NEW AUTOMATED CONTROL SYSTEM AT KURCHATOV SYNCHROTRON RADIATION SOURCE BASED ON SCADA SYSTEM CITECT

V. Dombrovsky, A. Dorovatovsky, Ye. Fomin, E. Kaportsev, V. Korchuganov, Yu. Krylov, K. Moseev, L. Moseiko, N. Moseiko, A. Valentinov (NRC Kurchatov Institute, Moscow, Russia), Yu. Efimov (CJSC RTSoft, Moscow, Russia)

Abstract

The description of new automated control system of Kurchatov synchrotron radiation source which is realized at the present time is presented in the paper.

The necessity of automated control system modernization is explained by the equipment replacement in which we take state of art hardware decisions for facility control and increase the processing and transmitting data speed are considerably increase and the requirements to measurement accuracy are become more strict.

The paper presents the detailed description of all control levels (lower, server and upper) of new automated control system and integration of SCADA system CitectSCADA v.7.2 into facility control system which provides the facility control, alarms notify, detailed reports preparation, acquisition and storage of historical data et al.

INTRODUCTION

Kurchatov synchrotron radiation source is the 2nd generation light source. It consist of LINAC (pre-injector) with electron beam energy of 80 MeV, electron booster synchrotron SIBERIA-1 with electron beam energy 450 MeV and main storage ring SIBERIA -2 with electron beam energy of 2.5 GeV. The storage ring SIBERIA-2 is a main synchrotron radiation light source in the hard X-ray spectrum. The booster synchrotron SIBERIA-1 is both booster synchrotron and independent synchrotron radiation light source in the vacuum ultraviolet and soft X-ray spectrum.

At the present time we carry out different works to upgrade and improve consumer quality of synchrotron radiation beams. In particular, new synchrotron radiation beam lines and user's experimental stations are constructed, new systems are installed, a replacement of some execution units and control electronic devices is carried out, acquired, stored and analyzed data are progressively extend, the requirements to quality of synchrotron radiation and electron beams are made more stringent and much more. All of that essentially complicates the further development of the existing control system. In addition, in some case, we will not be able to realize some required tasks (for example, we will not be able to essentially increase the speed of data acquisition and processing). The development and implementation of new automated control system using state of art hardware decisions and software will be the best decision.

NEW CONTROL SYSTEM

New automated control system essentially differs from previous system. New control system has multilevel equipment structure and uses a distributed control system instead of centralized used in the previous system. This allowed to increase the reliability of the control system, reduce the time and hardware resources on any data operation (read, write, processing), increase a flexibility and improve a performance of new control system.

All equipment involved into facility control system (operator's work stations, servers, crates with single-board computers, microcontrollers, oscilloscopes) are connected to a local network divided hardware on 3 levels: lower, server and upper level (see Fig.1). The organization of such a three-level local network allows to restrict access to the execution units thereby increasing reliability of the accelerator facility.

Lower Level

At the lower level of new control system acquisition of diagnostic data, execution of local and global facility technological systems control algorithms are carry out. The main part of the equipment used at this level are VMEbus standard equipment. The main units performing the required algorithms are VME single-board computers Emerson MVME5500 based on the PowerPC MPC7457 processor and the Marvel GT-64260B host bridge with a dual PCI interface and memory controller. On single-board computer real-time operation system LynxOS v.4.2 and special software are operated. In some cases, we will be use the equipment of such companies as National Instruments, Tektronix, I-Tech, B&R etc. or an unique equipment of our own design.

There are 8 subsystem at this level. Each subsystem controls only a certain part of the accelerator complex.

The vacuum subsystem controls a power supply of vacuum ion pumps. As opposed to other subsystems this is stand-alone subsystem and have no connections with any external equipment at lower level. All vacuum subsystem equipment is connected with the help a separate CAN-network only to the vacuum server at the next (server) level.

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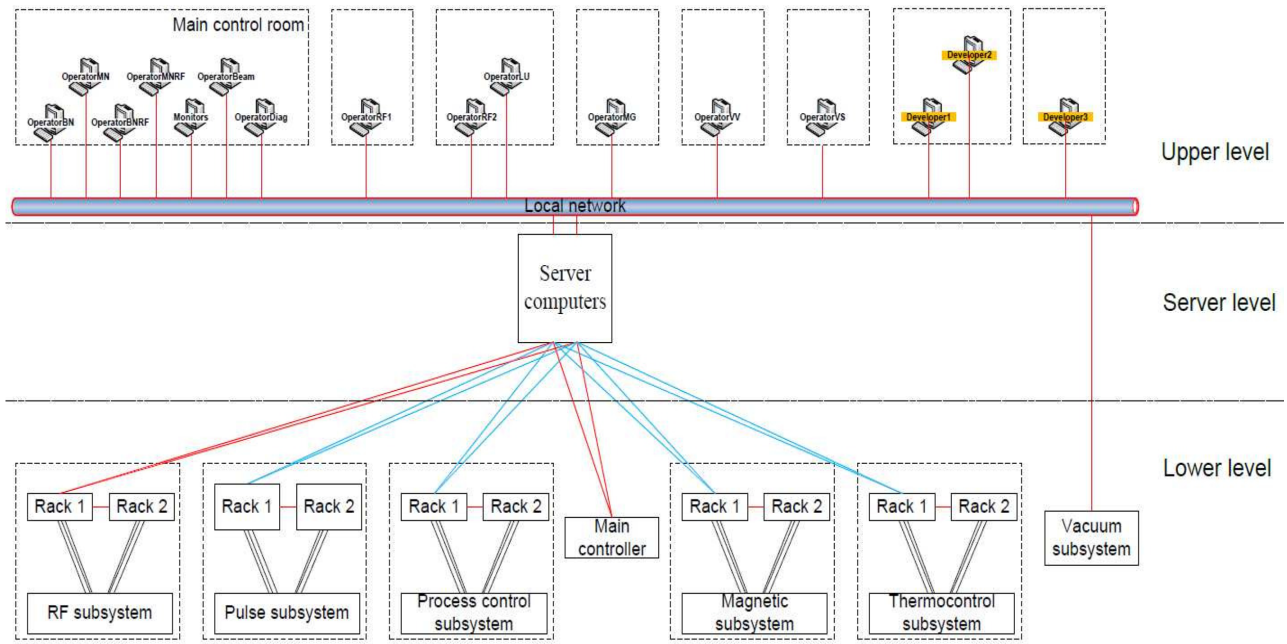

Figure 1: The layout of new automated control system at Kurchatov synchrotron radiation source.

The magnet subsystem controls a high-current power supply of linear optic elements and a low-current power supply of steering magnets and nonlinear optic elements. As well as this subsystem controls a power supply of the superconducting wiggler and measures the temperature of liquid helium in the wiggler tank.

The RF subsystem controls the parameters of RF generators and cavities of main storage ring SIBERIA-2 and booster synchrotron SIBERIA-1 as well as the klystron station which is the source of SHF power for LINAC.

The thermocontrol and thermostabilization subsystem at all times measures the temperature at many different points of the injector, booster synchrotron and synchrotron radiation source. In the case the temperature at any point will be so high (over critical value) the thermocontrol subsystem turns a critical subsystem.

The diagnostic subsystem measures different parameters of the electron beam (for example, electron beam current and life time, electron beam global reference orbit, betatron frequencies, etc.).

The pulse subsystem controls a power supply of pulse elements such as electron gun, inflectors and septum-magnets. Also this subsystem generates pulses with different time delays to control the electron beam transfer between injector, booster and main storage ring.

The time subsystem provides time synchronization on all equipment included in the control system. Between different subsystem we use NTP protocol for time synchronization with ~0.5 ms precision. Between different devices into the one subsystem we use IRIG protocol with ~0.02 ms precision in the case of distributed subsystem or our own protocol with the same precision in the case of concentrated subsystem (for example, several VME single-board computers in only one crate).

The process control subsystem realizes a direct control of all subsystems. For example, it controls electron beam energy ramping process or beam transfer between different accelerators. As well any global control algorithms (global or local electron beam reference orbit correction, photon beam stabilization at user's beamlines, etc.) or mathematical data processing are performed by this subsystem.

A creation of distributed control system at the lower level allows to easily step-by-step commission process into several stages with minimum links between old and new control systems during commission. In addition, there is a good flexibility in operation such system and adding new control channels.

Server Level

The server level of new control system consists of application servers and database server. This servers are operated under Microsoft Windows Server 2008 operating system.

The full-featured system for monitoring, control and data acquisition CitectSCADA is operated on applications servers. We have 4 application servers combined into 2 redundant clusters. The first cluster controls pulse and RF and process control subsystems. The second one controls vacuum, magnetic, thermocontrol and thermostabilization subsystems.

To store the data about current state of the accelerator complex the data acquisition and reporting system CitectHistorian v.4.3 is used. This system based on database management system Microsoft SQL server 2008. In addition, this DBMS is used as follows:

- the common database to store information about input/output channel parameters and description (for example, critical values, conversion factors, sampling rate, etc.);

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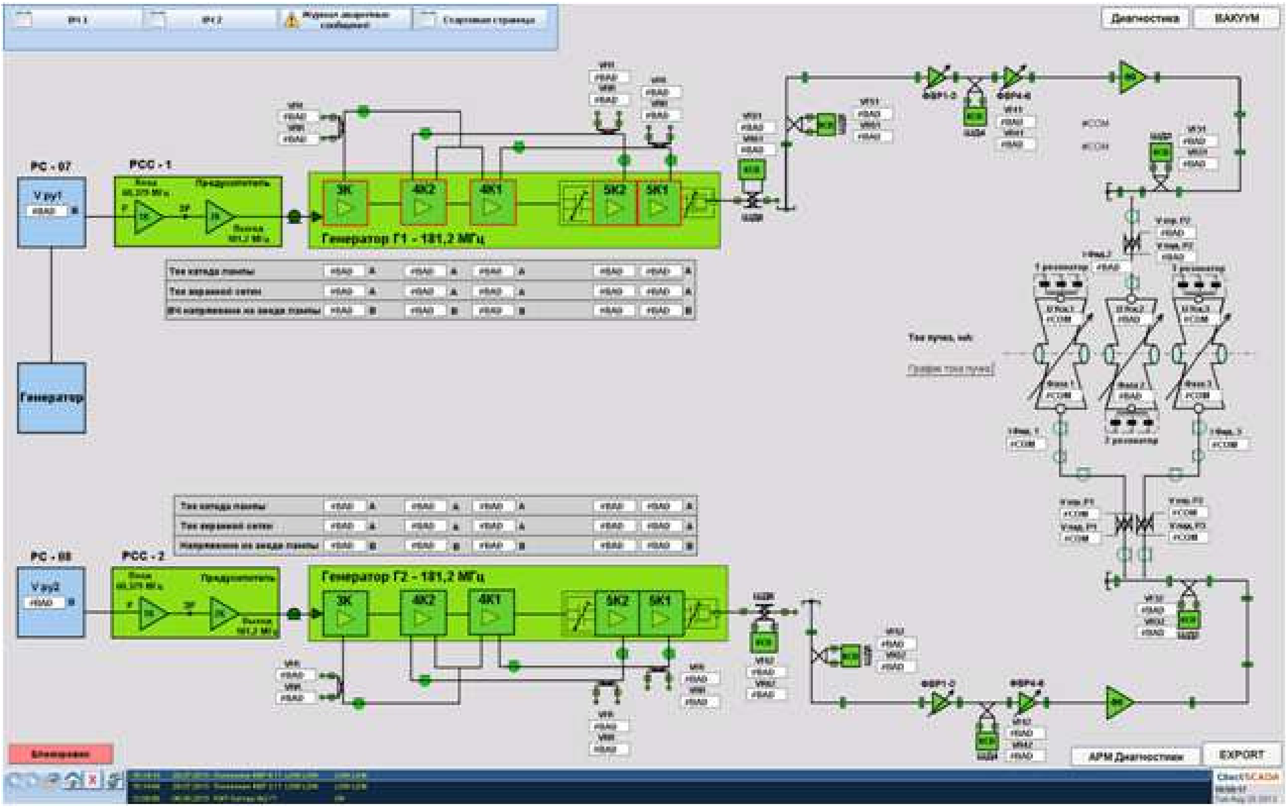

Figure 2: The example of the RF subsystem control user graphical interface.

- the database to store information about state of facility systems with high sampling rate at the time of emergency or alarm.

At this server level the following are realized:

- algorithms assignment;
- the data exchange between single-board computers, controllers, servers and operator's workstations;
- monitoring of the facility operation and some mathematical data processing;
- operator sessions logging;
- data storing into the database;
- data acquisition and processing on user's requests.

Upper Level

The upper level of new control system includes automated operator's workstations, workstations of technology services staff and the facility users. At this level, as well as server level, the system CitectSCADA is operated. But at this level the CitectSCADA has other tasks, namely:

- the processes visualization in graphical mode;
- alarms control;
- the detailed reports preparation;
- statistical process control.

The example of an user graphical interface you can see at Fig.2.

COMMISSION

Because of impossibility to fully commission of new control system without facility shutdown for a long time this process will be occur step-by-step. At the present time we commission vacuum and RF subsystems, as well as, the thermocontrol subsystem at the receiver of synchrotron radiation from supperconducting wiggler.

The first experience with new control system has achieved all its points. From the operator viewpoint the most important points are clear data presentation as the facility mimic panel or occurred alarms registration and operator notification into the automatic mode. From the scientific community viewpoint we obtain the opportunity to detail study the facility parameters on the request at any time.

CONCLUSION

New automated facility control system will be operated using modern equipment, provides all necessary information to operators and users in real-time and provides the scientific community a sufficient data archive for further study of the physical processes occurring into the facility.

The commission of new control system will allow to tune the facility more exactly and improve a quality of photon beam. We will be able to study any transient and breakdown processes in the detail.

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