OAK RIDGE National Laboratory

Introduction to HPC

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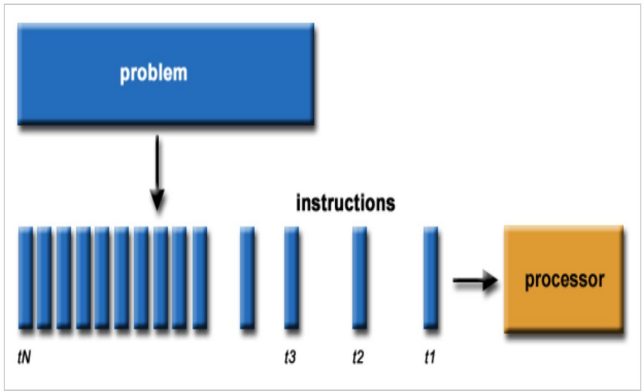
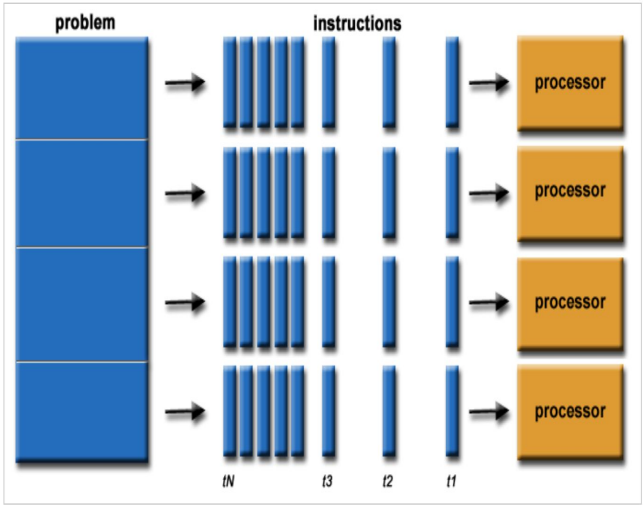
What is High Performance Computing?

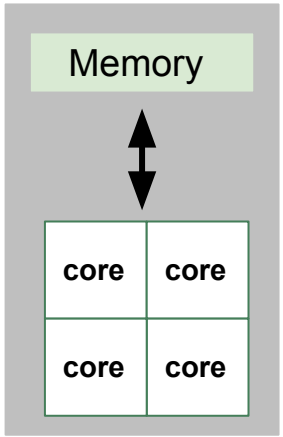
- High Performance Computing (HPC) is about solving the world's largest engineering and science problems with supercomputers.
- That means doing work efficiently in parallel



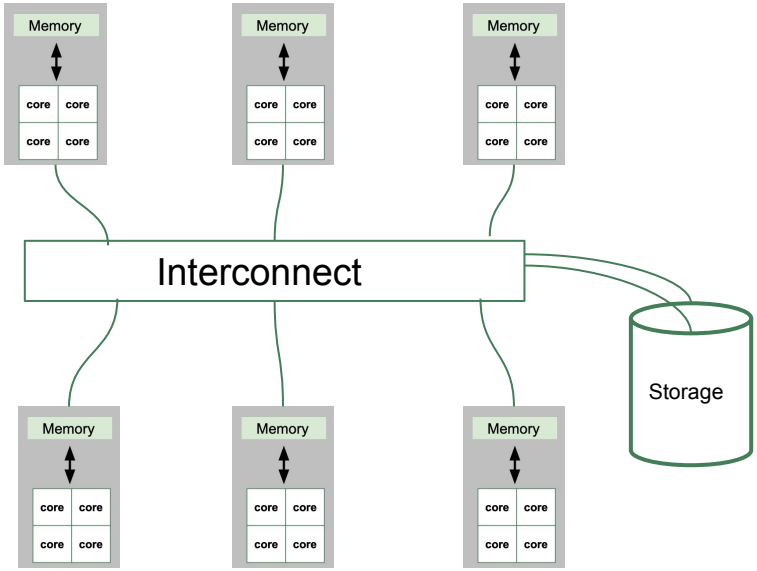


What is High Performance Computing?

- Supercomputers are made of compute servers, networks, and storage servers, that are all specially optimized to do operations in parallel.



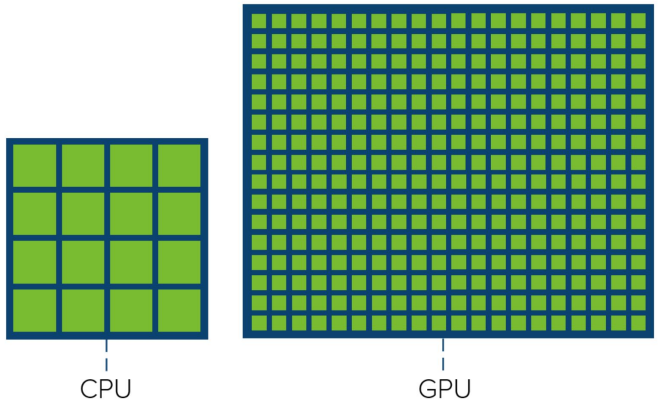
Node



Cluster

Processors

- Modern HPC nodes combine CPUS with accelerators such as GPUS.
  - CPUs generally have several compute cores that can run 10s of tasks at a time
  - GPUS have streaming multiprocessor that can run 1000s of tasks at a time.

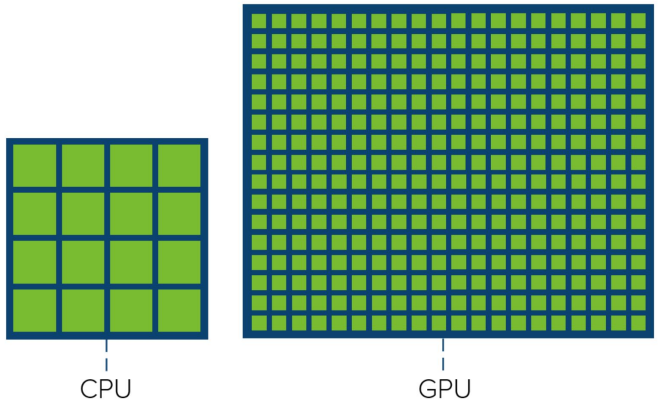


Processors

Much of an HPC programmers work is figuring out how to efficiently use all of the different levels of parallelism on a compute node and within a group of nodes.

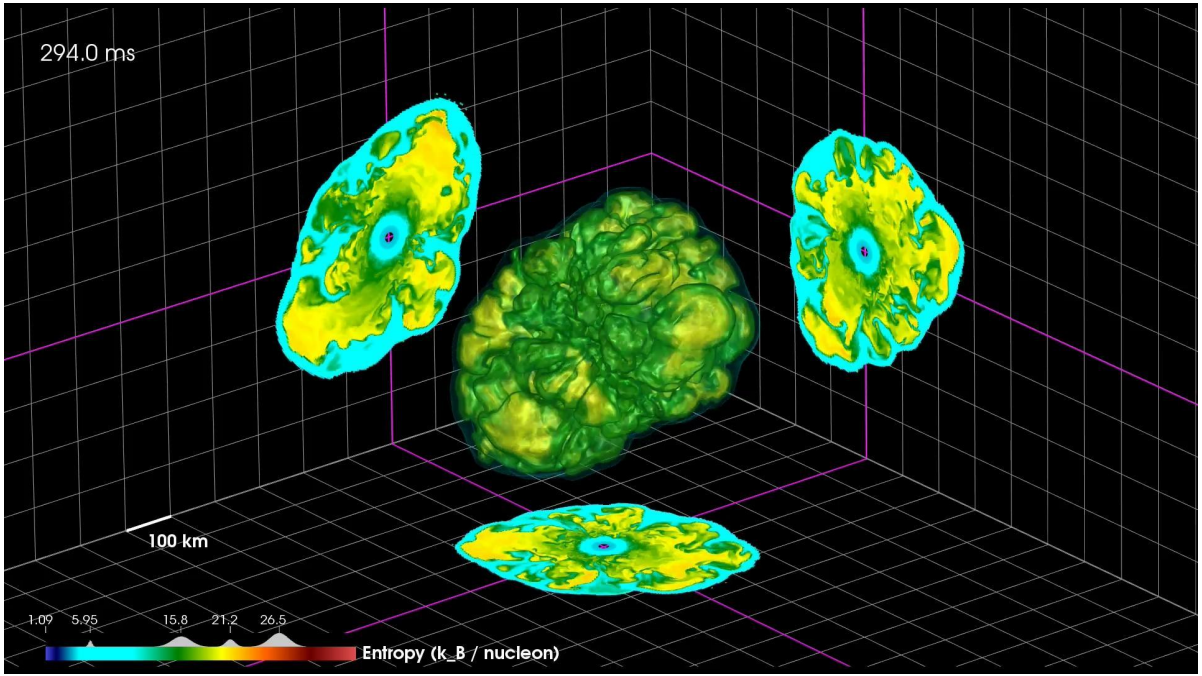
- Generally work is setup on the CPU and then moved to the GPU for processing.
- CPUs and GPUs have different caches of memory so the programmer must plan for the data movement between them.

We will cover several of the main tools and methods for utilizing the different levels of parallelism and their associated storage within an HPC cluster.



Why do HPC?

HPC allows simulations of nature to be built with enough detail that they can make accurate predictions of natural phenomena, so you can test things that are impossible to test physically or perhaps to expensive:



What Background do I need to do HPC?

You need to be able to teach yourself new techniques and ideas and then be persistent in using them.

What Background do I need to do HPC?

There are many paths to HPC:

- Domain scientist, mathematician, or a computer scientist depending on what you want to do.
- Domain Sciences/Mathematics/Engineering:
  - Generally, you get an advanced degree and use HPC for your thesis or post-education work.
- Computer Sciences/Mathematics:
  - Get a degree that focuses on the programming environment, languages, systems engineering, hardware or algorithms used in computing.

What Background do I need to do HPC?

HPC programers today have:

- Experience using compiled languages like C, C++, Fortran
- Experience with interpreted languages like python
- Experience with advanced math such as differential equations, Linear Algebra and statistics
- Experience with MPI, OpenMP, OpenACC, Cuda and other tools used for parallel and GPU computing
- Experience with MI/AI

But HPC is always changing so:

You need to be able to teach yourself new techniques and ideas and then be persistent in using them.

What do OLCF Computational Scientists and Engineers do?

HPC Career; NCCS Organization example:

- Advanced Technologies
  - Analytics and AI at Scale, Data Lifecycle and Scalable Workflows, Technology Integration
- Operations
  - Platforms, Software Services Development, System Acceptance and User Environment, User Access, Outreach, Communication, User Assistance
- Science Engagement
  - Chemistry and Materials, Life Sciences and Engineering, Nuclear Particles and Astrophysics, Algorithms and Performance Analysis
- HPC Systems
  - Clusters, Cybersecurity and Information Engineering, Infrastructure and Networking, Infrastructure Operations, Scalable Systems, Storage and Archive