

## CASE STUDY

### Intel® Software Development Tools

Intel® C /C++ Compiler, Intel® Fortran Compiler,  
Intel® Math Kernel Library, Intel® MPI Library,  
Intel® Xeon® processor, Intel® Xeon Phi™ coprocessor



# Altair Speeds Complex Simulation and Workload Management with the Intel® Xeon Phi™ Coprocessor

Cutting-edge software and architecture advance product engineering innovation



## OVERVIEW

Altair's software products enable a wide range of industries to conduct complex simulations crucial to engineering innovation and delivering reliable products to market. In a sector where supporting enhanced performance and new feature sets is critical, Altair wanted to test and utilize the new Intel® Xeon Phi™ coprocessor as quickly as possible to improve its customers' competitive advantage.

"By porting Altair applications on Intel Xeon Phi coprocessors, we are ensuring our users can run some of the most compute-intensive portions of their work on the most cutting-edge, high-performance architecture available," says Eric Lequiniou, Altair's director of high performance computing,



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*- Eric Lequiniou,  
Director of High  
Performance Computing,  
Altair*

## THE CHALLENGE

With a sophisticated customer base for whom performance, reliability, safety, and innovation are mission critical, Altair is committed to supporting the most up-to-date, advanced computing architectures. For this reason, Altair joined Intel early on in its development of the Intel® Many Integrated Core (Intel® MIC) and Intel Xeon Phi coprocessor. This gave Altair a head start in integrating the new technologies into its products and investigating ways to improve performance, scalability, and usability. As one of the first solution providers to port software onto the Intel Xeon Phi coprocessor, Altair is leading the industry in understanding the coprocessor's potential for powering complex simulation software applications and environments.

## THE SOLUTION

Altair tested and integrated two of its core products using the Intel Xeon Phi coprocessor: PBS Professional\* and RADIOSS\*.

PBS Professional is used worldwide as a workload management and job scheduling solution for high performance computing (HPC) environments, with features that dramatically speed scheduling and boost utilization and agility. Thousands of customer sites use PBS Professional to share distributed computing resources across geographic boundaries, thus increasing ROI on their existing resources.

Intel Xeon Phi coprocessor customers need to ensure HPC job schedulers like PBS Professional can recognize Intel Xeon Phi coprocessors as "consumable resources" where work can be scheduled. So Altair engineers integrated PBS Professional with the Intel Xeon Phi coprocessor and automated the steps to configure PBS Professional in an Intel Xeon Phi coprocessor environment—from interrogating Intel Xeon Phi coprocessors for

attributes to updating PBS configuration files accordingly. Since Intel Xeon Phi coprocessor utilization is viewed as a compute node within PBS Professional, Intel Xeon Phi device usage can be recorded within accounting logs (e.g., how many Intel Xeon Phi coprocessors and/or how many Intel Xeon Phi coprocessor cores were used) and incorporated into performance reporting.

“The fact that Intel Xeon Phi is a coprocessor and not just an accelerator makes a big difference for HPC environments. PBS Professional can schedule workloads to Intel Xeon Phi coprocessors just like any other node, and the setup for PBS administrators is easy. As our customers start adopting the Intel Xeon Phi coprocessor in production, they’ll be able to get up and running quickly and to analyze Intel Xeon Phi coprocessor usage effectively thanks to the groundwork we’ve laid with PBS Professional,” says Bill Nitzberg, Altair’s CTO for PBS Works.

Products like PBS Professional help users optimize usage of Intel Xeon Phi coprocessor resources by HPC applications like Altair’s RADIOSS.

RADIOSS is a leading structural analysis solver for highly nonlinear structural problems under dynamic loadings. It is highly differentiated for scalability, quality, and robustness, and consists of features for multiphysics simulation and advanced materials, such as composites. RADIOSS enables manufacturers to improve the crashworthiness, safety, and manufacturability of structural designs. For more than 20 years, RADIOSS has established itself as a leader and an industry standard for automotive crash and impact analysis.

Altair has successfully ported both the implicit and explicit RADIOSS solvers onto the Intel Xeon Phi coprocessor, using two different programming models (offload and native).

For the RADIOSS explicit solver, porting was done using a native programming model which requires codes to be highly parallel. The hybrid massively parallel processor (MPP) version of RADIOSS meets this requirement, allowing RADIOSS to leverage all the available cores of the Intel Xeon Phi coprocessor. Porting was a very straightforward process for the explicit code—Altair engineers did not

Key Findings	
<b>PBS Professional*</b>	<ul style="list-style-type: none"> <li>Current out-of-the-box support—Altair is one of the first workload management providers to offer this</li> <li>Altair toolkit (<a href="http://www.pbsworks.com/xeon-phi-toolkit">www.pbsworks.com/xeon-phi-toolkit</a>) automates the configuration the Intel® Xeon Phi™ coprocessor within PBS Professional</li> <li>Altair technical paper describes manual configuration of PBS Professional for scheduling jobs onto Intel Xeon Phi coprocessor devices (see resources at <a href="http://www.pbsworks.com/pbs-xeon-phi/">www.pbsworks.com/pbs-xeon-phi/</a>)</li> </ul>
<b>RADIOSS* explicit solver (native programming model)</b>	<ul style="list-style-type: none"> <li>First time porting entire RADIOSS explicit code on a coprocessor—this has not been possible on accelerators/GPUs due to the complexity of doing so</li> <li>Hybrid MPP parallel version of RADIOSS is very well suited to run natively on Intel Xeon Phi coprocessors, thanks to its superior scalability and flexibility. Altair is targeting this model for both implicit and explicit programming models.</li> <li>Can be run stand-alone or in heterogeneous mode using both the host and the Intel Xeon Phi coprocessor, improving overall infrastructure utilization</li> <li>Very straightforward porting process with no source code changes required</li> <li>Excited about performance potential</li> </ul>
<b>RADIOSS* implicit iterative solver (offload programming model)</b>	<ul style="list-style-type: none"> <li>Easy porting process</li> <li>Ability to use familiar tools—development continuity from Intel® Xeon® processors</li> <li>Developers pleased with results</li> <li>Very good performance using single Intel Xeon Phi coprocessor</li> <li>In one benchmark, execution time decreased by more than 2.5x (2.5x speedup to run solver on host plus the Intel Xeon Phi coprocessor compared to running on the host only (based on a 12-core CPU)</li> </ul>

need to change a single line of source code. RADIOSS explicit solver can be run stand-alone on the Intel Xeon Phi coprocessor or in heterogeneous mode using both the host and the Intel Xeon Phi coprocessor.

For the RADIOSS implicit iterative solver (offload programming model), the overall complexity of the porting process was comparable to porting to accelerators or GPUs. However, coding was greatly simplified by the tight integration of the offload directive inside the Intel® Compilers, eliminating the need to learn a new language like CUDA\* or OpenCL\*.

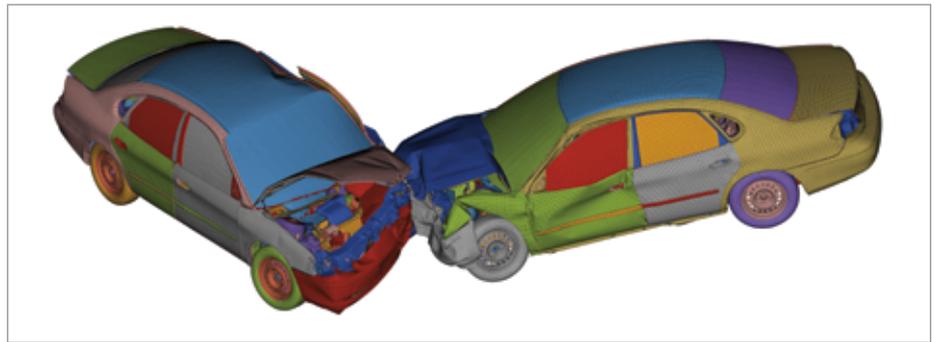
Intel has provided strong support for Altair throughout the testing and integration process—from an Intel application specialist familiar with RADIOSS to the [Intel® Many Integrated Core Architecture \(Intel® MIC\) forum](#). Intel worked with Altair on initiating RADIOSS porting to the Intel Xeon Phi coprocessor, as well as using offload and OpenMP\* directives applicable to the offload programming model.

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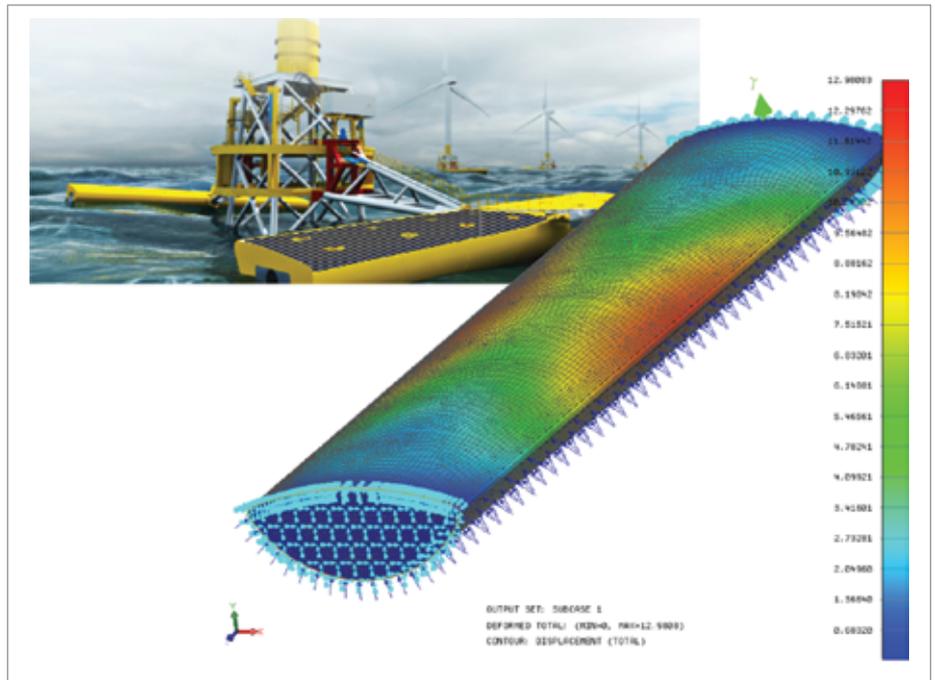
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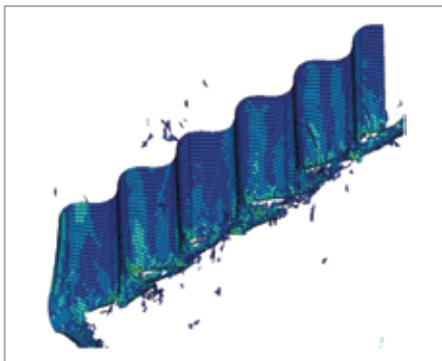
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Director of High  
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Altair



RADIOSS: Crash and Safety Evaluation



RADIOSS: Smoothed-Particle Hydrodynamics (SPH) Analysis



RADIOSS: Non-Linear Explicit Analysis on Composites

## Results

Altair is excited about the performance potential of the RADIOSS and Intel Xeon Phi coprocessor combination, particularly using the native programming model.

By evaluating both offload and native programming models for RADIOSS, Altair has been able to discover great potential for the native version on the Intel Xeon Phi coprocessor. With its ability to take advantage of Altair’s parallelization approach based on hybrid MPI OpenMP, the native model is more general and can be applied to both explicit and implicit schemes.

For the RADIOSS explicit solver, the straightforward porting of the native Intel Xeon Phi coprocessor version was impressive. Altair was able to produce this version simply by modifying the makefile options (-mmic). This was possible thanks to the native support of Intel® Fortran and Intel® C Compilers,

Intel® MPI Library, and Intel® Math Kernel Library (MKL) Library for the Intel Xeon Phi coprocessor. In addition, RADIOSS can be run in a heterogeneous mode using both the host and the Intel Xeon Phi coprocessor, allowing better overall infrastructure utilization. With the explicit solver running natively on the Intel Xeon Phi coprocessor, the host is freed up for other work to further enhance global performance. In heterogeneous mode, running simultaneously on the Intel Xeon Phi coprocessor and on the Intel® microarchitecture, codenamed Westmere, at present RADIOSS is able to run 1.4 times faster than on a 12-core Westmere.

The newest version is ultimately designed to support all RADIOSS options, both explicit and implicit. Says Eric, “For the first time, we are able to port RADIOSS explicit on a coprocessor. This would have been far too difficult on a GPU, but is now possible given the capabilities of the Intel Xeon Phi coprocessor.”

## Ongoing Development and Future Work

Altair is pursuing additional optimization efforts for the native programming model for RADIOSS on the Intel Xeon Phi coprocessor. Working specifically on vectorization and MPI communication efficiency, Altair has already achieved a 25 percent performance improvement compared to the initial porting. Performance on the Intel Xeon Phi Coprocessor alone is now comparable to a 12-core Intel® Xeon® processor, and Altair is continuing to see performance improve as it pursues this optimization effort.

Eric observes, “Optimizing for the Intel Xeon Phi coprocessor helps applications to run faster on the Intel Xeon processor as well. So, the required effort to optimize the native RADIOSS executable is really valuable across more systems than just Intel Xeon Phi coprocessors.”

## Conclusion

For Altair's customers, the availability of key software products on Intel Xeon Phi coprocessors combined with extensive support is exciting—opening up new possibilities for discovery and innovation. Using state-of-the-art Intel® CPUs helps Altair to access large cluster configurations to test, tune, and improve its solvers. With the improved processing made possible by the Intel Xeon Phi coprocessor and PBS Professional, users of applications like RADIOSS can explore more simulations and real-world design scenarios, get more accurate results faster, and speed time to market.

## About Intel® Software Development Tools

Intel has been providing standards-driven tools for developers in the high performance computing industry for more than 25 years. Its industry-leading tools include Fortran, C, and C++ Compilers, as well as performance profiling and analysis tools such as Intel® VTune™ Amplifier XE, Intel® Inspector XE, and Intel® Trace Analyzer and Collector. Performance libraries and programming models such as Intel® MPI library, Intel® Math Kernel Library, Intel® Cilk™ Plus, and Intel® Threading Building Blocks provide developers the tools needed to build applications for today and scale forward to tomorrow.

## Make Clustering Easy From the Start

Planning, building, and deploying a technical computing cluster has become fairly simple thanks to standards. Maintaining the cluster and making sure that all desired applications will run may not be as easy. With Intel® Cluster Ready, all those tasks become much simpler. Intel Cluster Ready provides certification for application interoperability. An Intel Cluster Ready-certified cluster will run Intel Cluster Ready registered applications out of the box. With the help of the Intel® Cluster Checker tool, a cluster can be checked thoroughly, before or after deploying, or during production or maintenance. Intel Cluster Ready supports the Intel Xeon Phi coprocessor.

## Altair is Intel Cluster Ready

Altair's PBS Professional, RADIOSS, and other CAE solvers are certified by the Intel® Cluster Ready (ICR) program. By ensuring these popular products are ICR-certified, Altair helps users get up and running more quickly in a cluster environment, lowering costs and increasing productivity.

Learn more about Intel® software development tools at <http://software.intel.com/en-us/intel-sdp-home/>.

## ABOUT ALTAIR

Altair 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 1,800 employees, Altair has offices throughout North America, South America, Europe and Asia/Pacific. With a 27-year track record for high-end software for engineering and computing, enterprise analytics solutions, and innovative product design and development, Altair consistently delivers a competitive advantage to customers in a broad range of industries.

To learn more about Altair, please visit [www.altair.com](http://www.altair.com) or [www.pbsworks.com](http://www.pbsworks.com).



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