Lin, P. T.; **Shadid, J. N.**; **Hu, J. J.**; **Pawlowski, R. P.**; **Cyr, E. C.**

Performance of fully-coupled algebraic multigrid preconditioners for large-scale VMS resistive MHD. (English) Zbl 1443.76152

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Summary: This work explores the current performance and scaling of a fully-implicit stabilized unstructured finite element (FE) variational multiscale (VMS) capability for large-scale simulations of 3D incompressible resistive magnetohydrodynamics (MHD). The large-scale linear systems that are generated by a Newton nonlinear solver approach are iteratively solved by preconditioned Krylov subspace methods. The efficiency of this approach is critically dependent on the scalability and performance of the algebraic multigrid preconditioner. This study considers the performance of the numerical methods as recently implemented in the second-generation Trilinos implementation that is 64-bit compliant and is not limited by the 32-bit global identifiers of the original Epetra-based Trilinos. The study presents representative results for a Poisson problem on 1.6 million cores of an IBM Blue Gene/Q platform to demonstrate very large-scale parallel execution. Additionally, results for a more challenging steady-state MHD generator and a transient solution of a benchmark MHD turbulence calculation for the full resistive MHD system are also presented. These results are obtained on up to 131,000 cores of a Cray XC40 and one million cores of a BG/Q system.

MSC:

76M10 Finite element methods applied to problems in fluid mechanics
65M55 Multigrid methods; domain decomposition for initial value and initial-boundary value problems involving PDEs
76W05 Magnetohydrodynamics and electrohydrodynamics
65F08 Preconditioners for iterative methods
65Y05 Parallel numerical computation

Keywords:

large-scale parallel iterative solvers; fully-coupled algebraic multigrid preconditioners; implicit finite element; resistive MHD

Software:

MueLu; Trilinos; Belos; PETSc; Tpetra; ML; Amesos2

Full Text: DOI

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