

High Performance Computing and Its Industrial Applications in Fugaku Era

Abstract

Most industries are currently using the time averaged turbulent flow simulation, called RANS, for the development as well as for the evaluation of their flow-related products. RANS is a model-based simulation of turbulent flows and the optimum model depends strongly on the individual flows. For this reason, RANS can never become a complete alternative to the tests made for the final evaluation of a product. On the other-hand, the Large Eddy Simulation, hereafter abbreviated as LES, directly resolves turbulent eddies in the production scale and provides accuracy compatible with the Direct Numerical Simulation (DNS) all the times. However, the LES requires billions of computational grids for its application to a high Reynolds number engineering flows, which was not feasible in the past. On the other hand, recent progress of the high-end computer performance is going to make such simulations, which use billions of grids, practical. With all of these in mind, we have fully optimized our flow solver, named FrontFlow/blue, to substantially shortened the time needed for such a high Reynolds number LES of an engineering flow. As a result, we have achieved 35 times speedup of our code and a parallel computing efficiency of over 85% by using approximately 3 million compute cores of Fugaku, the next flagship computer of Japan. In this presentation, we will review the features of our flow solver, describe the code optimization that has been made and resulted in such a remarkable performance improvement and finally provide several engineering applications of LES, which we believe will help the audience develop future vision of the computer aided engineering (CAE).