PERSONAL COMPUTER IN THE NSRL CONTROL SYSTEM

Shouming Hu, Weimin Li, Jingyi Li, Gongfa Liu, Songqiang Liu

National Synchrotron Radiation Laboratory,
University of Science and Technology of China,
Hefei, Anhui 230029, P. R. China

Abstract

The National Synchrotron Radiation Laboratory (NSRL) control system is a distributed control system, based on personal computers. It has been in operation for about ten years. Personal computers are used in the 800Mev Storage Ring and 200Mev Linac to control the accelerator subsystems, they are playing not only important roles as operation interface and database servers, but also the device controllers. At the front-end level, IPCs control physical devices in the field. Beamlines and insert devices also use PCs for control and data acquisition.

In phase II project of the NSRL, EPICS will be introduced into the NSRL control system, many PCs will be utilized as device controllers, OPIs and IOCs along with some VME crates and workstations.

1 INTRODUCTION

NSRL is the first dedicated synchrotron radiation facility in China, located on the West Campus of the University of Science and Technology of China (USTC), in Hefei city, Anhui Province. The facility is mainly composed of an 800 MeV electron storage ring, named the Hefei Light Source (HLS), and a 200 MeV Linac functioning as its injector. So far, the NSRL has equipped 6 beamlines and their experimental stations for research on Photoelectron Spectroscopy, X-ray Lithography, Soft X-ray Microscopy, Time-Resolved Spectroscopy, Photo-chemistry and XAFS, respectively. The XAFS station is a newly built experimental station for XAFS research, together with a 6 Tesla Super-conducting Wiggler, or Wavelength Shifter (WLS), which has been put into service at the end of 1998.

The NSRL control system is a distributed control system based on personal computers. Its main structure was completed in 1990 [1][2]. It has been in regular operation since 1992. During the past yeas, some new subsystems, new control components and applications are introduced into the system, along with the development of personal computers and network techniques [3].

The system consists of two main parts: the Linac control system and the storage ring control system. The design principle of the system follows the goal of convenient control, reasonable system response, reliable operation and easy maintenance, with provisions for future improvement and expansion.

The existing control system is also composed of a few separate subsystems that were self-developed during the HLS commissioning in late 1980's for immediate functions. Most of the subsystems use PC for controlling its own devices. Although some of the subsystems have been upgraded on the grounds of machine operating requirement, but some are still without much communication with others. During the control system upgrade plan [4] of the NSRL phase II project [5], this situation will be changed and improved. In the upgraded control system, EPICS will be introduced into the system. The hardware will be in 'Standard Mode' made up of PCs and Unix workstations, IO controllers (mainly use IPC with few VMEs and VXIs) and distributed intelligent modules inside the devices. They are connected to each other via ether local area networks or field buses. And the new software will be developed in the frame of the international shared EPICS system.

2 SYSTEM ENVIROMENT

PC (Intel X86) is the primary kind of computer used in the NSRL control system, the type of computers are changed in the wake of the PC market, from AT286 to Pentium II. The operating system on PCs encompasses MS DOS, Windows, Windows 95, WNT, Linux and Netware. C, C++, VB, VC, Delphi and LabWindows are utilized for the subsystems use PCs as their controls. The subsystems include ring main magnets power control, beam transport line power control, linac power control, linac energy stabilizer, timing system, injection control, vacuum system, radiation safety monitoring and protecting, thermal control system, beam position monitor and correct, storage beam current measurement and display, beam profile measurement, inserting devices (wiggler and undulator) control, operation database server. And all of the experimental stations use personal computers for data acquisition and processing.

The network environment has been set up in the control system since 1994, the 10M Ethernet (fiber and cable) has serviced the system without major problems at present. 100M fast Ethernet routers and switches are being employed.

3 HARDWARE CONFIGRATION

3.1 Basic structure

The basic configuration of the control subsystems is shown in fig. 1. It is the common mode of subsystem configuration. PC is used for both OPI consoles and device controllers. In addition to the PC controllers, there are MULTIBUS, CAMAC, STD bus and PLC controllers.

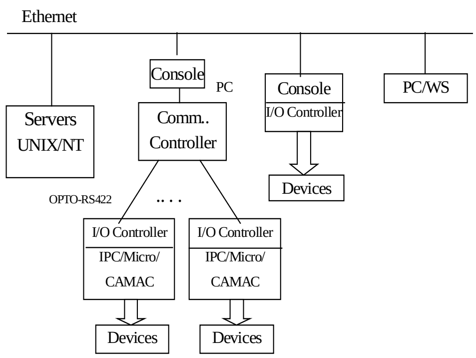

Fig. 1 The basic configuration

3.2 Software structure

The most frequently used programming language for application development is C. The object-oriented tools like VB, VC, Delphi, LabWindows have been applied to develop control applications in resent years. The componentware such as Microsoft DCOM, SUN's JavaBeans and Activ X, are considered for database access and application communication over the network. But at present, the database has no many data can be shared, and the communication between subsystems and applications are very much limited.

The basic software structure is shown in fig. 2.

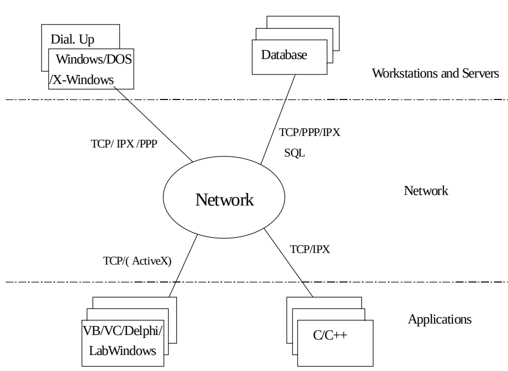

Fig. 2 Software structure

4 SYSTEM UPGRADE

4.1 Upgrade plan

As a part of the NSRL Phase II project, the upgraded control system will be based on EPICS, following the standard model of I/O controllers (IOC) connected to workstations (OPI) via Ethernet. Since VxWorks support PC as a target, we use PCs as IOCs for most subsystems. The I/O modules inside the IOCs are basically commercial products. Usually, IOC has disks with operating system and local applications installed, this is particularly useful when the system is in the development and test stage, and it is available for maintenance and modification later.

The OPIs will be SUN WS and PC Windows, develop tools are MEDM and Tcl/Tk.

The common system architecture is shown in fig. 3.

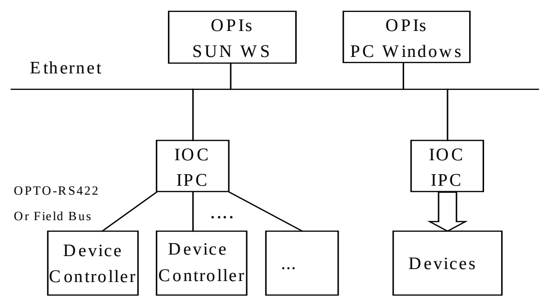

Fig.3 Common system architecture

4.2 Upgrade step

Subsystems will be upgraded step by step, since the machine is in the regular operation status during the upgrade period. We select the ring main power control system as the first subsystem to upgrade.

4.3 Status

The prototype design of the EPICS control system for main power supplies has been completed, and will be tested in this winter shutdown time. The software development and improvement for subsystems is in the process and will be continued. The EPICS database for each kind of hardware device is prepared one by one, this is the major tasks not only in the control structure, but also in the real-time database.

5 MAIN POWER SUPPLY CONTROL UPGRADE

5.1 PC for IOC and controllers

We will develop 11 new controllers for main magnets power supplies by using IPCs or PLCs, and use a personal computer (IPC) as IOC, to control the main magnets power supplies. Each power supply has one controller and we call them devices.

5.2 Database for the IOC

Corresponding to the controllers there are 12 devices (Q1-Q12) in this subsystem. Each device contains 30 records. The DTYP include MpsControl (bo), MpsStatus (mbbiD), GetSetpoint (ai), SetSetpoint (ao), RampTimer (ao), RampTable (sub), MpsDcct (ai).

For example, the main switch record of the storage ring bending magnets power supply controller is named:

RING:Q9:MainSw:bo

The hardware address is:

Q9 01 @"string".

5.3 Record support

The record type: there are 12 Switch/Control record (the DTYP is MpsControl),15 Status record (DTYP is MpsStatus) and 5 other type records(such as Ramp Table) for each device. The Ramp Table record is a subroutine record for downloading ramp table.

5.4 Device support module

Device support module is used to send command to driver. Command name is switch ON/switch OFF, reset, read record, set setpoint.

5.5 Driver support module

The driver layer is independent to the EPICS data structure. The communications between IOC and controller use standard RS232 or RS422 serial line. Device interface is realized in the driver support module.

The basic system directive include:

(1) open (name, flags, mode)
(2) read (fd, buffer, n)
(3) write(fd, buffer, n)
(4) ioctl (fd, function,arg)

Argument	Description	Value
name	the port name	/tyCo/0 and /tyCo/1
flags	access mode	O_RDWR
mode	UNIX style file access control	0
function	function code	FIOBAUDRATE arg = 9600
	function code	FIOSETOPTIONS arg = OPT_RAW

Driver Support Module subroutine entrance include:

set232Link()	initialize the serial port
send232Command()	send command to controller
check232Message()	check the message come from controller
send232RampTable	download ramp table

The communication follows the HESYRL communication protocol [6].

5.6 OPI application design

Host operation is mainly realized by MEDM and Tcl/Tk. Two display windows for main operation have been designed, one is status display window and the other is control window.

The operation mode includes single/group channel access and ramping/setting selection.

The Calibration, demagnetization and ramp table download operating functions are designed independently and run script in MEDM or under X-windows.

6 NETWORK

The 100M fast Ethernet routers and switches are being employed. This not only enables faster throughout but also helps application run more efficiently. The router and firewall filter or interrogate all traffic before allowing access into the control system, they not only guard against unwanted access, but also can be used to create a secure channel through the campus network.

7 CONCLUSION

The personal computers have been successfully applied in variety subsystems of the NSRL control system. The system upgrade will greatly enhance the control system abilities in efficient and reliable control, convenient operation, and systems' response. The real-time database will be set up and the system maintains will be easier than before.

8 ACKNOWLEDGEMENTS

We would like to thank the colleagues, who devoted their contributions or helps to the NSRL control system, both in China and abroad.

REFERENCES

[1] Yao Chih-Yuan, ICALEPCS'91, KEK, Japan, 1997,p.40
[2] C.Yao et al., Proc. Int. Conf. on SR Apl. Hefei, China,1989
[3] Proceedings of the Second National Symposium on Particle Accelerator Technology, China, 1998
[4] Weimin Li et al., ICALEPCS'97, Beijing, China, 1997, p.19
[5] Zuping Liu et al., "NSRL Phase II Project", SRI'97, Japan, 1997
[6] S.Liu "Software for Local control and Data Communication", Proc. Of Conf. on SR Apl., 1989
[7] N.Liu, et al. "The Influence of Superconducting Wiggler on HLS Storage Ring" China-Japan Joint Symposium, 1996