

Sun™ x64 Systems for Scalable MCAE Performance

Featuring Intel™ Xeon™ processors



Highlights

- Sun™ x64 servers and workstations featuring Intel™ Xeon™ processors have produced numerous leading and world-record MCAE and MCAD benchmark results, demonstrating considerable performance and scalability.
- Sun x64 servers and workstations with Intel Xeon processors are designed for high performance, combining speed with large memory capacity and high computational density.
- Sun Blade™ modular systems provide new opportunities for dense and scalable HPC clusters, and for running MCAE codes.
- All Sun x64 systems offer a choice of the Solaris™ Operating System, Linux, or Microsoft Windows.
- Sun Customer Ready HPC Clusters offer fast performance and agile deployment, with clusters that are ready-to-deploy and factory integrated for the most demanding HPC applications.



Manufacturers place significant demands on their computational systems, requiring focused compute power, large memory support, and balanced I/O capacity. The need to scale performance has only increased as models have grown in size and complexity, and as the diversity of modeled properties, conditions, and events has expanded. With a host of world-record benchmarks to their credit, Sun Fire™ rackmount servers, Sun Blade™ modular systems, and Sun Ultra™ workstations based on powerful Intel™ Xeon™ processors are especially suited to help mechanical computer-aided engineering (MCAE) applications scale.

Cluster-based virtual prototyping simulation in MCAE

Numerical simulation of real-world problems has become standard practice among manufacturers worldwide, helping to reduce costs and meet short time-to-market windows. At the same time, simulation has helped improve product quality, optimize materials usage, and address increasingly stringent governmental safety and environmental regulations.

Termed virtual prototype development (VPD) or mechanical computer-aided engineering (MCAE), these simulation techniques typically employ finite element analysis (FEA) methods. Together with high performance computing (HPC) technologies, the latest Sun x64 systems based on the Intel Xeon processor deliver outstanding performance and scalability for MCAE and VPD applications. These systems give manufacturing firms the computational capacity to produce better and safer products at affordable costs.

The widespread acceptance of simulation

As design complexity and computational capabilities have increased, leading manufacturers have accepted simulation as part of the early design process, with prototyping and testing done to ultimately verify and validate designs.

Simulation studies at the leading automotive and aerospace companies consist mainly of the following technologies:

- *Crash/occupant safety applications* such as LS-DYNA (Livermore Software Technology Corporation) and PAM-CRASH (ESI Group) account for most of auto makers' numerically-intensive computing cycles.
- *Noise, vibration and harshness (NVH) applications* provide modal analysis in the form of frequency response simulations.
- *Computational fluid dynamics (CFD) applications* are commonly used for steady-state or transient analysis of external airflow, engine underhood, underbody, interior climate control, instrument panel thermal management, and combustion. Popular applications include FLUENT (ANSYS Inc.), STAR-CD (CD-adapco), CFX (ANSYS, Inc.), and PowerFLOW (EXA).
- *Structures and Nonlinear FEA applications* typically include MSC.Nastran, MSC.Marc (MSC Software Corporation), ANSYS (ANSYS, Inc.), or ABAQUS (Dassault Systemes) for linear/nonlinear structural integrity studies.

These various MCAE applications place different demands on computer system architecture:

- Crash simulation is CPU intensive, with little demand on other resources.
- NVH puts large demands on all resources, including CPU, memory, I/O bandwidth, and storage.
- CFD is typically CPU, memory, and memory-bandwidth intensive.
- Adaptive meshing has become common in CFD, metal forming, and crash simulations, generating considerable computational demand.

Typical 3D production models today can consist of as many as 3-20 million elements in CFD simulations, 300,000-1,000,000 elements for crash studies, and 30,000-1,000,000 elements in linear/nonlinear structural analysis. These larger, more complex models require 64-bit computing architecture to achieve good performance, with clusters of systems running the Solaris Operating System (Solaris OS) or Linux becoming increasingly more popular.

Many crash and CFD simulation codes are particularly well parallelized and scalable, making 8-16 processor Solaris or Linux clusters ideal for same-day or overnight results. Most structural analysis codes do not scale as well to large numbers of processors, and engineers frequently employ four-processor systems (with a few using eight processors).

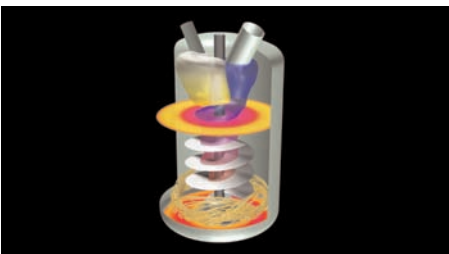


Figure 1: FLUENT Crutcher mixer CFD simulation using FIELDVIEW, FIELDVIEW image courtesy of Intelligent Light

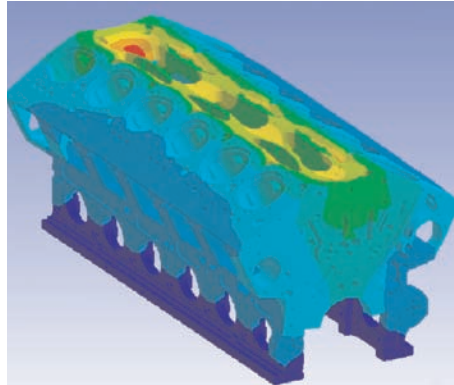


Figure 2: Deformation contours on an engine block, courtesy of ANSYS, Inc.

Deploying Sun x64 systems for manufacturing applications

Sun x64 servers and workstations based on the Intel Xeon processor are now rapidly gaining in popularity in MCAE and other high performance computing (HPC) markets. These affordable network- and cluster-ready 64-bit compatible systems offer excellent performance, price/performance, and a choice of operating systems. The result is leading 64-bit performance for MCAD and MCAE applications.

Sun x64 systems offer a balanced architecture that is designed for performance while leveraging the inherent performance aspects of Intel Xeon processors, such as quad-core capabilities. Multicore and multisocket Sun Fire rackmount servers and Sun Blade server modules are ideal for parallel MCAE applications (such as crash and CFD codes). With scalable multicore performance, large memory support, and high-bandwidth I/O and networking, these systems can provide ubiquitous building blocks for clustered HPC installations.

The rise of modular blade platforms

Blade platforms in particular — in both standalone and clustered configurations — are proving ideal for MCAE applications.

In fact, Sun Blade X6250 server modules based on Intel Xeon processors have produced several leading results with benchmarks running popular MCAE codes such as ANSYS, ABAQUS/Explicit, EXA PowerFLOW, LS-DYNA, and FLUENT. These server modules provide two sockets for Intel Xeon processors and up to 64 GB of memory, for good scalability. For example, Figure 3 illustrates the elapsed times (smaller is better) for EXA PowerFLOW test runs on Sun Blade X6250 server modules with both dual-core and quad-core Intel Xeon processors at the same clock frequency.

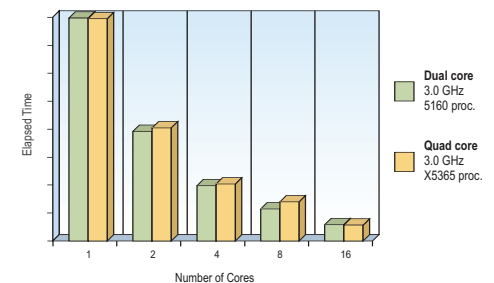


Figure 3: Sun Blade X6250 server modules demonstrate similar per-core performance when equipped with either dual-core or quad-core Intel Xeon processors

Sun Blade server modules with both dual- and quad-core Intel Xeon processors are well suited to MCAE workloads, yielding capacity for increased performance in the same physical footprint:

- Sun Blade 6000 and 6048 modular systems support Sun Blade X6250 server modules with two sockets for dual- or quad-core Intel Xeon 5000 Series processors and up to 64 GB of memory.
- Sun Blade 8000 and 8000 P modular systems support Sun Blade X8450 server modules with four sockets for two or four Intel Xeon 7200 (dual-core) or 7300 (quad-core) Series processors, and up to 128 GB of memory.

The growing importance of clusters

Increasingly, the scalability of certain MCAE codes is leading to increased deployments of small clusters of rackmount and blade servers.

Sun’s multiprocessor x64 systems featuring Intel Xeon processors are especially attractive for clustered configurations, given their high performance, large memory support, and I/O capabilities. InfiniBand interconnected clusters are particularly effective when compared to other technologies. Figure 4 illustrates the mean performance improvement of an InfiniBand cluster over an otherwise identical gigabit Ethernet cluster. As evident from the chart, the InfiniBand advantage grows with the number of nodes in the cluster.

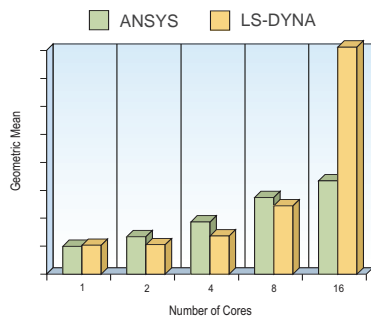


Figure 4: Mean performance improvement (higher is better) of an InfiniBand cluster over 10 Gb Ethernet with two popular workloads: LS-DYNA “Neon Refined” model and ANSYS V11.0 Distributed Suite

These results were obtained on a cluster of Sun Blade X6250 server modules interconnected via InfiniBand PCI Express ExpressModules and a Voltaire Grid Director ISR 9096 switch, which provides superior interconnect throughput and performance.

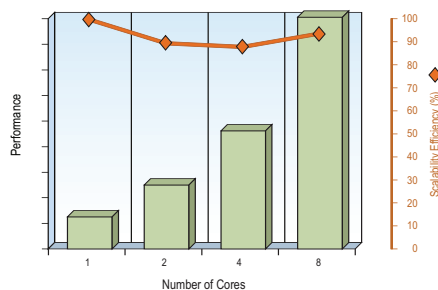


Figure 5: Performance and Scalability Efficiency of the FLUENT CFD benchmark code on an InfiniBand cluster of Sun Blade X6250 server modules (higher is better)

As Figure 5 suggests, on a FLUENT CFD benchmark, clusters of Sun Fire X4150 and X4250 rackmount servers, and Sun Blade X6250 and X8450 server modules can also offer excellent performance and scalability.

Leading Intel Xeon performance for MCAD

Beyond large simulation codes, manufacturing environments also require powerful engineering workstations with interactive and visually-realistic 3D graphics capabilities. Manipulation and visualization of complex models — both in terms of “preprocessing” and “postprocessing” — demand high levels of interactivity and visual realism as well as large memory support. Figures 1, 2, and 6 illustrate typical graphical results for various leading MCAE applications.

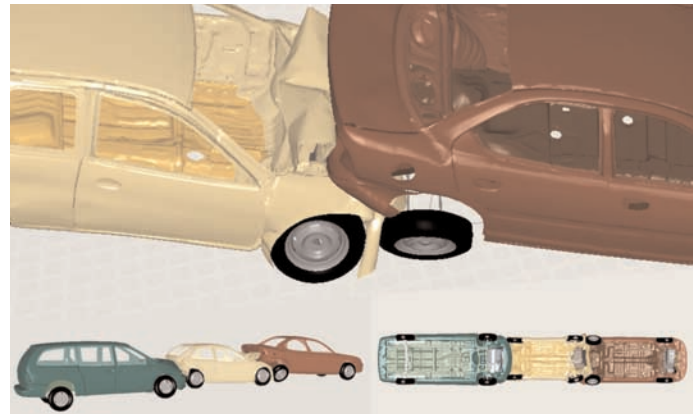


Figure 6: LS-DYNA “Three-Car-Crash” benchmark image courtesy Livermore Software Technology Corporation, with car models from FHWA/NHTSA National Crash Analysis Center at George Washington University

At the same time, manufacturers need to get the most from their computational resources. Sun HPC solutions can simplify infrastructure by allowing disparate systems to be pooled and managed as a singular computing system. MCAE users profit from this approach through optimized system utilization and throughput along with maximized user productivity.

Ultimately, Sun HPC solutions help drive innovation, providing the resources to get high-quality products to market more quickly while reducing costs and providing a rapid return on investment. The benefits of this approach include:

- Increased performance, scalability, and agility
- Clustering made easy with Sun Customer Ready HPC Clusters
- Reduced risk and time to deployment
- Eco-responsibility and greater density
- A scalable and open architecture

Sun Ultra 24 workstations powered by Intel Xeon processors have provided results in key benchmarks such as OCUS V5, SPECapc Pro/E Wildfire 2.0¹, and Solidworks 2007. Equipped with a range of NVIDIA Quadro FX 3D graphics solutions, Sun Ultra™ 24 workstations are ideally suited to these tasks. These 3D MCAD workstations can also be pooled together using Sun Grid Engine software to provide a cost-effective MCAE simulation cluster. Please see sun.com/hpc/benchmarks for the latest available benchmark results.

Sun high performance computing solutions

With increasingly complex designs and globally dispersed operations, manufacturers need to rapidly deploy effective tools to collaborate with multiple teams and partners.



Figure 7: Sun provides a full line of x64 systems for demanding MCAE and HPC applications

Along with a complete and innovative family of workstations and servers based on Intel Xeon processors (Figures 7 and 8), Sun provides the modular infrastructure that organizations need to rapidly deploy more competitive solutions:

- Sun Customer Ready HPC Cluster solutions provide fast performance, agile deployment, higher quality, and easier management — yielding ready-to-deploy, factory-integrated clusters based on Sun servers
- Sun Grid Engine distributed resource management (DRM) software and Sun xVM Ops Center help harness, consolidate, and manage even very large numbers of systems.
- Sun Ultra 24 workstations provide excellent computational performance characteristics and a range of available high-resolution NVIDIA Quadro graphics solutions to drive high-performance multi-display 3D MCAD and visualization applications.
- Industry-leading x64 rackmount servers — including the Sun Fire X4150 and X4450 servers — provide from two to four sockets for dual- and quad-core Intel Xeon processors.
- The Sun Blade 6000/6048 and 8000/8000 P modular systems deliver the performance, capacity, and I/O to support high-performance, large-memory applications, allowing entire grids or clusters to be consolidated into a single chassis or rack.

Learn More
 Contact a Sun Sales Representative to learn more about Sun x64 systems for MCAE based on the Intel Xeon processor, or visit:
sun.com/x64
sun.com/hpc
sun.com/servers/blades

For the latest benchmarks, please visit:
sun.com/hpc/benchmarks



Figure 8: Sun Ultra 24 workstations are ideal for MCAD, MCAE and visualization (STAR CD simulation of McLaren Formula 1 racer, image courtesy of McLaren International)

Feature	Sun Ultra 24 Workstation	Sun Fire X4150 Server	Sun Fire X4450 Server	Sun Blade 6000/6048 Modular System	Sun Blade 8000/8000 P Modular System
Sockets for Intel Xeon processors	One (dual- or quad-core)	Two (dual- or quad-core)	Four (dual- or quad-core)	Two per Sun Blade X6250 server module (dual- or quad-core), 10/48 server modules per chassis	Four per Sun Blade x8450 server module (quad-core), 10 server modules per chassis
Memory	Up to 8 GB	Up to 64 GB	Up to 128 GB	Up to 64 GB per server module	Up to 128 GB per server module
Form factor	Tower	1 RU	2 RU	10 RU chassis/rack	19/14 RU chassis

1. SPEC is a trademark, and SPECcap is a service mark of the Standard Performance Evaluation Corporation. Results from www.spec.org as of January 1, 2008. Sun Ultra 24, FX5600, overall composite of 3.33 for SPECcap Pro/E Wildfire 2.0.

