

NEW CONTROL SYSTEM OF THE LNS LINAC

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Abstract

The control system of the 300MeV-electron linear accelerator in the LNS (Laboratory of Nuclear Science, Tohoku University)[1] has been renewed. The new control system consists of PCs running Windows2000 and PLCs playing a role of IO Controller (IOC). COACK[2] was adopted as the management software to control the accelerator, and a database handling function was added to enhance the flexibility. The IOC software and the user-interface are composed of programs developed in Visual Basic and commercially available components (ActiveX Components). Construction of the basic framework has been completed, and more than 50% of the device connections, from the old control system to the new one have been changed so far.

1 INTRODUCTION

A 300-MeV electron linear accelerator (LINAC) was built in 1967 and has been working to produce a high intensity pulsed beam which is used in a wide range of research fields including nuclear physics, solid state physics, radiochemistry, material science, biology and so on. A 1.2-GeV electron synchrotron called the Stretcher-Booster ring (STB ring)[3] was completed for more advanced research of nuclear physics in 1997. In addition, a laboratory for new experiments has been constructed.

It was requested that the control system would be able to operate the LINAC not only from the central control room but also from other rooms by the time the new experiments began, and it was also necessary to have flexibility in order to extend research of accelerator science. The old control system, which was modified in 1985 to be a computer controlled system operated from workstations, was not necessarily enough to fulfill these requirements. Therefore, we planned to renew the LINAC control system in 2000.

2 POLICY OF THE NEW CONTROL SYSTEM

We have analyzed issues relating to the previous control system and requests to the LINAC operation methods, and then developed a basic policy for the new control system.

The previous system was composed of a workstation as the central computer, with original local network. The LINAC devices were controlled by a commercially available board computer, which used an original bus and the OS-9 as an operating system. The application program running on the workstation and the board computer was

developed by C. However, some problem had arisen recently. One of the problems was that trouble-shooting at malfunctioned equipment had become difficult because the workstation and the board computer were not available in the market. Another problem was that the replacement with a new computer was difficult since the original computer network being used could not be extended.

There was also the request that the new control system should have flexibility for accommodating new experiments as described in the foregoing section. In addition, it was necessary to prepare a development environment permitting a large number of staff to participate in development work in order to raise the development efficiency of the control system. At the time, this work was being done by only a limited member of people.

We decided the following fundamental policy in consideration of the matters mentioned above.

- Use of personal computer running Windows2000.
- Use of Visual Basic as the development environment.
- Use of COACK for system management.
- Use of PLC for control of the old LINAC devices.

3 STRUCTURE

In the next section, details of the control system based on this fundamental policy are described.

LINAC is constructed with various devices, and it can be grouped into function as follows.

Linac	Gun	
	RF	RF Driver
		Klystron
		Attenuator
		Phase
	Magnet	Focus Coil
		Q Magnet
		Steering Coil
		Beding Magnet
		ECS Magnet
		Switch Magnet
		Deguss Magnet
	Monitor	Beam Profile Monitor
		Beam Loss Monitor
		Current Monitor
	Vacuum	Ion Pump
Sub Pump		
Valves		
Cooling System		
Operation		

1 Gun, 2 RF, 3 Magnet, 4 Vacuum, 5 Monitor, 6 Cooling System, 7 Console, 8 Others

Table 1: LINAC devices list.

Each group can also be classified into smaller groups as shown in table 1. We have, accordingly, decided that a small group is a unit of an Input-Output-Controller (IOC) configuration and of the program for the control of the LINAC devices.

A PC running the COACK server forms the kernel of the control system, and relays all messages to the clients; therefore a large CPU load is anticipated. Accordingly, a PC with a high-performance CPU (PentiumIII-xeon 933MHz 2CPU) has been selected for the COACK server.

3.2 Software

In this section, we describe about the declaration of class structure using COACK features of the IOC devices, the program components used, and the management of

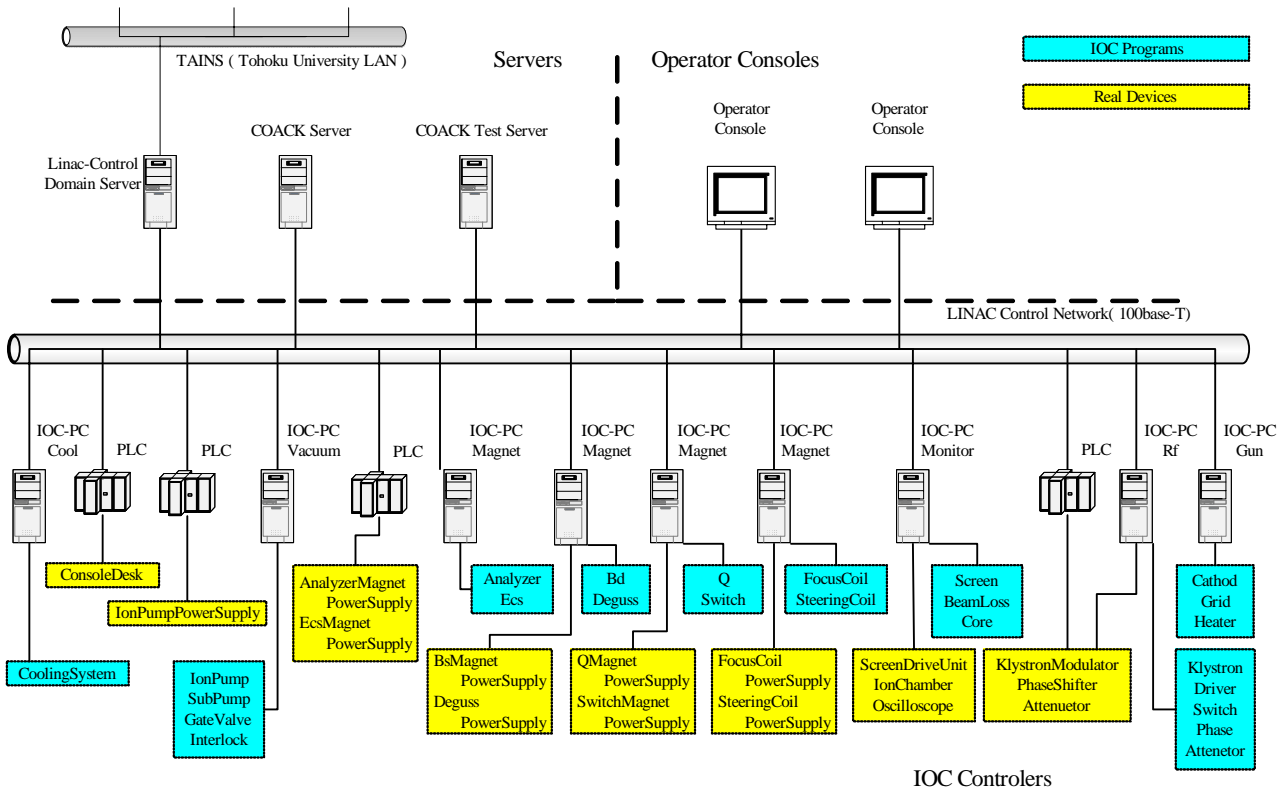


Figure 1: Structure of new control system of the LINAC.

3.1 Hardware

The structure of the hardware is simple, as shown in figure 1. The hardware can be classified into three categories (operator console, IOC, and server for management of the control system) by each function.

A PC used as IOC has, as far as possible, been used in only a basic configuration. For that purpose, boards with special functions such as digital input/output and analog input/output, etc. have not been installed. These functions, which were needed for the LINAC devices, have been achieved by using the PLC. As a result, all PCs have the same configuration, and quick recover from malfunction or even total breakdown will become possible by exchange with other PCs.

It is also possible to exchange the PLC with another one just by rewriting the PLC definition file, and it is not necessary to rewrite the program on the PC using a PLC program component, as described later.

IOC programs.

3.2.1 COACK and Device class

The controlled system devices are defined as Object-class in COACK. In generally, the definition way of the class is variously considered. They are an abstract expression such as magnets and vacuum, and a direct expression of the control device such as CAMAC and PLC, and others. The LINAC devices have been classified with each function of the control system as already mentioned, and the classes have been defined using this classification. In the definition of such classes, IOC program rewriting is not needed even if the device is exchanged.

3.2.2 Program Component

Software houses sell a variety of program components (ActiveX component) at present. Even the development environment of the component such as Visual Basic has been released, and it is possible and easy to make

components oneself. The Windows system itself also consists of a combination of components. Accordingly, selecting and using these components will simplify the programming of the control system. For the reasons stated above, the following components have been used to develop the control system.

- COACK standard components.

These are the standard components attached to COACK.

- TransportIcon - Securing of the session to the COACK server.
- CustomCommandButton - Making of the COACK commands.
- SessionManager - Monitoring of the session between clients and server.
- ClassBuilder - Obtaining information of the device class in the server.

- Commercial components

- FA-Engine[4] - This component controls the PLC, and corresponds to industrial PLCs supplied by many companies.
- Component-Works[5] - This component offers functions of the graphical user interface (GUI) elements such as graphs, buttons, indicators, and configuration of GPIB instruments.

- Components for enhancing COACK function.

COACK has a mechanism of adding a new function.

We have enhanced the COACK function using this mechanism.

- Database[6] - This component enhances the database

function which COACK has.

- Restore - This component restores the content of cache[7] when the COACK server is restarted. COACK retains the status of the IOC devices as a property value into cache. A problem on the IOC devices behaviour occurs since cache is initialized at the COACK server restart. Thus, this component is necessary to avoid these problems.

- Management of IOC process

PCs for running of the IOC program are usually put in a separate location. If a problem occurs on the IOC program, you have to go there to deal with it. We believe that this is an inefficient method and such work should be done through a remote operation. COACK has a function to monitor the session between the COACK server and the IOC program. If the session is broken for some reason, the information about the IOC process cannot be obtained, so it is necessary to monitor the state of the IOC process directly. We have therefore created a special component for managing the state of the PC and IOC process.

A component which bundles, the following functions, has been created by using WMI of Windows[8]. The Class diagram of this component is shown in figure 2.

- Monitoring the session between the COACK server and client.
- Monitoring the condition of the IOC program.
- Monitoring the condition of the PC.
- Starting and stopping the IOC program.
- Shutdown and reboot of PC.

(The WOL function is necessary for remote start of PC.)

4 CONCLUSION AND FUTURE

Program development has been easily achieved by utilizing the COACK, the program components and Visual Basic. Operation of the new system has begun (expect for a part – the electron gun, a part of the magnet power supply), and it is running well. We will make to deploy the excluded part by end of this year. In future, we will also generalize various components created while constructing the control system, and provide them as a standard COACK function.

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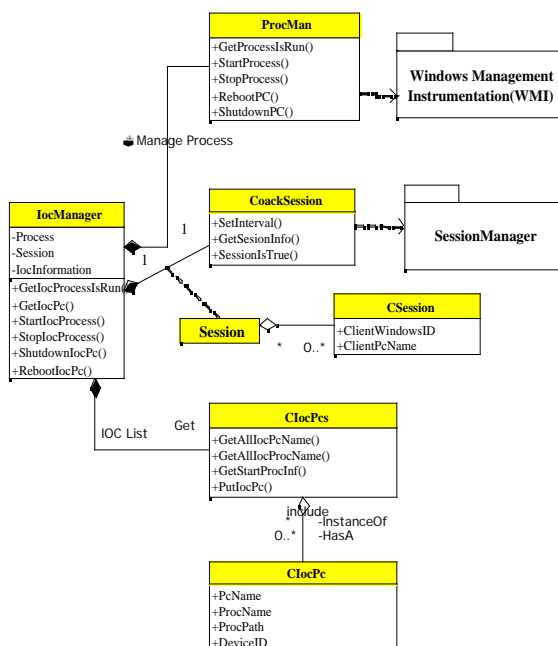


Figure 2: Class diagram of IOC Management Component.