Beamline Control System

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Introduction

The beamline control system at SPring-8 supports a front-end (FE), a transport channel (TC) with various optics, an interlock system on a programmable logic controller (PLC) and an insertion device (ID). Consequently, beamline users are able to control all the beamline components through the beamline control system, for example the ID can be controlled by the beamline users independently of the storage ring (SR) operation. This has not been achieved either at ESRF or APS. In this writing, we give the basic design and the present outline of the beamline control system at SPring-8.

Basic Design

A beamline control system of synchrotron radiation facilities offers an interface between a SR control system and application researches carried out in the experimental station. At SPring-8, the IDs are considered as a part of the beamline, so the beamline users can use the gap of the ID as a tunable parameter. This is worth mentioning as one of the special characteristics of the third generation synchrotron radiation facility. At the same time, it becomes important that the safety and the reliability of the SR operation should be protected from an irregular operation from the beamline control system.

Recent progress of the network technology lets the beamline control system change to the new manners. All the information of the beamlines and the status of the SR should be available from any information-terminal.

Since the beamline control system handles very high energy synchrotron radiation photons, scrupulous attention should be paid for its design; the interlock system and the control system are requested to be highly safe and simple to operate. Furthermore, high flexibility and easy maintenance are demanded to the beamline control system.

Considering the points above mentioned, the basic concept is decided as follows:

(1) Synthesis of the interlock and the control system.

(2) Management of all the information through the network with high security.

(3) GUI-based applications united look & feel.

(4) Sophisticated software design with easy maintenance.

Hardware Components

1) Networks and computer systems

At SPring-8, the main target equipments of the beamline control system are an ID gap, beam shutters, a monochromator, mirrors and beamline slit components. These target equipments can be divide into two categories. One is concerning the interlock system for safety, such as beamshutters, vacuum gauges, cooling water temperature monitors and experimental hutch status. The other category is concerning a common control system, such as actuator controls and data acquisition systems.

The computer system of each beamline diverges from the FDDI node system distributed around the SR. We have three kinds of networks[1)] as shown in figure 1. First one is the SR-LAN for the SR control system, and second one is the User's-LAN for beamline users. These two networks are bridged by one workstation using two ethernet ports in order to defend the SR and beamline control systems. We have a plan to replace this workstation with a fire wall system. The third network is a PLC network, TOS-LINE, for the beamline interlock system.

In each beamline, there are mainly five components, BL-WS (HP9000 712/100), BL-VME (HP743rt), BL-X (IBM PC/AT compatible), ID-VME (HP 743rt) and PLC (Toshiba T3 series). To supervise all the PLCs, we use BL-Master-WS(HP9000 715/64) from the SR control room. This WS is connected to the PLCs by an exclusive and independent optical fiber network, using SIF Station module.

On the beamline, the network of the beamline control system is separated by the BL-WS with two ethernet ports. One is the SR-LAN, and the other is the BL-local-LAN, which is a private network inside each beamline. The BL-VME and the ID-VME are connected to the SR-LAN, and the BL-X, which
is an Windows-NT operation terminal for users, is connected to the port of the BL-local-LAN.

The beamline users can control all the components of their beamline from the BL-WS or the BL-X, and also they can operate the beamline components through a serial communication line of the BL-WS. This allows the users to perform automatic operation from any user's computer system with online software.

2) Data acquisition system

We adopted Tsuji Denshi PM16C series as a standard type pulse motor controller of the SPring-8 beamline control system. This controller has functional switches for local control and a GP-IB interface for remote control. As a GP-IB controller, we are using ELNIS EVME-GPIB21 VME boards to connect Pulse motor controllers, Potentiometer controllers, Piezo controllers and other GP-IB modules. VMIC VMIVME-3122 and HSC HIMV-602A are employed as a ADC and a DIO VME board respectively. X-ray Beam Position Monitors (xBPMs) are measured by the ADC with 16-bit digitizing resolution at a rate of 100kHz. In the near future, we will be able to support a high speed feed back system, which stabilizes the X-ray beam position using the ID steering magnets.

The ID control system of SPring-8 is fairly different from those of ESRF and APS from several reasons. The manufacturer of the mechanical part of the IDs prefers that the gap related operation, such as a motor, an encoder, limit switches (LS), can be done without a PC or use of keyboard. Therefore, we decided to employ a gap controller unit (Tsuji Denshi, Inc., GPC series), which includes a stepping motor controller, an encoder reader and LS inputs with a GP-IB interface. With this unit, the ID gap can be opened manually in case of a VME unit malfunction. A stand-alone data acquisition unit (YOKOGAWA DA100), with a GP-IB interface, has been chosen to monitor the temperatures of a standard SPring-8 in-vacuum ID that has 32 thermocouples.

All of the beamline interlock system is constructed by hardwired relays or PLC interlock modules. Any software on WS or VME dose not intervene in the interlock sequence for human safety.

Software Framework

Kernel software[2), 3)] of the beamline control system is designed by the SPring-8 SR control group. It has a client/server architecture in order to keep stiffness of the system. On the beamline, however, we have an additional and special software frame to serve command requests from the beamline users' control system at the experimental station. Figure 2 shows the software structure of the beamline control system with the command request server on the GUI layer.

Since, all the components on the beamline should be controlled easily, Graphical User Interfaces (GUI) and similar Look&Feel interfaces are demanded for application software of each component. We are using a commercial GUI builder, X-Mate, for developing the application software with operator interfaces.

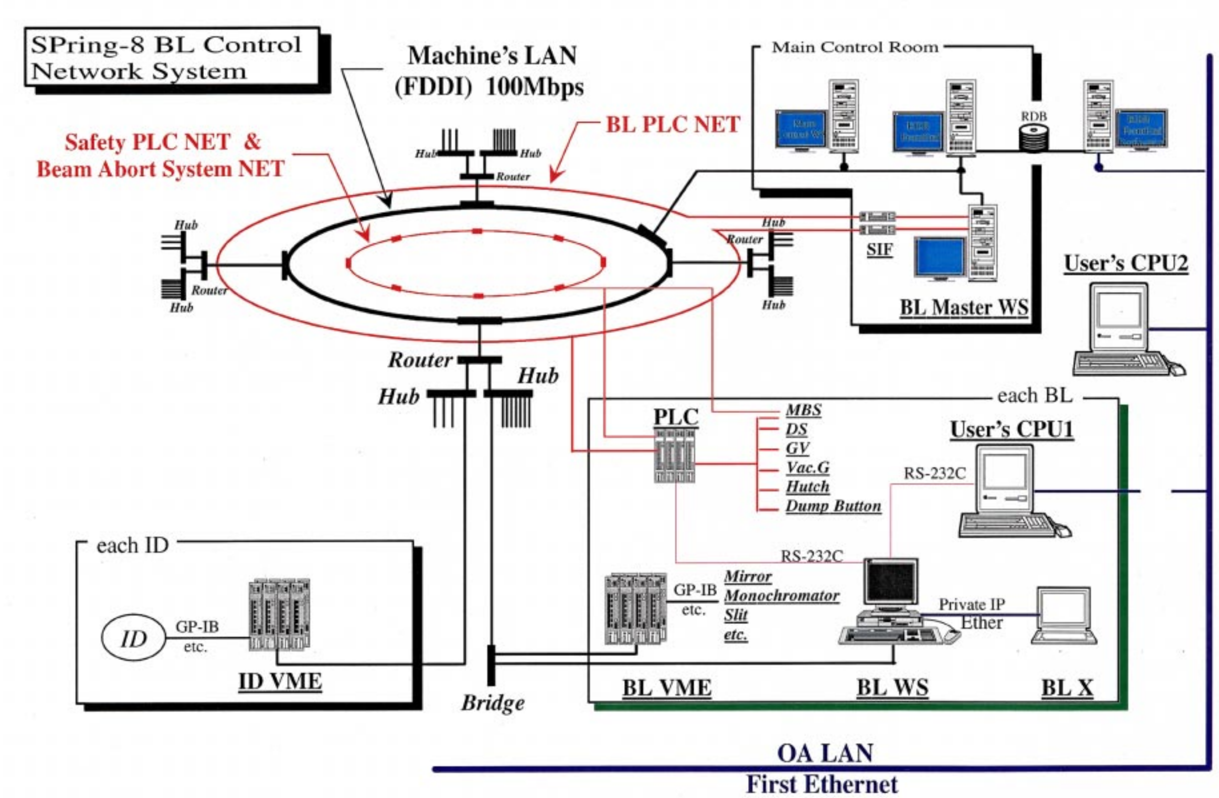

Figure 1: Schematic diagram of beamline networks.

We are planning to introduce a relational database management system (RDBMS) for the information control of all beamline status, vacuum, temperature, and other signals. The conceptual design of the database system has started. In the future, everyone can peruse all beamline information at any place.

Conclusion

The first version of the beamline control system has been tested at two commissioning beamlines, BL02B1 and BL47XU. In spite of limited resources, our system is highly functional and operated quite stably. However, because of many GP-IB modules, the system is scarce of some performance such as speed. Therefore, a future upgrade is inevitable in order to improve system speed. Now, we are planning to make a second version system with less GP-IB modules.

References

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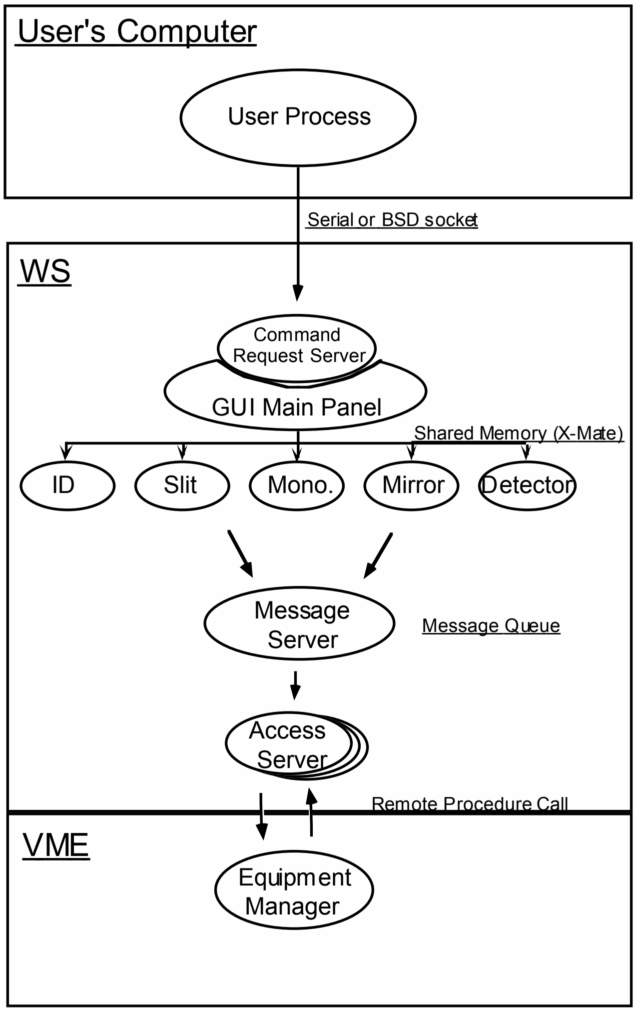

Figure 2 : Software framework of the beamline control system.