Experiment Control System

...A Brief History
And the path to Operations...

Clara Gaspar, November 2018
The JCOP Project

- Joint COntrols Project
  - Between the 4 LHC Experiments and a CERN Support Group: IT -> EN -> BE
  - Created in December 1997
  - First tasks
    - Gather Requirements from Experiments
    - In-depth Technological Survey
      - SCADA – Supervisory Control and Data Acquisition (commercial and “home-made”)
    - WinCC-OA (PVSS at the time) chosen
    - Define the Architecture, Develop the Framework
Why WinCC-OA?

Technical (& Financial) Reasons
- Windows & Linux (not so common)
- Distributed & Open Architecture
  - Could scale to very large distributed systems
  - Could integrate external tools (FSM, etc.)
- Many tools and interfaces:
  - Graphic Editor, Archiving, Alarm Handling, Drivers, etc.
- Many man-years of development for a small price

“Sociological” reasons
- Standard Interfaces: The same concepts everywhere
  (The datapoint mechanism, the scripting language, Gedi, etc.)
  - Can share resources within and outside the experiment.
  - Not perfect at everything, but a coherent and integrated set of tools
Today:

- Still extremely active
  - Meetings (almost) every week
  - Several FW components being revised and improved:
    - Archiving, Alarm handling, Device access, etc.
  - Provide Support & Training

JCOP Tools Usage:

- LHCb use the JCOP Concepts throughout ECS
  - DAQ/RunControl, DCS/BigBrother, etc.
- While the other LHC Experiments only for DCS
  - NA62 and ProtoDUNE more like LHCb
- Other CERN domains also use it:
  - Magnets, Cryogenics, Electricity, Cooling, Vacuum, etc.

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LHCb Upgrade ECS

- Same Architecture & Concepts as current system
  - Selected Concepts:
    - Integration & Homogeneity
    - Partitioning & Automation
    - Promote HW Standardization
      - Same board (PCIE40) for:
        - DAQ R/O (TELL40)
        - TFC + ECS (SOL40)
        - CAEN, Wiener, Iseg, ELMBs…
    - Separate Data/Control paths
    - Promote SW Uniformity
      - Guidelines, FW Components, FSM Templates
    - Small number of Operators
      - 1 Operator +1 Data Manager

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LHCb Operations

Main Tools:

- **RunControl**
  - Handles the DAQ & Dataflow
  - Allows to:
    - Configure the system
    - Start & Stop runs

- **AutoPilot**
  - Knows how to start and keep a run going from any state.

- **BigBrother**
  - Based on the LHC state:
    - Controls SD Voltages
    - VELO Closure
    - RunControl
Run Control

Matrix Domain
Sub-detector
**Partition:**
- Part of the system that can run independently and concurrently with the others (LHCb, VELO, RICH1, etc.)

**Some resources are shared:**
- TFC
- HLT
- Storage
- Monitoring
- Reconstruction

**Need to “Allocate”**
- In order to define the resources needed by a partition:
  - For example the number of HLT sub-farms
Sub-Detector Integration

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Run Control FSM

Steps:

- Allocate resources
- Configure Sub-systems: Apply Electronics settings, prepare DAQ/HLT jobs
- Start: Prepare to acquire data
- Start Trigger: TFC only
Run Control

Matrix Domain
Sub-detector
Activity Driven
Run Control Activities

**Activity**

“Activity” defines the “recipe” which will be applied by all sub-systems on CONFIGURE

- Ex.: PHYSICS|LEAD
  Will try to apply “PHYSICS|LEAD” everywhere, if not existing will try “PHYSICS”, if not existing “DEFAULT”

“Activity” also contains the global run settings:

- Architecture for farm nodes ->
- Nr. Sub-farms
- Trigger Config. (TCK)
- Data Type & Destination:
  - Local, Castor, Offline
- Calibration “Step Runs”
  - TAE flag, nr. events, nr. steps
Sub-detector Configuration

Configure/mode="PHYSICS|LEAD"
Check… Ex: Get “PHYSICS” Settings
Apply Settings
ECS Databases

WinCC-OA (Project) Data Base Context

- Configuration settings for a running mode “Recipes”
- Monitoring data (at regular intervals)
- If Needed for next run settings (Pedestal Followers)
- If Archive On
- If Passes Conditions filter
- To Offline
LHCb Operations

- **Main Tools:**

  - **RunControl**
    - Handles the DAQ & Dataflow
    - Allows to:
      - Configure the system
      - Start & Stop runs

  - **AutoPilot**
    - Knows how to start and keep a run going from any state.

  - **BigBrother**
    - Based on the LHC state:
      - Controls SD Voltages
      - VELO Closure
      - RunControl
Big Brother

Based on LHC state, controls:
- Voltages
- VELO Closure
- Run Control

Can sequence activities, ex.:
- End-of-fill Calibration
- Handshake Confirmation
- Voice Messages
Big Brother Scheduler

Scheduler:
Provides complete Run Control Automation
**Big Brother Voltage Table**

### HV Configuration

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<th>Subdetector</th>
<th>Injection</th>
<th>S1</th>
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### LV Configuration

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### Messages

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- **Matrix Sub-detector X LHC State**
Voltage Control

<table>
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<tr>
<th>Sub-Detector</th>
<th>State</th>
<th>Req. HV</th>
<th>%Ok</th>
<th>HV State (A/C)</th>
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- **State column** (Current SD state regard. LHC state)
- **Requested** (SD target state)
- **%Ok**
- **HV/LV State** (SD Current state)
Sub-detectors can have a “parallel” Safety tree

- Does not replace HW/DSS interlocks

DCS FSM
(HV FSM Equivalent)
Alarm Screen

- Normally empty
- Every alarm should be followed up
- May also provide complementary information to FSM Errors

Severities:
- Warning
- Error
- Fatal
Alarm Screen (Yesterday)
### Legend:

- **Not yet started**
- **Development started**
  (Tools identified)
- **Under development**
- **Almost Ready**
  (Prototype exists)
- **Ready**

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**Slide from Nov. 2006**

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<thead>
<tr>
<th>VELO</th>
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Conclusion

- ECS “Readiness”
  - Tools are better than in 2016, but:
    - Very short time
    - A lot to be done
    - (In 2008 we had an extra year…)

- Don’t hesitate to talk to us…