Case Study
Intel® Xeon Phi™ Coprocessor
Intel® Xeon® Processor E5 Family
Big Data Analytics
High-Performance Computing
Energy

Accelerating Energy Exploration with Intel® Xeon Phi™ Coprocessors

Cirrascale delivers scalable performance by combining its innovative PCIe switch riser with Intel® processors and coprocessors

To find new oil and gas reservoirs, organizations are focusing exploration in the deep sea and in complex geological formations. As energy companies such as Petrobras work to locate and map those reservoirs, they need powerful IT resources that can process multiple iterations of seismic models and quickly deliver precise results. IT solution provider Cirrascale began building systems with Intel® Xeon Phi™ coprocessors to provide the scalable performance Petrobras and other customers need while holding down costs.

Challenges

- **Enable deep-sea exploration.** Improve reservoir mapping accuracy with detailed seismic processing.
- **Accelerate performance of seismic applications.** Speed time to results while controlling costs.
- **Improve scalability.** Enable server performance and density to scale as data volumes grow and workloads become more demanding.

Solution

- **Custom Cirrascale servers with Intel Xeon Phi coprocessors.** Employ new compute blades with the Intel® Xeon® processor E5 family and Intel Xeon Phi coprocessors. Cirrascale uses custom PCIe switch risers for fast, peer-to-peer communication among coprocessors.

Technology Results

- **Linear scaling.** Performance increases linearly as Intel Xeon Phi coprocessors are added to the system.
- **Simplified development model.** Developers no longer need to spend time optimizing data placement.

Business Value

- **Faster, better analysis.** More detailed and accurate modeling in less time improves oil and gas exploration.
- **Enhanced ROI.** The processor and coprocessors work together to deliver maximum value from compute resources.
- **More processing power.** Performs more processing in the same data center space, for reduced costs.

"Working together, the Intel® Xeon® processors and Intel® Xeon Phi™ coprocessors help HPC applications shed performance constraints."

– David Driggers, CEO, Cirrascale

Speeding Seismic Analysis with Coprocessors

A premier provider of build-to-order infrastructure, Cirrascale works with its customers to engineer custom server solutions that can scale as data sets grow larger and workloads become more demanding. One of its customers is Petrobras, the Brazilian multinational energy corporation. "Like many oil and gas companies, Petrobras is continually looking for ways to scale performance of its compute-intensive seismic applications and increase compute density to make maximum use of its data center space," says David Driggers, CEO of Cirrascale.

To help accelerate seismic applications, Petrobras had been using servers equipped with graphic processing units (GPUs) to augment the main processors. But the company found the GPU approach did not fully capitalize on multithreaded applications.

Engineers from Petrobras and Intel demonstrated demanding seismic code running on a system with four Intel Xeon Phi coprocessors. They delivered performance per watt competitive with Intel® processor-only systems, but with significantly more processing being done on each server node thanks to the Intel coprocessors. However, because of the massive and growing data sets involved in seismic processing, the Petrobras team needed to know how well the performance would scale as more coprocessors were added. "Having twice the number of coprocessors doesn't necessarily deliver twice the performance," says Scott Ellis, engineering fellow at Cirrascale. "System latency can take a toll."

Designing a Solution for Optimum Scaling

Cirrascale set out to design a system to optimize scaling and minimize latency. In a traditional dual-processor server with four coprocessors, infrastructure providers such as Cirrascale typically attach one pair of coprocessors to each of the main processors. "Coprocessors in the same pair communicate directly, but to communicate with the other pair, they must go through the main processors first—a slower path that imposes a latency penalty on performance," says Ellis. "This approach also complicates programming, because programmers are forced to place data in different locations depending on which coprocessor will make actual use of it."

To enable better scaling, Cirrascale developed a PCIe switch riser that allows multiple Intel Xeon Phi coprocessors to communicate directly with each other as peers, without crossing through the main processors. Each proprietary riser holds up to four Intel Xeon Phi coprocessors.

The Cirrascale team developed a compute blade design with two switch risers holding a combined eight Intel Xeon Phi coprocessors, integrated on the blade with the Intel Xeon processor E5 family. "The Intel Xeon processor E5 family delivers superior performance for high-performance computing [HPC] applications compared with previous generations. At the same time, these processors support massive memory footprints and an abundance of high-speed I/O," says Driggers. "Working together, the Intel Xeon processors and Intel Xeon Phi coprocessors help HPC applications shed performance constraints."

Scalable Intel® Xeon Phi™ performance helps energize the future

Delivering Outstanding Test Results

Tests demonstrated the outstanding scalability of the new Cirrascale implementation. The testing was conducted using a server with eight Intel Xeon Phi 3120P coprocessors plus two Intel Xeon processors E5-2670. Scaling was measured in gigasamples per second, with each sample representing one point in a complex model of an oil or gas reservoir. "The test results show that we can scale with nearly a one-to-one ratio of performance gain to Intel coprocessors added," says Driggers. "While we tested with the Intel Xeon Phi 3120P, the results indicated that any Intel Xeon Phi coprocessor would have the same scaling, allowing customers to choose the best price-performance for their specific job."

Providing Faster, Better Seismic Analysis

The increased performance helps deliver better, more accurate modeling results. "Companies like Petrobras can perform more iterations of seismic models and generate more precise images of reservoir locations, avoiding costly drilling mistakes. This is a key consideration since a large portion of oil reserves that companies like Petrobras are investigating are located beneath deep and ultra-deep waters," says Driggers. "Locating reservoirs more quickly also helps reduce processing costs."

Maximizing Benefits from Compute Resources

The Cirrascale riser with Intel coprocessors also enables companies to obtain more work from their Intel Xeon processor E5 family than with GPU-based implementations. Instead of merely offloading work to coprocessors, the Cirrascale implementation shares work among the processors and coprocessors through standard message passing interface (MPI) protocols typically used in local networks. "The main processors perform as much as 40 percent of the computational work," says Driggers.

Simplifying Application Development

Using Intel Xeon Phi coprocessors allows software developers to work more quickly since they can employ the same tools and approaches as they do with the Intel Xeon processor E5 family. "Developers no longer need to spend hours taking into account where a piece of data resides or how to get it from one place to another," says Ellis. "All of the Intel Xeon Phi coprocessors on a Cirrascale server blade communicate as peers."

Reducing Cost of Ownership

Petrobras was impressed with the scalability test results for the Intel Xeon Phi processor blade system. "Scalable performance was one of the most important capabilities we needed the Intel Xeon Phi coprocessors to provide," says Paulo Souza, HPC consultant and software engineer at Petrobras.

Lessons Learned

"For true HPC, we find it is important to really understand how our code matches the architecture of the systems we are considering," says Paulo Souza, HPC consultant and software engineer at Petrobras. "That understanding has enabled us to perform optimizations with the Intel® Xeon Phi™ coprocessor and obtain excellent results."

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The company also sees the potential to reduce total cost of ownership using Intel Xeon Phi coprocessors. "With eight cards per server, we can reduce the overall number of server nodes," says Souza. "That saves data center real estate and helps reduce electricity and maintenance costs."

For its part, the Cirrascale team appreciates the ease of working with Intel Xeon Phi coprocessors. "Having a robust set of tools is very important for us to embrace a technology," says Driggers. "Intel Xeon Phi coprocessors have a mature tool set based on open standards that is simple for us to use, saves time, and allows us to speed up adoption of the Intel coprocessor-based systems for our customers."

Find the solution that's right for your organization. Contact your Intel representative, visit Intel's **Business Success Stories for IT Managers**, and check out **IT Center**, Intel's resource for the IT industry.

More information about Intel® Xeon Phi™ coprocessors can be found at **www.intel.com/xeonphi**

Software developer resources can be found at **https://software.intel.com/mic-developer**

For more information about Cirrascale products, visit: **www.cirrascale.com**

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