This case study was created as part of
the free and voluntary UberCloud Experiment

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Airbag Simulation with ANSYS LS-DYNA on UberCloud and Azure

KEY FINDINGS

- Fine mesh models (~132K cells) could be solved on the UberCloud HPC Cloud in under 30minutes – speeds that a workstation could not match.
- All required simulation tools came pre-installed in the UberCloud platform thus eliminating the need for IT
- Various mesh densities could be explored and benchmarked because of the flexibility of the UberCloud platform.

This document is based on one of the more than 200 technical case studies that have been generated by engineering teams participating in the UberCloud Experiment. You will benefit from the candid descriptions of the problems the teams encountered, how they solved them, and lessons learned.

Since their invention in 1968, automobile airbags have become a standard industry safety feature responsible for a significant reduction in automotive-related fatalities and injuries.

The technology continues to advance. For example, a recent UberCloud experiment, designed to better understand air bag inflation behavior under dynamic conditions, has added to that body of knowledge.

The simulation framework for the experiment used ANSYS LS-DYNA in an UberCloud container on Microsoft Azure computing resources. The UberCloud team running the experiment was able to achieve highly accurate results predictions and faster solution times based on their efficient use of the Azure resources.

The team included: Praveen Bhat who acted as the project's technology consultant and FEA expert; and HPC expert Burak Yenier, co-founder and CEO of the UberCloud.

Among the challenges they faced was the necessity to run a technically complex dynamic simulation within a stipulated, very short execution time. They had to use different mesh densities to accurately capture airbag behavior. It was a trade-off: the finer the mesh the more accurate the simulation results – but the longer the runtime.

COMPLEX PROCESSES SIMULATED IN THE CLOUD

Figure 1: Geometry and mesh model for a steering wheel with closed airbag model.

Below is a brief summary of the some of the steps taken by the team to run the simulation.

First, the steering wheel with folded air bag was meshed using 2D quad mesh elements. This included defining the contacts and interactions between different components in the steering wheel assembly and air bag.

The material properties for the steering wheel assembly with air bag were also defined along with the section properties that involved thickness definition for different components in the assembly.

The next step of the model setup was to define the model boundary conditions and assign load curves. The steering wheel geometry was fixed and the load curve provided the air bag opening forces, which were defined on the air bag component.

Then, the team defined the solution algorithm and convergence criteria along with output parameters and results that would be used for post processing.

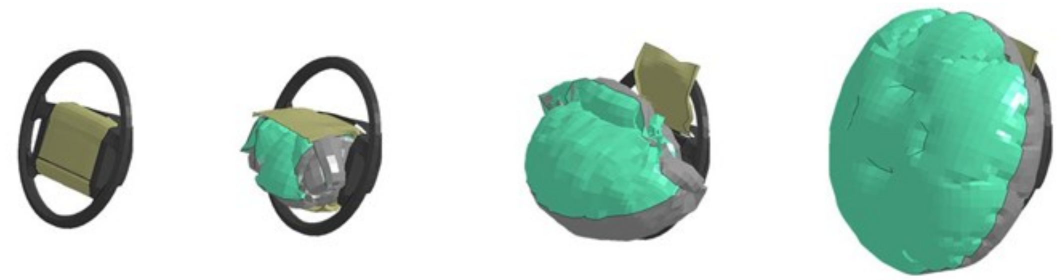
The model was solved in ANSYS LS-DYNA with parallel computing on 1 to 16 cores. The final result was used to view the output of the simulation result, and the respective result components were captured using the ANSYS post-processing software tool.

BENCHMARKING HPC PERFORMANCE

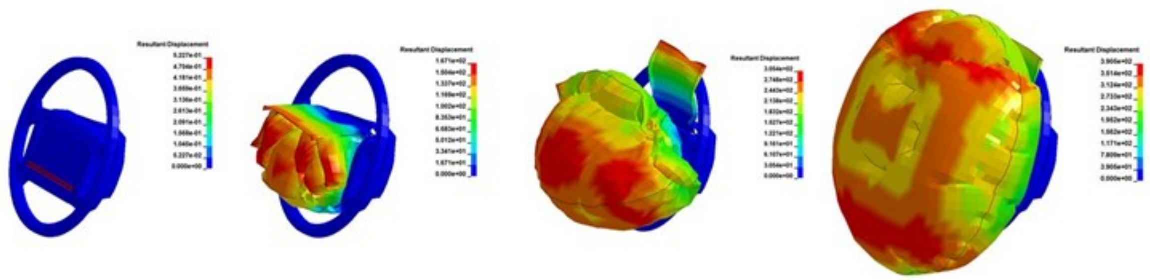
During the course of the experiment the team generated a number of benchmarks to track the performance of running the simulation in the cloud.

The HPC system used for the simulation was Microsoft Azure GS5 Instance with 32 cores, 448 GB RAM, Max Disk size OS = 1023 GB and local SSD = 896 GB, Cache size 4224, and Linux operating system.

The air bag model was simulated using ANSYS LS-DYNA in an UberCloud Container on the Microsoft Azure cloud platform. The model evaluated air bag behavior and it also determined the rate of air bag opening and the stresses developed on the air bag material.



Opening sequence of air bag



Contour plot on the steering and air bag assembly

Figure 2: Deformation plot of air bag.

Different finite element models were developed for fine and coarse mesh. Model data was submitted to the ANSYS LS-DYNA container.

The team captured the time for solving the model with different mesh intensity to benchmark the HPC system's performance in solving high-density mesh models. (Boundary conditions, solution algorithm, solver setup and convergence criteria remained the same for all models.)

Figures 3 and 4 compare the solution times required for different mesh density model with and without parallel processing. The comparison of the solution time with single core processor and 32 core processors showed that the time required to solve using parallel computing is significantly less when compared with running the same simulations with single core.

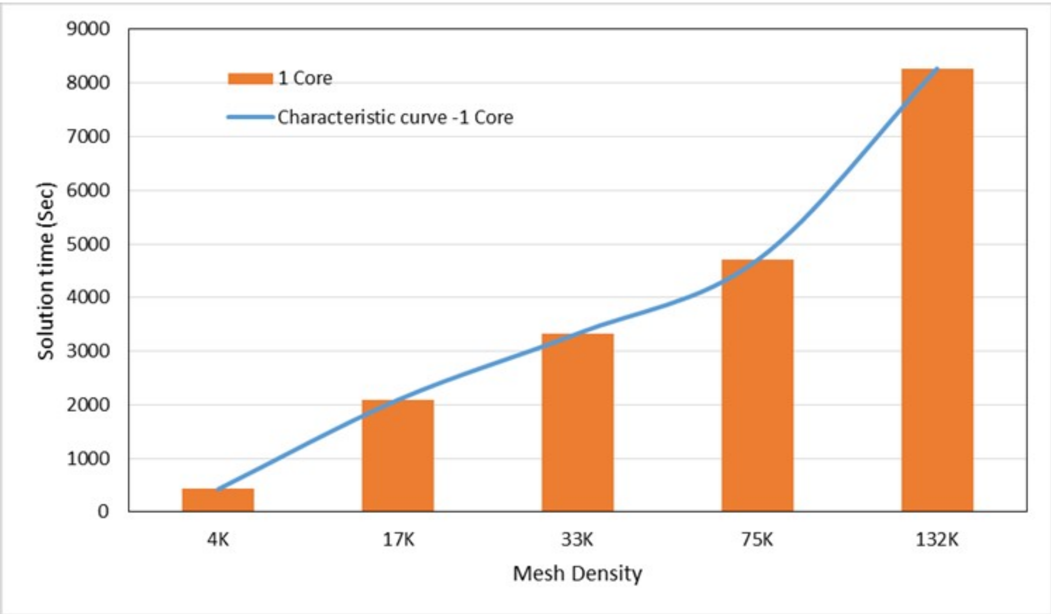


Figure 3: Solution time required for different mesh density with single CPU core.

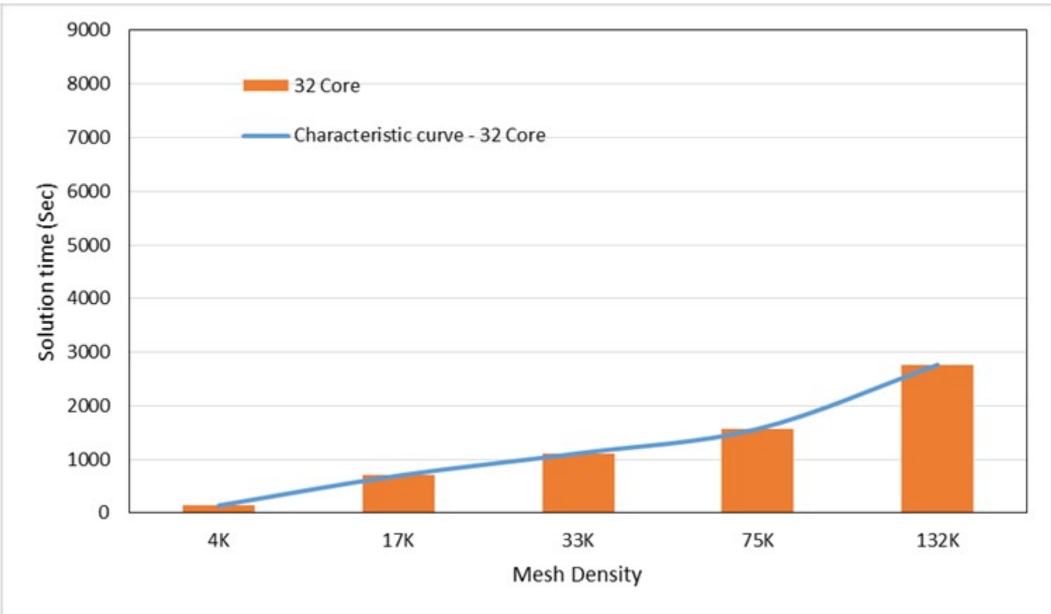


Figure 4: Solution time required for different mesh density using 8 CPU cores.

~1000 core hours were used to perform various iterations in the simulation experiments.

CONCLUSION: BUILDING CONFIDENCE IN THE CLOUD

The HPC cloud computing environment with ANSYS workbench and LS-DYNA made model generation easier and reduced process time drastically. Result viewing and post-processing was also faster and easier due to the ANSYS / Azure / UberCloud HPC set-up.

The team generated mesh models for different cell numbers and performed the experiments using coarse-to-fine to very fine mesh models. The HPC computing resource helped the team achieve smoother completion of the simulation runs without re-trails or resubmission. This allowed the user to obtain highly accurate simulation results.

The computation time requirement for a fairly fine mesh (~132K cells) was quite high and nearly impossible to achieve on a normal workstation. The HPC Cloud provided the capabilities needed to solve highly fine mesh models and reduce simulation time drastically – the team was able to obtain the simulation results within an acceptable time (~30 min).

The experiments in the HPC Cloud illustrated the power and flexibility of this approach and provided team members with additional confidence in their ability to setup and run the simulations remotely in the cloud. For example, different simulation setup tools were pre-installed in the HPC container, allowing the user to access the tools without any prior installations.

The use of VNC Controls in the Web browser made user access to the HPC cloud very easy – similar to accessing a conventional website.

The UberCloud containers helped smooth execution of the project by providing easy access to the server's resources. For example, the UberCloud ANSYS container integrated with the Microsoft Azure platform facilitated running parallel UberCloud containers, a powerful feature. Also, a dashboard in Azure allowed the team to track system performance and usage.

Overall, the selected HPC cloud environment was an excellent fit for performing complex simulation that involved huge hardware resource utilization with a high number of simulation experiments.

Microsoft Azure with UberCloud Containers allowed the team to perform advanced computational experiments that addressed difficult technical challenges with complex geometries – challenges that could not be solved on a normal workstation.

ABOUT UBERCLOUD

UberCloud makes it easy to run your simulations on powerful cloud infrastructure.

No more compromises on mesh quality or model fidelity because of hardware limitations. With UberCloud's flexible software platform and network of cloud partners, you get on-demand access to major providers such as Microsoft Azure, HPE and others. Choose from a variety of secure data centers, and hardware options such as InfiniBand, GPUs etc.

Unleash the full power of your analysis software and boost confidence in your results.

With over 200 technical-computing-as-a-service case studies, UberCloud has the experience, software platform and partnerships required for your success.

Engineers and scientists rely on UberCloud to manage the complexity of cloud and software operations, so they can focus on their analysis.

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