ECP | SLATE — Replacing ScaLAPACK

The objective of the Software for Linear Algebra Targeting Exascale (SLATE) project is to provide fundamental dense linear algebra capabilities to the US Department of Energy and to the high-performance computing (HPC) community at large. To this end, SLATE provides basic dense matrix operations (e.g., matrix multiplication, rank-k update, triangular solve), norms, linear systems solvers, least square solvers, and singular value and eigenvalue solvers.

NWChemEX	GAMESS	EXAALT	QMCPACK	STRUMPACK	

SLATE

CUDA/HIP	MPI	OpenMP	BLAS++	LAPACK++	Batch BLAS++
Exa MPI	SOLLVE	MKL	ESSL	cuBLAS	rocBLAS
OMPI-X					

| ECP	Standards	Vendor	SLATE

The ultimate objective of SLATE is to replace the venerable Scalable Linear Algebra PACKage (ScaLAPACK) library, which has become the industry standard for dense linear algebra operations in distributed-memory environments. However, after two decades of operation, ScaLAPACK is past the end of its lifecycle and overdue for a replacement, as it can hardly be retrofitted to support hardware accelerators, which are an integral part of today's HPC hardware infrastructure.

Primarily, SLATE aims to extract the full performance potential and maximum scalability from modern, many-node HPC machines with large numbers of cores and multiple hardware accelerators per node. For typical dense linear algebra workloads, this means getting close to the theoretical peak performance and scaling to the full size of the machine (i.e., thousands to tens of thousands of nodes). This is to be accomplished in a portable manner by relying on standards like MPI and OpenMP.

PERFORMANCE

Performance on 16 Summit nodes (672 POWER9 cores + 96 V100 GPUs total)
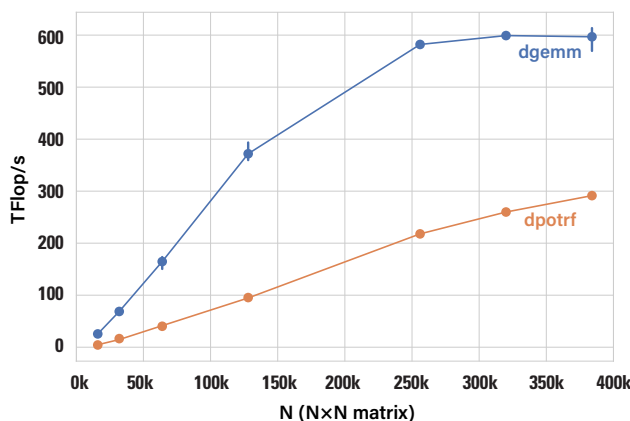
SLATE HIGHLIGHTS

Targets Modern Hardware
such as the upcoming exascale systems, where the number of nodes is large, and each node contains a heavyweight multi-core processor and a number of heavyweight hardware accelerators.

Guarantees Portability
by relying on standard computational components (e.g., vendor implementations of BLAS and LAPACK) and standard parallel programming technologies (e.g., MPI, OpenMP) or portable runtime systems (e.g., PaRSEC).

Provides Scalability
by employing proven techniques of dense linear algebra, such as the 2-D block cyclic data distribution, as well as modern parallel programming approaches, like dynamic scheduling and communication overlapping.

Facilitates Productivity
by relying on the intuitive single program, multiple data (SPMD) programming model and a set of simple abstractions to represent dense matrices and dense matrix operations.

Ensures Maintainability
by employing useful facilities of the C++ language, such as templates and overloading of functions and operators, and focused on minimizing code bloat by relying on compact representations.

SLATE PAPERS AND WORKING NOTES
http://icl.utk.edu/slate/#papers

Gates, M., M. Al Farhan, A. Charara, J. Kurzak, D. Sukkari, A. YarKhan, and J. Dongarra, **"SLATE Working Note 13: Implementing Singular Value and Symmetric/Hermitian Eigenvalue Solvers,"** SLATE Working Notes, no. 13, ICL-UT-19-07: Innovative Computing Laboratory, University of Tennessee, September 2019.

Gates, M., A. Charara, J. Kurzak, A. YarKhan, M. Al Farhan, D. Sukkari, and J. Dongarra, "**SLATE Users' Guide,**" SLATE Working Notes, no. 10, ICL-UT-19-01: Innovative Computing Laboratory, University of Tennessee, July 2020.

Gates, M., J. Kurzak, A. Charara, A. YarKhan, and J. Dongarra, **"SLATE: Design of a Modern Distributed and Accelerated Linear Algebra Library,"** International Conference for High Performance Computing, Networking, Storage and Analysis (SC19), Denver, CO, ACM, November 2019. DOI: 10.1145/3295500.3356223

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