Network based Data management system for KOMAC proton linac

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1. Introduction

The Korea Multi-purpose Accelerator Complex (KOMAC) has developed an integrated control system for the 100-MeV proton linear accelerator [1]. The final goal of the KOMAC control system for beam commissioning is to develop a network based on distributed control systems. The control system was designed into the basic control structure of three groups including the central control system, the local control system, and the console system. The central control system is responsible for the timing synchronization and interlock. The local control system is responsible for the distributed control system for several linac components, such as the vacuum, power supply, data acquisition, RF, and so on. The console system is responsible for the user interface as a control system client. In order to implement the control system, we have adopted an Experimental Physics and Industrial Control System (EPICS) software framework as the standard development tool. The EPICS is based on a distributed architecture that provides several solutions, such as independent programming tools on several hardware and operating-system platforms. The Input Output Controllers (IOCs) have been developed with a wide variety of hardware solutions from a personal computer to embedded devices. . In this paper, we will present the details of the integrated control system for beam commissioning of the KOMAC 100-MeV proton linac.

2. Control System

The goal of the linac control system is to develop vacuum, magnet power supply, cooling control, RF feedback control, timing synchronization, data acquisition, and machine protection systems. The control system needs several conditions, such as suitable solution for low cost and low manpower, easy maintenance, long life cycle, and reduced development time, high bandwidth of about 30 MB at 60 Hz for RF feedback control, timing for synchronized operation of 10 beam lines, and integration of all control signals through a hard-wired or soft-wired connection.

Most of the control systems are composed of the versa module europe (VME) central processing units (CPUs), which is able to transmit large data by using a handshaking protocol without a central synchronization clock. The other control systems are based on single board computers (SBCs), such as Coldfire and Intel Pentium processors, which support low cost and various applications. The operating system (OS) for SBC includes transmission control protocol (TCP)/internet protocol (IP) network stack at a kernel level. The strategy of an integrated operation is to network a mutual Ethernet device by using TCP/IP. EPICS middleware, which provides a network protocol and a basic framework, is a faultless choice [2]. The EPICS supports a channel access (CA) communication protocol to make TCP/IP connections and to transfer a process variable (PV) between the EPICS input-output controllers (IOC). The integrated control system will be realized by implementing a networked control structure of the distributed control systems for the 100-MeV proton linac, as shown in Fig. 1.

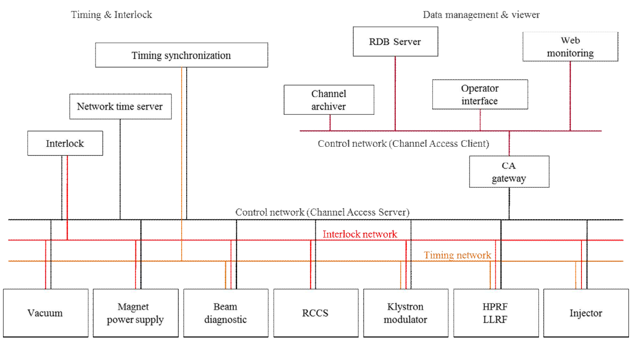

Fig. 1. Structure of the control system for the PEFP 100-MeV proton linac.

3. Data Management System

One of essential requirements for the KOMAC control system is to construct a network infrastructure for integrated operation, distributed control, and efficient maintenance. Although there are diverse control systems with disparate OS and CPU architectures, all systems have something in common, which is the Ethernet, the local area network (LAN) with a bus structure. The networking based on TCP/IP using Ethernet can realize an integration of distributed control systems. Our strategy is to implement a network application of the server and client model with a CA protocol by using the raw socket of an internet protocol

- Networking

The KOMAC consists of 53 IOCs, 12 OPIs, and 5 database servers, which have been implemented with an

EPICS open source software tool to realize an integrated control system based on software. The IOCs have about 4,500 PVs, which are focused on initial beam commissioning. The minimum size of a CA packet is about 16,384 bytes, so the total network payload used in 53 nodes is about 72 Mb.

At the initial phase, a main feature of the control network should be designed to allow a network traffic load to be increased by about threefold in the future. Therefore, the network was constructed by layering 3 backbone switches and a higher speed network, as shown Fig. 2. The switches are configured with virtual local area network (VLAN) that is divided into 6 VLANs for the function of the control systems.

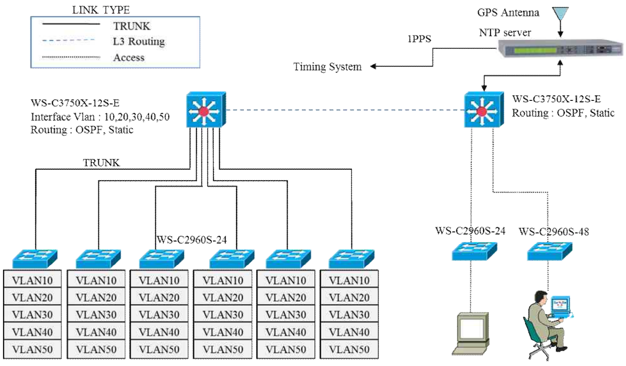

Fig. 2. Network configuration using VLAN of the backbone switch.

- Data Management System

The KOMAC has about 4,500 PVs of various records as shown in Fig. 3. Half of the PVs are included in experimental results. The PVs are classified into CA PVs and archiving PVs. In other to store and retrieve the experiment data of about 2,000 PVs, we decided to use an open source database, such as MySQL and PostgreSQL, as the data management system. Finally, MySQL, which is familiar to developers, and has features such as Oracle database, was selected.

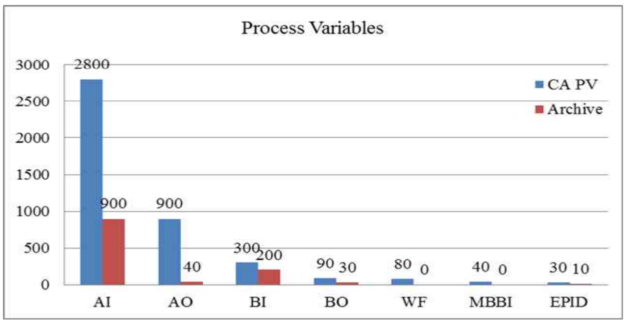

Fig. 3. Process variables (PV) for channel access (CA) PV and archiving PV.

MySQL has excellent engines, such as MyISAM, InnoSAM, Archive, and so on. If used appropriately to suit the purpose, MySQL can be great relation database archive for the data management system. After considering transactions, the locking level, and the data cache, we chose InnoDB Engine of MySQL, which supports three types, to give the maximum performance when processing large amount of data, such as Oracle. The data management system is classified into two categories, DB server and archive engine.

For the first beam commissioning, there are three databases and one archive engine server. Figure 4 shows that experimental data, linac operation data, and alarm data are stored in each of three distributed databases. The engine server that takes PVs from IOCs has an alarm engine and an archive engine, which transmit the collected data to the DB servers.

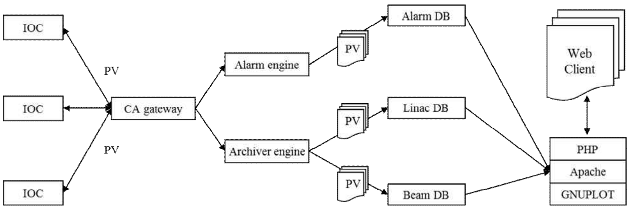

Fig. 4. Architecture of the data management system using the relational database (RDB) of MySQL.

The Web-user interface on the control system can search PVs in MySQL databases. The web application is implemented in personal hypertext pre-processor (PHP), hypertext markup language (HTML)-embedded scripting language which allows web developers to write dynamically-generated pages quickly. Finally, graphical-plotted images are displayed on a web browser by using Gnuplot.

4. Conclusion

This study has been focused on the design and the implementation of the data management system for the initial beam commissioning of the KOMAC 100-MeV proton linac. Most of the experiment data with the distributed control systems can be stored and retrieved by using data management system.

Acknowledgements

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