



Performance Brief
Quad-Core Workstation

Revolutionizing Your Workflow with Quad-Core Intel® Xeon® Processor-Based Workstations

From manufacturing to oil and gas to digital media, the game-changing Quad-Core Intel® Xeon® processor and Intel® Core™ microarchitecture let workstation users work differently, moving from serial to simultaneous workflows, and producing exceptional performance and productivity gains.



Introduction: Workstation Users on the Front Lines

Workstations powered by the Quad-Core Intel Xeon processor enable faster time-to-solution, massive throughput, and scalable workflows that improve insights and outcomes. They help you work differently and do more, faster.

Competitive pressures are on the rise, and the pace of business keeps accelerating. Workstation users are on the front lines, facing tougher problems, larger data sets, and tighter timelines.

A new generation of workstations—powered by the Quad-Core Intel® Xeon® processor and Intel® Core™ microarchitecture—is built for these challenges. With eight computing cores in a single workstation, these systems deliver approximately 80 Gflops of performance¹ and up to 64 GB of memory at your fingertips. Their game-changing performance delivers dramatic performance increases across a wide range of workloads. Even better, it empowers you to work differently, moving from serial to simultaneous workflows and performing more tasks concurrently.

Intel® Quad-Core Delivers New Ways to Work

In today's global economy, working differently isn't an option—it's a survival skill. Working differently isn't about changing the way you work. It's about doing more faster—accelerating how you work, getting comprehensive results faster, and shortening the time from initial idea to finished product.

Working differently, manufacturers can bring innovative products to market in record time. Energy companies solve more complex problems faster—to accelerate and optimize oil and gas exploration and recovery. Financial firms can execute smarter trading and investment decisions at speeds they once dreamed of. Design and entertainment houses can create ever more exciting digital content and still meet their aggressive deadlines.

By moving to a more scalable, simultaneous workflow, workstation users can speculate, simulate, and innovate more rapidly. For example:

- **Engineers** can work differently and do more, faster by using analysis-driven design to concurrently evaluate metrics such as pressure drop, peak temperatures, and flow distributions. By rapidly quantifying design quality, bad designs are ruled out and good ones are identified. **Impact:** Faster time-to-market with more innovative products.

- **Animators** can work differently and do more, faster by simultaneously performing Create and Render functions with little to no loss in workstation responsiveness. Animators can experiment quickly and ultimately be more daring and creative. **Impact:** More compelling results, faster.
- **Financial analysts, traders and portfolio managers** can work differently and do more, faster with the ability to track market actions more efficiently, execute faster research, and rapidly perform more complex analysis, all while concurrently communicating with customers and collaborating with colleagues. **Impact:** Better informed, higher quality decisions in less time.
- **Reservoir engineers** increase the complexity of their models and add more physics, deepening and accelerating the understanding of oil field conditions. **Impact:** Improved exploitation plans in less time, optimized oil and gas recovery.
- **Power office users** perform complicated and data-intensive office functions concurrently. These users quickly integrate data from across the enterprise, transform it into insights, then communicate and collaborate to impact business and technical decision-making. **Impact:** Greater certainty in decision-making, more precise predictions, improved corporate performance.

Intel Quad-Core Takes You from Serial to Simultaneous

Working differently and doing more faster means using scalable workflows which are made possible by the multiprocessing performance of the Quad-Core Intel Xeon processor. Working differently enables knowledge workers to replace traditional, serial development processes with ones in which tasks are performed concurrently and users are free to work differently and more interactively with their designs. With dual-processor workstations powered by the Quad-Core Intel Xeon processor, users employ up to eight cores to simultaneously create and render, design and simulate, develop and explore, or interact and model information. They can develop and visualize a more complete and robust design at speeds once reserved for

large supercomputers in air-conditioned glass rooms. Scalable workflows help you do more, faster by placing a premium on accessing the compute resources to run multiple applications and perform more disparate tasks in a single time-step at speeds that deliver actionable information in as little time as possible.

Whether the final product is a product design, oil field exploitation plan, investment decision or rendered imaging, scalable workflows create opportunities for users to rapidly iterate through ideas and alternatives. Users arrive at the finish line in less time and often with a superior end result because they've explored more design alternatives in a given timeframe.

With scalable workflows on Quad-Core Intel Xeon processor-based workstations, users can work differently and do more, faster. They can rapidly iterate through ideas and alternatives. They can move from serial to simultaneous workflows and compress the time to decision.

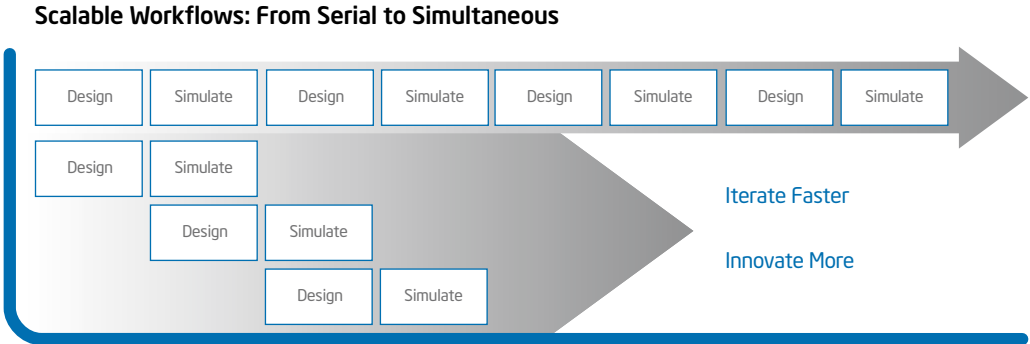


Figure 1. Scalable workflows take advantage of multi-core processing to collapse project schedules by enabling users to perform more tasks concurrently.

A Closer Look: Manufacturing

For manufacturing organizations, working differently and doing more faster employs scalable workflows to leverage computer-based modeling, simulation, rendering or analytics to accelerate and alter the process of developing an idea into a new product or improving the properties of an existing product. Product development processes become more effective when product simulation, rendering, modeling and analytic software can be used concurrently on a single Quad-Core Intel Xeon processor-based workstation.

Consider a hypothetical product engineer who performs 3-D design tasks on five design alternatives using SolidWorks Corporation's SolidWorks* 2005 and physical modeling with Ansys Inc's Fluent* flow modeling software 6.3.26 L1/L2 workloads.² Table 1 shows the engineer's output on dual-processor workstations performing five runs of each application in serial fashion. Table 2 shows the impact of using scalable workflows to perform the work concurrently.

As Figure 2 illustrates, the engineer handles up to 39 jobs per day when using scalable workflows with two Quad-Core Intel® Xeon® processor 5355 series processors. That's an increase of more than 300 percent compared to running the same workload in serial fashion (completing 13 jobs per day) on a dual-processor workstation based on a traditional single-core Intel Xeon processor.

Design, Iterate, and Analyze five alternatives in parallel using SolidWorks* and Fluent*²

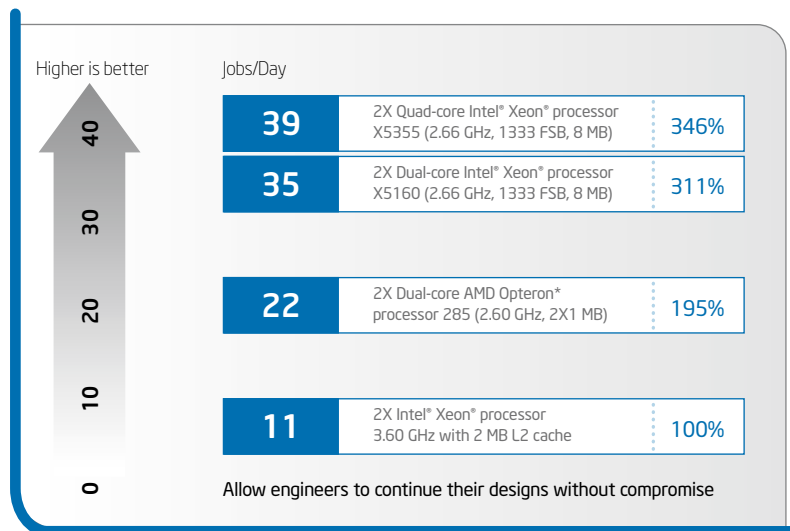


Figure 2. With scalable workflows and the ability to perform design and analysis concurrently on a dual-processor Quad-Core Intel® Xeon® processor 5355 series workstation, the engineer's productivity scales from 11 products per day to as many as 39, an increase of up to 346 percent over the output on the baseline of a dual-processor, single-core Intel Xeon processor-based workstation.

Working differently and doing more, faster employs scalable workflows to simultaneously run 3-D design and analysis software on a Dual-Processor Quad-Core Intel Xeon processor-based workstation.

Table 1. Serial Performance: Five Runs of SolidWorks* and Fluent*²

Workstation	SolidWorks	Fluent Max t	Total Time (Secs)	Jobs/Day
DP Quad-Core Intel® Xeon® Processor X5355 (2.66 GHz)	1853.83	1190	3043.83	28.4
DP Dual-Core Intel® Xeon® Processor 5160 (2.66 GHz)	1836.51	1845	3681.51	23.5
DP Dual-Core AMD Opteron® Processor Model 285 (2.60 GHz)	1885.69	2656	4541.69	19.0
DP Intel® Xeon® Processor (3.60 GHz, with 2 MB L2 cache)	2442.73	4181	6623.73	13.0

2. Actual performance may vary. See <http://www.spec.org> and <http://www.fluent.com> for more information on the workloads. Performance was measured using the SPECcap* benchmark on four typical system configurations. Tests performed June 2007 by Intel. See page 8 for configuration details.

Table 2. Concurrent Performance: Five Runs of SolidWorks and Fluent²

Workstation	SolidWorks	Fluent Max t	Total Time (Secs)	Jobs/Day
DP Quad-Core Intel® Xeon® Processor X5355 (2.66 GHz)	2173.37	1371	2173.37	39.8
DP Dual-Core Intel® Xeon® Processor 5160 (2.66 GHz)	2104.33	2417	2417	35.7
DP Dual-Core AMD Opteron® Processor Model 285 (2.60 GHz)	2030.74	3861	3861	22.4
DP Intel® Xeon® Processor 3.60 GHz with 2 MB L2 cache	2513.18	7511	7511	11.5

Intel® Core™ Microarchitecture: The Performance Engine

Quad-Core Intel Xeon processor-based workstations deliver the latest in cutting-edge processor technology, starting with Intel Core microarchitecture. As Intel's next-generation microarchitecture, it combines a variety of new features to deliver breakthrough energy-efficient performance and advanced capabilities across servers, workstations, desktops, and mobile PCs. Among its innovations:

- **Intel® Wide Dynamic Execution** increases performance and energy efficiency by enabling the delivery of more instructions per clock cycle and enhancing the efficiency of instruction execution. Every execution core is 33 percent wider than with previous generations, allowing each core to fetch, dispatch, execute and retire up to four full instructions simultaneously. Intel Wide Dynamic Execution incorporates a new Macro-Fusion capability that combines a number of common x86 instructions into a single instruction for execution, further increasing performance and energy efficiency.

- **Intel® Advanced Digital Media Boost** accelerates a broad range of applications, including financial, engineering, scientific video, speech and image, photo processing, and encryption software. This feature enables 128-bit (SSE/SSE2/SSE3) 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** improves performance and efficiency by significantly reducing latency to frequently used data. This multi-core optimized cache increases the probability that each execution core of a multi-core processor can access data from a higher-performance, more efficient cache subsystem.
- **Intel® Smart Memory Access** improves system performance by optimizing the use of the available data bandwidth from the memory subsystem and hiding the latency of memory accesses. It contains an important new built-in intelligence that processes out-of-order instructions more efficiently.
- **Intel® Intelligent Power Capability** improves system performance by optimizing the use of the available data bandwidth from the memory subsystem and hiding the latency of memory accesses. It contains important new built-in intelligence that processes out-of-order instructions more efficiently.

*Working differently
and doing more faster
employs next-generation
Intel Core microarchitecture
to deliver breakthrough,
energy-efficient perfor-
mance and advanced
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Intel Quad-Core Gives You the Power of Four

With the Quad-Core Intel Xeon processor 5300 series, Intel leads the industry in bringing the cost, performance, and energy-efficiency advantages of mainstream quad-core performance to the standard, high-volume marketplace. The processor presents two dual core dies with four independent execution cores in a single package. A dual-processor workstation based on the Quad-Core Intel Xeon 5300 Series processor offers eight physical compute cores in two sockets with up to 64 GB of memory. The Quad-Core Intel Xeon 5300 series processor features core speeds ranging from 3.00 GHz to 1.60 GHz, a choice of 1333 to 1066 MHz bus speeds, and a power efficient 20 watt maximum thermal design point (TDP). Also available are a low-power version (L5310) with a 50-watt TDP, and a single-processor quad-core product, the Intel® Core™ 2 Extreme processor QX6700.

The Intel® Xeon® processor 5300 delivers on performance, price, and reliability – the three most important vectors demanded by workstation users.

- **Performance.** The Quad Core Intel Xeon 5300 processor extends an already impressive performance leadership position for both workstations and servers.³
- **Price.** Intel's manufacturing expertise delivers world-class performance combined with superior energy/power efficiency at price points demanded by the market. The Quad Core Intel Xeon processor 5300 series manufacturing strategy enables Intel to deliver the performance demanded by the market today without increasing implementation risk or impacting reliability targets.
- **Reliability.** The Quad Core Intel Xeon processor 5300 series is based on a proven, established architecture to reduce risks. In addition, its energy-efficient architecture reduces stresses and strain and improves chip reliability.

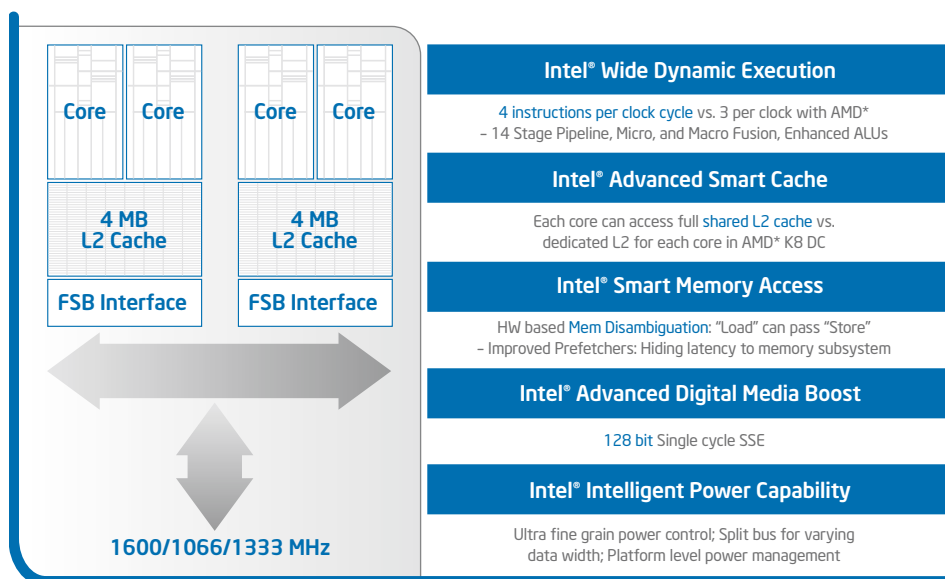


Figure 3. Quad-Core Intel® Xeon® processor 5300 series presents two dual-core dies with four independent execution cores in a single package.

The Quad-Core Intel Xeon processor delivers more performance at lower cost with increased reliability. It helps you work differently and do more, faster.

3. Performance claim based on industry standard benchmark publications such as SPECcap* and SPECint*_rate2006 as of 14 November 2007. Actual performance may vary. See <http://www.spec.org> for latest publications. At time of writing, no Quad-Core AMD Opteron* processor-based platforms could be purchased from multinational corporation vendors, so no comparison could be drawn to them.

Performance and Beyond

Quad Core does more faster. It delivers real performance today in the same thermal envelope as competitive offerings. It also delivers more performance per dollar spent, providing software applications with double the cache, larger memories, improved reliability and the opportunity to employ twice as many execution cores.

Workstation platforms with the Quad-Core Intel Xeon processor 5300 series also provide a range of advanced capabilities that contribute to performance increases and reductions in total cost of ownership:

- **Intel® Virtualization Technology** (Intel® VT). This is the industry's first hardware-assisted technology supporting today's industry leading virtualization software.
- **Fully-buffered DDR2 DIMM technology.** The latest in memory technology, fully-buffered DIMM technology provides significantly greater throughput and capacity while improving memory reliability
- **Intel® I/O Acceleration Technology.** This unique Intel technology moves network data more efficiently through Intel Xeon processor-based servers for fast, scaleable, and reliable networking

Intel's manufacturing prowess is unparalleled in the industry. We pioneered the move to state-of-the-art 65 nm process technology, enabling Intel engineers to pack millions more transistors onto a single chip while increasing energy efficiency. We manufacture our microprocessors by the millions, to deliver unprecedented advances across workstations, servers, and PCs while enhancing reliability and holding the line on costs.

We also collaborate across the industry to advance software tools and applications that take maximum advantage of Intel multi-core architectures. Intel® Software Development Products assist software developers in creating, developing, and porting applications and tools that embrace best practices for multi-core programming, facilitate threading applications, and help developers shorten the time to market. Available tools and products include Intel® Compilers, Intel® Performance Libraries, Intel® VTune™ Performance Analyzers, Intel® Threading Tools, and Intel® Cluster Tools.

Intel also offers software platform products such as Intel® Platform Administration Technology, Intel® Innovation Framework for Extensible Firmware Interface (EFI), and Intel® Media Codecs to help speed value delivery in the platforms.

Beyond Quad-Core: Tera-Scale Computing

Building on Intel Core microarchitecture, the Quad-Core Intel Xeon processor is another giant leap forward on Intel's road to the increasing computational performance and capacity of multi-core and many-core computing. It enables scalable workflows, accelerates time-to-solution, and increases throughput, matching the needs of today's demanding workstation users. It also points the way to the future.

Spurred by business growth, increasing globalization and the explosion of digital data, future workstation applications will likely be much more computationally intensive than anything we've seen to date. Intel technologists say we'll enter the "tera era"—an age in which workstation users will need teraflops (trillions of floating point operations per second) of computing power, terabits (trillions of bits per second) of communications bandwidth and terabytes (trillions of bytes) of data storage to handle the information all around them.

Intel is prepared to lead this transition. From 2001 to 2004, Intel technology advances delivered approximately an 18x increase in performance.⁴ The move to multi-core enables an inflection point of performance and capability that, based on our technology roadmaps, we currently anticipate will boost performance tenfold in approximately the next four years, along with bringing continuing improvements in performance per watt, throughput and scalability.

Scale Your Workflow with Intel Multi-Core

Quad-Core Intel Xeon processors based on the Intel Core microarchitecture vastly outperform previous generations of processors. They empower you to work differently, and help you perform more tasks in parallel, scale your workflow—and shrink the time from idea to finished product.

Think about how much more work you can get done – and how much faster – by moving from serial to simultaneous workflows. Learn more about workstations based on the Quad-Core Intel Xeon processor – and put the power of Intel quad-core computing to work for you.

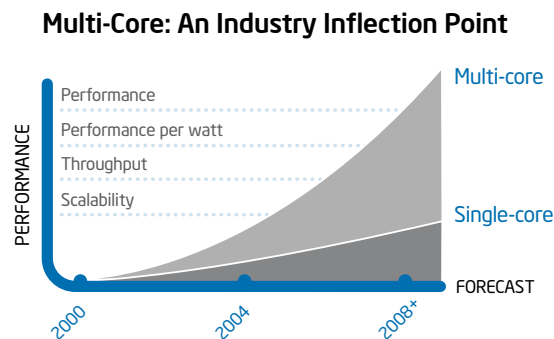
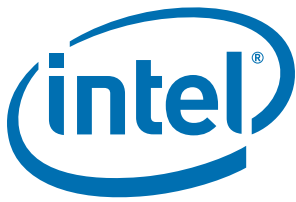


Figure 4. Intel's product roadmaps predict a tenfold performance boost in approximately the next four years.

4. Performance claim based on 17.5x increase in SPECint*_rate_base2000 scores on DP Quad-Core Intel Xeon processor X5365 (3.00GHz, score 214.0) shipping today in volume compared to DP Intel Xeon processor 1.26 GHz (shipping 2001, score 12.2) as of 14 November 2007. Actual performance may vary. See <http://www.spec.org> for details.



www.intel.com

Learn More

See how scalable workflows and Quad-Core Intel® Xeon® processor-based workstations can transform your work. Visit:

www.intel.com/performance/workstation/xeon/workflow.htm

<http://download.intel.com/products/processor/xeon/dc53kprodbrief.pdf>

System Configurations Referenced in Benchmarks:

- DP Quad-Core Intel® Xeon® Processor X5355 (2.66 GHz, 1333 MHz bus, 8 MB) on "Hoodspout2" BIOS 75 customer reference workstation, 8GB FBD667 memory, 160GB SATA HDD, NVIDIA Quadro® FX3450 driver 84.26, Microsoft Windows XP Professional x64-Edition SP2.
- DP Dual-Core Intel® Xeon® Processor 5160 (3.00 GHz, 1333 MHz bus, 4 MB) on SuperMicro® X7DAE BIOS 1.2 workstation, 8GB FBD667 memory, 160GB SATA HDD, NVIDIA Quadro® FX3450 driver 84.26, Microsoft Windows XP Professional® x64-Edition SP2.
- DP Dual-Core AMD Opteron® Processor 285 (2.60 GHz, 2x 1 MB) on Sun Ultra40® workstation, 8GB DDR-400 memory, 160GB SATA HDD, NVIDIA Quadro® FX3450 driver 84.26, Microsoft Windows XP Professional® x64-Edition SP2.
- DP Intel® Xeon® Processor 3.60 GHz with 2 MB L2 cache and 800 MHz system bus on SuperMicro E7525*-chipset-based workstation, 8GB DDR2-400 memory, 160GB SATA HDD, NVIDIA Quadro® FX3450 driver 84.26, Microsoft Windows XP Professional® x64-Edition SP2.

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.

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit Intel Performance Benchmark Limitations.

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.

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® Virtualization Technology requires a computer system with an enabled Intel® processor, BIOS, virtual machine monitor (VMM) and, for some uses, certain platform software enabled for it. Functionality, performance or other benefits will vary depending on hardware and software configurations and may require a BIOS update. Software applications may not be compatible with all operating systems. Please check with your application vendor.

Compatibility and upgradeability to Quad-Core Intel® Xeon® processor 5300 series is determined by the manufacturer. Please check with your OEM to determine compatibility and upgradeability.

Measured SPECint*_rate for Clovertown 2.66/1333 vs published AMD Opteron 2220 SE* (2.8 GHz, socket F)

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