

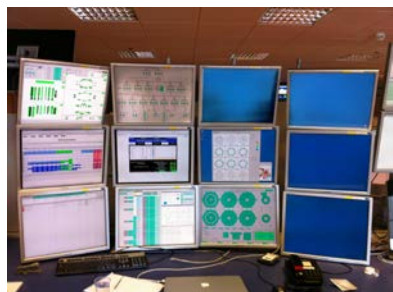


A Scalable and Homogeneous Web-Based Solution for Presenting Control System Data

ICALEPCS 2013, San Francisco

**Lorenzo Masetti
on behalf of PH-CMD CERN group**

CMS Control System Architecture



WINCC OA

USER INTERFACE

MONITORING AND
CONTROL



CMS FRAMEWORK

JCOP FSM

SUPERVISION

JCOP FRAMEWORK



DRIVER CLIENTS

MIDDLEWARE



DRIVERS



FRONT-END
HARDWARE

FRONT-END



CMS Control System Architecture



WINCC OA

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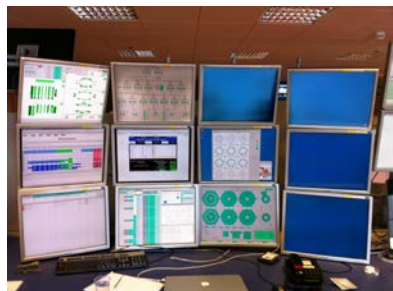


FRONT-END
HARDWARE

FRONT-END

DCS enables safe and
coherent operation of CMS

CMS Control System Architecture



WINCC OA

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About **3M** parameters
monitored and controlled

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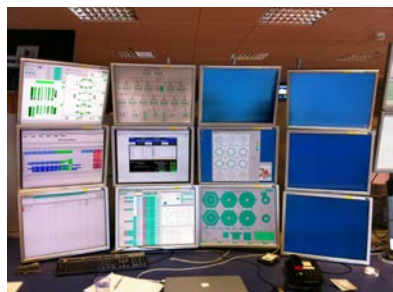
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Hierarchical Control



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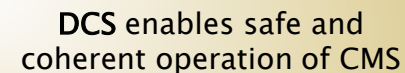
DRIVERS



FRONT-END
HARDWARE

FRONT-END

6



About **3M** parameters
monitored and controlled

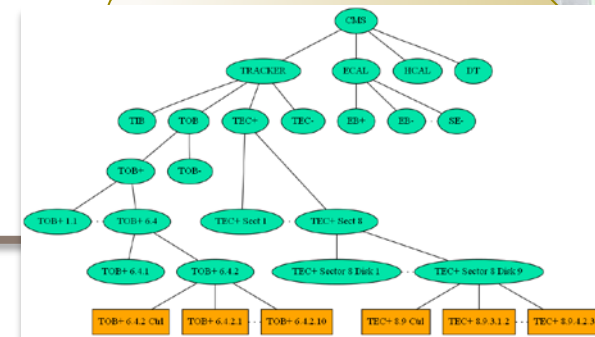
Hierarchical Control



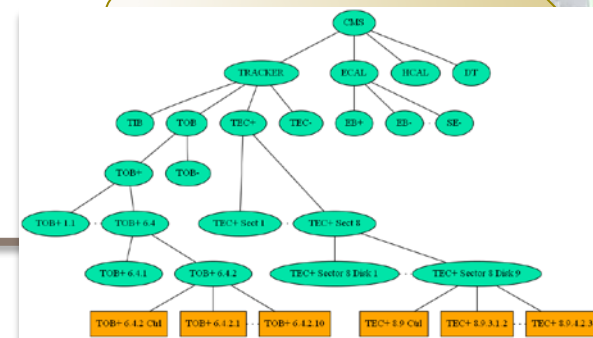
7

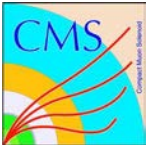


FRONT-END



8





Remote Access to DCS Data

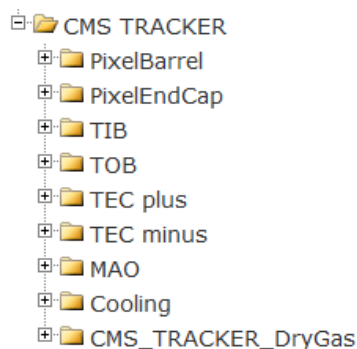
Why we need it?








- ❑ Remote Monitoring of Detector Status at any level of detail
- ❑ Incident Analysis
 - ❑ Access to online and historical (archived) data
- ❑ Long-term Trend Analysis
 - ❑ Access to archived data

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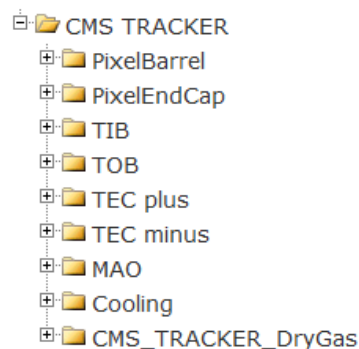









CMS TRACKER		ERROR
PixelBarrel	ON	
PixelEndCap	ON	
TIB	ON	
TOB	ERROR	
TEC plus	ON	
TEC minus	ON	
MAO	ON	

Remote Access to DCS Data

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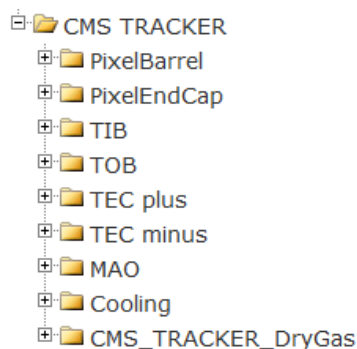









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System	State
CMS TRACKER	ERROR

Sub-System	State
PixelBarrel	ON
PixelEndCap	ON
TIB	ON
TOB	ERROR
TEC plus	ON
TEC minus	ON
MAO	ON

Traditional WinCC OA Interface

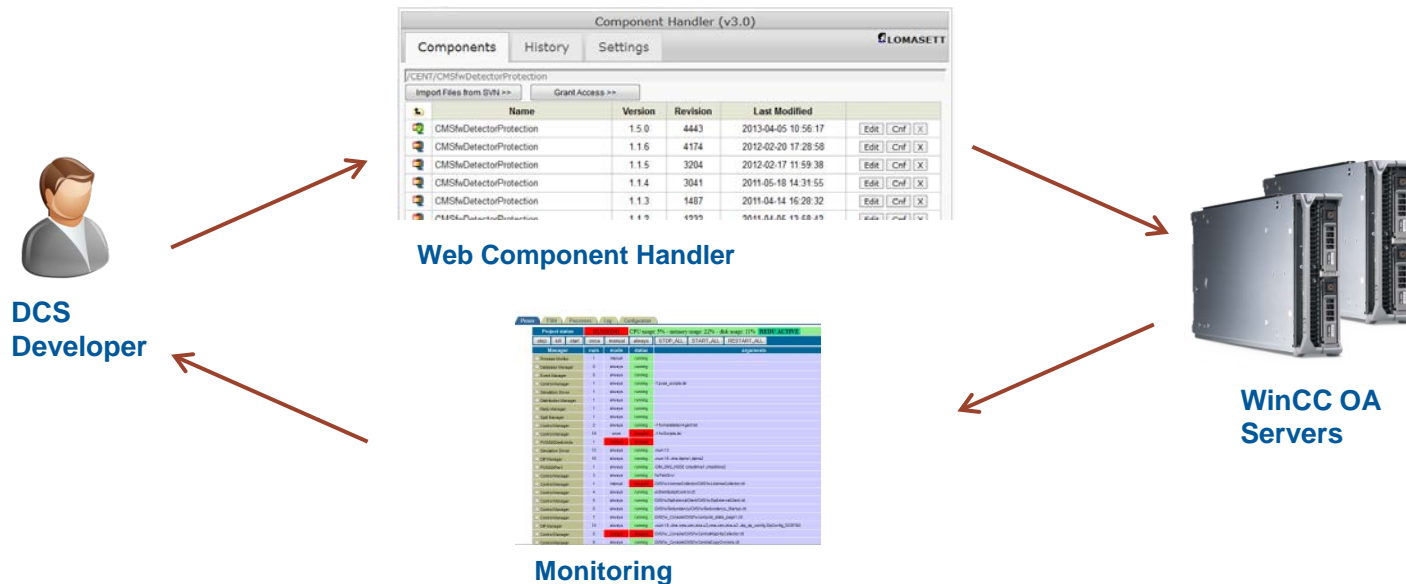
<ul style="list-style-type: none"> [-] CMS TRACKER <ul style="list-style-type: none"> [-] PixelBarrel [-] PixelEndCap [-] TIB [-] TOB [-] TEC plus [-] TEC minus [-] MAO [-] Cooling [-] CMS_TRACKER_DryGas
--

CMS TRACKER	ERROR
PixelBarrel	ON
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TEC plus	ON
TEC minus	ON
MAO	ON

CMS Web Interface

Remote Administration

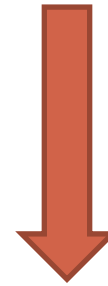
- ❑ DCS Developers do not access SCADA projects in production directly
 - ❑ Simplified maintenance
 - ❑ Flexible configuration of DCS machines
- ❑ Web based applications used for
 - ❑ DCS Software Deployment
 - ❑ DCS Infrastructure Monitoring and Control



Advantages of a Web Solution

Web Thin Client Architecture

- ❑ No specific software needed
 - ❑ Just a web browser
- ❑ Usable from mobile devices
- ❑ Scalable
 - ❑ Low Impact on SCADA System
- ❑ Simple Deployment
- ❑ Improves Expert On Call reaction time
- ❑ Large pool of freely available components to be reused for development

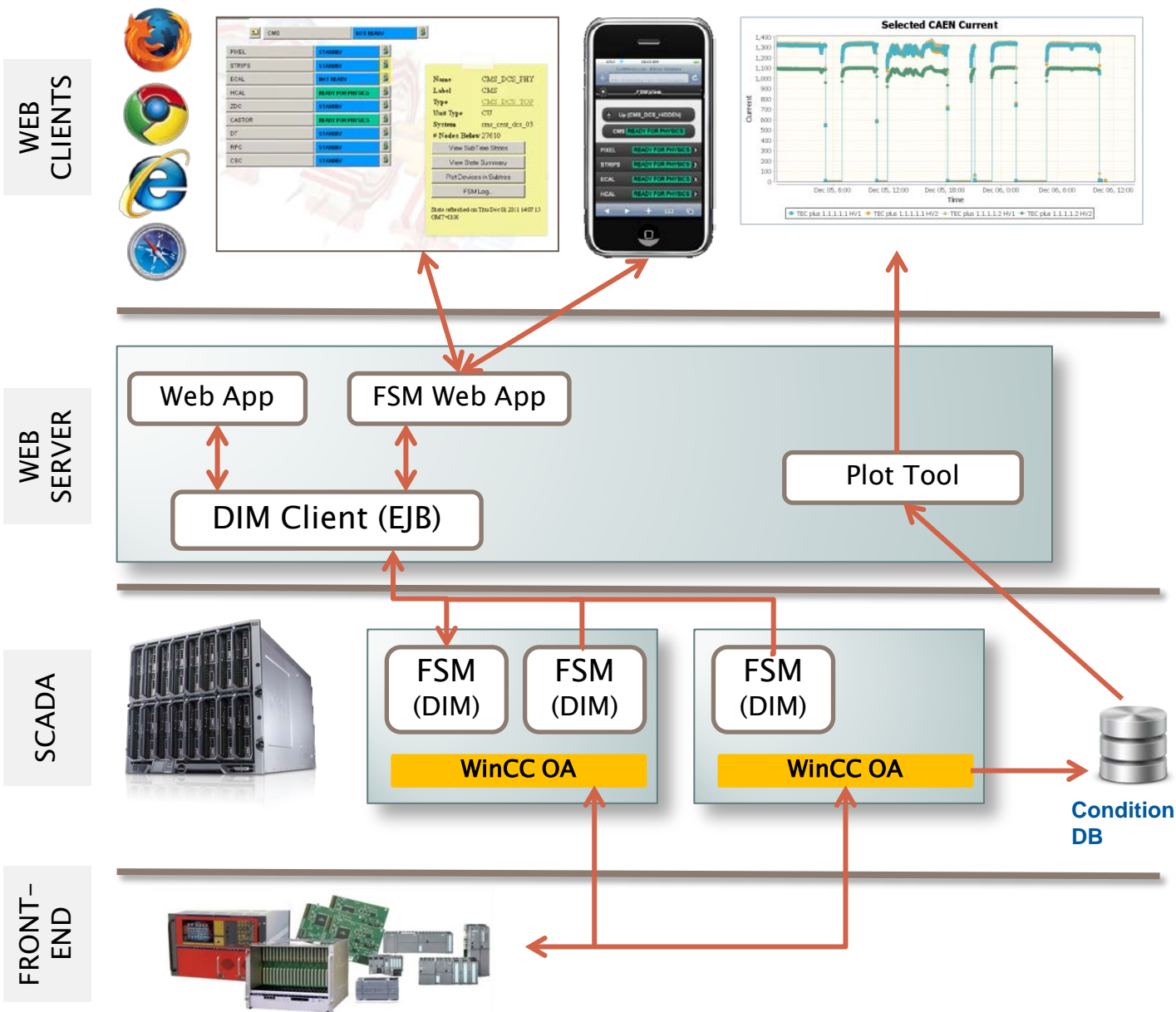


Our Approach

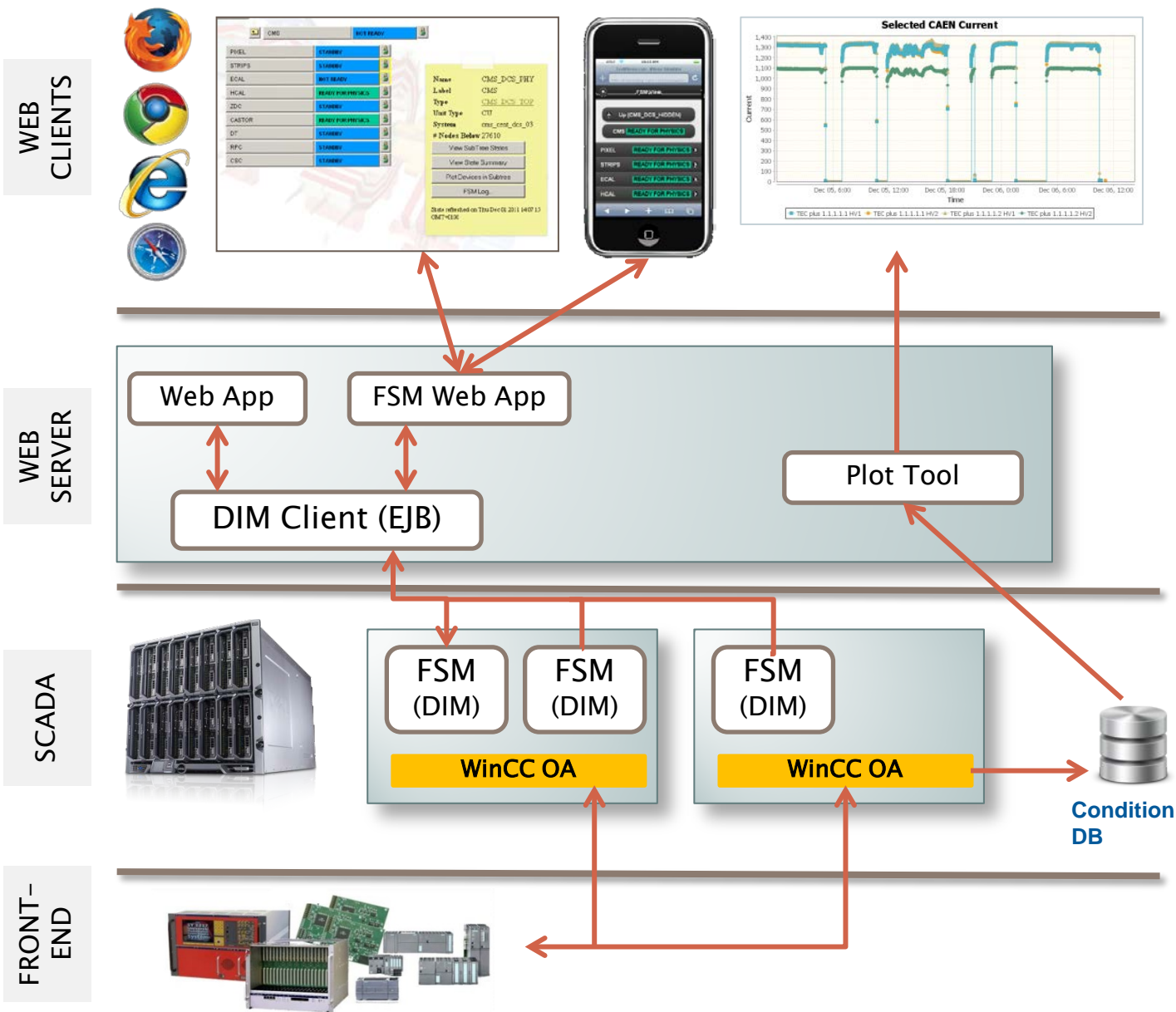
- ❑ **No automatic translation** of existing SCADA User Interfaces
- ❑ Development of a Web Framework for accessing DCS Data
- ❑ Standard Web Solutions
 - ❑ J2EE Portlets
 - ❑ EJB
 - ❑ Javascript
 - ❑ AJAX
- ❑ Integrated in an Enterprise Portal Environment
- ❑ Combine transparently data from various sources
 - ❑ Databases
 - ❑ Online Data



Strategy for Data Access

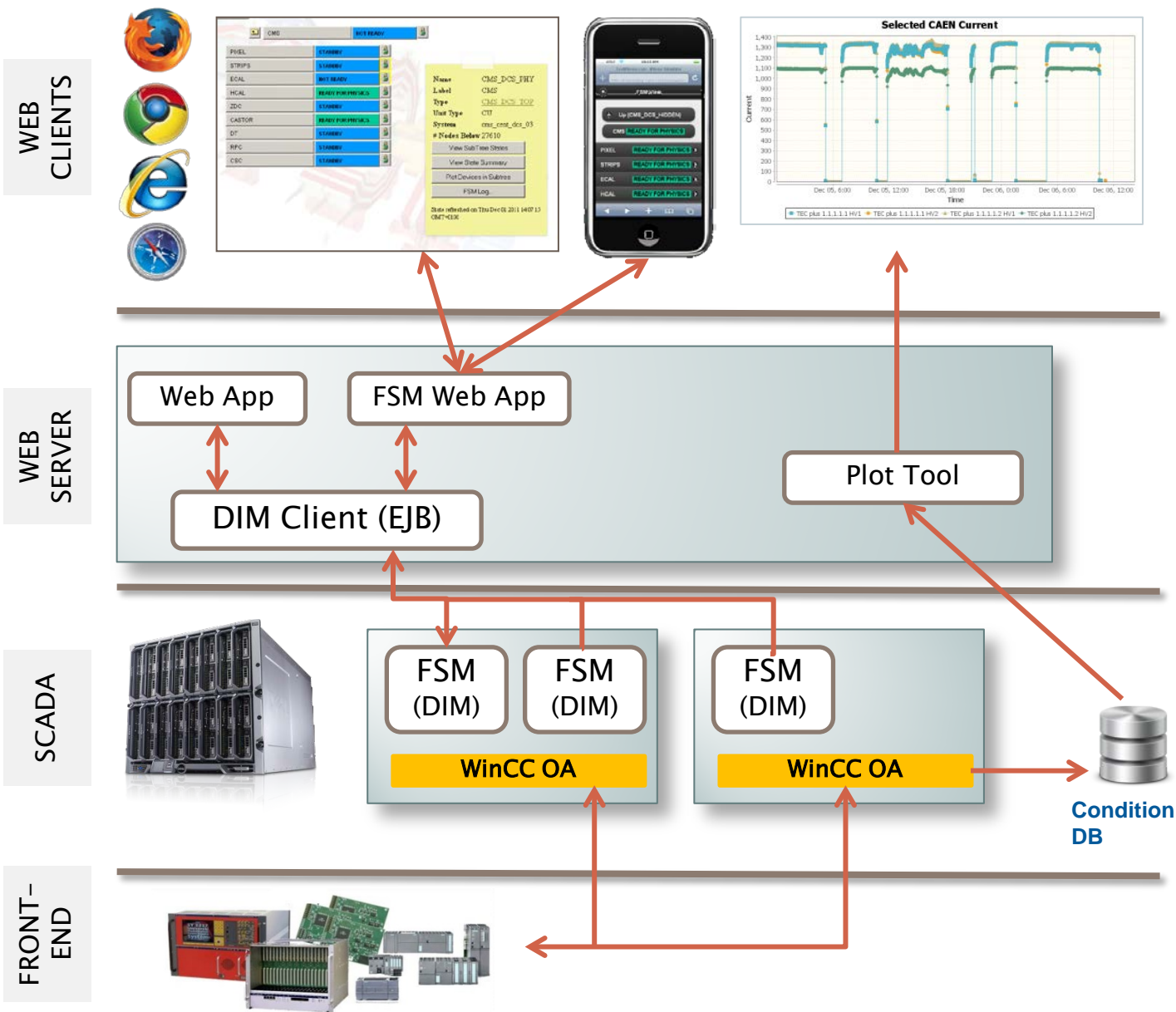


Strategy for Data Access



**No Direct Connection
from WinCC OA to Web
Server**

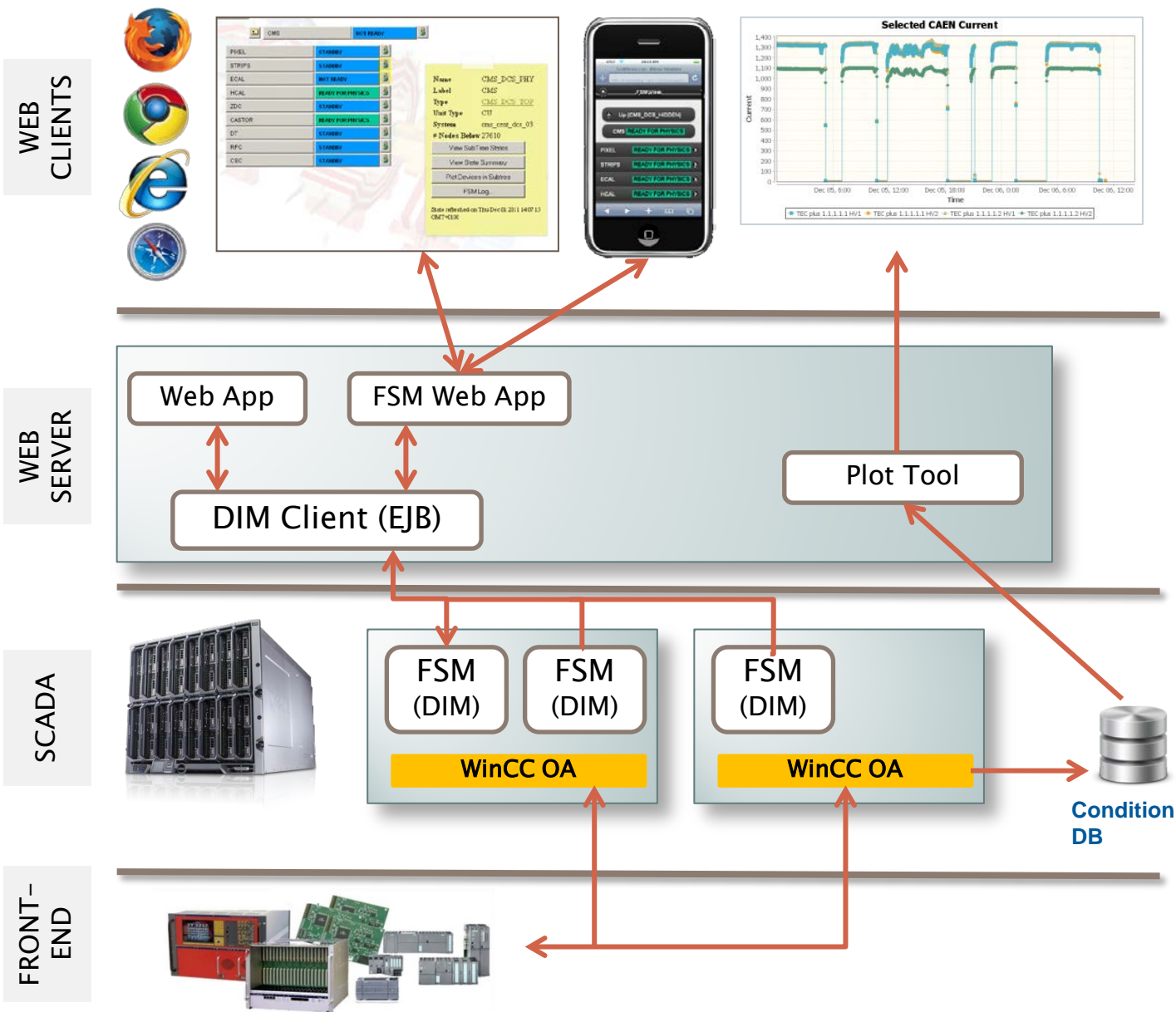
Strategy for Data Access



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Historical Data accessed
via Database

Strategy for Data Access

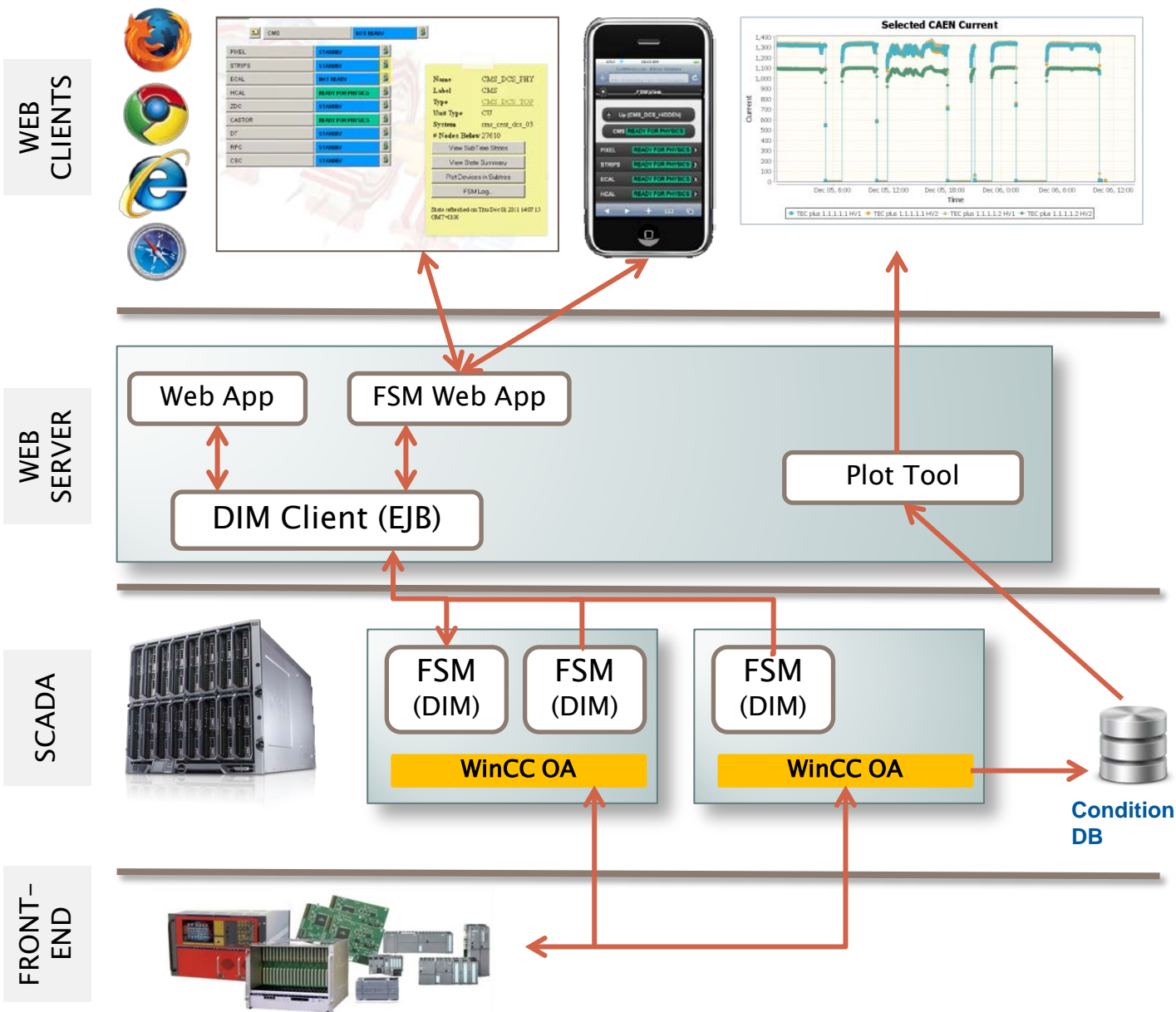


No Direct Connection
from WinCC OA to Web
Server

Historical Data accessed
via Database

Online Data accessed via
DIM (one EJB client)

Strategy for Data Access



No Direct Connection
from WinCC OA to Web
Server

Historical Data accessed
via Database

Online Data accessed via
DIM (one EJB client)

Multiple accesses served
by local cache

Last values from Database


Fast Display of Last Archived Values

- ❑ The last values of all archived parameters are stored in a separate table
 - ❑ Small table allows for faster queries
 - ❑ Last values in the DB are equal to the current reading in SCADA (with the approximation of the archiving deadband)
 - ❑ They can be used in the web display as “current value”

Last values from Database


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HO1P04_LV1

ON



Last values for HO1P04_LV1

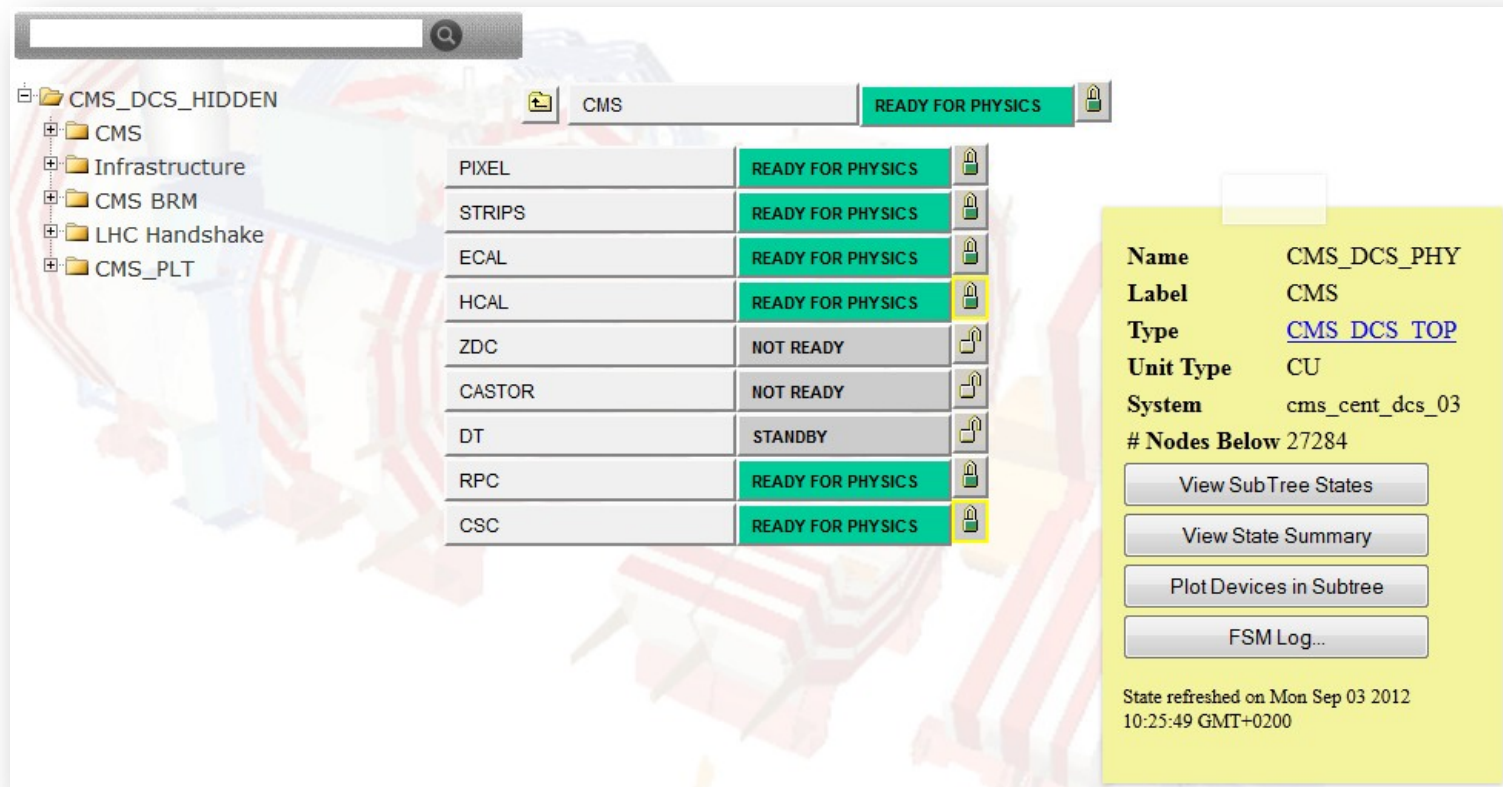
Device cms_hcal_dcs_02:CAEN/HCALLV01/branchController01/easyCrate5/easyBoard00/channel002

Label	Value	Timestamp (Local Time)
ACTUAL_IMON	7.57000017166138	Sep 20, 2013 16:44:53
ACTUAL_STATUS	1	Aug 30, 2013 15:58:54
ACTUAL_VMON	8.01000022888184	Aug 30, 2013 15:58:56

Plot...

Select column to plot... ▼

Example: Browsing the FSM Tree



The screenshot displays the CMS FSM Tree web interface. On the left, a tree view shows the hierarchy: CMS_DCS_HIDDEN, CMS, Infrastructure, CMS BRM, LHC Handshake, and CMS_PLT. The central pane shows the 'CMS' node selected, with a table of device states. The right pane provides detailed information for the selected node, including its name, label, type, unit type, system, and the number of nodes below it. Below this information are four buttons: 'View SubTree States', 'View State Summary', 'Plot Devices in Subtree', and 'FSM Log...'. At the bottom right, a timestamp indicates the state was refreshed on Mon Sep 03 2012 at 10:25:49 GMT+0200.

Device	Status	Icon
PIXEL	READY FOR PHYSICS	🔒
STRIPS	READY FOR PHYSICS	🔒
ECAL	READY FOR PHYSICS	🔒
HCAL	READY FOR PHYSICS	🔒
ZDC	NOT READY	🔒
CASTOR	NOT READY	🔒
DT	STANDBY	🔒
RPC	READY FOR PHYSICS	🔒
CSC	READY FOR PHYSICS	🔒

Device Information:

- Name:** CMS_DCS_PHY
- Label:** CMS
- Type:** [CMS DCS TOP](#)
- Unit Type:** CU
- System:** cms_cent_dcs_03
- # Nodes Below:** 27284

Buttons:

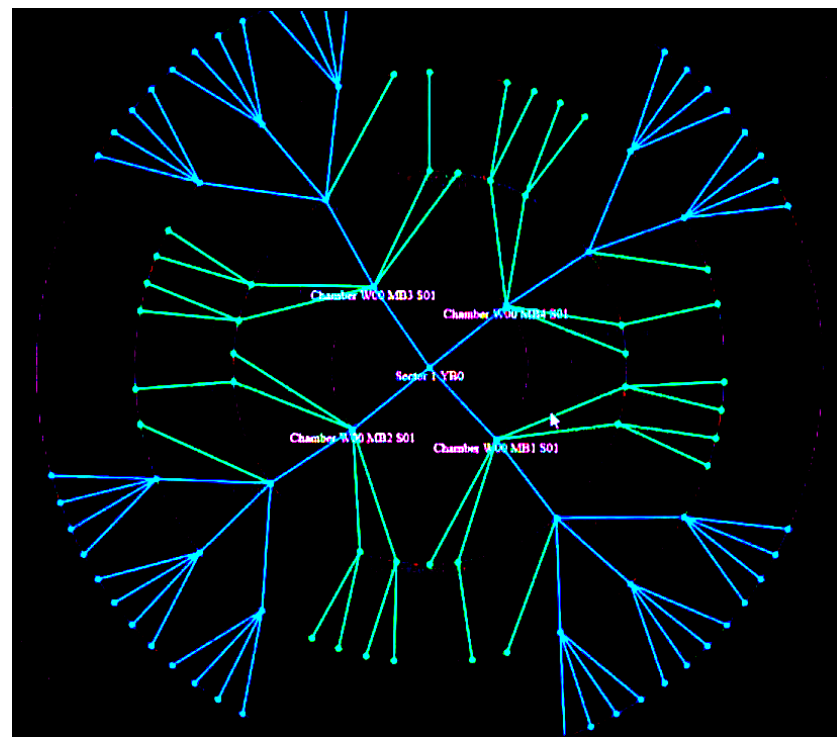
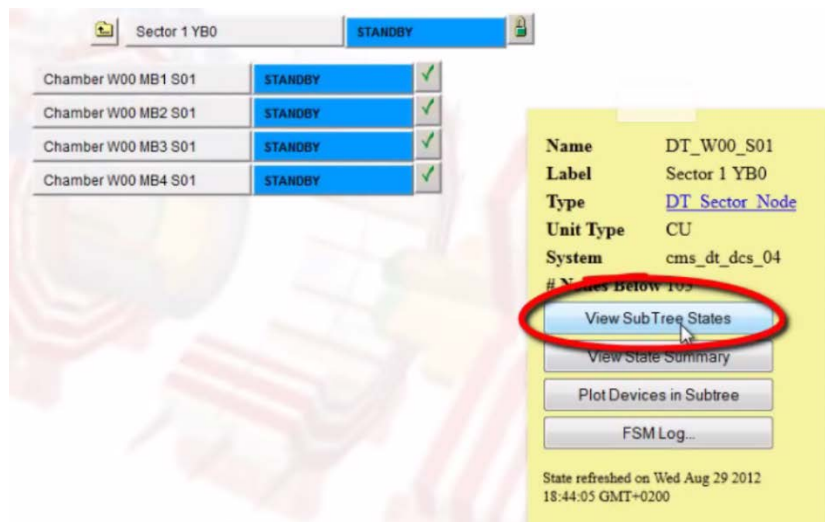
- View SubTree States
- View State Summary
- Plot Devices in Subtree
- FSM Log...

State refreshed on Mon Sep 03 2012 10:25:49 GMT+0200

- ❑ Interactive navigation in the FSM hierarchy from the web
 - ❑ Tree view
 - ❑ Web Interface looks like native SCADA interface

Radial Graph Visualization

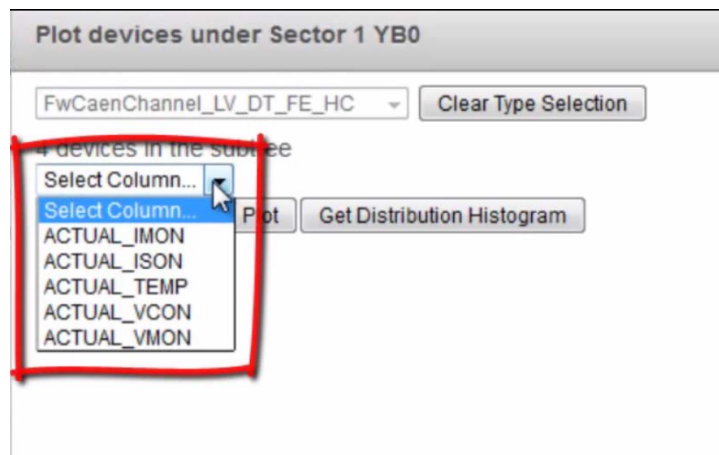
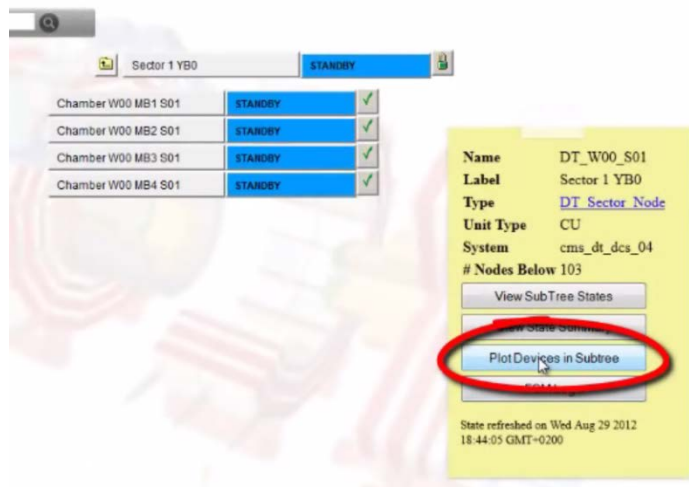
Using Javascript Visualization Library



- ❑ The radial graph gives a quick overview of the states of all the nodes in the selected sub-tree.

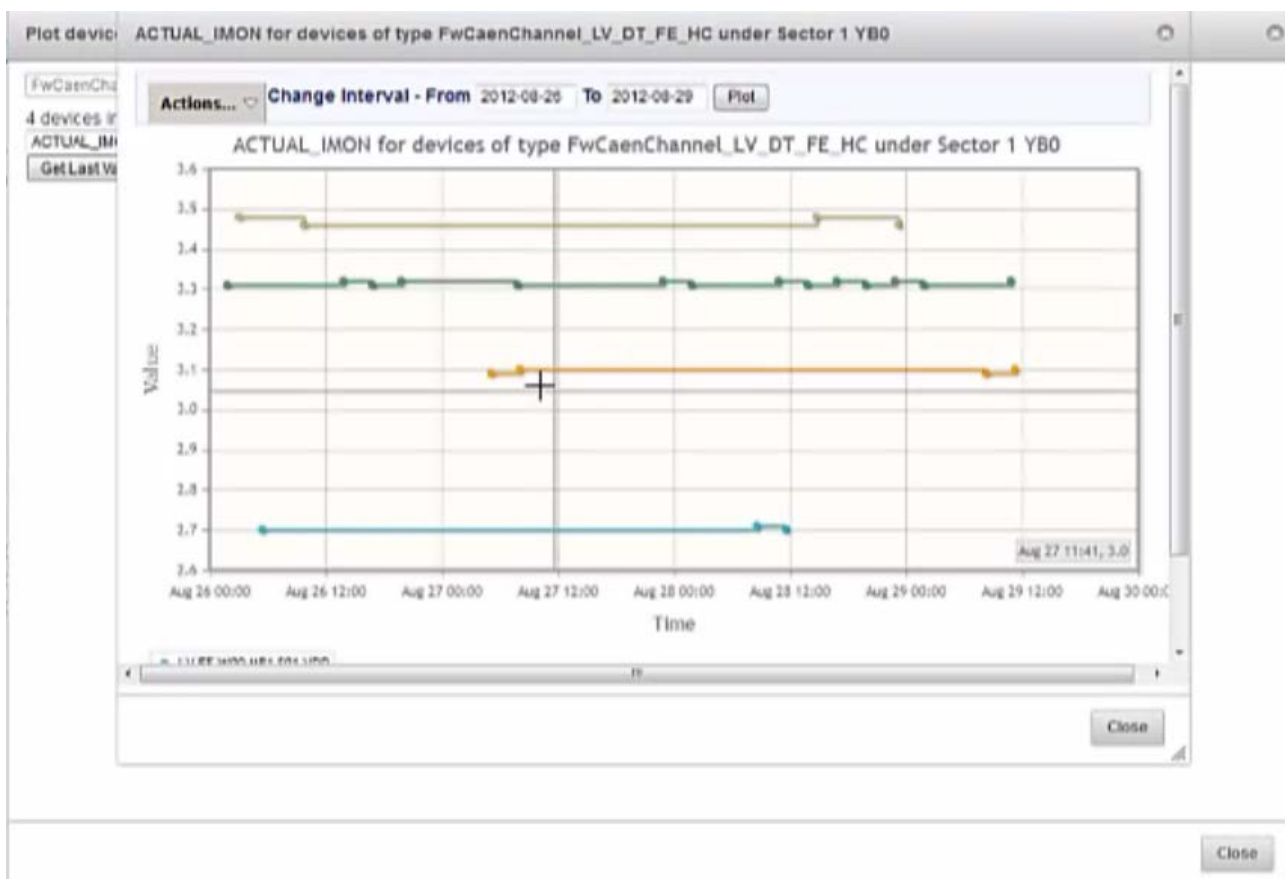
Plot for Devices in Subtree

Access to archived data



- ❑ Select the type of device and the parameter to plot
 - ❑ e.g. LV Current

Plot for Devices in Subtree



- ❑ Plot obtained with a few clicks
- ❑ Very useful for incident analysis
- ❑ Data from various sources (database, FSM) combined transparently



Custom Plots

Tracker CAEN Channel

Time Interval Select From and To Date ▾ From To

Select Alias TOB minus 1.1.1.2 HV1 ▾ Search pattern... Selected 2844 / 8734

Select Element ACTUAL_IMON ▾

☐ Save result to the DB

Actions... ▾

Custom Plots

Tracker CAEN Channel

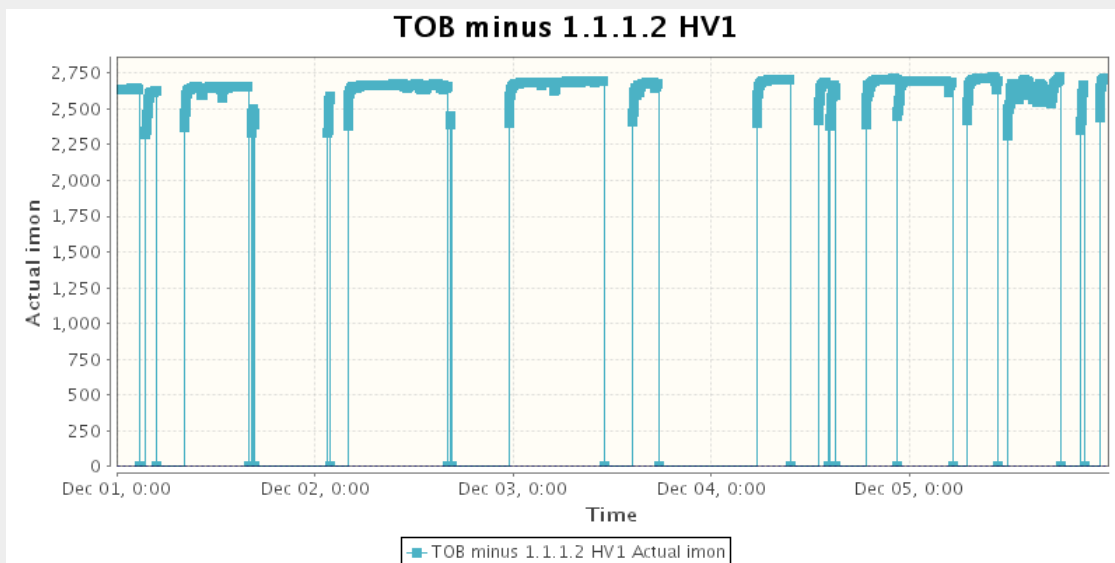
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Select Alias TOB minus 1.1.1.2 HV1 ▾ Search pattern... Selected 2844 / 8734
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 *Querying...*

Custom Plots

Tracker CAEN Channel

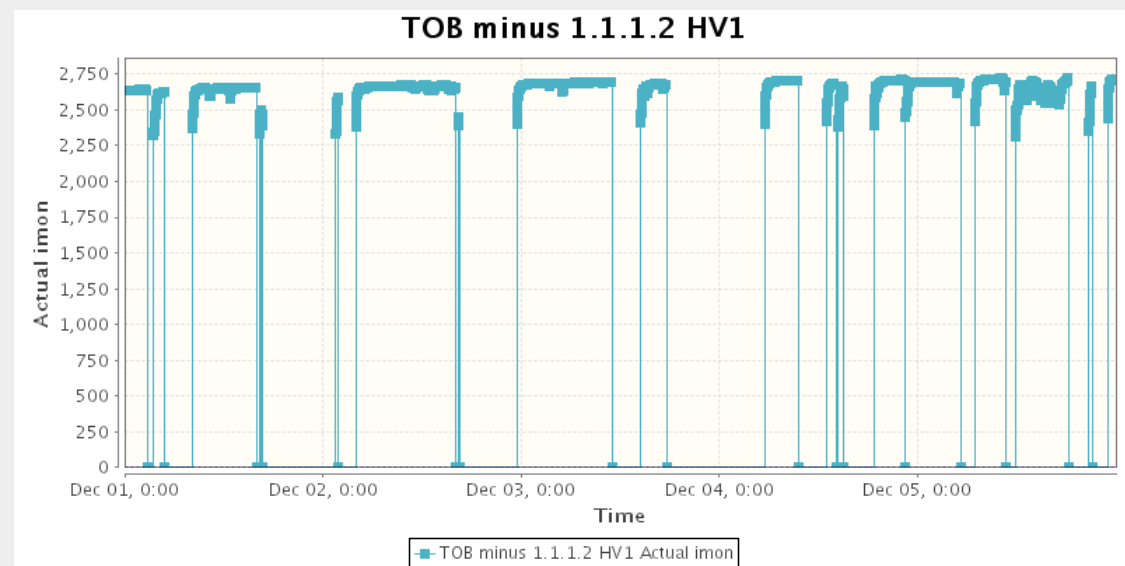
Time Interval Select From and To Date ▾ From 2012-12-01 To 2012-12-05
Select Alias TOB minus 1.1.1.2 HV1 ▾ **Search pattern...** TOB Selected 2844 / 8734
Select Element ACTUAL_IMON ▾
 ☐ Save result to the DB



Custom Plots

Tracker CAEN Channel

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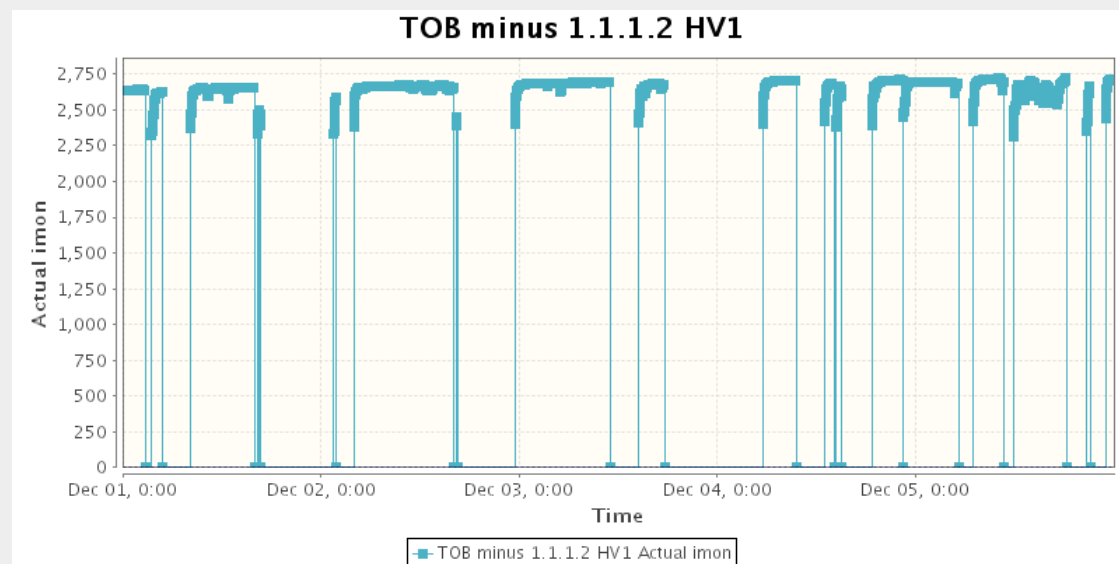


Predefined Templates allow non experts to plot relevant parameters

Custom Plots

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Predefined Templates allow non experts to plot relevant parameters

Archived Data accessed from Database without impact on the SCADA System

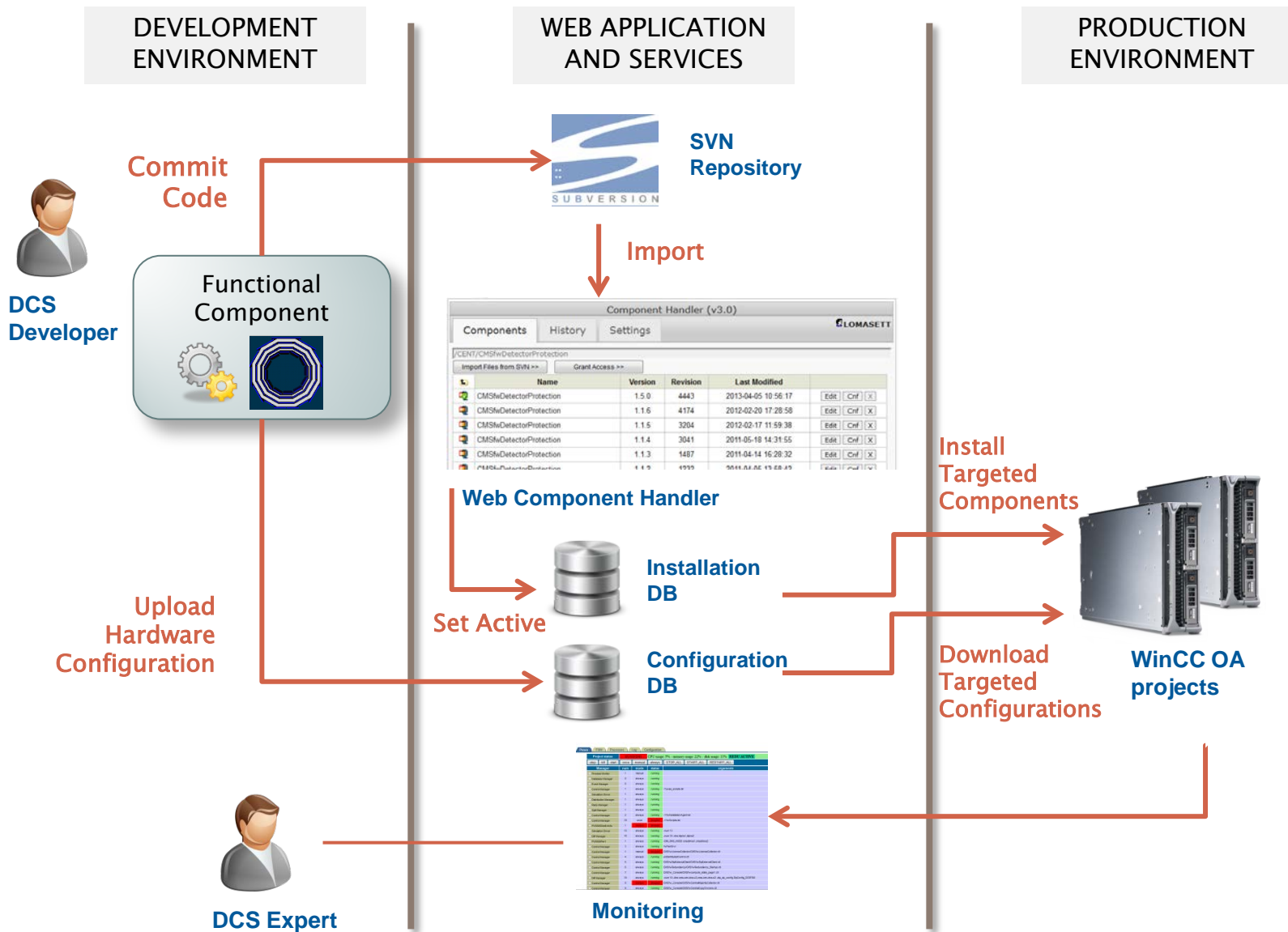
Read-only access

- ❑ Web Access to DCS Data is mainly read-only
 - ❑ CMS Operational Rules require that commands can be given only through the standard SCADA interface (only by the Central Shifter when CMS is controlled centrally)
- ❑ Some exceptions:
 - ❑ VME Crates can be switched on and off from the web interface
 - ❑ Access Control to ensure that user has proper privileges

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Administrative Tools

Web-Based Deployment



Administrative Tools

Web-Based Deployment

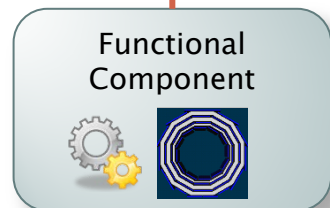
DEVELOPMENT
ENVIRONMENT

WEB APPLICATION
AND SERVICES

PRODUCTION
ENVIRONMENT

DCS
Developer

Commit
Code



SVN
Repository

Import

Component Handler (v3.0)

Components History Settings

Import Files from SVN >>> Grant Access >>>

Name	Version	Revision	Last Modified	Edt	Cnf	X
CMSfwDetectorProtection	1.5.0	4443	2013-04-05 10:56:17	Edt	Cnf	X
CMSfwDetectorProtection	1.1.6	4174	2012-02-20 17:28:58	Edt	Cnf	X
CMSfwDetectorProtection	1.1.5	3204	2012-02-17 11:59:38	Edt	Cnf	X
CMSfwDetectorProtection	1.1.4	3041	2011-05-18 14:31:55	Edt	Cnf	X
CMSfwDetectorProtection	1.1.3	1487	2011-04-14 16:28:32	Edt	Cnf	X
CMSSW_Production_2012_02_20	4.4.5	4955	2012-02-20 17:28:58	Edt	Cnf	X

Web Component Handler



Installation
DB



Configuration
DB

Install
Targeted
Components



WinCC OA
projects

Download
Targeted
Configurations

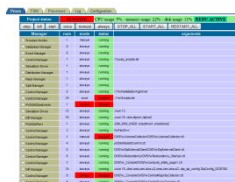
Set Active

Upload
Hardware
Configuration

DCS Developers provide
code and functionalities
packaged in components



DCS Expert



Monitoring

Administrative Tools

Web-Based Deployment

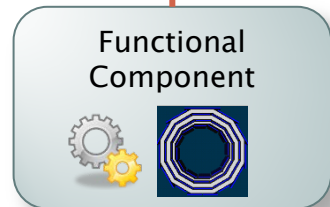
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CMSShDetectorProtection	1.4.5	4955	2011-04-05 15:00:45	Edt	Cnf	X

Web Component Handler



Installation
DB



Configuration
DB

Install
Targeted
Components



WinCC OA
projects

Download
Targeted
Configurations

Upload
Hardware
Configuration

Hardware Configurations
are stored in a dedicated
DB



DCS Expert



Monitoring

Administrative Tools

Web-Based Deployment

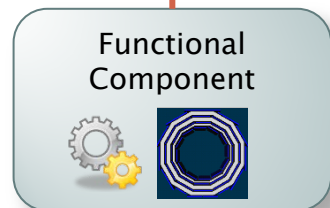
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SVN
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Code is imported from SVN
and a new version of the
component is released

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Web Component Handler



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DB



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DB

Install
Targeted
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WinCC OA
projects

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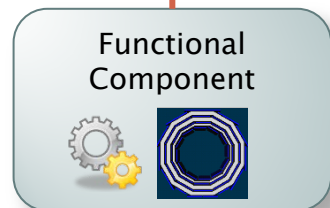
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CMSWinDetectorProtection	1.1.3	1487	2011-04-14 16:28:32	Edt	Cnf	X
CMSSoftProtection	1.4.5	4955	2011-04-06 15:55:45	Edt	Cnf	X

Code is imported from SVN
and a new version of the
component is released

Web Component Handler



Installation
DB



Configuration
DB

The Installation Tool
synchronizes with the DB
and installs the new version

Install
Targeted
Components



Download
Targeted
Configurations

WinCC OA
projects

Set Active

Upload
Hardware
Configuration

Hardware Configurations
are stored in a dedicated
DB



DCS Expert

Monitoring

Component	Status	Configuration	Version	Last Modified
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CMSWinDetectorProtection	Active	1.1.6	4174	2012-02-20 17:28:58
CMSWinDetectorProtection	Active	1.1.5	3204	2012-02-17 11:59:38
CMSWinDetectorProtection	Active	1.1.4	3041	2011-05-18 14:31:55
CMSWinDetectorProtection	Active	1.1.3	1487	2011-04-14 16:28:32
CMSSoftProtection	Active	1.4.5	4955	2011-04-06 15:55:45

Monitoring

The status of the SCADA
projects can be **monitored**
from the web

SCADA Monitoring and Control

- cms_cen_dcs_2
 - cms_alig_dcs_01
 - cms_brm_dcs_1
 - cms_cen_dcs_1
 - cms_cen_dcs_3
 - cms_cen_dcs_4
 - cms_cs_dcs_01
 - cms_csc_dcs_09
 - cms_dt_dcs_1
 - cms_dt_dcs_2
 - cms_dt_dcs_3
 - cms_dt_dcs_4
 - cms_ecal_dcs_01
 - cms_hcal_dcs_02
 - cms_rpc_dcs_1
 - cms_scr_dcs_01
 - cms_trg_dcs_01
 - cms_trk_dcs_1
 - cms_trk_dcs_2
 - cms_trk_dcs_3
 - cms_trk_dcs_4
 - totem_dcs_1
 - totem_dcs_2

[Switch Host](#)
[Refresh](#)

cms_cen_dcs_2: on DCS-S2F16-07-02

Pmon

FSM

Processes

Log

Configuration

Project status:		RUNNING		CPU usage: 10% - memory usage: 23% - disk usage: 11% REDU ACTIVE						
		stop	kill	start	once	manual	always	STOP_ALL	START_ALL	RESTART_ALL
Manager	num	mode	status	arguments						PID
<input type="radio"/> Process Monitor	1	manual	running							5172
<input type="radio"/> Database Manager	0	always	running							3592
<input type="radio"/> Event Manager	0	always	running							2432
<input type="radio"/> Control Manager	1	always	running	-f pvss_scripts.lst						5052
<input type="radio"/> Simulation Driver	1	always	running							4944
<input type="radio"/> Distribution Manager	1	always	running							3356
<input type="radio"/> Redu Manager	1	always	running							6956
<input type="radio"/> Split Manager	1	always	running							3596
<input type="radio"/> Control Manager	2	always	running	-f fwInstallationAgent.lst						4916
<input type="radio"/> Control Manager	19	once	stopped	-f fwScripts.lst						-1
<input type="radio"/> PVSS00DimErrInfo	1	always	running							4256
<input type="radio"/> Simulation Driver	13	always	running	-num 13						4340
<input type="radio"/> DIP Manager	16	always	running	-num 16 -dns dipns1,dipns2						8592
<input type="radio"/> PVSS00Perf	1	always	running	-DIM_DNS_NODE cmsdimns1,cmsdimns2						1708
<input type="radio"/> Control Manager	3	always	running	fwFsmSrvr						5880
<input type="radio"/> Control Manager	1	manual	stopped	CMSfwLicenseCollector/CMSfwLicenseCollector.cti						-1
<input type="radio"/> Control Manager	4	always	running	unDistributedControl.cti						6908

SCADA Monitoring and Control

- cms_cen_dcs_2
 - cms_alig_dcs_01
 - cms_brm_dcs_1
 - cms_cen_dcs_1
 - cms_cen_dcs_3
 - cms_cen_dcs_4
 - cms_cs_dcs_01
 - cms_csc_dcs_09
 - cms_dt_dcs_1
 - cms_dt_dcs_2
 - cms_dt_dcs_3
 - cms_dt_dcs_4
 - cms_ecal_dcs_01
 - cms_hcal_dcs_02
 - cms_rpc_dcs_1
 - cms_scr_dcs_01
 - cms_trg_dcs_01
 - cms_trk_dcs_1
 - cms_trk_dcs_2
 - cms_trk_dcs_3
 - cms_trk_dcs_4
 - totem_dcs_1
 - totem_dcs_2

SCADA projects can be monitored from the web

cms_cen_dcs_2: on DCS-S2F16-07-02

[Switch Host](#)
[Refresh](#)

Pmon

FSM

Processes

Log

Configuration

Project status:		RUNNING		CPU usage: 10% - memory usage: 23% - disk usage: 11%		REDU ACTIVE	
stop	kill	start	once	manual	always	STOP_ALL	START_ALL
Manager		num	mode	status	arguments		PID
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<input type="radio"/>	Control Manager	2	always	running	-f fwInstallationAgent.lst		4916
<input type="radio"/>	Control Manager	19	once	stopped	-f fwScripts.lst		-1
<input type="radio"/>	PVSS00DimErrInfo	1	always	running			4256
<input type="radio"/>	Simulation Driver	13	always	running	-num 13		4340
<input type="radio"/>	DIP Manager	16	always	running	-num 16 -dns dipns1,dipns2		8592
<input type="radio"/>	PVSS00Perf	1	always	running	-DIM_DNS_NODE cmsdimns1,cmsdimns2		1708
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<input type="radio"/>	Control Manager	1	manual	stopped	CMSfwLicenseCollector/CMSfwLicenseCollector.ctf		-1
<input type="radio"/>	Control Manager	4	always	running	unDistributedControl.ctf		6908

SCADA Monitoring and Control

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 - cms_cen_dcs_1
 - cms_cen_dcs_3
 - cms_cen_dcs_4
 - cms_cs_dcs_01
 - cms_csc_dcs_09
 - cms_dt_dcs_1
 - cms_dt_dcs_2
 - cms_dt_dcs_3
 - cms_dt_dcs_4
 - cms_ecal_dcs_01
 - cms_hcal_dcs_02
 - cms_rpc_dcs_1
 - cms_scr_dcs_01
 - cms_trg_dcs_01
 - cms_trk_dcs_1
 - cms_trk_dcs_2
 - cms_trk_dcs_3
 - cms_trk_dcs_4
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SCADA projects can be monitored from the web

cms_cen_dcs_2: on DCS-S2F16-07-02

[Switch Host](#)
[Refresh](#)

Pmon

FSM

Processes

Log

Configuration

Project status:

RUNNING

CPU usage: 10% - memory usage: 23% - disk usage: 11%

REDU ACTIVE

stop

kill

start

once

manual

always

STOP_ALL

START_ALL

RESTART_ALL

Manager	num	mode	status	arguments	
<input type="radio"/> Process Monitor	1	manual	running		
<input type="radio"/> Database Manager	0	always	running		
<input type="radio"/> Event Manager	0	always	running		
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DCS Experts can start and stop SCADA processes



Enterprise Portal: Advantages

- ❑ Single Sign On
- ❑ Role-based Access Control
 - ❑ Integrated with CERN Credentials
 - ❑ Easy to restrict some pages or functionalities to groups of users
 - ❑ Exported to DCS to define control privileges
- ❑ Portlets deployed independently
- ❑ Consistent Look & Feel
- ❑ Structured Navigation

Enterprise Portal: Advantages

- ❑ Single Sign On

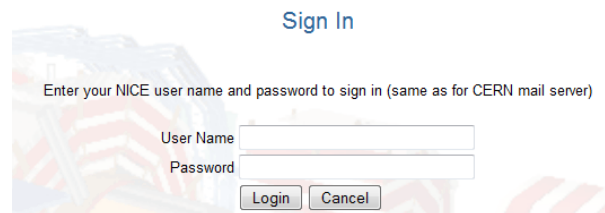
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Sign In

Enter your NICE user name and password to sign in (same as for CERN mail server)

User Name

Password



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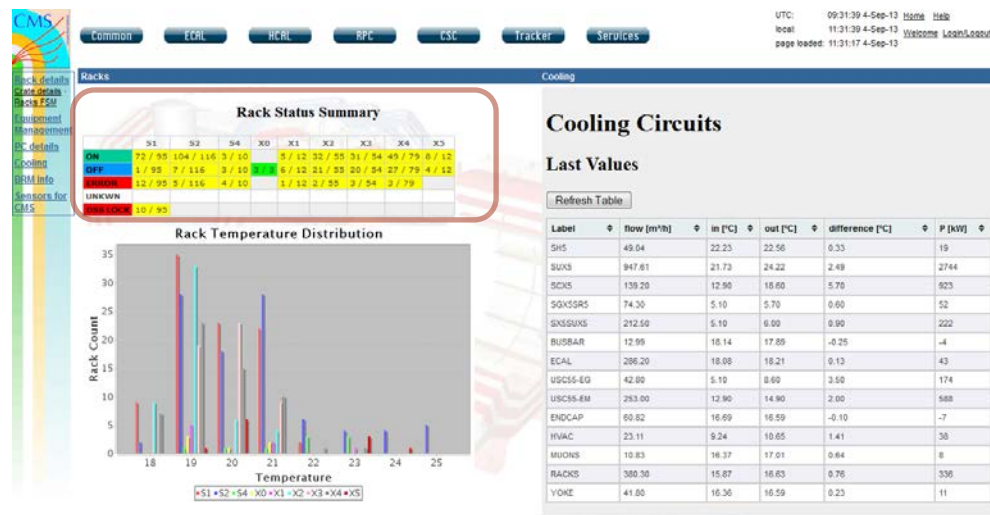
❑ Structured Navigation

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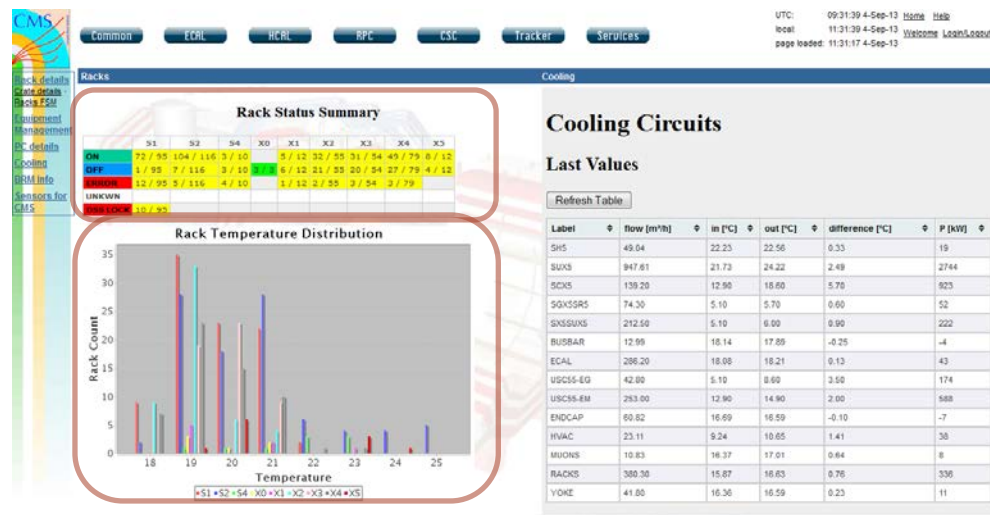
❑ Structured Navigation

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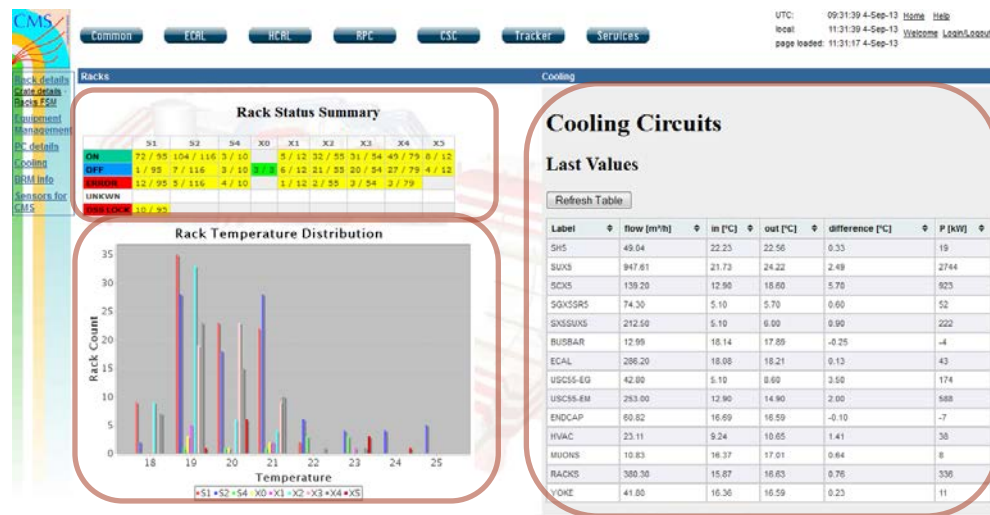
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Summary

- ❑ Web Interfaces used daily
 - ❑ 100s of CMS users access the portal for multiple purposes
- ❑ Number of users with access to DCS data has increased
- ❑ Usage of native WinCC OA interfaces in Terminal Server dropped
 - ❑ Limited to few cases when experts need to take very specific actions from remote
- ❑ Web Administration Tools are now an essential part of the deployment process and monitor tasks
 - ❑ Helped to achieve the flexible and maintainable architecture of the DCS
 - ❑ Now indispensable for CMS Operation