

CASE STUDY

Intel® Xeon® Processor E5 Family

Education

High-Performance Computing



A Powerful World First

The Leibniz Supercomputing Centre uses the Intel® Xeon® processor E5 family to build one of the world's most powerful computers

Germany's Leibniz Supercomputing Centre (LRZ) provides computing facilities for Munich's universities and the Bavarian Academy of Science and Humanities. As part of the Gauss Centre for Supercomputing (GCS), it is also a national centre for high-performance computing (HPC) and a leading supercomputing centre for the Partnership for Advanced Computing in Europe (PRACE), an affiliation of European organizations dedicated to operating European supercomputing infrastructure and to promote HPC usage throughout Europe. It is operating a new general-purpose HPC platform with over 155,000 Intel® Xeon® processor E5 family cores. Called SuperMUC*, the HPC platform is No. 4 in the TOP500 Supercomputer rankings and is the largest Intel-based computer in the world.



Foto: LRZ



CHALLENGES

- **New platform.** To remain competitive and provide European researchers with state-of-the-art compute power, LRZ needed a new HPC platform.
- **Three priorities.** Application performance, energy efficiency, and general all-purpose computing were its three main criteria.

SOLUTIONS

- **Detailed search.** LRZ considered all major HPC options including a variety of architecture choices.
- **Benchmarking.** Following benchmarking of eight varied HPC applications and several benchmark kernels, it chose a liquid-cooled IBM iDataPlex* system powered by over 155,000 Intel Xeon processor E5 family cores.

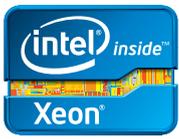
IMPACT

- **Largest supercomputer.** Called SuperMUC, the platform delivers three petaflops of computing performance and is the largest Intel-powered supercomputer in the world.
- **Performance surge.** SuperMUC delivers a 50x performance increase compared to the pre-existing HPC platform and a 16x performance increase per watt.
- **Cool inside.** A specially developed liquid cooling system ensures free cooling as long as the outside temperature remains below 50° Celsius.

At the cutting-edge

LRZ provides HPC facilities to German and European academic institutions and, as a PRACE Tier-0 supercomputing site, is responsible for promoting HPC usage across Europe. The organization takes a lead in improving highly energy-efficient HPC usage. Within any given year, up to 200 varying HPC projects can take place on its HPC platform. Each project is defined by its uniqueness. For example, one may seek to simulate blood flow throughout the body to explore the reasons for aneurisms; another will research on high-precision calculation of the earth geoid to better understand the internal structure of the planet and to determine tidal flows; while another will research optimal methods for reducing noise in aircraft and cars. The use of HPC computers is a more cost-efficient, systematic and often faster alternative to time-intensive and expensive experiments. HPC platforms have become a prerequisite for research in science and technology and are essential to remain competitive and attract all-important funding.

The widely varying nature of the projects meant that LRZ needed a general-purpose HPC platform that could handle the different applications. Its No. 1 priority was performance. Given the scale of the HPC platform usage, energy efficiency was also a primary consideration. Its existing HPC platforms, an SGI UltraViolet* computer with 2,080 cores and a MEGWARE* cluster with 1,424 cores, could not provide the increased performance LRZ needed.



Liquid-cooled HPC platform, based on Intel® Xeon® processor E5 family, provides 16x performance increase per watt

LRZ began exploring all the available HPC options including different types of HPC architecture. However, when it began the tendering process it stated that any submission that included cooling which took advantage of natural sources would be viewed favorably.

Cool and powerful

After evaluating the different HPC system offerings, LRZ selected the IBM iDataPlex platform powered by the Intel Xeon processor E5 family as the most powerful and cost-effective option. Uniquely, this HPC system is liquid cooled with fine copper tubing carrying water at 40°C into the servers. The processors run at approximately 60°C and the water runs out at 50°C, extracting 90 percent of the system waste heat. With over 19,000 processors powering the system, this amounts to a significant improvement in cooling efficiency.

LRZ was impressed by these energy efficiency gains and the fact that the processors could be freely cooled as long as the temperature outside was lower than 50°C. There are few places in the world where the temperature exceeds 50°C and certainly not where the HPC platform was set to be located, five miles outside of Munich.

While these energy-efficiency gains were tremendously positive from LRZ's perspective, the key was in the performance. By drilling down into the technical specifications of the HPC platform and the Intel Xeon processor E5 family, LRZ determined performance would be significantly higher than its existing supercomputing platforms.

It made these assessments based on eight applications that reflected the broad array of HPC projects that would be carried out on the platform. These included applications for astrophysics research, physics, and spatial and aeronautical design.

Following the benchmarking, an average 50x increase in performance was registered compared to its previous SGI Altix4700* platform.¹ This leap in performance was bolstered by an energy consumption increase of only 2.5x. In the final analysis, the HPC platform provided 20x more performance per watt.

Dr. Herbert Huber, LRZ, said: "We considered all major vendors for our new supercomputing platform, but the direct liquid cooling and powerful performance, as well as general HPC capacity, convinced us that the IBM platform powered by the Intel Xeon processor E5 family was the right choice for LRZ."

Top ranking

LRZ began implementing the supercomputer, called SuperMUC, in 2011, with the creation of a migration system powered by the Intel Xeon processor E5 family. Since August 2012, SuperMUC has been fully operational. It is the largest Intel-powered supercomputer in the world and ranks No. 4 in the TOP500 Supercomputers. It delivers an aggregate peak performance of more than three petaflops (three quadrillion floating point operations per second) and has more than 155,000 cores and more than 300 terabytes of RAM.

Dr Huber points out that certain features of the Intel Xeon processor E5 family made it particularly suitable for LRZ's performance and energy-efficiency needs. "Intel® Advanced Vector Extensions (Intel® AVX) help to improve the processing speed of applications. The separate memory and bus speed technology help enhance efficiency and Intel® Turbo Boost Technology² has certainly been effective in terms of optimal processor operating performance."

Lessons learned

When selecting a new HPC platform, LRZ's No. 1 priority was performance, followed closely by energy efficiency. After evaluating different HPC system offerings, it selected the IBM iDataPlex platform powered by the Intel Xeon processor E5 family. It offered a 50x increase in performance compared to LRZ's pre-existing platform with an increase in energy consumption of just 2.5x thanks to direct liquid cooling. Intel AVX helps to improve the processing speed of applications, while Intel® Turbo Boost Technology optimizes processor operating performance.

When a processor is operating below its limits on a given workload, Intel Turbo Boost Technology dynamically increases the performance. Intel Turbo Boost Technology 2.0 has multiple algorithms operating in parallel to manage current, power, and temperature to maximize performance and energy-efficiency.

Thanks to liquid cooling, the data centre in which SuperMUC is housed has a power usage effectiveness (PUE) of 1.1. The industry average is 1.5. Because of its effectiveness, the purpose-built warm water cooling capabilities, in the future, are likely to act as a template for natural, cost-efficient cooling data centre builds.

Because the Intel Xeon processor E5 family provides a standard instruction set that is well known, SuperMUC is especially user-friendly. As a result, it's far easier to adapt software for this platform than it is for other HPC platforms in the TOP500 Supercomputers. This is likely to accelerate research in many areas, from biometrics to astrophysics.

Find the solution that's right for your organization. Contact your Intel representative, visit Intel's Business Success Stories for IT Managers (www.intel.co.uk/Itcasestudies) or explore the Intel.co.uk IT Center (www.intel.co.uk/itcenter).



Copyright © 2012 Intel Corporation. All rights reserved. Intel, the Intel logo, Intel Xeon and Xeon inside are trademarks of Intel Corporation in the U.S. and other countries.

This document and the information given are for the convenience of Intel's customer base and are provided "AS IS" WITH NO WARRANTIES WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. Receipt or possession of this document does not grant any license to any of the intellectual property described, displayed, or contained herein. Intel® products are not intended for use in medical, lifesaving, life-sustaining, critical control, or safety systems, or in nuclear facility applications.

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.

² Requires a system with Intel® Turbo Boost Technology. Intel Turbo Boost Technology and Intel Turbo Boost Technology 2.0 are only available on select Intel® processors. Consult your PC manufacturer. Performance varies depending on hardware, software, and system configuration. For more information, visit <http://www.intel.com/go/turbo>

*Other names and brands may be claimed as the property of others.