가속기 제어시스템의 성능향상을 위한 연구

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Conceptual Design of PLS-II Control System for PLS

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Abstract - PLS(Pohang Light Source) will begin the PLS-II project that has been funded by the KOREA Government in order to further upgrade the PLS which has operated since 1992. The control system of the PLS-II has distributed control architecture, with two layers of hierarchy; operator interface computer (OIC) layer and machine interface computer (MIC) layer. The OIC layer is based on SUN workstation with UNIX. A number of PC-based consoles allow to remotely operating the machine from the control room. PC-based consoles use the Linux or Windows operation system. Similar consoles in the experimental hall are used to control experiments. The MIC layer is directly interfaced to individual machine devices for low-level data acquisition and control. MIC layer is based on VMEbus standard with vxWorks real-time operating system. Executable application software modules are downloaded from host computers at the system start-up time. The MIC's and host computers are linked through Ethernet network. It should enable the use of hardware and software already developed for specific light source requirements. The core of the EPICS (Experimental Physics and Industrial Control System)[1] has been chosen as the basis for the control system software.

1. Introduction

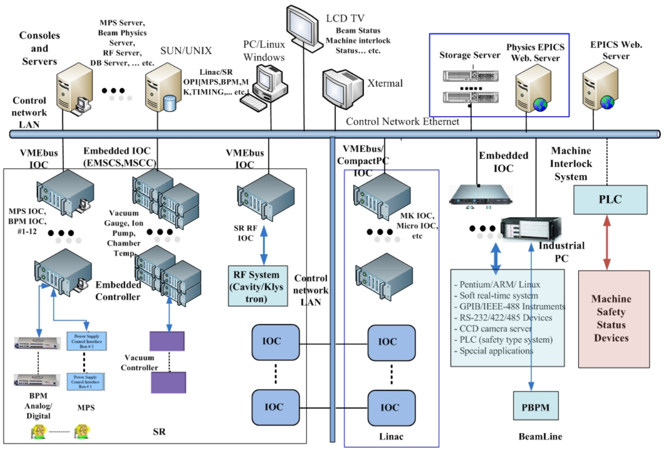
The accelerator control system provides means for accessing all machine components so that their parameters and value can be set and the whole system real time controlled remotely. These tasks include setting magnet current, collecting status data of vacuum system, taking orbit data with beam position monitors feedback control of electron beam orbit, and regulating the safety interlock monitors. In order to design a control system which can perform these functions satisfactorily, basic design requirements must be fulfilled. These are reliability, capability, expandability, cost control, ease of use and operational requirements[2]. The reliability requirement is usually not difficult to meet with proper use of commercial equipment. However, accurate estimation of PLS-II control system capability is not easy because it defends on operating system, utilities, networking overhead, and complex interactions between tasks. The control system for PLS-II is designed to convey all monitor, control, model-based, and computed data from all accelerator, facility, safety, and operations subsystems to accomplish supervisory control, automation, and operational analysis. The scope of the control system extends from the interface of the equipment being controlled through to the designers and operators of the accelerator facility, as well as synchrotron beam line experimenters and staff. The control system includes all hardware and software between these bounds: computer systems, networking, hardware interfaces, and programmable logic controllers. Cost requirement in the PLS-II project may be relaxed to reduce construction time and to compensate for the shortage of resources. PLS-II operation requirement include error detection and reporting, accelerator diagnostic, integral machine models and effective operator interface. With this control philosophy, we have worked on the PLS-II control system structure. After considering PLS-II accelerator topology, available resource, special accelerator hardware requirements and personal preference, we propose hierarchical system architecture for the PLS-II project. As a part of this updating project, control system is decided to use EPICS. EPICS IOCs can run on many kinds of operating systems, for example VxWorks, Unix, Linux, Windows, RTEMS and so on. Based on the idea of creating EPICS OPI on Linux and downloading real-time database to VME IOC target board, this article is mainly about how to setup EPICS base and EPICS extension on Linux operating system and furthermore how to finish communication between server and Linux control platform. In order to come into being a friendly environment of application development we will try our best to supply some templates. At last this article will also discuss that how the Linux platform works in the distribute network environment created by EPICS.

2. Control System Requirements

The control system architecture is a two-level structure following a standard model of contemporary control system for experimental physics facilities. The system architecture is flexible for expansion. The control system will adopt mature tools and a clear interface to assist system integration and development. The control network will be based on Ethernet with necessary redundancy links. The backbone will be a 100M or 1G Ethernet. In the equipments area, giga-bit switches will be installed at each equipment rack. High reliability and upgradable networking will be ensured. The operation interface based on many SUNs running in UNIX operating system, PCs running in Linux and EPICS clients applications. Windows-based systems are also supported. A control-system interface works with various subsystems through EPICS input-output controllers (IOC)[2]. IOC with VMEbus and Industrial Computer form factors will be used. Commercial dedicated EPICS IOCs with another form factor are also possible to be adopted. High reliability with adequate functionality is the key design requirement. Security is essential to protect the computer system from damage due to worm, virus, hacker etc. Security management will be addressed through the control system. Integration of the control system should be effective. All subsystems will share the same user interface. All systems will appear to have the same form from the point of view of a user of the control system. Control system applications must be designed to enable future upgrades to be incorporated economically. Wherever possible, application programs will be provided with command-line options, so that the functionality on offer can be increased by simply running the program with a different set of command line options.

3. Architecture of the control system

The control system architecture provides easy access to the equipment in a reliable and efficient way. It facilitates the development and maintenance of distributed applications, and the implementation of the required control schemes. It is designed to be modular and scalable in order to accommodate future changes and expansions. The architecture of the PLS-II control system hardware is shown in Fig.1. Its structure has distributed control architecture, with two layers of hierarchy; high-level computer system layer and low-level computer layer. The high-level computer system layer is based on 64bits SUN/UNIX and X-terminals. A number of PC-based consoles allow to remotely operating the machine from the control room. PC-based consoles use the GNU/Linux or Window-XP operation system. Similar consoles in the experimental hall are used to control experiments. The low-level computer layer is directly interfaced to individual machine devices for low-level data acquisition and control. Low-level computer layer is based on VMEbus standard with vxWorks real-time operating system and Industrial Computer with Linux. Executable application software modules are downloaded from host computers at the system start-up time. The low-level computers and host computers are linked through Ethernet network.



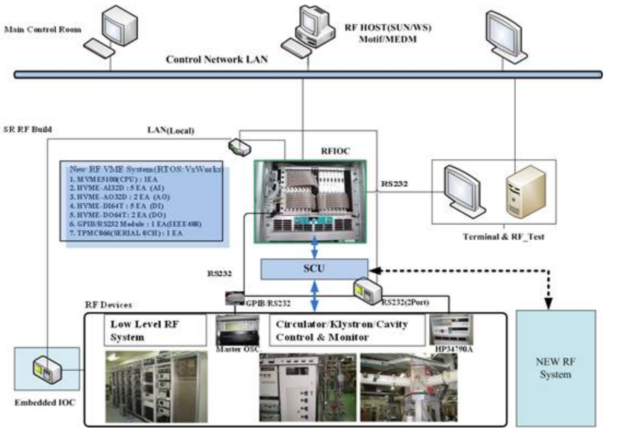
<Fig 1> The architecture of the PLS-II control system

3.1 RF Control System

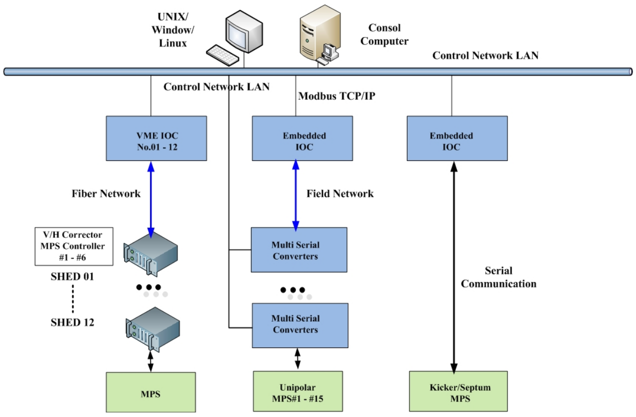
The control system is continuously being upgraded to accommodate additional control requirements such as the low level RF electronics. Part of the low level electronics were upgraded and replaced for enhanced performances of the phase feedback and automatic gain control loop, but the automatic phase-lock loop sowed some instability due to poor phase circuits, phase noises, and poor interface with control circuits. We use the EPICS tool kit as a foundation of the control system. We will develop RF control system for use VMEbus based VME I/O board and Multi-function board. After RF System installed, RF control system is upgraded. And control software is modified to support these changes. Applicationsoftware for LLRF device and operator interface software are being developed. The overall development of the EPICS based upgrade RF control system. Some control requirements of the LLRF controller is changed to modify MODBUS/TCP protocol. The structure of the upgrade RF control system is shown in Fig 2. The control system is 64bits VMEBUS based system. A PowerPC single board computer (SBC) is running the vxWorks real-time operating system. Control interfaces of the system consist of analog input/output, digital input/output and MODBUS/TCP connections. As shown on Fig 2 the SCU (Signal Condition Unit) is used to RFIOC control the Klystron and Cavity station.

3.2 MPS Control System

The power supply control system will be consist of the VME based IOC and the Embedded IOC based IOC. The VME system of the PLS will be used for the bi-polar power supply control system. The control method is the high speed control method by using the photo module of which performance and stability are proven in the PLS. Thus only the IP carrier module and the IPS (IP for Power Supply) module will be expanded according to the power supply expansion. The bi-polar power supply is used for the global orbit feedback so that stability and high speed control will be main requirements for the bi-polar power supply. 12 sets of VME IOC will be installed in the storage ring for the system configuration. The Embedded IOCs will be used for the Unipolar power supply control system. In the case of Unipolar power supply, the number of quadrupole power supply will be increased from that of the PLS. The Embedded IOC is connected to the power supplies by a power supply multi serial converters. This Embedded IOC is equipped with MODBUS TCP/IP Ethernet interface as well as 100Mps Ethernet. The kicker and the septum IOC will be controlled by the embedded IOC as well. In the case of the kicker, care must be taken in design and installation of controller for shielding and noise reduction, because lots of noises can be generated during the injection process. One embedded IOC will be developed and installed for the system configuration. The structure of the proposed power supply interface is shown in Fig 3.



<Fig 2> The architecture of the PLS-II control system



<Fig 3> The architecture of the MPS control system

4. CONCUSION

A Final design review of the PLS-II Control Systems for PAL. The Current PLS control system was initially installed EPICS IOC based and system control tested in test laboratory in March 2004. Installation in all systems will be completed during the November 2010 shutdown. The main tool is VMEbus Power PC based EPICS IOC and SUN based Host Extension. The OPI is programmed using MEDM. During the period, we also performed EPICS application research in various hardware and software environments. We are upgrading and modifying the control system to accommodate new control requirements and to apply long-term operational experiences

[REFERENCE]

[1] http://www.aps.anl.gov/epics
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[3] Taiwan Photon Source Design Handbook, June 2008(Draft).
[4] J. C. Yoon ,"Improvement of RF Control System for the 20Mev Proton Linac of PEFP", Proceedings of PAC 2005.
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