REMOTE EQUIPMENT USING JAVA REMOTE METHOD INVOCATION

Noriichi Kanaya, Nobuyuki Kobayashi, Yutaka Tahara, Daisuke. Kobayashi, Satoshi Sakasai, Shigeru Suenari, Hiroe Yano, Shoji Suzuki*) and Shigeru Sato*)
Department of Electrical and Electronic Engineering, Faculty of Engineering, University of Ibaraki, Hitachi, Ibaraki, 316-8511, Japan
*) Department of Physics, Graduate School of Science, Tohoku University, Sendai, 980-8578, Japan

Abstract

Remote equipment interface has been implemented using Java Remote Method Invocation (RMI) running under the distributed platforms running under Linux on a network. Remote equipment is employed for controlling a synchrotron radiation source at TSRF, and it is also used for high-energy accelerator control systems which are comprised of distributed computers and equipment such as analogue-digital converters, digital input/output ports and VME CPUs. By taking advantage of Java RMI's capability, many remote accesses are carried out easily without paying a lot of efforts for remote communication. We are planning to utilize such functionality with an EPICS control system at TSRF. Experience with Java Remote Method Invocation for accessing remote equipment/devices as the distributed remote objects is discussed.

INTRODUCTION

TSRF (Tohoku-university Synchrotron Radiation Source Facility) is a new third generation synchrotron radiation source that is currently proposed at Tohoku University Japan [1] [2]. TSRF is planned to be constructed at the site of Laboratory of Nuclear Science, Tohoku University, where a 300MeV-Linac and 1.2GeV Stretcher Booster Ring are currently in operation for nuclear physics experiments [3]. By taking advantage of the existing facility, TSRF employs the Stretcher Booster Ring as the injector for the TSRF storage ring. This can greatly reduce construction cost for the TSRF generation synchrotron radiation source. Table 1 shows principal parameters of the TSRF. Table 2 shows Wiggler/Undulator beamlines to be constructed for the first commissioning phase at TSRF

Table 1: Principal parameters of the synchrotron radiation source at TSRF

Beam Energy	1.8 GeV (Max. 2 GeV)
Circumference	244.8 m
Lattice	DBA×16
Straight Sections	5m x 14, 15m x 2
Emittance	4.9 nm-rad
RF Frequency	500 MHz
RF Voltage	1.0 MV
Beam Current	400 mA
Beam Lifetime	> 12 hr
Number of beamlines	50

Table 2: Wiggler/Undulator beamlines to be constructed for the first commissioning phase at TSRF

Research fields	Source
1. XAFS	Wiggler
2. XAFS (high precision)	Wiggler
3. XAFS (soft X-ray)	Bending M.
4. X-ray diffraction	Wiggler
5. X-ray topography	Wiggler
6. X-ray small angle scattering	Wiggler
7. Atoms and molecules (VUV-SX)	Undulator
8. Surface-solid: PES/fluorescence	Undulator
9. Spin polarized UPS	Undulator
10. Far infrared	Bending M.
11. Millimetre-wave	IR wiggler
12. Soft X-ray optics/microscopy	Undulator
13. Lithography	Bending M.
14. Photochemical process	Bending M.
15. Radiation effect on biomaterials	Bending M.

SYSTEM CONFIGURATION

The remote equipment is designed with Java RMI running under the distributed PCs on the network. For time critical operation such as a high speed beam feedback, it is implemented in another language in order to avoid any time delay caused by garbage collection.

Figure 1 shows the block diagram of the remote equipment. Java programs run on the Virtual Machine (VM) that provides homogeneous environment on different platforms independent of their operating systems and hardware architecture. The VM has no direct interface to devices which are tightly implemented on specific operating systems. Thus those physical devices are not accessible to control applications.

We have implemented the remote equipment on PCs running under Linux for controlling applications, including consoles. Man-machine interfaces, including graphic status displays providing menu driven interface were also coded in Java graphics class libraries. Remote access is carried out easily without paying a lot of efforts for remote communication.

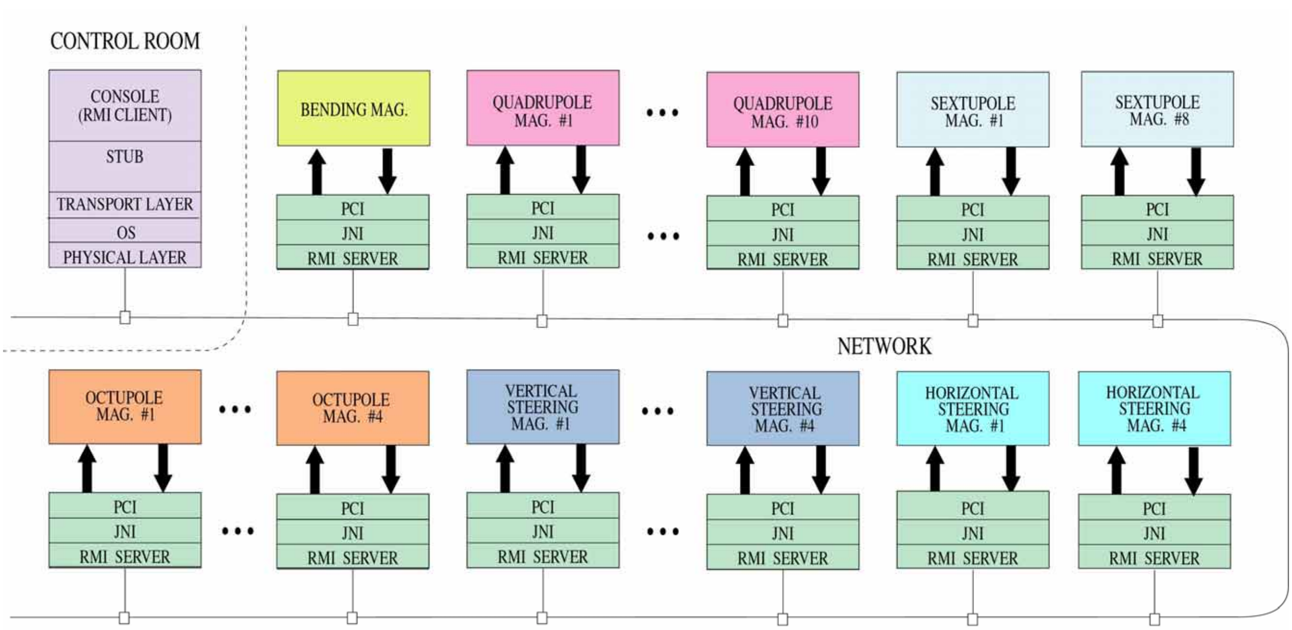

Figure 1: Remote Equipment using RMI for the 1.8GeV Synchrotron Radiation Source at TSRF.

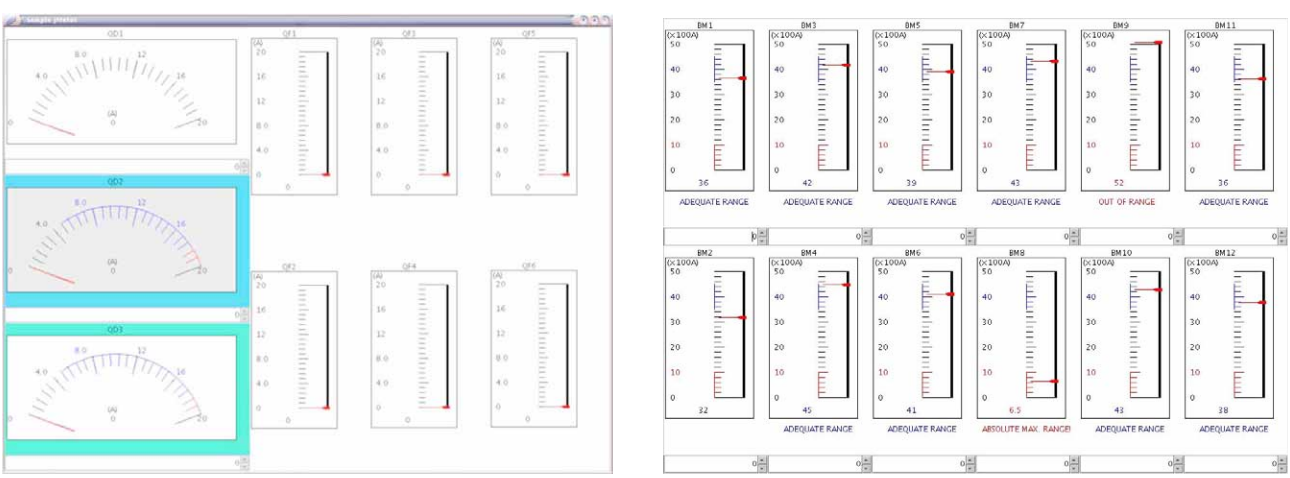

Figure 2: Screen shots of an operator console for a magnet controller.

Figure 2 shows screen shots of an operator console for magnet control indicating currents in magnets of the storage ring. The currents in the magnets are acquired by calling remote methods of a control server for the power supplies through the network.

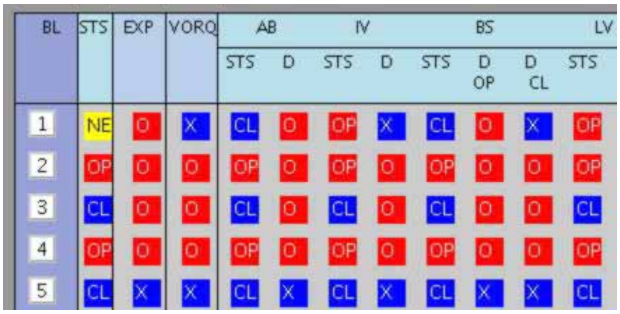

Figure 3: A screen shot of an operator console for emergency interlocks and summary status display for the beamline status.

Figure 3 shows a piece of screen shot of an operator console for emergency interlocks and summary status display for beamline status. From the left, beamline ID, summary status, status of experimental hall interlock, valve-open-request signal, valve status signals are depicted so that an operator can easily monitor the operation of the beamlines and the interlock status. The status of the beamlines is also acquired by calling remote methods of each control system for a beamline through the network [4].

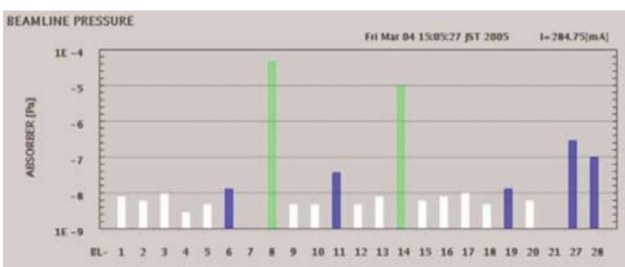

Figure 4: A screen shot of a console display for ultra-high vacuum of fifty beamlines.

Figure 4 shows a screen shot of an operator console for ultra-high vacuum status of fifty beamlines. Each beamline has two ultra-high vacuum gauges which are accessible by calling remote methods of each control server for a beamline through the network. White bars indicate that pressures in the corresponding beamlines are in UHV range less than 10^{-9} [Pa]. Blue bars indicate the pressures are almost in the reasonable range less than 10^{-6} [Pa]. Two green bars indicate the pressures are over 10^{-5} [Pa].

Figure 5: System status logging display.

Figure 5 shows a screen shot of a system status logging system which was implemented in Java and it receives a system operational message with a time stamp from any client or server on the network. The system status logging system is used for identifying a cause of system error for the client-server systems on the network.

The control program carries out the remote method as if it were a local method to control the remote device to be concerned. Thus any accelerator equipment on the network is transparent to the control programs.

As shown in Fig. 1 PCI/VME modules are connected to the bending magnets, quadruple magnets, beam position monitors, wigglers, undulators and other accelerator components. PCs are connected to a 1000-Mbps network during implementation and test phases. During commissioning phase for the TSRF synchrotron radiation source, the remote equipment will be ported and implemented. The remote equipment is also employed for the remote data acquisition system for the beamlines.

CONCLUSION

The remote equipment as remote objects using JAVA RMI is discussed for the TSRF 1.8GeV storage ring. The remote equipment deals with PCI modules on remote Linux hosts control system. Porting the remote equipment servers to Linux server on a Sparc chip is now under way. We plan to utilize such functionality with an EPICS control system for TSRF.

ACKNOWLEDGEMENT

The authors wish to express their gratitude to T.Watahiki, University of Ibaraki for his valuable suggestions and assistance, and Prof.J.Kasagi, Laboratory of Nuclear Science, Tohoku University for his valuable discussions.

REFERENCES

[1] S.Suzuki, M.Katoh, S.Sato and M.Watanabe, "Design of a Storage Ring Light Source at Tohoku University," Nucl. Instrum. Meth. Vol.A467-468,pp.72-75,2001.

[2] M.Katoh, S.Sato, S.Suzuki and T.Yamakawa, "Lattice Design of the Synchrotron Radiation Source

at Tohoku University," Proc. of the 5th European Particle Accelerator Conference,Spain,June,1996.
[3] M.Oyamada et al., Proc. of 10th Symp. on Accel. Sci. Tech. p463, 1995 (in Japanese).
[4] N.Kanaya *et al*, IEEE Transactions on Nuclear Science, 2005 (to be published).