CASE STUDY
Intel® Xeon Phi™ Coprocessor
High-Performance Computing

Leading the Way

South Ural State University implements highly energy-efficient RSC Tornado SUSU* supercomputer powered by Intel® Xeon Phi™ coprocessors

South Ural State University (SUSU) is one of Russia's leading universities and the largest in the country in terms of number of undergraduates. It carries out research into a wide range of fundamental and applied disciplines, relying heavily on its supercomputer center to support its industry-leading research. SUSU chose to upgrade its computing platform with an existing infrastructure previously deployed by leading local high-performance computing (HPC) solution provider RSC Group (www.rscgroup.ru/en). It implemented the new generation of innovative, energy-efficient RSC Tornado architecture with direct liquid cooling for standard server boards, powered by Intel® Xeon® processors and the latest Intel® Xeon Phi™ coprocessors. As a result, it has seen a significant performance increase while cutting energy costs by up to 60 percent.

"The latest Intel technology-powered RSC Tornado SUSU project is a breakthrough, which will foster end-to-end development of the Ural region's economy. Supercomputing opens new opportunities for innovative economic activity in our region and across the country, and SUSU is prepared to become the enabler of such development."

Alexander Shestakov,
Rector, South Ural State University

CHALLENGES

- **Support local economy.** The university provides core HPC resources to scientists and researchers engaged in enhancing the industry and economy of the whole eastern part of Russia
- **Optimize efficiency.** While increased performance to support research was key, SUSU also needed to keep energy use and total cost of ownership (TCO) low

SOLUTIONS

- **New platform.** The SUSU supercomputer, based on RSC Tornado architecture with enhanced direct cooling technology, was deployed
- **Powerful components.** The new platform is powered by the Intel Xeon processor X5680 and the latest Intel Xeon Phi coprocessors SE10X
- **Increased reliability.** Intel® Solid-State Drives (Intel® SSDs) and Quad Data Rate (QDR) Infiniband* connectivity complete the strengthened HPC environment

IMPACT

- **Lower TCO.** Energy costs were cut by up to 60 percent
- **Enhanced performance.** The system achieved 146.8 teraflops in the LINPACK* benchmark[1] and delivers peak performance of 236.8 teraflops
- **Diverse usage.** Researchers on over 250 projects benefit from the new platform by achieving better results faster

Building a tool for industrial advancement

The South Ural region, where SUSU is located, has a high concentration of industries such as metallurgy, mechanical engineering, fuel and energy, and computer manufacturing. This means the university focuses on using its HPC resources to tackle complex industrial tasks. About 54 percent of its workload is used for engineering modeling tasks, 42 percent for natural sciences, and four percent for social and economic forecasting.

After it was named National Research University, SUSU determined the following priorities for research, all of which would require the active use of powerful computing resources:

- Energy saving in the social sphere
- Efficient use of resources and energy in metallurgy
- Supercomputing and grid technologies in solving energy and resource-saving problems

These complicated calculations and simulations require an ever-increasing level of computing performance and the university needed to implement a more powerful HPC platform to meet this demand.

The best Russian regional HPC center implements supercomputer with the latest Intel Xeon Phi coprocessors to power industrial innovation

Meanwhile, with a large number of students and teaching staff to accommodate, space was at a premium. At the same time, the severe continental climate of the region means energy costs for heating the university are high. This is complicated further by the high energy consumption of much of SUSU's laboratory equipment. As a result, the most important requirements for the new SUSU supercomputer were optimization of space and energy consumption, while providing high computing power and low TCO.

The right components

The university believes that the performance of any supercomputer is driven primarily by its processors and its network connectivity. From the outset, SUSU knew it wanted a computing system based on Intel technology, as all of the previous generations of the university's supercomputers were based on Intel® architecture. It deployed the new RSC Tornado SUSU supercomputing platform, powered by 192 server blades with 384 Intel Xeon processors X5680 and 192 Intel Xeon Phi coprocessors. It delivered a peak performance of 236.8 teraflops and achieved 146.8 teraflops in the LINPACK benchmark test. Connectivity was provided by standard Infiniband QDR technology.

The direct liquid cooling capabilities incorporated within the RSC Tornado architecture ensure precision heat removal, which extends the service life of the electronic components. By replacing moving parts, such as fans and traditional hard disk drives, with Intel SSDs, the platform's reliability was also significantly increased.

The combination of direct liquid cooling features inherent in the RSC Tornado architecture and high-performance Intel® processors delivered superior system density and meant the whole solution could be deployed in just 50 square meters of space.

Industrial impact

According to the worldwide Green500 list, SUSU's new HPC platform is one of the most energy-efficient supercomputers in Russia and the Commonwealth of Independent States (CIS), being ranked 40th overall. Indeed, a very high level of energy efficiency (995 megaflops per watt) was achieved, and energy costs were lowered by up to 60 percent. At a peak performance of 236.8 teraflops, the new supercomputer consumed just 147 kW of power. The solution also achieved an industry-best power usage effectiveness (PUE) level of less than 1.1.

The upgraded SUSU supercomputer center is also the most powerful in the whole of eastern Russia. It currently has a total peak performance of 323 teraflops for several systems.

The enhanced performance means that since implementation, the new RSC Tornado SUSU supercomputer has supported over 250 research projects. It offers high-level software services via the Internet to scientists in both industrial and commercial organizations, as well as those carrying out educational and scientific research.

The SUSU supercomputer center now supports a wide range of tasks in fundamental and applied sciences, such as material science and nanotechnology, new material synthesis simulation, the creation of new medicines, and the exploration and appraisal of the region's mineral resources. Many of these are of vital importance, both regionally and nationally, such as calculating the electric field impact on humans working near power lines or the potential impact of various emergency and natural calamity scenarios.

Research groups have also been pleased with the new platform. "First, a computer model for the new product and a virtual test bed are developed, where we conduct computing experiments to find effective solutions," explains Leonid Sokolinsky, dean of the computing mathematics and informatics faculty as well as the head of the Supercomputing Simulation Laboratory at SUSU and doctor of physical and mathematical science. "Then, when all supercomputing calculations are complete, an actual product is created based on the model."

SUSU plans to increase the performance of its supercomputer even further. It will continue to use its Intel technology-based RSC Tornado SUSU supercomputer in a large-scale project to implement a cloud-based personal virtual computer educational platform. It has already started using this platform to train students who will become the region's leading engineering and technical professionals in the future.

Lessons learned

Creating an industry-leading supercomputer platform depends on a range of elements working together. As well as implementing the processors that were proven to deliver the best performance and energy efficiency, SUSU made sure that all the other elements of its data center – from connectivity to cooling to SSDs – were geared towards delivering the strongest results.

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[1] Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations, and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance

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