Special Guest Lectures

Scalable Solver Infrastructure for Multirate, Multiscale PDE Applications

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Abstract:
Optimal complexity algebraic preconditioners, such as multigrid/multilevel preconditioners for PDE-governed problems, keep the time spent in dominant algebraic kernels close to linear as the applications scale out to the limit of currently available parallel computers (e.g., BlueGene/L with 131,072 (2**17) processors). Krylov accelerators and Jacobian-free variants of Newton's method, as appropriate, are wrapped outside to deliver robustness in multirate, multiscale coupled systems, which are solved either implicitly or in more traditional forms of operator splitting. The Towards Optimal Petascale Simulations (TOPS, www.scidac.org/math/TOPS.html) project, directed by the speaker, is sponsored by the U.S. Department of Energy to research and deploy a collection of open-source scalable solver software components (PETSc, Hypre, SuperLU, etc.) for discrete problems arising in several large-scale applications, for instance, fusion reactor modeling and design. As the U.S. fusion energy community gears up for participation in the International Thermonuclear Experimental Reactor (ITER) consortium, the ultimate goal of which is abundant energy production outside of the planetary carbon cycle, simulations on petascale hardware are expected to play an essential role. We outline the TOPS software philosophy and research agenda and illustrate with a progression of five applications in DOE's magnetically confined fusion energy portfolio, ranging from swapping software through a standard interface to prototyping new codes.

Speaker's Bio:
David E. Keyes is the Fu Foundation Professor of Applied Mathematics in the Department of Applied Physics and Applied Mathematics at Columbia University, and Acting Director of Institute for Scientific Computing Research (ISCR) at Lawrence Livermore National Laboratory. With backgrounds in engineering, applied mathematics, and computer science, Keyes works at the algorithmic interface between parallel computing and the numerical analysis of partial differential equations, across a variety of applications. Newton-Krylov-Schwarz parallel implicit methods, introduced in a 1993 paper, are now widely used throughout computational physics and engineering and scale to many thousands of processors. Keyes is currently the Vice President-at-Large of SIAM, a member of the Presidential Council of Advisors in Science & Technology (PCAST, Networking and Information Technology Committee) and of the Advisory Committees of the Mathematics and Physical Sciences Directorate and the Office of Cyberinfrastructure of the National Science Foundation.

Refreshments will be served.

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