Operation Experiences and Development of the Control System in the SRRC

Jenny Chen, C. H. Kuo, K.T. Hsu, K. K. Lin, C. J. Wang,
J. S. Chen, C. S. Chen, K. T. Pan, K. H. Hu, C. C. Kuo, R. Sah
Synchrotron Radiation Research Center
No. 1 R&D Road VI, Hsinchu Science-Based Industrial Park, Hsinchu, Taiwan

Abstract

The control system of the SRRC is a two-level system. Console level computers consist of workstations and PCs. The device levels consist of VME based embedded systems. PC based system are also used for some device level applications. The console level operating system is VMS. DEC UNIX and WindowsNT will come soon. Devices level supports pSOS+, LynxOS, and WindowsNT. Most of the software components was development in-house. Integrated commercial software packages are also used. Web and Java for control related applications is under way. Device level systems have been ported to PowerPC based VME CPU modules running LynxOS of the control network has been changed to switched ethernet using fast as well as standard ethernet. Sophisticated electronic instruments are connected to the control system via IEEE-488 to ethernet adapter. A project to integrate the control of turn-key injector with main control system has been initiated recently. Achieving a seamless integration with limited resources is highly desirable. The operation experience and development of the SRRC control system will be summarized in this report.

1 Introduction

The control system of the storage ring of the SRRC (Taiwan Light Source, TLS) is a typical medium scale experimental physics control system in operation since its commissioning in 1993. The system is an example of the standard model. The system is still growing due to new devices installed on the accelerator system. There are some good as well as bad points of the system. Upgrade activities initiated since late 1996 use up-to-date technology to accommodate more devices and increase performance requirement. Details of upgrade activities are described below.

2 Early control environment and its operation experiences

SRRC control system is a two-level hierarchical system [1]. The upper layer consists of one server computer and several console workstations. The console workstations are the user interface. The lower layer consists of many field level controllers (VME crates system) which perform local data acquisition, interlock generation and carry out devices control requests from the workstations or server. The console level computers are VAX/VMS based and the lower layer are 68K/pSOS+ VME crates. The networking system is a standard thick/thin wire ethernet.

The system has been operated since the early commissioning of TLS nearly five years ago. The satisfaction level was gradually decreasing due to out-of-date computers and increased performance requirements. The numerous controlled devices have increased two-fold since the dedication. Response time is too slow, network congestion is increasing. Mass storage spaces is inadequate and latency in control applications are the typical symptoms of the existed control system.

3 New control system environments

The new control environment includes upgrades to the following: console level computer, VME crates, network, and application software development.

3.1 Console level computer development

Many new I/O channels are needed for the new devices being installed in the storage ring. Sophisticated applications are consuming more computer resources. History archive data is increasing steadily. Existing server computer and workstations are heavy loaded. To eliminate the degraded the server performance, upgrade activities are in progress since mid-1996.

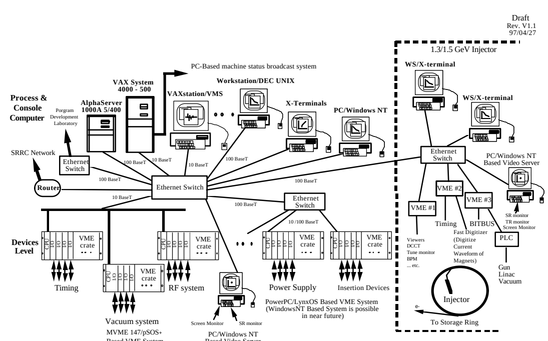

Figure 1. Control Hardware Architecture

Key software components of the control system on the workstations were ported to Digital UNIX at early of 1996. A new high performance entry-level DECserver 1000A 5/400 was installed in May 1997. The server provides more horse power and large mass storage space. A new 41.6 GB optical disk cartridge was installed at same time. The optical disk system provides at least 2 years of on-line archive data retrieve capability. New generation workstations will replace old machines to improve the response time and support more sophisticated application programs. The new server and workstations for control system are expected to replace out-of-date computers (most of these machines are five years old). The control system also supports PC solutions. PC/WindowsNT system has been in service since June 1997. The PC/WindowsNT consoles provides a similar GUI environment for the machine operation with low cost. PC/WindowsNT/Windows95 are also used in some devices level applications. For example, video applications for screen monitors and synchrotron radiation monitors will be done by PC/WindowsNT/Windows95 environments. Applying the PC/WindowsNT environment to accelerator related control is high receiving attention by the control community. The development effort will continue in order to keep up-to-date with the pace of technology advance.

3.2 VME crates system development

There are 25 VME crates system in service now. Several new VME crates system will be installed in the coming year in conjunction with the upgrade activities of the accelerator system. The old VME crate system is based upon MVME-147 CPU module running pSOS+ real-time kernel. The development environment is on the VAX/VMS workstation. To increase productivity, save manpower, improve system performance, and keep up-to-date, PowerPC CPU module and real-time UNIX were choose to use in the new VME environment. The current system has 8 nodes in MVME-147/pSOS+ environment. The remaining system is using the PowerPC/LynxOS environments. New VME crate systems to be implemented in the coming year includes U9 control, EPU control, 3rd RF systems, Landau cavity project, BTS diagnostics, several nodes for photon BPM (PBPM) front-end data acquisition, and several nodes for injector control integration.

3.3 Control network upgrade

Traffic on the control ethernet consumes about 30% of the network bandwidth 10 Mbits/sec. Load is expected to increase steadily. Topology of the control network was changed to switched ethernet on October 1996. The new control network infrastructure supports standard and fast ethernet connections. The backbone was changed to 100 Mbits/sec ethernet last November. The performance has improved drastically. Reliability of the control network is also highly improved. The new control network is operating very well. There is no downtime of the accelerator system due to network problems.

3.4 GPIB-ENET connected devices

For complex instruments, such as spectrum analyzers, connection to the control system is made by using GPIB-ENET adapters. NI-488.2M software installed on workstation is used to drive these instruments. Applications on workstation can access every accelerator device that is connected with the VME crates or GPIB-ENET. At presentation layer, UIM/X graphical user interface builder was used to develop applications.

3.5 Software and application development

The control software environment is almost same as previous system as shown in Figure 3 [1] but with some enhancements. The major difference is this environment working on different platforms and operating systems. The new system supports new software components including newly developed applications and commercial products. Typical commercial products include PVwave, LabView, ... etc.

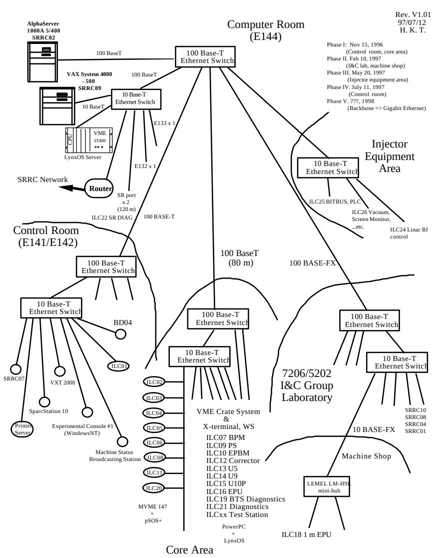

Figure 2. Networking Topology of the Control System

4 Control related developments

In addition to control infrastructure changes, a lot of control related development [2,3,4,5,6] is under way. Here are several examples.

4.1 Tune measurement

The tune measurement system is currently using a HP4396A spectrum/network analyzer to acquire spectrum information from the beam signal. The spectrum analyzer is connected to control system via a GPIB-ENET adapter. The tune measurement program is able to issue commands to drive the spectrum analyzer with the aid of NI488.2M library. Parameters setting is done via the operator interface. The parameters include frequency scanning range, beam excitation enable/disable, power level controlling, ... etc. New tune measurements using digital receiver technologies is under development.

4.2 Orbit display utilities

Orbit display is required during both routine operation and machine studies. A bar chart display of beam position monitor (BPM) readings has been in service since storage

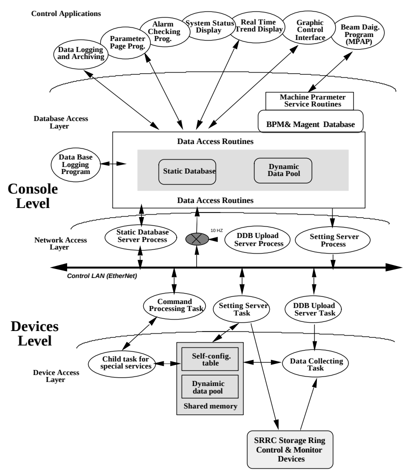

Figure 3. Control System Software Structure

ring commissioning. As machine study activities increases the ability to measure orbit changes as machine parameters are varied is desired. Since there are a lot of requirements for orbit display, a real-time display utility was developed. The utility provides display of absolute and difference orbits. Color grading display will be supported in new versions. The line style can be dot line and line-dot. Data averaging is also supported by the package. The updating period without any average is less than 0.5 sec.

4.3 Lattice function measurement tools

Lattice function information is very important for machine optimization especially for low emittance ring. Measuring the lattice function is the tedious work without automation. In order to solve this problem, tools to support lattice function measurement have been developed. The package provides beta function, dispersion function, beta function, and chromaticity measurement. The measured raw data as well as processed data can be save for later use.

4.4 Filling pattern measurement

The filling pattern plays a crucial role in the performance of the accelerator system due to the effect of coupled-bunch instabilities. A real-time filling pattern diagnostic tool is being developed. The system is composed of a VMEbus 500 MHz digitizer using an external clock from the master oscillator. The signal picked up by the stripline electrode is digitized by the fast ADC. Each data value is proportional to the amount of charge accumulated in the corresponding bunch. The data is then sent to a workstation to display the filling pattern and for other uses.

4.5 Orbit feedback development

A digital global beam position feedback system has been in operating since August 1996 [3,4]. The present system includes several VME crate systems, orbit acquisition, corrector control, and photon beam position monitor (PBPM) data acquisition. These crates share orbit information via a VMEbus reflective memory network. Orbit acquisition VME crate systems are PowerPC/ LynxOS based and use a high speed CPU engine (200 Mhz PowerPC) to support various operation modes. The orbit sampling rate is currently 1 kHz. The corrector control VME crate is also a PowerPC/LynxOS system. The feedback DSP modules are located on the corrector crate. Current efforts are to improve the performance of the feedback loops and to study control algorithm improvement. Local orbit feedback using electron beam position monitors (EBPM) as well as PBPM is under intensive test. Efforts will continue on improving the EBPM performance, PBPM integration, and loop performance of the local feedback.

4.6 Control system web development

A web server has been available since late of last year (http://www-icg.srrc.gov.tw). The light source web provides a real-time machine status display, limited control access on machine devices, and browsing on archiving data. Web access to the on line log book will be available in the near future. Applied Java technology for the control system is also in progress.

4.7 Insertion devices control

Control for insertion devices (ID) has been redone and now ID components connect to VME crate directly [6]. Clean and simple structures reduce control overhead as well as reduce response time. The new ID control infrastructure was tested with in-house ID engineering model ID (1 meter APU and 2 meter U10P). The control structure also will be used for U9 system which was contract to STI Optronics.

A one meter EPU engineering model is being implemented. The control effort is focused on system integration and motion control loop performance improvements. The phase of EPU should precisely control position. The tracking during phase change scenario is also important. Ensuring good tracking of different magnets during phase change is an important issue. The four meter EPU5.6 project has started recently. Control design and implementation are under way. Control system integration is expected to finish on April 1998.

5 Control integration for the injector system

The injector of the SRRC composed a 50 MeV linac and a 1.3 GeV electron booster. The injector system orginialy is an turn-key system with a separate control system. It is not convenient from maintenance and operation point of view. The injector control integration plan has been launch. The goals are to integrate injector control system with the TLS control system as a unified system. The existing control system consists a Bitbus network and one PLC to access devices of the injector. Both device level systems are connected to a PC working in iRMX III environments. A VAXstation uses as control control console.

The new system will replace the VAXstation and iRMX system with the console computers of the main control system and several VME crates as shown in Figure 1. The integration will be done while the injector is in standby mode after every TLS fill. This will minimize interference with the normal operation of the machine. The project is expected to be finished before the end of 1998.

6 Summary

The control system of TLS has five years of operation experience. Improving performance gradually under shrinking budgets and reduced manpower is a challenge. New development will use mature commercial products.

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