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

Database Futures Workshop, CERN
06-07 June 2011

Zory Zaharieva, Chris Roderick

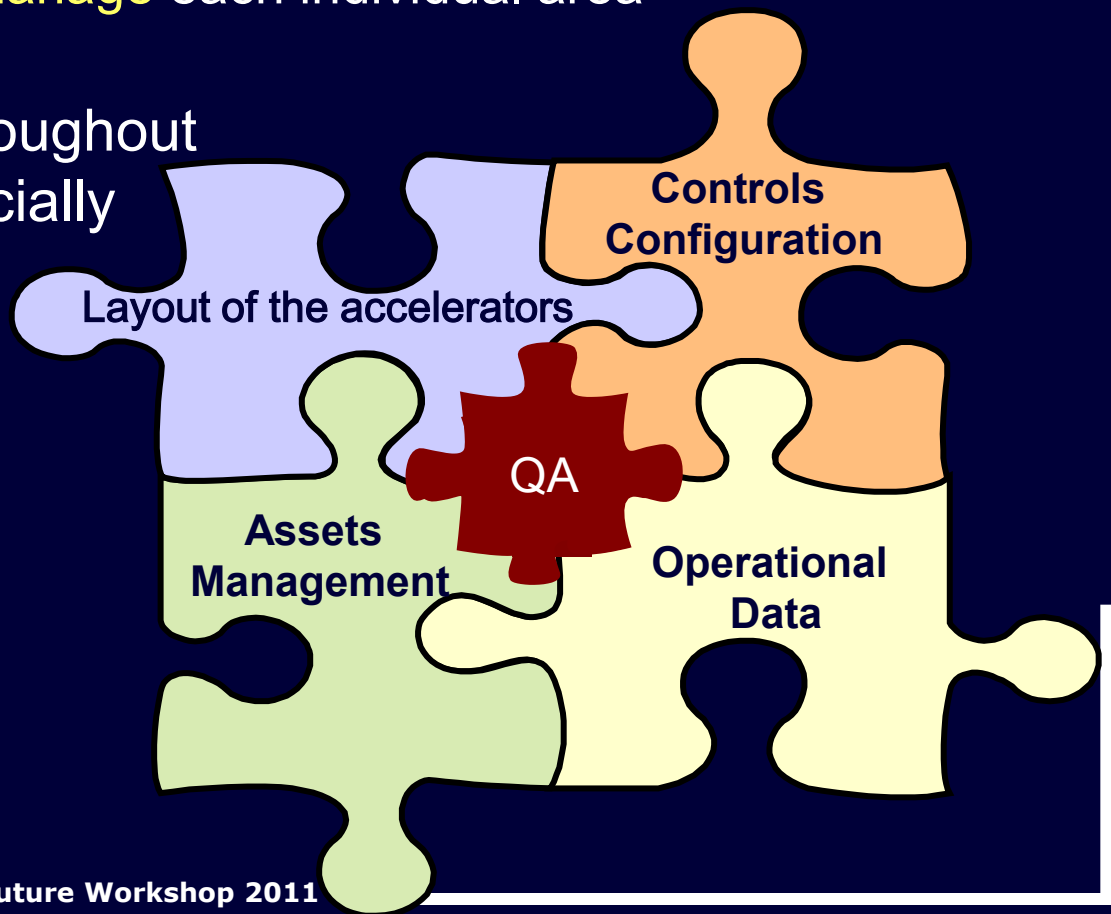
Beams Department
Controls Group
Data Management Section

Outline

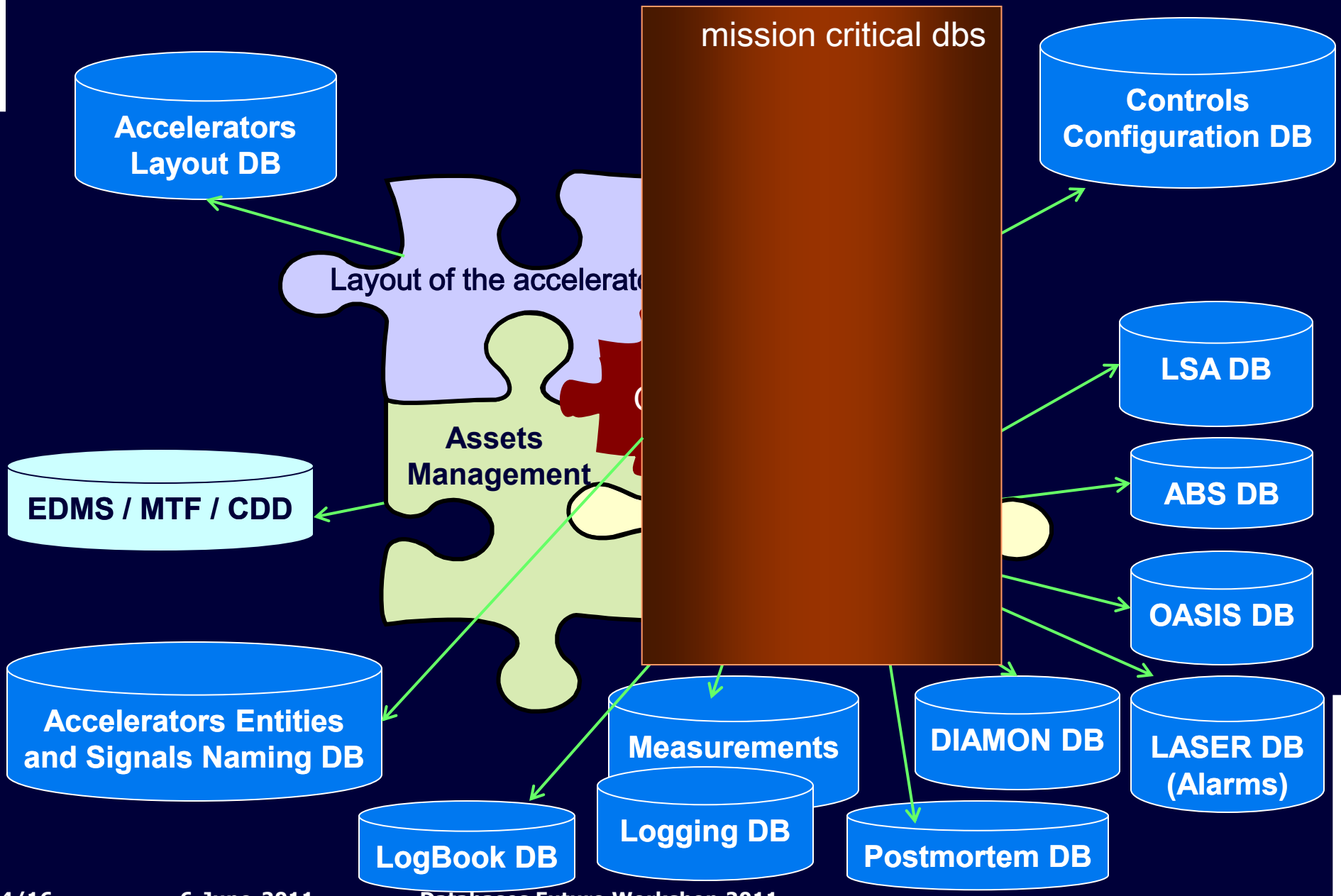
- Overview of the main data domains for the Accelerators
- Examples of mission-critical database-centric services for the Accelerators
  - Controls Configuration Service
  - Alarms Service
  - Settings Management
  - Logging Service
  - Instrumentation
- Conclusion

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
- ⓘ Integration of the data throughout the domains must be specially considered
  - ⇨ Common understanding
  - ⇨ Good communication

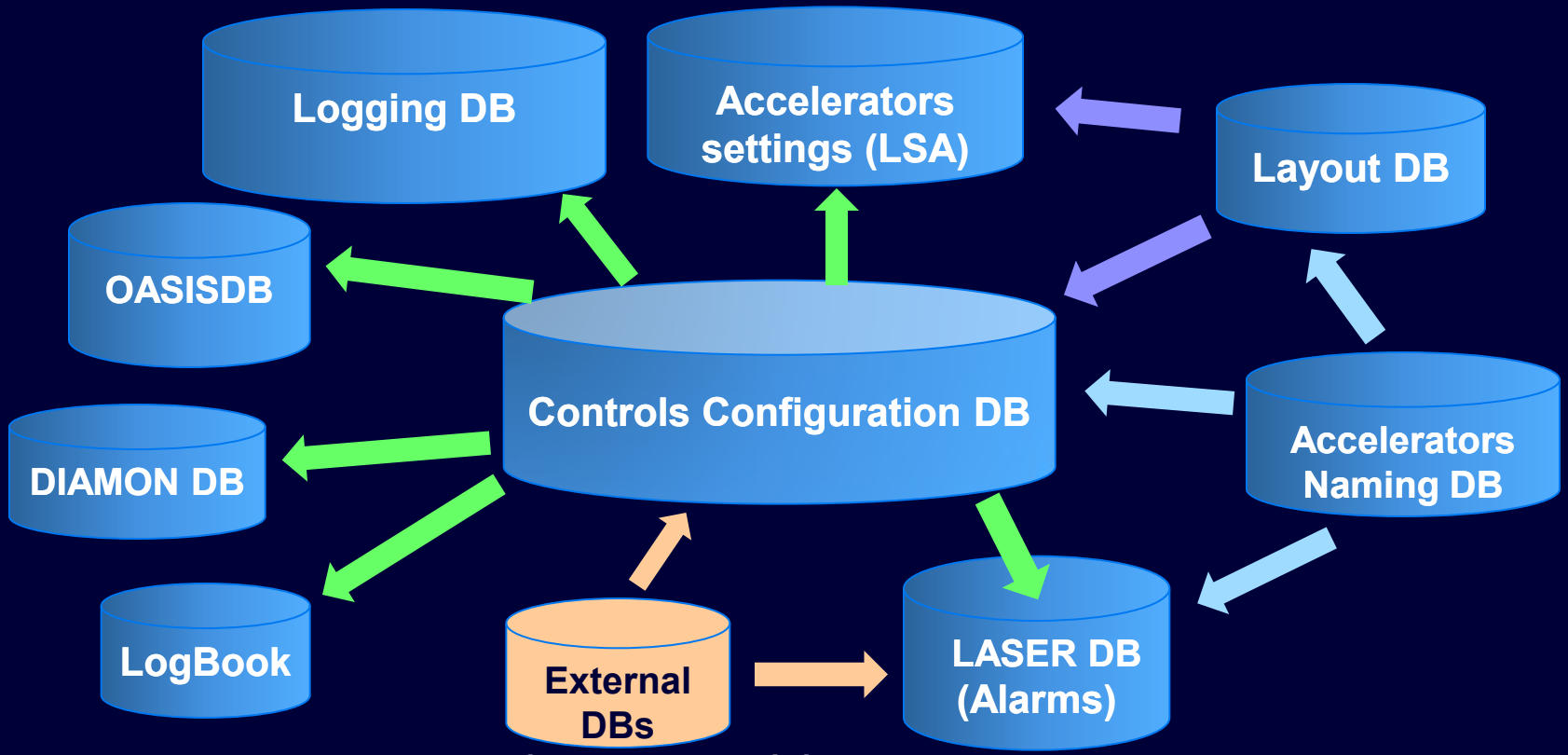


List of the Databases in the Data Domains



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

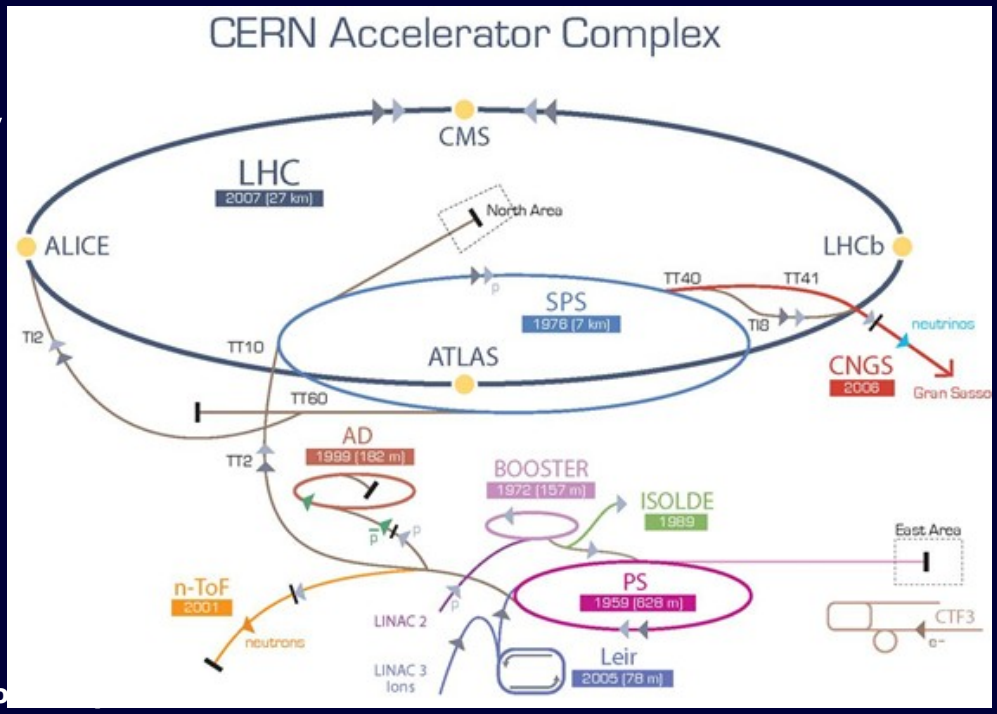
- Relational DB technology
  - Oracle Databases for all technical data
- Data-driven applications and APIs
  - Java, J2EE
  - Oracle technology applications stack
- Reliable database services
  - On-line usage of database services for the accelerators control and operation

Outline

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

Controls Configuration Service

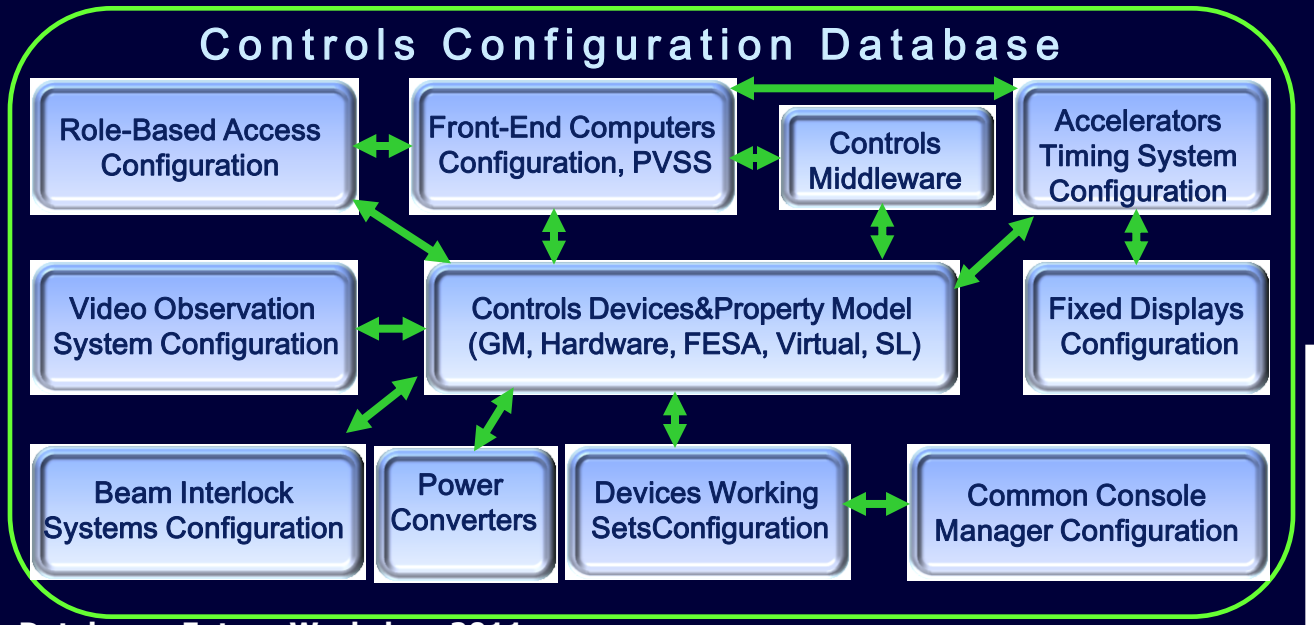
- The heart of the Controls System – the basis for the Configuration Management of the Controls System for all accelerators at CERN
  - Serves as a repository for the data for all configuration items and their relationships, required for the correct functioning of the Controls System
    - All controls 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

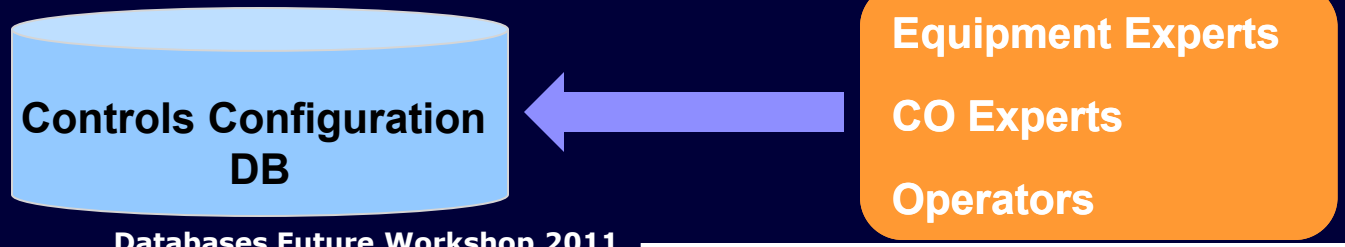
- The data in the CCDB represents components and their properties as seen by the Controls System
  - The complete Controls System topology - from front-end computers to control room operators consoles configurations
  - Mission critical service – 24/7/365
- Database complexity
  - Model the Controls 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



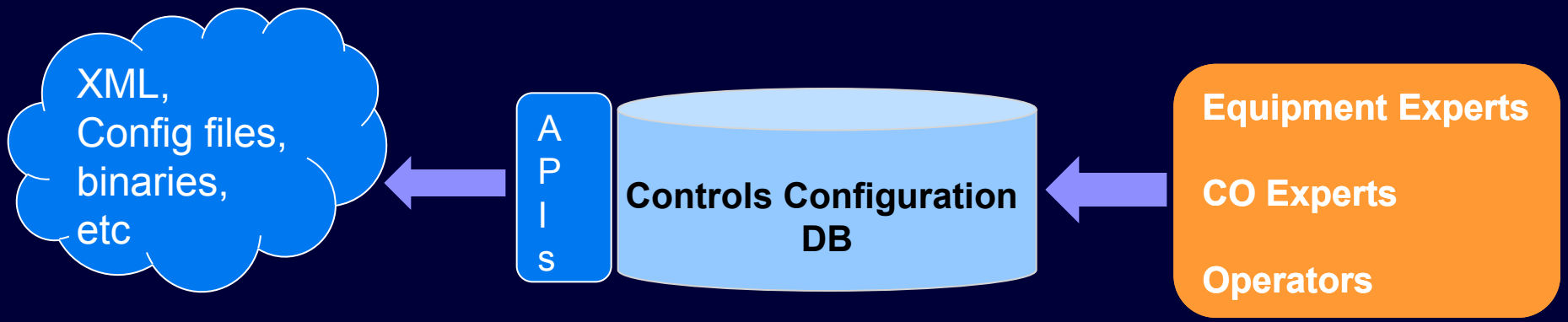
Controls Configuration Interfaces

- 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



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.



Outline

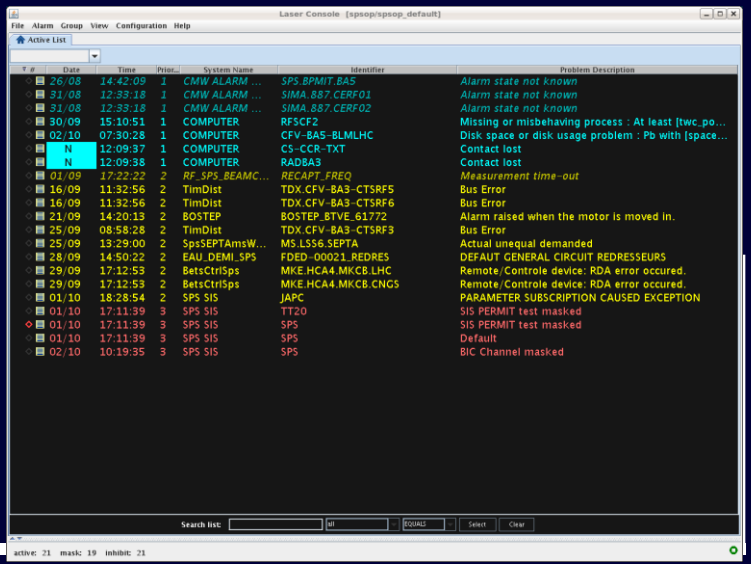
- Overview of the main data domains for the CERN Accelerators
- Examples of mission-critical database-centric services for the Accelerators
  - Controls Configuration Service
  - Alarms Service
  - Settings Management
  - Logging Service
  - Instrumentation
- Conclusion

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



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

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

Outline

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