CASE STUDY

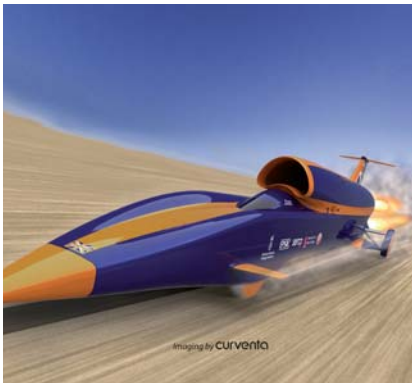
Intel® Xeon® processor 5500 series

High-Performance Computing
Performance: Data-Intensive Computing

Faster than the speed of sound

Swansea University turns to Intel® Xeon® processor 5500 series to bring the world's fastest land speed attempt back on track

Several years ago, Richard Noble, OBE, and Andy Green, OBE, were approached by Lord Drayson, UK Minister of Science, Department of Business, Innovation and Skills, to help inspire a new generation of scientists and engineers among the UK's schoolchildren. At the time, Drayson was with the Ministry of Defence and Noble and Green were well known for setting the first Supersonic World Land Speed Record of 763 mph (1,228 km/h) in 1997. The vehicle was a jet-propelled car called Thrust SSC* (SuperSonic Car). It was the first car to break the sound barrier. In response to Drayson's request Noble and Green developed the BLOODHOUND Project, an ambitious attempt to develop and build a jet-propelled car capable of reaching 1,000 mph. However, the main aim of BLOODHOUND is to reveal to future generations that engineering and mathematics are far more than dry subjects. As a result, the BLOODHOUND Education Programme, aimed at children of all ages, has been launched to engage them directly in the project and inspire them to become the scientists, engineers and mathematicians of the future.



Swansea University
Prifysgol Abertawe

CHALLENGES

- **Project delays.** The BLOODHOUND SSC is on a tight three-year deadline. However, computational fluid dynamics (CFD) design, carried out by Swansea University using an in-house FLITE aerodynamics system, was being slowed down by the university's computing platform. For example, it could take as long as a week to solve certain problems because of their scale
- **Educational sponsor.** The project's overarching aim is to inspire future generations of schoolchildren to become scientists, engineers and mathematicians. As such it needed a sponsor that placed the same importance on the education of children in scientific disciplines

SOLUTIONS

- **Industry-leading platform.** The project began using a cluster housed at the Intel® UK headquarters which is based on the Intel SR2600UR server platform and powered by 128 Intel® Xeon® processors 5500 series
- **Technology partner.** Intel became the official technology sponsor of the BLOODHOUND Project due to its long-standing commitment to driving new educational initiatives the world over

IMPACT

- **Performance boost.** The Intel Xeon processor 5500 series-powered SR2600UR platform provided five times faster performance than the university's in-house platform
- **Faster problem solving.** Equational problems that took approximately a week to solve on the university's in-house platform were typically solved overnight on the Intel Xeon processor 5500 series platform, bringing the project back on schedule
- **New headquarters.** As an official technology sponsor, Intel supplied the equipment for the BLOODHOUND Project's new headquarters including workstations, wireless infrastructure, laptops and service set-up
- **Successful take-up.** To date approximately 3,500 schools and youth organisations throughout the UK have signed up to participate in the BLOODHOUND Education Programme

"Intel's computer cluster, powered by the performance of the Intel® Xeon® processor 5500 series, has helped us bring the BLOODHOUND Project back up to speed again. Its performance has been so reliable and fast that we also intend to introduce it into the university's parallel PC clusters."

Dr Ben Evans
Senior Research Assistant
School of Engineering, Swansea University

A prestigious track record

The BLOODHOUND Education Programme is part funded by the Department for Children, School and Families but the build of the car is funded by private and corporate sponsorship. Swansea University is one of the project's five founding sponsors and today there are many other major sponsors.

Swansea University has a prestigious track record in developing and applying computational techniques for the solution of challenging problems in engineering analysis and design. Its computational modeling group has consistently achieved the top ranking in the UK government independent Research Assessment Exercises.

Applying CFD was critically important in developing the BLOODHOUND SSC. Every design element must be carefully considered in a jet-propelled car designed to travel at 1,000 mph. BLOODHOUND SSC is propelled by three engines: a 900-pound (400 kg) Eurofighter Typhoon* jet engine, a rocket and a third engine to pump the fuel.

Swansea University's five times performance increase provides the BLOODHOUND Project with an invaluable boost

No room for error

The build design must be close to perfection. For example, if the paint is thicker on one side than the other, it could be enough to alter BLOODHOUND's direction and possibly send it spinning along the ground like a high-speed, spiraling dart. Similarly, gravitational forces must be minutely calculated to ensure it doesn't actually take off or burrow towards the ground and become the world's fastest plough.

Dr Ben Evans, senior research assistant, School of Engineering, Swansea University, said: "There isn't a wind tunnel in the world that can mimic the degree of simulation required for BLOODHOUND. To get it right – and we can't afford not to – we need the application of sophisticated CFD techniques."

To achieve the incredibly high degree of specification required, the university broke the BLOODHOUND SSC design down into 50 to 60 million elements. Each element has its own equational problems and the university applied the Navier Stokes equations to each element. Navier Stokes describes the motion of substances that can flow. For BLOODHOUND SSC, this equates to airflows over the chassis and aerodynamics.

Slowdown

To run these CFD calculations, Swansea University uses in-house parallel PC clusters powered by non-Intel processors. Unfortunately, some of the calculations, running at optimal speeds, were taking between a week and two weeks to run. This was affecting the project timetable, leading to delays.

Intel offered the university access to its next-generation Intel® Xeon® processor 5500 series SR2600UR server cluster based at its UK headquarters. The university tested the performance of this SR2600UR server cluster against a pre-established benchmark and saw speed improve up to five times compared to the existing competitor-based system.

Fast forward

These results compelled the university to move its CFD applications to the Intel server cluster, which is powered by 128 Intel® Xeon® processors 5500 series. Dr. Ben Evans said: "The Intel server cluster cut down the CFD run time dramatically. Programmes that were previously taking a week to run were actually running overnight. This allowed us to accelerate our design work and catch up on the time we had lost."

As a result, the basic shape and layout of the BLOODHOUND SSC have been finalised and the project is now on track to have the jet-propelled car designed and ready to power across a desert in South Africa in 2011. Furthermore, Intel has become the official technology partner and is kitting out BLOODHOUND headquarters with a range of IT equipment. This includes services set-up, wireless infrastructure, CAD workstations, laptops and web site hosting.

Dr Ben Evans said: "Intel has a firm commitment to educating future generations about the value of science and mathematics. This is evident in the number of educational initiatives it is behind such as skoool.com, which is aimed at providing schoolchildren with new concepts in e-learning. These aims dovetail perfectly with the objective of the BLOODHOUND project which is to inspire future generations."

And so far the BLOODHOUND Education Programme has been enormously successful. Over 3,500 schools and educational organisations throughout the UK have signed up to participate in the project through online and classroom-related activities.

Spotlight on BLOODHOUND SSC / Swansea University

The BLOODHOUND Project is designed to create a national surge in the popularity of science, technology, engineering and mathematics. An iconic project, it entails extreme research and technology while simultaneously providing the means to enable the student population to join in the adventure. It's designed to set the first 1,000 mph record on land. Swansea University is one of the project's major sponsors and, due to its deep experience in computational fluid dynamics (CFD), is designing the shape and body of the car and component parts.

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