CASE STUDY

Intel® Xeon® processor 5500 series

High-Performance Computing
Data-Intensive Computing

Powerful processing propels university into the future

Leading German university turns to Intel® Xeon® processor 5500 series for high-performance computing

Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen is one of the three largest technical universities in Germany and one of the leading technical universities in Europe. In 2007, it was chosen as one of nine German Universities of Excellence by the German Federal Ministry of Education and Research and the German Research Foundation. The use of computer simulation for complex problems is of central importance to its activities and the university wanted to develop its high-performance computing to ensure it maintains its leading status.

RWTH AACHEN UNIVERSITY

Sun microsystems

"We need to stay ahead of the game and to be prepared for the future. By implementing an HPC server cluster powered by Intel® Xeon® processor 5500 series we're providing our researchers with the tools they need to stay out in front."

Dieter an Mey
HPC Team Lead,
Center for Computing and Communication,
RWTH Aachen University

CHALLENGES

- **High-performance computing.** The university needed to develop its HPC capability to ensure it was well equipped to meet future research demands.
- **RISC or server cluster?** RWTH Aachen wanted to establish whether a server cluster architecture would meet its HPC needs or whether it should stay with its existing RISC-based architecture.

SOLUTIONS

- **Evaluate Intel® Xeon® processors.** The university tested the performance of the Linux* and Microsoft Windows* 2008 operating systems on Intel® Xeon® processor 5500 series.
- **Establish next-generation performance.** RWTH Aachen carried out performance benchmarking tests on Intel® Xeon® processor 5500 series against previous-generation Intel Xeon processors.
- **Blade servers.** RWTH Aachen University tested servers from Sun Microsystems, powered by Intel Xeon processors 5500 series.

IMPACT

- **Implemented small server farm.** Intel Xeon processor 5500 series performed more powerfully than RISC architecture, leading the university to begin developing its HPC architecture based on Intel Xeon processors.
- **Greater memory bandwidth.** Intel Xeon processor 5500 series removed memory bottlenecks associated with previous-generation Intel Xeon processors. As a result, 192 Sun Microsystem blade servers and eight front-end servers were implemented, each powered by two Intel Xeon processors 5500 series.
- **2010 scale out.** In 2010, the university plans to implement some 400 more systems with over 20,000 cores powered by the upcoming Intel Xeon processors code-named Nehalem EX.

Underpinning the economy

RWTH Aachen has a long history of close and wide-ranging cooperation with national and international research centres and various industries. As a result, it is highly regarded for its successful contribution to the development of the German economy. This role is increasingly being extended within the European Union.

The university's Centre for Computing and Communication provides high-performance computing, virtual reality, and simulation services to thousands of scientists and students, alongside everyday IT services such as network maintenance, email and Internet access. The projects it has carried out range from developing optimal bevel gearing for machine tools to simulating grassland growth over the next 100 years for a former military base that is being transformed into a national park.

These and other activities require access to high-performance computing resources, so in 2007 RWTH Aachen began running a number of projects on several servers powered by the Intel® Xeon® processor 5100 and 5300 series. The aim was to evaluate an architecture powered by Intel processors. Since 2001 the university had been running a high-performance computing system based on Sun Microsystems SPARC* RISC architecture. With the acquisition of a Intel® Xeon® processor 5500 based cluster in 2008 the focus was shifted towards Linux and Microsoft Windows* 2008 as the main platforms for HPC.

Future research underpinning economic development across Europe receives a major boost

Early proof

The evaluation of the Intel® Xeon® 5100 and 5500 processor series revealed that cache-friendly applications like the above mentioned computational engineering contact analysis simulation of bevel gears performed exceptionally well on Linux* 2.6 and also on Windows compared to much larger RISC-based systems.

This performance increase and other factors – such as the flexibility of Intel Xeon processors to provide both Linux and Windows operating systems for HPC users within the university, fast interconnects, and good response times for file service consolidation – convinced RWTH Aachen to develop a new HPC server cluster architecture based on Intel processor technology.

As a result, when Intel® Xeon® processor 5500 series became available, the university evaluated its performance against Intel Xeon processor 5500 series and Intel® Xeon® processor 7400 series. The Intel Xeon processor 5500 series provided a much higher memory bandwidth than the Intel Xeon processor 5500 series, resulting in an about four times performance increase for memory intense kernel benchmarks. For real applications this turns easily into a two to three times improved overall performance.

Memory fast forward

The university also ran a Navier-Stokes Solver developed at the RWTH Chairs of Numerical Mathematics and Scientific Computing, consisting of some 50,000 lines of C++, to simulate two-phase fluid flows. This application considerably stresses the memory bandwidth of processors. The Intel Xeon processor 5500 series out-performed both Intel Xeon processor 5500 series and Intel Xeon processor 7400 series by a factor of approximately 2.5. This reflected the superior memory bandwidth of the Intel Xeon processor 5500 series.

Many applications in the computational engineering and science domain are memory hungry. The substantially improved memory bandwidth of the Intel Xeon processor 5500 series, added to the well-known cache friendliness of Intel Xeon processors, compelled the university to adopt these processors on a larger scale.

After evaluating the offers of various vendors, RWTH Aachen University decided to install eight Sun Fire X4170 front-end servers and 192 Sun Blade X6275 back-end server modules from Sun Microsystems. It plans to implement a further 2,500 Intel Xeon processors in 2010. These processors will have eight cores and are the successor to the Intel Xeon processor 7400 series.

Standards for the future

Another compelling benefit was the ability to utilise OpenMP*, a standard for developing parallel applications to run on multi-core Intel processors. Dieter an Mey, HPC Team Lead, Center for Computing and Communication, RWTH Aachen University, said: "Multi-core processors are clearly the future of computing. OpenMP supports shared memory parallel programming in C/C++ and Fortran on all architectures. OpenMP is well supported by Intel's software tools and, to ensure we get the greatest performance benefits from Intel multi-core processors, we need to develop parallel applications. OpenMP is the most important de facto standard for achieving this."

The improved performance of the new computer cluster will provide researchers and students with the resources they need for large-scale simulations. This will even further galvanise RWTH's reputation as a leading technical university, strengthening its robust relations with industry partners and further underpinning its work in helping to accelerate the German economy and, increasingly, the wider European Union economy.

Spotlight on RWTH Aachen University

Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen is one of the three largest leading technical universities in both Germany and Europe. Approximately 30,000 students are enrolled at the university, with more than half involved in engineering courses and about 7,500 studying natural sciences. Closely allied to industry and international research centres, the university has a reputation for helping underpin economic growth and advancement within Germany. Increasingly, this is being extended into the wider European Union.

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