§31. Real-time Video Streaming System for LHD Experiment Using IP Multicast

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In order to accomplish smooth cooperation research, remote participation plays an important role. Especially, visual and audio communication is essential. Therefore, NIFS introduced TV conference systems and VoD systems[1]. In addition to this, the user can watch the screen displayed in the control room (Fig. 1) remotely. In this screen, various images are displayed during the experiments, such as, the video images from the camera attached to the vacuum vessel, the last summary graph of the plasma discharge experiment, and so no. This image is helpful to comprehend how the experiment is going. The viewer is provided as a Java Applet, and the remote user can use the web browser to see the same display image as the researchers in the control room. However, because this is one-to-one communication, the load of the server depends on the number of the clients, and the server cannot serve high quality video images to the many clients at once. Furthermore, the video images are not clear enough to see the detail of graphs or not smooth enough to see the dynamic behavior of the plasma image.

In order to provide the high quality video images for many clients, the author has been developing a new system, and the prototype of the system was tested using the network between NIFS and Kyushu University[2]. Fig. 2 shows the overview of the system. The server locates in NIFS and the client locates in the Kyushu University, and they are connected by SINET3 via a L2 switch. The server captures the output signal from the video diverter that connected to the video projector in the control room. The captured images are sent to Kyushu University using IP multicast. Because IP multicast packets are automatically sent to the network where clients want, the load of the server doesn't depend on the number of the clients. Furthermore, there is another benefit using IP multicast. When a normal TCP based communication is used for the long distance network, its speed becomes deteriorated because the server has to wait for the ACK packets from the receiver for a longer time than short distance connection. For example, using normal TCP applications, the network speed between NIFS and Kyushu University becomes only ~10 Mb/s while it is connected by 1 Gbps optical fiber. However, because this service uses IP multicast, which is UDP, it can use the bandwidth of the network to the full because they don't have to wait for the ACK packet. The captured image is divided into small area fit to the Ethernet packet size, and displayed them one by one on the screen of the client. If the client lost packets, the area of the lost packets is not redrawn. Fig.3 shows the actual display of the client PC, and no packet loss is observed. The actual frame ratio sent from the server is 23 frames /sec, and the total transfer ratio becomes 420 Mb/s. It is difficult to measure the exact delay of the video images between NIFS and Kyushu University, but it is estimated 220 msec. This estimation is the sum of 200 msec, which is the delay of images measured between two PCs located at the local LAN, and 20 msec, which is the time to send IP packets from NIFS to Kyushu University.

By this test, the authors could demonstrate the usefulness of the video streaming service using IP multicast. Now, the authors are planning to increase the number of clients to make a more practical system.

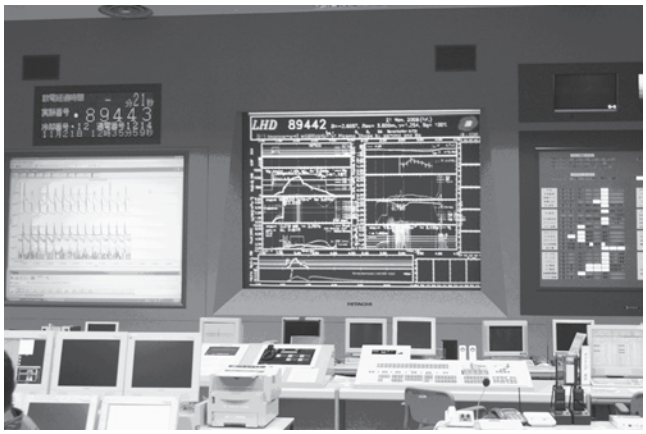

Fig.1 LHD Control Room

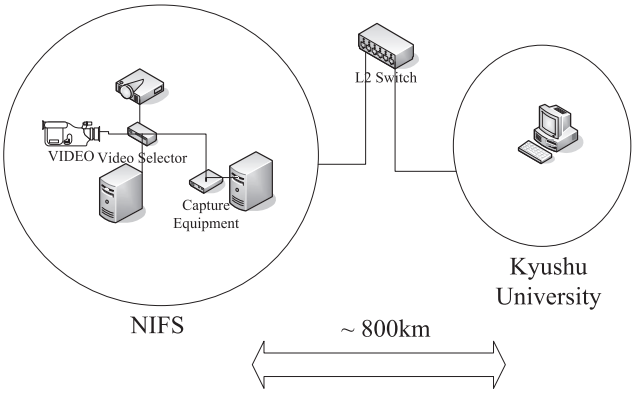

Fig2.SystemOverview

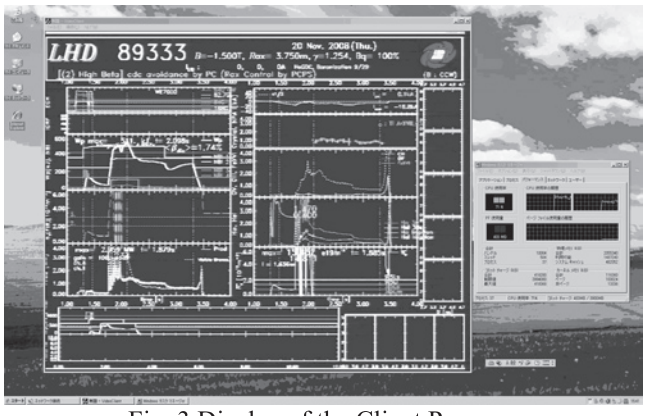

Fig. 3 Display of the Client Program

1) M.Shoji, et al., PCaPAC2000, Hamburg, Oct. 2000
2) M.Emoto, et. al., 18th International Toki Conference, Toki, Dec 2008