SOFTWARE EXTREME BENCHMARKING

Allocation: Illinois/0.40 Mnh
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EXECUTIVE SUMMARY:

The current allocation is a continuation for running extreme benchmarking for key computational fluid dynamics commercial codes on Blue Waters. The allocation helped us reach new "global" records in scaling two codes: Ansys-Fluent to 36,000 cores and Starccm+ of CD-Adapco to 20,000 cores.

INTRODUCTION

In service to the computational fluid dynamics (CFD) simulation community and in particular NCSA's Private Sector Program (PSP) industrial partners, PSP provides "extreme" benchmarking and scalability studies on leading CFD codes, which are used by and of high interest to its PSP partners. The objective of the project is to explore the scaling limits of these codes to inform users of the codes' scaling capabilities for better production workflow. Two world-class CFD codes were included in the study: Fluent from Ansys,Inc., and Starccm+ of CD-Adapco.

The project was carried out (and is still running) in close collaboration between the PI (PSP-CFD Lead, Ahmed Taha), independent software vendor (ISV; Ansys and CD-Adapco) and the Blue Waters vendor (Cray).

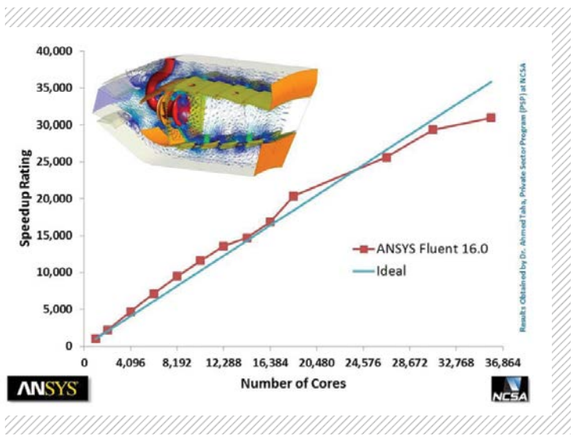

FIGURE 1:
Ansys-Fluent speedup scaling curve, 830 million cells, and 36,000 cores.

METHODS & RESULTS

In order for this project to serve the real-life industrial needs, four main parameters were essential in running this study: (1) a real-life application, (2) big mesh size, (3) complicated geometry, and (4) sophisticated physics. Close collaboration with ISV and Cray was essential in adjusting environments.

Case study 1: After scaling Fluent to 10,000 cores towards the end of 2013 using the Ansys benchmark model of 111 million cells, Ansys provided its biggest mesh model—830 million cells. We scaled the code to 36,000 cores, the second world record the project set. The previous record, which we set in the first phase of the project in early 2014 while using the smaller 111-million-cell model, was 20,000 cores [1]. Fig. 1 presents the scaling curve for Ansys-Fluent reaching 36,000 cores with over 80% efficiency [2].

Case study 2: Starccm+. CD-Adapco provided two of its biggest mesh models: 100 million cells and 514 million cells. As shown in fig. 2, the 100-million-cell model scaled to 13,000 cores, defeating the 8,000-core record set at the HPC Center Stuttgart (HLRS), Germany. We scaled the 514-million-cell model to 20,000 cores, defeating its previous 16,000-core record achieved at HLRS (fig. 3).

Among the many benefits of this extreme scaling study are [3–4]:

1. It provided users with information on how robust the flow solvers of the tested codes are, which is presented in the high-fidelity simulations running at such massive core counts.

2. It drove the mesh count, allowing more details in the complex physics needed for more thorough design studies.

3. It showed how time to solution was reduced so customers that have many cores can take advantage of this. However, this is not just for large core counts; even on smaller core counts, problems can be simulated with faster turn-around because of the good scaling.

4. This it is not only important for mega-jobs of huge mesh sizes. Success on extreme scaling also means that you can run smaller problems on more cores than before and see great scaling.

The study results added to the depth of the PSP strategic relationship with the ISV community. Other leading CFD ISVs approached the project lead to run similar scaling projects for their codes. We plan to continue to present our work and records at U.S. and global conferences.

WHY BLUE WATERS?

This project would have not able to reach this success level without Blue Waters. NCSA and Blue Waters are the only place capable of doing such work where you can find massive computational resources, experienced staff, and domain experts.

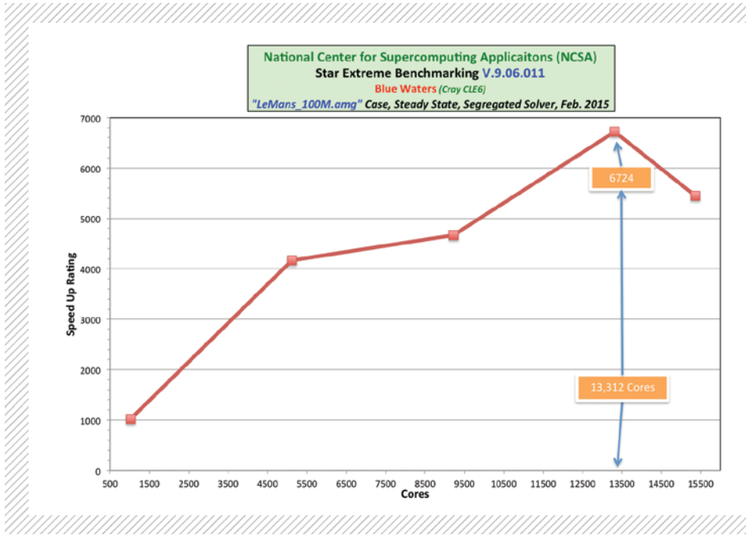

FIGURE 2:
Starccm+ speedup scaling curve, 100 million cells, and 16,000 cores.

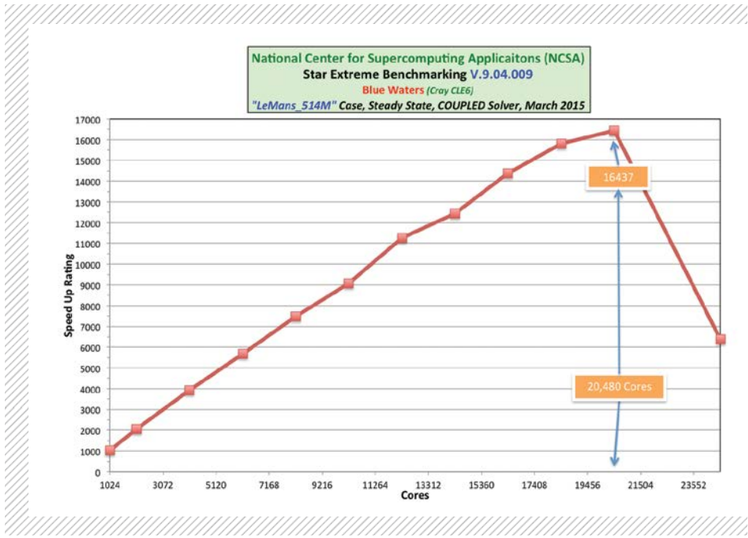

FIGURE 3:
Starccm+ speedup scaling curve, 513 million cells, and 20,000 cores.