## Activities of the NTUA-CMS Group on the Central Detector Control System of the CMS Detector



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## Outline

- Introduction to Control Systems
- CMS Detector Control System
- NTUA-CMS Activities



# Compact Muon Solenoid





## Detector Control System

- Control the detector
- Monitor the conditions under which it operates
- Sophisticated and sensitive equipment (more that 6 million parameters)
- Take necessary actions
- Around 10% of the total readout channels
- Data used for data quality as well as reconstruction



# Control Systems

- SCADA system (Supervisory Control And Data Acquisition)
- Monitor and Control a remote process
- Factories, airports, physics experiments
- Toolkits
- Tools for developing the supervisory layer
- Ability to connect to hardware (communication layer, drivers)



## Control Systems at CERN



#### Runtime DB

- Current image of the control system.
- Store values and structures.
- Each element of the system is a data point (DP) of a certain data point type (DPT).
- A DPT is a structure used to model data such as devices (Object oriented way)
- A data point consists of Data point Elements (DPE) that can hold values

#### Data point type HvChannel



#### Data point of type HvChannel



### Finite State Machine

• Efficiency in detector operation.

Division of system in nodes

 Set of states and Actions

States from bottom up

 Commands from up to bottom



## CMS Detector Control System (DCS)

- More than 35 individual systems
  Minimal systems modified by a bunch of JCOP-like CMS components
- Centralized
- Central DCS responsible for the maintenance of all the projects





## DB editor navigator

Administer all CMS systems

Store the system information in a Database

**Completely reworked** to fit CMS needs

Merged with the CMS installation utilities

#### - 🗆 × Projects Setup -Remote DB-Agent Status Redundancy – Host #1: DCS-S2F16-07-01 (active) Redundant STOPPED DB Editor and Navigator Version Restart Configure Stop Host #2: DCS-C2F43-13-01 (passive) (03.1314:22) E-Computers ⊡ DCS-C2F43-13-01 Details . -Summary Info File sync: Disabled ServiceProject Management Mode: Central Set to Local CMS CentralConfDbSetup - CMSfwCentralConfDbSetup 1.1.1 ⊡ CMS DIP PVSS-DB Consistency NOT OK -Requested Configuration through the FW System Configuration DB ⊕ CMS InstallUtilsNew All components are correctly installed CMS\_Majority Requested groups of FW Components E-CMS RACKS All component dependencies are OK ⊡ CMSfwFsmXm FSMfw 315 ⊡ ConfigurationDB 315 Performance No pending post-install scripts ⊡ CoreComponents 315 -RackFramework 315 Component consistency checked at 17.04.04 18:57 ⊡ DIP\_315 RemoteLogViewer 315 ⊡ FSMfw 315 E Performance -Component currently installed Show sub-components RackFramework\_315 Reinstall 🛛 Restart Pro: Overwrite File: 📥 ⊡ RemoteLogViewer 315 Requested Component Version Installed Component Version Pending | Files Is 📥 E DCS-C2F43-13-02 twCtrIUtils TwDeviceEditorNavigator 8.0.2 8.0.0 ⊡ DCS-C2F43-13-03 fwAccessControl 8.0.1 fwDevice 8.0.0 ⊡ DCS-C2F43-13-04 CMSfwFsmXml 1.0.2 fwFSM 32.1.0 ⊡ DCS-C2F43-13-05 CMSfwFsmXml 1.0.2 fwGeneral 8.0.2 ⊡ DCS-C2F43-13-06 ⊡ DCS-C2F43-13-07 fwXML 8.0.0 fwInstallationUtils 2.1 DCS-C2F43-13-08 fwDevice 8.0.0 8.0.0 fwLogErrHandler ⊡ DCS-C2F43-13-09 fwNode 8.0.0 8.0.0 fwNode DCS-C2E43-13-10 fwESM 32.1.0 fwRDBArchivina 1.1.4 ① DCS-C2F43-13-11 fwDeviceEditorNavigator 8.0.0 fwRack 5.4.4 fwAnalogDigital 8.0.0 fwTrending 8.0.0 ⊡ DCS-C2F43-13-14 fwTrending 8.0.0 fwXML 8.0.0 中DCS-C2E43-13-15 fwLogErrHandler 8.0.0 majority treeCache 1.2.17 . E · DCS-C2F43-13-16 ⊡ DCS-C2F43-26-01 Auto refresh (Values refreshed every 10sec) DCS-C2F43-26-02 Post-installs pending Incorrect installation DCS-C2F43-26-03 Register Reinstalls ⊡ DCS-C2F43-26-04 Components not in sync Broken dependencies ⊡ DCS-C2F43-26-05 Adopt Project Configuration DCS-C2F43-26-06

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			1	
	Timestamp	Severity	Last Installation Log	<b>_</b>
	15-MAR-17 05.26.42.801 PM	INFO	WCCOActrl(2): ReduAgent: Inconsistent status for progs file, pmon and status file. Expected status = PASSIVE Pmon st	ati
	30-MAR-17 04.20.24.978 PM	INFO	WCCOActrl(2): ReduAgent: Inconsistent status for progs file, pmon and status file. Expected status = PASSIVE Pmon st	.atu
	30-MAR-17 04.20.25.040 PM	ERROR	- cmccondined-solution and solution and s	
<b>•</b>	30-MAR-17 04.20.26.085 PM	ERROR	WCCOActrl(2): fwInstallationDB isProjectRegistered() -> Could not execute the following SQL query: SELECT id, system	id – j
	30-MAR-17 04.20.26.132 PM	ERROR	WCCOActrl(2): fwInstallationDB_storeInstallationLog()->Error retriving the project info from the DB	
	31-MAR-17 11.14.15.078 AM	INFO	WCCOActrl(2): ReduAgent: Inconsistent status for progs file, pmon and status file. Expected status = PASSIVE Pmon st	.atı, 🗾
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n Status 🥚 OK	Limit log messages 20	*	Clear logs before 1 hour ago 💌 Clear	
onent Installation Tool v.8.0.5				. 1
onfiguration DB Editor v.4.1.2			Options	lose

#### 🚱 Vision\_1: fwConfigurationDBSystemInformation\fwConfigurationDBSystemInformation\_dbEditorAndNavigator.pnl

Connectio FW Comp

System C

⊡ DCS-C2F43-26-07

⊡ DCS-C2F43-26-09 ⊡ DCS-C2F43-26-10 ⊞-DCS-C2F43-26-11

⊡ DCS-C2F43-26-12 由-DCS-C2F43-26-14 ⊡ DCS-C2F43-26-15 🗄 DCS-S2F16-07-01 DCS \$2514 07 03 Swtich to mode: Projects Setup

DB Server: cms pvss rdb

DB User: cms\_dcs\_conf DB schema v.: 5.1.6

-DB Connection -

# Configuration DB



## CMSfwInstallUtils

 CMS extension to the JCOP configuration DB tool, CMSfwInstallUtils.

• Quick and flexible way of selecting the datapoints.

• Save all information in a single click.

 Comparison mechanism between system and database

Datapoints	In project	In database	Addresses	Archiving	Alerts
Wiener/CAN15	Yes	Yes	OK	OK	OK
Wiener/CAN15/Crate1/Channel10	Yes	No			
Wiener/CAN15/Crate1	Yes	Yes	OK	OK	OK
CMSfwInstallUtils/deviceList/RackWiener_S5	Yes	Yes	OK	OK	OK
Wiener/CAN15/Crate1/Channel9	Yes	No			
Wiener/CAN15/Crate1/Channel7	Yes	Yes	OK	OK	OK
Wiener/CAN15/Crate1/Channel6	Yes	Yes	OK	OK	OK
Wiener/CAN15/Crate1/Channel5	Yes	Yes	OK	OK	OK
Wiener/CAN15/Crate1/Channel4	Yes	Yes	OK	OK	1 missing
Wiener/CAN15/Crate1/Channel3	Yes	Yes	OK	OK	OK
Wiener/CAN15/Crate1/Channel2	No	Yes			
Wiener/CAN15/Crate1/Channel1	Yes	Yes	OK	OK	OK
Wiener/CAN15/Crate1/Channel0	Yes	Yes	2 missing	2 missing	OK



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confdbChecks (dist\_1 - RackWiener; #1)

GMS CMC Install Itile Dh Ch

 $\times$ 

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## High Granularity CALorimeter (HGCAL)









#### HGCAL DCS

• Wrapped in a component

- FSM approach
- Oracle DB archiving
- Access Control

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## CMS LHC Communication

shake Stat	us Detector Protect	tion Status Simulat	e Handshake		- 15	
Machi	ne Mode: PRC	DTON PHYSICS	3		CMS to LHC COMMUNICATION	4
Beam I	Mode: INJ	JECTION PROE	BE BEAM			
					COMMUNICATION	V.
oftwa	re Inj. Inh	ibit: INJEC	TION ALLOWED	2		
ardwa	re inj. inn	IDIT: INJEC	TION ALLOWED	2		
DECTION						
W	A D MTM/C	TRABATAICACC		FADY I	OK	
-	ANDING		R			
Reply	from CMS:	EADY	View Replies from C	MS Subdetectors		
Reply HC BEAM	from CMS:	EADY	View Replies from C	MS Subdetectors		
Reply HC BEAM	from CMS: R	EADY	View Replies from C	MS Subdetectors		
Reply HC BEAM	from CMS: R MODE	EADY RAMP DOWN	View Replies from C	MS Subdetectors	NO BEAM	
Reply HC BEAM	Erom CMS : R MODE	EADY	View Replies from C	MS Subdetectors	NO BEAM	
Reply HC BEAM	from CMS: R MODE CYCLING SETUP	EADY RAMP DOWN NUECTION PROBE BEAM	View Replies from Cl	MS Subdetectors	NO BEAM	
Reply HC BEAM	Erom CMS : R MODE		View Replies from C	MS Subdetectors ABORT INJECTION PHYSICS BEAM	NO BEAM	
Reply HC BEAM	Erom CMS : R MODE CYCLING SETUP	EADY RAMP DOWN INJECTION PROBE BEAM	View Replies from C	MS Subdetectors	NO BEAM PREPARE RAMP	
Reply HC BEAM	Erom CMS : R MODE CYCLING SETUP CIRCULATE AND DUMP	RAMP DOWN INJECTION PROBE BEAM UNSTABLE BEAMS	View Replies from CO RECOVERY INJECTION SETUP BEAM STABLE BEAMS	MS Subdetectors ABORT INJECTION PHYSICS BEAM BEAM DUIV	NO BEAM PREPARE RAMP RAMP	
Reply	from CMS : R MODE CYCLING SETUP CIRCULATE AND DUMP	RAMP DOWN INJECTION PROBE BEAM UNSTABLE BEAMS	View Replies from CO RECOVERY INJECTION SETUP BEAM STABLE BEAMS	MS Subdetectors ABORT INJECTION PHYSICS BEAM BEAM DUM	NO BEAM PREPARE RAMP IP RAMP	







## Conclusions

- Overview of the Detector Control System of CMS
- Involvement of NTUA-CMS group in DCS
- Improvement and maintenance of the system
- CMS upgrade



## THANK YOU FOR YOUR ATTENTION!



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