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Speeding up multi-physics simulations through reuse of multigrid components

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Large scale scientific applications, such as fluid dynamics or MHD, rely on robust and efficient linear and nonlinear solvers for their simulations. The complex nature of such simulations may require taking small time steps which may result in a long time to solution, a significant part of which is taken by linear solvers. The sheer amount of work and transient nature of these problems allow for various approaches to reduce the overall simulation time. For example, nonlinear solvers for each transient step often produce a sequence of closely related systems, and a promising strategy is to leverage any such system similarities from within the linear solve phase.

In this talk, we will focus on simulations that use algebraic multigrid (AMG) methods as part of their solution process. We will concentrate on speeding up the AMG solver through reuse of components of the multigrid hierarchy throughout the nonlinear solve, and possibly across transient steps. The goal is to significantly reduce the multigrid hierarchy setup time while not significantly hurting the convergence. We will consider several AMG reuse strategies that differ in the amount of reused data. We will demonstrate the effectiveness of such strategies in parallel applications.