Stop
TestBeam Setup:

- Run Control based on JCOP framework
  - Interfacing to Cascade DAQ
- Integrated PS/(SPS) information
- Started integrating DCS devices:
  - HVs
  - Motors
Our Control System relies on the success of the following (common) projects:

- JCOP Framework
- GAS Control Working Group
- JCOV - Joint Cooling and Ventilation Control
- DSS - Detector Safety System
- Magnet Control
- Rack Control
- Data interchange Working Group (LHC,T.S.,Exps,etc.)
Conclusions (1)

- The best way to achieve an homogeneous and maintainable control system (and to save manpower) is:
  - To do the maximum in common
    - The Controls Framework is being developed and will be used by the 4 LHC experiments (Joint Controls Project)
    - New “Devices” should be developed in a re-usable way and included in the Framework
  - To Standardize on HW choices as much as possible
    - So that common SW can be used
- Please contact us for HW choices (of potentially common items)
  - like: power supplies, temperature sensors, etc
Conclusions (2)

In order to design and implement the LHCb Control System we have the following resources:

- Clara Gaspar
- Sascha Schmeling (fellow, prob. leaving soon)
- Richard Beneyton (cooperand, leaving soon)
- Boda Franek (Rutherford, at 25 %)

We have many interesting projects to offer...