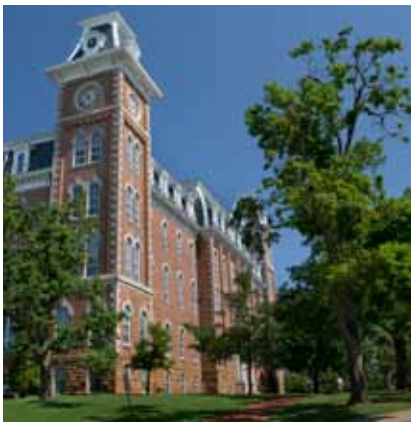
CASE STUDY
Intel® Xeon® Processor E5 Family
Education
High-Performance Computing
Energy, Environment, and Performance

Enabling Cutting-Edge Research with the Intel® Xeon® Processor E5 Family

The University of Arkansas High Performance Computing Center supports a growing user base and accelerates research by expanding resources based on Intel® processors



UNIVERSITY OF ARKANSAS

"According to our testing, the new nodes deliver from one-and-a-half to two times the performance of the previous-generation nodes. We can help researchers address larger research questions and produce results faster than before."

– Rick McMullen, Director, Arkansas High Performance Computing Center, University of Arkansas

The University of Arkansas High Performance Computing Center (AHPCC) supports a growing high-performance computing (HPC) user community from diverse academic fields. To accommodate more users and more complex projects, the center decided to expand an existing cluster, called "Razor." The expansion capitalizes on the Intel® Xeon® processor E5 family to deliver twice the peak performance of the existing cluster while conserving physical space and increasing the power requirement by only 20 percent. By providing the capacity for larger workloads and accelerating results, the center is attracting new researchers to the university and fostering cutting-edge research in Arkansas.

CHALLENGES

- **Support a growing, diverse research community.** Accommodate more researchers in an increasingly diverse array of fields at the University of Arkansas and across the state by expanding HPC resources.
- **Address complex questions, speed results.** Enable researchers to explore larger, more complex research questions and deliver results faster than before.
- **Control costs.** Expand HPC capacity and performance while controlling power, cooling, and real estate costs.

SOLUTION

- **IBM servers with the Intel® Xeon® processor E5 family.** The AHPCC designed Razor Phase II—a 1,792-core expansion to its existing Razor cluster. The expansion includes 112 IBM System x* iDataPlex* servers equipped with the Intel Xeon processor E5 family and QLogic InfiniBand* server adapters. The center optimizes applications with Intel® Software Development Tools.

TECHNOLOGY RESULTS

- **Faster research results.** The new cluster delivers one-and-a-half to two times greater performance per node than the previous cluster. In addition, Intel® Advanced Vector Extensions (Intel® AVX) helps boost performance for some bioinformatics codes by 30 percent.
- **Greater performance, same amount of space.** Razor Phase II delivers twice the peak performance of Phase I while consuming nearly the same amount of data center resources as the previous cluster.

BUSINESS VALUE

- **A more robust research institution.** The new cluster helps bolster the university's status as a leading research institution that provides powerful resources for a growing number of researchers on campus and across the state.

Over the last decade, the use of HPC resources at the University of Arkansas has grown substantially. "We began with a small group of users in physics, chemistry, and mechanical engineering," says Jeff Pummill, manager for cyberinfrastructure enablement at the AHPCC. "Today we have many more users from a wider array of fields, from science and engineering to business and finance. While physicists study the effects of quantum vibrations at the nanoscale level, bioinformatics teams are assembling the genome of a snake and exploring the genetic composition of rice crops."

To accommodate rising demand for HPC resources and contribute to the university's growing reputation as a leading-edge research institution, the AHPCC team decided to expand one of its primary clusters—Razor, named after the university's razorback mascot. This 1,512-core environment comprises 126 IBM System x iDataPlex servers equipped with the Intel Xeon processor 5600 series.

In planning for the expansion, the team had to consider a variety of user requirements. "Our goal is to support a wide range of scholarly research on campus and throughout the state," says Rick McMullen, director of the AHPCC. "We strive to determine exactly what researchers need to excel and then provide them with the best possible tools."

The Intel® Xeon® processor E5 family helps researchers address more complex problems and accelerate results

Beyond delivering the capacity, performance, and flexibility needed for research projects, the center must take cost into consideration. "Controlling costs is always important in a university environment," says David Chaffin, associate director for operations for the AHPCC. "We need to optimize the use of power, cooling, and real estate."

Building Razor Phase II with the Intel Xeon Processor E5 Family

The center secured funding for the expansion through a sizeable grant provided by the National Science Foundation. The AHPCC team then began designing the new environment by determining the mix of workloads that might run on the cluster and conferring with hardware vendors and the principal investigators who applied for the grant.

From early on, it was clear that the team would continue to use IBM System x iDataPlex servers based on Intel processors for the expansion. "The mix of users and workloads can change significantly over the lifetime of a cluster," says McMullen. "In building a new cluster or adding resources, we always try to select the platforms that will enable us to evolve the environment over time so we can accommodate changing needs and capitalize on new technologies."

Benchmark testing helped to guide the selection of the processor family. "Performance is a top priority. We need processors that can deliver the right combination of raw compute power, memory capacity, and memory bandwidth," says Chaffin. "The benchmark results we used as a guide showed clear performance advantages for the Intel Xeon processor E5 series compared with previous-generation Intel processors."

In running a benchmark applicable to bioinformatics workloads, the team saw a significant performance improvement when using the Intel Xeon processor E5 family with Intel AVX. "The benchmarking showed that Intel AVX could produce a 30 percent performance improvement for particular bioinformatics workloads," says Chaffin.

The team also noted how Intel® Turbo Boost Technology could also help increase single-core performance. "Not all of the scientific workloads are parallelized," says Pummill. "The ability to boost clock rates for integer operations is very important to us and our users."

Given the results of the evaluation process, the team decided to build Razor Phase II on the Intel Xeon processor E5 family. The expansion environment comprises 112 IBM iDataPlex systems with a total of 1,792 cores. For these systems (like all the others run by the AHPCC), the team selected QLogic InfiniBand adapters because of their price/performance, manageability, and reliability. The cluster uses a Scientific Linux* operating system and runs a wide range of codes, such as Velvet* and ABySS*, used for genomic assembly.

Intel software development products, including Intel® C++ and Fortran Compilers and the Intel® Math Kernel Library (Intel® MKL), help the team optimize code. "The Intel software tools are critical in maximizing the performance of researchers' codes on Intel processors," says Chaffin.

Extending Capacity while Controlling Costs

The expansion is helping the AHPCC address the tremendous growth in the HPC user community. "Razor Phase II can deliver two times the peak performance of Razor Phase I and can accommodate about twice the number of users," says Chaffin. "At the same time, Phase II consumes only about the same amount of floor space and data center resources as Phase I—we have increased power consumption by only about 20 percent. We are enabling more users to capitalize on HPC while keeping costs under control."

LESSONS LEARNED

In designing and deploying the new environment, the AHPCC team was reminded of the importance of optimizing applications to capitalize on processor advancements. "Organizations need to research their code base and recompile applications," says Jeff Pummill, manager for cyberinfrastructure enablement at the AHPCC. "That work is vital in fully exploiting the latest processor architectures."

Boosting Performance and Accelerating Research

With the Intel Xeon processor E5 family, the IBM System x iDataPlex servers can also provide significantly better performance per node than the previous-generation systems. "According to our testing, the new nodes deliver from one-and-a-half to two times the performance of the previous-generation nodes," says McMullen. "We can help researchers address larger research questions and produce results faster than before."

Arkansas researchers are already benefitting from the increased performance and capacity of the expanded cluster. "One physics professor needed to run a large workload rapidly to generate results for an academic paper, but he had already exhausted his time allocation for XSEDE resources, which are shared among scientists across the globe," says Pummill. "With Razor Phase II, he had the resources he needed to run his workload right here on campus. The new systems helped him complete the work in less than one day—about nine days faster than if he had used the shared resources."

Attracting Researchers to Arkansas

The AHPCC team anticipates that the expanded cluster will boost the university's reputation as a research institution, attracting new research—and additional grant funding—to the campus and to the state. "We have seen a number of faculty members who have taken positions at the University of Arkansas based on the HPC resources that we can provide," says Pummill. "Combined with the extensive assistance that our staff provides to researchers, we expect that the expanded Razor cluster will be a powerful draw for researchers in a wide range of fields."

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