# A case study: A Distributed Collaborative Simulation using extended Simulation Caching Framework

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## I. Introduction

We have been developing a framework to realize distributed collaborative simulation environment where several regional servers help to improve their simulation results by performing higher resolution simulation for the area of each interest, working with the central server which covers the whole area but in lower resolution. We extended our existing Simulation Caching Framework so that it could exchange necessary information such as boundary condition to improve both regional and global simulation.

## II. Distributed Co-Simulation Scheme

Simulation Caching Framework is a general-purpose framework for interactive remote supercomputing. The strategy is to utilize regional server to hide network delay by duplicately performing limited area and/or lower resolution simulation on regional server to give timely response. And higher resolution result on central server is seen as truth to update the regional data in some frequency for accuracy. In addition, the former framework has merely single-direction communication from central server to regional server (downward).

On the contrary, this research expect each user to perform finer-grid simulation on their interested region with the help of updating boundary condition in some frequency through downward quality control(DQC)(Fig.1), then inversely help refine coarse-grid simulation but wider area on central server through new implemented upward quality control (UQC) (Fig.2). In this way, collaboration between users can be realized via central server using the extended bi-directional quality control, expecting both regional and global simulation can be refined.

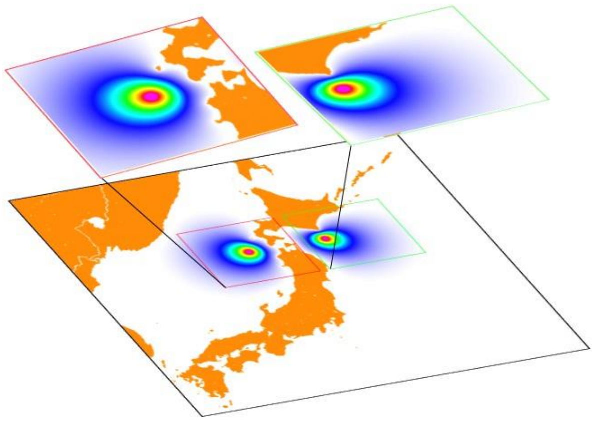

Fig.1 Distributed co-simulation with bi-directional refinement

## III. A case study of distributed collaborated simulation

As a case study, a 2D heat diffusion simulation is adopted to evaluate the effectiveness of the proposed bi-directional refinement model.

Intuitively, the regional fine-grid simulation seems to be beneficial definitely. However we found it behaves worse than standalone global coarse-grid simulation when using simple boundary condition. But once using complicated boundary, for example, introducing geographical boundary inside regional area (Fig.1), fine-grid simulation becomes winner in the comparison.

During investigation for the reason, we found this issue has been reported in two-way embedding algorithms of nested grid techniques [3]. The suffered issue is because there exists inevitable noises in fine-coarse grid simulation. The noises may source from several reasons: 1) the interpolation for fine-grid boundary from coarse-grid data, 2) different mesh size make simulation itself different inherently, and 3) the incorrect boundary condition since every time step's communication is unavailable in our case, and so on.

We would like to perform more details analysis on the effectiveness of the collaboration and at the same time, we would like to develop some scheme to reduce the noise.

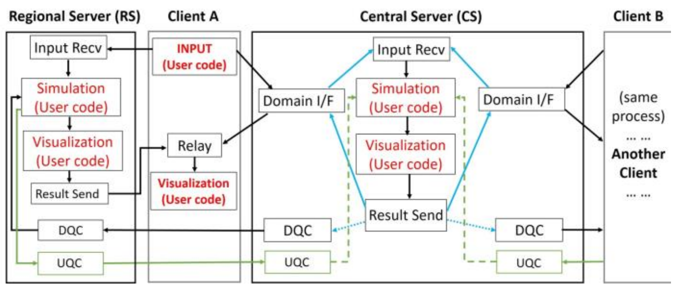


Fig.2 Implemented extended framework

## References

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[3] Koch SE, McQueen JT (1987) A survey of nested grid techniques and their potential for use within the MASS weather prediction model. NASA Technical Memorandum 8780