§2. Fusion Virtual Laboratory (FVL): the Experiments' Collaboration Platform in Japan

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"Fusion Virtual Laboratory (FVL)" is constructed on fusion dedicated virtual private network (VPN) named "SNET". SNET exists upon the Japanese academic internet backbone "SINET" which is operated by National Institute of Informatics (NII). SNET was built at first for the purpose of LHD remote participations in 2001. Since 2005, two other purposes of "All Japan ST research project" and "Remote sharing of supercomputer" have been added. It can be understood that the FVL concept is composed by LHD remote participation and All-JA ST research.

FVL now covers three fusion experiments; LHD at NIFS, QUEST at Kyushu Univ., and GAMMA10 at Univ. of Tsukuba. In these sites, data acquisition (DAQ) nodes are remotely operated from NIFS. All the raw data acquired by them are delivered to many collaboration sites once again through SNET. For the good presence of the remote experiment (RE) not the remote participation (RP) in FVL, high accessibility and good transferring speed are essential. When the ITER experiment will start in 2019, SNET could be also arranged to deliver the data domestically from ITER remote experiment center at Rokkasho.

Applying "Cloud" Technology for FVL

"Cloud" is a new technology which enables us to scale out the computing and data storing resources. We can consider applying the "cloud" for fusion experiments as follows:

1. Data acquisition (DAQ) cloud
2. Data storage cloud
3. Numerical computation/data analysis cloud

This FVL study intends to demonstrate the above issues between multiple distant (~ 1000 km) sites.

In FVL, more than 100 DAQ nodes are already operated for every plasma measurement. IP multicast messages are announced to share the experimental sequences and the real-time status of each DAQ. As many DAQ nodes have no dependence to each other, they behave like a "cloud".

Recently installed DAQ nodes have no spindles: They can boot through network without any system disk so that they could be so-called hot plug-and-play. This provides us the easiness of hardware maintenance and thus high availability of the system.

Remote DAQ monitoring and operation are also mandatory in FVL especially in steady state operation. In our LABCOM data system, the DAQ "agent" monitors each node and reports the real-time status by using IP multicast. The monitoring "manager" gathers those reports from agents to display them through the Web. As the entire channel statuses of DAQ are refreshed in every one second, we can detect and then recover their malfunction so rapidly. By using remote power controllers, not only DAQ processes but also power on/off and OS shutdown/boot can be also operated through the Web console.

The new storage cloud named *"IznaStor"* keeps going on the long verification tests[1)2)]. It already showed us good functionalities for high availability and performance, however, for the actual operation in experiment's long campaign we need a evidence of heavy load tests on it.

After the new cloud storage system passed the verification tests, it is expected to be the unified data access platform of FVL. It can provide the same data platform for both the numerical computations and experimental data analysis because it consists of 10 Gbps Ethernet network attached storages. (Fig. 1)

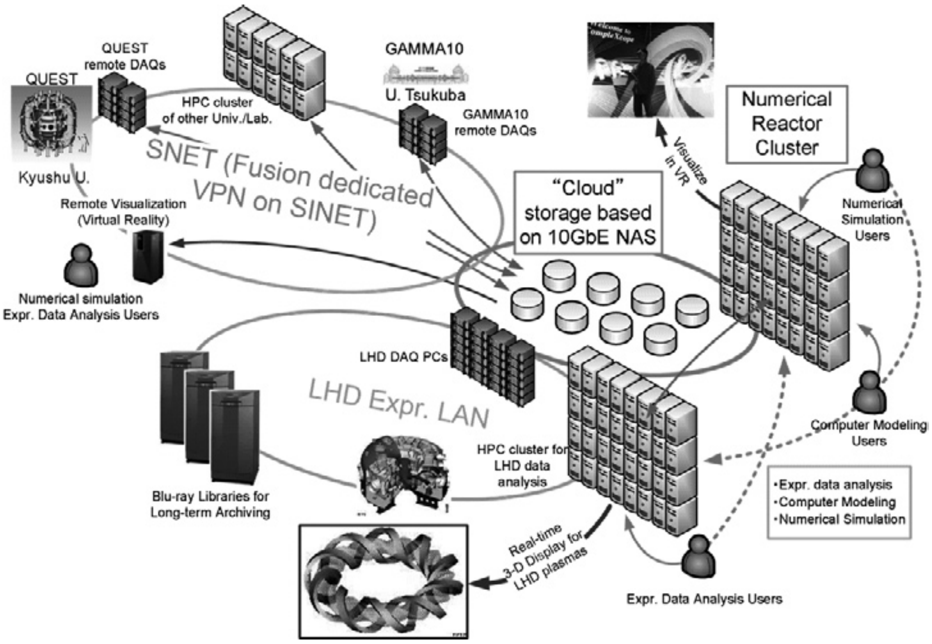

Fig. 1. Conceptual view of the unified data platform in FVL: the high-speed "cloud" storage goes between not only SNET remote experiments but also high-performance clusters for large numerical computations.

1) Nakanishi, H. *et al.*: NIFS Annual Report (2010) 181.
2) Nakanishi, H. *et al.*: NIFS Annual Report (2010) 532.