CASE STUDY

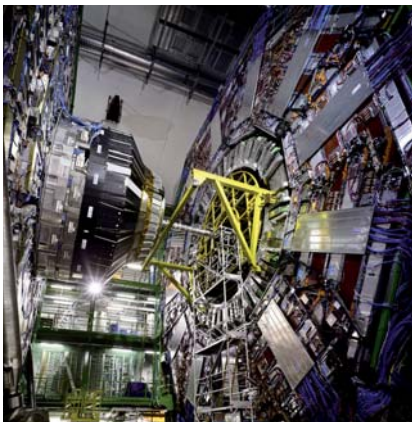
Intel® Xeon® processor 5500 series

Energy
Performance

Computing with Universal Performance

CERN openlab shows faster, more efficient analysis of physics data with Intel® Xeon® processor 5500 series

The European Organization for Nuclear Research – CERN – is one of the largest and most respected scientific institutions in the world. Founded in 1954 as one of Europe's first joint science ventures, it is established on the Swiss-French border near Geneva. CERN has 20 Member States from Europe, while other nations from around the globe also contribute to and participate in its research programme. It is carrying out research into fundamental physics and uses some of the most complex scientific instruments to study the basic constituents of matter and the Universe.



CERN openlab

"We've seen for ourselves the raw power and performance improvements of the Intel® Xeon® processor 5500 series."

Sverre Jarp
CTO
CERN openlab

CHALLENGES

- **Improve performance.** CERN needs to ensure its computing platform has the highest possible throughput to process the 15 Petabytes of data per year expected from the Large Hadron Collider (LHC) experiments and to distribute the data to be analysed worldwide
- **Optimise energy consumption** As the present CERN data centre is limited to 2.9 MW electrical power (not counting the power for cooling and ventilation), CERN IT needs to ensure an optimal balance of performance and power consumption

TESTED SOLUTION

- **Different flavours.** Intel® Xeon® processor 5500 series was evaluated in three flavours of varying power needs and performance levels against a series of benchmark tests

IMPACT

- **Increased efficiency.** Tests showed that the new generation processor delivers a 36 per cent energy efficiency improvement over the previous generation for CERN's environment
- **Lower power use.** By enabling Intel Xeon processor 5500 series' Simultaneous Multi-Threading feature, efficiency of the new platform can be boosted by up to 20 per cent

Staying Ahead of Research Needs

CERN's flagship is the LHC, a massive underground 27 km circumference particle accelerator that is used for some of the organisation's ground-breaking research. Altogether, this programme involves some 9,000 researchers from over 550 institutes and 113 countries, who will be working on the 15 million Gigabytes expected to be produced each year. The Worldwide LHC Computing Grid (WLCG) has been developed to respond to this unprecedented computing challenge. It is the result of collaboration between 34 countries and it combines the IT power of more than 160 computer centres.

CERN operates the primary computing centre (Tier0) to store all data from the LHC experiments and to support the first event reconstruction and to distribute the data to eleven Tier1 centres around the world, who will store a further copy of all data.

CERN openlab – a collaboration between CERN and industrial partners – supports the WLCG project by investigating various platforms to find the ideal solution for data filtering, the calibration process as well as for data analysis, simulation and event reconstruction. The openlab team also follows technology developments closely and evaluates new promising technologies in views of enhancing the computing environment of CERN and its partners.

Sverre Jarp, CTO, CERN openlab, explains: "CERN is operating a huge computing resource here, and we're always keen to get more performance out of it to drive research forward and get results faster. We need to balance this with our power considerations, as we simply can't go above the energy supply limit."

A Thorough Evaluation

When the new generation Intel® Xeon® processor 5500 series was launched CERN openlab was keen to assess its performance and energy-saving features. It chose to evaluate three different flavours of the processor (L5520, E5540 and X5570) with different levels of performance and cost in order to identify the most effective platform. All three types of the processor were evaluated with its Simultaneous Multi-Threading (SMT) and Turbo modes both on and off to illustrate clearly the impact of these new features.

Globally-recognised research organisation demonstrates enhanced computing power of latest Intel® Xeon® processor 5500 series

The evaluation units were tested based on a multiple usage environments. "We wanted to know how the platform would perform for us in different situations," says Jarp.

First, a series of energy measurements were made using a power analyser[1] and power intensive benchmarks (CPUBurn[2] and LAPACK[3]) to measure electricity usage under intensive load conditions. The second stage of the testing investigated each processor model's performance credentials, using the SPEC CPU2006[4] benchmark suite.

"We needed to look at performance per watt," continues Jarp. "The L5520 flavour may use the least power, but to get the same performance as before, we would need to use more units, which could end up costing us more in space and energy."

Additionally, CERN openlab ran the "test40" benchmark, designed specifically for performance testing in High Energy Physics simulation environments, and developed a "tbb" benchmark based on the track fitter from the High Level Trigger of the ALICE, an LHC experiment. It was adapted to run multithreaded on an x86 architecture using Intel's Threading Building Blocks (TBB).

Having completed these assessments, the team went on to test both the SMT and Turbo modes included in the new generation Intel Xeon processor 5500 series. The SMT feature was found to boost the computing platform's performance by between 15 and 20 per cent.

Based on the test results, CERN openlab demonstrated that the new low voltage Nehalem architecture (L5520) is 36 per cent more efficient in terms of performance per watt than the best previous Intel® Xeon® processor 5400 series using a DDR2 solution.

To achieve the same performance with servers of the previous generation, 720 additional servers would be required entailing a much higher capital expenditure and energy cost over the three year life-cycle. Based on the average European electricity cost (€0.15 per kWh), we estimated the energy and cost savings: over 5.5 million kWh or €850,000 over three years.

E5410 based server (200W)	0.2 kW
720 systems	144 kW
Operation 24h x 365 days	1,261,440 kWh
plus 50% for cooling	1,892,160 kWh
Cost per year	€ 283,824
Total energy saving over life cycle	5,676,480 kWh
Total energy cost saving over life cycle	€ 851,472

Strategic Computing

CERN IT has now decided to deploy by spring 2010 more than 2,000 dual processor servers to ramp up the computing capacity for the forthcoming restart of the LHC.

For each successive generation of the Intel Xeon processor, the openlab team found consistently energy and cost savings. CERN openlab will continue to test new generations of processors with the aim of integrating them into the LHC computing environment.

"Every time we tender, we need to see which offer is the most compelling. After having seen for ourselves the raw power and performance improvements of the Intel® Xeon® processor 5500 series, we have asked interested suppliers to submit their best proposals using the same benchmarks," says Jarp. "While it remains to be seen which offering is the most compelling, our tests indicate that Intel technology is a very strong contender."

Spotlight on CERN openlab

CERN openlab is a framework for evaluating and integrating cutting-edge IT technologies or services in partnership with industry. Through close collaboration with leading industrial partners, CERN acquires early access to technology that is still years from the general computing market. In return, it offers expertise and a highly demanding computing environment for pushing new technologies to their limits and provides a neutral ground for carrying out advanced R&D with various partners. To learn more about CERN openlab, visit **www.cern.ch/openlab** To obtain more details about the tests carried out within the CERN openlab framework, read the white paper, "Evaluation of energy consumption and performance of Intel's Nehalem architecture", **www.cern.ch/openlab-reports**

Find a solution that is right for your organisation. Contact your Intel representative or visit the Reference Room at **www.intel.com/references.**

Energy: Efficiency, Environment & Performance. Lower energy and cooling costs, while keeping mobile users going, through more environmentally-friendly computing

To learn more about Intel's Predictive Enterprise strategy visit **www.intel.com/predictiveenterprise**

Performance: Data-Intensive Computing. Support the most demanding business data processing and computationally intense graphics.

To learn more about Intel's Predictive Enterprise strategy visit **www.intel.com/references/pe/index.htm**

[1] http://www.zes.com/index.php?lang=en&site=download
[2] http://pages.sbcglobal.net/redelm/
[3] http://www.netlib.org/lapack/
[4] http://www.spec.org/cpu2006/

1009/JNW/RLC/XX/PDF 322850-001EN