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

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Large scale simulation using super-computer, which requires long CPU time and produces large amount of data, has been extensively studied as a third pillar in various advanced science fields in parallel to theory and experiment [1]. Such a simulation is expected to lead new scientific discoveries through elucidation of various complex phenomena, which are hardly identified only by conventional theoretical and experimental approaches. In order to assist such large simulation studies for which many collaborators working at geographically different places participate and contribute, we have developed a unique remote collaboration system, referred to as SIMON (Simulation MOnitoring System) [2,3].

A view of the SIMON system is illustrated in Fig.1. The SIMON is constructed as a ***client-server control system*** that exchanges information between super-computer (client) on which simulation is running and external workstation (server). The simulation transmits the latest information of ongoing simulation and requests the server to perform up-date processing at appropriate times during the simulation. According to the requests, the server is triggered by the client and starts the up-date processing such as data transfer, data analysis and visualization, etc. The server sends the latest results to web during simulation, so that collaborators can monitor the latest results at any time and place. Note that plural servers are available depending on the purposes of up-date processing. Two key ingredients i.e. *trigger method* and *formatting of macro*, are explained in the following.

For monitoring the status of simulation, two approaches are considered, i.e. *passive method* [4] and *active one*. Here we choose the latter that takes actions from the simulation toward an external server. In constructing the system, three viewpoints are considered, namely, (a) user's effort in changing the original program is small, (b) the system does not increase the computational load, and (c) the simulation is not interfered by various external troubles.

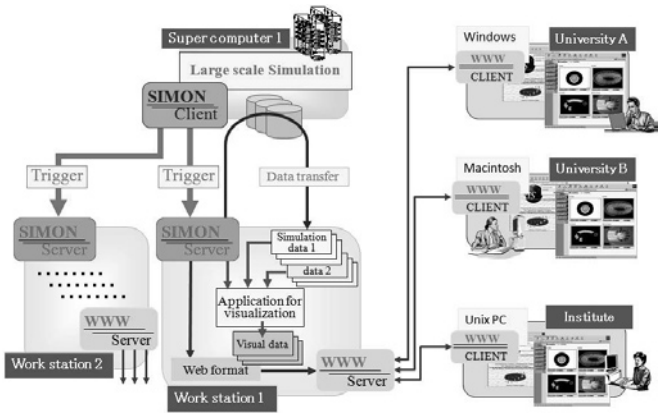

Fig.1: Schematic view of flowchart of various operations and functions in SIMON system.

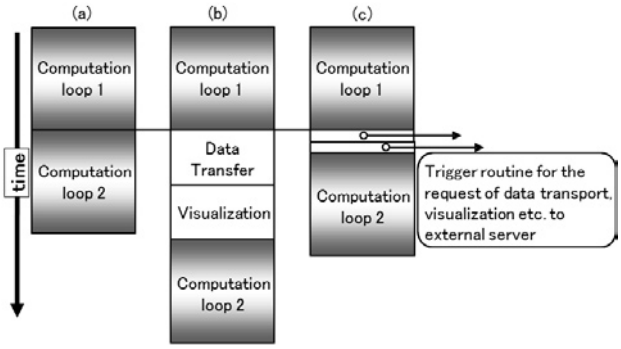

Fig.2: Loop of simulation and the role of trigger method: (a) basic simulation loop with no additional operation, (b) simulation loop including the operation of data transfer and visualization, (c) simulation loop including only request of data transfer and visualization via trigger method.

Figure 2 shows an example of program flowchart based on above ideas. Here, we have installed two tasks (data transfer and visualization) between two computational loops 1 and 2. In the case of Fig.2 (b), those two tasks are directory installed in the program. In this case, besides an increase of the execution time, once some trouble happens during these tasks, the simulation is interfered and/or interrupted. On the other hand, in the case of Fig.2(c), the simulation only transmits the requests related to these tasks to an external server after the loop 1 and then the server performs up-date processing according to the requests. It is noted that the time to transmit the requests to server is negligibly small, so that the simulation can move to the loop 2 immediately. Even if some trouble happens to the network and/or server machine, the simulation is not interfered. We refer this operation to as ***trigger method*** in the sense that an *ongoing simulation triggers an action requesting up-date processing to an external server*.

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, as shown in Fig.1.

We have successfully applied the SIMON system to a project investigating laser-matter interaction utilizing a 3-dimensional relativistic particle code, EPIC3D [2, 4].

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