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IS THE CERN RECOMMENDED SCADA USEABLE FOR THE ST DIVISION?

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Abstract

Supervisory Control and Data Acquisition (SCADA) systems are widely used at CERN and in industrial control environments. In order to limit the costs of purchase, maintenance and support, a recommendation for one SCADA system is in preparation by the SCADA working group. This SCADA system should be used for all CERN in-house developed applications as they exist today e.g. in the Technical Control Room (TCR). This presentation will show the actual environment for the control and monitoring of the technical infrastructure at CERN and the needs for the future LHC infrastructure monitoring. The presentation will cover the control activities of all ST groups represented in the ST Control System WG. A possible solution for the integration of the technical infrastructure data into a SCADA system and a solution for the data exchange with the accelerators and the experiments will be presented. This includes a short term planning for the evaluation period as well as the long-term strategy on how to implement the chosen solution.

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1 INTRODUCTION

This paper intends to describe the present status and the future guidelines for the use of SCADA systems in the ST Division. In 1999, the SCADA Working Group was established under the auspices of the CERN Controls Board with the aim of selecting and supporting a limited number of SCADA products applicable for use in all (or most) *controls* domains. On 8 June 2000, the SCADA Working Group presented the status of their work to the members of the ST Control Systems Working Group in relation with the preparation of the *Recommendation for the use of SCADA systems at CERN.* This has of course an impact on the existing infrastructure and calls for future investments in the ST controls environment.

2 CONTROL SYSTEMS AT CERN

Control systems are widely used all over CERN. They monitor and supervise equipment like electricity or cooling systems as well as cryogenics applications, accelerator control or physics experiments. All “technical” divisions at CERN develop and maintain control systems. To ease the co-ordination between the different hierarchic structures, a control board was put in place where each control group sends a representative to the regular meetings. The control board watches the control activities at CERN and recommends standard systems to be used. It reports to the technical director. The control board covers the divisions ST, SL, PS, LHC as well as the accelerator and experiment specific projects. The accelerators are represented by the LHC-Controls Project (LHC-CP) and the experiments are represented by the Joint Controls Project (JCOP). As all control systems have more or less the same building blocks, it seems reasonable to look for a common solution.

JCOP made an analysis of the experiments needs in terms of supervisory control and came to the conclusion to use a single SCADA in the four big experiments (ATLAS, CMS, LHCb, ALICE).

2.1 Component Ware vs. SCADA

Most of CERN’s controls applications are based on different software components, which can be classified in the three main levels: *operator console*, *data transmission* and *data acquisition*

The *data acquisition* layer consists mainly of specific drivers connected either directly or via field-buses to hardware. This ranges from PLCs to CERN developed special applications. The local control of the equipment is part of this layer.

The data transmission layer is used to transport data from the equipment to at least one control or monitoring application. This is usually done by remote procedure calls (RPC) or a middle-ware over a *TCP/IP* network.

The monitoring of the equipment is usually done from a control room using three main types of applications: *alarm lists*, *synoptic displays* (also known as mimic diagrams) and *data logging* for trending or post mortem analysis

A **SCADA** system is a software package that integrates the different components from the equipment drivers, the data transmission up to the operator’s applications in one product.

Component ware based applications are usually very flexible and have no real restrictions in terms of feasibility of applications but several system experts are required to maintain the variety of the different and often very specialised applications. SCADA systems cover most of the user requirements but are not as flexible as component ware. “Open” SCADA products allow nevertheless to develop individual functionality to cover special requirements.

2.2 Reason to prefer SCADA over component ware

Budget and staff reductions are today's reality at CERN. The construction of LHC requires however sophisticated and highly performing control systems. This goal can only be achieved if the different control groups work together and synergy effects are used. The aim is to reduce product and licensing costs, to group administrative and support activities to ease the maintenance of the systems and to obtain in-house expertise. Exchange of knowledge and people between divisions and experiments will be much easier and the time of problem troubleshooting might be shorter.

A CERN SCADA working group was set up with the mandate to investigate current use of SCADA at CERN and to propose a strategy for the future.

2.3 SCADA working group Phase II

The SCADA working group made an initial choice of a SCADA product during summer 2000. This choice was based on the user requirements of the four big LHC experiments (ATLAS, CMS, LHCb, ALICE) and the assumption that the control groups at CERN will have similar or even the same requirements. As the initial contract with the supplier covers only the LHC experiments, the Controls Board requested a second evaluation phase for the whole of CERN. The mandate covers mainly the definition of the support and training needs, the establishment of a CERN wide licensing concept and the evaluation of impact on users of other SCADA systems. The working group is composed of members of IT, SL, PS, LHC and ST divisions.

3 CONTROL SYSTEMS AND ACTIVITIES IN THE ST DIVISION

On a first –*equipment level*-, the technical infrastructure at CERN is controlled, monitored and operated by the different equipment groups of the ST Division, which include AA, CV, EL and TFM. The architecture and capabilities of the control systems on the equipment level are specifically designed and implemented according to the control requirements of the equipment of each Group in order to allow their operation in the most optimal conditions.

On a second –*control room level*-, the MO Group is responsible for the overall remote control and monitoring of the CERN technical equipment. Therefore, the TCR control and monitoring system is designed and implemented with the aim of integrating the different control systems that compose the equipment level in order to allow efficient remote operation.

The LHC shall be even more demanding in terms of control, monitoring and operation requirements. Consequently, the control systems of the existing technical infrastructure have started to be redesigned and upgraded and new control systems are being developed for the LHC technical equipment. This scenario involves modifications and new developments that arrive in parallel in the different ST equipment Groups, having to be incorporated to the TCR remote monitoring system at the same time.

The coordination between the control specialists of the different Groups becomes even more important in these conditions in order to assure a global coherent control system for the CERN technical infrastructure during the LHC era.

3.1 ST Control Systems Working Group

The ST Control Systems Working Group (ST CSWG) was established with the purpose of coordinating and developing a divisional strategy for the ST control systems. It is also intended to promote knowledge exchange and collaboration with the other CERN controls groups. All ST groups with control activities are represented in the Working Group: AA, CV, EL, MO and TFM.

Among other questions, the ST CSWG has discussed and analyzed the present status and the future guidelines for the use of SCADA systems in the ST Division.

3.2 ST Control Systems and the use of SCADA: State of the art

3.2.1 Wizcon - The choice for ST cooling and ventilation controls

The ST/CV requirements for the LHC era include precise and reliable regulation of processes with a high degree of inherent complexity, powerful supervisory tools, openness, networking and integration capabilities. In order to face them, a multi-node network control architecture has been selected, which is based on a fully industrial control solution using the *Wizcon* SCADA system. It will be progressively implemented all around the CERN sites between 2000 and 2004.

The CV Group started the SCADA architecture feasibility studies for the CV-LHC projects two years before the SCADA Working Group was created. The first Wizcon-based operational prototype was developed and installed at SPS-BA6 in 1997-1998. The reasons for this choice, which prevail until today, are both technical and economical.

From a technical point of view, Wizcon is well adapted to the CV process control applications, by easily allowing a flexible data-sharing between different stations and providing a real DCS – Distributed Control System- architecture.

The economical reason refers to the fact that Wizcon is an Israelite product, which benefits from a privileged framework stated between CERN and the Israeli Foreign Affairs ministry.

As a consequence of this choice, from 1998 onwards the CV Group has established some large-scale contracts (LHC ventilation, SPS cooling) where the Wizcon SCADA is integrated in a turnkey system. Therefore, the main CV facilities distributed all around the LHC and SPS sites will be under Wizcon control and supervision. In this context, and in order to evolve towards flexibility and homogenisation of the global CV control systems, the reuse of this architecture is desirable. Furthermore, some TFM turnkey systems will follow the same technical solution that is being used by CV.

The maintenance will be supported by the new “ST Software Support for Industrial Controls” contract (C168). The CV Group will keep the in-house expertise required to guarantee a workable contractual relationship with industry during all the projects life cycle, as well as a pool of knowledge inside the ST Division.

3.2.2 SCATEX - The choice for CERN electrical distribution supervision

The electrical distribution network in CERN consists of more than 100 substations spread over the CERN sites and the accelerator zones. The equipment installed has more than 100.000 associated states and measurements that must be monitored via a control system. The existing control system was designed and installed during the LEP construction but this system does not have the required flexibility, since it is based on CERN technology of the LEP era that has not followed the trends in industrial control systems.

A new system is now being implemented in several phases and the complete renovation of the electrical control system will finish by 2004. The new system is implemented and installed by an external contractor, who also provides specific interfaces for the integration in the TCR remote monitoring system. The control system architecture is based on an industrial SCADA system, which was specifically developed for their application in monitoring electrical distribution networks and includes special calculation modules that are only applicable to electrical process control.

The *SCATEX* system is composed of a set of centralized database and application servers, and provides the operators with monitoring capabilities such as network diagrams and alarm lists. The system interfaces to the electrical equipment via a number of remote terminal units, which are located in the electrical substations. These devices, which are also included in the scope of the contract, provide with a local supervision interface that is independent of the central control system.

The contract was written with the goal of installing an industrial control system where the supplier would be responsible for all the aspects of the implementation, installation and maintenance of the system. CERN will be responsible for a limited amount of regular preventive maintenance that will be performed under the C168 contract. This organisation frees up the human resources so that they can be allocated to the design of specific systems required for the LHC projects.

3.2.3 PVSS - The choice for other ST applications?

PVSS is the name of the SCADA system that was finally chosen to be the common slow control software package for the LHC experiments and it is the natural candidate to become the CERN standard SCADA.

PVSS is an acronym for *Prozeß-Visualisierungs und SteuerungsSystem* or *Process Visualization and Control System*, in English. It is a complete SCADA system with data acquisition, archiving, trending, alarm handling and data display functions. Different PVSS modules that communicate via the TCP/IP protocol handle these functions. The fact that modules communicate using TCP/IP makes it possible to scatter a system across several machines with different operating systems. PVSS currently runs on the Windows NT, Windows 2000 and linux operating systems.

At CERN, PVSS will be used for the slow control of the LHC experiments but is already being used by other experiments like the COMPASS and the GIF experiments. The LHC cryogenic and vacuum control may also come to use the PVSS SCADA system and the SL division has shown an interest in evaluating the product.

ST/AA is currently using several SCADA systems for the different access control applications. It would be technically feasible to use a single product for the future implementations and PVSS could satisfy the requirements.

ST/MO uses a component architecture with the TDS *Smartsocket* ™ application, *DataViews®* mimic diagrams and the *Central Alarm System (CAS)* alarm lists. We are about to start the implementation of supervision tools for new installations like the *SPS Water 2000*, the *LHC surface ventilation* and other systems. We must choose the technology to use for future supervision tools, the current *DataViews* tools being obsolete. It is natural to evaluate PVSS for use in the technical control room and it was decided to implement a prototype application for that purpose.

4 THE ST PROTOTYPE

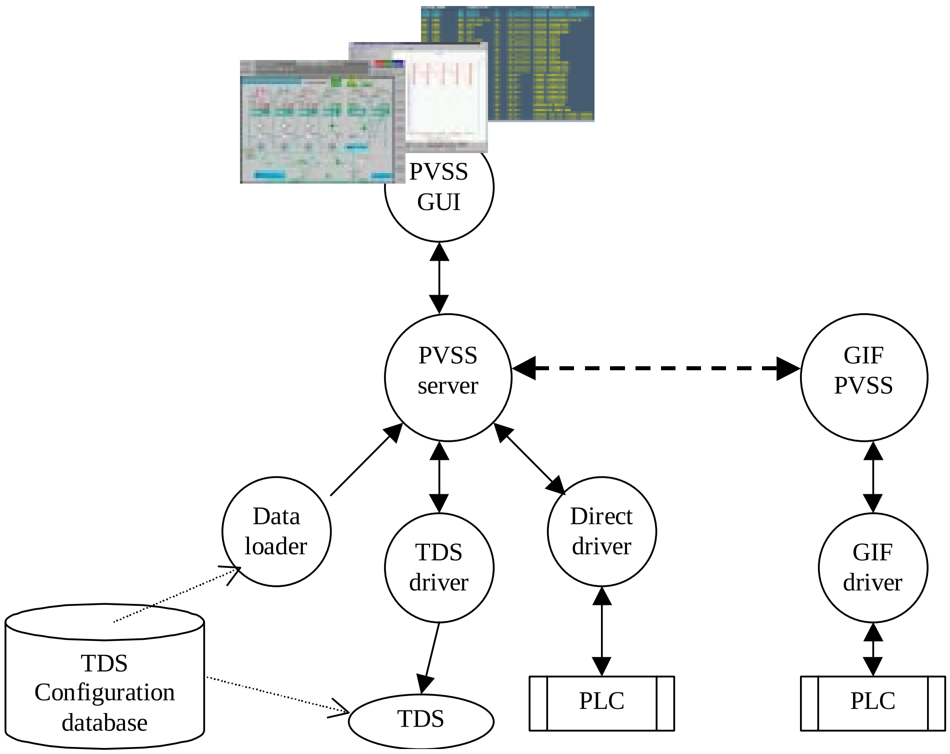
The prototype work is divided in a first phase developing a functional model and a second phase to test the performance of the PVSS system in the technical control room environment.

The functional model will re-implement the control tools for the SPS west zone cooling circuits using PVSS and give a set of tools to compare with the existing tools for the west zone. It will use 250 data points of which 115 are CAS alarms. There is one mimic diagram, 6 commands and 2 parameters archived in the logging database. Hence, the west zone is a small but complete installation that will cover different aspects of control room supervision.

An interesting feature of PVSS is the possibility to interconnect different PVSS applications. For the prototype we will interconnect the TCR PVSS application with a PVSS application used by the GIF experiment in the west zone. We will evaluate the possibility of exchanging data between PVSS systems and we have chosen an architecture that prototypes inter-system communication and intra-system redundancy for maximum availability.

4.1 Prototype architecture

Figure 4-1 shows the architecture of the prototype system. The bubbles represent different SCADA functions. The prototype contains a *TDS driver* acquiring data from the technical data server and a *direct driver* that can connect directly to a PLC. The configuration of the system is made automatically from the TDS reference database holding all currently supervised equipment details. In the figure, the system is communicating with the remote independent *GIF system*.



4.2 Results and future of prototype

The first phase of the prototype project has produced positive results; The *TDS driver* was implemented and is available on Windows NT and Linux. It has been running for several weeks and seems to be stable. The *mimic diagram* for the west zone has been developed and along with it, a number of reusable objects. The *alarm screen* of PVSS allows to make alarm lists easily. Alarm information can be coupled with mimic diagrams easily. However, the look and feel of the alarm list lacks a lot in comparison with the CAS console. The *data loader* was implemented using the native PVSS ASCII manager. The TDS tag naming and the PVSS data format could be mapped without problems and any data held in the reference database can now easily be loaded on to the PVSS system. Finally, the *data distribution* was successfully prototyped. It is possible to see the data points located in a remote system and to share data and commands but the performance still needs to be tested.

The second phase of the prototype which will be carried out during the first half of year 2001, should be a performance measurement of PVSS with a large data set (all current TDS tags), high traffic and with many concurrent users.

The prototype uses the TDS as its only data source but PVSS could really do the data acquisition itself and hence replace the TDS. One of the goals of the second phase will be to implement equipment drivers and do evaluate direct data acquisition from the PVSS.

If the final prototype is successfully validated, it will be possible to gradually phase out the TDS and replace it by a PVSS application. In order to achieve that, it is first necessary to have a single alarm display, then to port all TDS mimic diagrams to PVSS and finally to integrate equipment data through direct drivers rather than through the TDS driver. The data engineering and tag naming done for the TDS does not change and can be reused in PVSS. With this strategy, we may have a single PVSS control system for the technical control room by LHC start up.

5 CONCLUSIONS AND OUTLOOK

The four LHC experiments have chosen to use one and the same SCADA tool for their "slow control" systems. The Joint Controls Project, has evaluated hundreds of SCADA tools has finally chosen and bought the PVSS product for use in the LHC experiments. A CERN SCADA working group has the mandate to investigate how the PVSS contract currently made for the LHC experiments could be extended to include all interested CERN users in terms of licensing, support and training.

The different ST groups have varying needs in terms of control. The CV, TFM and EL groups have special requirements related to the nature of their applications and they have already chosen SCADA solutions different from the CERN recommendation. The AA and MO groups seem to be the best candidates to investigate PVSS for ST.

Although the technical control room has traditionally used a solution with different control system components forming a system, a solution using a single SCADA system could reduce the development and maintenance efforts. By using a common CERN-wide product, license costs are reduced and product expertise will evolve inside CERN.

ST/MO has started evaluating PVSS with a prototype application supervising the SPS west zone cooling circuits. The prototype has shown that the functionality of PVSS is acceptable for use in the TCR. The second phase of the prototype scheduled for June 2001, will validate PVSS performance in the technical services context.

Should the prototype be satisfactory, then PVSS could gradually be replacing the TDS application in the TCR. Other ST groups should then consider using PVSS to make use of the facilities of interfacing the TCR and the already acquired experience with this product that seems to become the CERN standard SCADA.