§39. Research on Remote Collaboration Based on Large Scale Simulation

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In recent years, computer simulation plays an essential role in various science fields. One of the examples is the fusion research such as ITER (magnetic confinement approach) and NIF (laser approach), in which large scale simulations have been extensively introduced to predict burning plasmas in advance of experiments. Such a research strategy based on computational science has been situated as a third pillar in parallel to theory and experiment. However, as the simulation becomes large scale and problems become complex, besides scientists directly managing simulation, participation and contribution of many collaborators who play different roles are essential [1].

In order to perform the study of large scale simulation efficiently, we have proposed a remote collaboration system, referred to as SIMON (simulation monitoring system), by which many collaborators working at geographically different places can participate to the project (Fig.1 and ref. [1-3]). In constructing the system, three viewpoints are considered, namely: (a) user's effort in changing the original program is minimized, (b) the system does not increase computational load, and (c) simulation is not interfered by various external troubles. In the SIMON system, the collaborators can monitor the latest information and results of ongoing simulation in super-computer via internet. The system is constructed based on a *client–server control system* using *trigger method*, which is a key ingredient of the system. In this system, a concept of *up-date processing* where various tasks are managed with proper time intervals during simulation is introduced. In this method, the simulation running on a super-computer actively controls the timing of up-date processing by sending various requests to an external server, which performs the tasks in parallel to the main simulation. In the present method, the simulation is interfered neither by network troubles nor up-date processing operations. The trigger method exchanges various information of ongoing simulation between super-computer (client) and workstation (server). By incorporating with internet technologies, the SIMON plays an important role as a simulation platform on which many collaborators can share the various information of ongoing simulation.

In the system, monitoring the status of simulation is one of key issues. Two approaches are considered, i.e. *passive method* and *active one,* in realizing the monitoring. The former accesses the simulation from an external server to get information, and the latter takes actions from the simulation toward an external server. Here we choose the latter which is robust to various computer and network troubles. Recent visualization software has a function that keeps various visualization procedures as a macro-file. Therefore, by programming requests used in the trigger method to macro-files, up-date processing such as data transfer and visualization can be performed automatically on server machine. Furthermore, by formatting visualization images by HTML, the procedure of up-date processing is drastically simplified. By utilizing such functions, the server makes the up-date processing results available to web. As a result, many collaborators working for the simulation at geographically different places can monitor the latest results.

Here, in order to increase the reliability of the system associated with network connection, we introduced the method that constructs login-shell of SSH dynamically and that changes the password for the network connection due by plural enciphers and increase the security level [3].

It is noted that the system is constructed based on conventional technologies without using special hard- and software applications. Therefore, the SIMON can be installed readily in any kind of client–server system. We have applied the system to a large scale simulation project of laser–matter interaction and confirmed that the system works well and plays an important role as a simulation platform. The system can be incorporated with various additional functions such as interactive management of simulation data and visualization through web page, which may increase the collaboration among scientists. Besides simulation, the key ideas of the system may be incorporated with experiments.

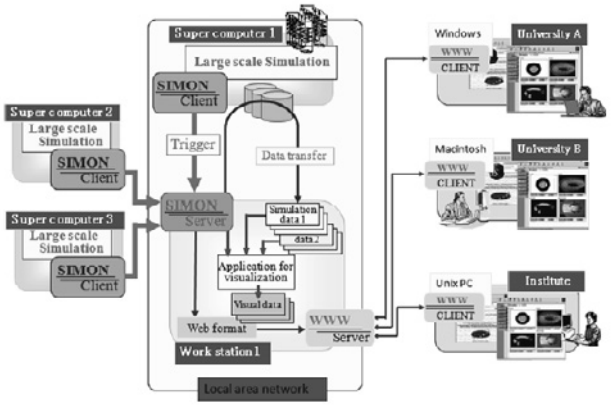

Fig. 1: Structure and functions of SIMON system.

[1] A. Sugahara and Y. Kishimoto, J. Plasma and Fusion Research: **vol.84**, 51-61 (2008)

[2] Y. Kishimoto and A. Sugahara, Fusion Engineering and Design **83**, 434-437 (2008)

[3] A. Sugahara and Y. Kishimoto, Plasma and Fusion Research: Regular Articles, vol. **6**, 2401022 (1-4) (2011)