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CV/TCR CONTROL SYSTEM PERSPECTIVES

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Abstract

At present, 35% of the CERN technical infrastructure points being monitored by the TCR are related to CV facilities. The adaptation of the CV systems to the LHC and the new experimental areas is leading to a re-engineering of all their control and monitoring systems in order to reach the more demanding requirements of the LHC era in terms of reliability and efficiency. In parallel, the TCR is redefining its role and establishing the means to continue providing a high-quality monitoring service to the community of CERN. The common aim is to achieve a smooth evolution from the existing systems to the new ones during the whole upgrading process. The integration of the CV control systems into a coherent TCR control and monitoring system requires the development and implementation of the appropriate technical solutions by a joint team in charge of co-ordinating the individual efforts and resources.

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1 INTRODUCTION

The Cooling and Ventilation (CV) facilities are not only representative in terms of the total amount of CERN data corresponding to the technical infrastructure but also, and much more important, because they provide services which are fundamental for the accelerators and for the experiments to run. In general terms, this means that when talking about CV facilities basic CERN services are being referred to.

On the other hand, the role of the Technical Control Room (TCR) is to monitor the overall CERN technical infrastructure [1]. Consequently, the TCR is responsible for providing a monitoring service to the CERN community. At the same time, and in order to carry out its task, the TCR itself needs to be provided with the equipment data coming from the electrical distribution, cooling water, air conditioning, vacuum, cryogenics, safety and other systems. Therefore, the quality of the service that CERN receives from the TCR is intrinsically interwoven with the quality of the equipment data arriving at the TCR, and also with the clear definition and fulfilment of procedures to integrate, update and eliminate these data from the monitoring and control systems.

This close relation between the services provided by the equipment groups and the TCR monitoring and operation responsibility implies that it is not possible to think in terms of isolated areas of work anymore if a coherent control and monitoring system is desired. The common objective of continuing to offer high-quality technical services will be possible only through a partnership-based organization of the work, and by means of the integration of both concepts and systems.

2 BACKGROUND

The characteristics of the systems are strongly determined by the strategies and the technologies available and in use at the moment of the systems' conception. Therefore, the systems in general, and the control systems in particular, have their own life-cycles. In every infrastructure that could be studied, and that would have been in operation for several years, new systems and old systems would be found mixed and working together: All of them with different capabilities, all of them with different problems, but all of them performing tasks, which contribute to the assembly.

The CERN CV facilities and the control systems governing them are not an exception in this technical evolutionary environment. They are at different stages of their individual life-cycles. In the SPS site, modern and powerful SCADA systems are being introduced. In the PS complex, several industrial PLCs linked together through fieldbuses form a hierarchical structure which communicates from its higher level with the TCR supervisory system through the standard Ethernet network, after that a recent project has upgraded the concentrator [2]. In different points of the SPS, LEP and Meyrin sites, the controllers of old and non-standard technologies called ECATCRs are currently being replaced by multipurpose monitoring devices [3], which are based on commercially available industrial control equipment. In addition to these technologies, other systems with distinct capabilities and coming from multiple vendors complete a heterogeneous reality.

This is the context to keep in mind, with systems of diverse generations, either home-made or developed in the industry, having to be controlled, monitored and maintained. The degree of complexity that a simultaneous evolution of the existing systems with the introduction of new technologies and the elimination of the obsolete ones carry can not be considered only a technical problem. It has to be treated through the integration and optimization of the resources by planning the needs and the actions to take in a structured process [4].

To face up to this heterogeneity, the TCR opted for an integration strategy some years ago. In a first stage of homogenization, the Technical Data Server (TDS) was implemented [5]. The TDS is an event-driven, distributed monitoring system, designed to interface to different types of equipment data. Afterwards, the TDS integration concept was complemented with a modular integration strategy based on offering four possible layers in the integration schema [6]. Each layer enabled the integration of equipment with different degrees of complexity, from simple electrical I/O ports to entire SCADA systems (see Fig. 1).

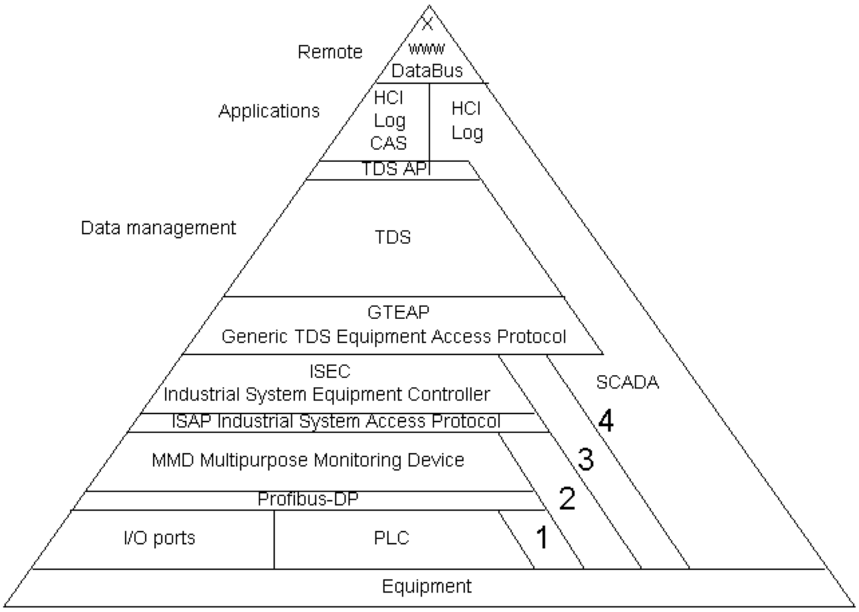

Figure 1: Integration layers for industrial control systems.

In the TCR, the CV facilities are monitored and remotely operated by using the UMMI applications [7] that have been developed either for general use or for specific complexes, like the PS, SPS, LEP and Meyrin sites. These mimic diagrams are complemented with the data provided by the alarm-reporting displays and with the data-logging system [8].

3 CV CONTROL REQUIREMENTS

The CV control requirements can be summarized by some basic criteria, which are the following:

- the complexity of the processes to be controlled, and the need to perform them with an increasing level of reliability and precision;
- the geographically distributed disposition of the CV facilities;
- the need for powerful local supervision tools;
- the possibility of integrating or evolving the existing control equipment into the new architectures.

These criteria can only be met by using a complete but also open and flexible control system. The local supervision functionality has to be satisfactorily fulfilled, as well as the openness, networking and integration capabilities, which can not be given up.

The technical solution, which has been selected by the CV group after having analysed their needs and having arrived at these basic criteria, corresponds to a multi-node control architecture allowing the integration of new and old process control systems geographically distributed by linking them through the SL/CO Ethernet network [9].

This multi-node network architecture is based on a software solution composed of two main elements: a SCADA/HMI package for supervision, and a PC-based control package to implement real-time programs for process control. The two elements complement each other in order to get the required accurate control for the degree of complexity inherent to the CV processes.

It offers the possibility to easily complement the basic functional configurations with technologies like OPC and web servers/clients, which meet the integration requirements and are becoming more and more present in the control system architectures (see Fig. 2).

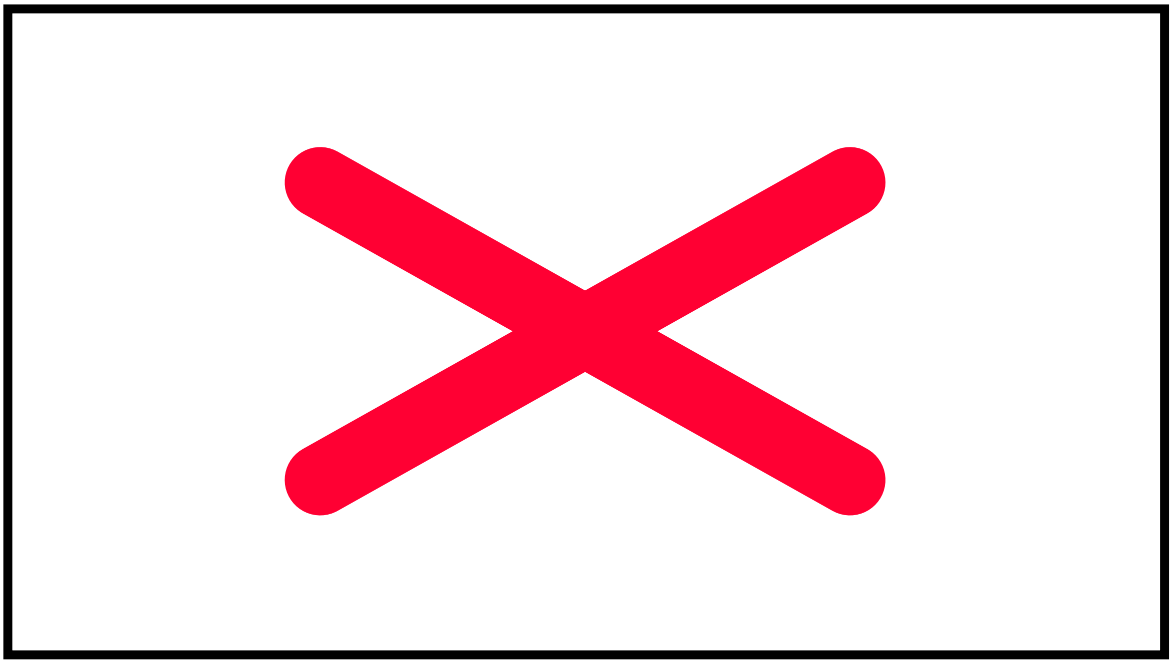

Figure 2: Multi-node control architecture.

4 TCR OPERATION REQUIREMENTS

The role of the TCR becomes in practice a complex monitoring and operation activity, since it is related to a wide range of equipment belonging to different application fields. This variety implies that the coherence of the control systems has to be very high if an efficient operation is desired. No ambiguity in the definition of the alarms or monitored data, and no ambiguity either in the instructions attached to each anomaly can be managed in a crisis situation by the operators in charge, since the amount of data does not give the opportunity to improvise.

The concept of coherence was the origin of the Technical Data Server Reference Database (TDSRefDB) [10]. The objective of this database is to ensure the system integrity regarding data definition. Each monitored data item is defined in the database by using a generic tagnaming convention [11], which covers the needs of all the systems to be supervised. The generic tagnaming convention is one more of the steps made in recent years towards the homogenization of the TCR monitoring system.

However, the TDSRefDB is not enough to keep the data integrity in a changing environment. The alarms and data attached to the equipment vary with time, if not the equipment itself. Consequently, the TDSRefDB content has to be kept up to date, by entering the new information, by modifying the existing data when necessary and by removing the obsolete points when they are no longer in service. These tasks have to be done following structured rules, which are stated in the Alarm Integration Procedure (AIP) [12]. The AIP will have a leading role during the upgrade towards the LHC, since the amount of data being introduced, modified and deleted from the database will be very significant.

Regarding the human–computer interfaces, some standard conventions have to be fulfilled so that homogeneity in the control room environment can be maintained. Mimic diagrams and operator diagnosis tools of a SCADA system can be integrated in the TCR operator console by using the fourth integration layer, which was foreseen for this kind of application. Data coming from the SCADA system will be diffused through the TDS middleware and will reach the TCR client applications: UMMI, data logging, central alarm server, and eventually web-based applications.

Nowadays, some applications to run on the web are being studied. The advantages of using this kind of technology at the TCR could include remote troubleshooting by the technical specialists [13].

5 COHERENCE THROUGH PARTNERSHIP

Both the CV and TCR groups have been working to study and develop strategies to face the requirements in their respective domains. Now, the moment has arrived for the co-ordination and merging of those strategies to be reinforced and the appropriate communication channels and procedures to be well defined and put into practice.

The most relevant aspects to take care of will be those concerned with the communication between the CV and TCR groups of the actions or projects to be developed on each side, so that they can be foreseen and planned with enough time and resources along the entire control and monitoring system. This co-ordination effort has to address the following:

- the detailed planning of the forthcoming activities, with special attention paid to the tests and acceptance of the new equipment or systems;
- the scheduling of the projects in time, to ensure that all the implied levels can reach the milestones by the critical dates, and to rationalize the distribution of resources to those milestones and schedules;
- the use and improvement of the available procedures in order to reach the desired smoothness in the integration and operation of the systems.

The coherence in the control and monitoring of the equipment is a global objective, which can not be reached through isolated initiatives, but only through processes interweaving at all the levels.

6 THE PRESENT AND FUTURE PERSPECTIVES

The main amount of work is to come. However, some projects and actions have already been launched and will soon be developed or even are already in operation.

- The SPS cooling at BA6 is monitored from the TCR through the TDS, to which the CV new-generation SCADA system has already been integrated. The work in the SPS complex will go on during this year, as well as in the PS and LEP sites.
- The LHC ventilation & fluids systems at surface level will start to be implemented during 2000. The first CV SCADA for these applications, corresponding to point 8, will be integrated in the TDS, and consequently available at the TCR at the end of February. Afterwards, the next points will also be progressively integrated.
- The integration possibilities of the TDS are continuously being upgraded, so that the easiest and best-adapted solutions can be offered to the new systems requiring the TCR services.

These first installations will be very important since they offer us the possibility to start a self-improving process by well documenting the technical decisions, the work done during the development [14], the test procedures and the conclusions of all these activities. In the long term, this documentation will establish the difference between having a flexible system ready to upgrade to best adapt it to the environment evolution, and having a system difficult to maintain because the knowledge base is lacking or is distributed among different people and supports.

7 CONCLUSIONS

Industrial control components have been progressively introduced in all the levels of the control and monitoring systems for the CERN technical infrastructure [15, 16]. First, about twelve years ago, the PLCs were introduced at the equipment level for process controls. Later on, the development and standardization of the industrial systems communication capabilities — from exclusively proprietary buses at the beginning, and up to standard communication solutions, such as TCP/IP or standard fieldbuses, more recently — allowed their expansion to any hierarchical level. The use of industrial control systems for the CERN technical infrastructure has been a common practice for several years. But today, these technologies are also being introduced in fields such as the accelerator and experimental areas' controls.

The industrial components increasing scope is not only a technological question, but also affects humanistic areas such as the economic and human resources management and the work organization. Therefore, the CERN groups and divisions with a background in the use of these technologies, but also in commercial relations with the industry, have to lead and to be the reference at CERN for those who are getting introduced now [17].

Today, the challenge is to well manage the organizational aspects related to the implementation of these systems. The difficulty is to design architectures to be operational on a long-term basis by using technologies that have a very fast evolution. The optimal solution should not be considered as the best system that the market offers today, but as the architecture that can be implemented with the technology available today and which will still be a good choice at least over the next ten years. This is the common aim of the CV and the TCR groups: to build up a long-term architecture, and to implement it smoothly during the upgrade towards the LHC. The key to success will be to establish coordinated schedules and procedures so that the individual efforts converge into one flexible and coherent system complemented by a well-documented knowledge base. The technical expertise is available; so, the managerial and communication aspects will be the decisive ones. It is with regard to these that special care has to be taken.

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