



Reaching New Frontiers in Physics

Case Study

Intel® Xeon® processor 5400 series

Scientific research
High-Performance &
Data-Intensive Computing

“With each new generation of Intel® processors, we know we can continue to increase performance for our application without significantly increasing the power or physical space we need.”

Dr. Andrew Lankford,
Professor of Physics,
University of California,
Irvine
Deputy Spokesperson,
ATLAS Collaboration



Intel® Xeon® processors help capture and analyze massive amounts of scientific data from the world's most powerful particle accelerator

Challenges

- **Maximize core counts.** Create a large cluster with as many cores as possible for an event selection system that examines data from numerous particle collisions simultaneously.
- **Optimize data throughput.** Ensure the data acquisition cluster can deliver the processing performance and throughput required to move data efficiently from one cluster to another.
- **Increase density and control costs.** Acquire the best high-performance systems possible while staying within budget and controlling power, weight, and real estate requirements.

Solution

- **HPC clusters that use Dell PowerEdge* servers with Intel® Xeon® processors.** Researchers decided to build high-performance computing (HPC) clusters using Dell PowerEdge* servers equipped with Intel® Xeon® processors to deliver the processing performance, core counts, and data throughput researchers need while controlling acquisition costs and reducing power, weight, and real estate requirements.

Impact

- **More science, higher-quality results.** The Intel Xeon-based clusters help researchers capture and analyze tremendous amounts of data, enabling them to produce more high-quality science than ever before.
- **One hundred percent greater processing power.** The Dell servers equipped with the Intel Xeon processor 5400 series deliver two times the performance of dual-core processors without significantly increasing power or real estate requirements.

Several hundred feet beneath the French-Swiss border lies the world's largest, most powerful particle accelerator—the Large Hadron Collider. More than 2,200 researchers from around the globe work at the CERN (the European Organization for Nuclear Research) laboratory on ATLAS, a large-scale particle physics experiment that studies the forces that have shaped the universe since the Big Bang. To create the high-performance computing (HPC) clusters that capture and analyze the massive amount of experimental data generated, researchers from the University of California, Irvine, and collaborating institutions selected Dell PowerEdge* servers equipped with Intel® Xeon® processors.

Researchers require cost-effective performance for HPC

The ATLAS event selection and data acquisition systems consist of HPC clusters that acquire data from the collider, select the particle interactions recorded for research, move data from one cluster to the next, and monitor both the experiment and the compute farms. For the data acquisition cluster, researchers need maximum compute power and data throughput. “The data acquisition system is responsible primarily for moving data from one cluster to another,” says Dr. Andrew Lankford, professor of physics at UC Irvine, and deputy spokesperson for the ATLAS collaboration. “We need fast processors to utilize the Ethernet bandwidth fully and to transfer data quickly.”

Intel® Xeon® Processors Deliver Performance and Density

For the event selection system, researchers need as many processor cores as possible. "The event selection system examines the hundreds of millions of particle interactions that occur every second and selects the few hundred most interesting for our research," says Lankford. "We need immense processing power for this selection process, but more importantly, we need a cluster with a massive number of cores so we can process multiple candidate events in discrete processors simultaneously."

In designing the clusters, the team faced a number of important constraints. "The primary constraint was the budget," says Lankford. "But we also needed to be sure the clusters would stay within our data center weight, power, and real estate limits."

Researchers select Intel Xeon processors for the ATLAS clusters

ATLAS researchers decided to build the event selection and data acquisition systems with Dell PowerEdge servers, including PowerEdge 1950 and 2950 servers. Nearly all servers are equipped with the Intel Xeon processor 5400 series. The data acquisition cluster includes approximately 300 servers while the event selection cluster currently includes 800 servers. Ultimately, the event selection cluster will grow to 20,000 cores. "By building dense clusters using Dell PowerEdge servers and Intel Xeon processors, we can access the performance and the large core counts that we need while keeping acquisition costs, cluster weight, power requirements, and real estate to a minimum," says Lankford.

"In addition to meeting our technical requirements, the Dell and Intel teams took great interest in our research," continues Lankford. "They realized the value of our scientific pursuits and were determined to help us acquire the equipment while staying within our budget."

The Intel technology road map was also influential in the decision to work with Intel. "With each new generation of Intel processors, we know we can continue to increase performance for our application without significantly increasing the power or physical space we need," says Lankford.

Through the relationship with Dell and Intel, the UC Irvine team helps other ATLAS researchers acquire the equipment they need to analyze experimental data. "Our interactions with Dell and Intel have been very rewarding, so we are happy to facilitate relationships among Dell, Intel, and our research partners around the globe," says Lankford.

Intel Xeon processors deliver 100 percent performance gains over previous generation

By using multi-core processors, researchers can achieve outstanding performance in a dense environment. "Compared with the previous dual-core architecture, the quad-core Intel Xeon processor 5400 series delivers a 100 percent increase in processing

Spotlight on the U.S. ATLAS Project

ATLAS is a particle physics experiment that uses CERN's Large Hadron Collider—the world's largest and most powerful particle accelerator. Researchers from UC Irvine and other research centers around the world study the origin of mass, extra dimensions of space, microscopic black holes, and evidence for dark matter candidates in the universe. The technology used for this project will lead to new applications in medicine, industry, commerce, and other fields of scientific research.



performance for our application in the same server form factor," says Lankford. "We anticipate similar improvements with future processing architectures."

ATLAS researchers intend to continue to integrate new Intel architectures as they become available. "Intel has developed a technology path that is easy for us to follow," says Lankford. "We can continue to benefit from greater performance and the ability to process more data, all while achieving the density and energy efficiency we need. The quad-core Intel architecture can increase energy efficiency by at least two times compared with the previous dual-core processors."

ATLAS researchers tackle fundamental questions

The Intel processor-based HPC cluster can deliver the performance that researchers require to tackle big questions about the birth and evolution of the universe whose answers come from very small particles. "We are investigating very important, fundamental questions. The more data that we can capture and analyze, the more we can learn about the natural world," says Lankford. "The Intel architecture will be instrumental in helping us make some profound discoveries."

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