Demonstration:
Partitioning, Automation and Error Recovery in the Control System of an LHC Experiment

Clara Gaspar, September 2001
Generic SW Architecture

Abstract levels

Control Units

ECS

Status & Alarms

Commands

Device Units

To Devices (HW or SW)

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A 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
PVSSII has tools for:

- Device Description (Configuration Database):
- Device Access (OPC, Profibus, drivers)
- Alarm Handling (Generation, Filtering, Masking, etc)
- Archiving, Logging, Trending
- User Interface Builder
- Alarm Display, Access Control, etc.

SMI++ provides:

- Abstract behaviour modeling (Finite State Machines)
- Automation & Error Recovery (Expert System like)
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.)

- A combination of PVSS II & SMI++

- Hierarchical Characteristics:
  - State/Commands
  - One Owner
  - Exclusive/Shared
  - Partitioning Mode

- Other Characteristics
  - Alarm Handling
  - Access Control
  - Archiving, etc.
Control Units (cont.)

- PVSS II
- Specific Behaviour FSM
- Ownership & Partitioning FSM
- Alarm Handling
- Logging & Archiving

Configuration Database

- Parent
- Commands/States
- Child
- Commands/States
- Child
- Commands/States
- Child
- Commands/States

Operator
- Configuration data
- Commands/States

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Device Units’s specific tasks are:

- Interface to the device it models
  - Implement Actions
  - Retrieve States

- Generate Alarms

- User Interfacing
  - Present specific information and receive commands
Device Units

- Provide the interface to the different devices

<Diagram>

PVSS II

- Behaviour FSM
- Alarm Handling
- Device Driver
- Logging & Archiving

Operator

Configuration data

Commands/States

Parent

HW/SW Device

Settings/Readings
Sub Detector HV

- OFF when all channels OFF
  - SWITCH_ON
  -> HV ON

- ON when all channels ON
  - SWITCH_OFF
  -> HV OFF

- ERROR when at least one channel TRIPPED
  - RECOVER
    (-> CLEAR_TRIP)
    -> HV ON
Sub Detector

- NOT_READY when at least one component NOT READY
  - GET_READY
    -> HV ON

- READY when all Components OK
  - SET_NOT_READY
    -> HV OFF

- ERROR when at least one component in ERROR
  - RECOVER
    (-> CLEAR_TRIP)
    -> HV ON
**DCS**

- NOT_READY when at least one detector NOT_READY
  - GET_READY -> all
- READY when all detectors READY
  - SET_NOT_READY -> all
- ERROR when at least one detector in ERROR
  - RECOVER -> all
Partitioning

ECS

DCS

DetDcs1

... DetDcsN

SubSys1

SubSys2

Dev1

Dev2

Dev3

DAQ

DetDaq1

... DetDaqN

SubSysN

DevN

To Devices (HW or SW)
Partitioning Modes

INCLUDED
Child Fully Controlled by Parent

EXCLUDED
Child Not Controlled by Parent

MANUAL
Parent does not send Commands

IGNORED
Parent Ignores State
Demo - DCS / Partitioning

DCS

Vertex

Tracker

Muon

HV
Temp

HV
GAS

HV
GAS

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Demo - DAQ

DAQ
  - NOT_READY
  - CONFIGURE
  - READY
  - START_RUN
  - RUNNING
  - STOP_RUN

DCS
  - Vertex
  - Tracker
  - Muon

Vertex
  - HV
  - Temp

Tracker
  - HV
  - GAS

Muon
  - HV
  - GAS

Tracker
  - FE
  - RU

Muon
  - FE
  - RU
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.
Demo - Run Control

**ECS**

- When LHC in PHYSICS
  - GET READY DCS
  - GET READY DAQ
  - START RUN DAQ

![Diagram]

When LHC in PHYSICS:
- GET READY DCS
- GET READY DAQ
- START RUN DAQ
Demo - Sub Detector RC
Safety
- When GAS in ERROR
  -> SWITCH_OFF HVs
HV Device
### Partitioning Sub-Systems

#### System State

<table>
<thead>
<tr>
<th>Sub-System</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calorimeter</td>
<td>READY</td>
</tr>
<tr>
<td>Muon</td>
<td>READY</td>
</tr>
<tr>
<td>Tracker</td>
<td>READY</td>
</tr>
<tr>
<td>Vertex</td>
<td>READY</td>
</tr>
</tbody>
</table>

**Messages**

Tracker is Excluded

**Include**

**Close**
Run Control

System | State
--- | ---
ECS | PHYSICS

Sub-System | State
--- | ---
DCS | READY
DAQ | RUNNING
LHC | PHYSICS

Fill Number: 103
Run Number: 234522

Trigger Rate:

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

Close
Sub-detector Control

![Sub-detector Control Interface]

- **System**: Tracker
- **State**: CALIBRATION

**Sub-System**
- **DCS**: READY
- **DAQ**: RUNNING

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

**Run Number**: 234522

**Live Time**: 100%

**Trigger Rate**:
- 0 Hz
- 70 Hz
- 100 Hz

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