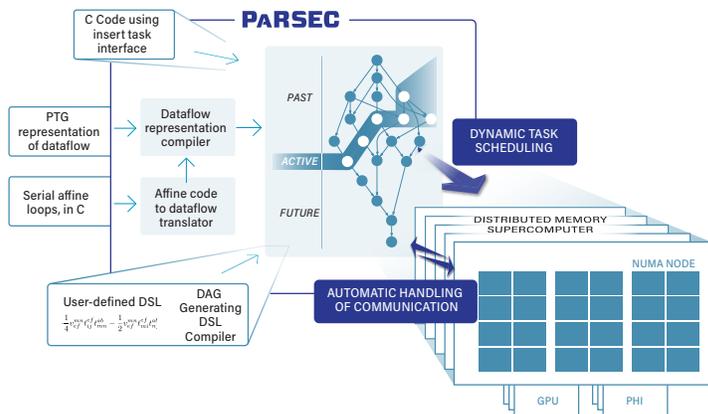


PARSEC

PARALLEL RUNTIME AND EXECUTION CONTROLLER

ICL's Parallel Runtime and Execution Controller (PaRSEC) project is a generic framework for architecture-aware scheduling and management of microtasks on distributed, many-core, heterogeneous architectures. The PaRSEC environment also provides a runtime component for dynamically executing tasks on heterogeneous distributed systems along with a productivity toolbox and development framework that supports multiple domain-specific languages (DSLs) and extensions and tools for debugging, trace collection, and analysis.



DOMAIN SPECIFIC LANGUAGES (DSLs)

Dynamic Task Discovery (DTD)

DTDs enable a sequential description of application data and tasks dependencies similar to OpenMP. Tasks are presented using an `insert_task` directive, with an option to declare typed dependencies (e.g., read, write, and atomic update), including on hybrid distributed environments.

Templated Task Graph (TTG)

DTE includes a set of C++ Template classes to express dynamic DAGs for heterogeneous datasets. At the heart of TTG lie the `Operand` class (which represents Tasks) and the `Terminal` class (which connects Operands together). In the `Operand` body, the programmer explicitly transmits data to output terminals to trigger the input terminals of destination tasks. The language is heavily templated, moving all compiler-decidable decisions at compile time and uses the Standard Template Library to encapsulate communications between Operands.

Parameterized Task Graph (PTG)

A PTG is a concise, symbolic, problem size-independent task graph representation, with implicit data movements that supports hybrid architectures via multiple task incarnation. In PTG, the developer expresses all flows of data between tasks in an analytical way using the tasks parameters. This representation is then used by PaRSEC to track dependencies and schedule tasks and data movement.

A Generic Runtime for Domain-specific Language/Extensions

The PaRSEC engine enables the domain scientist to implement a DSL to efficiently interact with the runtime, thereby improving productivity and portability.

With PaRSEC, applications are expressed as a direct acyclic graph (DAG) of tasks with edges designating data dependencies. This DAG dataflow paradigm attacks both sides of the exascale challenge: managing extreme-scale parallelism and maintaining the performance portability of the code.

The ECP Distributed Tasking at Exascale (DTE) effort is a vital extension that ensures that PaRSEC meets the critical needs of ECP application communities in terms of scalability, interoperability, and productivity.

Accelerate your Application with PaRSEC

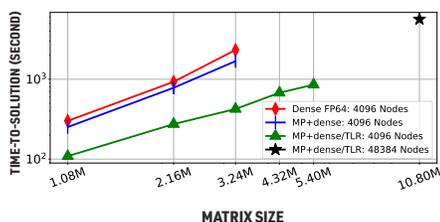
Write once, execute on any hardware: adding distributed memory and GPU acceleration to a PaRSEC code is simple, and performance portable, thanks to implicit data movement.

Write your main code in C, Templated C++, Fortran, Python, etc., your PaRSEC application is modular, and you can accelerate critical routines only, and use Open MP, Kokkos, Cuda etc. as the main body for your tasks. The PaRSEC ecosystems comes with tools for debugging, performance analysis as well as documentation.

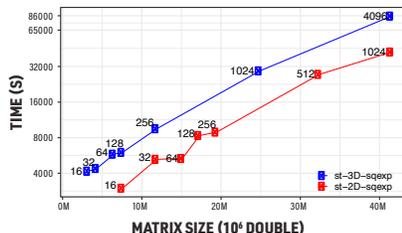
Installing PaRSEC on leadership class hardware and workstations alike is simple with CMake, Spack, PkgConfig integrations.

PERFORMANCE RESULTS

GORDON BELL FINALIST RUN:
ExaGeoStat Tile Low-Rank
Mattern 2D space-time of strong correlation on 4096 and 48384 Fugaku nodes

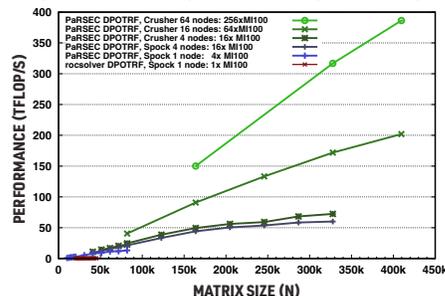


TILE, LOW-RANK, CHOLESKY FACTORIZATION FOR LARGE MATRICES
Shaheen II: 4096 nodes
(32 cores each @ 2.30 GHz [Intel Haswell])



PERFORMANCE PORTABILITY ON AMD ROCM HARDWARE:

Early results for Cholesky Factorization on pre-Frontier systems



SPONSORED BY



This research was supported by the Exascale Computing Project (17-SC-20-SC), a collaborative effort of the U.S. Department of Energy Office of Science and the National Nuclear Security Administration.



GORDON BELL FINALIST PRESENTATION AT SC22
Reshaping Geostatistical Modeling and Prediction for Extreme-Scale Environmental Applications

Tuesday, November 15
11:00am CST / C144

