Case Study

High-Performance Computing

Quad-Core Intel® Xeon® processors

Education

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Dan Stanzione
Director
High Performance Computing Initiative
Arizona State University

Resolving Complexity with Intel® Technology

Arizona State University's High Performance Computing Initiative delivers world-class computing with Intel® Xeon® processors

Challenges

- **Build world-class clusters.** Create world-class, high-performance computing (HPC) clusters to solve complex problems in environmental fluid dynamics and other fields.
- **Maximize value.** Achieve outstanding performance within research budgets.
- **Optimize applications.** Adopt software tools to optimize applications for the cluster.

Solution

- **HPC cluster featuring Intel® Xeon® processors.** The High Performance Computing Initiative (HPCI) team in the Ira A. Fulton School of Engineering at Arizona State University built a 2,200-core HPC cluster with Intel Xeon processors to produce high-resolution, real-time results for researchers.
- **Intel® software tools.** HPCI engineers use Intel software tools to optimize research applications for the Intel-based HPC environment.

Impact

- **Better science.** Using Intel-based clusters, the HPCI team is maximizing the quantity and quality of research performed at the facility.
- **Scaling performance without scaling costs.** HPCI researchers increased performance of their primary Intel-based cluster by 10 times over three years without substantially increasing annual costs.
- **Optimized applications.** Engineers enhanced application performance by up to 70 percent using Intel software tools.

Researchers at Arizona State University's High Performance Computing Initiative (HPCI) need world-class computing resources to address complex research problems, from identifying the optical effects of the jet stream over observatories to understanding the effects of environmental transport on global and regional scales. In building its primary high-performance computing (HPC) cluster, the HPCI team selected Intel® Xeon® processors to deliver the performance researchers require within their budget. HPCI engineers also adopted Intel® software tools to optimize the performance of research applications on the Intel architecture.

Researchers require high-resolution, real-time results

Selecting a powerful processing architecture was a top priority in building the primary HPCI cluster. "When we study multi-scale atmospheric dynamics over a relatively limited geographic area, we need to create high-resolution models," says Alex Mahalov, a professor in the Environmental Fluid Dynamics Program at Arizona State University (ASU). "We also need to generate that high-resolution data in real time to produce accurate predictions and forecasts."

Intel® Xeon®–based systems enable the HPCI team to scale up or down easily—within budget

Selecting cost-effective systems was also key. "Most of our research funding comes from grants or federal funds," says Dan Stanzione, director of the HPCI. "There is no question that we need to find the best value for the performance."

Intel Xeon–based systems deliver the performance required for HPCI research

The HPCI team selected multi-core Intel Xeon processors for its primary HPC cluster. "I have worked on large research projects at national laboratories that use Intel-based HPC systems, and I have great confidence in the performance of the Intel architecture in an HPC environment," says Mahalov.

The primary HPCI cluster, named "Saguaro," is a 22-teraflop system that comprises 2,200 Intel Xeon processor cores in Dell PowerEdge* 1955 servers. The HPCI engineers initially deployed servers with single-core Intel Xeon processors, but they progressed to servers with Dual-Core Intel Xeon processors and then ultimately to Quad-Core Intel Xeon 5300 series processors when they became available. The HPCI team plans to add Quad-Core Intel Xeon 5400 series processors in the near future. "The Quad-Core Intel Xeon processors deliver the outstanding performance we need for high-priority jobs," says Mahalov. "We can use the single- and dual-core systems to give students opportunities to conduct serious work on a powerful high-performance cluster."

Intel software tools enhance performance by 70 percent

To optimize research applications running on the clusters, the HPCI team relies on Intel software tools, including Intel® C++ and Intel® Fortran compilers, the Intel® VTune™ Performance Analyzer, the Intel® Math Kernel Library, and the Intel® MPI Library. "Intel software tools are essential for our work," says Stanzione. "Using Intel software tools, we have improved the performance of some applications by 60 to 70 percent versus other software tools."

HPCI scales performance by 10 times in three years

The price/performance ratio of Intel Xeon–based systems enabled the HPCI engineers to build a large cluster that can help produce more and better science. "Researchers can analyze more genetic sequences, move from studying an airplane wing to the entire plane, or increase the resolution of a weather simulation," says Stanzione. "Intel-based systems enable them to tackle more problems on a larger scale and produce more detailed results."

At the same time, the HPCI team can build smaller clusters to solve complex problems within limited budgets. "Often my challenge is to solve a complex problem when my client can only afford a small cluster," says Mahalov. "With an Intel-based HPC cluster, I know that I can achieve the performance I need with a relatively small number of processors. Intel technology allows me to maximize my return on investment."

As Intel develops more powerful processors, the HPCI team can also scale up clusters cost-effectively. "By working with Intel, we can dramatically improve a cluster's performance year to year without increasing the budget," says Stanzione. "We have increased the performance of Saguaro by 10 times over its first three years without substantially changing the annual budget."

Intel-based HPC cluster attracts funding and researchers

By improving the quantity and quality of the work produced, HPCI researchers are able to garner more funding and attract more researchers to the school. "My funding agencies have specific problems that they want me to solve. With an Intel-based HPC cluster, I can deliver. As a result, I can attract more research funds," says Mahalov. "These state-of-the-art HPC clusters are also attracting world-class researchers. People are coming to ASU to see the breakthroughs that can be achieved using Intel Xeon–based HPC clusters."

Spotlight on the High Performance Computing Initiative at Arizona State University

The High Performance Computing Initiative (HPCI) in the Ira A. Fulton School of Engineering at Arizona State University offers world-class, high-performance computing to the researchers and their industrial partners in fields such as environmental fluid dynamics, biofluidics, and nanoelectronics. Saguaro is one of several Intel processor–based clusters at the HPCI.

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