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Delivering science and technology
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Cluster Benchmarking

Presented by CSCNSI

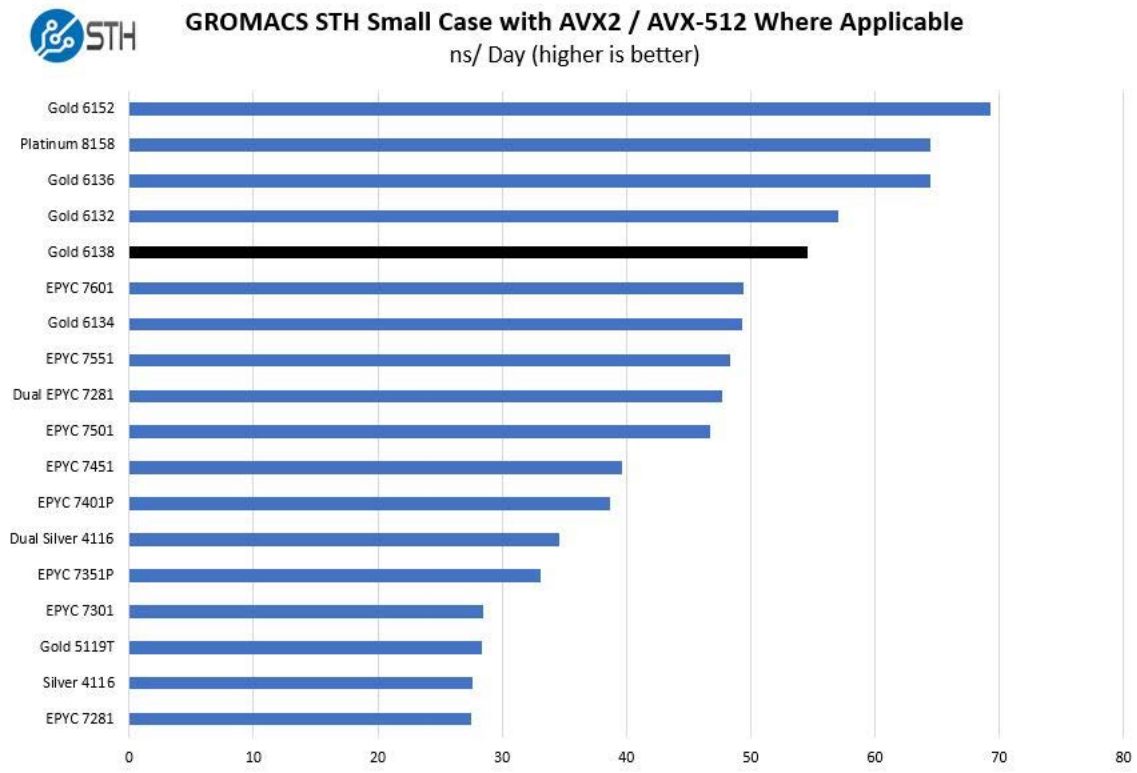
Why Benchmark?

Benchmarking is the processes of collecting quantifiable data on system performance

- Benchmarks can help us:
  - Evaluate comparative system performance
  - Identify bottlenecks for application performance
  - Estimate performance of an application on a given system
- Benchmarks are often a required as part of the “acceptance” process
  - Newly purchased systems are often contracted to reach a certain SSI
    - SSI = “Scalable System Improvement”, i.e. how much faster is this system than the old one?
- Benchmarks can sometimes be an early warning sign that something is wrong with a system, either in design or in function

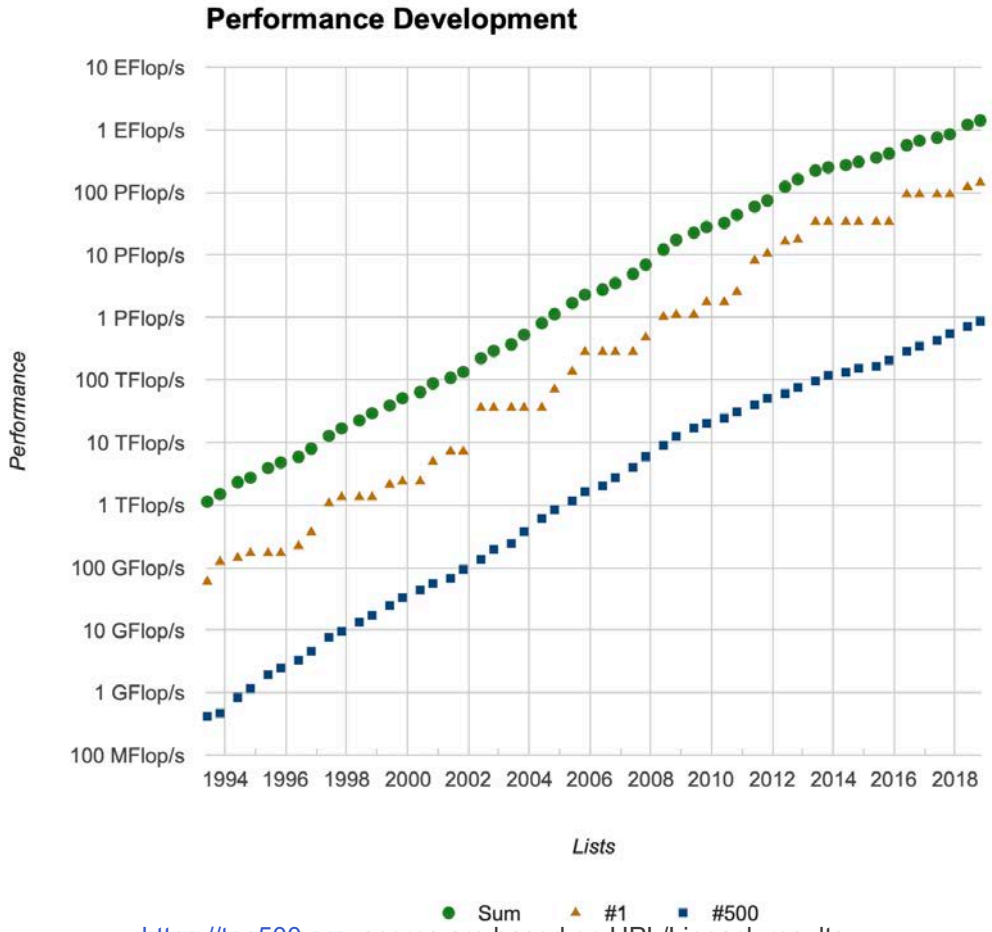
“Real” benchmarks

- The best way to know how a system will perform with an application is to run the application!
- Often, the data we collect with a real benchmark is simply the time it takes to run an application
- There can be problems with real benchmarks:
  - We may not have tuned or ported our application for the new platform
  - Results with one specifically build or data set may differ from another
  - We may not have the software available
  - They don’t always tell us why an application performance better or worse



Synthetic Benchmarks

- Synthetic benchmarks tend to focus on a class of algorithm, or particular hardware function
- Synthetic benchmarks can help understand which components perform better and worse
- Synthetic benchmarks have problems too:
  - It can be hard to predict how a specific complex application will perform
  - Systems can be tuned for synthetic benchmarks and ignore performance that really matters



https://top500.org: scores are based on HPL/Linpack results

Hybrid benchmarking

- Generally we want a combination of real and synthetic benchmarks
- Using a hybrid approach can give us:
  - High confidence that specific applications will perform
  - Understanding of which components help/hurt performance

Synthetic “micro” benchmarking

- Test a specific component or metric
- Examples:
  - Test network fabric latency/bandwidth
  - Test memory bandwidth
  - Test CPU vector operations
  - Test disk seek time
  - GPU performance
  - …

- Common Tools:
  - Netperf (TCP networks point-to-point)
  - ib_{send/recv}_{bw/lat} (Infiniband point-to-point)
  - Bonnie++ (filesystem performance)
  - Stream (memory performance)
  - Intel MPI Benchmarks (“IMB”, MPI operations bencharking)

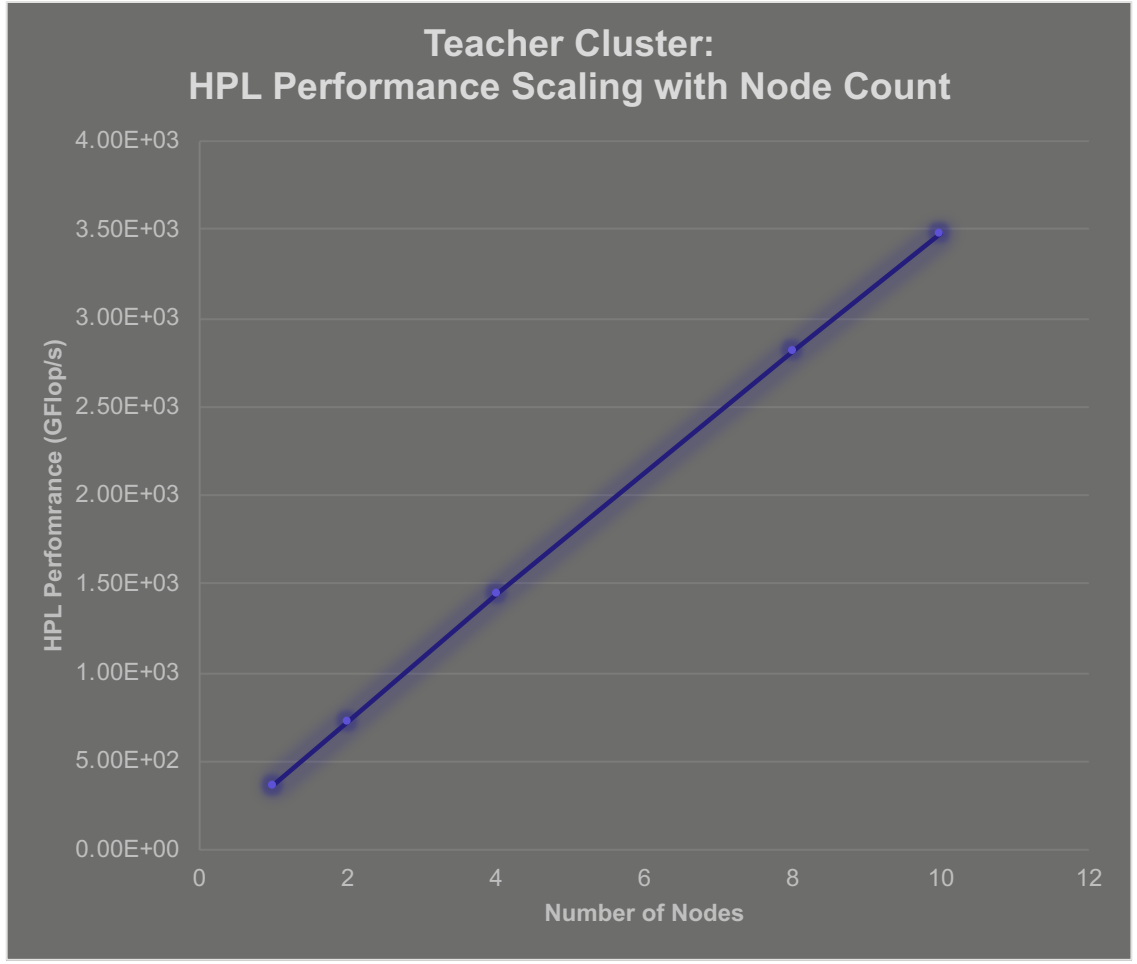
Synthetic “macro” benchmarking

- Macro benchmarks tend to try to solve a typical *kind* of problem that can tell about overall performance
- Often solving mathematical problems:
  - Linear algebra
  - Differential Equations
  - Graph theory
- High scores on these when you places on the big lists like:
  - Top500.org
  - Green500.org
  - Graph500.org
  - …

- Common Tools:
  - HPL (“High Performance Linpack”, distributed matrix operations, standard for top500.org)
  - HPCG (“High Performance Conjugate Gradients”, tests various linear algebra applications)
  - DGEMM (dense matrix, low communications overhead)
  - SMG2000 (Linear PDE solver)
  - …

Benchmarking scalability

- A common technique in both real and synthetic (mostly macro) benchmarking
- Focuses on how linear the quantity scales while increasing parallelism
- Is often critical to knowing how big to build a system
- Often coupled with profiling tools (when feasible) to understand why scaling breaks down



Some things to keep in mind…

- You probably want to build benchmarks for the hardware you're on
- Understand what the tool does, and how to tune it
- Keep your results well organized
- Try building against different libraries/tools:
  - Linear algebra: OpenBLAS, ATLAS…
  - Compilers: GCC, Intel, PGI…
  - MPI: OpenMPI, IntelMPI, MPICH…

Questions?