Linux Networx proven

Metalcasting Simulation Case Study

Audi's Challenge: Building Safer & More Reliable Cars

Solution Summary	
Challenge	Audi needed a supercomputing solution that could simulate cast designs for their new Audi Space Frame.
Solution	A Linux Networx Evolocity MAGMASOFT® Cluster System, specifically designed for the metalcasting industry.
Business Value	**Audi was able to reduce their simulation time from 2 weeks to 2 days.** Audi estimates that the faster simulation times, as well as the higher accuracy of the simulation results, have the potential to save money equivalent to the costs of one mold and also decrease the number of rejections, thereby reducing the costs of the car.
High Performance Cluster System	A 16 node, 32-processor Evolocity MAGMASOFT Cluster System. Part of a unique partnership between Linux Networx and MAGMA that includes a fully integrated solution with the necessary software and management tools to get the job done.
Cluster Management tools	Clusterworx®, ICE Box™
Casting Software	MAGMASOFT

Challenge

Next time you see a sporty Audi A8 cruising down the road, you'll know that Linux played a role in designing this popular car. Throughout its storied history, Audi has taken on the role of automotive technological pioneer. So when the German car manufacturer started designing the new Audi Space Frame®, a high-strength aluminum frame structure designed for greater safety, increased performance, improved handling, and lower fuel consumption, this product was no exception. The only mass-produced car frame made completely of aluminum, the Audi Space Frame is enjoying much success on new models of the A8 and A2. However, Audi wanted to further enhance the safety of their cars and recently embarked on designing the 4th generation Audi Space Frame – an encounter that led to the company's adoption of Linux Clusters.

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The Design Process

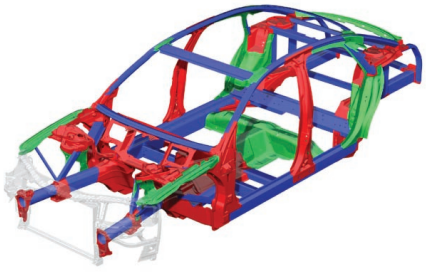
How a car part comes to fruition is a long, arduous task, involving many different disciplines like design, crash tests, and metallurgy. The parts for the Audi Space Frame are made from pouring liquid aluminum into a mold, which is then solidified into a casted car component. This seemingly simple task can be problematic as minor differences can dictate the product's failure or success. The mold design determines how the liquid aluminum fills the cavity and subsequently solidifies. If a particular design shows areas of the component with highly different solidification times, weak spots can occur that jeopardize the safety of the part.

The traditional way for designing and building a mold is to produce several casting simulations to roughly confirm the chosen concept, build a prototype, run tests, and when desired results aren't achieved, a new design is created to try and fix the problems. This approach was successful in the past, however it was very time consuming and the mold's success wasn't confirmed until the design had already been finalized. To incorporate any changes into the design after this point was costly and time consuming. More recently, the efficiency of this approach has been increased by the extensive use of simulation techniques, such as computational fluid dynamics (CFD), in the early design phase of a car.

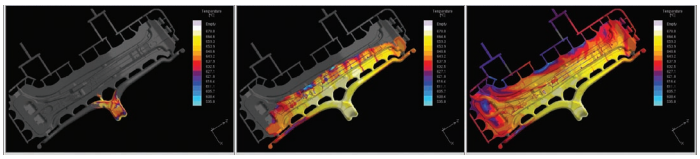
Audi had used casting simulation applications in the past; however, to produce one simulation of a cast on their existing UNIX-based computing system would take two weeks, an unacceptable and costly time frame. This restriction limited the value of the simulation technology. To successfully and efficiently design components for the new Audi Space Frame, Audi needed to deploy a casting simulation application on a high performance computing system.

Investigating Linux Clusters

When Audi started investigating new computing architectures, the highest priority was given to the reliability of the system, which had to be proven by benchmarking procedures and documentation of other successful installations. The second priority for Audi was the price/performance ratio. Audi needed a computing solution that was powerful, yet fit within their budget.



A simulation of the next generation Audi Space Frame



Simulations of liquid aluminum flowing into Audi's mold design

Linux Networx, a provider of Linux cluster systems, had been working closely with MAGMA, the producers of MAGMASOFT® casting simulation software, to produce a cluster system optimized for the CFD market. The Evolocity® MAGMASOFT cluster system is a comprehensive system designed specifically to improve the speed and accuracy of the casting process. Audi was drawn to the Evolocity MAGMASOFT solution as it was designed specifically for casting applications and offered a compelling price/performance ratio.

MAGMA was also using a Linux Networx cluster technology in-house for its own consulting engineering service. With the installation of a 32 processor Evolocity™ cluster, MAGMA was able to reduce its response times on complex projects and lend its computing power to MAGMASOFT customers.

Rigorous benchmarking tests then ensued on a Linux Networx Evolocity system deployed with MAGMASOFT at Linux Networx GmbH, the European division of Linux Networx. The Evolocity system ran one of the largest MAGMASOFT datasets ever, processing 200 million cells. An average number of cells typically run on a cluster ranges from 100,000 to a million. Because Linux Networx was the only vendor able to meet Audi's specifications and produce successful benchmark results, Audi purchased a 32-processor Evolocity cluster. Audi's cluster included 32 Intel® Xeon™ processors and a Myrinet 2000 interconnect.

"Linux Networx exceeded our expectations by not only providing an extremely reliable system, but providing a turnkey cluster system preloaded with MAGMASOFT," said Erich Blümcke, casting simulation specialist at Audi. "The fact that MAGMA decided to develop its future software on a Linux Networx cluster demonstrates the capabilities of this cluster in the engineering design market."

Total Cluster Management

With a 32-processor system, Audi wanted to ensure that each node was operating at maximum efficiency, but didn't want to spend time and resources having administrators monitoring the cluster for optimal performance. Audi was able to easily combat this problem by installing a complete suite of cluster management tools from Linux Networx. Clusterworx, a comprehensive cluster management software solution, and ICE Box, a cluster management hardware appliance that fully integrates with Clusterworx to increase system uptime and track cluster performance.

"There was a situation during the summer when the HVAC unit of our server room failed on a Saturday, so no one was there to correct the problem. When we returned on Monday, the Linux Networx cluster was the only system running fine, all the other servers were shut down due to cooling problems," said Blümcke. "The cluster management tools kept the system healthy in this situation, even though no one was there."

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The Results

Since installing the cluster at their site, Audi has seen significant performance gains that were impossible to achieve with their existing machine. Casting simulations that used to take two weeks now finish in two days.

"A rapid simulating time was a prerequisite to reduce the total turnaround time of even large problems to two-five days in order to integrate the casting simulations into the general product development chain of new cars," said Blümcke. "The Linux cluster enables Audi for the first time to accurately simulate the filling and solidification process of large structural parts."

Because of Audi's move to a Linux Networx system, Audi estimates that the faster simulation times, as well as the higher accuracy of the simulation results, have the potential to save money equivalent to the costs of one mold and also decrease the number of rejections, thereby reducing the costs of the car.

"We are getting involved into the design of about 2 to 3 structural parts that are relevant for crash worthiness. The handling of these parts was simply not possible on the Unix hardware platform," said Blümcke. "Only the use of the Linux cluster enabled Audi to tackle the integration of casting simulation into the design process of new cars."

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Linux Networx brings its powerful cluster technology to those seeking high availability and high performance computing systems. To date, the company has built some of the fastest cluster systems in the world and has developed unique hardware and versatile software to facilitate overall system management.

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MAGMA Foundry Technologies, Inc., is committed to casting excellence. MAGMASOFT® is a comprehensive simulation tool that helps avoid gating and feeding problems, predicts casting quality, aids permanent mold design and reduces fettling costs. Since it founding in 1988, MAGMA has been the pacesetter in defining a new direction for the foundry industry.