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Implementation of the Networked Computer-based Control System for PEFP 100MeV Proton Linear Accelerator

Young-Gi Song*, Hyeok-Jung Kwon, Ji-Ho Jang, and Yong-Sub Cho
PEFP, KAERI, 150, Deokjin-dong, Yousung-gu, DaeJeon, 350-353, Korea
**Corresponding author: ygsong@kaeri.re.kr*

1. Introduction

The 100MeV Radio Frequency (RF) linac for the pulsed proton source is under development in KAERI [1]. The main systems of the linac, such as the general timing control, the high-power RF system, the control system of klystrons, the power supply system of magnets, the vacuum subsystem, and the cooling system, should be integrated into the control system of PEFP. Various subsystems units of the linac are to be made by other manufacturers with different standards. The technical integration will be based upon Experimental Physics and Industrial Control System (EPICS) software framework [2]. The network attached computers, such as workstation, server, VME, and embedded system, will be applied as control devices. This paper is discussed on integration and implementation of the distributed control systems using networked computer systems.

2. Control Network

The PEFP 100MeV proton linac will be composed of several subsystems. The control systems for the local systems should be attached to control network for a distributed control system. The PEFP control network is based on Ethernet interface. Figure 1 shows a control network connection simulation between backbone and workgroup switches. There are two routers to raise data transfer rate and to route the control data. The workgroup switches are configured with VLAN.

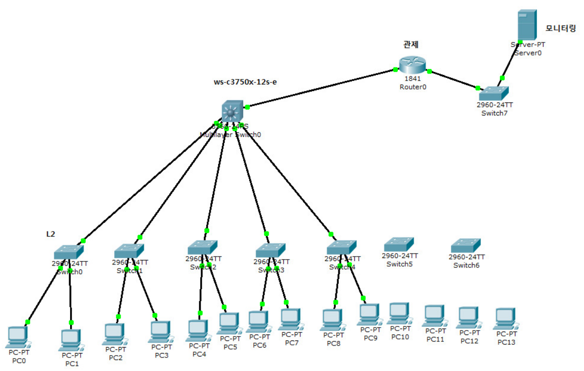

Figure 1: Schematic layout of PEFP control network

The control systems will be interconnected through LAN network and will make highly systemized interaction with one another. The integrated operation will be realized by the network connections and by the interactions among control systems of subsystems. The software tool for verified development tools, distributed control, and efficient maintenance is required. The EPICS tool provides the channel access (CA) communication protocol to make Ethernet connections and transfer Process Variables (PV) among Input Output Controllers (IOC) [3]. The EPICS provides software architecture for realizing a distributed control system and supports software modules such as a standard communication protocol and processing database. The graphical user interface tools can be used for the configurations of databases and they can be used as a kind of graphical programming language.

3. Hardware

The control system includes magnet power supply system, vacuum system, beam diagnostic system, low level radio frequency, modulator, and resonance control cooling system [4,7]. The time synchronization system is used to provide the accurate trigger signals for synchronized operation of the RF generator, the low level RF, the klystron and so on.

For the PEFP control system, we chose the station of the target IOC that runs in a different environment where compiled. The IOC station consists of various CPU types, such as VME based PowerPC 7410, 7457, 8540. Figure 2 shows a distributed control system with various IOC servers. We have two development environments for target IOCs. The one is to use a cross-compile environment with Wind-River workbench on RHEL. The VME IOCs with workbench are applied to LLRF, Event Timing system, and BPM. The other is to use RTEMS for vacuum units, magnet power supply, and cooling system.

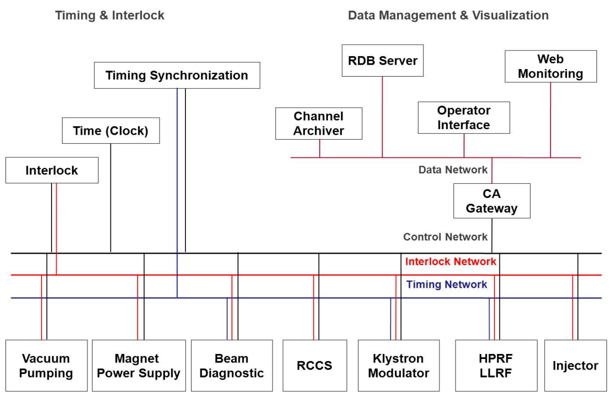

Figure 2: Overview of PEFP control system

As a client system for operator interface, we chose the station of Soft-IOC that runs in the same environment as which it was compiled. The workstations are used for a graphic user interface, data archiving, and CA gateway between control system and operator interface. The graphic display is done by EDM, ALH, and MEDM [8]. A gateway application has been tested in order to minimize the control network traffic and give permission to access and the CA gateway for PVs access security rules will be installed.

4. Software

We have studied how the EPICS system can be used for the PEFP control system and which features in EPICS can be used for specific control requirement. The EPICS provides software architecture for realizing a distributed control system and supports software modules such as a standard communication protocol and processing database. The EPICS has the state notation language as a programming sequential operation that interact with EPICS process variables.

For a smoothing operation of a machine and minimize the diagnostic time, all parts must be designed with integrated features to make the control system possible to verify that all devices are working correctly and enabling quick response for repair in case of an error. So an application program to utilize alternative hardware in the event of a failure is needed. This strategy needs some extra instrumentation.

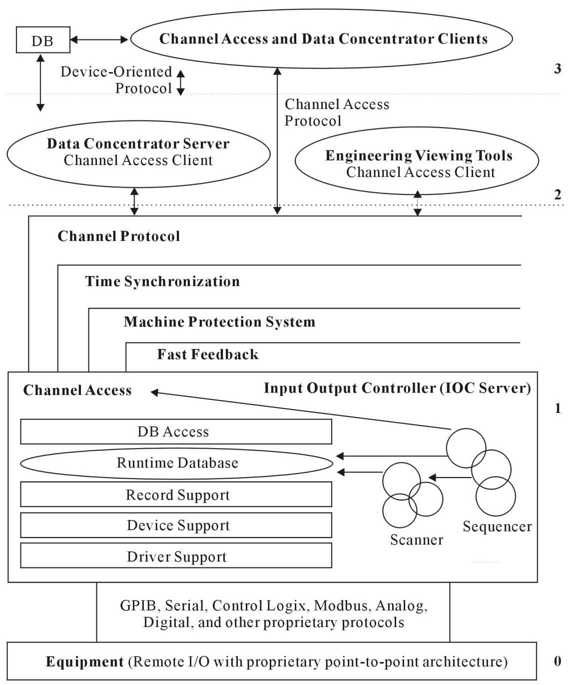

Figure 3: Architecture of IOC software

The architecture of network based distributed control system is depicted in Figure 3. Different levels of access and control reside at distinct layers. Layer 1 contains dedicated equipment controllers, which in turn interface to specific equipment through point-to-point protocols (layer 0). Layer 2 contains accelerator operation and monitoring activities. Layer 3 includes high level physics modeling, making use of live data and data stored in the site relational database. At the highest layer (layer 3), access is provided for activities that do not involve moment-by-moment control or monitoring of the accelerator.

For the linac data storage, oracle is a good choice due to its storage capability. However, it is not attractive because of high cost. A preferred way is developing of add in engine for MySQL in order to extend data archiving and data retrieving abilities.

5. Conclusions

The VME-IOC and Soft-IOC for 100MeV linac control systems, such as vacuum units, magnet power supplies, LLRF, and water cooling systems, have been developed. The IOCs will be arranged for monitoring and controlling the subsystems of the PEFP proton linac. In the future, the machine will be extended with much more control points. In addition, running of the machine for long time accumulates a huge database which is necessary for future analysis. Therefore, plan for long term storage and access needs of data is important.

Acknowledgement

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