THE CSNS CONTROLS PLAN

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Abstract

The China Spallation Neutron Source (CSNS) is a accelerator based high power project currently under planning in China. The CSNS controls system will refer SNS control framework using EPICS. High level applications of the CSNS will choose XAL core and Eclipse plateform. This paper introduces controls design outline and progress. Some technical plan, schedule and personnel plan are also discussed.

INTRODUCTION

The China Spallation Neutron Source (CSNS)[1] will be a 120/240 KW accelerator based facility which is comprised of five major sections as shown in the figure 1: a front end consisting of a 50 Kev H^{-} ion source followed by a 3MeV RFQ; a 81/132MeV linac; a 1.6 GeV RCS; a 120/240 kw spallation neutron target. There are high availability and reliability of requirements to the controls system since this facilty has a strong radiation. For the similarities between the China Spallation Neutron Source (CSNS) and the U.S. Spallation Neutron Source (SNS), the SNS control framework will be used as a model for the machine controls.

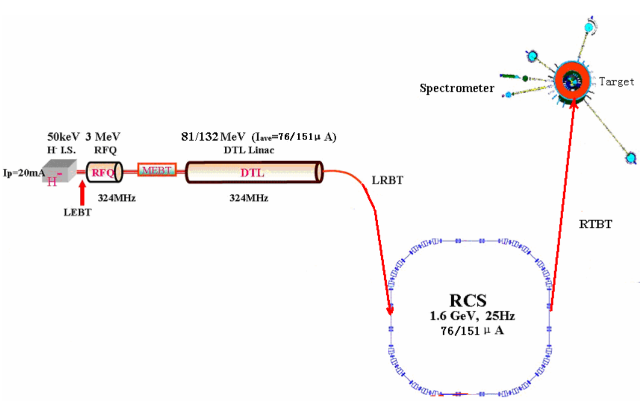

Figure 1: The Schematic Layout of the CSNS Facility

CONTROL SYSTEM SCOPE

The defined scope for the control system is: that it will be a site wide monitoring and control system for the accelerator, target and conventional facilities. It will include all hardware and software of the following aspects as shown in the figure 2: computer systems. networking, front-end controllers and hardware interface, machine protection system, as well as timing system. The control system will not include any control or data acquisition for the target and the experimental stations. It further will not include the personnel protection system, which is a separate system that will be monitored by the control system. The control system will interface to the local areas covering the linac, RCS, transfer lines, target and experimental stations.

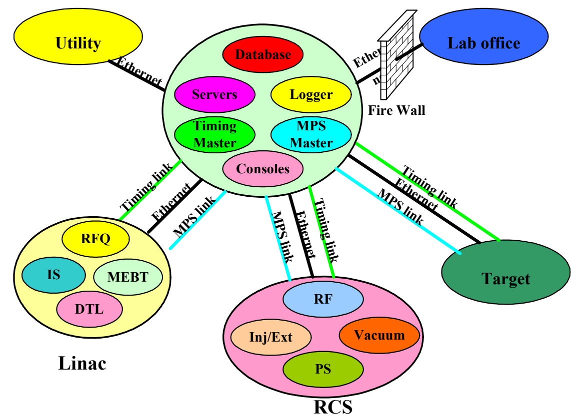

Figure 2: CSNS Controls Scope

Architecture of HW/SW

The CSNS control system will adopt the standard two-layer architecture [2] with PC/Linux workstation as the client and VME crates as the server. There will be no field bus to a third layer, but extensive use will be made of a field bus or serial interfaces from layer two, to the equipment. EPICS 3.14.9 and VxWorks 6.2 will be used for EPICS development environment.

Equipment Interface

The interface from the control system to the equipment will be through VME Power PC processors (Input Output Controllers) (IOCs). Early IOCs will use MVME6100 (PPC7457) already applied in LCLS[3] control system. IOCs will be installed for each subsystem as shown in the figure 3. There will be some PC/linux as IOCs for EPICS database communicate with the network-based controller. The preferred interfaces to the equipment will be analogue,digital and serial (RS232, RS485 etc.). There will be many PLC-based systems for vacuum and equipment interlock and conventional facilities. So, CSNS intends to choose same PLC manufacture. For cost reason, YOKOGAWA PLCs already applied in J-PARC[4] will be adopted. Soft IOC (PC-based) will be used for interfacing to the PLCs via the Ethernet/IP. Each IOC will also contain an event receiver for 25Hz synchronous operation and accurate time stamping of data.

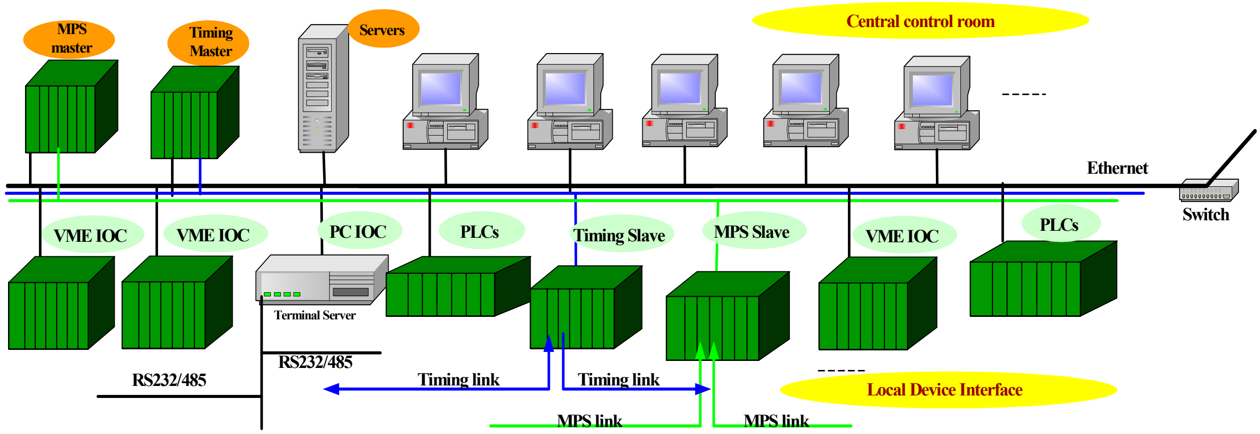

Figure 3: CSNS Controls Architecture

Front-end control interface

Front-end include an ion source and LEBT. The Ion source control system is typically a single component of the CSNS controls system. It includes 5 parts: power supplies, vaccum, temperature measurement, water-cooling and timing. All are required to be controlled locally in the tunnel and remotely at the central control room. The power supplies will work in the high voltage environment. So, they require high reliability and availability of the control system. The power supply control system will send commands and setpoints and waveform to the power supplies and read back the status and current and waveform from the power supplies. The new version PSC/PSI[5] developed by BNL will be used for the power supply control. The vacuum controls include Ion/molecule pump control and status monitoring and read gauge. The preferred interface will be using PLCs for the pump and gate valve ON/OFF control and status and temperature monitoring. The Digi serial port server will be chosen for the gauge monitoring via RS232/RS485. The extracted and accelerated power supplies should be interlocked with the vacuum. The temperatures of the Cs room and transfer line need to keep constant. So, they should be closed-loop controlled. YOKOGAWA temperature control/PID and monitor modules will be used for the control and monitoring of the temperatures of the Cs room and transfer line.

Power Supply Control Interface

There will be about 300 various magnet power supplies distributed in the linac, LRBT, RCS and RTBT. Some magnet PS are DC power supplies, the others are pulsed or dynamic ramping power supplies. Although these PS are different, the control interface to the different PS will be standardized. Since the ring is a Rapid Cycling Synchrotron (RCS), the dipole and quadrupole power supplies will provide 25 Hz sin waveform output to the magnets. The power supply group is developing a digital controller (DPSCM) with PWM regulation. All the PS will be proposed to a digitized PS with PWM regulation. The DPSCM will be an intelligent controller with the Ethernet port. How to interface to the DPSCM is becoming an argument There will be threes solutions proposed. The first one is the control interface to the DPSCM through the Ethernet port with Modbus/TCP protocol. The second one is embedded EPICS IOC into the DPSCM. The third one is to add a customized interface board to connected to the DPSCM through optical fiber. The final solution is not yet decided.

The injection/extraction power supplies belong to pulsed power supplies. YOKOGAWA WE7000 series function generator and digitizer will be used for waveform generator and display of these power supplies.

Vacuum Control Interface

Vacuum controls include about 160 Ion pump control and status monitoring as well as gauge monitoring and gate valve ON/OFF/interlock and status monitoring. The preferred interface will be using PLCs for Ion pump and gate valve ON/OFF control and status monitoring. The Digi serial port server will be chosen for the gauge monitoring via RS232/RS485.

Machine Protection System

Machine protection system (MPS) will be required to issue hardwired "permit to operate" signals to equipment. It include three levels of protection [6]: a hardware based "fast protect" system which will turn off the injector and dumps the beam whatever something wrong happens with devices or radiation dose over limit; a routine interlock system provided by PLCs which will permit injection pulse-by-pulse; a software based "run permit" system provided by IOCs which will compare the accelerator state with the operator selected running mode before the injection.

Consoles

The consoles will be workstations and for cost reasons these are likely to be PCs running Linux. There are also some requirements to provide some PCs running windows for Win32 based applications. All systems – accelerators, target and conventional facilities- will be operated and monitored from the central control room, although there will be local control rooms available for device commissioning and troubleshooting.

Central Servers

There will be several central servers at the central control room. They are likely to be PC servers running Linux. They will provide development, applications, relational database, network, data archiver and viewer, alarm management, error logging, logging services and IOC booting.

Applications

The device application requirements can be met through the standard EPICS tools, control panels through EDM, alarm management through Alarm Handler, archiving through Channel Archiver together with Oracle database. Since web browsers have become an easy way to view and manipulate the control data, CSNS control team is also planning to developed web-based control panel.

Because the similarities between the CSNS and the U.S. SNS, the high level application framework will adopt XAL [7], used at SNS. XAL has been used for SNS commissioning and operation for over four years. Recently, the EPICS community is planning to merge XAL into the Eclipse framework. Eclipse framework is also used for future EPICS version called Control System Studio (CSS). CSNS controls team is undertaking to separate SNS specific code from present XAL release and develop CSNS specific beam line devices by extending XAL devices on the Eclipse framework. Since RCS is different from the accumulated ring of SNS, online model of CSNS should be developed.

Database

VDCT will be used for IOC DB configuration during the device control testing since it's convenient for the developer to create IOC DB.

The RDB is planned to manage conventional control system information together with the control system configuration. The RDB will store equipment info(magnet measurement and survey/alignment), device configuration parameters(Channel/device name, constants, calibration, I/O address,etc), the state(all settings) of the machine and historical real-time data. All IOC DBs will be generated out of the RDB so ensuring that there is a central repository for all control parameters. CSNS will choose Oracle as RDB. The Oracle DB design will refer to SNS global database schemes. The CNS RDB schemes are currently being defined.

Network

A preliminary control system network design is based on 100Mbit switched Ethernet with a Gigabit switched Ethernet backbone. The network infrastructure will connect the control system computer room to each of the local control and instrumentation areas with single and multi mode fibre. There will be a firewall between the control network and campus network. The control network will use a central core switch in the central control room and edge switches at each local control and instrumentation areas. The control network will be separate into a several subnet. EPICS CA gateway will be used for the different IOC PV access and effective management of traffic and security.

CONSTRUCTION

The detailed program of work for construction phase of the project is currently being planned. The project will be approved by the government soon. The R&D work of the control has just been started because the early R&D budget limitation. These R&D include IOC development platform and the power supply control prototype and PLCs and fieldbus application possibilities. CSNS will attempt to standardise on all vacuum and power supplies which will facilitate the controls task. The site construction of the project will start in 2008. The site has been chosen to be at Dongguan in Guangdong province. R&D work will be done in IHEP. Beam commission is planned to start in 2012.

CONCLUSION

The front-end device interfaces for the CSNS controls system is now being defined. Some device control interfaces have been defined. Because some requirements to the devices are not yet clear, the CSNS control team need times to discuss with the device group about the control interface to those devices.

CSNS control team is not only responsible for the CSNS controls construction, but also for the BEPCII commissioning. CSNS would have a minimum resource requirement to get a basic system up and running. So, CSNS control system will choose mature software and hardware and standardized interface to the equipment of the entire facilities (linac, RCS,target etc.).

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