An implementation of the PC-based control system at KEK 12GeV Proton Synchrotron Complex.

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Abstract

Throughout the twenty history of the KEK 12GeV proton synchrotron (PS), the accelerator control system has been replaced twice, motivated by the development of the computer and interface hardware technologies. The third generation of the PC-based new control system is now implementing and aiming to replace the second generation based on the VME/MPA system. A detail of the new system configuration and hardware interface and software for this new system are described in this article.

1. CURRENT SYSTEM

The KEK 12GeV proton synchrotron complex has been organized in 1968. The accelerator control system was designed based on mainly a manual control, because of a poor environment of the computer world and interface hardware. A small computer is installed only for recording the operational data.

The second generation of the accelerator control system had started to implement so as to improve the architecture of the machine control based on mainly the computer in 1985. The system configuration was a distributed VME system both for hardware interface and computers, and those were connected through a MAP network. The VME was an invention of the new hardware interface and fitted to make a distributed system. To realize the distributed system, we developed an environment named "OBJP"[1] which contains the PASCAL pre-processor, network server and some support programs. The network around the VME system was taken by implementing the MAP network, which had the possibility to transmit either the digital data or the analogue signal. Beside the digital command and data transfer through the network, CATV video signals or a computer graphics signals are shared as the control information transfer. By this sense, the MAP was the most reliable network capable to transfer both kinds of signals on a single line.

The system configuration was a distributed computer system. Some VME computers were installed in the distributed VME crate, which performed as an I/O server. A programming server computer was placed near the control room for control software developments, and the software programs were down loaded into the distributed computers from that. The control presentation panels were distributed around the main console desk and the operator interfaces were made by the touch-panel hardware. The touch-panel was a layer of the server program launcher and the hierarchy of the layer was carefully designed by clustering the machine device concerned.

This VME/MAP system is still the main components of the current PS control system. However, some of the hardware or the MAP components become old and difficult to maintain. And also the industry has stopped to supply the touch-panel hardware.

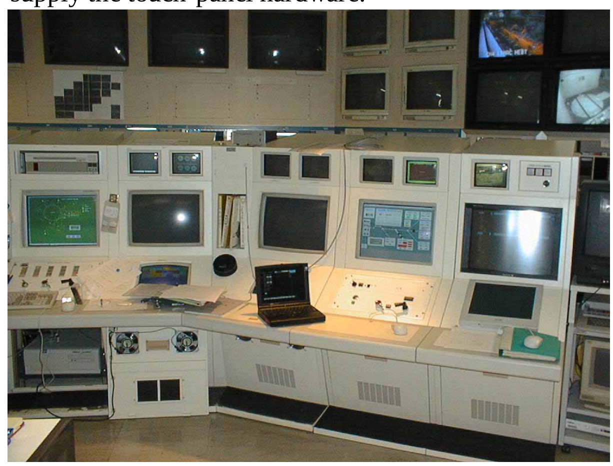

Figure 1. The main control console at KEK PS.

The implementation of the third generation of the PS control system had started in 1994 for avoiding these difficulties and motivated by the development of the computer world. The main part of the current system is still VME. However, some part of that is now replacing by the PC-based new system. The PC system has two kind of connections, PLC system for power supply control and fast data acquisition system. The concept view of the current system configuration is depicted in Figure 2.

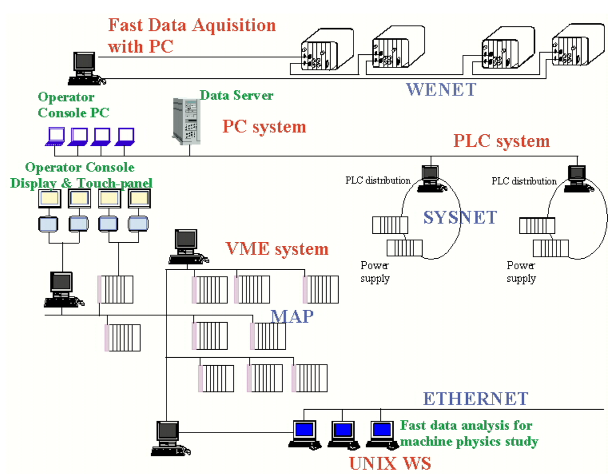

Figure 2. The current system configuration.

2. PC-BASED NEW SYSTEM

For the third generation of the accelerator control system at KEK PS, PC-based system is chosen. The consideration to chose the system were as follows:

The control or the data presentation panel is possible to develop not by the control people but by the operator or the user themselves. The accelerator components of the PS have so long history that it was difficult to implement the know-how, which is strongly dedicated to the equipment, into the panel by the people without concerning the devices.

The control and data are classified into two types, slow and fast. The magnet power supply control is classified slow and unified by taking a single network protocol. The data acquisition is classified fast and now making the unification according to the available network protocol.

The control or the application development should be provided by user friendly environment. And GUI builder software needs to be implemented for the people who dose not have sufficient knowledge about the software development. The MS-WindowsNT is implemented because that has a lot of application software suitable to equipment control and data presentation. And Active-X control provides so simple procedure to build up the control and presentation panel by employing Visual Basic, Delphi and Visual C++ *etc*. The panel development environment is basically the drag and put the Active-X component on the panel and edits the properties of that. And also the user procedure is related to the presentation software or the API functions dedicated directly to the hardware. By this environment, software development is easy to carry out without knowing any detail of the coding and implementation of the hardware.

2-1. Programmable Logic Controller (PLC) System.

The control modules of the magnet power supply for the beam transport line, between 40MeV LINAC and 500MeV booster ring, and for the connection line of two LINAC tanks are mainly replaced by employing the programmable logic controller (PLC)[2]. The magnet control does not need fast control but all the magnet control have the same procedure, like analogue/digital command/data to set or to read the output current and some sort of status. So that it is easy to unify the control procedure for the magnet control.

The PLC for the magnet control are the DAC, ADC and DIO modules. Digital Analogue Converter module is used for setting the current. Analogue Digital Converter modules is for read out the current. Digital In/Out modules are employing for setting some commands to the power supply such as On/Off, Reset *etc*., and some other status bits are read into it.

The PLC are installed into the distributed chassises and the chassises are connected each other by the commercial network named *SYSNET*, which is the optical fiber network having the transfer rate of 2Mbps. Figure 3 shows the fundamental layout of the PLC system.

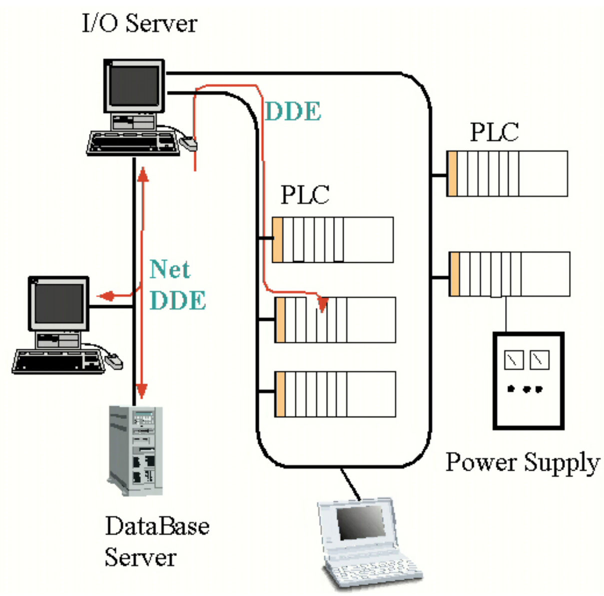

Figure 3. The PLC system configuration.

The IO access to the PLC module is written by the SCADA soft and which provides some kind of DLLs for the user application program. The application or the presentation panel software are developed by using the commercial software *InTouch*, in which the IO access to the PLC modules and packing those access program are automatically performed.

The control and presentation panels are easy to develop by dragging and putting the components on the frame. And the event procedure of each component is achieved by relating it to the stored *TAG*, which is the packed IO access described above. Figure 4 shows the typical PLC control panel on the main console desk.

Figure 4. PLC control panel.

The current assembling of the PLC modules is not providing the one to one correspondences to the power supply. For a power supply, DAC, ADC and DIO modules need to be installed. We are now developing a special dedicated PLC module for the power supply control. A single PLC module will be provided to a single power supply control.

2-2. Fast data acquisition system.

The other PC-based system is used for fast data acquisition. It needs to be acquired and logged not only the operational data of the accelerator equipment but also some beam related data to examine the machine physical condition. The operational data are still taken by VME. The PC-based system is providing mainly for the physical data acquisition, such as betatron tune meter and extraction kicker monitor *etc*.

The system is consisting of new developed modules, named *WE*[3]. The *WE* has a lot of modules such as DIO, DAC and digitizer *etc*., and all of those are installed in a powered chassis. The chassises are connected through an optical fiber network, *WE-NET*, which is designed to have the capability of 250Mbps data transfer. The attractive feature of this system is that the driver software for each module is already implemented in the module itself. And some kind of presentation panel is also implemented in it. The system provides plug and play architecture so that these driver and presentation panel software are automatically read out in the control system when the module is put into the chassis (figure 5).

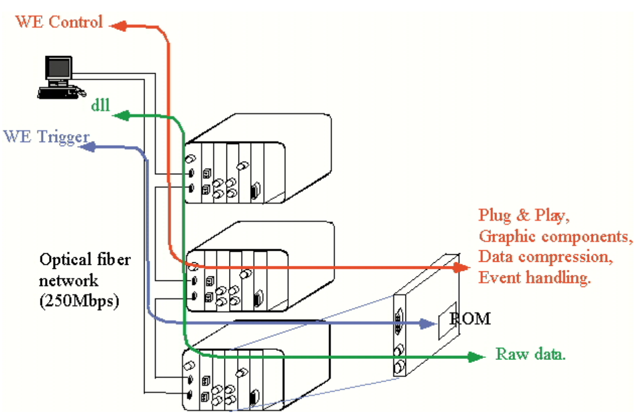

Figure 5. Fast data acquisition system.

The *WE-control* is a stand alone control system, which automatically recognizes the modules installed in the system and displays the control panel stored in the module on the console and also enables operator to access the module. In addition to that, application program interface (API) library is supplied and provides the access method directly to the module concerned.

The data in the *WE* module is automatically compressed so that it reduces the network traffics.

The first prototype of *WE* is installed for betatron oscillation monitor, in which white noise rf kicker is used to excite the transverse oscillation for the beam and spontaneous beam position is detected by the beam position monitor pick up[4]. The control and presentation panel was developed by MS-Delphi using the *WE API*, as shown in figure 6.

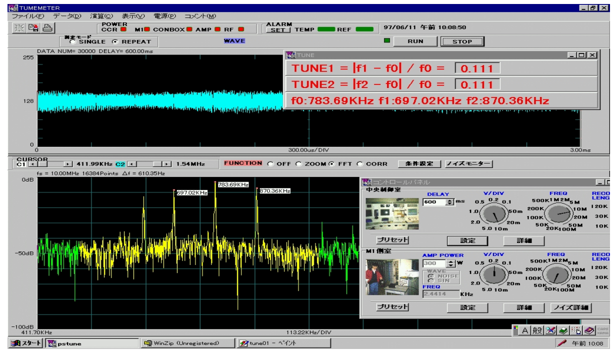

Figure 6. Tune meter control panel.

The other example of the *WE* system is the fast beam extraction kicker monitor shown in figure 7.

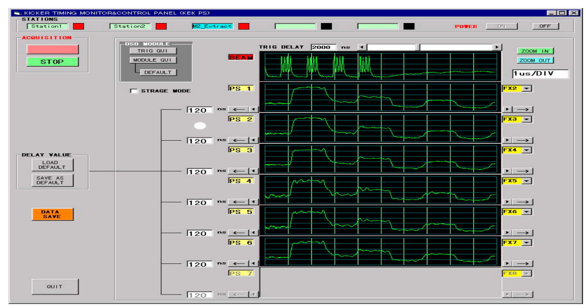

Figure 7. The control panel of the extraction kicker monitor.

The high performance of the *WE-NET* and data compression improve the refresh rate of the measurement, about five measurements in a second.

Now, the replacement of the KEK PS control system by PC-based system is now successfully undergoing. And full replacement including data base will be foreseen.

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