SOFTWARE RENOVATION OF THE CERN EXPERIMENTAL AREAS

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Abstract

The Experimental Areas at CERN's Antiproton Decelerator (AD), Proton Synchrotron (PS) and Super Proton Synchrotron (SPS) have recently undergone a wide-spread electronics and software consolidation based on modern techniques. This paper will describe the scale of the software renovation and how the issues were overcome in order to ensure a complete integration into their respective control systems.

INTRODUCTION

The CERN Experimental Areas include 7km of beam lines (Figure 1) with just over 400 detectors used by about 2400 experimental physicist and covering three different locations: the North Area (SPS), the East Area (PS) and the Antiproton Decelerator (AD). This instrumentation allows the observation of particle beams via 7 families of detectors (Table 1). The main requirement for the consolidation was to reduce down-time for physics and to reduce the required man-power for CERN to maintain and operate the beam instrumentation in these lines.

Table 1: Detector Families

Detector family	Number in the Areas
Scintillation Counters [1]	50
Filament Scintillators	65
Cerenkov counters	8
Delay wire chambers[2]	36
Analog wire chambers	65
Gas electron multipliers[3,4]	4
Scaler-counters.	190

HARDWARE SOLUTION

Until recently the hardware to control the beam instrumentation was implemented with CAMAC and NIM modules that had become obsolete and were generating frequent faults. In order to make the hardware more reliable and simpler to troubleshoot, new equipment-oriented hardware was developed in VME [1]. About 30 such VME crates are now controlling all the beam instrumentation equipment in CERN's experimental areas.

Figure 1: A beam line in the North Experimental Area.

SOFTWARE SOLUTION

The software structure chosen to accompany this hardware renovation is based on a classic three tier structure (Figure 2). The operational user GUI connects to the **C**ERN **E**xperimental area **S**oftw**A**re **R**enovation (CESAR) [5] J2EE server from where the Controls Middle Ware (CMW) [6] grants access to the Front End Software Architecture (FESA) server [7] and configuration databases.
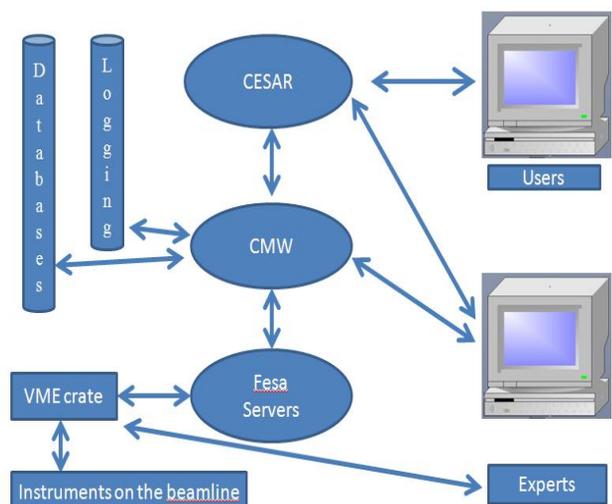
Figure 2: The three tier Software structure used.

CESAR

This tier allows a high level of abstraction. From the controls point of view the VME crates access detectors on many different beam lines whereas the end-user only wants to see equipment on the beam line on which he/she is working. This extra level of abstraction enables all the access rights, beam line configuration and display code to be separated from the hardware server code.

CMW

An object oriented device model implementation middleware with extensions to cover accelerator control created for the demands of LHC.

FESA

An environment for developing, deploying and maintaining front-end software. This enforces CERN accelerator control standards.

The equipment specialist can access hardware on four levels:

- CESAR GUI's where they have the same functionality as the users, which often allows simple misunderstandings to be ironed out.

- Expert GUI's (Figure 3) providing extra, potentially dangerous functionality, where processes such as pressure scans can be carried out. A separate expert GUI shows the status of all equipment of a single type (shown in Figure 4), which is useful as the equipment specialist often tests by instrument type and not by beam-line.

- FESA navigator which is a data driven GUI program for setting and getting all parameters defined in the front-end FESA class.

- Locally run programs on the VME front-end with no complex communications software involved.

These separate possibilities are important as they allow each level of the structure to be tested separately in case of doubts whether an issue is related to hardware or a software tier.

All computers, VME crates and the various servers running on them are constantly monitored by the CERN Controls Group "DIAMON" tool, a universal tool for diagnostics on the controls infrastructure across all CERN accelerators.
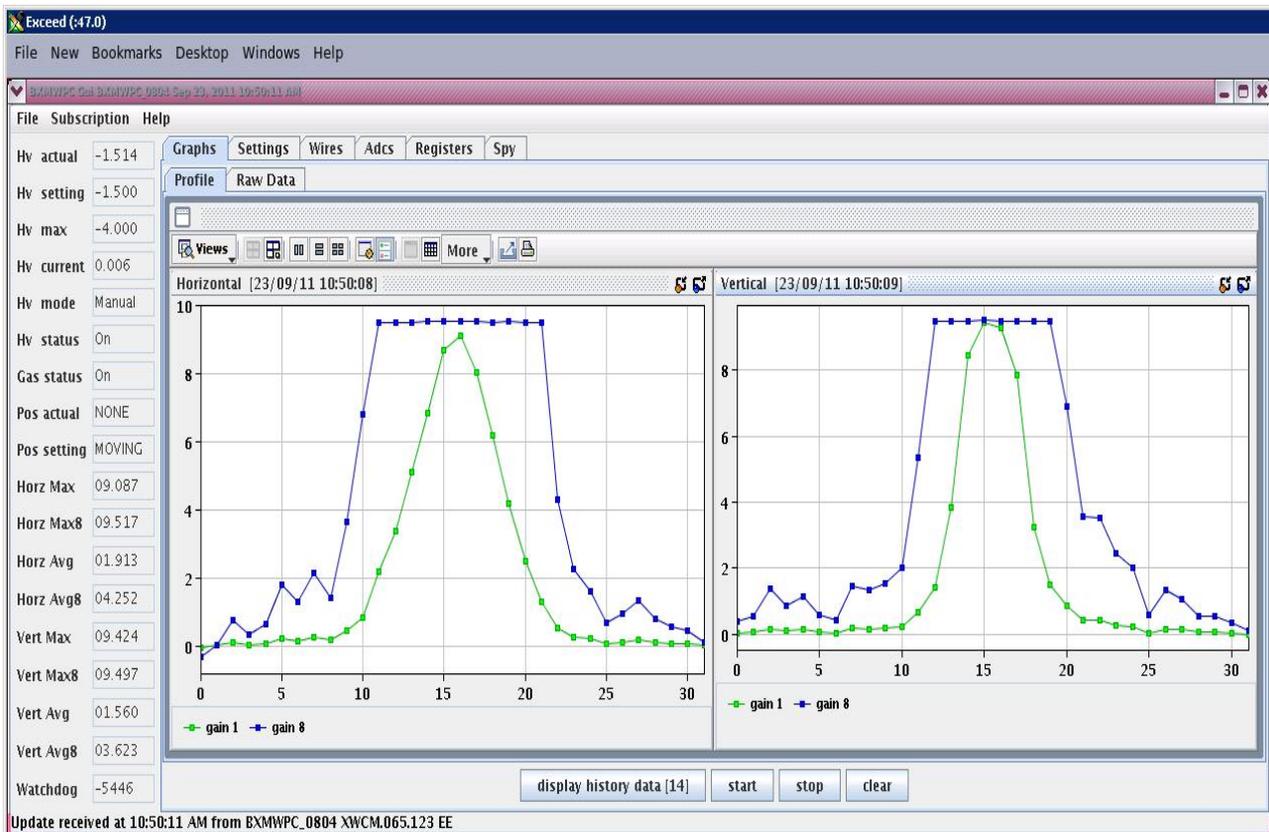
Figure 3: Example of an expert GUI, this one is for the control of an Analog wire chamber.

Device Name	Equipment Name	Module Name	Pressure	Pressu...	HV	HV Set...	HV de...	HV Max	Counts	CountsPm1	CountsPm2	Time of last...	Uptime	Action
BXCET_0200	XCET 021 520	XCET10<<	.960	1.050	-1.362	-1.360	-1.360	-1.700	0	0	791	0923 11:0...	0911 10:4...	click here
BXCET_0201	XCET 021 523	XCET01<<	.006	-1.000	-1.395	-1.400	-1.400	-1.800	0	114	1051	0923 11:0...	0911 10:4...	click here
BXCET_0202	XCET 022 459	XCET09<<e	2.490	2.500	-1.651	-1.650	-1.650	-2.000	10774	32985	12177	0923 11:0...	0911 10:4...	click here
BXCET_0203	XCET 022 465	XCET26<<	2.479	2.500	-2.070	-2.070	-2.070	-2.300	10658	28166	12177	0923 11:0...	0911 10:4...	click here
BXCET_0500	XCET 041 505	XCET06<<	.078	.040	-1.418	-1.420	-1.420	-1.600	348116	377425	664611	0923 11:0...	0902 09:2...	click here
BXCET_0501	XCET 042 474	XCET02<<□	.094	.100	-1.747	-1.750	-1.750	-1.900	2734843	2997365	32471800	0923 11:0...	0902 09:2...	click here
BXCET_0600	XCET 042 533		.000	1.000	0.000	-1.000	-1.000	-1.400	0	0	1304	0923 11:0...	0906 07:4...	click here
BXCET_0601	XCET 042 534	XCET07<<2	.055	.014	-1.473	-1.470	-1.470	-1.700	303	104499	9271	0923 11:0...	0906 07:4...	click here

Figure 4: A display of all the Cerenkov counters of the North Area.

STATUS

FESA Servers and Expert GUI`s have been developed for all new equipment-oriented hardware modules and we are now in the process of introducing new detector families, requiring similar solutions. In parallel existing hardware modules are being used to control new instrument-types with only minor changes to the servers.
An example of this is for the East Area target telescopes that will benefit from the existing VME module and server of the Scintillation Counter. The target telescope is an intensity measuring device based on scintillation that observes the particle production through a 5 meter long pipe perpendicular to the beam axis.

VME front-end crate controllers are currently changing from LynxOS to Linux. This move was in parts caused by modern software being memory hungry. The increase in speed of the new controllers has made the need for a specific real-time operating system an unnecessary overhead. The switch of operating system and controller card has used more manpower than expected due to the requirements/exploitation of current standards e.g. C to ANSI C and missing features in the new compilers which were used unknowingly in our old code.

CONCLUSION

As a result of this hardware and software renovation CERN's Beam Instrumentation Group has been able to support more experimental users, with fewer CERN staff dedicated to these areas. The instrumentation of the experimental areas is now based on modern, maintainable software tools and on the hardware side the new equipment-oriented approach has increased the reliability of the electronics. Both of these consolidations have made the overall maintenance load significantly smaller. From a user point of view the control system has changed from a command line to a more intuitive GUI based interface that provides better displays. A further side effect of using CERN standard software solutions has been to enable other software experts to remedy issues where formerly only the author of the code had the needed knowhow.

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