



Performance Brief
Quad-Core Workstation



Enhancing Analysis-Based Design with Quad-Core Intel® Xeon® Processor-Based Workstations

With eight cores and up to 80 GFLOPS of peak performance at your fingertips, a new generation of Intel®-based workstation supercomputers helps users of Abaqus® Unified Finite Element Analysis software from SIMULIA bring higher-quality products to market faster than ever.



The Pressure's On

Competition is tougher, schedules tighter, designs more complex. It's not enough to create innovative products that meet customer needs. You've got to do it faster and smarter than ever before. You've got to work differently.

Leading manufacturers are doing just that. By combining the Abaqus® Unified FEA product suite from SIMULIA with workstation supercomputers based on the Quad-Core Intel® Xeon® processor 5300 series, they're inventing ways to transform their workflows. In doing so, they're finding ways to help cut costs and inefficiencies, improve design quality and gain a competitive advantage.

Best-In-Class Simulation

Simulation is critical to understanding and predicting the real-world behavior of physical phenomena—and the earlier in the development process you run your analytical simulations, the better. Best-in-class manufacturers use simulation techniques earlier, more often and more effectively than less successful companies, according to a study by the Aberdeen Group. They also get to market faster and with lower development costs.¹

Abaqus Unified FEA software provides technology-leading finite element modeling and analysis solutions that enable analysis-based design across a broad spectrum of industrial applications. Whether you're developing a complex assembly, inventing new materials, or trying to improve a complex manufacturing process, Abaqus offers powerful and complete solutions to help you create, edit, monitor, diagnose and visualize finite element and multiphysics analyses.

Until recently, the power to run sophisticated engineering and scientific simulations meant massive supercomputing resources. Not any more.

Supercomputing That's More Affordable— And More Personal

A new breed of workstation supercomputers powered by two Quad-Core Intel Xeon Processor 5300 series is changing the picture—and helping create new ways to transform design and engineering workflows for Abaqus users. These new workstation supercomputers empower you to work differently, performing analysis-based design earlier and more interactively. With an Intel®-based workstation supercomputer, you can simulate and analyze Abaqus problems with millions of degrees of freedom (DOF) on your workstation. While you'll still need a clustered HPC solution for larger and more complex simulations, you can do preliminary validation and set-up runs locally. By running five million DOF jobs on your workstation supercomputer, you help free expensive, high-performance clusters to focus on mega-size analysis. Each user wins: Small jobs can be processed quickly, efficiently and locally; larger jobs can run with fewer interruptions from smaller, less-complex simulations.

Accelerating Time to Market

Today's Quad-Core Intel Xeon processor-based workstation supercomputers help give you the opportunity to develop computer-aided designs, generate meshes, run analyses and review results on one system. You can move **from serial to simultaneous workflows**, analyzing components while they are being designed and iterating through the design/analysis cycle faster (Figure 1).

Using a workstation supercomputer, it's easier to explore many variations of a design, including geometry, materials and conditions. You can quickly and accurately assess critical dimensions or features and provide feedback to the design team earlier in the product development process. For example, you might compare results with and without a rib to decide if the design is strong enough—while the shape and key dimensions are still being established.

Working Differently: From Serial to Simultaneous Workflows

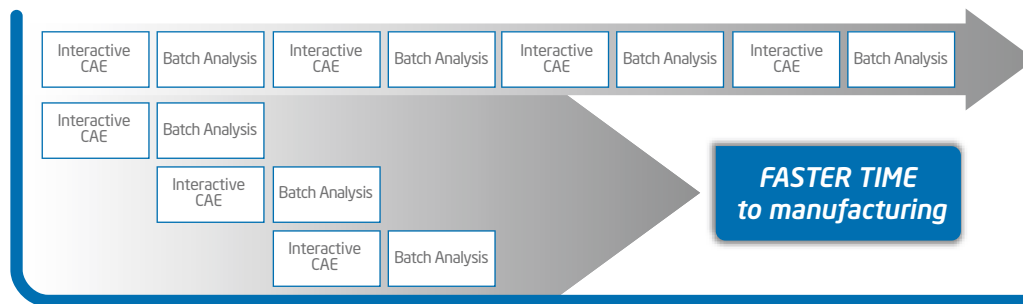


Figure 1. Adding more computing cores lets you interleave design and analysis—to shorten overall development time and generate more robust designs.

Putting Performance to the Test

SIMULIA and Intel developers have worked closely to optimize SIMULIA solutions to take full benefit of the Quad-Core Intel Xeon processor 5300 series. We put our work to the test in July 2007 when we examined the performance of simultaneous workflows on dual-core, quad-core and eight-core workstations running the Abaqus/Standard Direct Solver while simulating interactive mesh generation with Abaqus/CAE. The results demonstrate the power of this new breed of software and hardware—and show that when combined and used simultaneously, these technologies help free users to create and test ideas faster.

To test the performance of the solver, we used the Abaqus S4b benchmark problem, a real-world nonlinear static analysis that simulates bolting a cylinder head onto an engine block.³ The solver workload had 5.3 million degrees of freedom—far too large a problem to have run on the workstations of a generation or two ago, while also allowing meaningful interactive work to proceed simultaneously. Table 1 describes the systems used to run the tests.

To simulate the user's interactive tasks, we ran a script that repeatedly generated a mesh for a 3-D solid model with 720,000 degrees of freedom on the system configurations shown in Table 1. The interactive workload ran on a single core of each system, since that's typical of how many interactive tasks, which are single-threaded, would be run.

Figure 2 shows the performance and productivity advantages of Abaqus applications running on a workstation supercomputer based on the Quad-Core Intel Xeon processor 5355 compared to the Dual-Core Intel Xeon processor 5160. As a stand-in for previous-generation workstations, we ran the interactive script on one core of a single Dual-Core Intel Xeon processor 5160 and the solver on the other core; in this configuration, the solver took nearly 172 minutes to complete one iteration.

What's Behind the Intel Performance?

Simply put, it's the new Intel® Core™ microarchitecture, which is vastly different from the systems on many engineering desktops today. For starters, Intel Core microarchitecture delivers a near **doubling in performance** core for core over previous-generation Intel technology² that's typical of what's on many engineering desktops today. Intel Core microarchitecture combines five key technologies to deliver improved performance and energy efficiency:

- **Intel® Wide Dynamic Execution** delivers more instructions per clock cycle and enhances the efficiency of instruction execution.
- **Intel® Advanced Digital Media Boost** enables 128-bit SSE instructions to be completed at a rate of one per clock cycle, effectively doubling these instructions' execution speed compared to previous generations.
- **Intel® Advanced Smart Cache** is a multi-core optimized cache which increases the probability that each execution core of a multi-core processor can access data.
- **Intel® Smart Memory Access** contains an important new built-in intelligence to process out-of-order instructions more efficiently.
- **Intel® Intelligent Power Capability** improves energy efficient performance and reduces noise and energy consumption.

Table 1. Workstation Configurations

	Dual-Core Intel® Xeon® Processor 5100 Series Configuration	Quad-Core Intel® Xeon® Processor 5300 Series Configuration
Processor	2 Dual-Core Intel® Xeon® processor 5160	2 Quad-Core Intel® Xeon® processor 5355
Total number of cores	4	8
Clock speed	3.0 GHz	2.67 GHz
Microarchitecture	Intel® Core™ microarchitecture	Intel Core microarchitecture
Application	Abaqus®/Standard v6.7-1	Abaqus/Standard v6.7-1
Operating system	Red Hat Enterprise Linux* 4 Update 4	Red Hat Enterprise Linux 4 Update 4
RAM	16 GB of DDR2-FBD/667	32 GB of DDR2-FBD/667
Level 2 cache	4 MB	8 MB
Storage	U320 15k 73 GB disks configured in a software RAID 0 using the Linux* Ext2 file system	U320 15k 73 GB disks configured in a software RAID 0 using the Linux Ext2 file system

2. For example, see <http://www.intel.com/pressroom/archive/releases/20060523corp.htm>.

3. www.simulia.com/support/v66/v66_performance.html.

Using all eight cores of the dual Quad-Core Intel Xeon processor 5355 configuration, we ran the interactive script on one core and the solver on the remaining seven cores. The solver job was completed in 63 minutes—up to a **2.7x speedup**.

That performance improvement can translate into a significant increase in productivity across your day. Instead of completing fewer than three solver runs on the older-generation system over

an 8-hour day, you could complete seven runs. Instead of almost 14 runs over a week, you could finish almost 38 runs. You would also maintain the convenience and productivity of having personal control over running the solver on your own workstation supercomputer. And if your current workstation is based on earlier-generation Intel NetBurst® microarchitecture, you can expect to see an even more dramatic improvement.

Improving Productivity with Abaqus FEA Software on a Quad-Core Intel® Xeon® Processor 5355-Based Workstation Supercomputer⁴

With the interactive script running on one core and the solver on seven cores of the Quad-Core Intel® Xeon® processor 5300 series, the solver ran up to 2.7x faster than on one Dual-Core Intel® Xeon® processor 5160.⁵

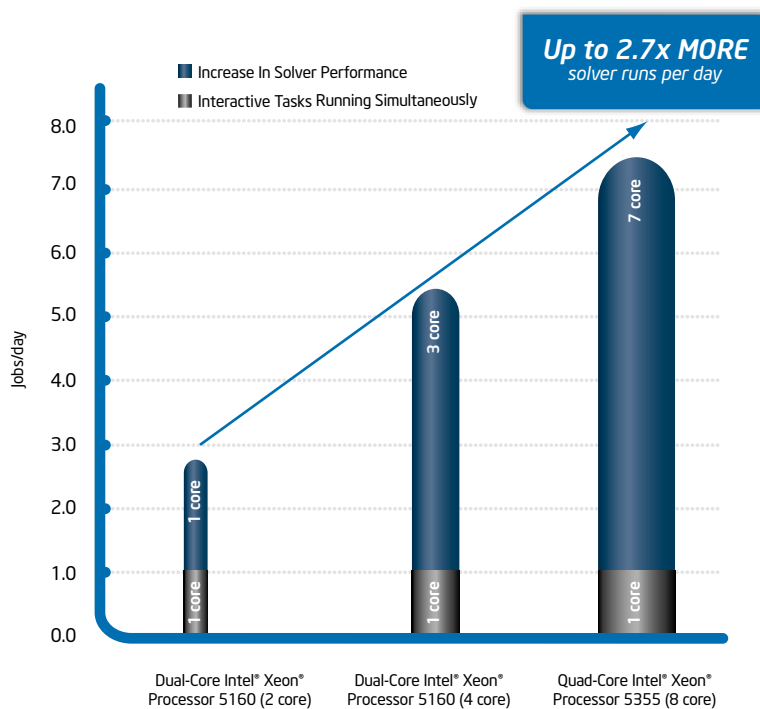
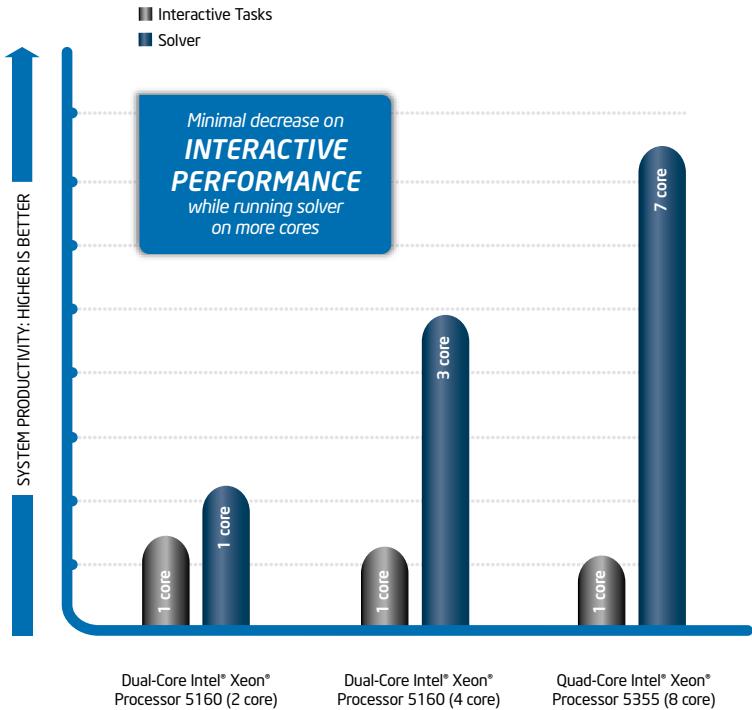


Figure 2. Workstation supercomputers with the Quad-Core Intel Xeon processor 5300 series help provide the performance to run your interactive workload while solving problems that would have required an HPC cluster a generation or two ago.

Figure 3 shows an equally significant finding: Even running a 5.3 million DOF problem, interactive performance held steady on the dual quad-core workstation. **The solver had only a modest impact on the performance of the interactive script.** This demonstrates that users can simultaneously perform interactive tasks and run highly demanding “solves” without seriously

impacting system performance—or user productivity. Our interactive workload involved mesh generation, but it could also consist of visualizing simulation results, generating documents and reports, or a wide range of other tasks. The net result is increased productivity and throughput, and the ability to iterate through more design and analysis work more quickly and ultimately with better results.

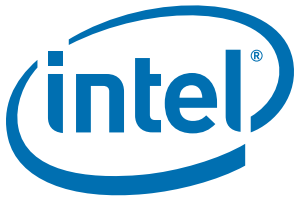
**Intel® Multi-Core Technology Means Great Interactive Performance—
Even While Solving a 5.3 M DOF Problem in the Background⁶**



Use Quad-Core Intel® Xeon® processor 5300 series based workstations to significantly speed applications such as Abaqus® Unified FEA. Run simulation and analysis on one set of cores and perform interactive tasks on other cores. That’s the power to work differently.

Figure 3. With eight cores, the solver had minimal impact on the mesh generation script, enabling interactive work to proceed unimpeded.

6. Performance measured by Intel July 2007 on the systems described in Table 1.



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Analysis-Driven Design: Faster and Easier

Abaqus Unified FEA software from SIMULIA and workstation supercomputers powered by the Quad-Core Intel Xeon processor 5300 series provide an outstanding solution for analysis-driven design. Combining these two powerful technologies helps enable workstation users to work differently, running large analysis applications while enjoying great performance on interactive tasks. This evolution in workflow can enable manufacturing organizations to improve design quality, reduce development costs, and speed time-to-market.

Learn more about the Abaqus Unified FEA product suite and Quad-Core Intel Xeon processor 5300 series-based workstation supercomputers. Contact your Intel or SIMULIA representative or visit us on the web:

www.intel.com
www.simulia.com

About SIMULIA

SIMULIA is the Dassault Systèmes brand that delivers a scalable portfolio of Realistic Simulation solutions including the Abaqus product suite for Unified Finite Element Analysis, multiphysics solutions for insight into challenging engineering problems, and lifecycle management solutions for managing simulation data, processes, and intellectual property. By building on established technology, respected quality, and superior customer service, SIMULIA makes realistic simulation an integral business practice that improves product performance, reduces physical prototypes, and drives innovation. Headquartered in Providence, RI, USA, with R&D centers in Providence and in Suresnes, France, SIMULIA provides sales, services, and support through a global network of regional offices and distributors. For more information, please see www.simulia.com

Relative performance for each benchmark is calculated by taking the actual benchmark result for the first platform tested and assigning it a value of 1.0 as a baseline. Relative performance for the remaining platforms tested was calculated by dividing the actual benchmark result for the baseline platform into each of the specific benchmark results of each of the other platforms and assigning them a relative performance number that correlates with the performance improvements reported.

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Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See http://www.intel.com/products/processor_number for details.

64-bit computing on Intel® architecture requires a computer system with a processor, chipset, BIOS, operating system, device drivers and applications enabled for Intel® 64 architecture. Processors will not operate (including 32-bit operation) without an Intel® 64 architecture-enabled BIOS. Performance will vary depending on your hardware and software configurations. Consult with your system vendor for more information.

Intel does not control or audit the design or implementation of third party benchmarks or Web sites referenced in this document. Intel encourages all of its customers to visit the referenced Web sites or others where similar performance benchmarks are reported and confirm whether the referenced benchmarks are accurate and reflect performance of systems available for purchase.

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