Control System

1. Status

Since user experiments has been started, there was no accelerator downtime caused by control system failure. The control system was stable enough to keep high availability of the experimental time for the synchrotron radiation users. After meeting the basic demands of the control system, most of the effort was devoted toward improvement of usability of networks, database utilization, temporary data taking, and centralization of accelerator control systems.

In this year, one of the major improvements in the control system was made by focusing on the integration of the existing control systems into the central controls in order to realize more transparent operation of SPring-8 accelerators. In particular, the booster synchrotron control system was successfully integrated into the central control system by replacing a part of its original system with the SPring-8 standard control system.

Improving the usability of the beamline network for experimental users was also one of the major works this year. The configuration of the beamline users' LAN was upgraded to allow on-line experimental data transfer from the experimental hall to the off-site users' home institutes. The new network architecture became available by introducing firewall technology with adequate security performance.

2. Integration of Booster Synchrotron Control System

Since December 1996, booster synchrotron in SPring-8 has been in operation with the control system built on five DEC workstations running Open VMS and 14 VMEs with Motorola MVME 147SA-1 CPUs running OS-9 [1]. It was developed and implemented independently of the storage ring control system. The system successfully performed operation of the synchrotron during the commissioning phase and subsequent steady operation. However, tighter integration with the storage ring control system was requested for the needs of future development and transparent operation of the accelerators. It was decided to integrate the present synchrotron control system with the storage ring system [2]. The synchrotron control system was successfully integrated by replacing all CPU boards with HP9000/743rt boards and installing the newly developed control software based on the same architecture of the storage ring. A database and alarm system were also newly installed in the system. We kept the existing VME I/O cards and low-end equipment controllers. Making these replacements started in February 1998, the new control system began to operate in January 1999. During the replacement and test stages, interference to the accelerator operation was minimized to a negligible amount and no user experiments were interrupted.

3. Front End Electronics Systems

3.1 Development of Field Controllers

After machine operation started, requirements for temporary measurements and controls began to increase. These included measurements of cooling water temperature, temperature of RF-fingers in beam pipes and so on. In order to meet the demands, we introduced three types of systems: portable VME controllers and PC-based controllers [3] as well as the simple network-based data taking device called Smartlink systems. Each system needed to be inexpensive so that it could distribute around any place of the storage ring. In addition, a portable VME controller consisting of an 8-slot VME chassis and a HP9000/743rt CPU were used in ordinary devices control. This controller system was applied to control the temporary vacuum operation. However, the VME system was too expensive to use as the temporary controller, so we introduced rather inexpensive PCs with a free PC-UNIX operating system (Linux) as the supplementary system of the VME. We succeeded in migrating our control software running on the HP-RT to Linux. We also developed some device drivers for ISAbus I/O boards.

3.2 Applications

The PC controllers were applied to the temperature measurements of magnet cooling water, CATV switch and GPIB device controls flexibly. They were working quite well. The SmartLink systems, which can be directly linked by Ethernet, were introduced in order to measure the temperature at higher resolution than a VME AI read-out. Because they are quite compact, they can be installed in a small space, which is not possible with the VME or PC system. The data from the SmartLink was collected with a socket program in the Equipment Manager (EM) running on a HP workstation. This system is compact enough, but it currently has stability problems.

Because the PC controller with an Intel CPU had different byte ordering (endian) from the HP9000/743rt and HP workstations, we prepared a target- independent version of the poller/collector RPC-based data acquisition software. The new version was successfully applied to the data acquisition system including the PC controllers. In previous poller/collector software, the raw binary data from the VMEs were collected and sent to HP workstations with better performance than the current collector software. However, the deterioration of the performance over the network was found to be negligibly small.

4. Network

Until summer 1998, the accelerator control network consisted of three segments, and a router was routing packets between each segment. Because of the integration of the booster synchrotron control system with the SPring-8 control system, we changed the network configuration to achieve higher traffic throughput over the network. One change was replacing the router with switching HUBs. The switching HUB provided much more bandwidth than the router by a factor of about 7. Another change was modification of the network configuration from segmented domain to single domain to eliminate the routing overhead. To avoid electrical interference, we replaced all Ethernet yellow cables with optical fibers for the booster synchrotron.

For better operability of the accelerators from the central control room, we installed a video system between the central control room and the injector control room. Thirteen video signals from the injector control room were connected to a video matrix switch which provided the video signal to five video monitors on operator consoles. The operator can select any combination of signals to display on any monitor.

5. Database Development

The database initially developed for managing data for the storage ring grew to store the data for beamlines, synchrotron and New SUBARU. The number of data increased from 4,600 points to 9,500 points, and the size of the archive database was expanded from 10 GB to 26 GB in 1998. The injector synchrotron and New SUBARU were successfully placed under management of the database management system. A total of 209 tables and corresponding functions were added as routine work to the database system for those machines.

To serve many demands, the server machine was successfully changed from a Hewlett-Packard J220 two-CPU machine to a K250 four-CPU machine of the same manufacturer. The relational database management system, Sybase ASE 11.5, served with no downtime during storage ring operation. An additional database server for spare and off-line use was also replaced by a K260 four-CPU machine. This machine provides web services to indicate both current machine status like stored beam current and beam lifetime. Furthermore very detailed individual equipment information is also provided to the web clients distributed in the SPring-8 site. The web server responds to about 100,000 accesses a day on average.

In addition to numerical data, *i.e.* machine logging data and machine parameters, the database system has begun to manage non-numerical data for SPring-8. A machine operation shift table and daily meeting record was the first trial. Shift leaders receives an E-mail advance notice from the database machine a day before their work is scheduled. Everybody at SPring-8 can check the daily operation meeting records managed by the database with WWW browsers. We are planning to expand this system to the entire document management workload required for the accelerator operation.

6. Beamline Control

6.1 Interlock System

In this year, eight new beamlines were constructed: BL24XU, BL27SU, BL11XU, BL16XU, BL16B2, BL29XU, BL20B2 and BL46XU. Because some of these beamlines had special features such as multi-branch, which had 2 or 3 experimental stations, and medium-length beamline over 200 m, we changed the configuration of the control system to maintain consistency among the beamlines. One of the changes was improvement of the beamline interlock system (BLIS). For the new beamlines, the BLIS had to handle a larger amount of data for the interlock status than for the prior beamlines. We improved the framework of the BLIS to meet this demand and to prepare for further expandability.

The communication protocol TCP/IP on Ethernet was adopted for the data acquisition from the BLIS instead of the old TOS-LINE PLC network. The interlock network architecture was also changed from a ring layout to the star topology because the latter was robust against network failure. The BLIS status of beamlines was taken independently of each other to support independent connection/disconnection of each interlock subsystem. Another change was installation of the new rfBPM interlock system for insertion devices. The rfBPM interlock system consisted of modules of beam position alarm (BPA), gap alarm (GAPA) and optical bus that connected each GAPA. The new interlock system was monitoring the electron beam orbit near the insertion devices in the storage ring. Whenever the electron beams shifted from the normal position, GAPA could abort the stored beam immediately.

6.2 Beamline Users Network

The configuration of the beamline network was also changed by introducing firewall technology to protect network security of the beamline. At this time, there are two networks for experimental users. One is a BL-USER-LAN, which is protected by the firewall system in the experimental hall. The other is a laboratory public OA-LAN, which is connected to the internet directly via a router. This year, firewall systems were installed to interconnect the BL-USER-LAN and the OA-LAN. This established both security and usability such that beamline users could control beamline equipment safely or send out experimental data to off-site home institutes on-line via the network. The system was found to be flexible enough for imposing any suitable rule, secure enough, and satisfactory in performance. We installed a security policy that allows no access to the protected network from outside of the laboratory.

6.3 Server Software

A server process on the beamline control workstation, command interpreter (CI), was newly introduced to the control software framework of the SPring-8 storage ring. It was useful for the operation of either complicated components, such as monochorometers or several types of equipment at once. A compound SVOC message issued from the user's machine or operation GUI was translated and decomposed to primitive SVOC messages in CI, and then those messages were sequentially passed to AS according to the control sequence. Consequently, the CI could reduce the number of primitive SVOC messages sent from the user machine. In this framework, the software overhead due to network communication was substantially reduced and the performance of communication throughput between the user machine and the control workstation was improved remarkably.

References

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