White Paper
Intel® Xeon® processor E5 v3 family
Intel® Xeon Phi™ coprocessor family
Digital Design and Engineering

(intel)

Three Paths to Faster Simulations Using ANSYS® Mechanical™ 16.0 and Intel® Architecture

Executive Summary

Even incremental performance gains for engineering simulations can improve productivity and shrink product development timelines. Tripling performance can transform entire workflows, allowing design teams to run more and larger simulations in less time to improve innovation, quality, safety, reliability, manufacturability, and time to market.

ANSYS and Intel worked closely together to deliver up to 3.2x higher performance[1,2] for design and engineering simulations by optimizing ANSYS Mechanical™ 16.0 for the multi-core Intel® Xeon® processor E5 v3 family and the many-core Intel® Xeon Phi™ coprocessor. Although the highest performance gains will be realized by a full hardware and software upgrade, smaller but still compelling gains can be achieved through less-aggressive upgrade strategies.

This white paper describes three different hardware upgrade paths. It also provides guidelines and performance benchmarks that can help decision makers determine the best way to increase performance based on their simulations, budgets, and business requirements.

ANSYS Mechanical 16.0 for Simulation-Driven Product Development

ANSYS is a leader in engineering simulation software for accelerating and improving product design workflows. With ANSYS software, companies can foresee how product designs will behave in real-world environments without the costs and delays of creating physical prototypes. Based on this information, they can refine and validate their designs earlier in their development processes, when the time and dollar cost of making changes is much lower.

ANSYS Mechanical provides comprehensive Finite Element Analysis (FEA) tools for structural analysis, including linear, nonlinear, and dynamic studies. Design teams can take advantage of a variety of tools, element libraries, and structural simulation options to explore a wide range of mechanical design problems. ANSYS Mechanical also offers thermal analysis and coupled-physics capabilities for acoustic, piezoelectric, thermal-structural, and thermoelectric analysis.

New Capabilities for Next-Generation Designs

ANSYS Mechanical 16.0 delivers new capabilities that design teams can use to minimize the weight of their products and to improve structural performance and reliability. They can work more easily with thin materials and elastomers, for example, and they can model composite materials that have nonhomogeneous properties and unusual manufacturing dependencies.

ANSYS Mechanical 16.0 also provides new tools and features to support more innovative and complex system designs. One example is adaptive remeshing, which automatically refines the mesh in highly distorted areas without requiring users to stop their simulation. Another example is improved support for modeling contact areas, which can provide deeper insight into multi-part designs.

Faster Simulations on Both Windows* and Linux*

ANSYS works with Intel to optimize ANSYS software for each new Intel® processor generation. The Intel Xeon processor E5 v3 family provides up to 18 cores per processor, which is 50 percent more than the previous generation. An Intel Xeon Phi coprocessor delivers even higher levels of parallelism. With up to 61 cores, a single coprocessor can provide up to 1.2 teraflops of performance.[3]

"With release 16.0 of ANSYS® Mechanical™, ANSYS has become the first commercial engineering simulation provider to support Intel® Xeon Phi™ coprocessors on both Windows and Linux*. The results are impressive. Adding one coprocessor to a current-generation hardware platform delivers an average speed-up as much as 3.2X across a variety of benchmarks."*

– Wim Slagter,
Lead Product Manager for HPC
ANSYS

ANSYS Mechanical 16.0 is optimized for the Intel Xeon processor E5 v3 family across all software versions. It is optimized for Intel Xeon Phi coprocessors across all versions of the sparse symmetric solver (including both the SMP and DMP versions for Windows* and Linux*). With these advances, the great majority of ANSYS users can now combine Intel® Xeon® processors and Intel Xeon Phi coprocessors to achieve higher performance for their simulations.

Automatic Offloads for Optimized Performance "Out of the Box"

ANSYS uses a number of Intel® Software Development products to optimize its code for Intel architecture, including the Intel® Math Kernel Library (Intel® MKL), Intel® Compilers, and the Intel® VTune™ Performance Analyzer. Intel MKL includes automatic offload library routines that route highly parallel code segments to the coprocessor and handle all buffer management and data transfers from the host to the coprocessor and back.

Intel MKL also handles threading of computationally intensive kernels for parallel performance. With this support in ANSYS Mechanical 16.0, users can take advantage of Intel Xeon Phi coprocessors with almost no effort. They only have to add a single option to the command line (or switch it on in ANSYS Workbench*). Once activated, the application workload is automatically balanced across available processors and coprocessors to optimize simulation performance.

Three Upgrade Paths - Guidelines for Achieving Higher Performance

ANSYS and Intel tested ANSYS Mechanical software running on a variety of server configurations based on Intel Xeon processors and Intel Xeon Phi coprocessors. Multiple benchmarks were used to measure performance gains across different workloads. As described below, the magnitude of the gains will depend on both the hardware configuration used and on the type of model that was simulated. This information can be useful for determining the best upgrade path based on particular workloads, business requirements, and budgets.

Before choosing an upgrade path, there are some general issues to consider.

• **Using newer, faster hardware platforms** based on the Intel Xeon processor E5 v3 family tends to increase overall performance, but typically decreases the magnitude of the gains delivered by adding an Intel Xeon Phi coprocessor (the higher-performing platforms have less to gain by offloading highly parallel code segments). Running simulations on larger numbers of CPU cores has a similar impact, increasing overall performance, but decreasing the gains provided by adding a coprocessor.

• **Multiple Intel Xeon Phi coprocessors can be used per platform**. However, for performance reasons, the maximum number of simultaneous processes executed per coprocessor is limited to eight.

- **The amount of acceleration provided by an Intel Xeon Phi coprocessor varies for different classes of simulation**. For ANSYS Mechanical simulations, more acceleration is achieved when:

  - The sparse solver is running in the in-core memory mode (meaning that the large intermediate file created by the sparse solver is kept within system memory).

  - The assembled matrix size is greater than two million equations.

  - Models are three dimensional, have bulkier or thicker geometry, contain higher-order element types, or include certain types of boundary conditions, such as constraint equations.

Customers will also want to consider total costs when planning an upgrade. The costs for each upgrade strategy will depend on a number of factors, including vendors, integration costs, licensing fees, and existing infrastructure. Considerations to keep in mind include the following:

- **There is no cost for upgrading to ANSYS Mechanical 16.0** from an earlier software release, for those customers with a Technical Enhancements and Customer Support (TECS) agreement. The same licensing models apply to both releases.

- **An Intel Xeon Phi coprocessor requires a single ANSYS HPC license**, the same as for a single core of the Intel Xeon processor E5 family. For example, if you are running ANSYS Mechanical on two cores of the Intel Xeon processor E5 family, adding one ANSYS HPC license would allow you to run it either on three cores of the same processor or on two cores of the same processor plus an Intel Xeon Phi coprocessor. The performance potential of Intel Xeon

Phi coprocessors makes them an exceptionally cost-effective way to increase performance in many scenarios.

- **Choosing the appropriate Intel Xeon Phi coprocessor is important**. If you are running ANSYS Mechanical on one or two Intel Xeon processor cores (using a base license), the Intel Xeon Phi coprocessor 3120A will provide good acceleration. If you are running ANSYS Mechanical on three or more Intel Xeon processor cores, the Intel Xeon Phi coprocessor 7120A is strongly recommended, since the extra on-chip memory it provides is necessary to support more than 3 MPI ranks.

The three options for upgrading hardware are described below. The tested server configurations are shown in Table 1 near the end of this paper. They include a typical, 3-year-old system powered by the Intel Xeon processor E5 family and a newer system powered by the Intel Xeon processor E5 v3 family.

To provide useful data across a wide range of customer scenarios, multiple benchmarks were performed for each upgrade option, using different numbers of Intel Xeon processor cores (from 2 to 24) and different numbers of Intel Xeon Phi coprocessors (from 1 to 4). All three upgrade strategies assume the use of ANSYS Mechanical 16.0.

A summary of the results is provided below. For more detailed information, contact your ANSYS representative.

Bronze Upgrade: Add One or More Intel® Xeon Phi™ Coprocessors to an Existing System

This is a cost-effective approach that delivers substantial performance gains, while requiring minimal hardware changes and only one additional HPC software license for each Intel Xeon Phi coprocessor. As shown in Figure 1, an ANSYS Mechanical simulation running on four cores plus a single Intel Xeon Phi coprocessor 7120 delivers up to 2.6X the performance of the same simulation running only on the four cores.

Bronze Upgrade: Add One or More Intel® Xeon® Phi™ Coprocessors to an Existing System
Ansys® Mechanical 16.0 V16sp–5
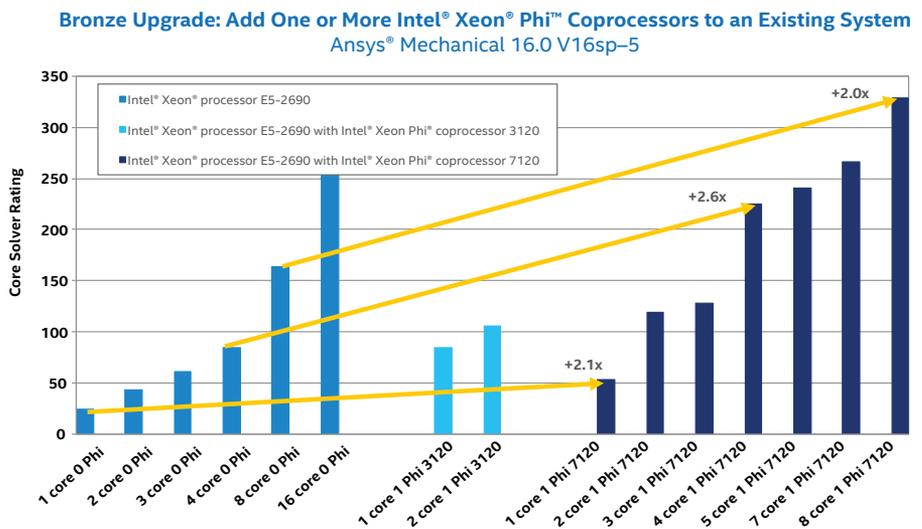
Figure 1. Adding a single Intel Xeon Phi coprocessor 7120 to a server powered by the Intel Xeon processor E5-2690 can provide up to 2.6X the performance of the same system without a coprocessor.

Silver Upgrade: Move to New Systems Based on the Intel® Xeon® processor E5 v3 family

This approach will require replacing the hardware platform, so upgrade costs will be higher than simply adding a coprocessor to an existing system. However, licensing costs will not change as long as simulations continue to run on the same number of processor cores. As shown in Figure 2, upgrading to systems based on the Intel Xeon processor E5 v3 family can provide up to 1.6X the performance of typical, 3-year old systems based on the Intel Xeon processor E5 family.

Although these gains are less than those provided by adding a coprocessor, upgrading to the Intel Xeon processor E5 v3 family and upgrading other platform components (newer operating system, more memory, solid state drives, and so on) can help to improve performance for all ANSYS software, rather than just the sparse solver. Depending on workloads and business needs, this upgrade path can be an excellent option.

Gold Upgrade: Move to New Systems and Add a Coprocessor

This strategy offers the highest potential gains for ANSYS Mechanical simulations. As shown in Figure 3, upgrading the hardware system and adding a single Intel Xeon Phi coprocessor 7120 can increase ANSYS Mechanical performance by a factor of up to 3.2X.

This upgrade path can also be expected to boost performance for other ANSYS software and functions running on the same platform. Assuming ANSYS Mechanical simulations run on the same number of Intel Xeon processor cores as on the previous system, one additional ANSYS HPC software license will be required for each Intel Xeon Phi coprocessor.

Silver Upgrade: Move to a New System based on the Intel® Xeon® processor E5 v3 family
Ansys® Mechanical 16.0 V16sp–5
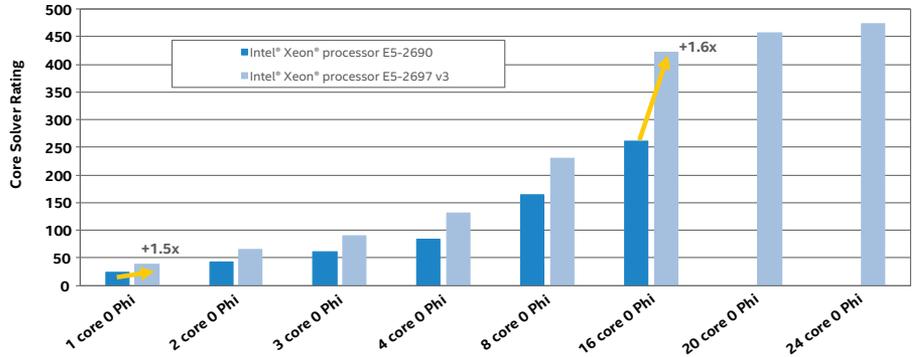
Figure 2. Upgrading to new systems powered by the Intel® Xeon® processor E5 v3 family can provide up to 1.6X the performance of systems based on the Intel® Xeon® processor E5 family for ANSYS Mechanical, while also improving performance for other ANSYS software components.

Gold Upgrade: Move to a New System and Add Intel® Xeon® Phi™ Coprocessors
Ansys® Mechanical 16.0 V16sp–5
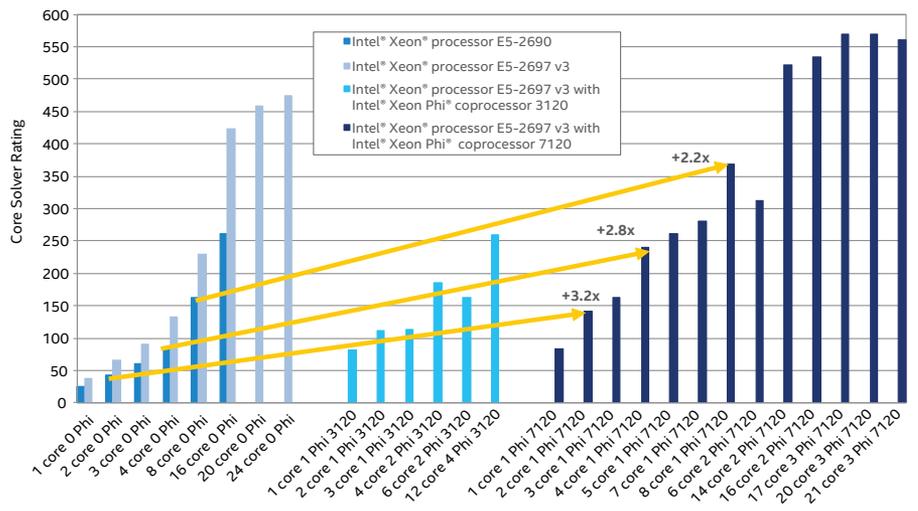
Figure 3. Upgrading to new systems based on the Intel® Xeon® processor E5 v3 family and adding a single Intel Xeon Phi coprocessor 7120 can provide up to 3.2X the performance (for simulations running on two processor cores).

Table 1. Server Test Configurations

	ADDITION OR ENHANCEMENT	TYPICAL 3-YEAR OLD SERVER
Processor	Intel® Xeon® processor E5-2697 v3 (18c, 2.6 GHz)	Intel® Xeon® processor E5-2690 (12c, 2.9 GHz)
Coprocessor	0–4 x Intel® Xeon Phi™ coprocessor 7120 A (61 active cores, 16 GB GDDR) 0–4 x Intel® Xeon Phi™ coprocessor 3120A (57 active cores, 6 GB GDDR)	
Memory	128 GB (16 x 8 GB DDR3 1600)	
Storage	1 TB 7200 RPM SATA hard drive	
Benchmark	V16sp-5	
Application	ANSYS Mechanical 16.0 Sparse Solver	
Operating System	Red Hat Enterprise Linux Server 6.5	

Higher Performance to Come

ANSYS and Intel will continue to deliver higher value with each new hardware and software generation. Advances in ANSYS design and simulation tools will help design teams model and test more complex designs with less effort. Future Intel processors and coprocessors will continue to raise the bar for performance, parallelism, and energy efficiency.

ANSYS and Intel will also work together to ensure that ANSYS software makes efficient use of new Intel® hardware innovations and to deliver tested and validated solutions that can be deployed quickly and with confidence. Since ANSYS licensing models allow no-cost upgrades to the latest software releases for customers with current TECS agreements, refreshing workstation and server platforms based on Intel processors will provide regular opportunities to decrease time-to-results for complex simulations.

Upgrading other platform components (newer operating system, more memory, solid state drives, and so on) can help to improve performance for all ANSYS software, rather than just the sparse solver. Depending on workloads and business needs, this upgrade path can be an excellent option.

LEARN MORE

Save Money and Maximize Performance with
ANSYS Mechanical 16.0 on Intel® Architecture (Webcast).
http://www.ansys.com/Campaigns/intel-phi4fea

ANSYS Mechanical 16.0.
http://www.ansys.com/Products/Simulation+Technology/Structural+Analysis/ANSYS+Mechanical

Intel Xeon Processor E5 v3 Product Family.
http://www.intel.com/content/www/us/en/processors/xeon/xeon-processor-e5-family.html

Intel Xeon Phi Product Family.
http://www.intel.com/content/www/us/en/processors/xeon/xeon-phi-detail.html

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