

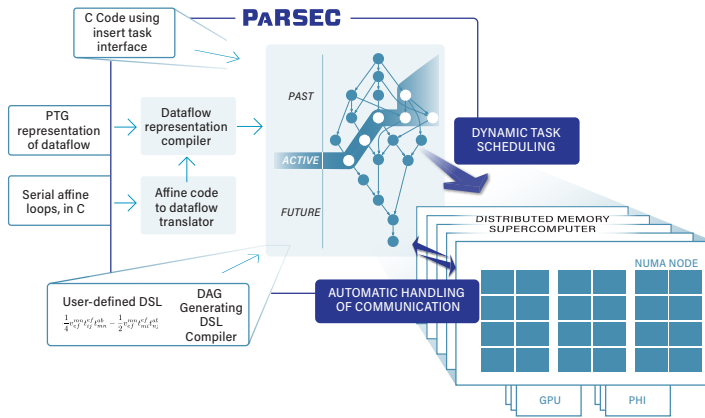
PARSEC

FIND OUT MORE AT <https://github.com/icldisco/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.



A GENERIC RUNTIME FOR DSLs

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.

ACCELERATING YOUR APPLICATION WITH PARSEC

Write once, execute on any hardware: adding distributed memory and GPU acceleration to code with ParSEC 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 ecosystem comes with tools for debugging and performance analysis as well as documentation.

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.

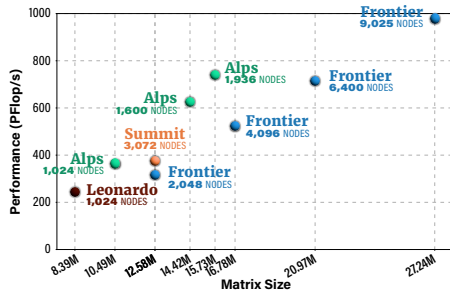
Templated Task Graph (TTG)

DTE provides C++ Template classes for dynamic DAGs on heterogeneous datasets. TTG features the Operand class (for Tasks) and Terminal class (which connects Operands). In the Operand body, data transmits to output terminals to trigger input terminals of destination tasks. This templated language pushes compile-time decisions and uses the Standard Template Library for Operand communication.

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.

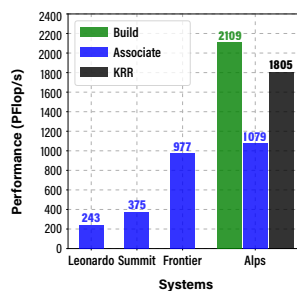
WINNER 2024 GORDON BELL AWARD FOR CLIMATE MODELING



PAPER: Boosting Earth System Model Outputs and Saving PetaBytes in Their Storage Using Exascale Climate Emulators

This exascale climate emulator is to address the growing computational and storage demands of high-resolution Earth System Models. By leveraging advanced numerical methods with the ParSEC dynamic runtime system, the resulting pipeline, stochastically models spatio-temporal variations in climate data, boosts computational efficiency, greatly enhances the accuracy of climate emulators, and provides critical insights for understanding climate change and extreme weather patterns.

FINALIST 2024 GORDON BELL AWARD



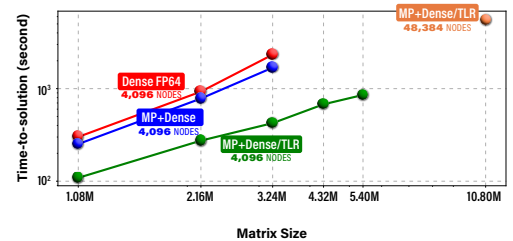
PAPER: Toward Capturing Genetic Epistasis from Multivariate Genome-Wide Association Studies Using Mixed-Precision Kernel Ridge Regression

By implementing mixed-precision computations and relying on ParSEC, Exascale GWAS significantly enhances Kernel Ridge Regression (KRR), a critical technique for analyzing genetic data, achieving a performance improvement of five orders of magnitude over the state-of-the-art CPU-only REGNIE, the current leading software for similar tasks.

FOREST: FOSTERING AN OPEN RUNTIME ECO-SYSTEM FOR THE TASK-BASED SYSTEM PARSEC

This NSF POSE-funded project seeks to establish an open ecosystem and foster a community around the ParSEC project. We are actively seeking collaborators and contributors interested in steering the future of ParSEC's development.

FINALIST 2022 GORDON BELL AWARD



PAPER: Reshaping Geostatistical Modeling and Prediction for Extreme-Scale Environmental Applications

We extend the capability of space-time geostatistical modeling using algebraic approximations, illustrating application-expected accuracy worthy of double precision from majority low-precision computations and low-rank matrix approximations. Our adaptive approach scales on various systems and leverages the Fujitsu A64FX nodes of Fugaku to achieve up to 12X performance speedup against the highly optimized dense Cholesky implementation.



Student Cluster Competition (SCC)
November 17-19, 2025

IndySCC
November 17-19, 2025