Control System

Ryotaro TANAKA
Toru FUKUI
Yoichi HIRAMATSU
Yuichi ITOH
Naoyasu HOSODA
Kazuo KOBAYASHI
Masahiko KODERA
Takemasa MASUDA
Yoshinori NISHINO
Yasunao SAKAKI
Atsushi TAKETANI
Akihiro YAMASHITA
Takeshi WADA

1. Introduction

At the beginning of this year, construction of the control system of the storage ring finished, and the system was exposed to actual accelerator operation. The control system worked well during beam commissioning of the storage ring. The fast start up of the control system and its stability was good enough to perform smooth SR commissioning and overall performance of controllability was satisfactory.[1]

An accelerator downtime caused by the control system was less than two days; mainly resulting from hardware troubles associated with the network LAN switch and the database server disk. The client/server software scheme has proved to be robust and it was possible to localize the system trouble. Built-in redundancy prevents any serious breakdown of the system and no major failure has been caused by the control software.

2. Front-end electronics system

2.1 VME System

VME systems, distributed around the storage ring, are working well to control accelerator devices. But there have been some hardware troubles related to Remote Input/Output fieldbus system (RIO), namely several type-A slave cards and one master card. For the diagnostics of faults and operation logging, static RAM (SRAM) boards of the VME provided a useful way to trace the operation sequence.

The way of booting an operating system (HP-RT) was changed from a network boot server to a local PCMCIA flash disk. Because the flash disk is a local read-only device, the system becomes more reliable and faster to boot up.

The start up of three server processes on the VME system, namely the Equipment Manager (EM), the Collector Server (CS) and the Time Adjustment Server (TAS), were changed to start automatically in the booting up sequence. The operation stability of the EM of the RF system became more stable after diagnostic efforts to improve the GPIB lock/unlock mechanism. An Equipment Manager Agent (EMA), providing faster control software than the EM, was employed as the feedback software during the ramping up of the klystron power.[2] The EMA also worked as a fast looping software to set the beam bucket numbers at successive injections. These are working well on the local VME system and much faster than remote access over the network.

We integrated GPIB raw commands into the SR control framework to facilitate temporary measurements and device diagnostics. It is possible to control and obtain data from measurement equipment with X-window applications. For example, the control software of the spectrum analyzer is often used for machine studies.

The local time of each computer is adjusted through the TAS scheme. One of the operator consoles in the control room is assigned as the master clock, and it plays a role as the Time Adjustment Client (TAC). All clocks in workstations and VME CPUs are synchronized with the master clock to within 10msec through communication between the TAC and TASs.

2.2 Data acquisition system

The Poller and Collector system for periodically taking data from accelerator equipment has been working well.[3] The Pollers are taking data at intervals of between 1 and 60 seconds, according to equipment response time. Data are taken and stored to the ring buffer. CSs send data taken by the Pollers to the Collector Clients(CCs). CCs store all data from the CSs on the database at intervals ranging between 1 and 60 seconds. Beam current data are stored every second, while the slower 60-second cycle is used for monitoring water temperature and so on. The Pollers run with a lower priority than the EMs because the EM should immediately execute actions according to commands initiated by the operators. To avoid deadlock, whenever the Poller starts to take data from GPIB it changes its priority to the same level as of the EM.

3. Network

The accelerator control network was modified during the 1997 summer shutdown.[4] The IP address for the accelerator control network moved to a private address that allows for internal use only and prevents Internet access. A firewall system was installed to protect the accelerator control system from undesirable access through the laboratory public LAN (user LAN). In order to access the logging data and develop the accelerator control program, a NFS file server, a Web server and a secondary database server were included in the firewall protected network. The firewall system allows network traffic from the user LAN to the servers, or from the accelerator control network to the servers; but not from the user LAN to the accelerator control network. The firewall allows on-site staffs to access logging data via Web browsers or through database access libraries, but prevents control of the accelerator. This configuration is working well and the firewall system has adequate network throughput.

4. Database system

4.1 Database system

A relational database system (SYBASE system 11 server) stores almost all of the data required for storage ring operation.[5] It served data from the beginning of commissioning of the SR to the end of year with few troubles. The database stored not only equipment parameters, but also a large amount of SR logging data. The volume of logging data had exceeded 10GBytes by the end of 1997. At that time, the number of data points recorded in a data taking cycle had increased from 3995 to 4625, without causing any observable performance deterioration. This was a clear demonstration of the expandability and flexibility of the database system.

4.2 Data access

Machine physicists, equipment specialists and operators can access the database in two ways. One is to use a set of functions that are called from their own applications written in C language. The other is to use a Web browser, such as the Netscape communicator. Common gateway interface (cgi) programs provide easy data access for every computer on site. Figure 1 shows an example of browsing data.

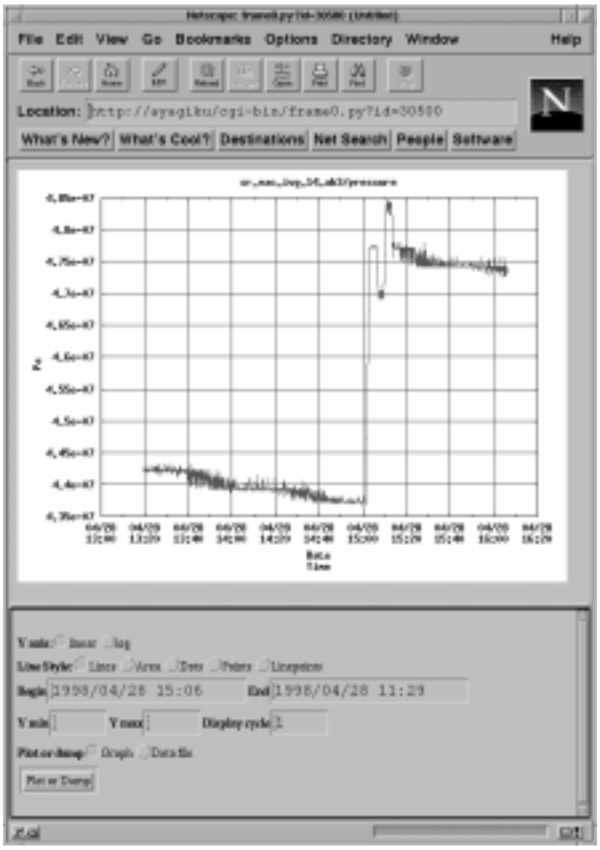

FIG. 1 An example of data browsing using Netscape. The data are taken by sending SQL commands to the database via cgi.

4.3 Plans

The database system was developed for the SR control, however we begin to apply it to other control systems in the SPring-8 facility. During the next year, there are plans to use them to other accelerators, including the SPring-8 synchrotron and New SUBARU. A SYBASE system 11.5, on a Hewlett-Packard J220 two CPU workstation with 512MBytes memory managed the system during the year. This will be upgraded next year to a HP K250 4CPU with 2GBytes memory in order to meet the increasing demand for the data storage.

5. Alarm

The alarm system was built as a database client and comprises a watch, display and voice alarm.[6] These are independent applications that communicate only with the database system. Watch applications read the status of equipment from the on-line database and compare them to threshold or reference data retrieved from the parameter database. When an alarm occurs, the application writes the alarm status onto the on-line database. The display application reads the alarm status written in the on-line database and displays the warning(s) on console screens. An artificial human voice alarm application warns when a severe alarm signal is being written on the database. The alarm watch application records an alarm history on the archive database, listing when it occurred and when it ended, together with details of alarm status.

These alarm applications constructed independently around the database system provided easy development, maintenance and expansion. For example, we added cgi programs to view alarm status and history using Web browsers, in addition to a dedicated display application written in C language for the X window system.

The system recorded 403109 alarms during the year. Users can easily access each entry with search keys such as signal name, begin time, and end time through the alarm applications.

6. Beamline control

6.1 Beamline control system

The beamline control system has been constructed with the same architecture as that of the storage ring control system. It consists of one UNIX workstation and two VMEbus systems. These are connected to the FDDI accelerator network via routers. An interlock system, built with the Programmable Logic Control unit (PLC), guarantees human safety and equipment protection.

Network interconnection between the accelerator and beamline computers allows user operation of insertion devices (IDs). After ID commissioning, beamline users can operate IDs by getting a grant from the accelerator operator if orbit distortion of electron beams caused by the gap operation is negligible. For some beamlines, independent operation of IDs by beamline users was performed.

6.2 Beamline database

The Poller and Collector system has also been installed in the beamlines. Data from the ID system and X-ray transport system are taken at 10sec intervals and stored in the machine database in the same way as in the accelerators. Machine physicists can perform off-line correlation analysis by comparing ID gap data with closed orbit distortion (COD), and so on. The common data access method is advantageous for such purposes.

References

[1] R. Tanaka et al., "The first operation of control system at the SPring-8 storage ring", Proc. of ICALEPCS'97, Beijing, China, 1997.

[2] A. Taketani et al., "Medium-speed feedback software based on the existing control system", Proc of ICALEPCS'97, Beijing, China, 1997.

[3] A. Taketani et al., "Data Acquisition System with Database at the SPring-8 Storage Ring", Proc of ICALEPCS'97, Beijing, China, 1997.

[4] T. Fukui et al., "Design and performance of the network system for the storage ring control at SPring-8", Proc of ICALEPCS'97, Beijing, China, 1997.

[5] A. Yamashita et al., "The database system for the SPring-8 storage ring control", Proc of ICALEPCS'97, Beijing, China, 1997.

[6] A. Yamashita et al., "The Alarm System for the SPring-8 Storage Ring", Proc of ICALEPCS'97, Beijing, China, 1997.