IMPLEMENTATION OF THE SSRF VACUUM CONTROL SYSTEM

H.F.Miao, W.Li, Y.J.Liu, L.R.Shen, SINAP, Shanghai, China

Abstract

The Shanghai Synchrotron Radiation Facility (SSRF) is a third generation light source consisting of a 150MeV Linac, a full energy booster and a 3.5GeV storage ring. The vacuum control system is a standard hierarchical control system based on EPICS. Serial device servers are used to connect most of vacuum devices such as gauge controllers, pump power supplies to the control network directly and integrated with EPICS using soft IOC. Ethernet based PLC systems are adopted for the valves control, temperature monitor, etc. The soft IOCs are running on the rack servers and the VLAN is used for separate to the other systems. It is a high performance system and running well for daily operation now.

INTRODUCTION

SSRF control system is a hierarchical standard accelerator control system based on EPICS [1]. The development and runtime environment of control system have been set up and come into use. It composed with the network system, Input/output Controller (IOC) system, Operator Interface (OPI) system, and device controller.

Vacuum control system uses the same structure. Linux-based PC IOCs running on some rack servers are used for vacuum control. There are over 700 vacuum devices installed at the whole machine, comprise gauges, pumps, vacuum valves, RGAs (Residual Gas Analyzer), etc (see Table 1). Gauge controllers, pump power supplies, RGAs are equipments based on serial port. Client processes running on the IOC communicate with them depending on the serial device server linked to the control network. For valve controllers, temperature sensors, etc, PLC systems with Ethernet module are used to link them to IOC through control network (see Fig. 1). A set of device/driver support modules for EPICS to support network-based controllers are used to implement these controls [2].

Table 1: Vacuum Device List

Device	Linac	Booster	Ring	Total
Gauge controller	8	19	48	75
IPS	16	86	304	406
TSPC	0	0	229	229
RGA	0	3	4	7
Valve	2	13	26	41
Total	26	121	611	758

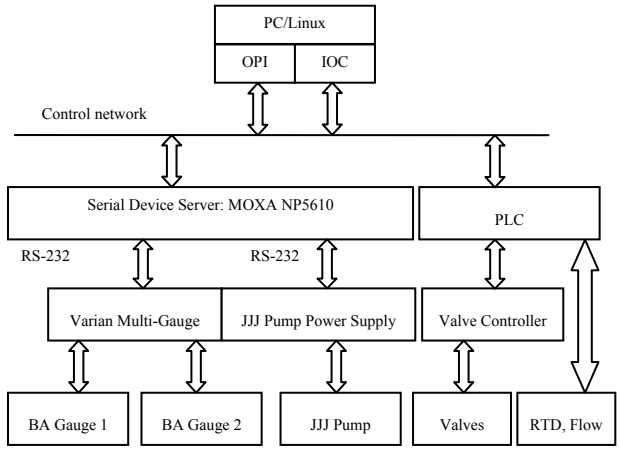

Figure 1: SSRF vacuum control layout

Serial Device Server

MOXA NPort 5610-16 serial device servers [3] are used to make it possible for software to access serial devices anywhere over a local LAN or the Internet (see Fig.2). NPort 5610 serial device servers ensure the compatibility of network software that uses a standard network API by providing TCP Server Mode, TCP Client Mode, and UDP Mode. In our case, we use TCP Server mode. In TCP Server mode, NPort provides a unique IP:Port address on a TCP/IP network. NPort waits passively to be contacted by the host computer, allowing the host computer to establish a connection with and get data from the serial device. This operation mode also supports up to 4 simultaneous connections, so that multiple hosts can collect data from the same serial device at the same time.

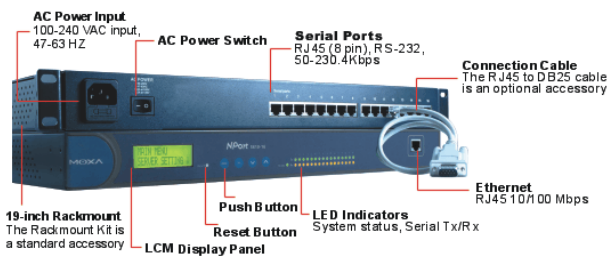

Figure 2: MOXA Nport 5610-16 serial device server

DEVICE CONTROL

Fig. 3 shows vacuum devices: gauge controllers, pump power supplies and valve controller.

Figure 3: Vacuum devices

Gauge Controller

Gauge controller use Varian Multi-Gauge Controller [4]. Varian Multi-Gauge is a half-rack, modular vacuum gauge controller. It operates up to three ion gauges and eight thermocouple gauges simultaneously or adds process control options such as setpoints by using fewer gauge boards. In our facility, each controller installs two BA gauge boards, a setpoint board and a RS232 board. Setpoint board contains eight setpoint relays, which can be assigned to any of the installed gauges. The setpoint trigger level and a hysteresis level are programmable. The RS232 option is available via a plug-in PCB with a standard 9-pin D connector. This option allows complete operation of the Multi-Gauge via a computer using serial communication. In this case, each gauge assigns 4 setpoints, and normal open relay connector allows using the switch contacts for the MPS to control valves or stop beam.

With NetDev driver and device support according to ASCII protocol of Multi-Gauge, EPICS based software implement the monitor and remote control of gauges. In monitor, we can read pressure, setpoint state, setpoint pressure level and gauge state, and for control, we can set setpoint pressure level, set emission and degas on/off, change pressure unit, etc (see Fig. 4).

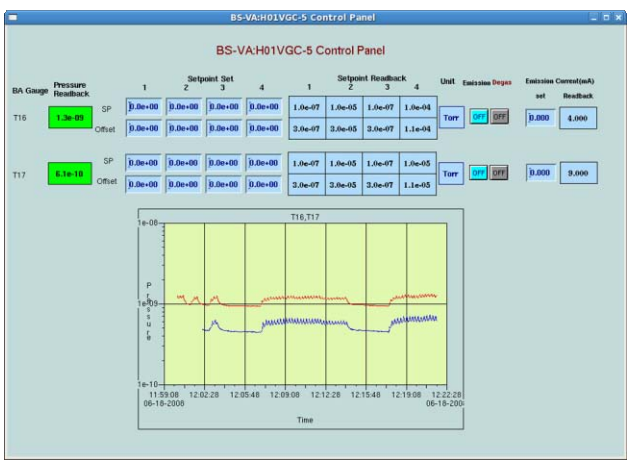

Figure 4: Multi-Gauge control page

Pump Power Supply

Pump power supply use JJJVac IPS and TSPC, which operates one sputtering ion pump or one titanium sublimation pump. Each power supply is RS232 based, and connects to the control network with MOXA serial device server, communicates with soft IOC.

With NetDev driver and device support according to ASCII protocol of JJJVac power supply, EPICS based software implement the monitor and remote control of pumps. We can read the high voltage value, ion current, and the state of power supply and pump. And we can also on-off the high voltage, set the parameters of the power supply (see Fig. 5).

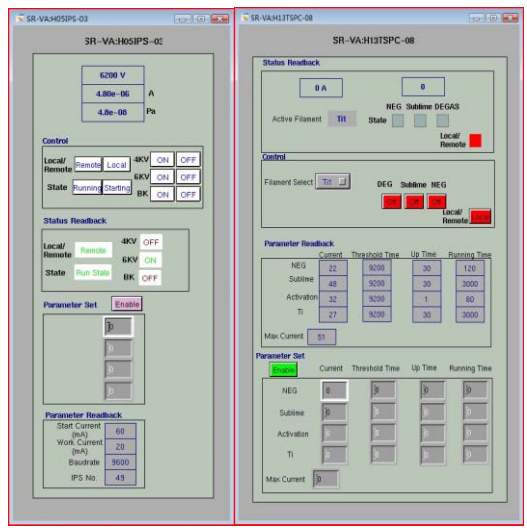

Figure 5: JJJVac IPS and TSPC control page

Valve

Valves use VAT Electromagnetic valves and link to the Ethernet based Yokogawa FM3 PLC systems through valve controllers. DI modules are used to read the state of valves, and DO modules to switch the valves. Normally valves are controlled by the interlock logic from MPS PLC system.

IMPLEMENTATION

Running and Development Environment

PC Linux based system are set up for development and operations. All of the OPI and the server system running the fedora 7 system for supply the EPICS development and high level physics application environment. EPICS base 3.14.8.2 is used. Using NIS and NFS to manage user account and share resource [5]. As part of runtime environment, Soft IOC server for vacuum control and EPICS application server such as archive are installed at the server room.

SSRF using the 1000Base-T control network instead of field bus for mostly device controller, like the PLC and lot of serial based device (using protocol translate: serial to Ethernet translator), most of device are connected by the

control network directly and integrate with EPICS using soft IOC. The backbone redundancy design was adopted to ensure the network reliability. The different system separate to different subnet by VLAN (Virtual Local Area Network) that can be division and recombine convenient and flexible.

Vacuum Control OPI

SSRF use EDM for the machine operator. Vacuum OPI page use interactive graphical interface designed in a hierarchical structure, including monitor pages and control pages. From the main pages, operators can change into equipment pages or device pages. Fig.6 and 7 show vacuum OPI pages.

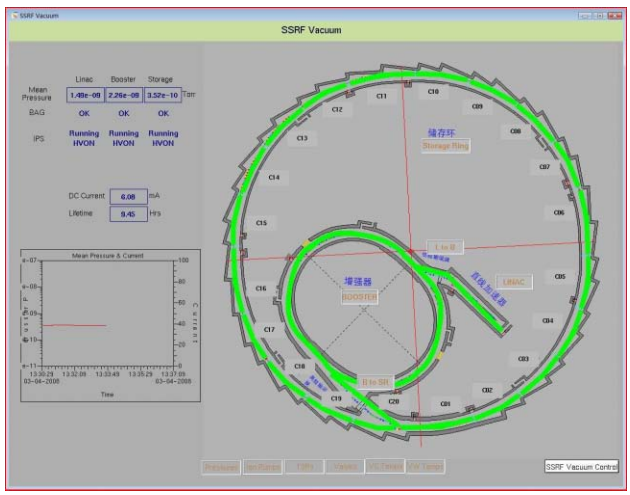

Figure 6: SSRF vacuum overview

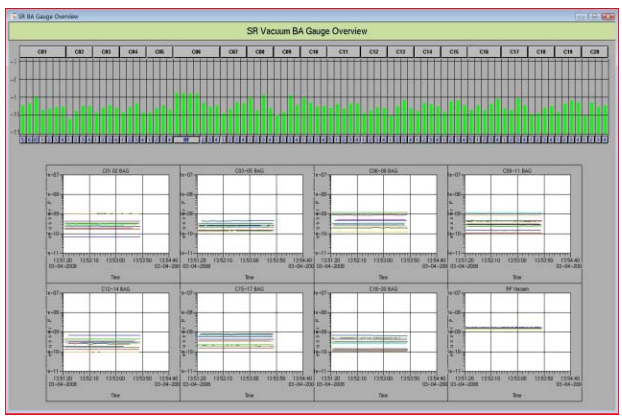

Figure 7: Storage ring vacuum show

Data Archive and Retrieval

Now we use Channel Archiver for data archive and analysis. ArchiveEngine save appointed channel served by vacuum ioc servers. Java archive client is used to be the main data retrieval tool (see Fig. 8). In the future all these data should be store in SSRF centre database, which is just in testing process now.

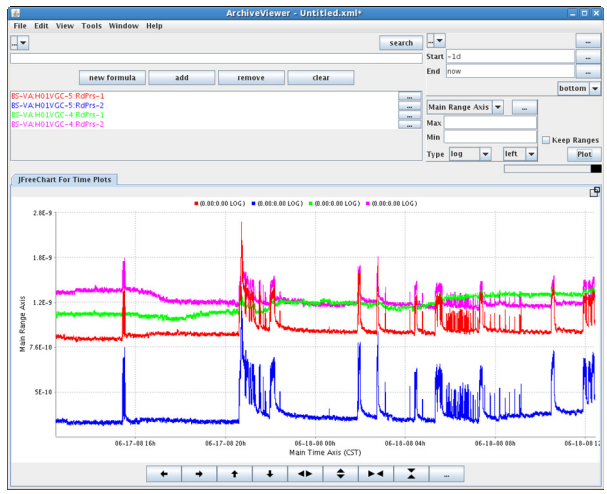

Figure 8: Java archive client

CONCLUSION

The SSRF vacuum control system has been set up as a distributed controls system based on EPICS. It provides remote control and monitor of over 700 vacuum devices. Serial device servers are adopted successfully to connect most of the devices to the IOC through control network and integrate into EPICS structure. All of the vacuum device data are refreshing at 1Hz rate and can update to a high rate as 10Hz according to the response time of the vacuum devices. In fact, the system has proven to be high performance with reliable daily operation since December 2007.

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