Multi-petaFLOPS performance

Germany's Leibniz Supercomputing Centre uses IBM solutions to build an energy-efficient supercomputer that delivers 3 petaFLOPS performance

Overview

The challenge

The Leibniz Supercomputing Centre faced the task of building and operating a new supercomputer with multi-petaFLOPS performance. This is expected to set new standards of energy efficiency.

The solution

The LRZ chose IBM System x iDataPlex servers with Intel® Xeon® processors for its new high-end supercomputer. The so-called SuperMUC contains more than 150,000 processor cores and 300 terabytes of memory.

The advantages

By using innovative hot-water cooling technology on the hardware side and intelligent controlling code on the software side, the super-computer consumes significantly less energy than conventional solutions. As a result, the operating costs and environmental impact of this supercomputer are greatly reduced.

Located on the outskirts of Munich, the Leibniz Supercomputing Centre (LRZ) provides high-performance computing (HPC) resources to hundreds of researchers throughout Germany and to the 19 other member countries of the Partnership for Advanced Computing in Europe (PRACE). LRZ caters to diverse interests, providing massive processing power to investigate challenging questions in science and engineering. Researchers are tracing the evolution of matter in the universe, designing aircraft that can carry infrared telescopes, improving the efficiency of and reducing the noise emitted by jet engines, and investigating the characteristics of viruses. As part of an initiative to enhance HPC resources in Germany, LRZ has received € 83 million in funding to build and operate a new "tier-0" multi-petaFLOPS supercomputer. The LRZ team had to design a cluster that would deliver outstanding processing performance and be exceptionally energy-efficient.

Delivering 3 petaFLOPS with standards-based IBM systems

After conducting extensive benchmark testing on systems from a variety of vendors, the LRZ team selected IBM System x iDataPlex servers with Intel® Xeon® processors for the new supercomputer. Dubbed "SuperMUC" (borrowing the abbreviation MUC for the Munich international airport), the new supercomputer will contain 150,000 processor cores and have 300 terabytes of memory. The 12 petabytes of permanent storage is based on the IBM General Parallel File System (GPFS). When completed in 2012, SuperMUC will deliver a peak performance of 3 petaFLOPS, making it one of the most powerful supercomputers in the world. The standards-based architecture will enable LRZ to provide the flexibility required to support a broad array of research projects. "Researchers will run more than 200 different applications on this supercomputer," says Professor Arndt Bode, chairman of the LRZ board of directors. "Had we adopted a special-purpose architecture or used accelerators, we would have had to spend hundreds of hours porting applications. Using a standard instruction set, we can deliver outstanding performance for the widest range of codes."

Reducing energy consumption by 40 percent with IBM's hot-water cooling technology

With help from IBM, the LRZ team has designed an energy-efficient cluster that will constrain power dissipation and minimize the environmental impact of supercomputing. SuperMUC will capitalize on an innovative hot-water cooling technology developed by IBM in its Zurich and Böblingen R&D laboratories and first implemented in the Aquasar supercomputer built for the Swiss Federal Institute of Technology Zurich (ETH Zurich). This chip-level cooling technique dramatically reduces the power required to cool servers. Moreover, the collected thermal energy can be redirected to the LRZ's heating system. Overall, LRZ expects that, by using this hot-water cooling technology, it can achieve a power usage effectiveness (PUE) ratio of just 1.1.

The LRZ team will employ software tools to help further improve the supercomputer's energy efficiency. For example, energy-conscious scheduling tools will monitor the energy consumption of software applications and create administrative policies that optimize processor frequency for particular applications and shut down nodes that are not being used. Additional tools will help researchers make the most of the massive parallelism available with the supercomputer. "By binding specific application threads to particular cores, we can enhance application performance and achieve substantial improvements in energy efficiency," says Bode. Creating an energy-efficient system will help cut costs and maximize the funding available for hardware. "With the hot-water cooling technology and additional software tools, we can reduce energy consumption by 30 to 40 percent compared with traditional air-cooled systems. This translates into at least €1 million per year in power savings," says Bode. "By avoiding those costs, we have been able to invest more heavily in processors and memory to build a more powerful system."

Accelerating large-scale research

The new supercomputer will help researchers achieve results rapidly, even for extremely large workloads. "SuperMUC will give researchers in Germany and across Europe the computational power to address large-scale questions in science, engineering, medicine and a range of other fields."

To learn more about IBM System x iDataPlex, visit: **ibm.com/systems/x/hardware/idataplex**
For additional information about IBM General Parallel File System (GPFS), visit: **ibm.com/systems/software/gpfs**

„SuperMUC provides a hitherto unparalleled level of energy efficiency combined with extremely high performance. This is made possible by the massive parallelization of Intel multi-core processors and the use of IBM's innovative hot-water cooling technology."

— Prof. Dr. Arndt Bode, chairman of the LRZ board of directors

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IBM Deutschland GmbH
IBM-Allee 1
71139 Ehningen

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