TURN-KEY APPLICATIONS FOR ACCELERATORS WITH LABVIEW-RADE

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Abstract

In the accelerator domain there is a need of integrating industrial devices and creating control and monitoring applications in an easy and yet structured way. The LabVIEW-RADE framework provides the method and tools to implement these requirements and also provides the essential integration of these applications into the CERN controls infrastructure.

We present three examples of applications of different nature to show that the framework provides solutions at all three tiers of the control system, data access, process and supervision.

The first example is a remotely controlled alignment system for the LHC collimators. The collimator alignment will need to be checked periodically. Due to limited access for personnel, the instruments are mounted on a small train. The system is composed of a PXI crate housing the instrument interfaces and a PLC for the motor control. We report on the design, development and commissioning of the system.

The second application is the renovation of the PS beam spectrum analyzer where both hardware and software were renewed. The control application was ported from Windows to LabVIEW-Real Time. We describe the technique used for a full integration into the PS consoles.

The third example is a control and monitoring application for the "CLIC two beam test stand". The application accesses CERN front-end equipment through the CERN middleware, CMW, and provides many different ways to view the data. We conclude with an evaluation of the framework based on the three examples and indicate new areas of improvement and extension.

INTRODUCTION

At CERN there are different frameworks for application development, communication and front-end tasks programming. Adding specialized instruments that use dedicated software while making use of different frameworks can become a difficult and time consuming task. This led us to create the RADE framework a few years ago: a Rapid Application Development Environment realized in LabVIEW that covers all three control tiers. With the RADE framework developers and engineers don't have to cope with all the different interfaces and hardware and can focus on the job at hand, creating turnkey control and monitoring applications in a quick, stable and flexible way.

RADE

The RADE framework aims to give users a total package for development, maintenance and support, making it quick to implement flexible, stable and maintainable through well defined development templates, guidelines and documentation [1].

Templates, documentation, source control, updates, and libraries are all part of the framework, ready to be used in a few clicks.

The RADE distributed architecture provides a quick and flexible mean to interface with almost all equipment at CERN. Databases, frontends, file systems, PLC's and servers are all reachable through RADE. If a toolkit, protocol or library is missing it can easily be added to one of the framework's application servers or added on to the framework's native library package [2].

APPLICATIONS USING RADE

RADE can, with its high flexibility and wide range of libraries, be used in almost any control or monitoring application. Three applications covering different needs are shown here.

The LHC Collimator Survey Train - Multiple Alignment Control System (MACS)

The beam cleaning insertions in point 3 and 7 will become one of the most radioactive zones in the LHC. It was obvious since the beginning that standard alignment measurements will no longer be possible due to the high radiation level of up to 4mSv/h. The concerned zone is a 500 m long straight section of the LHC tunnel with 37 collimators and 26 reference magnets to be measured. The precision should be comparable to the rest of the LHC ring; meaning 0.15 mm in a sliding window of 200 m. Conventional measurements would take 4 days for a team of 3 people. The measurements must either be extremely reduced or one had to find a way to execute the measurements remotely controlled. Reducing the measurements is not considered as an option, as the collimation system is one of the most important parts of the machine protection system.

The basic strategy [3] was to use as much as possible off the shelves components. Various options have been studied, and finally a combination of two different techniques has been chosen. The system is based on a "MoveInspect" photogrammetric measurement system from AICON 3D Systems. This is a fast, precise and non-tactile way to measure the sockets of the radioactive collimators. This system is limited to a relatively small volume and a considerable effort is needed to cover the 500 m of LHC tunnel.

In order to cover the whole zone, a stretched wire reference is used. More precisely, 5 overlapping and fix installed wires are used to connect the different acquisition volumes of the camera system. The aim is to measure the position of the collimators with respect to the surrounding reference quadrupole magnets at the extremities of the wires.

The software developed for the train project has been made using LabVIEW. The software is divided into two parts, the sequencer (Fig. 1) running on the train and communicating with instruments, and the remote GUI giving information to the user who will be positioned outside the tunnel. The application communicates with the PLC on the train using the "Fetch-Write" protocol from Siemens™ through TCP-IP. The other instruments in the systems (ie MoveInspect Camera system from AICON™, Wyler™ Zerotronic inclination sensors, Aeroel™ XLS35 laser micrometer) have been controlled using separate homemade drivers, communicating either through TCP or RS232 protocols.

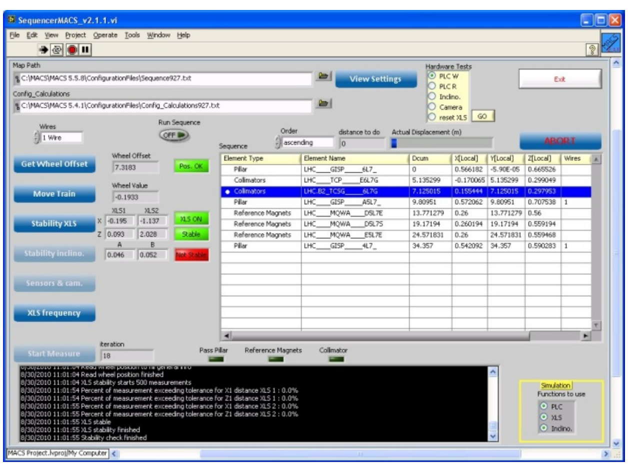

Figure 1: MACS Sequencer panel.

The sequencer is the main software and takes over the control of the whole train once activated. The remote GUI gives the operator the progress and status of all running applications, such as status of all sensors, results of stability tests, measurements and final results. In addition to the MACS software some other programs are used. The AICON MoveInspect software for the cameras, the CERN SU software Chaba for transformations and LGC++ are used finally for the calculation of the alignment.

Renovation of the PS Beam Spectrum Analyzer

The PS Beam Spectrum analyser was a single Windows based PXI crate from National Instruments, hosting dedicated RF cards used to perform Spectrum analysis on RF signals from the PS.

The analyser was mainly designed to perform spectrum and other frequency analysis on RF signals in the PS, but it is also used to do spectrum analysis on OASIS signals [4], which are obtained from remote hardware through a standard protocol.

Since this system is an integral part used to diagnose the RF signals in the PS, operators didn't think the application, running on Windows, was properly integrated into the CERN Control Room (CCC) consoles running Linux.

The PXI solution had so far worked fine, so it was decided that the new system would have a similar setup, but with the user application on the Linux console (Fig 2).

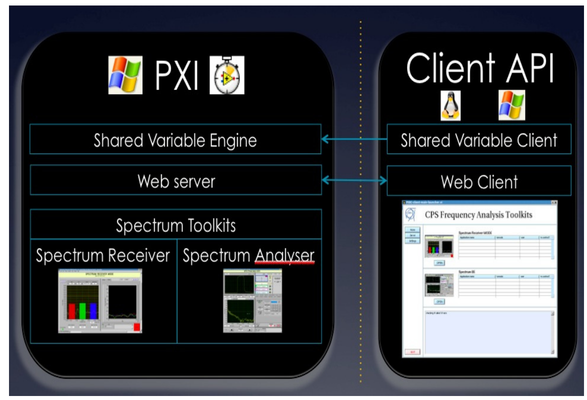

Figure 2: Spectrum Analyzer concept.

Two sets of PXI front-ends with a real time operating system called ETS and dedicated RF cards where installed and the existing software on Windows was converted into a split client-server application making use of LabVIEW remote panels and RADE [5].

The client part (Fig. 3) was adapted to the Linux system running on the consoles in the CCC and the server part was compiled for LabVIEW Real Time (ETS).

The communication between server and client was done using Shared Variables, a standard LabVIEW protocol, and the server would control its real time applications through a state machine based master.

This implementation concept proved quite powerful since any analysis application could later be added to the server and called from the client running in the CCC, and several applications still under development will be added at a later stage.

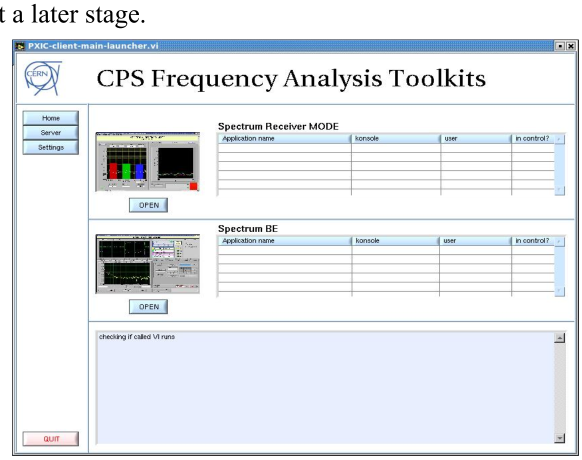

Figure 3: Spectrum Analyzer Linux Client.

With the use of LabVIEW and RADE the conversion of the old software and the installation of the new systems went quite smooth. A few adjustments to the real time headless environment had to be done.

Two-Beam Test Stand

The Two-Beam Test Stand (TBTS) in the CLIC experimental hall (CLEX) is aimed to test the two-beam acceleration scheme for CLIC, an electron-positron collider project. Beam stability, beam loss issues and RF structures are studied in this set-up.

All the signals are acquired through FESA devices, which are easily accessible using the CMW wrapper or the JAPC interface. The aim for this project is to be able to visualise the Beam Position Monitor (BPM) and RF signals in many different views such as horizontal vs. vertical graph or beam intensity or as a history graph. The BPM are probably the most important diagnostic devices used from the beginning.

First one needs to make sure that the beam actually gets to the dump and that it has roughly the same amplitude all the way. The RADE framework has been used to run the acquisition as a server task. Each graphical user interface then acts as a client taking only the necessary data to display in the appropriate format, without unnecessary data duplication.

The beam can be followed from the LINAC to TBTS within a single view (Fig. 4). When the beam is ready to be sent to the desired experimental area, the user can switch to a dedicated GUI to the see the beam position in time (Fig. 5).

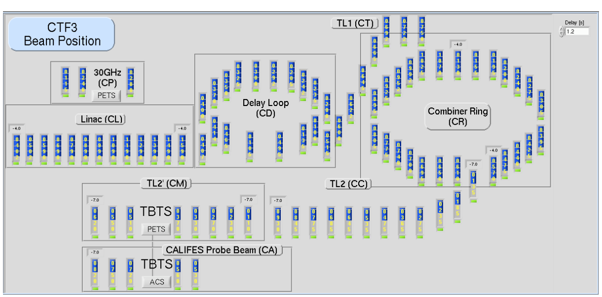

Figure 4: CTF3 beam position.

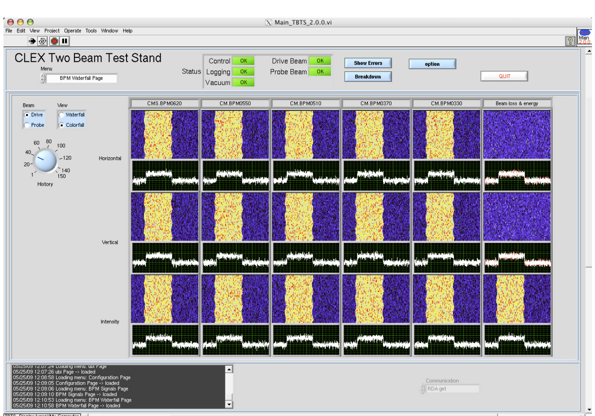

Figure 5: TBTS waterfall display.

The user can also adapt the current in the magnets directly from this application using RBAC and RADE [5]. Right clicking on the synoptic allows the operator to have access to magnet and valve parameters (Fig. 6).

Using the same scheme, a second application has been created for CALIFE experiment, still in the CLIC experimental hall (CLEX).

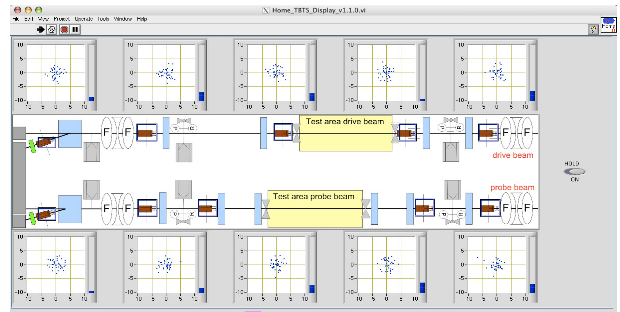

Figure 6: TBTS beam position and magnet controls.

CONCLUSION

The described examples above all use different technologies and techniques for communication and controls between software and equipment. The RADE framework and LabVIEW made it possible in a convenient and flexible way to realize the projects in a uniform environment within a reasonable time.

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