BEAM LINE CONTROL SYSTEM FOR BARC-TIFR SUPER CONDUCTING LINAC BOOSTER

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Abstract

LINAC control system is a distributed control system. Hardware is distributed geometrically for RF control and monitoring with four nodes for RF control[1][2]. Systematic distribution is applied by addition of different node for Beam line instrument control (BLS) which consists of different focussing magnets, steerers and beam diagnostics devices (Faraday cups and BPMs) and magnetic field measurement devices hall probes. All the focussing and diagnostics devices have their built-in microprocessor based electronic interfaces, which can be remotely accessed by RS 232/RS 422 link. The serial devices are connected to three different 16 port RS232 to Ethernet converter switch, which are connected to LINAC lab by Ethernet link. Multilevel software is developed in JAVA, with useful and attractive virtual panel interface provided by monitor and keyboard.

Keywords: BTS(Beam Transport System),LCS(Local Control Station), SDS(Serial Device Server),MPS (Magnet Power Supply system), FC (Faraday Cup), BPM (Beam Profile monitors), OIF (Operator Interface Front Panel), EIU (Equipment Interface Unit)

INTRODUCTION

LINAC is a superconducting Booster in which Heavy ion Beam is injected from 14 MV Pelletron Tandem Accelerator. The Super Conducting LINAC booster phase I was commissioned in year 2002 and Phase II with complete LINAC in year 2007. There are four control nodes for RF control. One node is added for the control of Beam Line devices Known as BTS (Beam Transport system). BTS is a multilayer system with equipment interface unit distributed along the LINAC booster and LINAC beam line (Fig 1). Two EIU nodes are kept in LINAC hall and one in LINAC beam hall. BTS LCS PC is located in LINAC hall.

All relevant Beam line Devices are connected to the nearest SDS (EIU) system. Various options are available to realise the system like RS485, RS 422 that are used to control serial devices. We have decided to use Ethernet as a control bus to maintain uniformity with already existing RF control system. Well-established TCP/IP protocol suite over Ethernet provides a reliable field bus for control system.

It is a data driven system giving complete configurabilty of the system by textual database table.

SYSTEM ARCHITECTURE

Facility is in operation from year 2002 and previously control of different magnetic supplies was carried out by micro controller based system which was using RS422 bus for different Magnet power supply systems. Beam diagnostics instruments were hard-wired. As the new beam lines were added to the system the choice was to be made for complete integration of the system with existing LINAC system. Also the standalone system is provided so that beam from Pelletron can be tuned to the Beam lines of LINAC without any further boost in energy. System is also capable of adding new devices as and when new beam lines of LINAC are installed over a period of time. Hence computer based control system architecture has been selected for easy reconfigurability and expandability of the system. A multi layer architecture (Fig. 1) has been realized for BTS.

All MPS are having their intelligent controllers which follow simple ASCII protocol for control and monitoring of the MPS. Other Beam Diagnostics units are indigenously developed Micro controller based devices[3] and support RS 232 communication. All these local controllers are connected to their nearest RS232 to Ethernet switch (SDS).

SDSs are interconnected to LINAC control network by Ethernet LAN. A PC connected to the LAN acts as a data concentrator which is named as BTS LCS. A graphical user interface has been provided as a separate application that can be accessed from anywhere in the control LAN. User Interface can be operated either from LINAC integrated control System or as a standalone system.

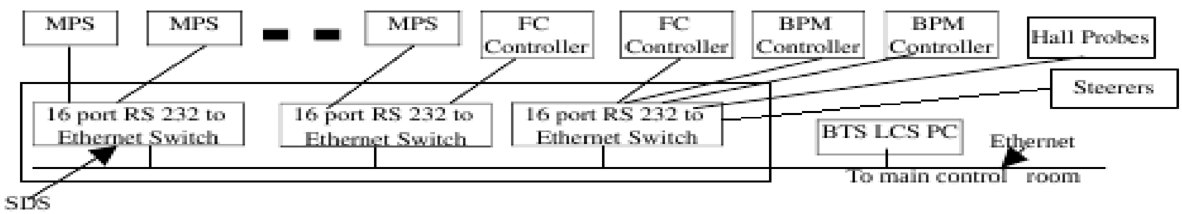

Figure 1: System Architecture

Equipment Interface unit consists of three sixteen port Serial to Ethernet converter supplied by MOXA [4]. It has 15 KV ESD protection for Serial line signals making it suitable for industrial control environment. It can be operated in Various modes (Real COM, TCP Client / Server etc) with maximum four connection for each port. All configuration for the Serial Device server can be done by a web interface supplied by the device vendor. TCP Server mode has been chosen for this system. Each Serial port has been assigned a unique port id and maximum connection has been limited to one to achieve accesses control. SDC has automatic reboot trigger by using its built in watchdog trigger timer.

BTS LCS is implemented on a PC which connects to all SDSs and provides services to operator interface. System can be simultaneously accessed from multiple Operator interfaces and necessary care has been taken for this purpose. In case of BTS LCS PC failure BTS LCS software can be started from any other node in the system which gives us inherent redundancy and reliability. All instrument controllers are intelligent controllers, status and control points of all the instruments are stored in the memory of local instrument controllers and BTS LCS. This feature provides a very good reliable system as they complement each other in case of failure, of any system.

SOFTWARE ARCHITECTURE

Control software is implemented in JAVA which uses TCP /IP protocol to interact between EIU - BTS LCS and BTS LCS- BTS OIF. All configurable databases are part of BTS-LCS. Simplified Software architecture is explained in fig 2. BTS-OIF connects the BTS LCS and loads the configuration database from BTS LCS .

BTS-OIF opens three threads with BTS LCS namely scan thread , Ctrl Thread 1 & 2. The scan thread updates the system status at the rate of 10 hertz .The Ctrl thread 1 and 2 are used to transfer control requests to BTS LCS. Using multiple threads for scan and control is very useful as it transfers the synchronization responsibilities to TCP/IP stack. Simultaneously two magnets can be selected and controlled. MPSs are grouped in two columns which can be configured by configuration database. Two keys are used for current changes (increase./decrease) for each magnet power supply. A group of keys have been ergonomically connected on the keyboard. Selection of Faraday cup and BPMs are realized by mouse.

A special Soft Panel Meter has been developed in JAVA, which displays the Faraday cup with automatic ranging. Soft panel meter needle has a hysteresis similar to the analog panel meter for smooth display of current changes in current value. A teslameter, used for Hall probe readout, provides the read back of magnetic field values automatically at periodic interval of 100 ms to 1 sec depending upon the rate of change of field values.

Software has been properly developed using object oriented principle. Separate GUI objects have been developed for Magnet control , Faraday cup and BPM panels, which gives us flexibility in integration of the operator interface in different configurations.

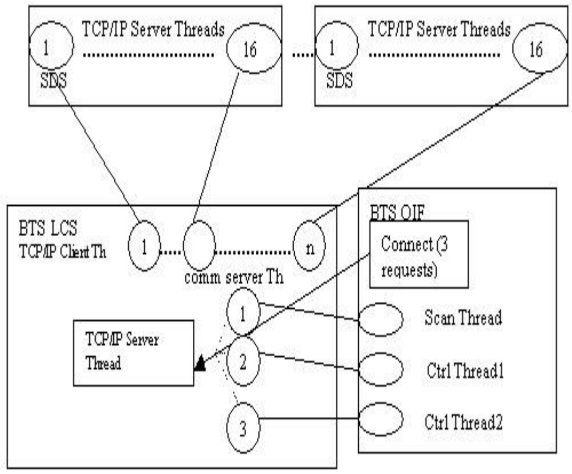

Figure 2: Simplified Software Architecture

CONCLUSIONS AND FUTURE SCOPE

The system is in use for past one year without conventional rotating knobs and found to be satisfactory. An USB based four channel rotating knob has been developed which will be integrated in the OIF. A low cost USB based BPM digitizer is also developed and standalone test has been found very satisfactory. Integration of BPM digitizer is in progress. Cryogenics level and Vacuum monitoring system hardwares are under development which will be added to the LINAC control system as part of same BTS LCS and different configuration of OIF will be provided wherever suitable. For ease of deployment of JAVA web start will be used.

ACKNOWLEDGEMENT

We sincerely offer thanks to Dr. P Singh, Project Manager, LEHIPA, Physics Group for supporting the activity. We thank Shri Sandeep Powale and Mr Mahesh Pose from DNAP , TIFR for their help during the system installation.

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