NUCLOTRON CONTROL SYSTEM. PROSPECTS OF THE PROGRAM COMPLEX DEVELOPMENT

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Abstract

From the March 1993 twenty-seven runs of the superconducting synchrotron Nuclotron have been performed by the present time [1]. Successful operation of the accelerator depends on efficient work of the Nuclotron Control System (NCS) [2] which provides machine functioning during all runs.

The one of the NCS integral and essential parts is Nuclotron Program Complex (NPC) that supports such functions as data acquisition, processing, storage and browsing of the on-line and archive data [3]. At present time NPC is presented by the wide and various set of program tools and applications.

NCS PROGRAM COMPLEX

Introduction

The NCS consists of two physical levels: an Operator Control Level and a Front End Level. The Front End Level comprises both industrial personal computers (IPC) from ADVANTECH with peripheral specialized data acquisition modules and intelligent CAMAC crate-controllers with embedded micro-PCs and outer modules connected directly to the IPC bus.

The second level consists of servers and workstations which compose the Nuclotron Local Area Network (LAN), the subnet of the LHE General Ethernet Network. Novell NetWare 5.1 is the Nuclotron subnet network operating system. The NCS supplies all appropriate man-machine tools and control programs for operators to run the accelerator.

NCS General Layout

As a part of the NCS, the software development was begun with the accelerator construction. And it is in a progress at present time. The NCS is a distributed system. Its subsystems are 500 m spaced from one another. So geographically it is separated on four parts, while the LAN comprises four independent segments (Fig.1).

At present time NCS provides control functions and data browsing for such subsystems as thermometry and cryogenics, radiation safety, beam injection and beam diagnostics on the first turns, circulating and extracted beam diagnostics, beam lines in the experimental hall, slow extraction system, main power supplies, magnetic field correction, radio frequency and alarm system.

Interface usability and program functionality depend on both the program development instruments (language, environment, tools, available packets and libraries) and PC's high performance capabilities which are used for program developing, testing and debugging processes. Also we should take into account the network structure and throughput which determine remote program interaction.

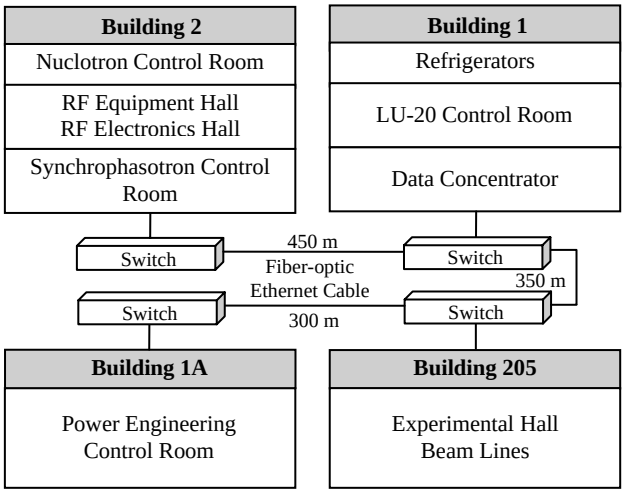

Figure 1: NCS general layout.

Previous NPC Structure

NPC evolution progress went through the following phases. At the beginning such languages as C and Assembler were used for programming and programs were running under the DOS. Computers in segment were connected with a thin coaxial cable, while the segments between each other had connection through the thick coaxial cable with 10 Mb/sec throughput capacities. All the data and executive programs were placed on the file-server under the Novell NetWare 3.11 network operating system control (Fig.2).

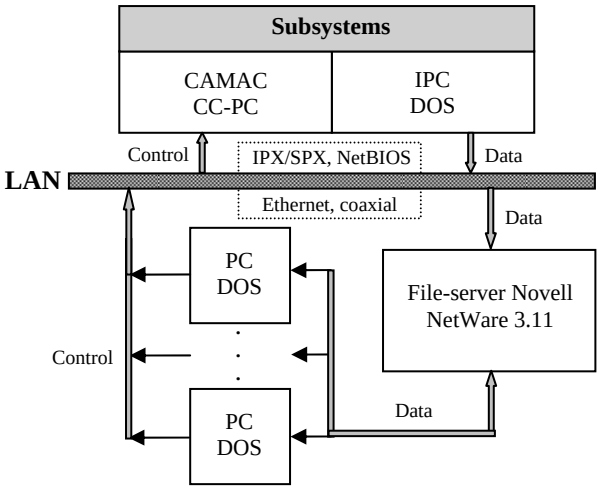

Figure 2: Previous NPC structure.

IPX/SPX and NetBIOS protocols were used for data transmission while the control executive modules and programs for data browsing with the cyclic and archive data files were placed on the server. In that way a single file-server played the role of the centralized data storage. And it was the place where the most of programs have been lunched from. At the same time the complete information set about the status of the whole machine and its parameters was available in the dynamic runtime database which being updated each accelerator cycle. Access to the database information was gained by the consoles independently in order to display relevant parameters about the elements required by the operators. Accordingly, the information can be both observed on display screens, and processed and written on hard disks together with experimental data for future off-line physics analysis.

Current NPC Structure

Further, the network gateway with embedded web-server was used. First version of the Nuclotron web-page was designed and the thermometry subsystem java-applet has started successfully. Thus HTML and Java technologies were involved into the work.

Due to the server and PC re-equipment in 2002, network functioning was placed under the Novell NetWare 5.1 network operating system control. Main Control Room was the first where twisted-pair cable has been used for connection between the computers in segment. Using object-oriented programming, first applications with modern GUI were created and successfully tested. Web-server (Apache 3.12) installed on updated server platform and enhancements of the network structure allowed extending access to the renewed Nuclotron web-site.

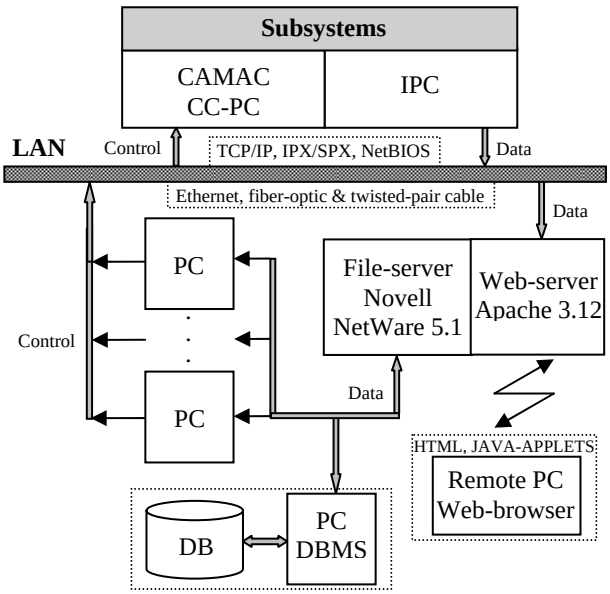

Figure 3: Current NPC structure.

It has increased the number of java-applets up to four. Thus one could have remote access to whole the data available for operators in Control Room through the web-interface and browse information from such subsystems as thermometry, magnetic field cycle, slow extraction system and beam intensity.

In 2003 the development of the database application for the storing of the accelerator operation modes parameters was begun. In future the mode statistics gathered during the accelerator runs will allow operators to find the nearest to the required mode from the saved and load the most of subsystems by necessary parameters. During the last three runs this application was successfully tested and improved, while the initial statistics being gathered.

As a result at present time we have the following NPC operation layout presented in Fig.3.

Possibilities and Improvements

Consequent enhancement of the network and computing equipment as well as using of modern software development kits supposes a new data exchange method to be applied. It includes client-server architecture and application of TCP/IP protocol stack. In that way the server (front-end program) will register clients (control and observing programs) which interested in having the data (parameters) from (of) any subsystem. With information being updated during the last acceleration cycle, server-program transmits renewed data block only to the registered client-programs by-passing the file-server. It allows file-server to avoid excessive requests and disk read/write operations, and to keep only archive files associated with records in the separate database which will be developed for easier and faster search of the information.

Accordingly, during the last accelerator run the beam slow extraction feedback control system based on the client-server architecture was successfully tested. Similar projects for other subsystems are under designing and creation now. All this will allow in the near future improve the Nuclotron Program Complex reliability, operation efficiency and control functions.

REFERENCES

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