

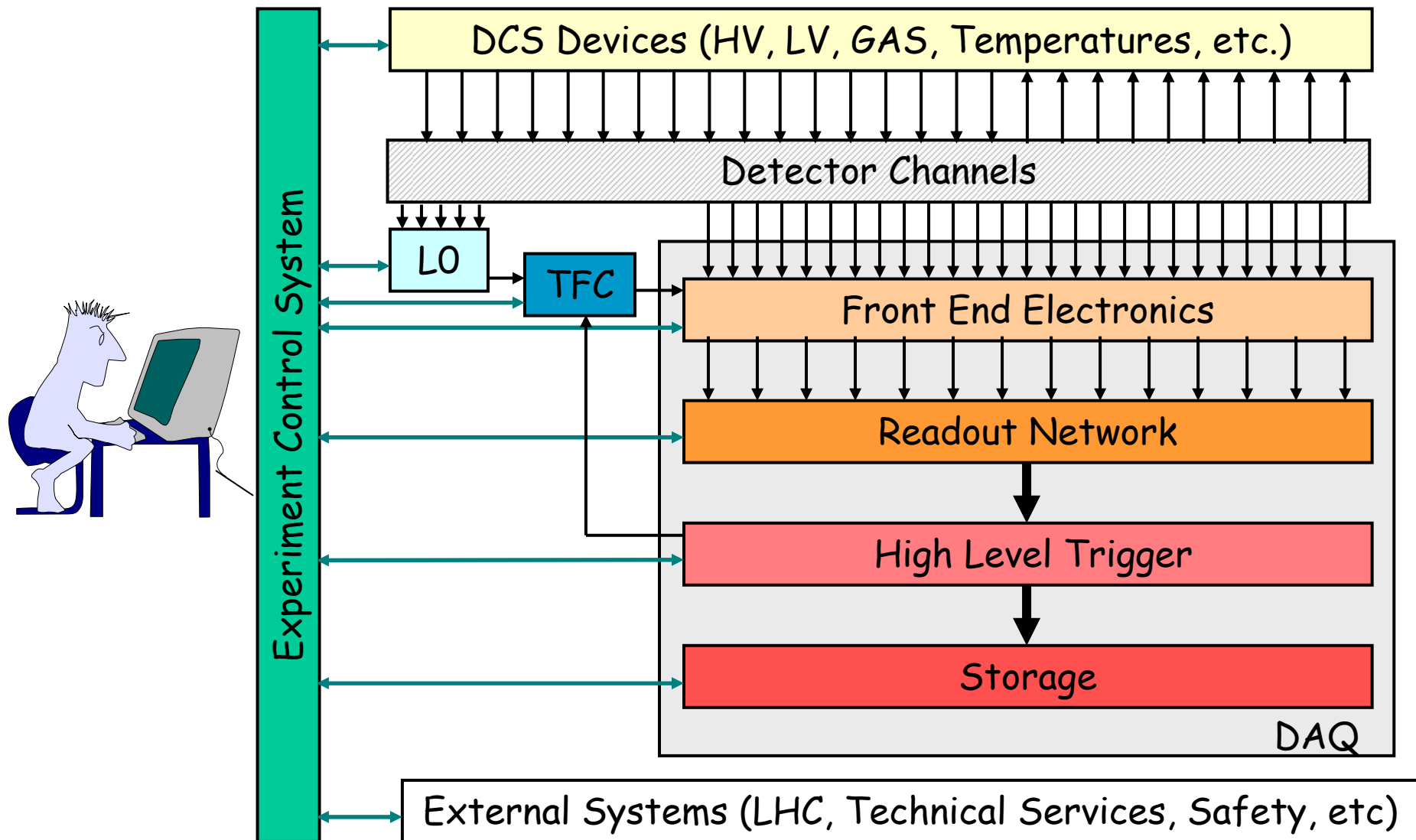


# LHCb Experiment Control System

## Scope, Status & Worries

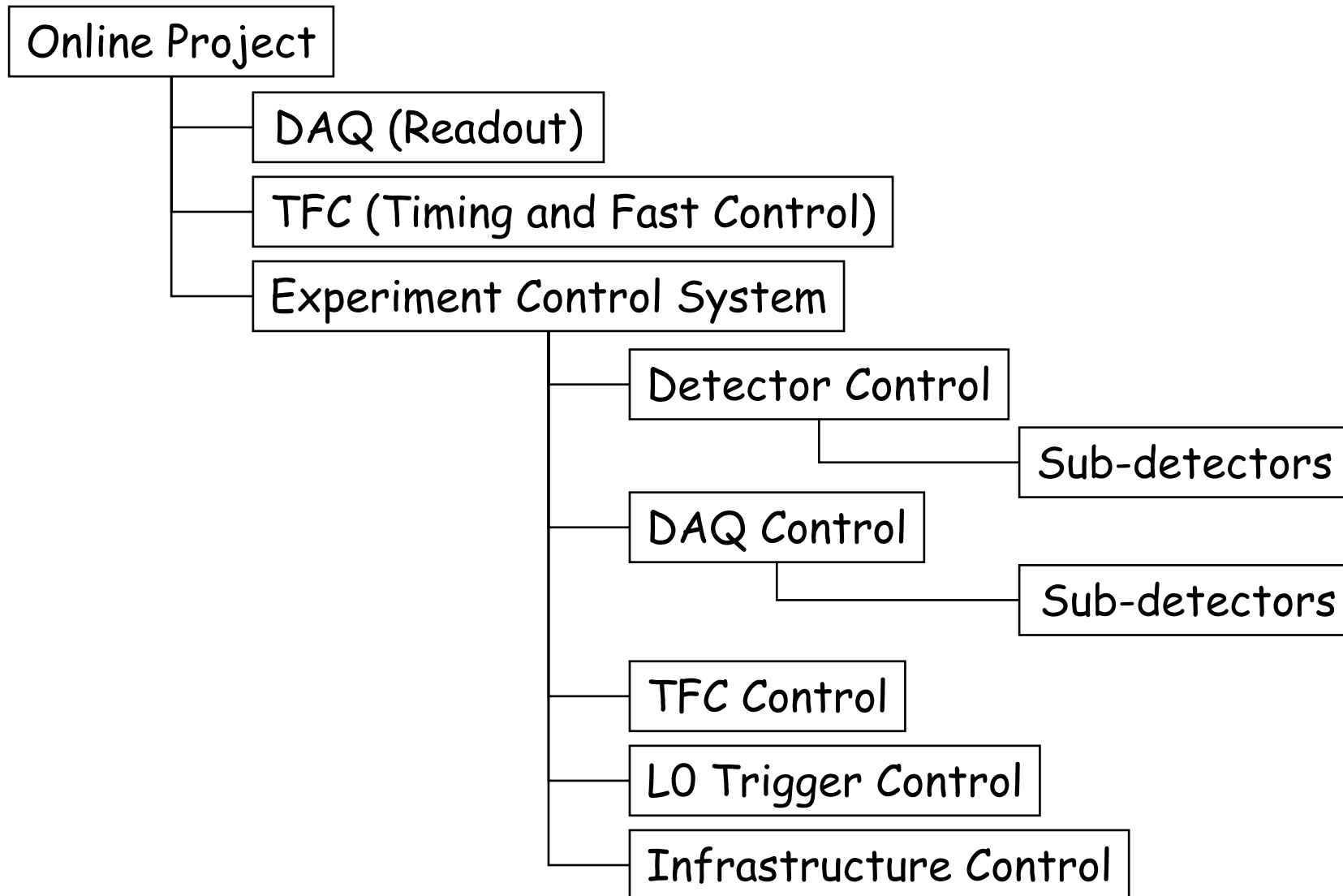
*Clara Gaspar, April 2006*

# ECS Scope





# Project Organization



*Clara Gaspar, April 2006*



# Central team

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## ■ Responsibilities:

- Provide guidelines & tools for sub-detectors:
  - | JCOP + LHCb specific
- Provide complete central applications:
  - | Central DAQ/TFC/HLT control, RunControl, etc.
- Provide central services
  - | Infrastructure (PCs, network, Databases, etc.)
- Provide support to Sub-systems
  - | During development, installation and commissioning
- Coordination & Integration



# Sub-detector/Sub-systems

## ■ Responsibilities:

- Integrate their own devices
  - | Mostly from FW (JCOP + LHCb)
- Build their control hierarchy
  - | According to Guidelines (using templates)
- Test, install and commission their sub-systems
  - | With the help of the central team



# Tools: The Framework

- **JCOP + LHCb Framework** (Based on PVSS II)
  - A set of tools to help sub-systems create their control systems:
    - | Complete, configurable components:
      - | High Voltages, Low Voltages, Temperatures (ex.: CAEN, WIENER, ELMB(ATLAS), etc.)
    - | Tools for defining User Components:
      - | Electronics boards (SPECS/ CC-PC)
      - | Other home made equipment (DIM protocol)
    - | Other Tools, for example:
      - | FSM for Building Hierarchies
      - | Configuration DB
      - | Interface to Conditions DB
      - | Archiving, Alarm handling, etc.

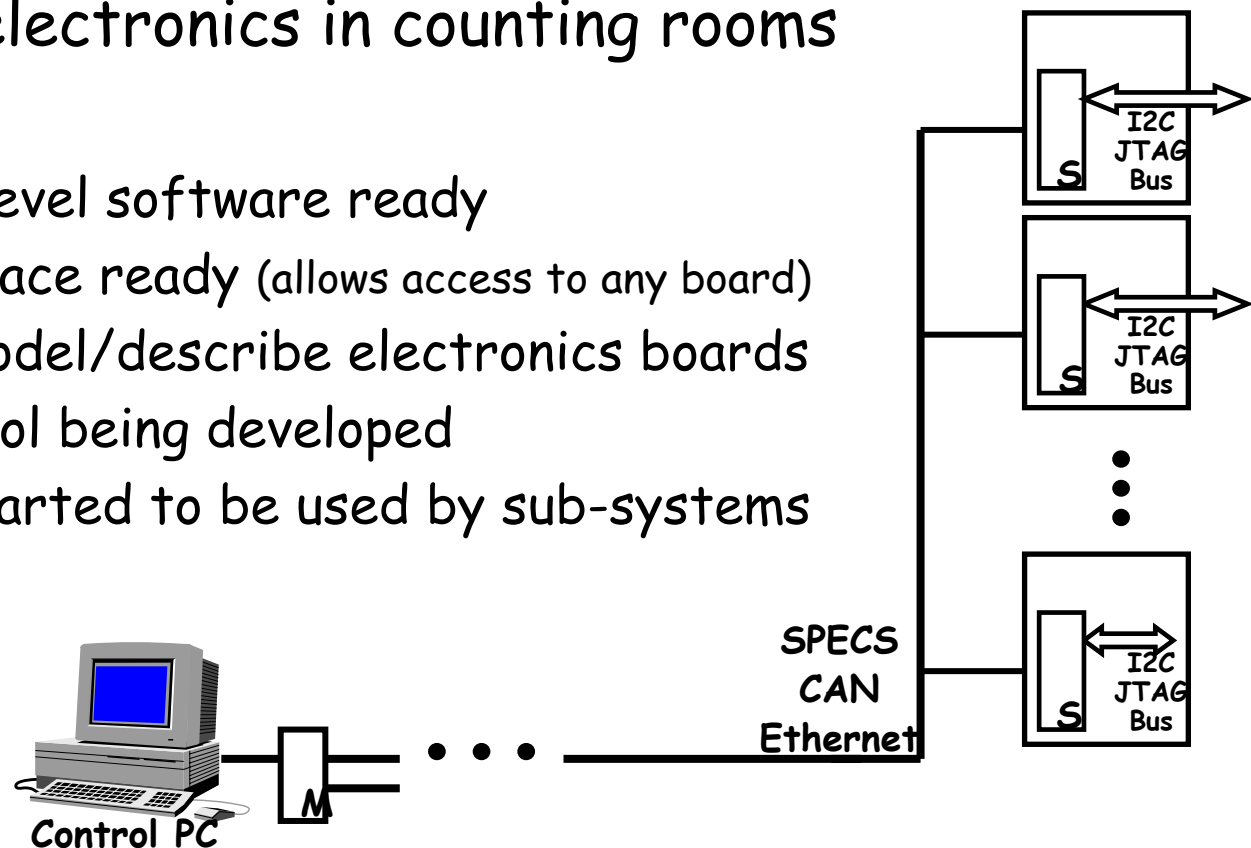
# Tools: Electronics Interfaces

## ■ Interfaces proposed:

- SPECS/ELMB - for electronics in radiation areas
- CC-PC - for electronics in counting rooms

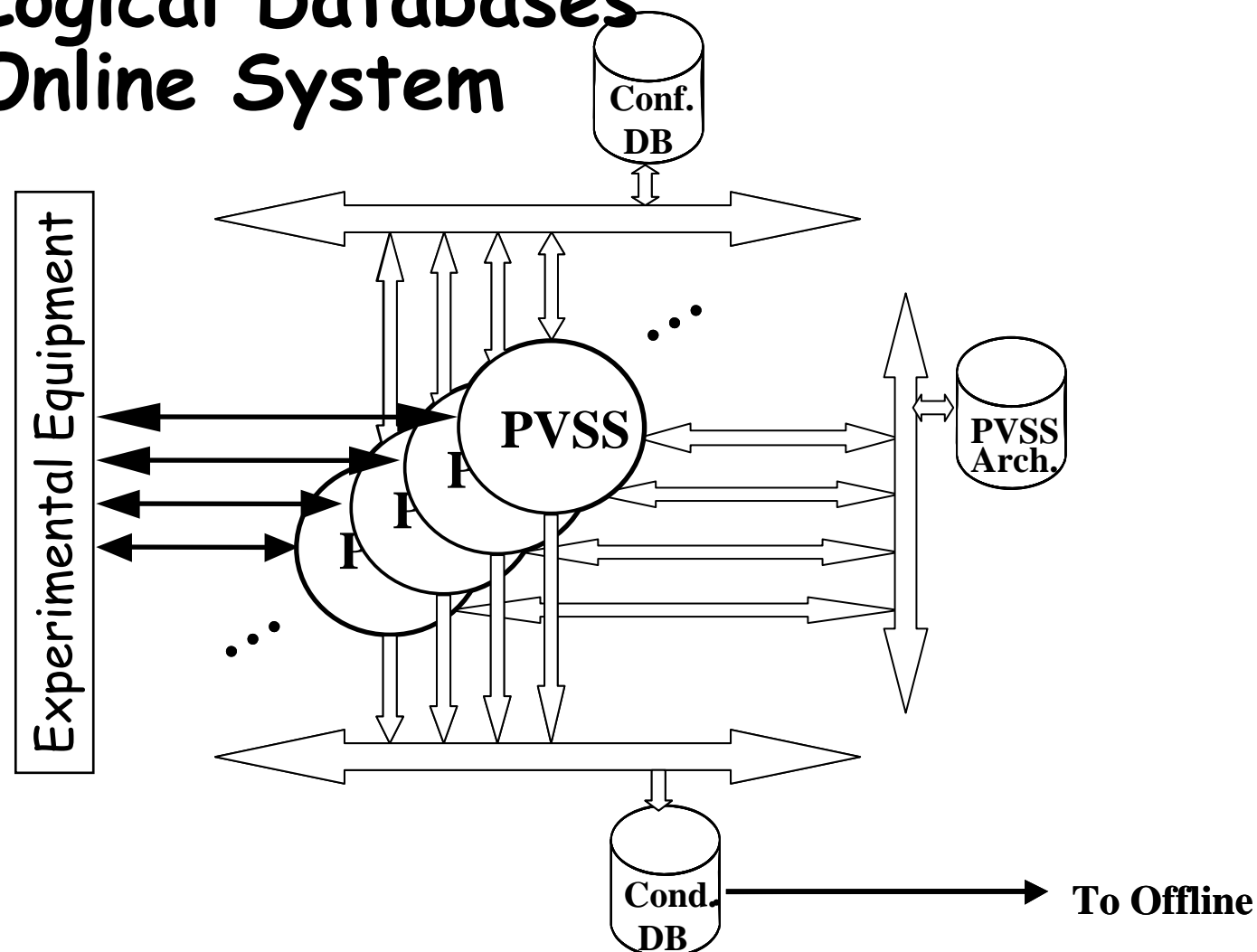
## ➔ Status

- | HW & Low-level software ready
- | PVSS interface ready (allows access to any board)
- | A Tool to model/describe electronics boards
- | TELL1 control being developed
- | Tools are started to be used by sub-systems



# Tools: Databases

## ■ Three Logical Databases in the Online System







# Tools: Databases

## ■ Configuration DB (Oracle) contains:

- | All data needed to configure the HW or SW for the various running modes (ex.: HV settings, Pedestals, trigger settings, etc.)

### ➔ Status: First versions exist

- | LHCb part: connectivity & queries (partitioning)
- | JCOP part: device settings (running modes and versions)

## ■ PVSS Archive (Oracle) contains:

- | All monitoring data read from HW for monitoring and debugging of the Online System (ex.: HV readings, temperatures, etc.)

### ➔ Status: Delivered with PVSS (Still worrying)

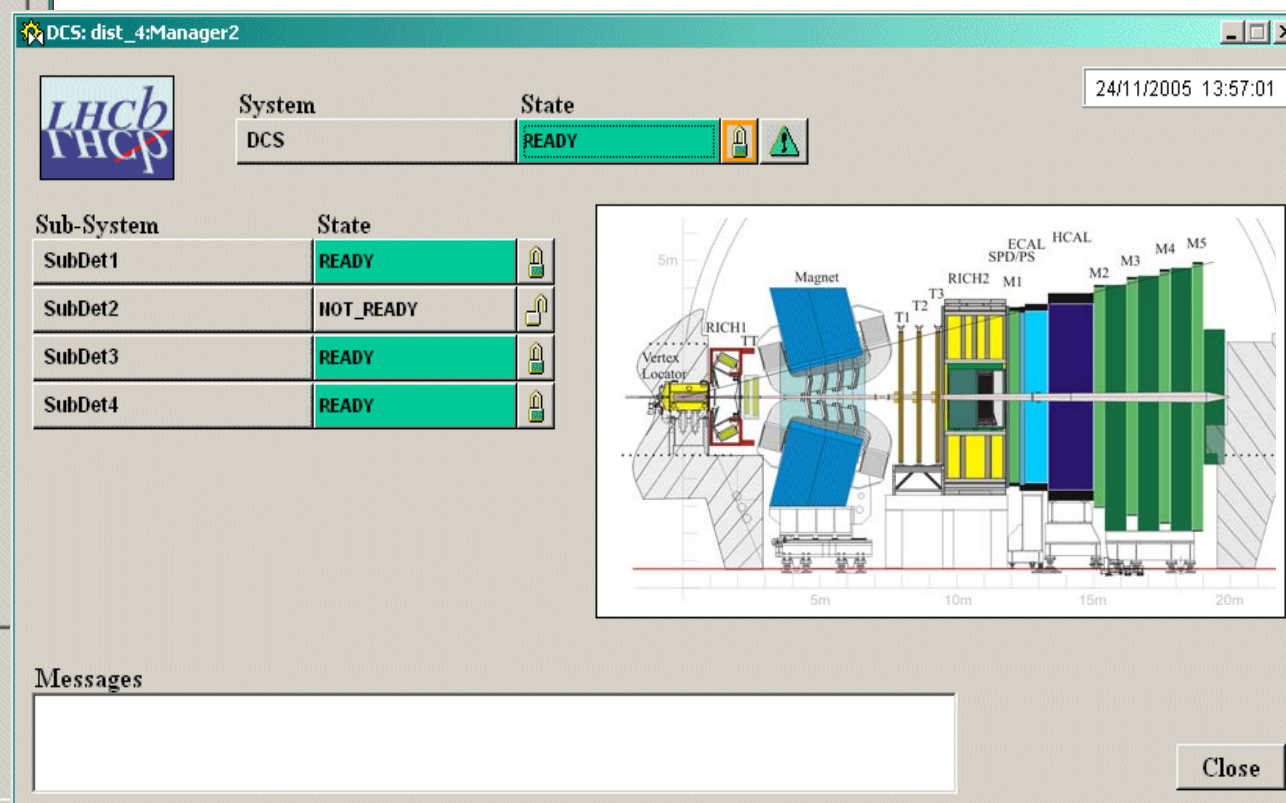
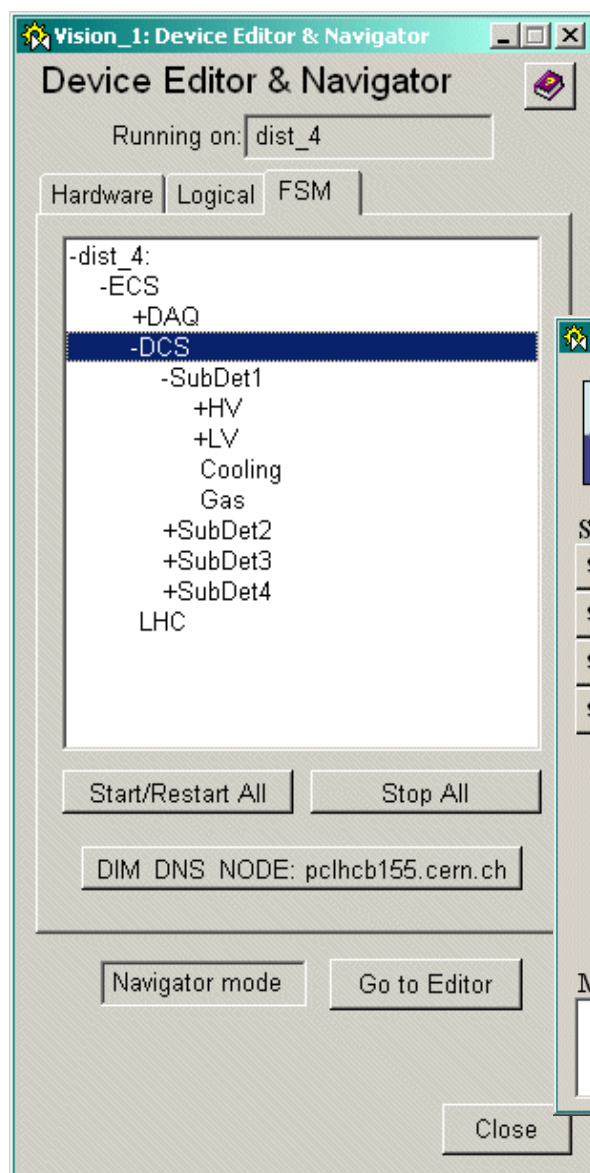
## ■ Conditions DB (COOL/Oracle) contains:

- | A subset of the monitoring data read from HW if it is needed for Offline processing
- | Some configuration data once it has been used (ex.: trigger settings)

### ➔ Status: COOL tools provided by LCG, PVSS interface being developed

# Tools: Integration (FSM)

- Started defining guidelines:
  - Naming conventions.
  - Standard "domains" per sub-detector:
  - Standard states & actions per domain



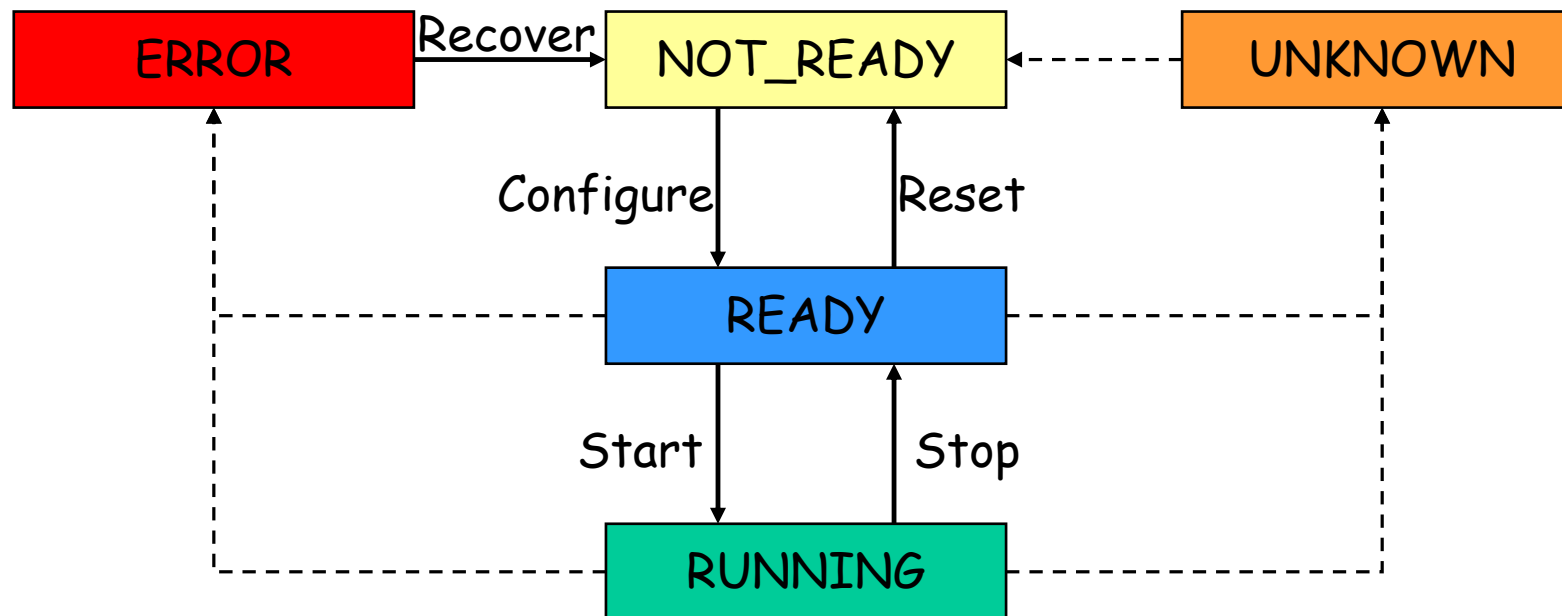


# Guidelines: FSM Domains

- Standard “domains” per sub-detector:
  - DCS
    - | DCS Infrastructure (Cooling, Gas, Temperatures, pressures, etc) normally stable throughout a running period
  - HV
    - | High Voltages or in general components that depend on the status of the LHC machine (fill related)
  - DAQ
    - | All Electronics and components necessary to take data (run related)
  - DAI
    - | Infrastructure necessary for the DAQ to work (computers, networks, electrical power, etc.) in general also stable throughout a running period.
- And standard states & transitions per domain.
  - Templates available as FW Component
- Doc available in EDMS: <https://edms.cern.ch/document/655828/1>

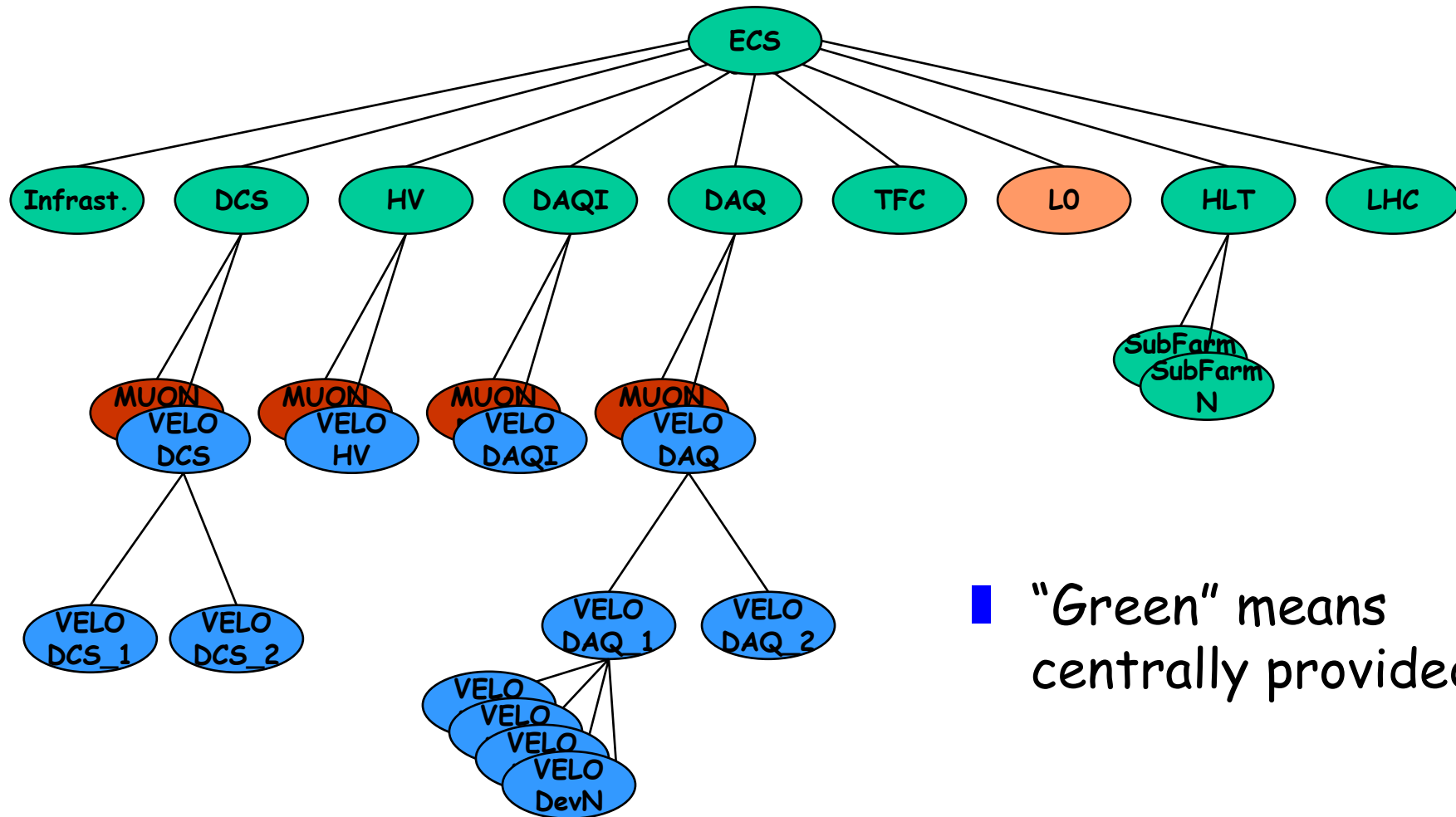
# Guidelines: FSM States

## ■ State Diagram for Trigger and DAQ Domains:



- Possible intermediate "CONFIGURING" and "STARTING" states if operations slow...

# LHCb Hierarchy



■ "Green" means centrally provided

# Application: Infrastructure

## ■ Integration of Infrastructure Services:

- | Power Distribution and Rack/Crate Control (CMS)
- | Cooling and Ventilation Control
- | Magnet Control (Monitoring)
- | Gas Control
- | Detector Safety System

➔ Status: All advancing in parallel (mostly JCOP)

## ■ And interface to:

- | LHC machine
- | Access Control System
- | CERN Safety System

➔ Status: Tools exist (DIP protocol)

## ■ Sub-detectors can use these components:

- For defining logic rules (using their states)
- For high-level operation (when applicable)



# Application: TFC Control

- Integrates: CC-PC, FSM, ConfDB, etc.
- Being used by several Sub-detectors

Settings of ODIN/OdinV2\_00 under the None

## TFC Local Run Control

19/07/2005 20:58:36

System	State
Partition_OdinV2_00	RUN_RUNNING

Sub-detector	State	Icon
ECAL	RUN_NOT_READY	✗
HCAL	RUN_NOT_READY	✗
INNER_TRACKER	RUN_NOT_READY	✗
MUON	RUN_NOT_READY	✗
OdinV2_00	RUN_RUNNING	✓
OUTER_TRACKER	RUN_NOT_READY	✗
PS_SPD	RUN_NOT_READY	✗
RICH1	RUN_NOT_READY	✗
RICH2	RUN_NOT_READY	✗
TRIGGER_TRACKER	RUN_NOT_READY	✗
VELO	RUN_NOT_READY	✗

### Statistics and status

Orbits	110597	Periodic Trig. A	0
Bunch IDs	0xFFFF   0x1DF	Periodic Trig. B	0
Total L0 Trig.	9828442	Calib. Trig. A	0
Gated L0 Trig.	9812350	Calib. Trig. B	0
L0 Trigger Rate	0.00	Calib. Trig. C	0
L1 Triggers	9811418	Random Trig.	9812350
L1 Rejects	9419704	Auxiliary Trig.	0
L1 Accepts	391713	Timing Trig.	0
L1 Trigger Rate	0.00	L1 IP Dest.	0
L0 Throttle	648240	HLT IP Dest.	0
L1 Throttle	0	L0E Reset	1095
Global Status	OK	L0E+L1E Reset	0

### L0 trigger

- ☐ L0 external trigger
- ☒ Random L0 trigger
- ☐ Force random L0
- ☐ Periodic trigger A
- ☐ Periodic trigger B
- ☐ Calibration trigger A
- ☐ Calibration trigger B
- ☐ Calibration trigger C
- ☐ Auxiliary trigger
- ☐ Force auxiliary L0
- ☐ Timing trigger
- ☐ Max L0 triggers

### L1 trigger

- ☐ L1 external trigger
- ☐ L1 trigger via GbE
- ☒ L1 internal trigger
- ☒ Random L1 trigger

### Commands

- ☒ L0E FE reset
- ☐ L0+L1E FE reset
- ☐ Periodic command
- ☐ IP assignments

### Configuration

ODIN running

Configure THOR

### Initialization

System Reset Soft Reset Initialize

Subscribe Cnts Counter Reset Counter Update

Save settings Close

Messages



# Application: CPU Control

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- For All Control PCs and Farm nodes:
  - | Very Complete Monitoring of:
    - | Processes running, CPU usage, Memory usage, etc.
    - | Network traffic
    - | Temperature, Fan speeds, etc.
  - | Control of Processes:
    - | Job description DB (Configuration DB)
    - | Start/Stop any job (type) on any group of nodes
  - | Control of the PC
    - | Switch on/off/reboot any group of nodes
- FSM Automated Monitoring (& Control):
  - | Set CPU in "ERROR" when monitored data bad
  - | Can/will take automatic actions



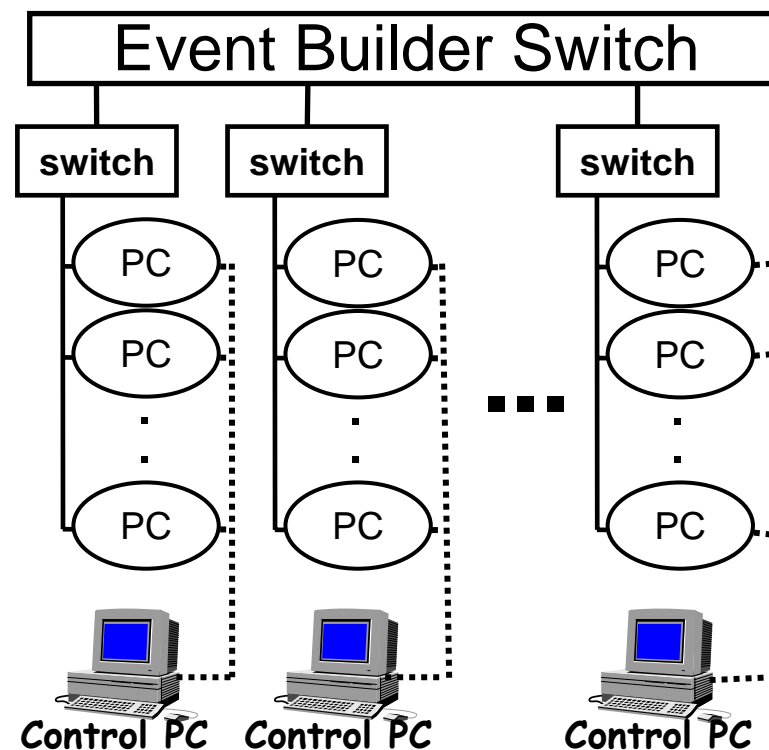
# Application: HLT Control

## ■ Integrated for Real Time Trigger Challenge:

### ■ Monitoring & Control of:

- | Farm Infrastructure
- | Trigger Jobs (Gaudi)
- | Event Builder
- | (MEP Producer)
- | Run Control

- ➔ The RTTC was one of the pioneers of the integration of ECS components
- ➔ Being upgraded for 1MHz readout





# RTTC Run-Control

subfarm001: System1:Manager3

LHCb THCP

System  
subfarm001

Sub-System	State
node00101	RUNNING
node00102	RUNNING
node00103	NOT_RE
node00104	RUNNING
node00105	RUNNING
node00106	RUNNING
node00107	RUNNING
node00108	RUNNING
node00109	RUNNING
node00110	RUNNING
node00111	RUNNING
node00112	RUNNING
node00113	RUNNING
node00114	RUNNING
node00115	RUNNING
node00116	RUNNING
node00117	RUNNING
node00118	RUNNING

node00101: System1:Manager3

LHCb THCP

System  
node00101

State  
RUNNING

Sub-System	State
node00101HLTjob1	RUNNING ✓
node00101L1job1	RUNNING ✓
node00101Testjob1	RUNNING ✓
node00101HLTjob2	RUNNING ✓
node00101L1job2	RUNNING ✓
node00101Testjob2	RUNNING ✓

L1

HLT

Test

L1 bandwidth 63.186444030

L0 accepted 2928

L1 GEN accepted 151

L1 MUON accepted 0

L1 accepted 185

L1 result different 0

L1Gaucho/NL1TRACKS

L1Gaucho/PT1

L1Gaucho/PT2

L1Gaucho/PT1vsPT2

ROOT viewer

Save info

Messages

Close

# Next "Challenges"

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- **VELO "ACDC" Now and in June**  
(Alignment Challenge and Detector Commissioning)
  - **Complete Read-out chain (1/4 of VELO):**
    - | Front-end boards, Tell1 boards, TFC System, Readout Network, Small Farm
  - **Several DCS Components:**
    - | Few ELMBs (Temp. and LV monitoring), CAEN Easy (LV), ISEG (HV)
  - **Run Control**
- **This setup will evolve into a combined TestBeam in September with other Sub-detectors**

# Other "Challenges"

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## ■ Configuration DB Tests

- Installing Oracle RAC in our private network  
(With help/expertise from Bologna)

➔ Simulate load -> Test Performance

➔ Test with more than 1 DB servers

## ■ HLT Farm @ 1 MHz scheme (RTTC II)

- Full Sub-farm with final number of processes  
in each node

➔ Test performance and functionality of  
Monitoring & Control System



# Manpower

## ■ Our Team (Online people participating in control):

Task	CERN	External effort
Coordination	0.5	
DIM & FSM (SMI++) tools:	0.5	1 (Rutherford)
Electronics HW (SPECS, CC-PC):		1.5 + 0.5 (Orsay/Genova)
Electronics SW Tools (SPECS, CC-CP):	2	
DCS + Infrastructure:	1	
Configuration DB:	1	
Run-Control & Sub-detector integration:	1	0.5 (Marseille)
Farm Control & Gaudi Monitoring:	2	1.5 (Bologna)
Central DAQ & TFC Control:	1	
Conditions DB interface:	1 (soon)	

- If it doesn't decrease and with JCOP's help  
-> seems adequate

## ■ Main aims:

### ■ Promote commonality

- | To allow reuse of software & ease maintenance
  - | Standard electronics interfaces
  - | Central purchasing of PCs, network, etc.

### ■ Provide centrally as much as possible:

- | To avoid sub-detector developments and try to optimize performance.
  - | Integrate the access to electronics boards
  - | FSM Guidelines with template implementation
  - | Integrate the Conf. DB access ( "Configurator" Object)

### ■ Obtain a coherent and homogeneous system



# Coordination

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## ■ Communication channels:

### ■ ECS Web page

- | Info, guidelines, software

### ■ 1<sup>st</sup> ECS Tutorial organized recently

- | Very successful (71 participants !?)

### ■ ECS section in the LHCb week Online meeting

### ■ Many individual discussions per Sub-detector (case-by-case basis)

# Integration & Commissioning

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- **Sub-system commissioning**
  - Done by each team within their schedule  
(for ex. after there are cables and power)
    - | With our help
- **Central ECS & Infrast. Commissioning**  
(PCs, Network, DBs, and central applications)
  - Done centrally in parallel
- **Integration of Sub-systems (into ECS)**
  - Done centrally one-by-one after each ready
    - | With their help



## ■ Technical worries

### ■ Performance

- | PVSS (for complex electronics and farm jobs)
  - | Assumed 1 PC for ~50 boards/~50 farm nodes
  - | But then:
    - | Our system is highly parallel (could buy more PCs)
    - | Will try disabling "Last Value Archive"...
- | Database Access (Conf.DB, Archive, Cond. DB)
  - | But then:
    - | Will have an Oracle RAC with several DB servers...
- | FSM hierarchies (in other experiments)
  - | Too many nodes -> needs coordination effort (>1000 nodes for HV before the real channels)

## ■ Non-Technical worries

### ■ Support:

- | FwDIM and FwFSM are widely used (FwFarmMon)
  - | Need more (better) help from JCOP/Central DCS teams
- | To the Sub-detectors
  - | Try to make sure they respect the rules...

### ■ Schedule:

- | Sub-detectors are late (just starting)
  - | But then: More and better tools are available!

### ■ Commissioning:

- | All the problems we don't know yet...
  - | For example: Error Detection and Recovery