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**Performance Portability in Hybrid and Heterogeneous  
Multigrid Solvers**

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Obtaining high-performance, scalable, portable implementations of linear solvers running on today's emerging manycore and accelerated supercomputers has become an immense challenge. To that end, we developed a multigrid proxy app, HPGMG-FV, designed to: proxy the multigrid aspect of linear solves found in applications built on CHOMBO or BoxLib, allow for co-design of discretization and algorithm, and evaluate emerging programming models and architectures.

In this talk, we explore software techniques developed that provide scalability and performance portability when running on CPU and GPU-accelerated supercomputers and clusters. Moreover, these techniques hide choices on programming model (OpenMP vs. CUDA, MPI vs. UPC $\times\times$ ) and implementation (e.g. cache/thread blocking) from the user and functional description. We show, with proper usage of affinity to avoid NUMA issues and thread migration, that MPI $\times$ OpenMP performance can exceed flat MPI performance. Moreover, we show that heterogeneous CPU $\times$ GPU implementations can exceed CPU-only performance. Finally, we show network architecture is paramount in delivering scalable performance for even the largest problem sizes.