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A Graphical User-Interface Control System at SRRC

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Abstract

A graphical user interface control system of 1.3 GeV synchrotron radiation light source was designed and implemented for the beam transport line (BTL) and storage ring (SR). A modern control technique has been used to implement and control the third generation synchrotron light source. Two level computer hardware configuration, that includes process and console computers as a top level and VME based intelligent local controller as a bottom level, was setup and tested. Both level computers are linked by high speed Ethernet data communication network. A database includes static and dynamic databases as well as access routines were developed. In order to commission and operate the machine friendly, the graphical man machine interface was designed and coded. The graphical user interface (GUI) software was installed on VAX workstations for the BTL and SR at the Synchrotron Radiation Research Center (SRRC). The over all performance has been evaluated at 10Hz update rate. The results showed that the graphical operator interface control system is versatile system and can be implemented into the control system of the accelerator. It will provide the tool to control and monitor the equipments of the radiation light source especially for machine commissioning and operation.

I. INTRODUCTION

A third generation synchrotron radiation light source has been constructed and commissioned at current stage in SRRC. It includes a turn-key electron injector (50MeV Linac and 1.3 GeV booster synchrotron), a BTL and a SR with triple bending archromat lattice [1]. Two level hierarchical computer hardware systems were linked by Ethernet and four layers software structures were configured to simplify the architecture of the control system. High performance workstations have been used as operator consoles and VME crate based intelligent local controllers (ILC) have been used to interface field level equipments. In order to access and control devices and equipments on the BTL and SR easily, a graphical operator interface technique was implemented on the control system of the synchrotron radiation facility at SRRC. This simple, flexible and expandable control system was used to commission the BTL and the SR of SRRC. Large than 10 mA stored beam and several tenth minutes lifetime was achieved quickly within short commissioning period.

II. HARDWARE SYSTEM CONFIGURATION

Two level hierarchical hardware architecture were adopted for the control system at SRRC [2]. The open system configuration ensure the expandability of the control system. The hardware system configuration of the control system at SRRC is shown in the Figure 1. Top level computers include a process computer which is VAX Systems 4000-500 supermini computer, several workstations (VAXstation 3100-76 and VAXstation 4000-60) running under VMS and one DECstation 5000-200 run under Ultrix acts as a file server for intelligent local controllers (ILC). Multiple ILCs at bottom level are use to interface with the field devices. Both level computers are linked by Ethernet network. The control local area network is also connected to the control system of 1.3 GeV full energy electron injector and laboratories wide network through multi-port router. All ILCs are used to monitor or control the equipment on the BTL and SR.

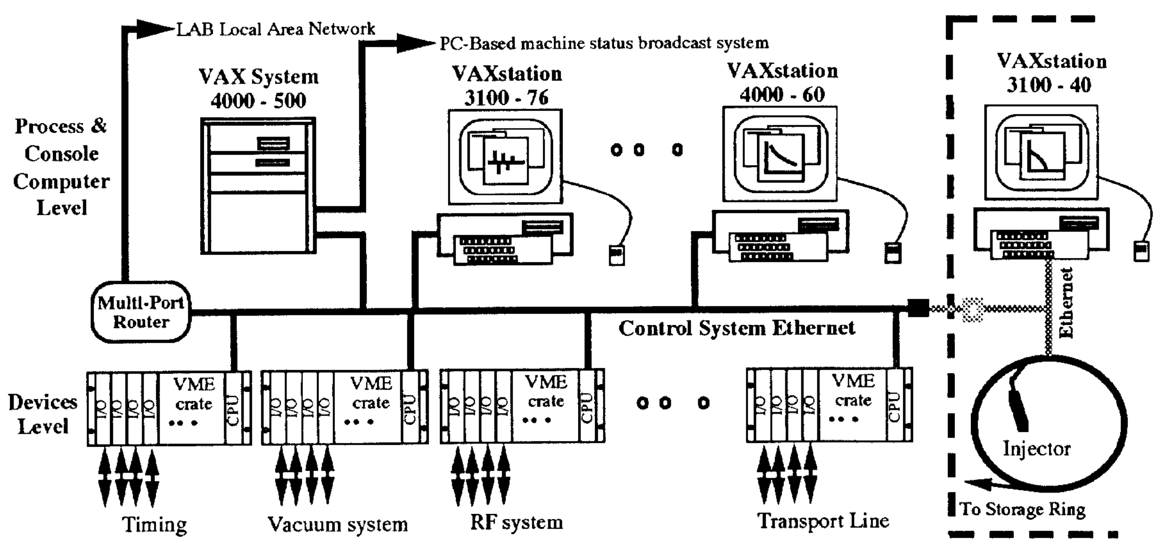

Figure 1. Hardware configuration of the control system at SRRC.

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The ILC is VME crate based system which includes Motorola MVME-147 CPU board and variety of interface cards. The MVME-147 CPU board consists of 68030 microprocessor, 68882 floating point coprocessor, 4M byte on board memory and Ethernet interface. The ILCs are connected to the hardware devices or equipments via parallel or serial input/output (I/O) as well as IEEE-488 bus interface. Data acquisition, open or closed loop control functions of the equipment are handled by ILCs. A device, such as magnet, pulse magnet, vacuum gauge/ion pump current or valve, RF controller, diagnostic instrumentation, can be accessed from operator console. The update rate of the dynamic data from ILCs to console computer is about 10Hz.

III. SOFTWARE SYSTEM

Software system has been developed by SRRC staffs using C language under VMS environment. The software is structured into four layers and is shown in Figure 2, there are device access, network access, database access, and applications. Real time database of the control system for the BTL and SR facilities at SRRC has been implemented and tested successfully. Modularized software designed approach ensured flexibility, expandability and maintainability of the system.

The device access processes are run on ILCs. The PSOS+ real time multitasking kernel provides the ILCs with task scheduling, memory allocation, event handling and message queueing. The PNA+ network package provides socket interface in TCP/IP protocols. Those software package are purchased from commercial available products. The control tasks and various I/O drivers as well as application programs were implemented at SRRC and are successful running on ILCs. In order to develop all the necessary software on ILC, VAX machine is used as a host and connected to the target ILC via Ethernet. Microtec cross C compiler, cross assembler, and S-record linker which are installed on the VAX machines are developing tools. The XRAY+ running on VAX is used to aid the software debugging. The developed software are downloaded in S-record format file to the desired target ILC to start the running activity on it. All ILC software package has been developed by two man-years and the result is quite successfully.

The network access software is in charge of the data exchange between console level computer and ILCs. The TCP/IP protocol is used to provide an open environment.

The console level computers are running under VAX/VMS environment. The function of the process computer and workstation is slightly different The process computer keeps the system-wide static database and maintains it. At the system start-up, each workstation requests and receive a copy of the static database form the process computer to achieve consistency. Each console computer then has all database information necessary to process dynamic

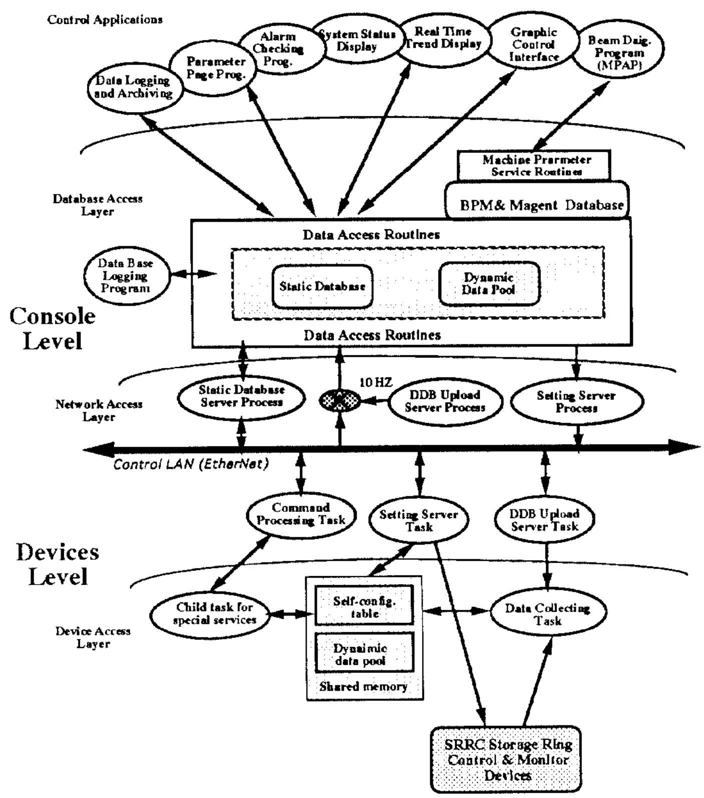

Figure 2. Block diagram of the software system

database frames received from ILCs. The upload command is broadcasted by an ILC which connects to 10Hz injection trigger signal then each ILC broadcast its dynamic database after receiving the command. The workstations are mainly for operator interface to operate the machine. All of the console level computers can be expanded easily without increasing the network traffic load.

The central database which includes the static and dynamic database are created on the console level computers. It is used as data buffer between the low level tasks at ILCs and console level applications. The application programs get equipment parameters or machine parameters directly from database rather than from ILCs. Many applications are coded and run at console computer, such as data logging/archiving, alarm checking, real-time multiple trend and correlation plot display as well as machine modeling programs.

The novel man machine interface technique is used to develop a graphical operator interface control system. The graphic user interface software was developed based on X-window/Motif. The graphic editor program was developed and used to edit the display pattern of the machine component and built up the relationship between the component and the static database. Those pattern file is stored in the hard disk by using ASCII file format. The console program reads those ASCII file and make a connection between the component pattern and dynamic database. This program is also capable of the data reading, setting and display of linked devices. Operator interface pages on workstation can be a simple spread sheet, a control panel of a subsystem shown as Figure 3 or object oriented form as show in Figure 4. The subsystem or components on BTL and SR can be accessed from workstation by mouse and keyboard. Multiple software knobs, multiple file trend display and correlation plot functions are also available. This man machine interface makes the machine commissioning or routine operation more easily and friendly.

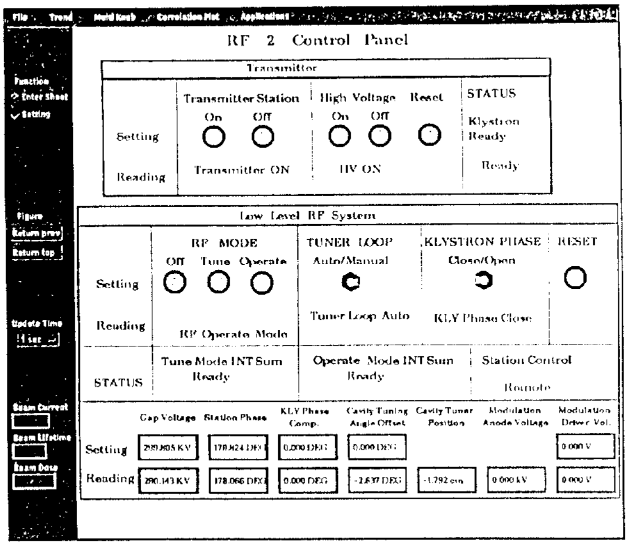

Figure 3. RF system control panel interface

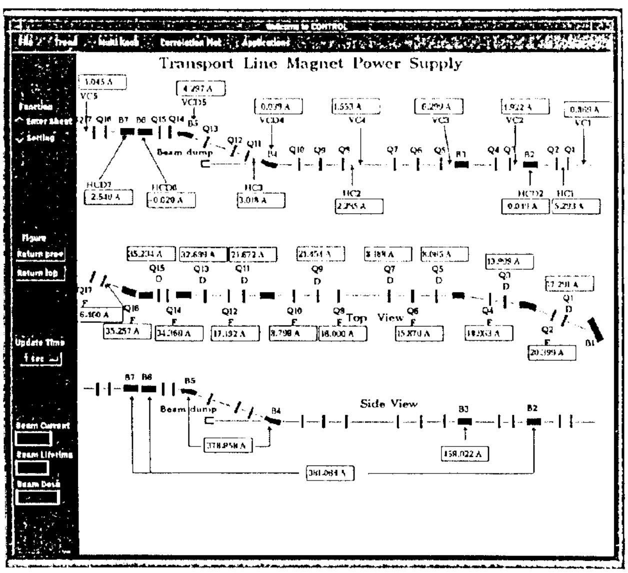

Figure 4. Trasnport line power supply control interface

IV. SUMMARY

Graphical oriented man-machine interface has been implemented on the control system for 1.3 GeV synchrotron radiation light source at SRRC successfully. It demonstrated that graphical operator interface of the control system are helpful for commissioning of the machine. Most of the design specifications has been achieved. The turning and modification of the control system now is under way to improve the system performance.

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