DEPLOYING THE UNICOS INDUSTRIAL CONTROLS FRAMEWORK IN MULTIPLE PROJECTS AND ARCHITECTURES

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ABSTRACT

The UNICOS industrial controls framework, initially designed for LHC cryogenics controls on top of the PVSS-II SCADA system, is being successfully deployed for several other projects based on different architectures.

This includes a variety of front-end systems (multiple PLC and VME solutions), communication methods and device models.

In addition to the reuse of components and tools allowing fast development for the hardware commissioning phase and ensuring coherence between front-end and supervision process variables, this choice guarantees common HMI standards and will thus facilitate their use by the operation team.

These projects benefit of the already developed integration with LHC accelerator central facilities (alarms and data logging).

INTRODUCTION

The UNICOS project (for UNified Industrial Control System) provides an homogeneous control system for the cryoplants supplying liquid helium to the LHC accelerator, the cryogenic equipment in the machine tunnel, and the ATLAS & CMS cryogenic systems. This system is now in use since 2002 for the commissioning of these cryoplants.

The technical design took advantage of accumulated expertise on previous cryogenic systems such as for LEP2, based on the Decentralised Control Systems of the process industry. For UNICOS, CERN required the providers to offer open interfaces between the different layers, instead of closed solutions forcing dependence on a single supplier. This resulted in a design based on SCADA and PLC industrial components.

MAIN FEATURES OF THE UNICOS FRAMEWORK

The advantages of layer independence appeared from the early phase of the project, allowing to easily change the SCADA layer in order to fit with recent CERN standardization on PVSS-II. This choice permitted to share common components with the LHC Experiment Joint Controls project (JCOP).

It then appeared that the project core of the cryogenics applications (otherwise called framework) could be applied to other domains, the first one being the detector gas control systems[2].

Briefly stated, the UNICOS framework is targeted to allow Supervision development with minimal SCADA expertise, and evolutive maintenance of supervision layer by operators/users. It applies well to strongly device-oriented distributed system designs, where process logic and sequences are in the front-end layer. The operator layer functionality consist mostly of device monitoring in a hierarchy of views, trending (on-line and archival) based on time-stamping at the source, alarms, events and device control.

Conversely, this solution is not appropriate to build computation-intensive applications which can be found in other areas of accelerator controls.

GENERIC SUPERVISION FEATURES

The supervision part of the framework allows connexion to multiple front-ends.

All user interface appears within a main window frame (able to manage 2 displays), consisting in:

- a fixed header (adaptable for each application domain) allowing access to common views such as system status, window tree, alarm list, event list,..
- a central panel for the process views (synoptics and trends)
- a footer area which contains context-dependent buttons (typically, the set of possible actions on a selected device).

Common features allow to log operator actions, to navigate through a hierarchy of synoptic views arranged in a tree, and to integrate the application with CERN Accelerator Controls utilities: LHCLogging for long-term archival, LASER Alarm system.

Other features of interest are the Event list, alarm lists (device/system), object lists who can be filtered to view a subset of interest.

Horizontal navigation (left/right) has been included for synoptics referring to geographical location.

A generic Device overview panel can be automatically built, with different structuring rules according to device types or domain, and is very valuable for first commissioning of systems.

DEVELOPING APPLICATIONS

Configuration-only development

A typical application development using a set of pre-existing devices consists of the following steps:
- Select the set of domain-specific device types,
- Import the instances of devices (typically from Excel sheet),
- Draw and order Synoptics with graphical tool
- Configure pre-defined Trends, archived device list and alarms

This can be entirely done via configuration; baseline contains general-purpose utilities e.g to export devices in an external file.

Adding devices

New devices can be integrated without touching the framework core, by programming according to a set of rules (import check, animation,..)

The device model used at supervision level is similar for all device types and consists of:
- A widget with generic graphical behavior (showing data quality, alarm state, mode such as Auto/Manual) as in figure 1.
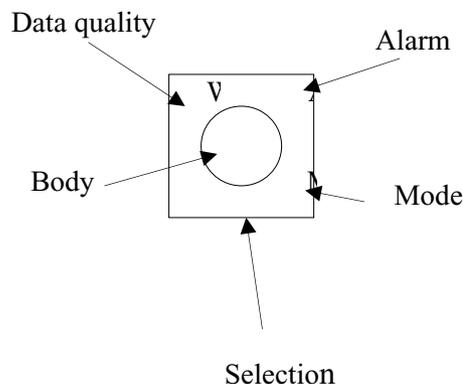
Figure 1: widget device model.

- A Faceplate as pop-up window provides a complete view of the device data, an on-line trending, context-dependent commands, plus diagnostic and information links.

Each device has general attributes named: Domain and Nature (used e.g. to organize the device overview tree).

NON CRYOGENICS APPLICATIONS

The first non-cryogenic application developed for LHC experiments gas controls introduced a clean method to integrate additional domain-specific devices. With this feature, a series of new application developments based on the UNICOS framework has been launched using various architectures.

The LHC Quench protection system (QPS) supervision uses new devices and communicates with LynxOS front-ends via subscription to the Common Middleware (CMW) protocol. It is a large application, accessing 100.000 sensors on 35 Lynx-OS PC front-ends.

The Power Interlock Control (PIC) supervision uses similar device types and hierarchy as QPS but communicates with 6900 sensors on 43 SIEMENS S7-PLCs. Its main panel is shown on figure 3. These two applications are closely related from the operations point of view, and although developed by different programmers, the coherency of their user interfaces is automatically ensured.

In addition to standard features, they provide together generic panels per powering sector, used for operation or expert, a special event-list and buffer snapshot views.
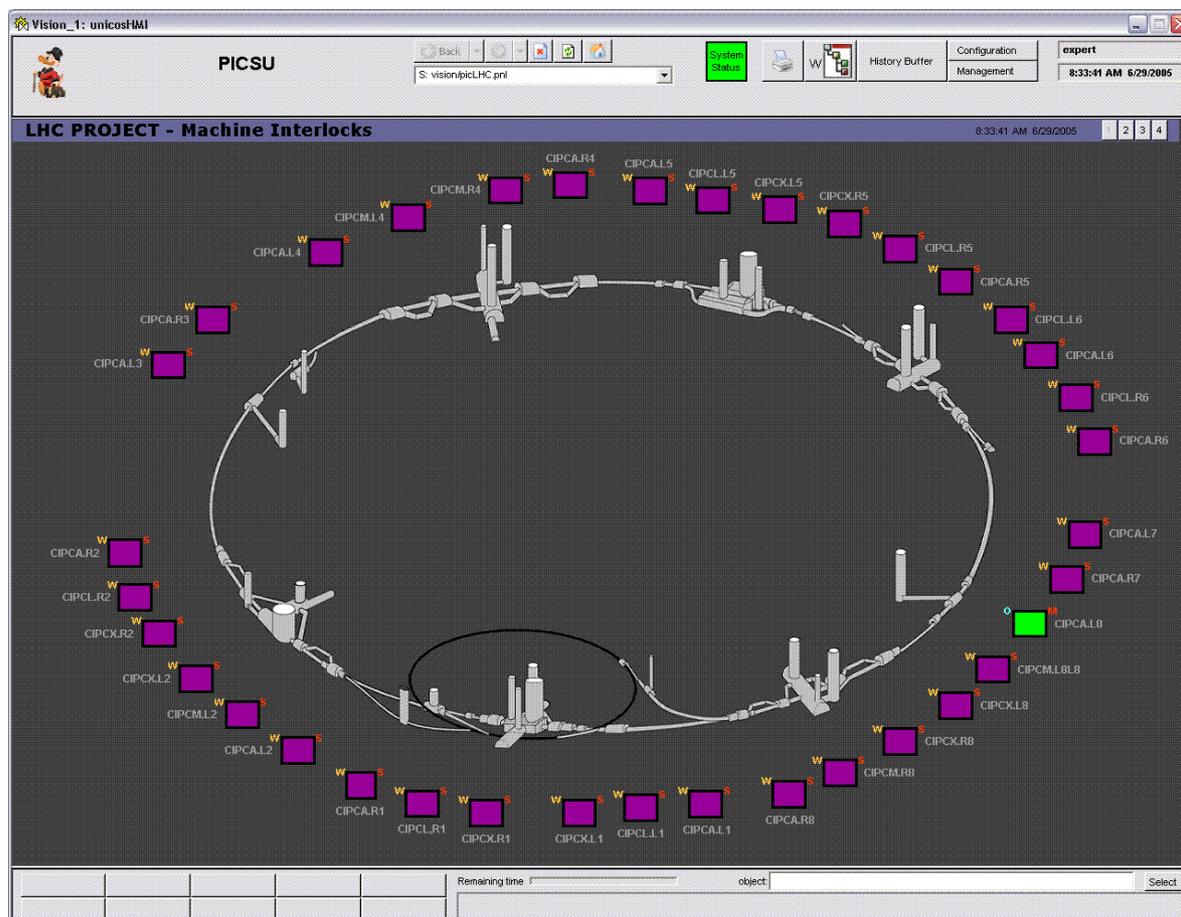
Figure 2: Example of Power Interlock Controllers main panel.

The Cryotunnel application is an expert tool for cryomagnet instrumentation system, covering Temperature, Pressure, Level sensors and Heater controllers.

It interfaces with devices on LynxOS front-ends via CMW client interface.

In addition, small expert supervision interfaces to existing PLCs have been developed on demand, as they require little initial effort (in the order of a day's work) through the use of the automatically generated Device Overview panel.

Other technical infrastructure domains at CERN are evaluating the possibility to use the UNICOS framework in outsourced developments, because its strong descriptive model will facilitate the maintenance work.

RETROFITTING LEGACY APPLICATIONS

When consolidation of ancient industrial controls is required, most often the supervision layer is the main incentive for renovation (ancient software, running on non-supported platforms), while the PLC

hardware remains operational. We have analysed several solutions for such problems at CERN, keeping in all cases the existing PLCs:

- Complete upgrades of both PLC software and supervision to UNICOS: when the existing PLC code is well structured and a functional analysis can be done by a process engineer, this offers the best solution in terms of long-term maintainability .
- Encapsulation of PLC logic by interfaces to Unicos I/O devices on the I/O side and to Unicos process control devices on the supervision communication side. This is applicable for well-organised existing PLC code. It permits supervisory view of the I/O side and associated simulation and test facilities provided in UNICOS.
- Interface only the PLC logic to supervision side. This offers limited features but can be implemented in a PLC containing not very well structured code.
- Insert a UNICOS PLC as gateway, when the existing PLC code cannot be touched (too ancient or risky).

CONCLUSION

The concepts of the UNICOS framework have shown their usefulness when developing several applications for a well-defined process domain, and the operational needs are covered by SCADA features. A whole set of operational facilities are made available while investing a limited design and implementation effort.

They are used successfully in non cryogenics control applications within different distributed architectures with PLCs of Schneider or SIEMENS families and LynxOS or Linux front-ends.

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