Success Brief

Quad-Core Intel® Xeon® processor 5400 series

High performance computing

CERN openlab

"Intel® technology is critical to our development of the Large Hadron Collider — a particle accelerator created to study the origins of the universe."

Sverre Jarp,
CTO, CERN openlab

Recreating the Big Bang

Next-generation Quad-Core Intel® Xeon® processor 5400 series delivers significant performance and energy gains, advancing CERN's studies into the origins of the universe

Company:	CERN: world-leading research organisation in elementary particle physics
Product evaluated:	Quad-Core Intel® Xeon® processor 5400 series with 45nm Hi-k technology
Challenge:	CERN needed to find a high-performance, energy-efficient server processor to continue increasing the computational power of the four experiments belonging to the Large Hadron Collider (LHC), whilst keeping energy consumption to a minimum
Results:	The second-generation Quad-Core Intel Xeon processor 5400 series showed a 10% performance increase, and a similar 10% improvement in performance per Watt compared to the previous-generation Quad-Core Intel Xeon processor 5300 series
Impact:	CERN will be able to more efficiently analyse the 15 petabytes of data that the LHC experiments will deliver every year, enabling particle physicists to gain greater insight into the origins of the universe.
Next steps:	Intel and CERN will continue to work together to evaluate and roll out increasingly faster and more energy-efficient multi-core processors to run the LHC

Challenge

CERN is the largest particle physics laboratory in the world, and is currently finalising the construction of a new particle accelerator – the Large Hadron Collider (LHC). At 27km in circumference, the LHC will be the largest and most powerful particle accelerator ever built, and will enable physicists to recreate the conditions that existed just a fraction of a second after the 'Big Bang'.

A colossal computing infrastructure will be required to process the 15 petabytes of data that will be generated annually by experiments in this new system. The biggest challenge CERN faces in successfully deploying the required resources are the power and thermal limitations of its computing facilities.

As with all data centres, the CERN computing centre in Geneva has a thermal limit. Using modern cooling technologies, the maximum amount of generated heat that can be removed by the cooling and ventilation system is 2.5 Mega Watts (MW). Currently the facility is running at around 2.0MW. Given that CERN needs to increase its computing power on an ongoing basis, it is expecting to reach its 2.5MW limit within a year or two.

As a result, CERN had an urgent need for a high-performance, energy-efficient server processor to continue increasing the computational power of the LHC whilst keeping energy consumption to a minimum.

Deployment

Intel® technology and multi-core evolution have been critical to the development of the Large Hadron Collider (LHC). For years, the heart of CERN's computing resources consisted of hundreds of ordinary PC workstations, each equipped with two Intel® Pentium III and Pentium® 4 processors – based on the Intel Netburst® architecture. Although increases in successive processor generations delivered performance gains, the corresponding rise in dissipated power eventually became a serious problem.

Fortunately the move to multi-core processors – 700 Dual-Core Intel® Xeon® processors 5100 series and 1,300 Quad-Core Intel Xeon processors 5300 series – based on the Intel® Core™ microarchitecture enabled ongoing improvements in overall performance, without a corresponding increase in power consumption.

To further build on these performance and energy gains, CERN was keen to evaluate the benefits of deploying the second-generation Quad-Core Intel Xeon processor 5400 series with 45nm Hi-k technology. It ran a series of benchmarks using the SPECInt 2000* benchmark, as well as some of its own evaluation tests.

SPECint was chosen as the default benchmark because it closely mirrors CERN's application performance. By dividing the SPECint results by the amount of power consumed, CERN was able to establish how much processing power it was able to achieve from each Watt of energy consumed – referred to as SPECint per Watt.

Results

The second-generation Quad-Core Intel Xeon processor 5400 series with 45nm Hi-k technology shows a performance increase of 10% when compared to the Quad-Core Intel Xeon processor 5300 series.

It also offers improved memory capacity which can lead to even greater performance. Although the benchmarking carried out by CERN did not highlight the full advantages of the processor's improved cache, similar benchmarking using the Oracle RDBMS did. Together with Intel and HP, Oracle is one of CERN's openlab partners.

During its benchmarking, CERN openlab found that the second generation Quad-Core Intel Xeon processor 5400 series showed a performance increase of 15% when running its memory-intensive database servers when compared to the Quad-Core Intel Xeon processor 5300 series.

The real benefit for CERN, however, lies in the fact that the Quad-Core Intel Xeon processor 5400 series not only increases performance, but also lowers the SPECint per Watt ratio. Compared to the previous-generation Quad-Core Intel Xeon processor 5300 series it showed a 10% improvement in performance per Watt.

Impact

For CERN, one Watt saved on server power consumption has the added benefit of saving an additional Watt on power requirements for the cooling system. In other words, one Watt saved on power consumption translates into a total saving of two Watts.

For many organisations, these reductions would translate in to direct cost savings. For CERN, the benefits are indirect. Since the computing requirements for the Large Hadron Collider (LHC) are without limits, CERN will be able to use the power-efficiency gains enabled by the Quad-Core Intel® Xeon® processor 5400 series to install additional computers.The organisation will nevertheless hit a power limit in the near future.

This extra processing power will enable CERN to speed up the reconstruction and analysis of the 15 petabytes of data that the LHC is expected to deliver every year. By providing physicists with better insight into the study of the smallest known particles – the fundamental building blocks of all things – the Quad-Core Intel Xeon processor 5400 series will play an important role in revolutionising mankind's understanding of the origins of the universe.

Future

Over the years, CERN has directly benefited from milestones in technology development by Intel. Most notably, the performance per Watt gained from the move from single-core processors based on the Intel Netburst architecture to dual-core processors based on Intel Core microarchitecture.

This was followed by the introduction of first-generation Intel® quad-core technology which provided similar performance per Watt but occupied less physical space. Now, the next-generation Quad-Core Intel Xeon processor 5400 series with 45nm Hi-K technology is improving the performance per Watt ratio even more. But it does not stop there.

Over the next few months, CERN will begin to retire its inefficient legacy infrastructure, replacing it with more energy-efficient Intel quad-core technology. Looking even further in to the future, it will continue to work together with Intel to evaluate the benefits of subsequent developments in Intel® multi-core technology.

The migration towards the Quad-Core Intel Xeon processor 5400 series will also enable CERN to embrace the Predictive Enterprise computing vision. Performance improvements brought about through greater energy efficiency provide CERN with systems better able to analyse the large amounts of data generated by the LHC. In turn, this will ensure CERN remains a leading force in particle physics research.

Find a business solution that is right for your company. Contact your Intel representative or visit the Intel® Business/Enterprise Web site at http://www.intel.com/business/server.htm

0408/JNW/RLC/XX/PDF 319753-001EN