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U-70 PROTON SYNCHROTRON EXTRACTED BEAM LINES CONTROL SYSTEM MODERNIZATION

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Abstract

A 70 GeV Proton Synchrotron Extracted Beam Lines Control System is described. Approximately 130 Magnet Dipoles and Quadrupoles, 20 Correction Magnets, 50 Beam Collimators, and BPM equipment spread over 1 Km have to be controlled. The old system was based on the PDP-11/40 and LSI-11 compatible computers and the MIL 1553 STD as a Field Bus. It successfully operated about 15 years. A new system includes home made Equipment Controllers based on I 8051 Processors, CAN Field Bus, FECs, Servers, Consoles connected by Ethernet. On the first stage of modernization, PDPs and LSIs are replaced with PCs connected by Ethernet. Equipment controllers are being successfully tested in the Collimators and Corrector Magnets control during a run.

1 INTRODUCTION

The Extracted Beams on the Serpukhov 70 GeV Proton Synchrotron are spread over 1 km. They include approximately 130 Magnet Dipoles and Quadrupoles, 20 small Correction Magnets, 50 Beam Collimators, BPM, vacuum, interlock and other equipment. The Power Supplies (PS) of the Dipoles and Quadrupoles are installed in the special building 500m away. Total number of the I/O signals about 1500.

The old Control System was designed in the early 80s [1]. It included PDP-11/40 compatible Host Computer, two LSI- 11 compatible FECs, and five MIL 1553 Field Buses to distribute the digital commands to the PSs. The old system was also used to connect two Beam Control Rooms with the PS Building Control Room, Digital Voltmeters and distributed multiplexers for the control of the magnets current. During the 10 years of operation, the system demonstrated high reliability, but heavy condition electronics, as well as time, caused the system to degrade. A major disadvantage was the slow (tenths of seconds) setting of regimes. A parallel access to the equipment from different control rooms also was impossible.

A new project is based on the standard 3-layer model. The backbone of the system is an Ethernet LAN connecting a Power Supplies Building with the Beam Lines area including experimental control rooms. The three layers consist of an upper level presented by PCs, a middle level by special Field Bus controllers GPFC [2], and a lower level by home-made Equipment Controllers (EC). GPFCs and ECs will be implemented on the second stage of upgrading, after testing with a small group of equipment. On the first stage, implementation of PCs connected by Ethernet was performed without changing interface electronics.

2 SYSTEM ARCHITECTURE

The layout of the control system is shown in Figure 1. There are three main groups of controlled equipment. The most numerous are Dipoles and Quadrupoles PSs in the PSB. They are connected to PCs in the PSB Control Room by four MIL 1553 Field Buses. A CAMAC Crate houses relevant Bus Controllers. Field Bus is used for distribution of regime digital commands to DACs of PSs. Control of regimes is provided by means of distributed Analog Multiplexer connecting PS Shunts to the Digital Voltmeter. A Status Register is used for controls of polarity, water cooling, etc.

A second group of equipment is the low current PSs of Correction Magnets distributed along Beam Lines. They are controlled from two Beam Control Rooms in the same way.

A third group are Beam Collimators. The multiplexed Collimator Controllers (CAMAC modules in two Beam Control Rooms) perform position control with help of shaft encoders and length modulation controls of DC Motors.

3 THE SOFTWARE DESCRIPTION

The software is developed under MS Windows 98/NT using Visual C++/Visual Basic and client-server approach based on DCOM (Figure 2). The configuration of the PSs is placed in the Microsoft Access database.

The complex data exchange between different PCs in the different buildings and user-friendly interfaces are available. The powerful database tools provide different possibilities in the post-mortem analysis, easy configuration, and extensibility of the data tables.

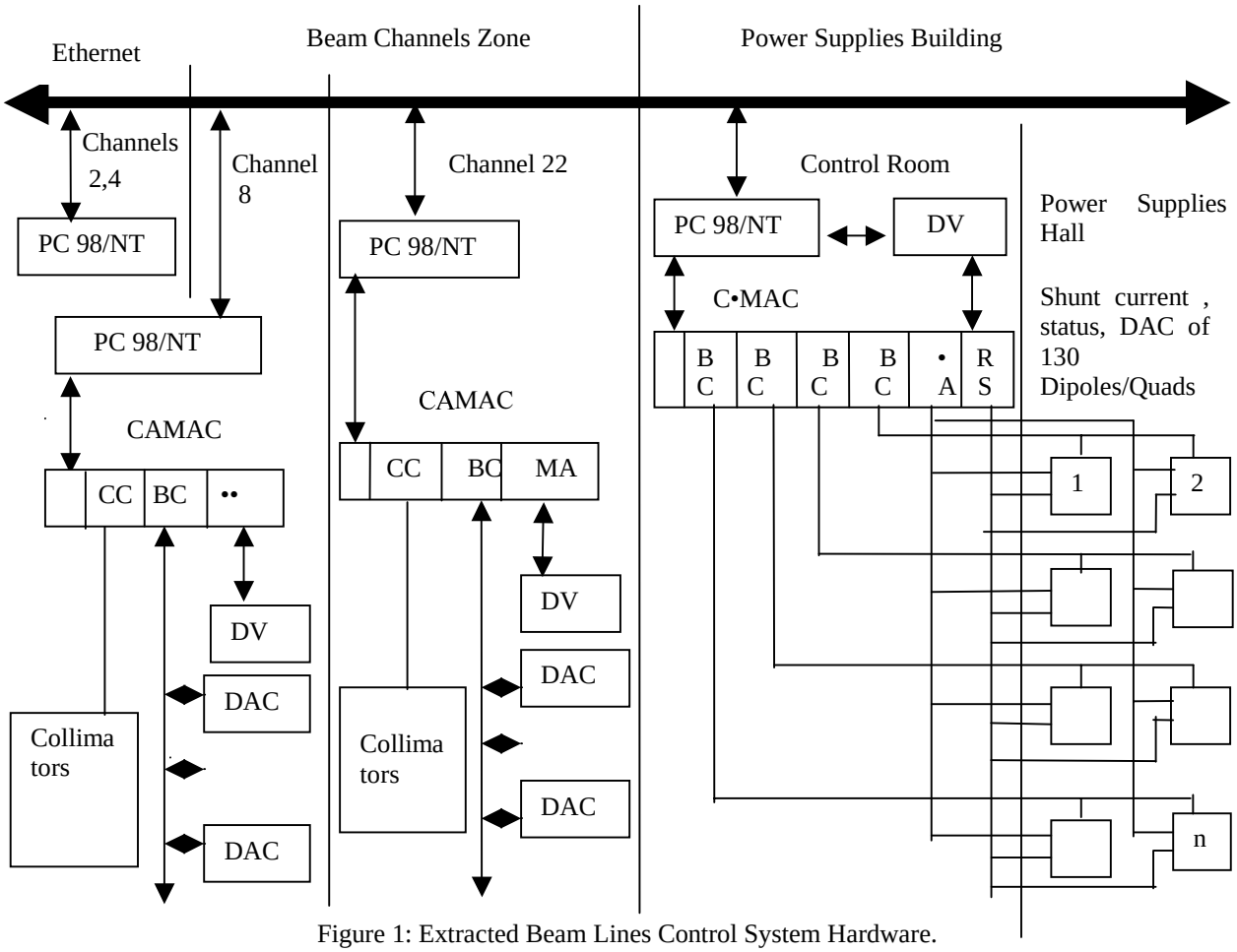

Figure 1: Extracted Beam Lines Control System Hardware.
CC – Collimator Controller, BC – MIL 1553 BUS Controller, MA – Analog Multiplexer,
DAC – Digital to Analog Converter, DV – Digital Voltmeter, RS – Status Register.

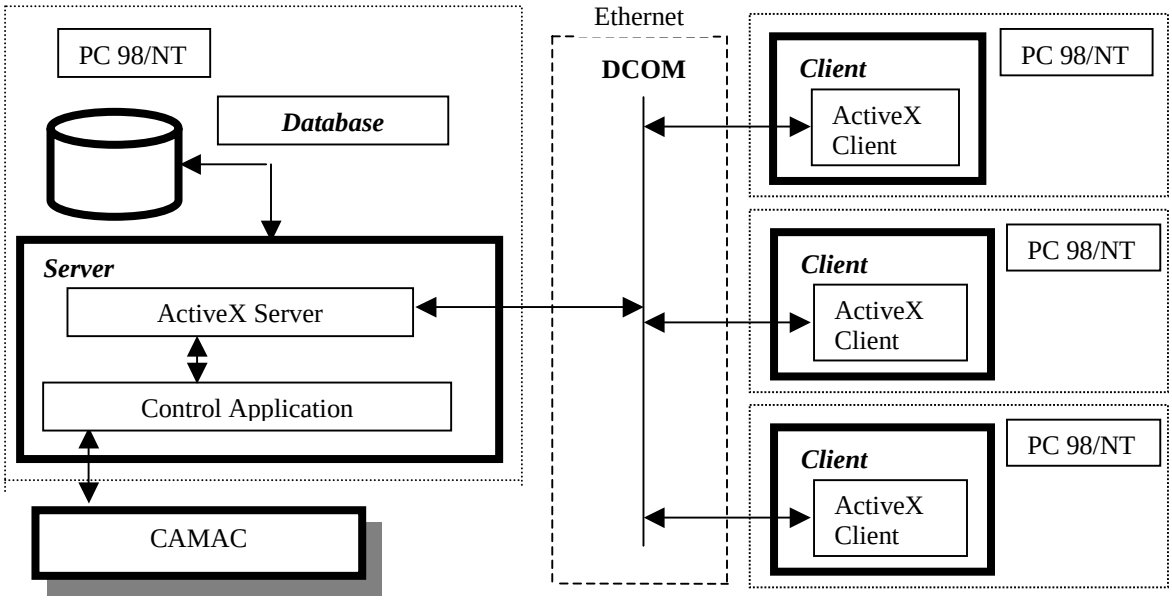

Figure 2: The structure of the Power Supplies control system software.

Control of the PSs from the different control rooms in more convenient ways is also available, and the conflicts with the simultaneous access to the equipment are down to a minimum.

New features to access the data through the web browsers have been added.

The implementation of the equipment controllers on the second stage of the upgrade will provide parallel access to the Power Supplies and Collimators.

REFERENCES

[1] Preprint IHEP Protvino 88-73, Protvino, Russia, 1988.

[2] A.Matioushine at al., A Configurable RT OS Powered Fieldbus Controller for Distributed Accelerator Controls, Proc. Of ICALEPCS'97, Beijing, China, November 3-7, 1997, p.321.