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TCR INDUSTRIAL SYSTEM INTEGRATION STRATEGY

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Abstract

New turnkey data acquisition systems purchased from industry are being integrated into CERN's Technical Data Server. The short time available for system integration and the large amount of data per system require a standard and modular design. Four different integration layers have been defined in order to easily ‘plug in’ industrial systems. The first layer allows the integration of the equipment at the digital I/O port or fieldbus (Profibus-DP) level. A second layer permits the integration of PLCs (Siemens S5, S7 and Telemecanique); a third layer integrates equipment drivers. The fourth layer integrates turnkey mimic diagrams in the TCR operator console. The second and third layers use two new event-driven protocols based on TCP/IP. Using this structure, new systems are integrated in the data transmission chain, the layer at which they are integrated depending only on their integration capabilities.

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1 INTRODUCTION

This paper explains the integration strategy of new industrial control systems supervised by the Technical Control Room (TCR) at CERN. The aim of this integration is to allow these systems to send their data to the Technical Data Server (TDS), which is the information system that centralizes data of the CERN technical infrastructure. This strategy will allow the TCR to provide a better service in its main function of system monitoring, and at the same time will allow the different equipment groups at CERN to improve their function of system control.

Experience shows that different industrial control systems always have different integration capabilities. For this reason, different levels of control system integration are provided. The first level allows the integration of digital or analog I/O ports, or a PLC, at the Profibus-DP level. The second level allows the integration of Programmable Logic Controllers (PLC) with TCP/IP communication capabilities using the Industrial System Access Protocol (ISAP). A third level permits the integration of external drivers at the TCP/IP level, using the Generic TDS Equipment Access Protocol (GTEAP). The fourth level permits the integration of turnkey mimic diagrams in the TCR operator console and the selective transmission of certain points to the TDS according to the monitoring requirements of the equipment groups.

2 STRATEGY

The main objective followed by the authors is to harmonize the integration of industrial control systems in the technical infrastructure managed by the TCR, providing at the same time a coherent environment. This will make this process known, repeatable and optimized.

Integration of systems is always laborious owing to inherent differences between systems. One solution is to provide different possibilities of integration, but maintaining at the same time a homogeneous environment. This is done using the integration layers. This structure of layers has three main advantages.

- Modularity: it easily allows the integration of one or more systems into the general structure.
- Independent treatment of systems and, consequently, isolation of the problems.
- Reusability of solutions, when they have been proved and tested in a particular system.

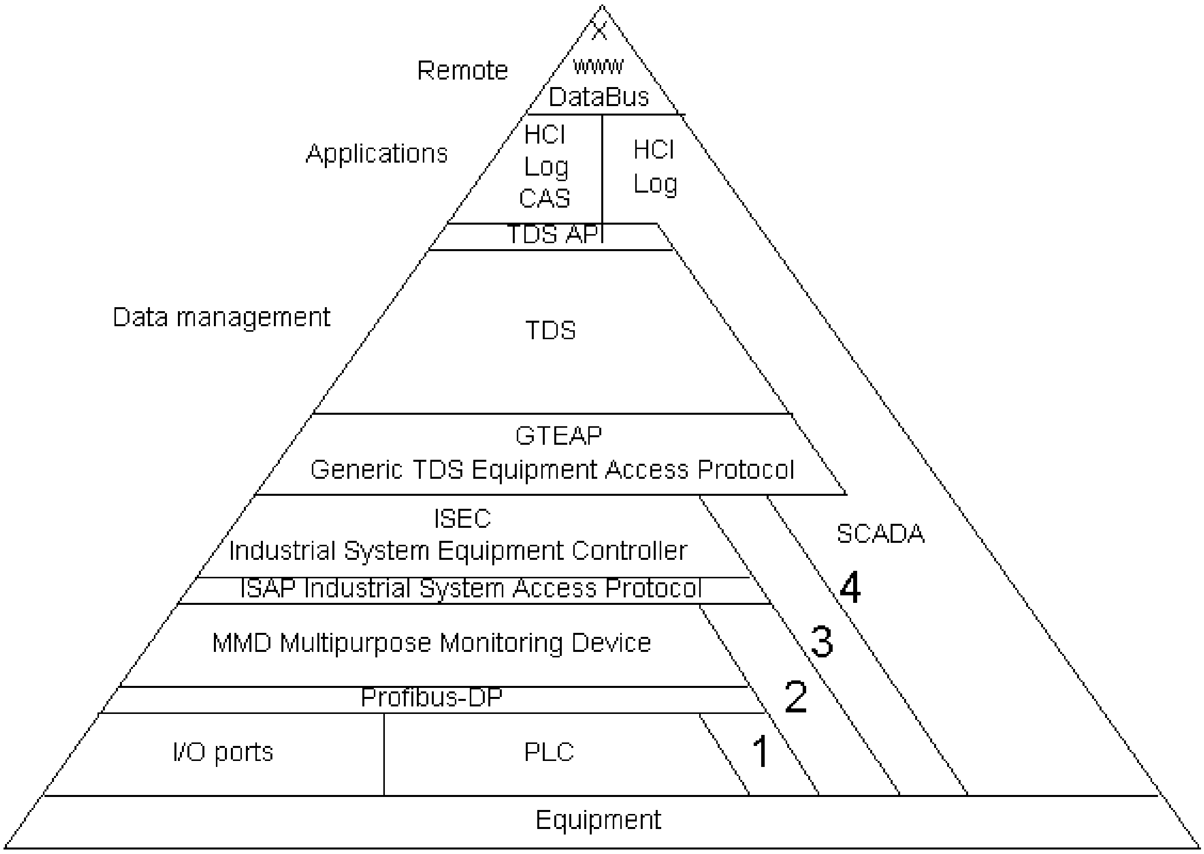

Figure 1: Integration layers for industrial control systems.

3 INTEGRATION LAYERS

The different integration layers (Fig. 1) are described below.

3.1 First integration layer

This layer integrates digital or analog I/O ports, PLCs without TCP/IP connection capabilities, or other data acquisition devices connected to the equipment.

These elements are integrated into the system using a fieldbus of type Profibus-DP.

An added value provided by ST/MO to the equipment groups is a fully developed multipurpose PLC that can be easily plugged into different systems. The PLC is called a Multipurpose Monitoring Device (MMD).

To monitor I/O ports, this PLC runs standard software that only needs parametrization, so there is no additional software to be written. The MMD is a standard reusable component that can be used in many systems.

Another important characteristic is the management of time. The objective followed by our group is to diffuse the data acquisition time as close as possible to the data itself. This is called the data time-stamp. Time-stamp management will allow future applications to analyse causality issues in equipment malfunctions. In this case, the MMD must be synchronized for the monitoring system, and the communication between the MMD and other data diffusion levels allows the transmission of the data time-stamp as well as the data itself.

One example of the use of this type of integration is the removal of the Equipment Control Assemblies (ECA) designed by the TCR (EREM project [1]). In this project, industrial Wago I/O ports used to acquire data from the equipment have been integrated at this level.

3.2 Second integration layer

PLCs with TCP/IP connection capabilities are integrated in this layer.

Industrial systems are integrated at this layer using the Industrial System Access Protocol (ISAP). This protocol is based on TCP/IP. Some advantages of this protocol are the following.

- It allows the diffusion of binary or analog data, and their corresponding timestamp.
- It allows the modification of values in the monitored equipment. The execution of these modifications is always controlled, and a report is always sent to the user.
- It allows the external synchronization of the time of the PLC.
- It monitors the communication status between the equipment controller and the PLC, even when no data are diffused. Errors are reported to the end user.

The ST/MO group provides a generic equipment controller (EC) developed to integrate the applications that do not have a specific EC. This equipment controller is called Industrial System Equipment Controller (ISEC), and it has been developed by a company specialized in control systems, following the specifications given by ST/MO [2], [3]. Some important characteristics of this equipment controller are the following.

- ISEC is an event-driven system. This means that it treats new data only if a change is detected, optimizing data processing capabilities.
- Three models of PLC are supported by ISEC: Siemens S5, Siemens S7 and Telemecanique, following the recommendations addressed to the CERN community relating to the integration of PLC in the technical infrastructure [4].
- ISEC implements maintenance capabilities requested by users. This means that this EC is able to filter data depending on the status of the monitored equipment, and not to send them to the data diffusion system if the equipment is in maintenance. This capability avoids incorrect data and false-alarm diffusion due to the fact that some manipulations are performed in the equipment, i.e. for periodic maintenance activities.

One example of integration at this level is the Mekatron fire-detection control panel used for Zone 19.

3.3 Third integration layer

This layer integrates the equipment driver.

The way the driver communicates with the TDS is by the GTEAP. This protocol, developed jointly with the TDS, has proved its performance and robustness in many applications. It is based on TCP/IP.

In order to use the GTEAP, equipment groups must develop their own equipment controller. A complete description of this protocol and rules to use it are explained in the TDS Interface Control Document [5].

At this integration level, ST/MO provides the TDS [6] to the equipment groups as the entry point of the data to be monitored.

Examples of integration at this level are the ventilation system for the tunnel of the SPS or the control of the heating plant of the Meyrin and Prévessin sites.

3.4 Fourth integration layer

This layer permits the integration of a complete and independent SCADA system.

Mimic diagrams and operator diagnostic tools of a SCADA system are integrated in the operator console. Data that must be supervised by the TDS are integrated using GTEAP, in order to be able to perform data correlation between equipment in different technical systems. This typically includes alarms and data logging. The SCADA system should be able to integrate the functionality required for the GTEAP; otherwise an EC must be developed.

One example of this is the SCADA system that will be purchased and installed for the supervision of the CERN electrical network (ENS) [7].

4 QUALITY ASSURANCE

In order to manage the activities involved in the specification and development of the tools produced by this project, and to ensure optimum quality levels, established methods have been used throughout. The Goal Directed Project Management (GDPM) [8] method is used for the control of project activities, project time and budget. Software development activities are controlled using the European Space Agency (ESA) PSS05 Software Engineering Standards [9]. Software configuration activities [10] are covered using Razor [11] from Tower Concepts, Inc. as software configuration tool.

5 CONCLUSION

The ST/MO group analyses and provides reusable solutions to integrate equipment data according to the integration capabilities of the local control system. Simple data acquisition systems will be placed in the first integration layer. PLCs with TCP/IP communication capabilities will be placed in the second integration layer. Equipment drivers with more added functionality will be placed in the third integration layer. A complete SCADA system, with a full control of the data, will be placed in the fourth integration layer.

This approach eases the maintenance and allows the management of fewer software modules of greater quality. It also provides a shorter response time in solving equipment data integration issues.

References

[1] P. Ninin, *ECATCR removal project (EREM)* CERN (1998).

[2] P. Ninin, R. Bartolomé, *ISEC industrial system equipment controller: user requirements document*, CERN (1998).

[3] A. Linares, *ISEC industrial system equipment controller: technical specification*, GTD (1998).

[4] D. Blanc, D. Brahy, W. Heinze, J.-M. Maugain, O. Van Der Vossen, S. Waeffler, R. Rausch, *Recommendations for the use of programmable logic controllers (PLCs) at CERN*, CERN (1998).

[5] P. Ninin, D. Romanet, A. Vega, F. Fernández, C. Delgado, B. Cantau, *TDS Interface control document*, CERN (1996).

[6] P. Ninin, R. Bartolomé, B. Cantau, C. Delgado, H. Laeger, A. Lund, R. Martini, P. Sollander, *Technical data server: a modern vision of large scale supervision*, CERN (1997).

[7] ST/EL, *Operational requirements for the electrical network control system*, CERN (1996).

[8] Andersen, Grude and Haug, *Goal directed project management, Second Edition*, Kogan Page (1998).

[9] C. Mazza, J. Fairclough, B. Melton, D. de Pablo, A. Schieffer, R. Stevens, M. Jones and G. Alvisi, *Software engineering guides*, Prentice Hall (1996).

[10] T. Mikkelsen, S. Pherigo, *Practical software configuration management*, Hewlett-Packard Professional Books, Prentice Hall PTR (1997).

[11] *Razor user's guide*. Tower Concepts, Inc. (1997).