§52. Japanese Fusion Virtual Laboratory between LHD, QUEST, and GAMMA10

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The data acquisition and management system of LHD, namely *LABCOM/X system*, consists of network distributed functionalities of acquisition, storage, and data retrieval clients. As for the storage, we logically define double-tier structure in it. The first tier consists of some pairs of hard-drive arrays, RAIDs, connected by 4Gbps FibreChannel switches, and the second tier is three sets of Blu-ray disc libraries. The whole capacity of these two tiers is several 100 Tbytes, now.

For the 1st tier storage, the cluster file-system Red Hat GFS2 is used in several sets of RAIDs and redundant I/O servers which are mandatory to be multiplexed for higher availability and throughputs. Please note that our storage section is completely separated from the data acquisition one through the high-speed network, and therefore, we can have remote data acquisition if we can extend the high-speed local-area network through the wide-area VPN to reach external experimental sites. (Fig. 1)

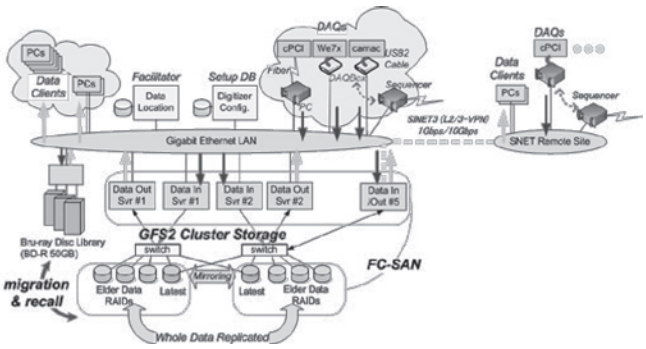

Fig. 1. Schematic view of *"LABCOM/X"* distributed data platform and its extension for remote site by SNET

Fusion Virtual Laboratory in Japan

In addition to the original LHD experiment, the *LABCOM/X system* has recently covered QUEST and GAMMA10 experiments under the new framework of "Fusion Virtual Laboratory" where users can access the data equivalently regardless of their whereabouts. Such the activity is named "SNET", which is based on a closed VPN on Japanese academic internet backbone SINET3 and covers multiple experimental remote devices, at first LHD in NIFS (2002), and QUEST in Kyushu University (2008), and GAMMA10 in University of Tsukuba (2009) (Fig. 2).

For the experiment data platform, the functionality of data access control is mandatory when used across multiple experimental sites. It should be for both the user and data belongings for each site. There are 3 query keys to retrieve data in our system; site group, diagnostic or data name, and the shot number. In our implementation, the access privilege is given to the prior registered hosts for each site. Collaborators can join multiple site groups and register his/her host to both sites to access the both data.

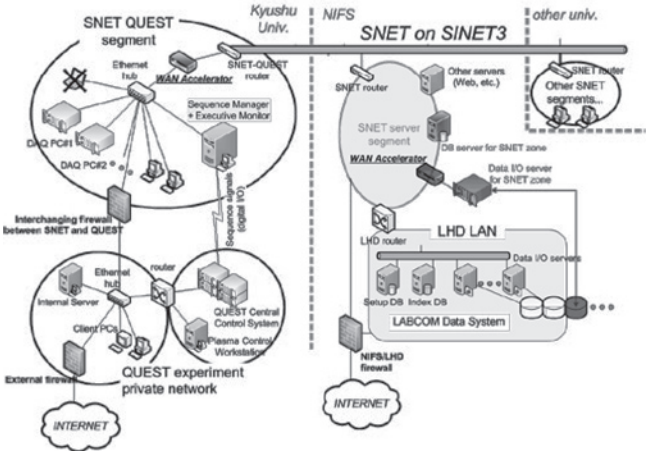

Fig. 2. SNET formation between NIFS server segment and QUEST local network: Similar remote segment has also been made for GAMMA10.

There exists a well-known TCP/IP long fat-pipe data transferring problem in which usual Windows or Linux PCs can only provide a few Mbps even on Gigabit Ethernet. To solve it, we have installed TCP/IP WAN accelerator commercial products, Fujitsu WANDIRECTOR A100, on each top of the SNET experimental sites (Fig. 2). They provide us very stable throughputs of about 300 Mbps over 1000 kilometer distance.

Taking the growing data volume into account, we also try to make a Linux box as a similar gateway for faster throughputs, *i.e.* 90 % of Gigabit Ethernet bandwidth. With the combination of tuning the TCP parameters and packet pacing, the effective throughput can finally reach almost 90 % of 1 Gbps Ethernet bandwidth. (Fig. 3) Here, the necessary software is completely free.

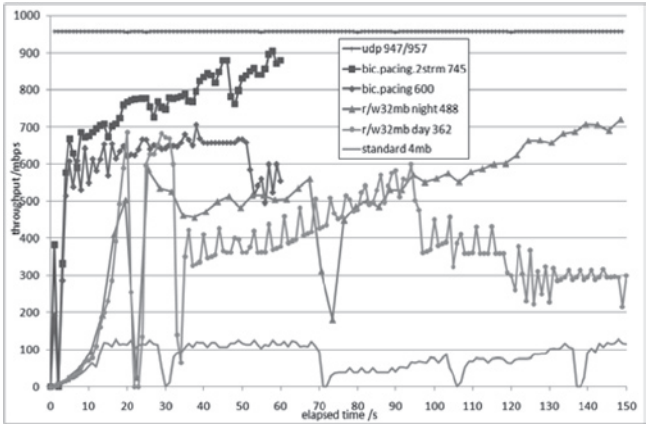

Fig. 3. Examination results of WAN TCP/IP acceleration schemes. (done between NIFS and MIT, US)

1) Nakanishi, H. *et al.*: Fusion Eng. Des. **83** (2008) 397.