THE CONTROL SYSTEM UPGRADE FOR THE PLS STORAGE RING MPS'S

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Abstract

PLS (Pohang Light Source) is a synchrotron light source located at Pohang, Korea. The storage ring of PLS has 42 unipolar type and 146 bipolar type MPSs (Magnet Power Supplies). We have developed new control system for these MPSs using EPICS (Experimental Physics and Industrial Control System) and MODBUS protocol. In this paper, the hardware and software structures as well as the communication protocols for this new MPS control system are presented.

INTRODUCTION

The original control system for PLS storage ring consists of console computers and DACS (Data Acquisition and Control System). DACS, again, has two layers – SCCs (Subsystem Control Computers) and MIUs (Machine Interface Units) which are distributed around the machine. The console computers are mid-range engineering workstations and DACS are based on VMEBus and the Motorola 680x0 microprocessor. The DACS uses a real-time operating system OS-9. For the communication network between SCCs and MIUs, MIL-1553B is used and SCCs are linked to the high level computers through Ethernet (TCP/IP).

As the number of control points increased, this multi-layer architecture had more chances to be trapped in communication faults. Also, we needed to replace the old system with newer hardware and software with better performances. In 2001, therefore, we began to upgrade the storage ring control system using the EPICS. As of now, the upgrades for the BPM (Beam Position Monitor) and MPS systems are finished and the performances proved to be satisfactory.

The storage ring of PLS has 42 unipolar type and 146 bipolar type MPSs. In the old system, the unipolar type MPSs are controlled through serial communication and the bipolor type MPSs are controlled by parallel communicatio. For the simple and stable operation, we developed MPS control hardware equipped with Ethernet port. And the software was developed using TCP/MODBUS protocol [1,2]. By standardizing the protocol, we could reduce the number of EPICS IOC (Input Output Controller) device drivers which should be developed and, furthermore, we had more cases that already developed drivers can be applied to other devices.

As the IOC, we chose Windows NT/2K based PC server and version 3.14.0beta1 was used as the EPICS base software. Also, MEDM and ADT (Array Display Tool) were adopted as the OPI (Operator Interface) software. These tools can be uniformly used under the Solaris, Windows, and Linux environments. More customized interfaces were developed using directly EZCA functions in the Windows.

HARDWARE

At the first stage of the development, only VME based EPICS IOC with VxWorks OS (Operating System) was considered as the only target type. However, as more people got involved in the development, there occurred various demands requiring targets of other types. The typical one is based on personal computer with Linux or Windows. It can benefit from low prices, abundant applications, and convenience in development [3]. Table 1 compares the old and new system specifications.

Table 1 Old and new control systems

Item	Old	New
OS	OS-9	**Windows NT**
OPIs	Solaris (non EPICS)	**EPICS Solaris/Linux/Windows**
Network	1M/10Mbps	**10/100/1000Mbps**
Control Layer	3	**3 or 2**
CPU Board	Motorola VME147S	**Compaq ML530 Server Intel Xeon 1GHz or 2.4GHz**
Field bus	RS422, Parallel	**Ethernet 10base/RS422**

In addition to the target, network architecture plays a critical role in EPICS operation. Different from UDP ca server in vxWorks environment where accesses are permitted only from the same subnet, channel access server using TCP in Windows/Linux environment can be accessed from anywhere with the IP and PV name. Therefore, we use the physically dedicated network for EPICS control and monitored data are distributed through specific EPICS gateway.

Magnet Power Supply of Storage Ring

As you can see in Table 2, there are 140 corrector MPSs distributed around storage ring. The unipolar MPSs include MPSs for bending, qudrupole, and sextupole magnets. All bending magnets are connected to one MPS.

Each focusing and defocusing sextupole magnets are making one family, respectively. For the quadrupole magents, there are 2 kinds. That is, all 24 Q4 magnets are serially connected, and same situation holds for Q5, and Q6. However, Q1, Q2, and Q3, has there own MPS for each cell thus making the number of families for all quadrupole magnets 39. We placed single family MPSs at separate building called MPS building located near by the SR building.

Table 2 shows the number and location of each MPS family of storage ring.

MPS		number	location
Bipolar	Corrector	140	12/cell (1-11) 6 for #12
	Bending Trim	2	#11, #12
U N I P O L A R	Bending	1	MPS Building
	Q1	12	SR
	Q2	12	SR
	Q3	12	SR
	Q4	1	MPS Building
	Q5	1	"
	Q6	1	"
	SD	1	"
	SF	1	"
Bipolar	Skew	4	SR #3,#5,#8,#11

Control Network Configuration

Figure 1 shows the network configuration of MPS building at which the high current MPSs (Bending, Q4, Q5, Q6) are located. This network is connected to the operation room through 8-core fiber optical cable. Figure 2 shows storage ring network configuration for EPICS implementation which includes Q1, Q2, Q3 and Beam Based Alignment (BBA) shunt controls. In addition to these, we have linac network and all these networks are connected to the operation room via switching hubs and with 3 subnet structure.

SOFTWARE

There are 140 power supplies for SR corrector magnets. In the previous control program, we used one process including 140 threads each of which was assigned to one MPS control. However, in this way, a lot of time consumed for controlling. This time delays not only are undesirable for controlling itself but also made synchronization problem when applying, e. g., feedback correction. Therefore, when we install IOC for correctors, we made one process per each cell and assigned one thread for each power supply.

For OPI (OPerator Interface), we utilized various EPICS extension softwares [4] to review their pros and cons. First, MEDM (Motif Editor Display Manager) was used to build MPS control panel (Figure 3). ADT (Array Display Tool) was used for monitoring panel to display reading and offset values (Figure 4). Finally, we used EZCA (Easy Channel Access) together with Microsoft Visual C++ to build customized panel (Figure 5).
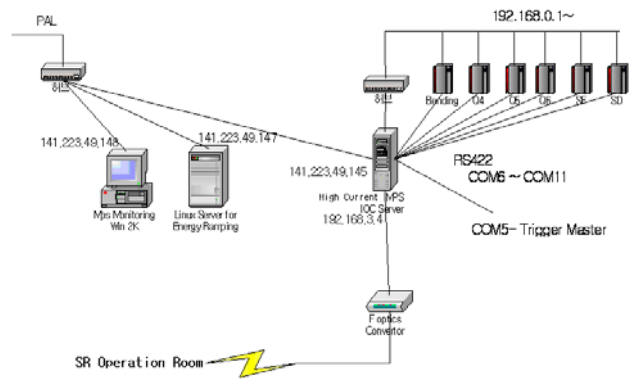

Figure 1: MPS Building Network for High Power MPS (Bending,Q4,Q5,Q6,SD,SF)
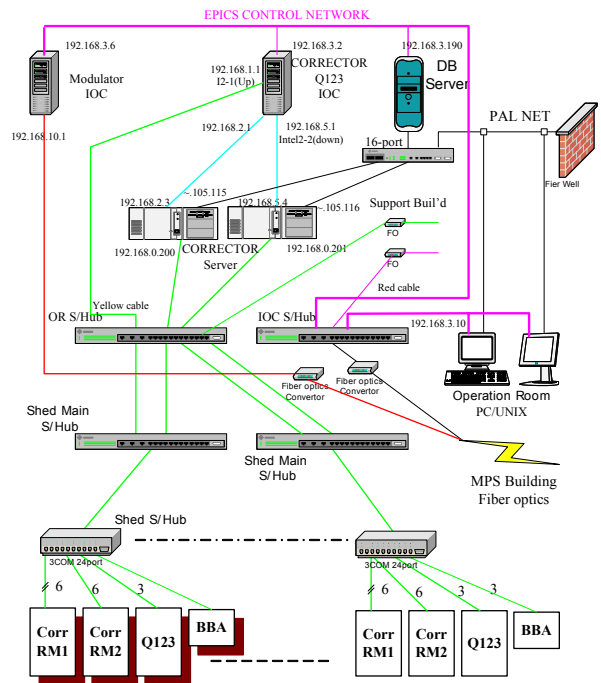

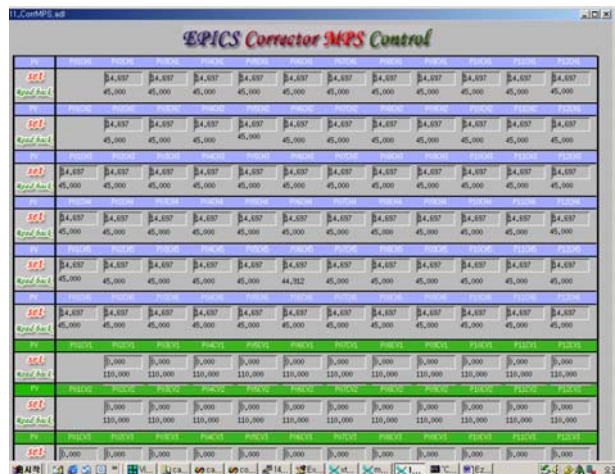Figure 2: SR EPICS control network
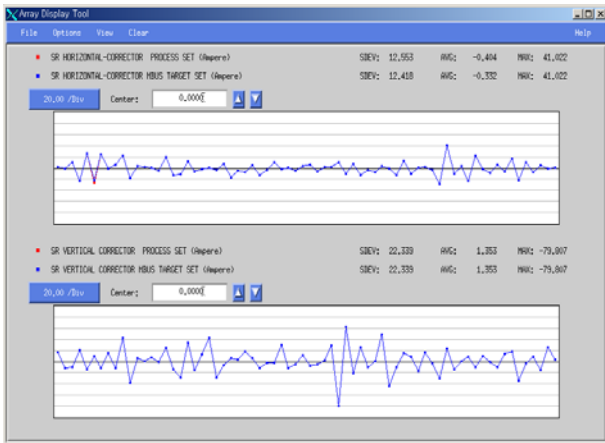

Figure 3: OPI using MEDM
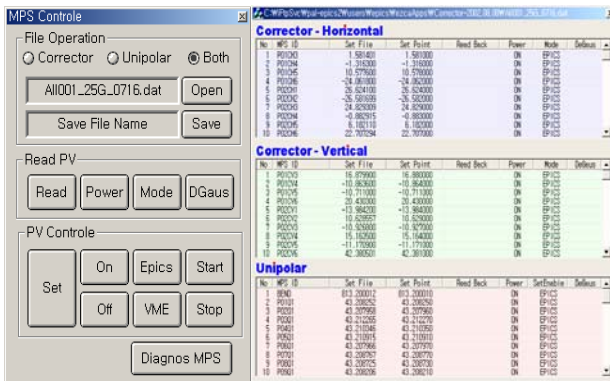
Figure 4: OPI using ADT

Figure 5: OPI using EZCA with Microsoft visual C++

As mentioned above, we used Modbus/TCP as the communication protocol. Modbus, the communication protocol introduced to the market by Schneider Electric (Modicon) in 1979, which became a de facto standard and has proved to be the most reliable and easy to implement, is the most widely used network protocol in the industrial manufacturing environment. MODBUS/TCP is a variant of the MODBUS family of simple, vendor-neutral communication protocols intended for supervision and control of automation equipment. [5]

In general, each I/O signal corresponds to a Modbus address. For MPSs, analog input/output and binary input/output signals are needed . We assigned addresses 1~10000 to binary output, 10001~20000 to binary input, 20001~3000 to analog input and 30001~40000 to analog output signals. For each MODBUS address, a EPICS PV is given and the names are of type SR_XXX:MBUS-

AI:Cn:Sn where Cn (n=1,2..) are corrector MPSs and Sn (n=1,2..) are signals.

The total EPICS PV numbers are 2800 and 588 for corrector and unipolar power supplies respectively.

RESULTS

We have successfully upgraded the PLS MPS control system using EPICS. Control architecture was redesigned for efficiency and MODBUS/TCP protocol is used to simplify the development. By assigning a EPICS PV to a MODBUS address, we could easily determine the specifications of device drivers.

In the process of testing the control system, PutArray() function of EZCA did not work as we expected when arrays were applied to the function. IOC database recognized the arrays arrived while the device drivers did nothing about them. By sending the PVs one by one with appropriate time interval (5 ~ 10ms), we could solve the problem.

Except the above problem, the control system worked well and we could control and monitor the device by considering only the PVs not the devices directly. And, so far, performance does not depend on the numbers and locations of the IOCS. Also, we confirmed the stability of systems consisting of Linux and/or Windows NT. Encouraged by the success of MPS control system, we will apply EPICS to as many control systems as possible.

ACKNOWLEDGMENTS

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