EPICS AT NSRL

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Abstract

HLS (Hefei Light Source) at NSRL (National Synchrotron Radiation Lab) consists of three parts, 200Mev Linac, transport line and 800Mev storage ring. The control system is based on EPICS (Experimental Physics and Industrial Control system). In this system, PC-based hardware is widely used for front-end controllers(FDC), Input/Output Controllers (IOC) and Operator Interfaces (OPI). A number of Programmable Logic Controllers (PLC) and SUN workstations are also used in the control system. This paper will cover the experience of using PC-based hardware under EPICS, the field bus used in HLS control system, data archiving, communication, and some analysis tools for physics and operation use.

1 INTRODUCTION

HLS is a second-generation dedicated light source. It is composed of a 200 MeV linac, a beam transport line, and an 800 MeV electron storage ring. As a part of NSRL phase II project, the upgrade of HLS control system began from the end of 1997 [1].

The new control system is upgraded based on EPICS following the standard model. For practical and economic reason, a large number IPCs are used as OPI, IOC and FDC. The system includes the following subsystems:

- ring main magnet power supply control and monitoring.
- ring correctors magnet power supply control and monitoring.
- linac and transport line magnet power control and monitoring.
- ring injection control and monitoring.
- flag control and monitoring .
- vacuum monitoring.
- water system.
- radiation safety monitoring.
- RF cavity control and monitoring.
- closed orbit feedback system.
- beam measurement system.

2 HARDWARE

Figure 1 gives an overview of new HLS control system hardware structure. Two SUN workstations and several PCs with Linux operating system are used as OPIs. SUN workstations are mainly used to control and monitor main PSs and other key subsystems. A SUN E250 server is used for running history database manager including data archiver and a relational database manager (RDM). It is also used for network management.

IPC is used as IOC in most subsystems. IOCs communicate with FDCs via opto-coupled RS422/485, RS232 over optical fiber, CAN bus or GPIB. A communication card based upon ISA/PCI bus is necessary. For example, in the subsystem of "ring main magnet power supply control and monitoring", the IOC communicate with 12 power supply controllers via opto-coupled RS422 in “point to point” mode. The MOXA’s multi-serial card C168P is used to expand the serial ports. Correspondingly the device driver is written to add the VxWorks’s “tty”[2].

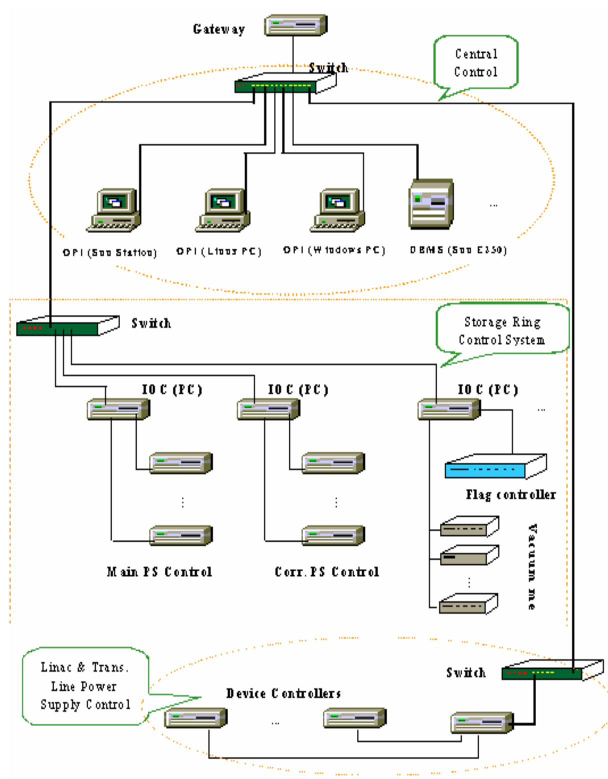

Figure 1 Overview of HLS Control System

IPCs are employed for most FDCs due to the inexpensive price and the support of a large amount of commercially available hardware and software products. Generally, FDCs face 4 kinds of signals: Analog Input (AI), Analog Output (AO), Digital Input (DI), and Digital Output (DO). A large amount of high quality commercial I/O modules based upon ISA/PCI bus are used.

100M-Ethernet is used in the local area network (LAN) to get high network transport speed.

3 SOFTWARE

Solaris and Linux are used as operating system for OPIs. Some OPI tools are used. MEDM running under Solaris or Linux is used to build various controlling and monitoring screens and manage these screens to control and monitor associated channels. AHL is used to monitor the alarm status of various sets of channels. Archivers, e.g. SDDSMonitor and SDDSlogger, run on SUN E250 server to archive the values of various channels. A relational database management system (RDMS), Oracle, also runs on the SUN server to manage and provide access to the archived data. A TCL/TK script is used to backup and restore the values of records for bumpless reboot of IOCs. Database tools, such as DCT, is used to construct database [3].

The heart of each IOC is a memory resident database together with various memory resident structures describing the contents of the database. There are about 2,000 records resident in several IOCs that consist of the distributed database. The following record types are frequently used: AI, AO, BI, BO, Mbbi (Multi-bit Binary Input), Mbbo (Multi-bit Binary Output), MbbiDirect (Direct Multi-bit Binary Input), MbboDirect (Direct Multi-bit Binary Output), subroutine, RT (Ramping Table), etc. Where RT is developed for storage ring ramping. Before using DCT to create a run time database for the IOC, we write the Device Support and Device Drivers (if necessary) for each type of record.

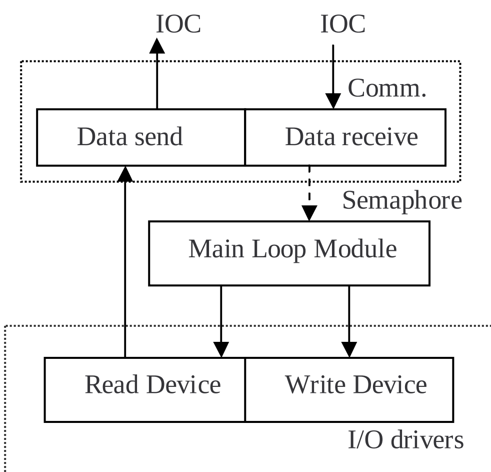

Figure 2 FDC software functional diagram

The software for FDC is based on VxWorks multi-task mechanism and consists of three parts: communication module, main loop module, and I/O drivers. Figure 2 is the functional diagram. The main function of communication module is to receive the message from IOC and then check if the message is correct. If correct, a semaphore is given, which will be taken by the main loop module. When the main loop module takes the semaphore, then it reads and parses the message. If the command from the message is a kind of write one, main loop module calls the corresponding driver to set the value from the message to the corresponding channel. If the command is a kind of read one, main loop module calls the corresponding driver to read the corresponding channel and then send back the response message via communication module. There are a number of I/O drivers to provide a way to access the corresponding hardware channels [2].

We use SDDS toolkits and SDDS-compliant toolkits to do data archiving and analyses. For example, sddslogger and sddsmonitor are used to archiving data, sddsslope and sddsfft are used to do data analyses. We also developed a number TCL/TK scripts, which are used in the routine machine operation and machine study, for example, machine parameter backup and restore, ramping control and so on. Another kind of TCL/TK scripts combined with SDDS tools, for example closed orbit correction, are used in machine physics based study.

4 SOME KEY SUBSYSTEM

4.1 Main magnet power supplies control system

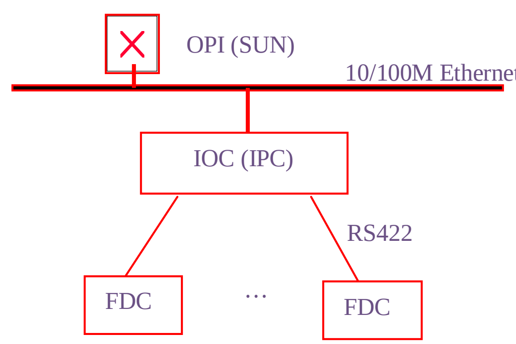

Figure 3 Main magnet control system

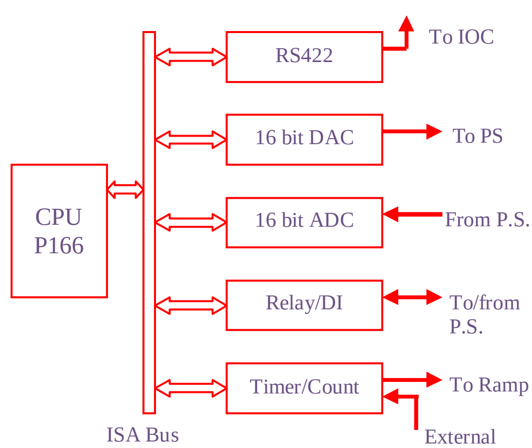

Figure 4 FDC of main magnet power supply

Figure 3 and figure 4 shows the main magnet power supply control system and the FDC of the supplies. They are us PC based hardware.

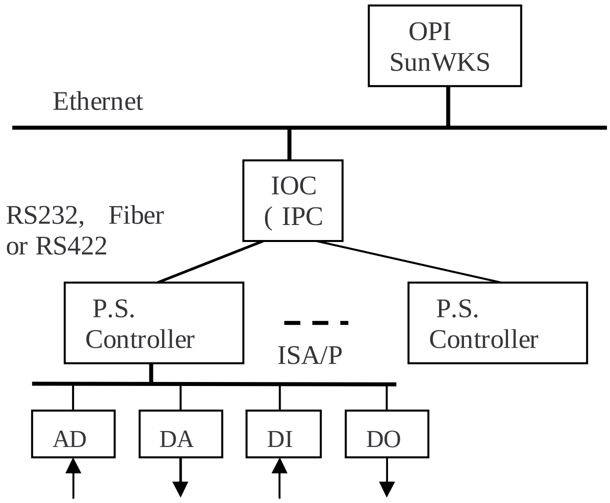

Figure 5 The control system of Power Supplies

4.2 Other power supplies control system

There are some other power supplies in HLS, which are used for ring correctors, transport line magnets and linac focusing coil and etc. The structure of their control system shows in figure 5, which employs PC based hardware.

4.3 Flag control

There are a number of Flags along the storage ring as well as the transport line. They are controlled to come in and go out the beam orbit by two channel of 24V pulse. The operation is valid only one of these two channels is powered. A set of BO, Subrotine and MBBODirect records are used to control a flag. Figure 6 describes flag control system.

4.4 Vacuum Monitor

A TCL/TK/BLT script, which has a CA interface, is used to monitor the vacuum data of HLS. Figure 7 is the monitor screen of HLS storage ring.

4 CONCLUSION

According the experiences in the operation of the several subsystems, e.g. the subsystem of ring main magnet power supply control and monitoring, the PC based control system of HLS is proven to be reliable and extremely cost effective. We take some measures to avoid EMI, e.g. we use optical fiber to communicate data in the subsystem of ring injection control and monitoring to avoid the EMI of the pulse power supply.

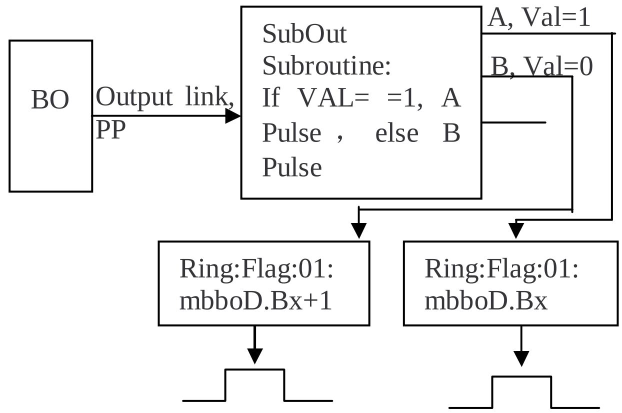

Figure 6 Flag Control

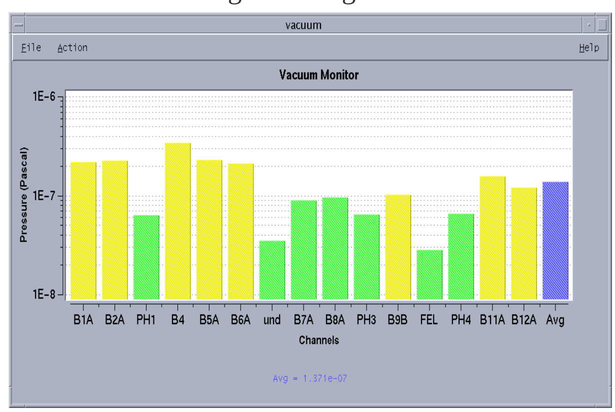

Figure 7 Monitor Screen of HLS Storage Ring Vacuum

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