§8. Fast Data Transfer Method toward the LHD Remote Data Archiving for Disaster Safety

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The LHD data acquisition (DAQ) and archiving system, *i.e.* LABCOM system, continues growing in both number of DAQ nodes and the total data amount (Fig. 1). In the 17th annual campaign in 2013, it has renewed the world record of total data amount of 891.6 GB for a 40 min long pulse experiment. Nowadays, total storage capacity for the LHD and the related data is about 1 PB.

The importance of the data archive naturally increases as the amount grows. Therefore, it becomes more necessary for the LHD data archive to take the disaster safety into consideration. Even though we always stores at least three copies of the whole data with the parity redundancy, it would not be safe enough against a big natural calamity which may destroy most of the buildings in the site. One of the expected solutions would be to have a data replication site which should be more than several hundred kilo-meters distant from the NIFS Toki site.

It is generally known that TCP has a problem in transferring high-bandwidth data stream through a long distance connection, which is often called as “long fat pipe network (LFN)” problem[1]. When a packet loss happened, the TCP congestion control algorithm once lowers the sending rate to an enough safe level and then gradually recovers it up to the maximum bandwidth. This is why the average speed becomes far below the ideal one. An effective solution is to pace the packet sending rate just below the effective bandwidth at the moment, which tunes the inter-packet gap (IPG) timing.

To make LFN tests by using real long distance network, we have prepared the test platform shown in Fig. 2. The round-trip time between Japanese sites are about 20 ms, and is about 300 ms for JA–EU. Fig. 3 shows the result between NIFS and IFERC sites, where pacing and the window size tuning were applied. It clearly shows more than 90 % of 2.4 Gbps bandwidth was stably used.

We can conclude through the LFN bandwidth tests that it is technically possible to realize the real-time long-distance replication for the LHD data. As a new SNET collaboration program, we also plan to test other TCP acceleration methods such as massively multi-connection file transfer protocol (MMCFTP) [2] developed by NII.

1) T. Yamamoto, M. Emoto, H. Nakanishi, J. Plasma Fusion Res. **89**, 7 (2013) 474–478.
2) K. Yamanaka, S. Urushidani, H. Nakanishi, *et al.*, Fusion Eng. Des. **89**, 5 (2014) 770–774.

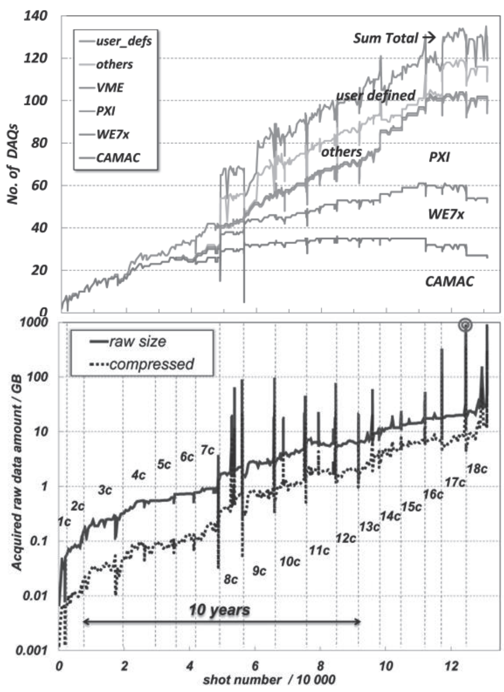

Fig. 1. Continuous growth of DAQ nodes (top) and the data amount (bottom) in LHD: The data grows exponentially which fits the Moore’s law, 100 times in 10 years. Upper spikes of raw data amount correspond to long-pulse experiments, and the double circle mark shows the world record of 891.6 GB/pulse (2013).

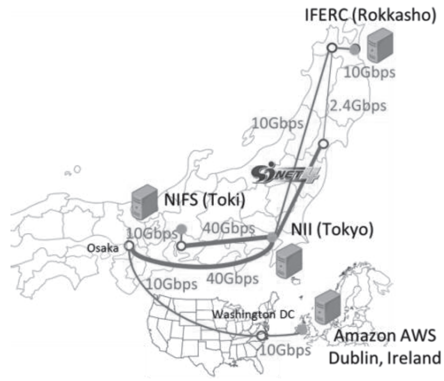

Fig. 2. Geometry for the high-performance, long-distance network data transfer tests[2]. Most of the paths are on SINET4 backbone except the US-EU Atlantic link.

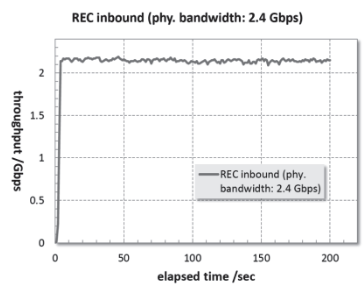

Fig. 3. Experimental result of NIFS → IFERC via 2.4 Gbps link. By tuning TCP-related and packet pacing parameters, more than 90 % of physical bandwidth could be utilized for the data transfer with zero packet loss. No parallel connections were used.