SOFTWARE EXTREME BENCHMARKING

Allocation: Industry/595 Knh
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EXECUTIVE SUMMARY

The current allocation is a continuation for running extreme benchmarking for key computational fluid dynamics (CFD) commercial codes on the Blue Waters. The allocation helped us reaching new "global" records in scaling two codes: Ansys-Fluent to 114,000 cores and Starccm+ of CD-Adapco to 102,000 cores.

INTRODUCTION

In service of 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 commercially oriented CFD codes, provided by Independent Software Vendors (ISVs), which are used by and are of high interest to many industrial partners. The objective of the project is to continue exploring the scaling limits of these codes to inform users of the scaling capabilities for better production and workflow. Two world-class CFD codes are included in the study: Fluent from Ansys,inc. and Starccm+ of CD-Adapco.

The project was carried out in close collaboration between the projects primary investigator, Ahmed Taha, independent software vendors (ISV) Ansys and CD-Adpco, and the Blue Waters vendor (Cray, Inc.).

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 collaborations with the ISVs and Cray were essential in adjusting environments.

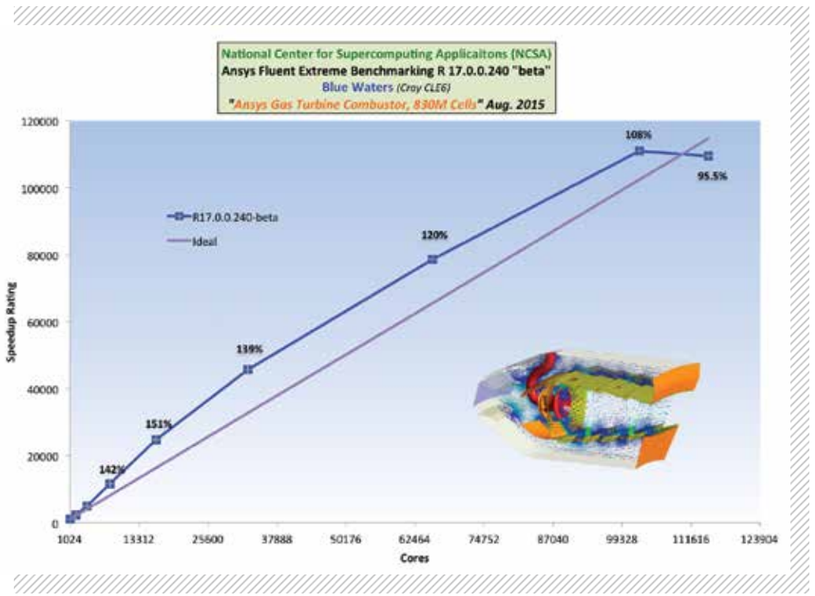

FIGURE 1: Ansys-Fluent Speedup Scaling Curve, 830M Cells, and 114,000 Cores.

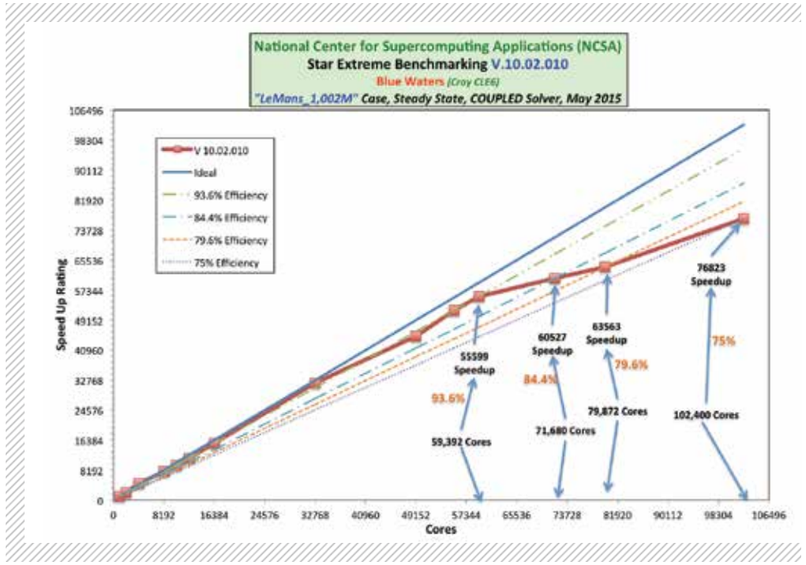

FIGURE 2: Starccm+ Speedup Scaling Curve, 1B Cells, and 102,000 Cores.

Case Study 1: Ansys-Fluent scaled to 10,000 cores using Ansys Benchmark Truck model of 111 million cells. Using successive upgrades of Fluent, the same model was scaled to 20,000 cores, followed by scaling to 36,000 cores using a bigger mesh of 830 million cells for the Ansys generic gas turbine combustor model in mid- 2015 with 80% scaling efficiency. The project concluded its 2015 BW allocation by achieving the highest scaling record of 114,000 cores with 95.5% scaling efficiency using the "beta" version of Ansys-Fluent 17.0 (Fig.1).

Case Study 2: In early 2015, Starccm+ scaled to 13,000 cores using the LeMans racing car model of 100 million cells using Starccm+ V.9.06.011. In March, a bigger mesh of 514M cells for the same model scaled to 20,000 cells. CD-Adapco provided a bigger mesh for the same LeMans model with 1 billion cells, which we scaled to 59,000 cores with 93.6% scaling efficiency then to 102,000 cores with 75% scaling efficiency using Starcccm+ V.10.02.010 (Fig.2). Per this achievement, NCSA currently holds the global record for scaling Starccm+ to 102,000 cores.

Among the many benefits of this extreme scaling study are:

- It provided users with information about the robustness of the flow solvers of the tested codes, which are presented in the high fidelity simulations running at such massive core counts.
- It drove the mesh count, allowing more details on the complicated physics involved for more thorough design studies.
- It showed how time to solution is 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.
- It showed that extreme scaling 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.

WHY BLUE WATERS

Blue Waters has been instrumental in allowing this work to reach high levels of success. The massive computational resources and expert staff of NCSA and Blue Waters make it the only place capable of handling a project of this magnitude.