Aeronautics

Computational Scaling for an Unstructured-Grid CFD Solver

Aeronautics Research Mission Directorate

FUN3D is a suite of unstructured-grid computational fluid dynamics (CFD) codes used for a broad spectrum of aerodynamic analysis and aeronautic design challenges supporting NASA missions. FUN3D utilizes an adjoint-based technique for design optimization, error estimation, and mesh adaptation. To enable these computationally demanding adjoint-based strategies for 3D simulations of complex flowfields, FUN3D must take full advantage of massively parallel computing environments. This project seeks to evaluate and improve application performance for FUN3D simulations running on many thousands of processor cores.

Using NASA's powerful supercomputers, we have demonstrated that complex FUN3D simulations can be run effectively on large numbers of processors. To mitigate performance drops associated with communication on a single system, we are investigating whether a single set of Message Passing Interface (MPI) constructs can be used over multiple supercomputers in which the underlying MPI implementations differ greatly. Limitations of these implementations—such as scalability of MPI collectives, memory used by message passing libraries, and synchronization—are being examined in conjunction with the MPI constructs used by FUN3D.

By enabling the software to run more reliably and efficiently on the world's largest supercomputers, analysis and design cycle times can be dramatically lessened, ultimately reducing cost and turnaround times for a myriad of aeronautics and aerodynamics projects.

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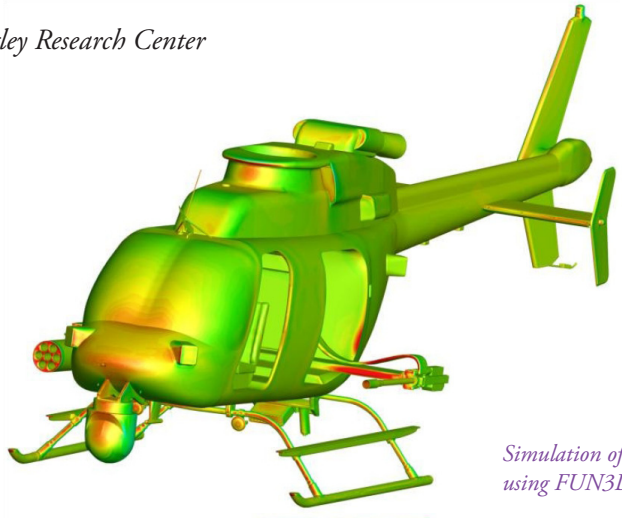

Simulation of an armed IA-407 helicopter performed using FUN3D. Tin-Chee Wong, US Army