

# Overview of Data Management solutions for the Control and Operation of the CERN Accelerators

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Zory Zaharieva, Chris Roderick



Beams Department  
Controls Group  
Data Management Section





# Outline

- ➔ Overview of the main data domains for the Accelerators
- ➔ Examples of mission-critical database-centric services for the Accelerators
  - ➔ Controls Configuration Service
  - ➔ Alarms Service
  - ➔ Settings Management
  - ➔ Logging Service
  - ➔ Instrumentation
- ➔ Conclusion



# Data Domains for the Accelerators

➔ The Accelerators data management

➔ Complex, challenging

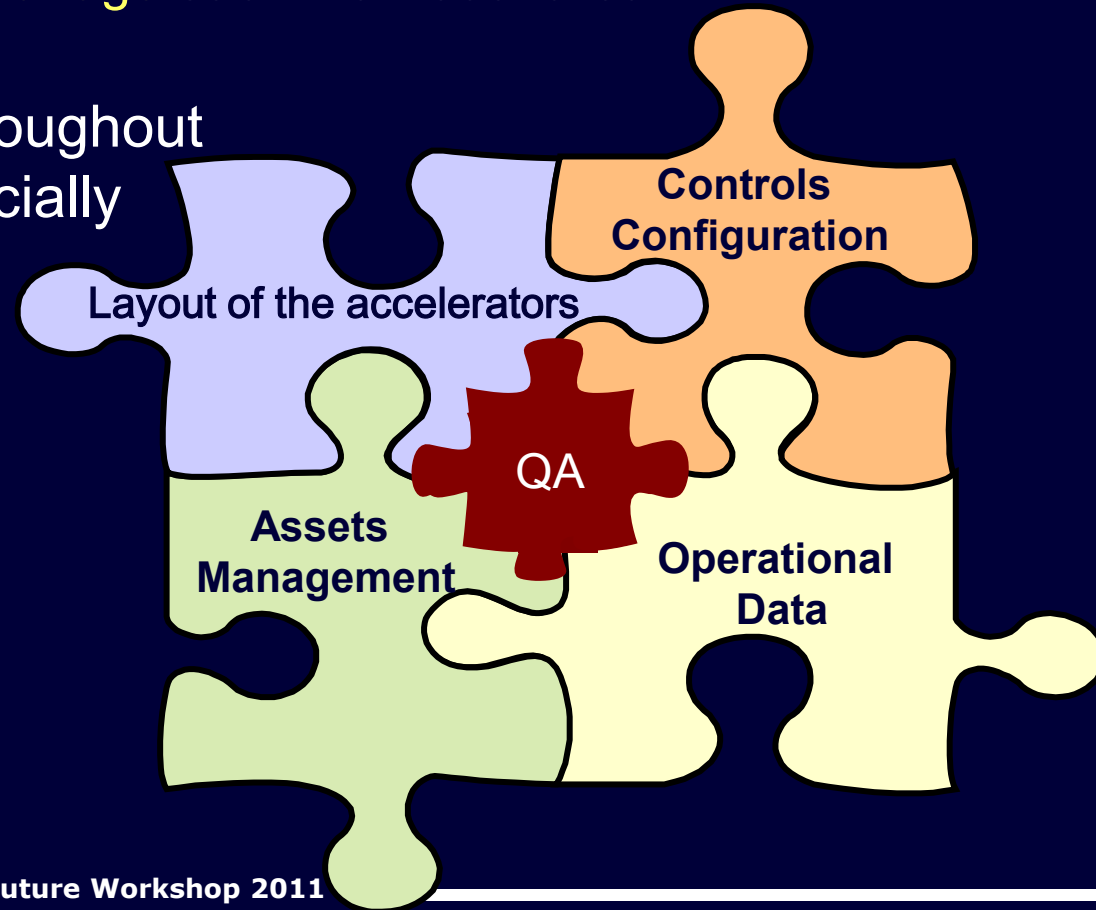
➔ Logical break-down of the data

➔ Easier to organize and manage each individual area

① Integration of the data throughout the domains must be specially considered

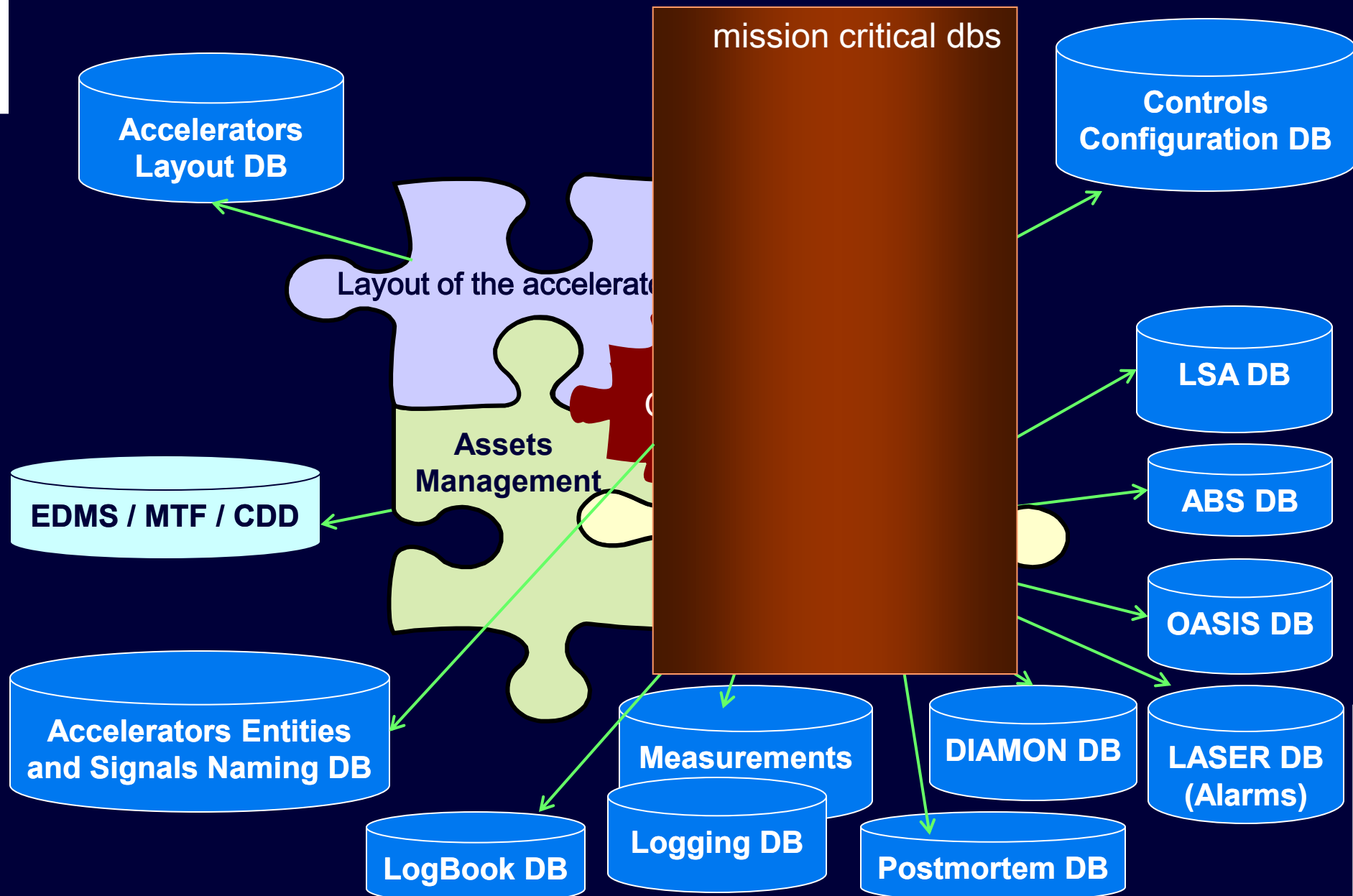
➔ Common understanding

➔ Good communication



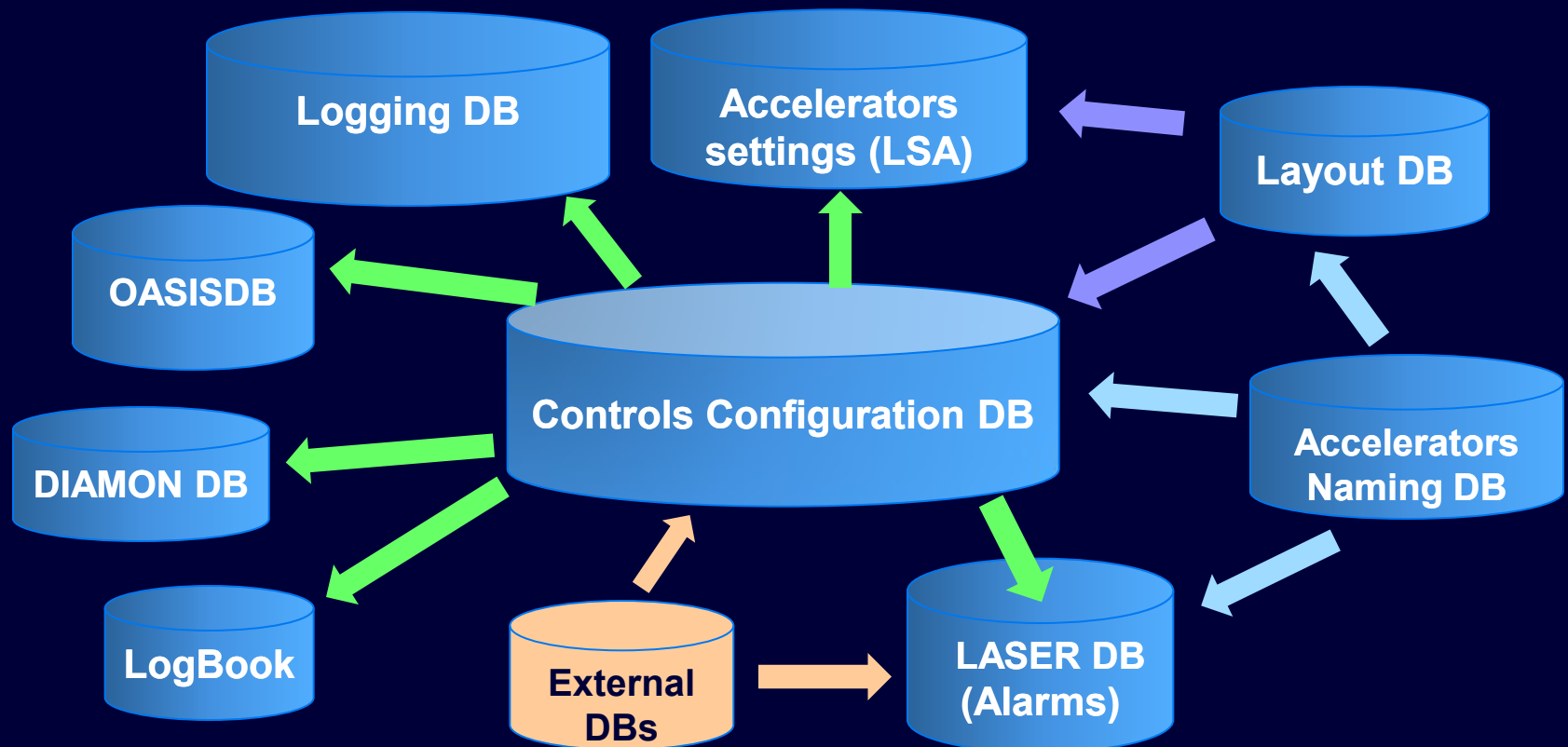


# List of the Databases in the Data Domains



# Interdependencies between the databases

- ➔ Data is maintained only in one place
  - ⇒ Ensuring **single source of consistent data**
- ➔ **Data propagation** from one domain to another for the purpose of the accelerator complex operation
  - ⇒ Execution on manual, semi-automatic or automatic basis
  - ⇒ Database views, materialized views, PL/SQL code for data propagation





# Implementation Strategy

## ➔ Relational DB technology

⇒ Oracle Databases for all technical data

## ➔ Data-driven applications and APIs

⇒ Java, J2EE

⇒ Oracle technology applications stack

## ➔ Reliable database services

⇒ On-line usage of database services for the accelerators control and operation



# Outline

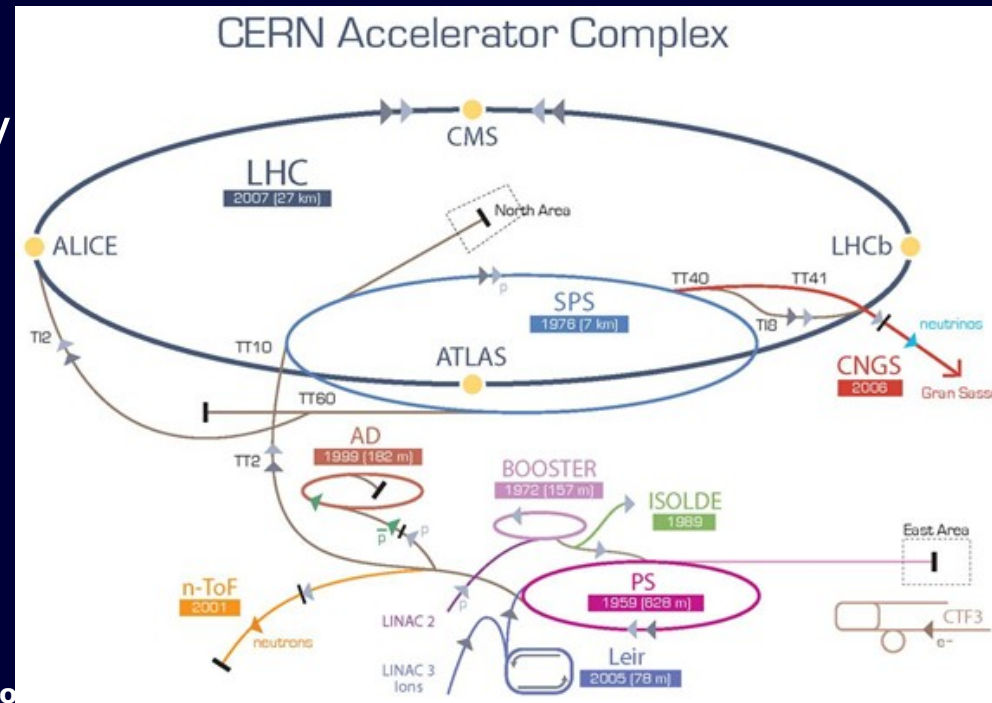
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# Controls Configuration Service

- ➔ **The heart** of the Controls System – the basis for the Configuration Management of the Controls System for all accelerators at CERN
  - ⇒ Serves as a repository for the data for all **configuration items and their relationships**, required for the **correct functioning of the Controls System**
    - All controls devices (~77,000) and parameters (~ 2,000,000)
    - Hardware and software configuration of all Front-End Computers (~3 000), Drivers generation
    - The Accelerators Timing System, etc.

- ➔ Service with 25 years of history
  - ⇒ Supporting the requirements of the PS, SPS and LHC complexes (10 accelerators)

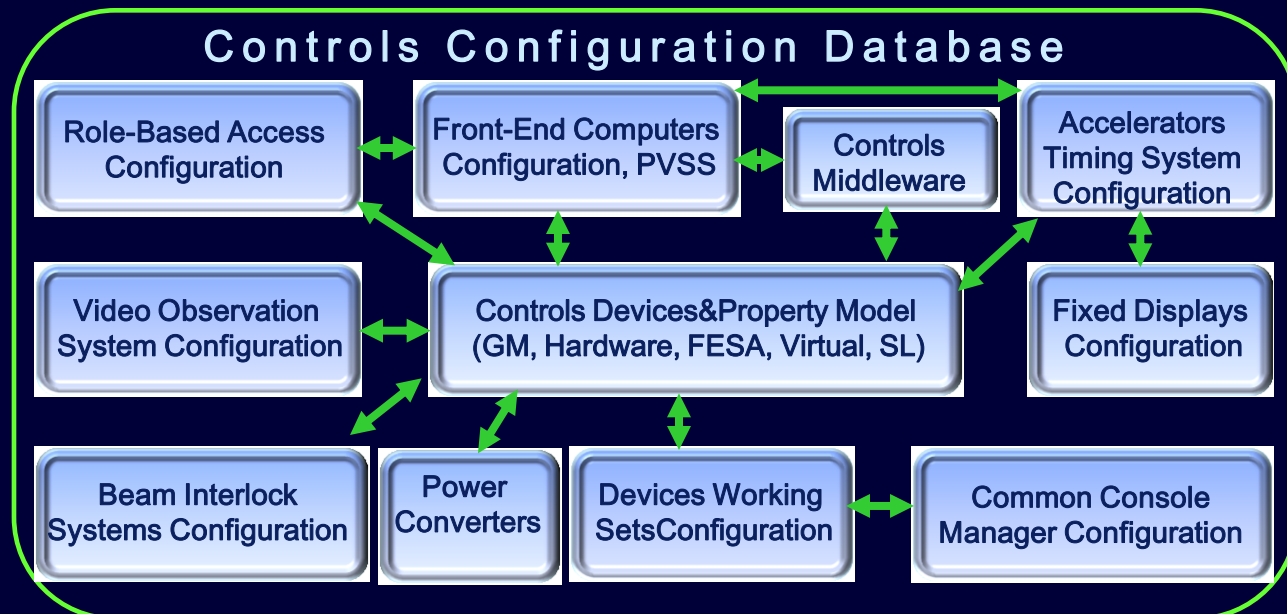




# Controls Configuration DB

- ➔ The data in the CCDB represents components and their properties as seen by the Controls System
  - ⇒ The complete Controls System topology - from front-end computers to control room operators consoles configurations
  - ⇒ Mission critical service – 24/7/365
- ➔ Database complexity
  - ⇒ Model the Controls System into a relational database, maintain data consistency while enforcing the business rules

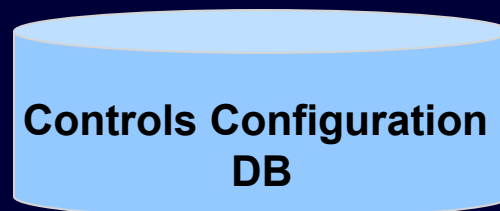
| DB Statistics     |        |
|-------------------|--------|
| Tables            | 914    |
| Constraints       | 2,388  |
| Lines PL/SQL code | 42,100 |
| Volume            | 60 GB  |





## Controls Configuration Interfaces

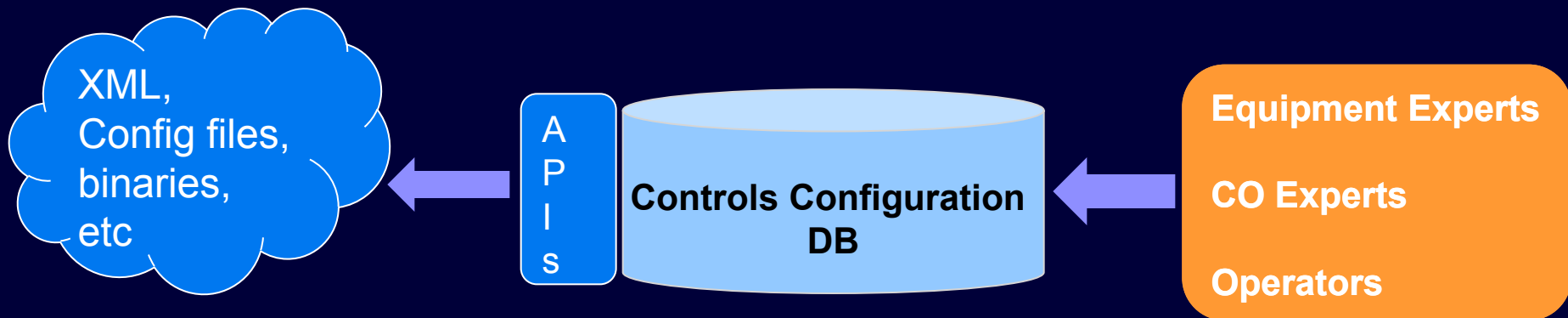
- ➔ Web-deployed applications for browsing / editing of data by users
  - ⇒ Set of **12 Data Editing applications** - 230 users
    - Based on Oracle ADF (J2EE)
    - Strict authorization - fine grain access control (custom authorization modules and virtual private db features)
  - ⇒ **Data Browser** – 160 reports covering all areas of the CCDB
    - Based on Oracle APEX
  - ⇒ **History Log Browser** – used by the Controls Exploitation team
    - Provides access to the history log – all data modifications are recorded since 2005
      - Audit of every session opened in the CCDB
      - To know: who did what and when
      - The history log serves as a basis for versioning of the configuration data for each component described into the CCDB



Equipment Experts  
CO Experts  
Operators

# Controls Configuration Interfaces

- ➔ APIs to extract the data / generate files to be used by the different components of the Controls System
  - ⇒ Java, PL/SQL, C
  - ⇒ Various output formats: text files for drivers generation, hardware and software configuration of computers, XML and binaries for Controls devices configuration, etc.





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# Accelerators Alarms (LASER)

➔ LASER (Alarms) - capturing, storing and notification of anomalies for the whole accelerator chain (PS, SPS, LHC, MTB) and technical infrastructure

⇒ Service - 24/7/365

➔ Alarms DB - 3 different database areas

⇒ Pre-defined alarm definitions

⇒ User configurations for the alarms displays

⇒ Time-stamped run-time alarms events coming from 250 sources processed and distributed to ~ 50 consoles

| DB Statistics     |        |
|-------------------|--------|
| Tables            | 207    |
| Constraints       | 241    |
| Lines PL/SQL code | 31,400 |
| Volume            | 195 GB |

| Date  | Time     | Priority | System Name     | Identifier         | Problem Description                                  |
|-------|----------|----------|-----------------|--------------------|--|
| 26/08 | 14:42:09 | 1        | CMW_ALARM ...   | SPS BPMIT_BA5      | Alarm state not known                                |
| 31/08 | 12:33:18 | 1        | CMW_ALARM ...   | SIMA_887_CERFO1    | Alarm state not known                                |
| 31/08 | 12:33:18 | 1        | CMW_ALARM ...   | SIMA_887_CERFO2    | Alarm state not known                                |
| 30/09 | 15:10:51 | 1        | COMPUTER        | RFSCF2             | Missing or misbehaving process : At least [twc.po... |
| 02/10 | 07:30:28 | 1        | COMPUTER        | CFV-BA5-BLMLHC     | Disk space or disk usage problem : Pb with [space... |
| N     | 12:09:37 | 1        | COMPUTER        | CS-CR-TXT          | Contact lost   |
| N     | 12:09:38 | 1        | COMPUTER        | RADBA3             | Contact lost   |
| 01/09 | 17:22:22 | 2        | RF_SPS_BEAMC... | RECAPT_FREQ        | Measurement time-out                                 |
| 16/09 | 11:32:56 | 2        | TimDist         | TDX.CFV-BA3-CTSRF5 | Bus Error  |
| 16/09 | 11:32:56 | 2        | TimDist         | TDX.CFV-BA3-CTSRF6 | Bus Error  |
| 21/09 | 14:20:13 | 2        | BOSTEP          | BOSTEP.BTVE-61772  | Alarm raised when the motor is moved in.             |
| 25/09 | 08:58:28 | 2        | TimDist         | TDX.CFV-BA3-CTSRF3 | Bus Error  |
| 25/09 | 13:29:00 | 2        | SpSSEPTAmsW...  | MS.LS58-SEPTA      | Actual unequal demanded                              |
| 28/09 | 14:50:22 | 2        | EAU_DEMI_SPS    | FDED-00021_REDRES  | DEFAULT GENERAL CIRCUIT REDRESSEURS                  |
| 29/09 | 17:12:53 | 2        | BetsCtrlSps     | MKE.HCA4.MKCB.LHC  | Remote/Controle device: RDA error occurred.          |
| 29/09 | 17:12:53 | 2        | BetsCtrlSps     | MKE.HCA4.MKCB.CNGS | Remote/Controle device: RDA error occurred.          |
| 01/10 | 18:28:54 | 2        | SPS SIS         | JAPC               | PARAMETER SUBSCRIPTION CAUSED EXCEPTION              |
| 01/10 | 17:11:39 | 3        | SPS SIS         | TT20               | SIS PERMIT test masked                               |
| 01/10 | 17:11:39 | 3        | SPS SIS         | SPS                | SIS PERMIT test masked                               |
| 01/10 | 17:11:39 | 3        | SPS SIS         | SPS                | Default  |
| 02/10 | 10:19:35 | 3        | SPS SIS         | SPS                | BIC Channel masked                                   |

# Accelerators Alarms (LASER) DB

## ➔ Alarms definitions - 3.6 million data elements

- ⇒ Imported into the LASER DB coming from 31 providers
- ⇒ Domains: access control, beam transfer, beam diagnostics/loss, RF, IT computer surveillance, radiation monitoring, power converters, vacuum system, interlocks, cooling and ventilation, cryogenics, CERN electrical grid, etc.
- ⇒ Standard format for the interface tables
- ⇒ Intensive 2-stage ETL process with complete data validation

## ➔ Specific user configurations

- ⇒ Alarms to display categories assignments, filter definitions, display masking of data, etc.
- ⇒ Suite of Data Management Tools – give users the possibility to explore their data and maintain it
- ⇒ Web-deployed APEX-based interfaces



The screenshot shows the 'LASER ALARMS DATABASE - Data Browser' interface. The main content area is organized into several sections:

- Definition**: A list of links for 'Alarms', 'Categories', 'Sources', and 'Instructions'.
- Analysis Events**: A list of links for 'Charts' and 'Reports'.
- Alarms**: A list of links including 'General Alarms', 'Reduction Alarms', 'Alarm in Reduction', 'Alarm Location', 'Alarm Status', and 'Provider(TNs)'.
- Categories**: A list of links including 'Categories', 'Categories Tree', and 'Categories Per Alarms'.
- Sources**: A list of links including 'Sources'.
- Instructions**: A list of links including 'Instructions' and 'Alarm Instructions'.
- Charts**: A list of links including 'TI Fault Family', 'Events per Source', and 'Events per Category'.
- Reports**: A list of links including 'Active Alarms' and 'Activated-Terminated Alarms'.



# Alarms Events

- ➔ Short-term archive - alarms run-time events data
  - ⇒ Average of 170,000 events per day
  - ⇒ Peaks of up to 1000 events per second
  - ⇒ Last 6 months of data
  
- ➔ Long-term archive
  - ⇒ PL/SQL code for transferring the on-line data into the long-term archive executed as a db job once per day
  
- ➔ At the beginning of each year archiving of the previous year data is done – PL/SQL code with reduction of the data factor of 10
  - ⇒ since 2005
  - ⇒ Stored between 4 to 10 GB/year archived data



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