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NEXT-GENERATION TRILINOS FOR VERY LARGE SCALE LOW MACH CFD SIMULATIONS: A CASE STUDY

Paul Lin[1*], Matthew Bettencourt[2], Stefan Domino[2], Travis Fisher[2], Mark Hoemmen[2], Jonathan Hu[2], Eric Phipps[2], Andrey Prokopenko,[2] Sivasankaran Rajamanickam,[2] Christopher Siefert[2], Eric Cyr[2], Stephen Kennon[2]

[1] Sandia National Laboratories, P.O. Box 5800 MS 1320, Albuquerque NM 87185, USA, ptlin@sandia.gov

[2] Sandia National Laboratories, Albuquerque NM 87185, USA

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Trilinos is an object-oriented software framework for the solution of large-scale, complex multi-physics engineering and scientific problems [1]. While the original version of Trilinos was designed for scalable solutions for large problems, the need for increasingly higher fidelity simulations has pushed the problem sizes beyond what could have been envisioned two decades ago. When problem sizes exceed a billion elements even scalable applications and solver stacks most likely will require a complete revision. The next-generation Trilinos employs templated data types in order to solve arbitrarily large problems and provide the required fidelity critical to the work of a national laboratory. We present a case study that involves vertical integration of Trilinos with a new low Mach fluid engineering application code. The case study describes how this integration process matured and improved the next-generation Trilinos, provides best practices for future application codes that will employ the next-generation Trilinos, and demonstrates the capability provided by the new Trilinos by demonstrating scalability for problem sizes that are much larger than previously obtained from the current production code. Through the use of improved algorithms and better software engineering practices we demonstrate good weak scaling for the matrix assembly and solve for the engineering application for up to a nine billion element fluid flow large eddy simulation (LES) problem on unstructured meshes with a 27 billion row matrix on 131,072 cores of a Cray XE6 platform.

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