CASE STUDY
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High-Performance Computing
Performance for Data-Intensive Computing

Boosting Shared-Memory Supercomputing

NCSA doubles performance and nearly triples memory capacity with SGI Altix* UV system based on the Intel® Xeon® processor 7500 family

As one of the premier high-performance computing (HPC) research institutions in the U.S., the National Center for Supercomputing Applications (NCSA) provides HPC resources for a wide range of scientific applications, including many whose performance needs require highly parallel shared-memory architectures. NCSA recently replaced its previous shared-memory system, an SGI Altix* supercomputer based on the Intel® Itanium® 2 processor, with an SGI Altix UV supercomputer powered by the Intel® Xeon® processor 7500 family. NCSA says the new system, which it calls Ember, consumes half the power while delivering double the performance and nearly triple the memory capacity.

"Our expectation was that we'd see a baseline of maybe a 20 to 50 or 70 percent increase in application performance over the previous system. What we found is that many applications are seeing a factor of two increase in performance, and sometimes much more."

– John Towns,
Director of Persistent Infrastructure
NCSA

CHALLENGES

- Rising demand, aging system. At nearly six years old, NCSA's Intel Itanium 2 processor-based shared-memory supercomputer couldn't keep up with rising demand.

SOLUTIONS

- Technologies to maximize data-intensive performance. NCSA chose an SGI Altix UV system with 256 six-core Intel Xeon processors 7500 family. The system has 8 TB of RAM and runs Red Hat Enterprise Linux*.

IMPACT

- More speed and capacity. The new supercomputer provides 16 teraflops (TF) of peak performance and 13.5 GB per second of I/O bandwidth, helping scientists accelerate progress on a variety of complex and important problems.
- Cost and energy savings. The system consumes half as much power as the previous platform while delivering double the performance—the equivalent of four times more performance per watt.
- Increased density. The system has just four racks of compute nodes, making it four times denser than its predecessor and freeing valuable space in the data center.

Resources for Memory-Intensive Applications

Parallel shared-memory supercomputers are crucial resources for HPC applications in areas such as computational chemistry, fluid dynamics, and solid mechanics—and the demand for those resources is growing. Few organizations understand that demand better than NCSA, a national leader in providing advanced infrastructure for open scientific discovery through the TeraGrid* program and its successor, the eXtreme Digital* (XD*) program.

Six years ago, NCSA replaced an SGI shared-memory system that used proprietary processors, with an SGI Altix system based on the Intel Itanium processor. NCSA later upgraded the system to the Intel Itanium 2 processor, but by 2010, that system was failing to keep pace with soaring demand. "Our allocation requests for shared-memory systems consistently exceeded the available resources—by as much as seven times, in one review of requests," says John Towns, director of persistent infrastructure at NCSA and chair of the TeraGrid Forum.

The Intel® Xeon® processor's energy efficiency helps give NCSA four times more performance per watt

Towns says Ember is an essential tool for shared-memory applications, particularly for those where memory bandwidth can be a major constraint on performance. His team chose the Intel Xeon processor X7542 at 2.66 GHz and configured the system to provide maximum memory bandwidth per core for parallel shared-memory computing with large datasets.

"We made several choices that were important to support parallel shared applications in a shared memory environment more effectively," Towns explains. "The specific processor, the configuration, the DIMM size, the core count, and other factors are all aimed at maximizing memory bandwidth. Ember also provides researchers with approximately five and one-third gigabytes per core, which is more memory per core than any other system that's available across TeraGrid."

Towns says the Intel Xeon processor X7542 at 2.66 GHz lets researchers take full advantage of Intel® QuickPath Interconnect (Intel® QPI). Intel QPI optimizes shared-memory performance with an integrated memory controller and high-speed, point-to-point connections from one processor to another and between processors and memory. "With this processor, we're at the highest QPI clocking and QPI bandwidth," he states. "That improves communication between the processors and the node boards within the shared memory environment and supports our parallel applications more effectively."

Individual applications run on up to 384 processor cores on the Ember system, giving researchers access to a 2 TB pool of shared memory. To handle the massive storage requirements, the system connects to two SGI InfiniteStorage* 15000 controllers with 700 TB of capacity.

Advancing Research and Industry

In production since November 2010, Ember provides additional resources to researchers across the nation's TeraGrid and XD programs. In addition, NCSA works with a number of private companies to accelerate their use of innovative architectures, and Ember makes it easier for those companies to adapt shared-memory architectures with higher core counts and use their performance to drive economic growth.

"The industry is typically several years behind where we are, but we work with several technology-savvy companies whose goal is to be just six months behind us," Towns says. "Bringing in platforms like Ember is of great interest to them because they know this is in their future. Working with us to prototype and test their next-generation applications and often to run production versions of their applications is very beneficial in helping them take advantage of the latest advances."

SPOTLIGHT ON NCSA

The National Center for Supercomputing Applications (NCSA) was established in 1986 as one of the original sites of the National Science Foundation's Supercomputer Centers Program. Located at the University of Illinois at Urbana-Champaign, NCSA is supported by the state of Illinois, the University of Illinois, the National Science Foundation, and grants from other federal agencies. NCSA is a leader in deploying robust HPC resources and in working with research communities to develop new computing and software technologies.

As for NCSA's future: "The new E7 platform will definitely be on our radar as we look to deploy and maintain a next-generation evergreen system," says Towns.

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