SERVICE ASSET AND CONFIGURATION MANAGEMENT IN ALICE DETECTOR CONTROL SYSTEM

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Abstract

ALICE (A Large Ion Collider Experiment) is one of the big LHC (Large Hadron Collider) detectors at CERN. It is composed of 19 sub-detectors constructed by different institutes participating in the project. Each of these subsystems has a dedicated control system based on the commercial SCADA package "WinCC Open Architecture" and numerous other software and hardware components delivered by external vendors. The task of the central controls coordination team is to supervise integration, to provide shared services (e.g. database, gas monitoring, safety systems) and to manage the complex infrastructure (including over 1200 network devices and 270 VME and power supply crates) that is used by over 100 developers around the world. Due to the scale of the control system, it is essential to ensure that reliable and accurate information about all the components – required to deliver these services along with relationship between the assets – is properly stored and controlled. In this paper we will present the techniques and tools that were implemented to achieve this goal, together with experience gained from their use and plans for their improvement.

INTRODUCTION

A Large Ion Collider Experiment (ALICE) [1] is one of the big Large Hadron Collider (LHC) detectors at CERN that is optimized to study the physics of the quark–gluon plasma in nucleus–nucleus collisions. The experiment collaboration consists of 1550 physicists, engineers and technicians from 37 countries.

ALICE is composed of 19 sub-detectors constructed by different institutes participating in the project. Each of these subsystems has a dedicated control software based on the commercial SCADA package "WinCC Open Architecture" [2] and numerous other software and hardware components delivered by external vendors.

The ALICE Controls Coordination (ACC) team supervises the integration of all of these applications into one global Detector Control System (DCS) [3] that allows one to monitor and operate the whole experiment from a central operator console. The group is also responsible for providing shared services (like database, environment monitoring) and for managing complex infrastructure (including over 1200 network devices and 270 VME and power supply crates) that is used by over 100 developers around the world. The DCS includes as well interfaces to external systems maintained by other groups at CERN. Examples of such systems are beam interlock, safety mechanisms or software for acquisition and processing of physics data. The full context of the ALICE DCS is illustrated in Fig. 1.

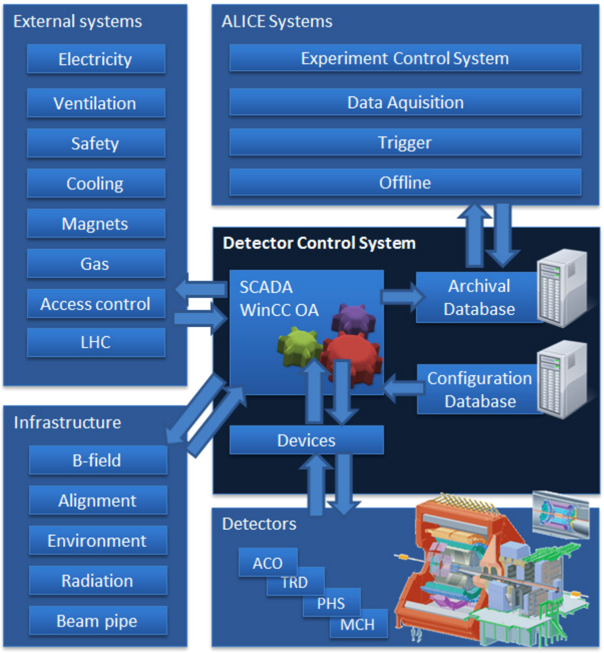

Figure 1: Context of ALICE Detector Control System.

The on-call expert service and training of DCS operators, who supervise the detector from the central console in Run Control Centre, are another tasks of the ACC group.

The team also participates in JCOP (Joint Controls Project) [4] – a collaboration of different experiments at CERN created to share the development effort needed for preparing software components used in their controls systems.

SERVICES AND THEIR ASSETS IN DCS

The aforementioned services require numerous software and hardware assets. Due to the scale of the control system, it is essential to ensure that reliable and accurate information about all these components along with the relationship between them is properly stored and controlled.

To meet these requirements, the central DCS team explores the possibilities to adapt best practises from ITIL (IT Infrastructure Library) [5] to manage its commitments, user groups and resources.

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The ITIL has already been used at CERN to create the common Service Desk for the whole organization and to define incident and the request fulfilment processes [6].

The information about the components that are used in the DCS is recorded in 3 main Configuration Management Databases (CMDBs):

- LAN Database stores information about all the network devices at CERN.
- Detector Construction Database (DCDB) [7] is a universal repository for parts that exist in the ALICE detector. This storage allows creation of custom types of objects (together with definitions of attributes) and their hierarchies via a generic data model.
- JCOP System Information Database [8][9] stores data about WinCC OA control applications along with the information about the machines they are running on and their supporting software (like e.g. OPC servers).

Following the ITIL recommendations, the Configuration Management System (CMS) has been established on top of these CMDBs to provide a common interface to combined data about each of the component.

Another requirement for the tool has been that it copes with a continuously evolving environment. The main sources of changes in the ALICE DCS environment are:

- installation of additional detector modules,
- exchanges and upgrades of existing equipment,
- evolution of software (e.g. new operating systems),
- new dependencies between already existing components (e.g. additional software safety interlocks);

The services the ACC team is delivering have been identified and recorded in the CMS in a service portfolio together with their related users. The hierarchy of configuration items in the CMS is presented on Fig. 2.

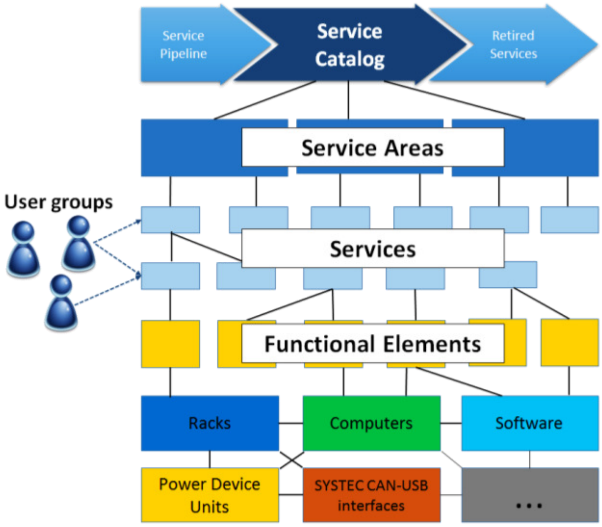

Figure 2: Types of supported configuration items and their relations.

The service portfolio includes a place to store services that are currently available (*service catalog*) as well as offering possibility to record retired services and new but not yet published services (*service pipeline*).

The concept of abstract "functional element" was introduced for the description of the logical layer between services and instance of hardware. Such objects corresponds for example to IP addresses that are assigned to network devices and are used in code and configuration files of applications. Thanks to that, these software components don't need to be modified in case of replacement of the hardware - only a reference *network device-alias* needs to be updated in the LAN Database. Functional elements also allows organizing different types of components into logical groups.

The CMS also permits the recording of dependencies between the aforementioned components and software and hardware configuration items as directed graph structure.

ARCHITECTURE

The CMS has been developed in the Oracle APEX environment and has been integrated with CERN SSO (Single Sign On), LDAP and E-Groups mechanisms to provide user authentication and authorization.

The tool has been also connected to the System Information database via the mechanism of Oracle database links and integrated via web services with the LAN Database. Mechanisms of Oracle Collections and XQuery are used for processing the data from this latest source.

The information about the Service Catalog is stored in a generic data model of DCDB, which allows for simple access to construction data from this storage.

The CMS can also be used to export data needed for proper labelling of hardware including unique part identifiers generated by the DCDB [10].

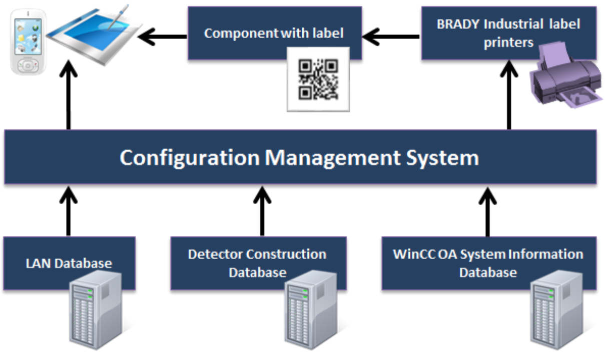
Component with label
BRADY Industrial label printers
Configuration Management System
LAN Database
Detector Construction Database
WinCC OA System Information Database

Figure 3: Configuration Management System – information flow.

RELATIONS BETWEEN COMPONENTS

Migration of experts is a factor that has to be taken into account in the case of long-term projects like ALICE. The expert knowledge about an individual sub-detector is maintained by the various institutes that developed these subsystems. It may happen that the transfer procedure does not explain the overall context for all the components. This is a motivation to centrally manage those dependencies. Similar initiatives have already been taken to monitor and authorize the connections between WinCC projects [11].

The CMS allows the tracking the relations of every component up to the level of services and user group both in tabular and graphical form. It is possible also to explore the dependencies down in the hierarchy to get the information about all the sub-components that are needed for the proper functioning of particular object.

The diagrams are generated in MS Visio so that a user can automatically lay out shapes and connectors neatly and apply further formatting easily. Every graphical object has a link to the details of the represented component from the CMS for quick access.

The diagrams can be used especially for change impact analysis and during resolving incidents and problems.

A sample diagram for the impact analysis for scenario of a broken power supply unit is presented on Fig. 4.

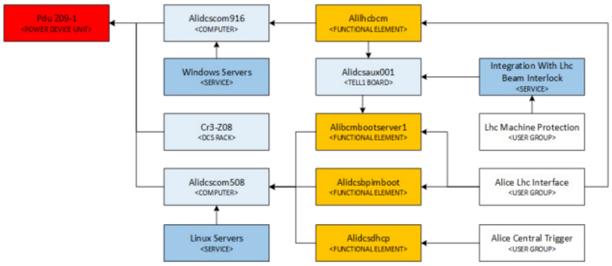

Figure 4: Automatic generation of diagrams showing dependencies between configuration items for impact analysis - sample result.

CONCLUSIONS

The complexity of the ALICE DCS required the implementation of dedicated software for the asset management. The tool evolved from a simple web application based on spreadsheets to a comprehensive solution integrated with all the sources of information about the infrastructure and its dependencies with services and particular user groups.

Using Oracle APEX technology, existing CERN IT services and a generic data model it was possible to deliver a wide range of functionalities to end users in a relatively short period of time and to minimize effort of the ACC group for maintenance and administration of the application.

The Configuration Management System has been so far successfully used in practice for managing control servers and their software. New modules, like service portfolio and racks management, are available and the data is mostly loaded.

The main challenge is to maintain the discipline among the users to keep the data up to date, especially in case of incidents requiring urgent on-call expert intervention. This effort, however, should pay for itself as the updated information will be supporting the experts in making right decisions in such situations.

It is envisaged in the future to extend the functionality of the Configuration Management System on more types of components and to invite other ALICE groups and members of JCOP project to assess its usefulness in their projects.

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