Managing operational documentation in the ALICE Detector Control System

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Abstract. ALICE (A Large Ion Collider Experiment) is one of the big LHC (Large Hadron Collider) experiments at CERN in Geneva, Switzerland. The experiment is composed of 18 sub-detectors controlled by an integrated Detector Control System (DCS) that is implemented using the commercial SCADA package PVSSII. The DCS includes over 1200 network devices, over 1,000,000 monitored parameters and numerous custom made software components that are prepared by over 100 developers from all around the world. This complex system is controlled by a single operator via a central user interface. One of his/her main tasks is the recovery of anomalies and errors that may occur during operation. Therefore, clear, complete and easily accessible documentation is essential to guide the shifter through the expert interfaces of different subsystems. This paper describes the idea of the management of the operational documentation in ALICE using a generic repository that is built on a relational database and is integrated with the control system. The experience gained and the conclusions drawn from the project are also presented.

1. Introduction
ALICE (A Large Ion Collider Experiment) [1] is a big LHC (Large Hadron Collider) detector at CERN optimized to study heavy ion collisions.

It is composed of 18 sub-detectors constructed by different institutes participating in the project. Each of these subsystems has a dedicated control system built from the commercial SCADA (Supervisory Control and Data Acquisition) package PVSSII [2], components developed within the JCOP framework [3], specific custom-made tools and also software and hardware interfaces (e.g. OPC servers, CANBUS to PC interfaces) that are delivered by external vendors.

The central Detector Control System (DCS) [4] integrates all the aforementioned subsystems and shared services, like gas, rack monitoring etc., to allow a single operator to control the whole experiment from one common User Interface.

In total, the DCS includes over 1200 networked devices, over 1,000,000 monitored parameters and numerous custom made software components that have been prepared by over 100 developers from all around the world.
2. Documentation in ALICE DCS

2.1. Role of documentation in DCS operation

The DCS is operated in the 24/7 mode. The shift duties are not covered by a dedicated group of professionals but are proportionally shared by the collaborating institutes. As a result of this policy, the DCS is manned by a relatively large number of operators, each with limited experience e.g. in 2011 average operator did 11-12 8 hour shifts [5].

To address this requirement, the DCS central team prepared a set of mechanisms, including simplified panels and automated procedures, to hide the complexity of the detector. Nevertheless, one of the main operator's tasks is recovery of anomalies and errors that may appear during operation. Therefore, clear, complete and easily accessible documentation is essential to guide the shifter through the expert interfaces of different subsystems.

The sub-detectors and the central team each provide an on-call expert in case of exceptional situations that cannot be solved by the shift crew. However, due to the complexity of the control system, it can also happen that the current on-call expert is not a developer and does not possess detailed knowledge of the failing component that was used in the given subsystem. Therefore, comprehensive expert documentation is also critical to reduce the time needed to restore the correct state of the experiment.

2.2. Documents flow

In figure 1 it is shown how the knowledge of operating the DCS is transferred to different groups of users.

![Figure 1. Documentation flow in ALICE DCS.](image)

Classical, printable, documentation (DCS Guide) is used for static instructions for the operators. It is composed of 3 sections: theoretical introduction to the ALICE control system, shifter reference (standard operator duties) and troubleshooting (set of well-documented recovery procedures for known issues).

Temporary procedures and recent issues are stored in a wiki application: TWIKI [6]. Each operator is expected to review this source of information immediately before the start of every shift.

For well defined and repeatable procedures that require user interaction, e.g. preparing the experiment for beam injection and afterwards confirming ALICE readiness to the LHC control room (the procedure is called the Injection Handshake, figure 2), the instructions for the operator are integrated with the PVSS panels and are displayed the moment they are needed to be executed. This type of dynamic documentation seems to be most effective at minimizing the time of the operator’s reaction and any risk of human error.
The relevant emergency procedures are delivered to the operator by the alarm help mechanism that is integrated with the central alert screen (figure 3). The instructions are written in the XML files and stored within PVSSII projects. XSD (XML Schema Document) and XSL Transformation are used for formal validation of the file contents and for formatting of final documents, respectively.

3. Generic approach to documentation management

3.1. Review of classical approach

The current document structure satisfies the main needs of the DCS operation. Nevertheless there is room for improvement:

- The presented structure introduces redundancy, for example, recovery procedures are very often part of subsystem documentation and they are also simultaneously written in alarm help files.
- Some instructions need to be developed in many variants (versions existing in parallel), e.g. in expert documentation detailed specification of procedures is required; while on control panels...
the operators expect rather brief descriptions. Currently there is no tool that supports maintenance of such procedures.

3.2. Generic repository

To remove redundancy of documentation and improve its maintenance, a new generic storage, built on a relational database (Oracle), is being implemented (figure 4). Its main concept is to add flexible and extendable structure to all the instructions and to store them all in a unified way. Two primary mechanisms were introduced to meet these requirements:

- Hierarchical categories: the instructions can be assigned to many categories, which improves classification and reporting capabilities and also allows extension of the repository for new types of documents.
- Links: this mechanism allows tracking of relations between the procedures and helps keep the integrity of the stored information. For example, if the DCS Guide refers to an expert documentation, then a person wishing to make an update will be alerted that there are other documents that may also need to be changed.

The text of each procedure can be saved either in the HTML format or in a developed XML dialect designed to describe simple workflows (with elements: step, decision, connection, comment, start, and end element). In the instruction content, apart from attachments, images and ordinary URLs, it is also possible to create special references to other documents, which are supported by the links mechanism of the repository, and are therefore traceable.

The repository also stores definitions of roles (actors) for the DCS system. Each of these roles can be assigned to an instruction as the performer or as the responsible. Tracking the latest assignments is very important especially in the CERN experimental environment because of the relatively high turnover of the personnel.

In the future, the new repository is intended to become the only source of operational instructions for the ALICE DCS. The present documents and tools will be replaced by specialized generators that will access the repository and automatically create the final documents.

Figure 4. The logical structure of new documentation repository.
4. Conclusions
The DCS documentation plays a very important role in providing efficient and safe operation of the ALICE experiment.

Nevertheless, the maintenance of the information in a distributed and fast changing experimental environment requires considerable effort. Therefore the introduction of a more homogeneous and automated solution should be profitable in the long-term.

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