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for Intel Platforms and Technologies

## Boosting Performance in Life-Enhancing Designs

“ Solving increasingly larger and more sophisticated models is clearly a demand from ABAQUS users. VTune Performance Analyzer is an important part of our technical collaboration with Intel to meet those demands. ”

**Ken Short**  
Vice President of Marketing  
ABAQUS, Inc.

### Simulating Real Life Solutions

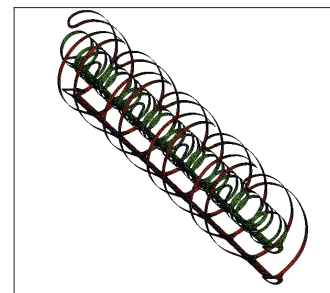
Businesses often need to simulate the physical response of structures and solid bodies to load, temperature, contact, impact, and other environmental conditions. Engineering companies that develop items as diverse as medical devices or automobile tires, which have real-world critical safety importance, require this capability. ABAQUS, Inc., along with the help of Intel, offers a compelling solution for these simulation requirements.

ABAQUS, based in Pawtucket, Rhode Island, is a leading developer of design modeling and analysis solutions for customers in diverse industries including automotive, offshore drilling, power generation, and medical fields.

#### THE APPLICATION

### ABAQUS simulates and analyzes complex designs

ABAQUS offers a suite of engineering design analysis software products, including nonlinear finite element analysis (FEA) tools, and tools for advanced linear and dynamics application problems. Resulting designs yield life-enhancing medical products like joint replacements, coronary stents, and other medical devices.



FE Model of a Medical Stent

The company's flagship product, ABAQUS/Standard provides for comprehensive, general-purpose finite element analysis that includes a broad range of analysis capabilities. ABAQUS/Standard is core to most ABAQUS products, and double-precision general matrix-matrix multiply (DGEMM) is one of its core functions. A powerful complement to ABAQUS/Standard, ABAQUS/Explicit, the other ABAQUS solver, provides nonlinear, transient, dynamic analysis of solids and structures using explicit time integration.

### Making a good thing great

The Intel® Math Kernel Library (Intel® MKL) is composed of highly optimized functions for math and engineering applications requiring high performance on Intel platforms. Intel MKL has linear algebra consisting of LAPACK and BLAS, Fast Fourier Transform (FFT) and vector transcendental functions (vector math library/VML).

The Intel® VTune™ Performance Analyzer allows developers to identify and locate bottlenecks in their code by collecting and displaying performance data. With Event Based Sampling, you can view the performance of your code in relation to processor events, and extract data in several ways.

#### THE CHALLENGE

### Improving analysis performance

ABAQUS wanted to improve both of their solver products—each of which posed different challenges. With ABAQUS/Standard, they needed to ensure that the DGEMM performed well each time the

software was updated or ported to a new platform, and searched for a tool to improve performance of their matrix algebra functions on Intel processor-based platforms.

ABAQUS/Explicit needed a high-performance profiling tool to isolate modules for optimization and provide better performance on Intel processor-based systems.

“By adopting the Intel® MKL DGEMM libraries, our standard benchmarks timing improved between 43% to 71%, which is very impressive.”

**Matt Dunbar**  
Software Developer  
ABAQUS, Inc.

## THE ANSWER ‘Kicking’ kernel performance

ABAQUS routinely used Intel MKL DGEMM in its ABAQUS/Standard analyzer software. Matt Dunbar, an ABAQUS engineer said, “...the DGEMM part of Intel MKL is critical to our product’s performance.”

As proof, ABAQUS engineers conducted benchmarks on ABAQUS/Standard running on a 2.0 GHz Intel® Xeon™ processor-based computer that solved typical finite element analysis problems. The T1-std benchmark was a barrel vault, a linear static analysis of a mesh of shell elements. Most of the execution time was spent in the inner loop of the solver. Without Intel MKL DGEMM, it took 267 seconds to solve; with Intel MKL DGEMM it took 150 seconds—a 43 percent improvement.

ABAQUS benchmark problems	Time To Solve Problem		
	With Intel® MKL DGEMM	Without Intel MKL	Improvement
T1-std	150 sec.	267 sec.	43%
T4-std	2869 sec.	9950 sec.	71%
T7-std	206 sec.	559 sec.	63%

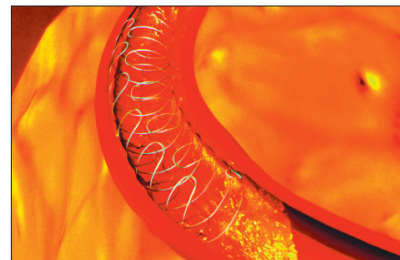
*\*\*Benchmarks were run on a 2.0 GHz Intel® Xeon™ processor-based system*

Other problems included a flywheel with centrifugal loads (T4-std) and J-integral analysis of an elbow with a crack (T7-std). The MKL benchmark results proved to be even more impressive: 71 and 63 percent improvement, respectively.

## Spotting bottlenecks

ABAQUS engineers used Intel VTune Performance Analyzer as a profiler for running ABAQUS/Explicit on Intel Pentium® 4-based and Intel Xeon processor-based systems. With the Intel VTune Performance Analyzer, they identified a 30% performance degradation caused by operations on de-normalized floating point values.

Dunbar stated, “VTune has the advantage of having, in addition to time in the routine and call graph profiling, event-based sampling. This feature helped pinpoint exactly why there was a performance problem.”



Expanded Stent

Dunbar reported that his engineering team would have had a 50 percent chance of finding the source of the problem without the aid of the VTune Performance Analyzer. The relatively small VTune analyzer effort invested by ABAQUS yielded a significant benefit in application performance.

## THE ADVANTAGE Reducing development time

What advantages did ABAQUS achieve with using Intel MKL and Intel VTune Performance Analyzer? It’s clear that they benefited from Intel MKL DGEMM because FEA solutions were achieved at a faster rate; and they were able to spot bottlenecks with Intel VTune Performance Analyzer, which dramatically reduced development time. As a result, ABAQUS customers can solve their FEA problems faster and get their products to market sooner.

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