§1. Verification of Analysis of Helical and Tokamak Plasma Characteristics with a Broadband Network for Construction of the Fusion Research Grid

Ozeki, T., Naito, O., Hayashi, N., Takenaga, H.,
Isayama, A. (JAEA Naka),
Iba, K. (RIST),
Peterson, B.J., Nagayama, Y.

i) Introduction

Concentration of the fusion research on large experimental facilities increases research collaborations among universities and institutes. To carry out experimental collaboration, many researchers must visit a separate experimental facility. Therefore, the issue is an increase of research efficiency and a decrease of a travel cost. Rapid progress of information technology, such as a broadband network and security, makes possible the participation in experimental research from their own research laboratories remotely.

Our purpose is a development of a remote research environment on a broadband network like the SINET3 which connects research-institutes throughout the world.

ii) Fusion research grid

A fusion research grid consists[1)] of high level technologies of a network and security. In building a remote research environment, there are some issues concerning network connection, sharing research resources and communicating with each other. The first issue is that the use of the remote research environment must be limited to trusted users and prevent unauthorized access. Second, a fair response speed must be ensured even on an international communication line. Third, the connection interface must be carefully implemented, so as not to depend on a certain software environment and increase the cost. Fourth, the connection to the available supercomputers should be seamless, because the analysis in nuclear fusion research requires huge amount of computational resources.

Advanced technologies in networking and security support the foundation of Fusion research grid. They consist of Public Key Infrastructure (PKI), Virtual Private Network (VPN), Web technology and the ITBL. PKI and VPN provide the remote research environment with security. Web technology provides a user friendly interface with a small communication load.

iii) Remote experiment system

Remote experiment system has functions of setting experimental parameters and of monitoring plant conditions and experimental results remotely. Our research group has developed a prototype remote experiment system for JT-60U. This system may provide the technological basis of remote experiments of the large facilities, such as LHD, ITER and JT-60SA.

This system has two functional parts. One is a security part based on ITBL grid infrastructure. [2)] This part uses an electronic certificate to authenticate clients, and it makes encrypted tunnels between a remote experiment server and a personal computer of the remote researcher after the authentication process. The other one is a control part of the experimental device. This part provides researchers with an interface to set parameters of the experimental facility and with a function to visualize the experimental process. The researchers can use these functions by web browser. Application of the web browser needs no special hardware and software. Therefore the researchers can use common personal computers. Optimized allocation of the system functions to a server computer and a client computer provides good efficiency of protocols and usability under a long delay of an international communication.

iv) Verification of the remote experiment system

The remote experiment system has been tested from Max-Planck institute for Plasma-physics (IPP) in Germany on 13th December 2007. Researchers of IPP used the Internet Explorer version 6 of Windows XP and the Java Runtime Environment version 5. Though a long delay has occurred about 290 milliseconds of a round trip time (RTT) between IPP and JAEA Naka, interactive works, for example, parameters setting, have obtained smoothly like use in Japan. In addition, functions of experimental status monitoring were useful to make them feel as if they were there.

The data setting program was made by a Java applet of web technology. It simplified the protocols of the remote experiment system and decreased the value of the data communication, and it reduced the load of the remote experiment server. This technology results in the improvement of turn around time and usability despite adding security processing.

v) Conclusion

Cryptographic processing time with ITBL security functions and communication delay using an international line caused problems of usability for researchers. Application of web technologies and functional decomposition of the remote experiment system with Java technology have achieved suitable communication protocols. It can avoid the delay trouble of interactive tools, for instance, the remote experiment system, to maintain usability and security. This structure provides trade-off between security and usability. We have developed one of the remote research environment on the broadband network like the SINET3 using these technologies, successfully.

Visualization of experimental data requires efficient file transfer because the data size is too large and the file transfer time must be short. Therefore, throughput performance needs to be improved presumably using the next generation TCP protocol.

1) K.Iba, T.Ozeki, T.Totsuka, et al., Fusion Engineering and Design, **83** (2008) 495-497.
2) K.Higuchi et al., Proc. of the Inter. Conf. on Supercomputing in Nuclear Applications, Paris, (2003) 22-24.