



Good vibrations: AUDI improves driving luxury with Intel® Itanium® 2 processors

SOLUTION SUMMARY

Challenge

In use for three years, the RISC-based servers at the AUDI AG data centre in Ingolstadt (used to calculate airflows in the vehicle interior and the dynamic behaviour of bodyworks) were at the bottom end of the performance spectrum. In the CAE area, however, performance is key, and equates to a competitive advantage for the company. AUDI was therefore on the lookout for exceptionally high-performance servers that also offer an outstanding price/performance ratio, are reliable, and can easily be expanded in a cluster arrangement. These capabilities allow server performance to be adapted without difficulty to meet future demands as the simulation models become larger and more detailed.

Solution



As a first step, in May 2003 AUDI switched the servers used for the airflow simulations to HP Integrity* servers with dual Intel® Itanium® 2 processors running HP-UX* 11i v2 with its robust, mission-critical operating system with superior performance. In October 2003, these four servers were expanded to support eight dual Itanium 2 processors. At the same time, the company switched its finite elements system for calculating the dynamic behaviour of vehicle bodyworks from the RISC architecture to the four HP Integrity servers based on dual Itanium 2 processors. After achieving positive results, AUDI plans in spring 2004 to convert its virtual wind tunnel from 64 RISC processors to 64 Itanium 2 processors. Several workstations with Itanium 2 processors are also being taken into operation on a test basis.

Business Value

By using Intel Itanium 2 processors for HP Integrity servers with the HP-UX 11i v2 operating environment, AUDI increased performance of its systems by a factor of roughly 1.5 times while reducing costs by one-third that of a comparable RISC-based system. The higher performance of the systems is resulting in higher staff productivity, more accurate simulation models, and ultimately, in a competitive advantage for AUDI. For AUDI AG customers, improved airflow simulation in and around the vehicle, and improved body design ultimately results in a perceptibly more luxurious ride.

Hardware

HP Servers based on Intel® Itanium® 2 processors

Business Challenge

PERFORMANCE DEMANDS: SIMULATION OF AIR-CONDITIONING AND OF RIDE COMFORT WITH REGARD TO VIBRATIONS

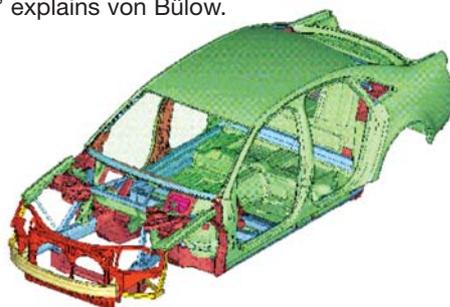
Cars are meant to be luxurious, to make it possible for the driver and passengers to enjoy a comfortable journey. AUDI AG sets great store by the comfort drivers enjoy, as is demonstrated by the new flagship of its fleet of vehicles, the AUDI A8 12-cylinder. The engine benefits from AUDI's comprehensive expertise assimilated over many years of successful involvement with motor-sports. The interior defines an atmosphere of ultimate luxury. Ergonomic perfection is paired with an ambience that sets the standard even for the luxury class cars produced by competitor companies, in terms of style, exclusivity and functionality. Luxury at this level is designed in with the aid of simulations. Among other things, computers using the Intel Itanium 2 processor support AUDI in establishing the optimal air-conditioning for the respective type of vehicle.

The company's success proves that its approach is the right one: in 2002, AUDI recorded its highest ever sales result with a total of € 22.6 billion. In the same year, AUDI delivered more than 735,000 new AUDI cars to customers, a new record for the AUDI Group. Including the Volkswagen Group Vehicles sold through the AUDI subsidiary Autogerma in Italy and Lamborghini, the AUDI Group sold more than 995,000 units in 2002. The company's headquarters are located in the city of Ingolstadt, Germany, and the workforce numbered more than 51,000 people in 2002. Among the countries where AUDI has subsidiaries around the world are: Europe, the US, China, Brazil, Japan, and Israel.

"In addition to optimal positioning of the air-vents and calculating the ventilation and the distribution of the temperature zones, the work also involves engine cooling as part of the simulations carried out at the data centre," Hans-Ulrik von Bülow, Senior CAE Systems and Methods Analyst at AUDI AG, explains. "To that end, we use CAE systems to map the entire cooling cycle. In this way, even during the development phase for the car, staff can identify how heat is extracted from the engine and the aggregates like the dynamo in the motor-room. The aim is to perfect engine cooling so that the engine can achieve optimal performance under all climatic conditions."

Luxury also includes the dynamic behaviour of different bodyworks, in terms of the overall vehicle. Special emphasis is placed on vibrations and on acoustic behaviour. AUDI builds a model of the entire bodywork from CAD data. Finite elements software then simulates the dynamic behaviour of the vehicle. Says von Bülow: "Every car has several particular individual frequencies where AUDI specifies target values. Using numerical simulations AUDI then optimizes the acoustic and vibration behaviour."

Another area where engineers focus is de-icing of the car windows. Experts use the term "defrost behaviour" to describe the vehicle's ability to defrost and demist the windows. "A clear view and draft-free, pleasant air-conditioning to the interior increase the degree of luxury considerably. Our customers can rely on the fact that we will find the optimal airflows to make a journey in one of our cars as comfortable as possible," explains von Bülow.



RISC ARCHITECTURE AT THE LOWER END OF THE PERFORMANCE SCALE

Up until now, AUDI used proprietary RISC systems to calculate the data. "It is particularly important for us to obtain the most high-performance computers respectively available currently on the market. The faster AUDI is able to carry out the computations for the simulations, the greater the competitive advantage," von Bülow says. "Additionally, with faster computers it is possible to perform the calculations for ever more detailed and ever bigger models. This directly benefits car drivers. The more accurate the models become, the more luxurious the experience when using the vehicle."

At the end of the time during which AUDI's RISC servers were operated, these computers were at the lower end of the performance spectrum. "Our challenge was to find new servers that work reliably, run the CAE applications used by AUDI, and offer the maximum computing performance possible at this time," von Bülow explains. "AUDI pays close attention to the price/performance ratio for the servers. Even at this stage, I can reveal that the switch to HP Integrity servers running the Intel Itanium 2 processor enabled us to reduce costs significantly while simultaneously making a massive increase in performance."

"With the new Itanium® 2-based system, we have been able to greatly increase the throughput of our MSC.Nastran* simulations, in comparison with the legacy RISC systems which were previously in use."

Hans-Ulrik von Bülow,
Senior CAE Systems and
Methods Analyst, AUDI AG

Business Solution

Preparations for replacing the outdated RISC-based servers for the flow simulation began in May 2003. The AUDI Purchasing Division issued a request for proposal for the new servers. In addition to Intel, traditional RISC providers also submitted proposals for the new servers for the Ingolstadt data centre. Says von Bülow: "We let all the servers process the same calculations and then compared the results with one another. From this trial, the Hewlett-Packard HP Integrity servers running HP-UX 11i v2 with dual Itanium 2 microprocessors offered the best price/performance ratio by some margin using our applications." In addition, the HP Integrity servers offer high scalability, allowing AUDI to easily and cost-effectively expand the system as future growth requires.

"The HP Integrity systems with Itanium 2 processors are roughly a third cheaper, while offering 1.5 times faster the performance," von Bülow says. The operating system used is HP-UX 11i v2. The biggest advantage is that the applications that previously ran on the RISC-based computers can be used immediately on the HP Integrity servers with Itanium 2 microprocessors due to the HP-UX 11i v2 leading

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binary compatibility technology with RISC processors for better investment protection.

To reduce the risk of the implementation and shorten time to value of the new solution, AUDI tested and validated its HP Integrity solution at the HP Solution Centre in Boeblingen, Germany. "Even if problems were to arise during the switch to the new servers, the old applications could be used immediately. For our company, this meant additional security, in case it was not possible to complete the software on schedule." By specially compiling the software for the Itanium 2 processors, the processors' performance can be optimized.

Says von Bülow: "By greatly shortening the simulation time – in comparison with the RISC-based systems previously in use – the new HP Integrity systems with Itanium 2 processors have enabled us to complete our analysis in less time, allowing us to shorten our product development cycle." Von Bülow has special praise for the relationship with Intel: "Intel is proactively approaching the CAE software manufacturers and is helping them to optimize their software. This is a factor that our company similarly took into consideration for the switch to the Intel architecture."

In October 2003, the expansion of the flow simulation servers from four computers with dual Itanium 2 processors to eight computers with dual Itanium 2 processors took place. In doing so, AUDI is pursuing a scale-out strategy: the existing servers remain unchanged and are supplemented by a number of new servers. The flexibility of the Itanium 2 microarchitecture is advantageous because AUDI can adapt its computing performance to be a perfect match for its requirements, and only pays for the capability it actually requires. At the same time as expanding the flow simulation servers, AUDI purchased four HP Integrity servers with dual Itanium 2 processors to calculate finite elements with MSC.Nastran*.

The procedure for the flow calculation was the same as for the servers: once more, the HP Integrity servers with dual Itanium 2 processors won against RISC providers due to performance and superior price/performance ratio. "To date, the HP Integrity servers with the Intel Itanium 2 processors have satisfied all our expectations. Without exception, the systems have been running stably since being introduced, and in some instances they are realizing major improvements. Calculations that previously used to take AUDI four days can now be completed in a single day," von Bülow says.

FASTER MEMORY ACCESS THANKS TO 64-BIT TECHNOLOGY

In total, 25 computers access the new systems, approximately two-thirds of which are located in Ingolstadt and one-third is connected through the network in Neckarsulm. "Particularly with the MSC.Nastran systems, we are reaping the benefits of switching to 64 bit," von Bülow explains. The systems are equipped with 24-GB RAM in each instance, of which 12 GB serves as a file cache system. A single processor therefore offers 6-GB RAM for the simulation calculations. On systems with 32-bit processors, the maximum possible is 2 to 4 GB. On top of that, there is the wider storage bandwidth, which is of critical importance in the CAE area, and faster access to the hard disks. "The whole I/O area on the systems with Itanium 2 processors is ideally suited to providing the fastest calculations," von Bülow says. "With the new HP Integrity system with the Itanium 2 processors, we have been able to greatly increase the throughput of our MSC.Nastran simulations, in comparison with the legacy RISC-based systems which were previously in use."

The improved computing performance is not only of benefit to staff at AUDI. Shorter computing times mean higher productivity and, at the same time, increased competitive capability. Customers in particular will feel the benefits of the ever more accurate simulations. The more sophisticated calculations for the bodywork and airflows inside the vehicle open up new dimensions for vibration and climate comfort. The positive experiences with the Intel architecture are also influencing the wide-ranging future plans at AUDI.

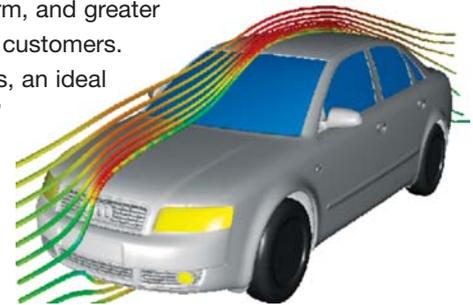
"Performance is the be-all and end-all in the CAE business. HP Integrity servers with Itanium 2 processors have proved that in addition to top-level performance, they also offer an outstanding price/performance ratio. For AUDI it is therefore a logical move to switch other existing RISC-based systems soon to computers with Itanium 2 processors," says von Bülow.

“The next major changeover is scheduled for spring 2004. At that time, an HP Integrity Superdome* with 64 RISC processors is being switched to a server with 64 Itanium 2 processors. Our exterior aerodynamics software will profit from noticeably more power so that AUDI will be able to conduct more extensive examinations of flow behaviour. A reduced air resistance leads to lower fuel consumption.”

Even for the workstation area, AUDI is seriously considering a switch to HP Integrity systems with Itanium 2 processors. Of the roughly 200 workstations currently used in the CAE sector, around 10 percent are equipped with Intel® Xeon™ processors. From as early as January 2004, this figure will increase to 25 percent. “The Intel Xeon processor-based workstations with high-end graphics cards are being used because of their very good price/performance ratio for preparing the result and models,” von Bülow says. “From 2004 onward, we will use workstations with Itanium 2 processors on a test basis.

Many manufacturers have already switched the core calculations for their software to Itanium 2-based systems. AUDI will soon benefit not only from the ‘number-crunching’ offered by the high performance of the Itanium 2 processors, but also from graphics-intensive programs in the front end.”

Hans-Ulrik von Bülow provides a succinct summary of AUDI’s experiences: “In many CAE areas, the Intel Itanium 2 processor is the processor of choice. Every bit of additional performance that this processor offers means a competitive advantage for AUDI in the long term, and greater luxury for our customers. In other words, an ideal combination.”



LESSONS LEARNED

- The choice of ultra-modern Intel® technology promotes an outstanding price/performance ratio. The use of leading Intel technology is an assurance for reliability, availability and ease of servicing/maintenance. For AUDI, the switch to Intel Itanium® 2 processors has paid off due to its outstanding price/performance ratio. The outstanding performance makes it possible to carry out more detailed simulations in a shorter time-frame, and ultimately results in greater luxury for AUDI customers. Not only is the company saving money, it is also gaining a competitive advantage.
- The Intel Itanium 2 processor offers a high-performance, scaleable and cost-effective solution for the CAE area. If company-critical applications

make it necessary to have extremely high computing capability, high throughput, and short response times, the Intel Itanium 2 processor forms the basis for a high-performance, robust and significantly scaleable solution. Staffs at AUDI are able to compute their simulations more effectively.

- Flexibility with the switch from proprietary RISC systems is a major benefit. The ultra-modern 64-bit technology from Intel offers flexibility, making it possible to lower procurement and operating costs, and can be used with the widest possible range of operating systems and software. AUDI uses the flexible scaling of the servers for cost-favourable adjustment of performance to the requirements of the CAE department.

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