## Creating a new standard in virtual crash testing

Altair advances frontal crash simulation with help from Intel® Software Development products.

### Company
Altair Engineering, Inc. empowers client innovation and decision making through technology that optimizes the analysis, management, and visualization of business and engineering information. Privately held, with more than 1,300 employees, Altair has offices throughout North America, South America, Europe, and Asia/Pacific. With a 25-year track record for product design, advanced engineering software, and cloud computing technologies, Altair consistently delivers a competitive advantage to customers in a broad range of industries. Built on a foundation of design optimization, performance data management, and process automation, HyperWorks is an enterprise simulation solution for rapid design exploration and decision making. To learn more, please visit [www.altair.com](http://www.altair.com) and [www.altairhyperworks.com](http://www.altairhyperworks.com).

### Mission
Deliver the first simulation code to solve a full vehicle frontal crash simulation with more than 1 million elements in less than five minutes.

### Product
RADIOSS is a next-generation finite element analysis (FEA) solver for linear and non-linear simulations. It can be used to simulate structures, fluids, fluid-structure interaction, sheet metal stamping, and mechanical systems. This robust, multidisciplinary solution allows manufacturers to maximize durability, noise and vibration performance, crashworthiness, safety, and manufacturability of designs in order to bring innovative products to market faster.

### Challenge
Use state-of-the-art hybrid programming mixing different parallelization techniques to achieve more scalability and deliver optimal performance for very large number of processors.

### Results
The five-minute goal was successfully exceeded (294s achieved using 1024 cores [128 MPI x 8 OpenMP*]) and overall performance has been increased by 10x.

### Impact
Altair improved customer satisfaction by exceeding customer performance and timeline requirements.

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*Dr. Uwe Schramm  
CTO for HyperWorks  
Altair Engineering, Inc.*
Challenge: Why Altair’s products benefit from utilizing parallelism

Virtual crash tests are one of the most time-consuming tasks in the automotive development process. Altair wished to demonstrate the feasibility of a new analysis process that drastically reduces the simulation time needed for virtual crash testing. In terms of the product lifecycle, it sought to reduce both prototyping costs and time to market—two key competitive advantages for Altair customers.

Massively parallel programming enables very good scalability using domain decomposition techniques and an MPI communication library; such scalability tends to decrease as the number of processors increases and the amount of data to compute decreases.

Altair used state-of-the-art hybrid programming mixing different parallelization techniques (MPI and OpenMP) to achieve more scalability and deliver optimal performance at very large number of processors. To accomplish its goal, Altair leveraged the optimization made possible by Intel® compilers, libraries, and tools to sustain the required efficiency. There exists no real alternative to achieve the necessary level of performance.

Results

The five-minute goal was successfully exceeded (294s achieved using 1024 cores [128 MPI x 8 OpenMP]) and overall performance was increased by 10x. As a result of hybrid programming, scalability of the code demonstrated up to 1024 cores. In addition, a new numerical algorithm, called Advance Mass Scaling (AMS), decreased computational costs. Altair enjoyed improved customer satisfaction by exceeding current customer performance and timeline requirements by enabling faster evaluate design variant evaluations and less time-consuming design sensitivity and robustness analysis. For the market, this advancement can be considered a disruptive approach by cutting simulation time from the hours previously required to minutes, making possible new processes and advancements in virtual crash testing such as finer meshes, integration of better material laws with rupture, optimizations, and scatterings, etc. By decreasing the delay of virtual crash testing, both time to market and costs can be drastically decreased.

How Intel® Software Development products assisted

To meet its speed, scalability, and performance objectives, Altair incorporated a range of Intel Software Development tools, including the following:

- Intel® compilers
- Intel® Vtune™ Performance Analyzer
- Intel® Cluster Toolkit
- Intel® Trace Analyzer and Collector
- Intel® MPI Library

Altair and Intel were also able to leverage the Intel® Xeon® processor 5500 series-based clusters and deliver substantial performance improvement for crash simulations. This improvement will have long-term benefits for the industry.

Finally, Intel provided technical help for running and optimization, access to computing resources, and marketing support.
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