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INFRASTRUCTURE CONTROLS INTEGRATION AT ESS

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Abstract

The European Spallation Source (ESS) project is starting the construction of the buildings June 2014. When the access to linac tunnel and gallery building is ready, the commissioning of the first sections of the accelerator starts. A proper operation of this machine relies on the services provided by different infrastructure systems (water cooling, electrical power systems, ventilation, etc.) These systems will be used long before beam operation starts and need to be operated via the Integrated Control System (ICS) from the Control Room. Due to the number and variety of these systems, their heterogeneous characteristics and the different teams of designers, the integration process into ICS is challenging. Experience in other facilities [1, 2] shows that a late integration produces higher maintenance and operation costs, and even impact on the reliability of the machine. This paper presents the strategy developed by two partners, the Controls and Conventional Facilities Division (CF). It is planned to capture the requirements for the interfaces and to ensure an early integration of Infrastructure Systems into the EPICS environment. First results of this approach are shown for some systems.

INTRODUCTION

This paper describes the strategy followed for the integration of those systems related to the technical infrastructure at ESS into the ICS. The main goal of this activity is to provide operation and monitoring capabilities at the ESS Control Room for all those systems that are relevant for the overall operation of the machine. CF Division is responsible for a set of systems (main power power supply, cooling water, HVAC, etc.), which can have a direct impact on the machine performance. Also some of those systems have interfaces with safety and protection systems under the scope of Controls Division. The number of them is significantly large and they are very different between them in terms of architectures, their users, requirements and even design teams.

These arguments justify an early action to identify those interfaces and provide an architectural design for this purpose. Moreover, some of the technical infrastructure systems need their own control functionalities for those areas that are not relevant for the machine or because of maintenance purposes. For instance the Main Power Supply System needs to have some PLC based controls in order to balance the power into different parts of the system when the loads connected to the system change.

CF is responsible for their own systems. However, those systems that are relevant for the machine operation will be monitored and operated from the ESS Control Room. Therefore, CF will provide ICS with access to all the required signals for this purpose. CF will own HMIs for maintenance purposes. Those systems that are not relevant for the machine operation will be completely under the scope of CF.

In the first section the scope of the ICS is explained. Following that the different SCADA systems managing technical infrastructure systems owned by CF are listed. Finally, the strategy followed to determine which of the technical infrastructure systems should be integrated into ICS, which signals are needed in the ESS Control Room from those systems and how to capture the information to design the interface is described. The first results of this activity and some conclusions are the last two sections.

ESS CONTROL SYSTEM

The Integrated Control System (ICS) is in charge of the controls for all parts of the machine, including the accelerator, target, neutron-scattering systems and conventional facilities [3]. ICS will connect all its parts and provide operation, control and monitoring capabilities as a single working entity. It is based the Experimental Physics and Industrial Control System (EPICS). ICS includes those services that need to run continuously regardless of ICS user activities, such as the archiving of process variable (PV) values; monitoring of alarm states, etc. . It also includes the central systems such as timing, the Machine Protection System (MPS) and the Personnel Safety System (PPS).

TECHNICAL INFRASTRUCTURE SYSTEMS

CF will deliver a number of systems covering different areas of the technical infrastructure. Some of the systems are process related like cooling water, main power supply or HVAC. Others are related to security and safety (fire detection systems, evacuation alarms,...) or related to the logistics inside the facility (access systems or transport systems). For the control of those systems the existence of three SCADA systems was agreed between CF and ICS:

- Power SCADA. PLC based distributed control system to deal with power balancing in primary, distribution and secondary substations.
- Building Management System (BMS). Monitoring and maintenance of process based systems (HVAC, Cooling Water, Transport Systems...)
- Sec-Net Systems. Operation and monitoring of security related systems (access to buildings, security video, fire...).

* R. Schmidt was on leave from CERN at ESS from April to December 2013

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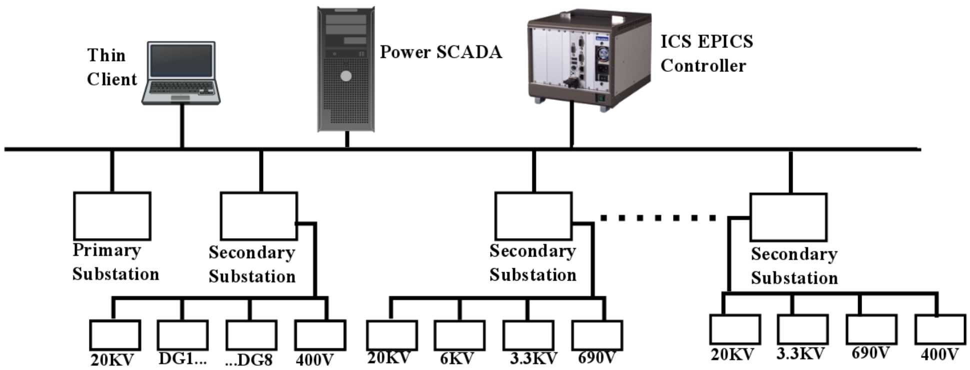

Figure 1: Preferred type of interface.

INTEGRATION STRATEGY

The first step made by CF and ICS was to define a preferred type of interface. It is expected that a great part of the infrastructure systems will be PLC based. So preferred interface means that whenever it is possible the interface made in a reliable way and avoiding single points of failure. For instance, to interface a technical infrastructure system at the PLC level is preferred, rather than do it with the SCADA system. Figure 1 contains a very simple schematic of the interface between the ICS an the CF Main Power Supply System. The ICS is connected directly to the control network on the system. A direct connection to the Power SCADA would create a single point of failure for both systems part of the interface. In general, it is also much more reliable and common to interface those systems directly through PLCs or more standard buses (in terms of EPICS integration). Because of that, both organisations have also agreed in a list of buses and protocols to interface equipment (RS-485/Modbus RTU, Ethernet/s7plc, Ethernet/Modbus TCP, Profibus, etc.)

The Integration Sessions

The list of technical infrastructure systems is quite long and they are very different between them. Therefore, to deal with the integration process, CF and ICS agreed in creating 7 different working groups to deal with the design of the interface. Each group handles a number of systems and it is composed at least of the designer of the system (CF) the person in charge of the SCADA that correspond to this system (CF) and the Leader Integrator from ICS. Group 1 is in charge of cooling water, compressed air and deionized water systems. Group 2 deals with HVAC systems. Group 3: Main Power Supply, Backup Power and UPS Systems. Group 4 deals with Low Voltage Systems. Group 5 is in charge of Extra Low Voltage Systems. Group 6 is about Transport Systems (elevators and cranes) and, finally, Group 7 deal with the spaces required in the facility for the ICS equipment. The procedure to design the interfaces for the different systems takes place in the so-called integration sessions (see Figure 2). Each working group has a kick-off meeting of 120 minutes. The topics of this meeting are: short introduction to EPICS control systems, explanation of the overall strategy, questions from the system designers, definition of the scope of the systems and next steps. If the result of the kick-off meeting is that the system needs to be integrated into ICS, regular integration sessions are called, which they are 90 minutes long. The design of the CF systems is an ongoing process, so the information captured in the integration needs to adapt to the design stage of the system. The actions taken in order to mitigate this issue are:

- The capture of information follows a top-down approach going from general to more particular questions.
- At the end of each integration session, the team decides whether there is information enough to meet again or some action or waiting time is needed to have the necessary information to proceed.

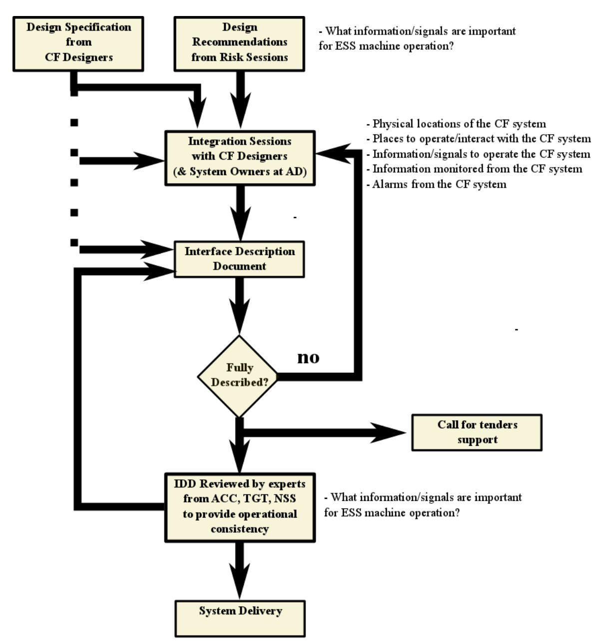

Figure 2: Flow Diagram.

The materials used in the integration sessions are the documents from the designers and the design recommendations from a risk analysis, which was done for the design of the Machine Protection System. The design of the interface is expected to be split into preliminary design and detailed

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design. After defining the scope of the systems a list of tables is filled by answering a set of questions (milestone for the system design, is the system PLC based?, physical location in buildings, points of interaction with the system in the different buildings...). The first two tables to fill is the location of the system. The second table goes through the different buildings determining the interface points with the ICS and the SCADA in charge of the system. If all of the rows in the second table are negative, the team knows early in advance that the system will not have any interface with ICS. With this two first tables a preliminary design of the interface can be issued. A general architecture can be drafted by knowing the general structure and the type of controllers for this system. The next information captured is the exact location of the different equipment parts of the system. Some notes are taken containing information of the particular unit (an air handling unit, for instance). Many of the technical infrastructure systems are composed by entities that are repeated a significant number of times. For example, air handling units in HVAC Systems or secondary substations in Main Power supply Systems. Taking advantage of this characteristic, these entities are defined as typical objects. The control interface for them is defined during the integration sessions by filling dedicated tables. In this way, the saving of a considerable amount of time is expected, so the same integration work does not need to be repeated. Once, all the equipment is collected together with its exact physical location and its controls interface (signals, ports, etc...) the final goal of this process is reached. The final information for the detailed design of the interface will be a list of all the interface devices (type, location, name...) and a list of signal flowing across the interface (signal, name, type, sampling rate,....). An important aspect is to detect if a particular signal needs to raise alarms in the operation of the system. All the information collected will produce the following tables:

- Table 1: System characteristics (name, scope, PLC based?, interacts with ICS?, Interacts with SCADA?)
- Table 2: Building distribution. A matrix containing the buildings where the system is present.
- Table 3: Interfaces per building. For each building this table contains if a systems is interfaced by ICS, SCADA, both or none of them.
- Table 4: All the equipment of the system per building.
- Table 5: Typical Objects
- Table 6: List of interface devices for the system
- Table 7: List of signal for the system interface.

With all the information collected in this process, three types or deliverables will be produced: Requirement, Interface Controls Document and Design Document. All of this documentation needs to be approved by the Change Control Board of this project. In order to complement all the information collected and incorporate operational experience and all the suggestions by the future operators of the machine, a procedure of reviews has been setup. The result of this process will be submitted to review to experience operators from other facilities. Internal reviews will also take place involving teams all across the facility, so they can also incorporate theirs suggestion for the future operation of the different technical infrastructure systems.

RESULTS

Applying the strategy described before, the integration of a subset of the systems has already begun. The status of the integration of the technical infrastructure systems is the following:

- Cooling Water System. The scope of the system is already defined. The integration process is in a waiting-time to have more design information available.
- HVAC System. Detailed information about the Tunnel Building and Gallery Building is already available. Waste Water System were already discarded for the integration with ICS.
- Power Supply System. Detailed information about the equipment Tunnel Building and Gallery Building already available.
- Transport Systems. Almost all them discarded for integration with ICS.

CONCLUSION

A method for the integration of the technical infrastructure systems has been designed at ESS. Technical Infrastructure Systems are very different between them, designed by different teams and may have a big impact in the operation of the machine. Long term maintainability in other facilities have been detected, which have been derived from a faulty integration in the control systems or dramatic changes in the operation budget. This strategy is designed to mitigate those risks. The overall methodology has been described and the first results are shown.

REFERENCES

[1] J. Stowisek, S. Roy, A. Suwalska , "Technical Infrastructure Monitoring at CERN", TS-Note-2005-015, EDMS Nr: 590512.

[2] J. Stowisek, A. Suwalska, T. Riesco , "Technical Infrastructure Monitoring from the CCC", Proceedings of EPAC 2006, Edinburgh, Scotland.

[3] ESS Technical Design Report: http://eval.esss.lu.se/cgi-bin/public/DocDB/ShowDocument?docid=274