§17. Preliminary Result of Online Operation of the LHD Data Acquisition and Management System

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The LHD data acquisition and diagnostics control systems have started their operation along with the experimental sequences. The first period of the LHD experoments began on Mar. 31 1998.

To establish the cooperation with the LHD central control equipment, the timing signals of the experiment master sequences S1 ~ S10 and some interlock lines are given to the diagnostic-related subsystems through the wired connections. The diagnostics control system has one master PLC (programmable logic controller) to receive them, and the VME computer which manages it will read the signal status and redistribute them toward the data acquistion systems through the network protocol "ONC RPC 4.0."

Among the data acquisition server computers and their management computer, the experimental time sequences are notified as the timing events which will awaken the different processes in the data acquisition sequence. The CAMAC data acquisition, for instance, has two events of the setup and the initialization as the pre-trigger processing, and one acquisition in post-trigger. The transmission way of these timing events are implemented by using the network package named "HARNESS" which realizes the object-sharing virtual space among its participant computers. Its communication protocols are simply based on TCP/IP. The virtual shared memory package Harness is another presentation protocol layer we have applied for the data acquisition and management system, as shown in Fig. 1. While RPC provides a simple mechanism of giving and receiving messages, Harness makes the shared memory space among the invited participant computers where any kinds of experimental data objects can be shared simultaneously.

As for the data retrieve, transfer, and store, remote and local clients can directly communicate with the experimental database servers. The LHD data acquisition system adopted the object-oriented database (OODB) and its management system (ODBMS) named "O_2" due to the suitability for the object-oriented data handling manner which unifies the overall system construction. The transactions between database management servers and clients are implemented by using the O_2 bindings (i.e. computer language API), and so we applied C++ for storing/retrieving data and Java for setup parametes. These transactions can also be transferred on TCP/IP, while the language binding API provides higher-level accessing functions which are independent of the network or transport protocols.

Especially for the LHD data acquisition system, fast network connections are indispensable for the data cross-reference among the distributed server computers. It is because they have to treat the huge amount of experimental data, and the typical amount of the rawdata in the second LHD experimental period is considered to be up to a few 100 MB

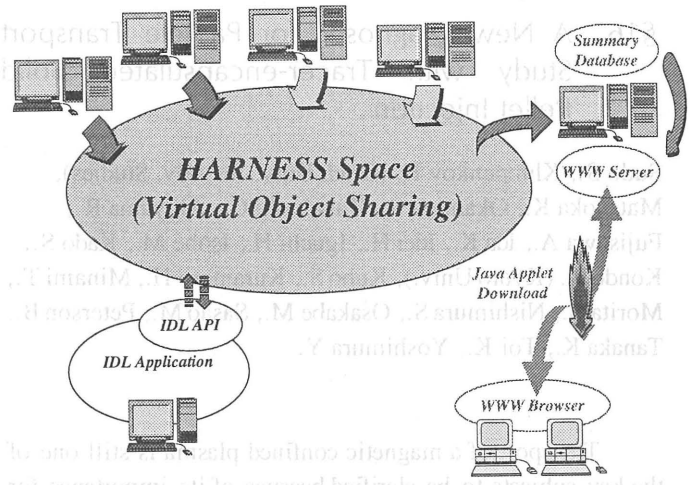

Fig. 1: Virtual shared memory system by HARNESS: It provides the object sharing functions and the task processing synchronization.

per each shot. As the fusion plasma experiments have the general tendency that experimental data transfers concentrate within a definite time period just after the discharge, the maximum transfer rate in it are surely expected. Such characteristic is quite suitable to apply the impermanent point-to-point connection by means of a momentary circuit-switching technology. As the fast switching network, we have adopted the 100Mbps FDDI-based switching equipments as the local connection for each data acquisition computer, and as a backbone of their network, applied a 622Mbps ATM.

As the preliminary operation of the data acquisition system in the first term of the LHD experiment, we have applied the two kinds of CAMAC data acquisition ways; one is using the massively parallel processing (MPP) system as we considered to be the main system, while the other is the standalone test-bench system which can originally control the CAMAC systems locally for the test use. The latter was auxiliary applied to supplement the treatment for the special devices or modules. The total amount of the acquired rawdata volume in each diagnostics are listed in Table 1.

Table 1: Acquired rawdata mass in 1st-cycle LHD experiment. (shot #1 ~ #1888)

Diagnostics	Data (MB)	main/aux.
H_{alpha}	4,231	main
Millimeter wave	4,361	aux.
Bolometer	8,276	aux.→ main
Fast Ion Gauge	1,825	main
ECH	3,380	aux.
Impurity Monitor	2,169	main
Magnetics	12,847	main/aux.
Langmuir Probe	6,706	main
Total	43,795 (ave.23.2MB/shot)	