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ShyLU : A package for on-node smoothers and hybrid preconditioners in Trilinos

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This talk will present recent developments in the ShyLU package in Trilinos. ShyLU was originally developed as hybrid Schur complement solver. ShyLU is a MPI + X Schur complement solver where the X refers to additional levels of parallelism based on the architecture. This second level of parallelism has become critical for performance in modern architectures. This talk will focus on recent on-node factorizations and preconditioners in ShyLU. We discuss three different algorithms. First, we discuss a left-looking, data-parallel, non-supernodal (in)complete factorization. This algorithm is a parallel version of the Gilbert-Peierls algorithm. Second, we discuss a right-looking, task-parallel incomplete Cholesky factorization. This algorithm derives from the algorithm-by-blocks style of algorithms popular in the dense linear algebra community. Both these algorithms use a two-dimensional matrix layout for reduced synchronization costs. While the task-parallel algorithm is asynchronous, the data-parallel algorithm reduces the synchronization costs by algorithm specific techniques. Third, we discuss a new implementation of the iterative algorithm to compute the incomplete LU factorization and the triangular solve. This is a highly parallel, asynchronous algorithm that is uses nonlinear iterations to compute the LU factorization.

The first two algorithms are targeted towards medium level of concurrency and the third algorithm is targeted towards very high concurrency architectures. We compare the task-parallel and data-parallel algorithms to other solvers in both CPU and Xeon-Phi architectures. We present results of the third algorithm in GPU architectures. All three algorithms are implemented using the Kokkos library in Trilinos for portable performance across different architectures.