STANDARD DEVICE CONTROL VIA PVSS OBJECT LIBRARIES IN ALICE*

L. Wallet, A.Augustinus, P.Chochula, L.Jirden, CERN Geneva, Switzerland

Abstract

The device control in the Large Hadron Collider (LHC) experiments at CERN is largely based on OPC servers and PVSSII Supervision Control And Data Acquisition (SCADA) systems. A software framework enables in addition the user to set up his PVSS project for the different devices used.

To achieve a homogeneous operational environment for the ALICE experiment, these devices need to be controlled through standard interfaces. PVSS panels act as the upper control layer and allow for full control of the devices. The PVSS object oriented feature has allowed the development of device Object Libraries.

This paper gives an overview of the device control architecture including PVSS, software framework, and OPC server. It describes the Object Libraries developed for some devices, and it explains how these libraries are integrated in the ALICE controls environment.

INTRODUCTION

The ALICE experiment is dedicated to heavy ion physics. It consists of 18 sub-detectors and more than 1000 physicists, engineers and technicians from 90 institutes in 30 countries contribute to the project.

The selection of the equipment is largely determined by the sub-detector needs and the implementation of its control is the responsibility of the sub-detector groups. The majority of these groups have little expertise in controls especially in view of the size and complexity of the ALICE experiment.

SCOPE OF THE ALICE DCS

The primary task of the Detector Control System (DCS) is to ensure safe and correct operation of the ALICE experiment [1]. It provides configuration, remote control, and monitoring of all experiment equipment. In order to ensure a coherent control and limit the resources needed to develop it, communalities across the sub-detectors are exploited and common solutions are developed and employed wherever possible.

ALICE DCS is hierarchically organized in sub-detectors and devices. [2].

Hardware Architecture

The detector control system is sub-divided in three layers as shown in figure 1.

- The Supervision Layer: It consists of operator consoles in the ALICE control room (ACR) located at the surface of the experiment area. It allows for supervision and operation of the experiment.

- The Control Layer: It consists of worker nodes (WN) of each detector, database servers, PLCs and power supply devices placed in the counting rooms situated in the underground area.

- The Field Layer: It consists of frond-end electronics, sensors and devices, located in the cavern (UX) and exposed to magnetic fields and radiation.
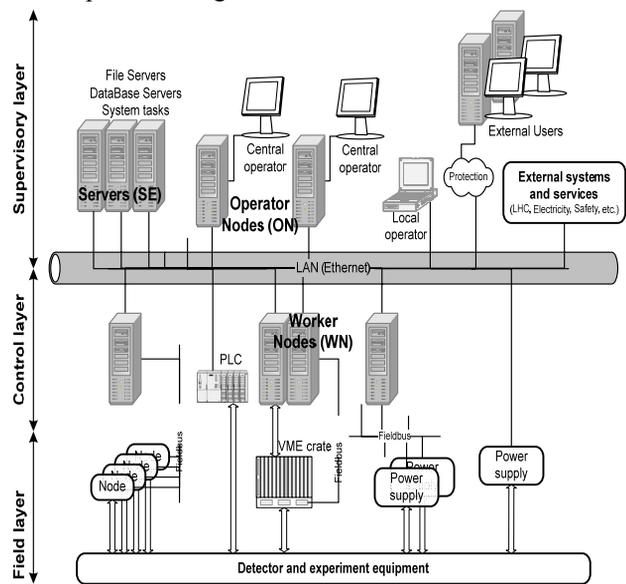

Figure 1: ALICE DCS architecture.

These equipments communicate via the DCS Network to which about 1 400 devices are connected and via field busses with lengths up to 200 meters.

Software Architecture and Tools

The Detector Control System of the ALICE Experiment is implemented using the commercial SCADA system PVSSII [3]. The other LHC experiments at CERN also use it. PVSSII is an object-oriented process visualization and control system that is used in industry and research. PVSSII is designed as a distributed system where the various tasks performed by programs called managers can be distributed over several machines.

PVSSII is the core software of the control system. It is used to connect to hardware devices and to acquire the data they produce. Such data can be monitored, initialized, configured, plotted, archived etc. PVSSII allows also sending commands and settings to the hardware devices. PVSSII applications are managed as projects and store all relevant information needed for an application (databases, panels, etc.). All PVSSII applications are built of panels and scripts. Panels may include static or dynamic widgets. The Object Libraries are built on the concept of dynamic widgets.

The ALICE detector control system uses Windows XP as operating system. The bottom layer of the software architecture generally consist of the interface driver. The interface to the field devices is based on the OPC standard [4]. The manufacturers are requested to provide OPC servers for their devices which enables easy integration with the control system. The OPC is based on the Microsoft technology DCOM (Distributed Component Object Model) and provides a standardized access method and unified interface between the control layer and the SCADA system. OPC servers are provided as a standard industrial toolkit that enables to communicate with commercial available devices. Figure 2 shows an overview of the various software layers.
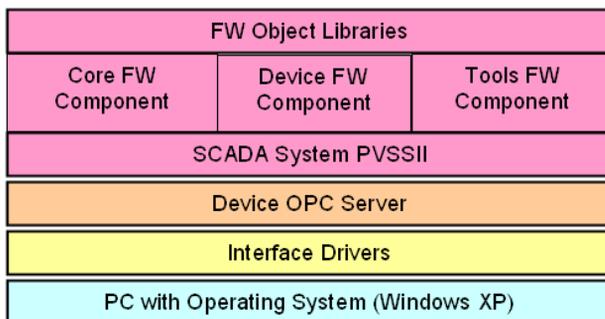

Figure 2: Overview of the various software layers.

THE FRAMEWORK APPROACH

A large number of developers in the institutes around the world participate in the development of the ALICE control system. The complex integration of all these different developments would be very time consuming if no standard methods are provided. This is why the Joint Control Project (JCOP) was established to identify the common needs, and to provide standard solutions, which LHC experiments can use as a basis for their projects [5]. JCOP has identified a number of standard technologies to be used by all the experiments including hardware devices, field busses, communication protocols, and SCADA systems.

The Framework

The Framework acts on the SCADA system layer as an unified toolkit for detector control system developers. The Framework helps to reduce the development effort of the control system developer in many ways. It provides homogeneous interface to SCADA and other toolkits. It also provides a simple way to setup rapidly a working system to control a specific type of device such as a power supply or a crate. It reduces the prerequisite knowledge needed to start the development work.

ISEG Framework Component

To illustrate the benefit of using the Framework Component, an example will be described now to setup a high voltage project in one of the ALICE sub-detectors (Transition Radiation Detectors). This detector is using a high voltage system of 1080 channels from the company

ISEG. As shown in the table 1, crates, modules, and channels need to be controlled via individual PVSS process variables called "Datapoints". All these datapoints have to monitor, plot and archive the relevant information of the high voltage system.

Table 1: Count of Datapoints in TRD High Voltage System.

Device	Nb Device	DPs / Device	Total DPs
Crate	4	20	80
Module	64	100	6 400
Channel	1024	30	30 720
Other (bus)	3	5	15
Total			37 215

An ISEG framework component is available to facilitate the creation, configuration and control of the ISEG devices. The device data is provided by the hardware through CAN field busses and an OPC server. This data, which is accessible in the OPC server, is called OPC item. Each OPC item is directly mapped to one or several PVSS datapoints. These datapoints contain all the information concerning the ISEG High Voltage System (voltage, current, temperature, alarms, etc.). The framework component also enables the organization of the datapoints in an appropriate structure following the device configuration. For example, ISEG hardware devices generally follow the structure: Canbus – Crate – Module – Channel. The Framework Component will provide to the developers the possibility to organize the Datapoints following the same structure. The component can be installed and removed using another Framework Component, the Installation tool.

PVSS DEVICE OBJECT LIBRARIES

As mentioned earlier, the ALICE experiment consists of many sub-systems and controls slices. The aim is to standardize, and to provide common solutions to the many different developers.

Standard Tool for Users and Developers

As described above, Framework Components are used to create the device datapoints architecture. Other JCOP toolkits offer functionalities like trending, alarm handling, access control and Finite State Machine [6]. The major challenge of Object Libraries is to integrate properly these tools and to make them easily accessible. In addition, the Object Libraries provide many advantages for users and non-PVSS expert users and it reduces significantly the panel's development work.

Object Libraries have two main advantages. On one hand, they ease the operator task thanks to the introduced standardization of the various device control panels. On the other hand, they reduce the developer's job as only basic software knowledge is required to set up a control application for a standard device.

The ISEG Objects Library

An Objects Library has been developed on top of the ISEG Framework Component. This library is composed of four main objects. Each main object is dedicated to control a device (canbus, crate, module, and channel). These objects are themselves connected to the others sub-objects which are not visible in the PVSS catalog. The main objects monitor the basic information for each device. The sub-objects enable the expert users to set some commands, to display more information, and to access expert settings. These sub-objects are displayed on some dedicated "pop-up" panels. Main object and sub-objects of an ISEG module are shown in figure 3. For security reasons, the pop-up is opened in a modal mode, which means the users are not allowed to control several pop-up's at the same time.
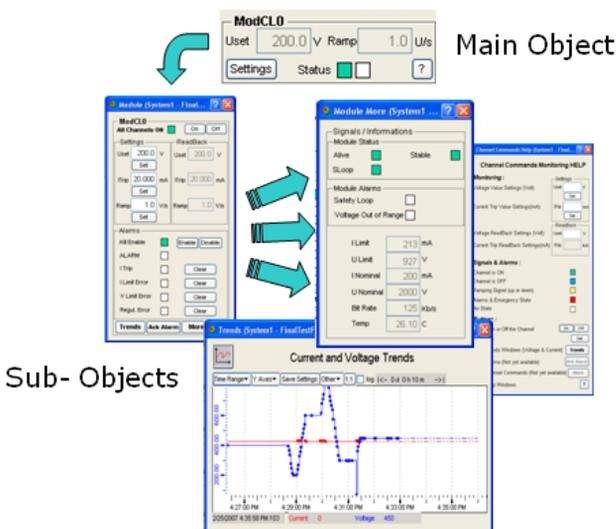

Figure 3: ISEG Objects Library main and sub-objects.

As mentioned earlier, the main object is connected to a "Datapoint Element" (DPE). A datapoint element represents a device, and regroups all the datapoints referring to this device. Table 1 shows that an ISEG module, which is represented as a DPE, regroups hundred Datapoints. Finally, all information referring to a device is easily accessible from the main object.

Integration of the Libraries in the ALICE DCS

The various developers involved in the ALICE DCS have different coding practices, and very different levels of knowledge of PVSS. The upper layer of the control consists of the panels and the object libraries force the developers to use object-oriented programming. To build a panel, the developers simply have to drag and drop the different objects from the PVSS catalog and to connect them to the DPE. A full system can be controlled via a single panel. As shown on Figure 4, the users have

the possibility to control 192 high voltage channels regrouped in 24 modules and 3 crates via a single panel. The information is displayed in a homogeneous way (fonts, colors, size, etc.).
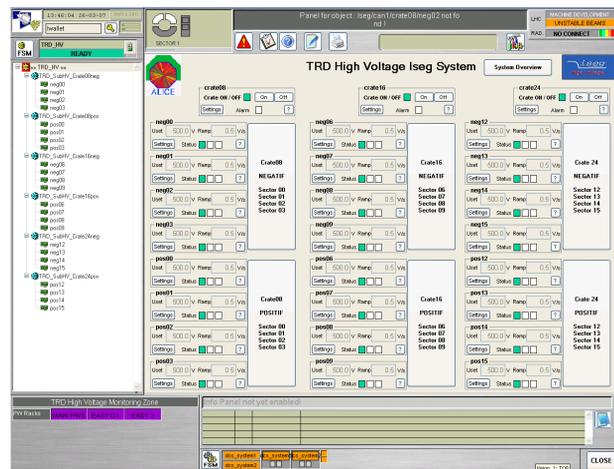

Figure 4: Object Libraries in a standard User Interface.

CONCLUSIONS

Object Libraries have been developed for ISEG High Voltage devices and Wiener VME Crates in the ALICE experiment. Several developers and users have currently integrated these libraries into their projects. More libraries will be developed in a near future to cover the majority of standard devices in ALICE. Combined with the Finite State Machine and other standard tools developed at CERN, the Object Libraries enable the users to control the full detector in a homogeneous way. More features need to be implemented such as the access control. As many devices are CERN standard, the Object Libraries will be integrated in all the LHC experiment control systems.

REFERENCES

[1] ALICE Collaboration, Technical Design Report, CERN/LHCC/2003-062.

[2] L.Jirden, A.Augustinus, M.Boccioli, P.Chochula, G. De Cataldo, S.Kapusta, P.Rosinsky, C.Turcado, L.Wallet, N. Nitti, Alice Control System – Ready for LHC Operation, ICALEPCS07, Knoxville, USA 2007.

[3] PVSSII SCADA Product, ETM, http://www.pvss.com

[4] OLE for Process Control, OPC foundation, http://www.opcfoundation.org

[5] O.Holme, "The JCOP Framework", ICALEPCS05, Geneva 2005.

[6] G. De Cataldo, A.Augustinus, L.Jirden, P.Chochula, M.Boccioli, Finite State Machines for Integration and Control in ALICE, ICALEPCS07, Knoxville, USA2007.