IMPROVEMENT OF PHOTON FACTORY ADVANCED RING CONTROL SYSTEM

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Abstract

As a part of the Photon Factory Advanced Ring (PF-AR) upgrading project, the control system is upgraded. Considering the importance to realize the seamless operation between PF-AR, injector linac and KEKB, we decided to adopt EPICS as a basis of the control system. The old control system of the PF-AR was based on the HIDIC mini-computer system and the CAMAC was used as a field-bus. In order to minimize the cost and the work of renewal, we didn't change the device interface layer below CAMAC. A total of 13 EPICS Input/Output controllers (IOCs) are used to replace HIDIC mini computers, and we use the VME modules such as CAMAC crate controller, GPIB interface and the timing synchronization module. The ARCNET driver modules are also used mainly for the control of magnet power supplies. For the archiving of accelerator parameters, we use Channel Archiver, which is one of the EPICS extensions. We have also renewed the accelerator safety control system using the PLC.

INTRODUCTION

The PF-AR, 6.5 GeV electron storage ring for pulsed X-rays, was originally constructed as an injection booster to TRISTAN main ring, and had also been used as a synchrotron radiation source during the intervals of injection to the TRISTAN. The upgrading project of PF-AR [1] which intended to reconstruct the ring as the SR light source was successfully finished as shown in these proceedings [2]. Replacement of the control system with the system reliable and easy for machine operation was the part of the project.

DESIGN CONCEPT

General Description

In the standard model of the accelerator control, the system can be classified into three layers: device interface layer, equipment control layer and presentation layer. Figure 1 show the old control system based on HIDIC mini-computer system which had been used as the TRISTAN control system [3]. In this system, device interface layer which consists of a large number of CAMAC modules were used for input/output signal processing. In order to minimize costs and works of the replacement, device interface layer under CAMAC had not been changed. Because the seamless operation between PF-AR, linac and KEKB is important, we adopt EPICS[4] to realize it. We replaced the HIDIC mini-computer system with EPICS Input/Output Controller (IOC). The equipment control layer and the presentation layer upgraded using today's standard technologies.

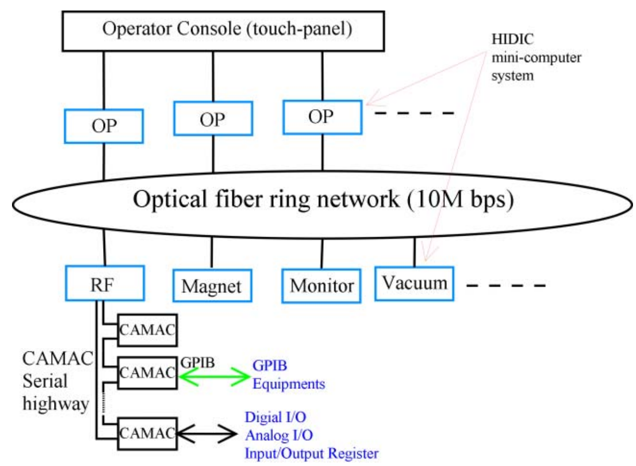

Figure 1: AR control system before the improvement (TRISTAN control system). "OP" denotes the HIDIC mini-computers for control of operator console.

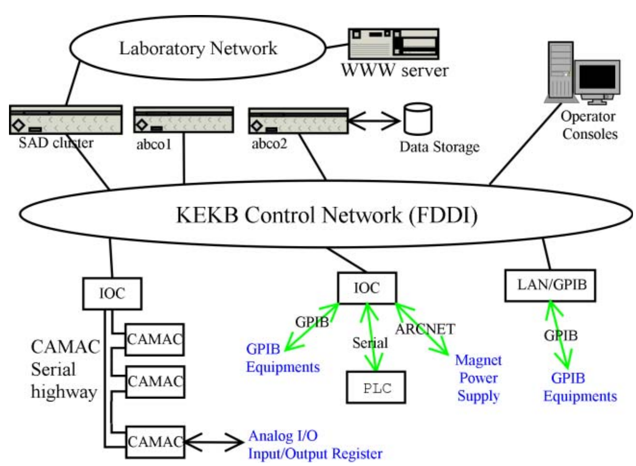

Figure 2: AR control system after the improvement.

Device Interface Layer

We use several kinds of field busses such as CAMAC, RS232, GPIB and ARCNET. The CAMAC modules are mainly used in many groups such as RF, Beam Transport (BT) and Beam Monitor (BM). In these groups, the existing CAMAC serial highway, which has a data transmission rate of 2.5Mbps, are fully used. Many kind of common CAMAC modules were developed for

TRISTAN. For example, we use ADC, DAC, status input gate (SIG), status output register (SOR) and input/output register (AIO). We did not create a new CAMAC module but only re-calibrate or repair the broken modules. ARCNET is used to control the magnet power supplies. We use the same power supply control interface module (PSICM) as KEKB[5].

Programmable logic controllers (PLCs) are used for vacuum control system[6] and for the accelerator safety interlock system. Status of PLC is transferred to the CPU board of EPICS IOC via RS232C. We don't control the PLC from IOC (read-only).

We need to control some GPIB equipments such as digital voltmeters, signal generators or oscilloscopes. In TRISTAN control system, CAMAC-GPIB board controlled the GPIB device. We decided not to use them. Mainly, we use VME-GPIB controller board (National Instruments, NI-1014) or LAN-GPIB interface (Agilent Technologies, E2050A). Driver and device support for EPICS was developed by BESSY[7].

Equipment Control Layer

The location of IOCs distribute at four sub control buildings and the main control building. A total of 13 IOCs are used for PF-AR and connected through FDDI network. Each IOC consists of VME subrack, CPU board (Power PC 750, 64MB memory), CAMAC Serial Driver(VSD 2992), remote access server module (Mitsubishi Electric, DRSJ-01), etc. Some IOC contains the GPIB interface board. Two IOCs for magnet control equip the event trigger module (EVR) which is used to synchronize the trigger of acceleration[8].

A new UNIX server workstation was installed for PF-AR, and the machine is also used for KEKB operation. The specification of the workstation is as follows: 2 CPU, 440MHz PA-8500 processor, 1GB memory, 36GB system disk, 100GB external RAID disk, HP-UX 11 operating system. On the other hand, the SAD [9] cluster machines are extensively used for the modelling or controlling of PF-AR. A number of software was already developed for KEKB operation. Some of them were used with a small modification for PF-AR operation.

Presentation Layer

We use X-terminal or its emulator for the operator consoles. There are eight personal computers (1GHz, Pentium III CPU), five of them are running on Linux operating system with dual-head display board, three of them are Windows 2000 machines with four-head display.

SOFTWARE

General

The TRISTAN control system used NODAL[10] and PCL[11] for software development. We decided to extract the data such information as cabling, however, we don't to translate any programs into new control system. Each working groups developed new programs for machine operation. In order to record the history of many files, we utilized CVS (Concurrent Versions System) for the management of software.

Although the most of the record types are already developed by EPICS community or KEKB, we must develop several new EPICS record. For example, we modify the existing KEKB BPM record to BPM-AR record. For Magnet control, we add some functions to the KEKB magnet record to support energy ramp-up for PF-AR operation.

EPICS runtime database is created by several methods. For example, database for BPM record is developed by a schematic editor Capfast and then converted to the EPICS database format. In many cases, simple database is written by text editor. Detail of the beam position measurement system is reported in ref. [12].

As for the presentation software, MEDM (Motif-based EPICS Display Manager) and the scripting software such as Python/Tkinter and SAD/Tkinter are mainly used. SAD[9] is a language for accelerator design developed at KEK. For the control of orbit measurement/correction, injection tuning, SAD is very effective because it equips an interface to EPICS channel access protocol. We can measure any accelerator parameters using SAD and can perform the calculation using it. On the other hand, Python language is also used for the application that does not require the lattice parameters.

Oracle database is used to store wiring information and property of magnet power supplies[13]. The data is extracted and converted to EPICS database.

Archive/Retrieval

We adopted the Channel Archiver[14], which is one of the EPICS extensions. The ArchiveEngine programs are running on HP-UX workstation, and almost 9000 records are always monitored and stored to the disk. Amount of daily archive depends on the status of machine operation. Roughly speaking, magnet group and RF group need 100MB/day, and another group is 10-30MB/day.

WWW

A dual Pentium III machine for the WWW server is working. The machine acts as a front-end of CGI interface of Channel Archiver. Due to the security reason, this machine can be accessed only from inside KEK. In order to show the operation status to the outside world, operation information is transferred to another web server machine periodically.

INTERLOCK SYSTEM

Radiation safety system of PF-AR is already built as a part of a KEKB safety system[15]. In order to manage the safety among the beamline safety system, KEKB safety system, linac beam trigger signal and the interlock signal from PF-AR operation system, we installed a new PLC (OMRON). In the old control system, this interlock was made up of many logical circuits installed in NIM modules, however, reliability of the decrepit system was not sufficient. We carefully check the logic and ported them to a new ladder program on the PLC. The block diagram of this accelerator safety system is shown in Fig.3.

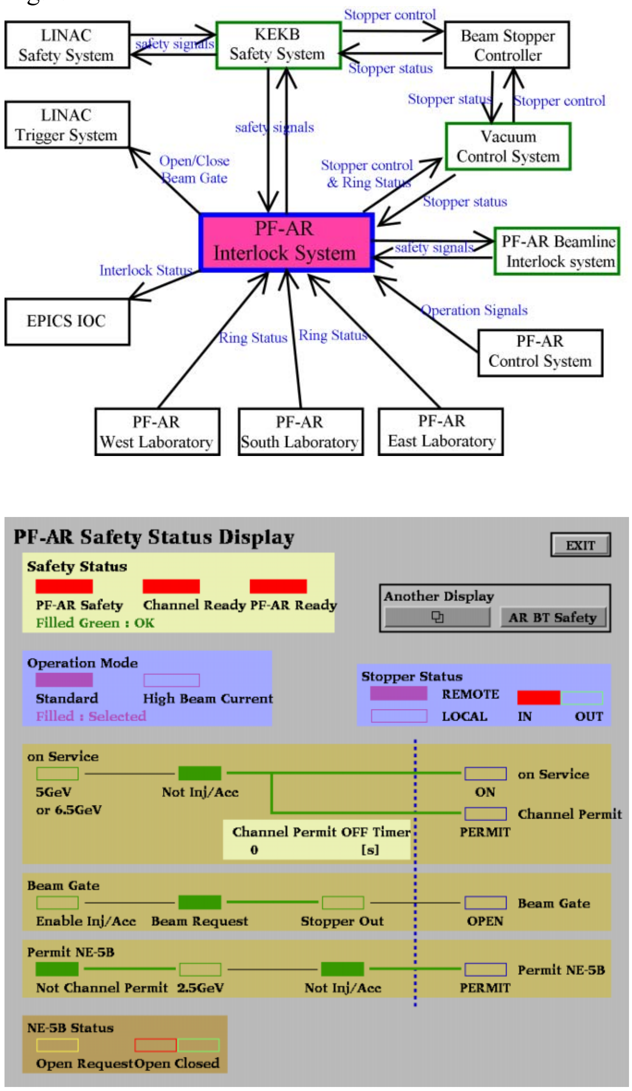

Figure 3: Block diagram of the PF-AR interlock system after the renewal(top) and the example of MEDM display panel(bottom).

SUMMARY AND FUTURE PLAN

Renewal of PF-AR control system was successfully finished. We continue the software development for the stable and reliable operation. Because one of the insertion device dose not have interface to EPICS based system, we are developing the software for them. This will start operation from the next user run period. Electronic notebook is also an important issue. We must develop more general interface for it.

ACKNOWLEDGEMENT

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