8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

STAR-CD computational fluid dynamics on IBM Blue Gene/P

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Key Words: *Supercomputing, Computational fluid dynamics, Applications, Massively parallel computing.*

ABSTRACT

CD-adapco and the IBM High Performance Computing group decided to port the STAR-CD version 4.04 application to the IBM Blue Gene/P massively parallel supercomputer. Several organizations, including government laboratories and industrial corporations, have expressed interest in exploring the possibility that some of their most difficult and time consuming problems could benefit from a Blue Gene version of the STAR-CD code. This paper discusses the efforts required to accomplish the port and also shows the results of several studies that demonstrate the scaling of the application.

Blue Gene/P is the second generation of the high successful Blue Gene computer system. The Blue Gene design is based on a concept of using thousands of low power, low frequency processors along with special purpose networks and software to achieve extreme scalability at a lower cost and lower power consumption than other current designs.

STAR-CD version 4.04 includes robust computational fluid dynamics solvers, but it is actually an integrated CAE platform for performing powerful multi-physics simulations, including: combustion; multiphase flow; heat transfer; conjugate heat transfer; melting and solidification; and stress.

In this paper, various types of problems including both easily generated test cases and real customer problems are examined for applicability to massively parallel computing. In addition, we discuss the suitability and efficiency of some of the different solvers available in STAR-CD, for example, the algebraic multigrid (AMG) and the incomplete Cholesky conjugate gradient (ICCG) solvers, which are used to solve the intermediate linear equation systems appearing in the code's implicit nonlinear iterative scheme. Scalability and efficiency for these solvers as a function of the model size and the number of MPI tasks employed will be explored.

A preliminary scaling study for an external aerodynamic flow solution (see Figure 1) shows very good scaling to 256 MPI tasks and will be tested to at least 2048 MPI tasks in early 2008.

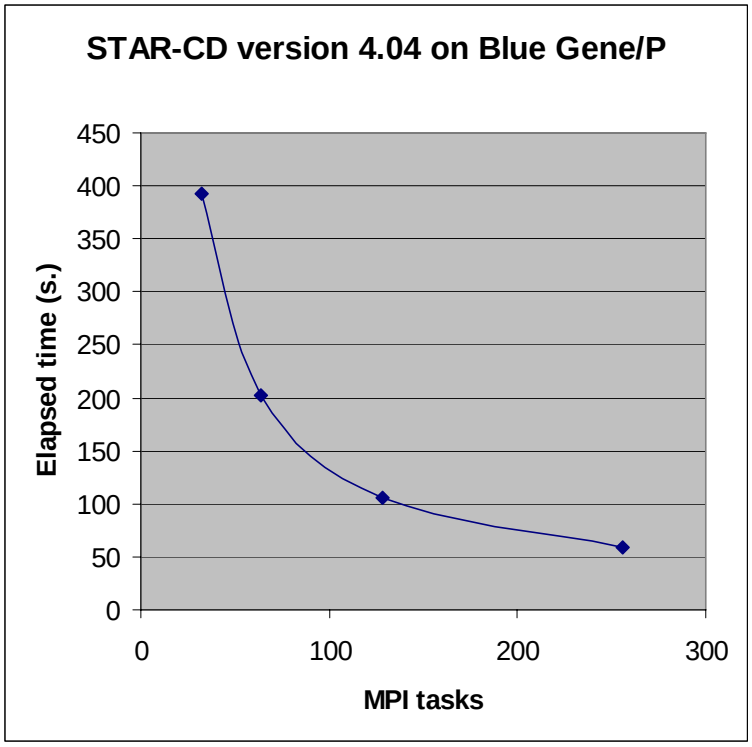

Figure 1. Preliminary scaling study for 6 million fluid cell model external aerodynamic flow for 20 iterations showing good performance to 256 MPI tasks.