THE WONDERLAND OF OPERATING THE ALICE EXPERIMENT

The Challenges of Operating a Large Physics Experiment
OUTLINE

• Introduction and context
• The evolution of the experiment
• The challenges and how to master them
  • How these challenges are different between experiments and accelerators
  • Justify the ‘a’ and ‘e’ in ICALEPCS…
INTRODUCTION

• Heavy Ion experiment
• 20 sub-detectors
• 16 x 16 x 26 m
• 10 000 tons

• 1300 collaborators
• 116 institutes, 33 countries
Pb – Pb Event

Pb+Pb @ sqrt(s) = 2.76 ATeV
2010-11-08 11:30:46
Fill : 1482
Run : 137124
Event : 0x00000000D3BBE693
• Control & Monitoring 20 sub-detectors, 2 magnets, various services
  • 1 000 000 channels

• Designed as strict hierarchical system
  • Strict separation between sub-detectors

• Behaviour modelled with hierarchy of Finite State Machines
  • Commands going down, states coming up
  • Partitioning feature
Detector Control System

- Implemented with commercial SCADA (PVSSII)
  - With CERN and ALICE specific extensions
- Applications developed by detector teams
- Over 150 controls PCs, 1200 networked devices
Experiment Evolution: From Installation to Routine Operation

- 2006: installation, debugging
- 2008: first collisions
- 2009: cosmics data, restart
- 2010: first full year of operation, first HI
- 2011: ‘routine’ operation
The Detector Control System has to

- follow the evolution of the experiment equipment
- follow the evolution of the use of DCS
- follow the evolution of the users of DCS
The experiment is a very dynamic object

- Squeeze in more detectors at each opportunity
- Devices to control (or the way to access them) is changing

Likely to be more dynamic than the accelerator environment

- If only because of 20 different, independent detector groups
The Evolution Challenge
Use and Users of DCS

• Evolution of the use of DCS
  • Started off with debugging
  • Moved from local operation to central operation

• Evolution of the users of DCS
  • Started off with developers and experts
  • Evolution to detector experts to non-expert users
Reducing number of operators

- From 25 local, detector, operators to 5 central operators

DCS was designed with central operation in mind

More a psychological than a technical issue

- Convince detectors to transfer control of their baby to a central operator
The central operator needs dedicated tools.

- All sub-detectors need proper integration in central top level control system.
  - Importance of homogeneous development upstream.
  - Major coordination challenge.
- Tools to operate groups of detectors.
- Automation wherever possible.
  - Recurrent actions, actions that need to be performed to guarantee safety of detector equipment e.g. on change of LHC beam mode.
<table>
<thead>
<tr>
<th>DCS groups</th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>Group D</th>
<th>Group E</th>
<th>Group F</th>
<th>Others</th>
</tr>
</thead>
</table>
| Aco        | READY   | Aco     | Aco     | Aco     | Aco     | Aco     | }
| Emc        | READY   | Emc     | Emc     | Emc     | Emc     | Emc     | }
| Fmd        | READY   | Fmd     | Fmd     | Fmd     | Fmd     | Fmd     | }
| Hmp        | READY   | Hmp     | Hmp     | Hmp     | Hmp     | Hmp     | }
| Mch        | MOVING READY | Mch | Mch | Mch | Mch | Mch | }
| Mtr        | READY   | Mtr     | Mtr     | Mtr     | Mtr     | Mtr     | }
| Phe        | STANDBY | Phe     | Phe     | Phe     | Phe     | Phe     | }
| Pmd        | STAY CONFIGURED | Pmd | Pmd | Pmd | Pmd | Pmd | }
| Sed        | READY   | Sed     | Sed     | Sed     | Sed     | Sed     | }
| Spd        | READY   | Spd     | Spd     | Spd     | Spd     | Spd     | }
| Ssd        | READY   | Ssd     | Ssd     | Ssd     | Ssd     | Ssd     | }
| T00        | READY   | T00     | T00     | T00     | T00     | T00     | }
| To1        | READY   | To1     | To1     | To1     | To1     | To1     | }
| Tec        | READY   | Tec     | Tec     | Tec     | Tec     | Tec     | }
| Tcd        | READY   | Tcd     | Tcd     | Tcd     | Tcd     | Tcd     | }
| V00        | READY   | V00     | V00     | V00     | V00     | V00     | }
| Zdc        | READY   | Zdc     | Zdc     | Zdc     | Zdc     | Zdc     | }

V0 rate = 163.22 kHz

400 300 none none 200 none none

- enable radio boxes for changing groups/partitions

Panel by: Ombretta Pinazza
Popup Message

Condition: Beam mode == PREPARE RAMP
Detector(s): TRD
Command: GO_SUPERSAFE

Do you want to execute the procedure?

Ok  Cancel
The Single Operator Challenge

- All these tools need to be flexible and configurable
  - Cope with changes in operation of the experiment
- Central operator need to react on anomalies in ALL sub-detectors
  - Tools to access procedures (and ensure they are valid)
  - Make sure only relevant messages reach the operator
The Single Operator Challenge

- High turnaround of operators
  - Very specific to HEP culture
  - Many operators that only do few shifts
    - Not necessarily controls nor detector expert
  - As opposed to accelerator world
    - Limited number of operators, that usually are controls or machine experts, that do many shifts
- ALICE 2011: 926 shifts, more than 80 operators, on average only 11 days of operator shift work
The Single Operator Challenge

• Requires huge effort for training
  • and administration

• Requires clear, extensive documentation
  understandable for non-expert, and easily accessible
The Coordination Challenge

• Initial stage, development
  • To overcome cultural differences: Start coordinating early, strict guidelines

• During operation, maintenance and operation
  • Again, due to HEP culture, original developers tend to drift away
    • (apart for a few exceptions) very difficult to ensure continuity for the control systems in the projects
  • In many small detector projects, controls is done only part-time by a single person
Conclusions

- **Experiment environment evolves rapidly**
  - DCS design: think scalability, flexibility

- **Central operation**
  - Cope with large number of operators
  - Adequate and flexible operation tools, automation
  - Easily accessible, explicit procedures

- **Experiment world is dynamic, volatile**
  - Requires a major coordination effort