WHITE PAPER

Ansys

HOW TO SELECT THE BEST PROCESSOR AND HPC SYSTEM FOR YOUR ANSYS WORKLOADS

As manufacturers move toward Industry 4.0, computer-aided engineering (CAE) is becoming an even more crucial element in the design and testing of a variety of products. As a result, experts predict the CAE software and hardware market will reach a market value of USD 8.7 billion by 2026[1]. Computers can help engineers more efficiently design, analyze, and manufacture their products, whether you're talking about automobiles, aircraft, ocean-going vessels, trains, or the machines and tools used to build them. Using high-performance computing (HPC) clusters to run simulations and solve complex equations, CAE can reduce development time and cost, and simultaneously improve product quality and customer satisfaction.

Ansys use cases require compute, memory, and input/output (I/O) to varying degrees, depending on their application. To reap optimal benefit from Ansys applications, manufacturers need a modern HPC system that can balance performance needs with other considerations such as power consumption and Ansys software licensing expenses. These environmental demands and others will compel manufacturers to seek a combination of both **hardware** (processors and servers) that is performant but cost-, space-, and energy-efficient, and **software** that is optimized to take advantage of hardware technologies. **To assist manufacturing engineers in the selection process, Intel, HPE, and Ansys have teamed up to help them realize greater efficiencies through optimized performance resulting in more innovation time.**

/ MATCHING PROCESSOR WITH PERFORMANCE

With more than 30 3rd Gen Intel® Xeon® Scalable processors available, choosing the most appropriate processor for a particular Ansys workload may seem a bit daunting. Through close collaboration and co-innovation, Intel, HPE, and Ansys are helping manufacturing engineers to optimize computing environments and performance through careful processor selection to:

- Reduce time to results by solving larger and more complex problems with greater accuracy.
- Deliver more performance in a smaller footprint to reduce data center floor space requirements and lower energy costs.
- Minimize system downtime and unplanned outages through improved system reliability.
- Identify performance bottlenecks and reduce costs of Ansys performance testing on select Intel CPUs.

Results

A sampling of performance improvements across Ansys workloads demonstrate how the collaboration is guiding customers toward positive performance outcomes:

- Running a dozen standard benchmarks in **Ansys Fluent** resulted in a 13-18 percent improvement in jobs per day, with less wall-clock time using the latest Intel processor.
- Five standard **Ansys CFX** benchmarks ran better on a 3rd Gen Intel Xeon Scalable processor with jobs-per-day improvements from 19-29 percent wall-clock times of up to 24 percent faster.
- Three types of crash simulations run in **Ansys LS-Dyna** resulted in a 41 percent improvement in jobs per day on the 3rd Gen Intel Xeon Scalable processor with consistently lower wall-clock times.

[1]https://www.prnewswire.com/news-releases/global-computer-aided-engineering-cae-market-to-reach-8-7-billion-by-2026--301321641.html

/ CHOOSING THE RIGHT PROCESSOR FOR THE JOB

Intel's latest processors for HPC workloads are 3rd Generation Intel Xeon Scalable processors offering manufacturers a variety of SKUs to choose from. This ensures performance is optimized for the right resource constraints. Compared to previous-generation Intel Xeon Scalable processors, the 3rd Gen processors offer improvements in three areas: compute, memory, and I/O.

Compute:

- Up to 40 cores in a standard socket
- Enhanced per-core performance, including a 20 percent boost in instructions per clock (IPC)
- Wide range of frequency, feature, and power levels
- Intel Speed Select Technology (Intel SST), which provides fine-grain control over CPU performance that can help to optimize total cost of ownershitp (TCO)
- Built-in HPC and artificial intelligence (AI) acceleration with Intel Advanced Vector Extensions 512 (Intel AVX-512) and Intel Deep Learning Boost (Intel DL Boost)

Memory:

- Increased memory capacity with up to eight channels — up to 6 TB of system memory per processor
- Enhanced memory performance with support for up to 3200 MT/s DIMMs (two DIMMs per channel)
- Increased L1 and L2 cache
- Faster internode connections with three Intel Ultra Path Interconnect links at 11.2 GT/s
- Support for Intel® Optane™ persistent memory 200 series

I/O:

- Support for PCI Express (PCIe) Gen4 and up to 64 lanes (per socket) at 16 GT/s
- Intel Optane solid state drives (SSDs), with consistently high performance and up to 100 drive writes per day (DWPD)
- Support for a wide range of network fabrics

Processor Recommendation Breakdown for Ansys Workloads

Manufacturers can use Table 2 (below), along with the subsequent detailed discussions to follow to guide their processor choices (actual choices will vary by customer need).

Table 2. General processor recommendations for Ansys workloads

Discipline	Workload Priorities	Typical Software Applications	Recommended SKUs
Computational Fluid Dynamics (CFD)	High memory capacity and bandwidth Moderate frequency needs Highly scalable to hundreds of thousands of cores	Ansys CFX Ansys Fluent	6346 (16c, 3.1/3.6 GHz, 36 MB, 205W) 6336Y (24c, 2.4 GHz, 36 MB, 185W or 12c, 2.9 GHz, 36 MB, 150W or 8c, 3.1 GHz, 36 MB, 140W) 8358 (32c, 2.6/3.4 GHz, 48 MB, 250W) 8360Y (36c, 2.4/3.1 GHz, 54 MB, 250W or 32c, 2.5/3.2 GHz, 54 MB, 250W or 24c, 2.6/3.3 GHz, 54 MB, 220W)
Structural Modeling/Finite Element Analysis (FEA)	High core counts and frequencies High memory requirement	Ansys LS-DYNA Explicit	8352Y (32c, 2.2 GHz, 48 MB, 205W or 24c, 2.3 GHz, 48 MB, 185W or 16c, 2.7 GHz, 48 MB, 185W) 8358 (32c, 2.6/3.4 GHz, 48 MB, 250W) 8362 (32c, 2.8/3.6 GHz, 48 MB, 265W) 8360Y (36c, 2.4/3.1 GHz, 54 MB, 250W or 32c, 2.5/3.2 GHz, 54 MB, 250W or 24c, 2.6/3.3 GHz, 54 MB, 220W)
Mechanical Engineering/Noise, Vibration, and Harshness (NVH)	High memory capacity Medium to high frequencies and input/output (I/O) Negligible benefits from higher cores	Ansys Mechanical, Ansys LS-DYNA Implicit	6334 (8c, 3.6/3.7 GHz, 18 MB, 165W) 6342 (24c, 2.8/3.5 GHz, 36 MB, 230W)

Ansys Computational Fluid Dynamics (CFD)

Table 3. Ansys CFD Workload Characteristics

Performance Factor	Importance
Memory Capacity	High
Memory Bandwidth	High
Fabric Latency	High
Core Count	Medium
Frequency	Medium

Ansys CFD applications are used for simulating the flow of air, fluids, heat, and viscous material, and have many uses in a wide variety of industries — including aeronautic science, drag simulation in car shape design, and jet and thermal flow in engine design. CFD-related workloads are typically analyses of complex, often unstructured meshes with tens to hundreds of millions of cells. The data involved usually requires preprocessing, which can affect runtimes and the quality of results.

To achieve optimum performance, Ansys CFD applications need plenty of memory capacity and memory bandwidth (see Table 3). Although a processor with a high clock speed is usually ideal for this purpose, it is less crucial for Ansys CFD workloads that are running on a large cluster. With large clusters, communication throughput is becoming more important than compute speed, so the processor speed is not as critical. With the exception of transient models, I/O performance is generally not a critical performance factor.

Four 3rd Gen Intel Xeon Scalable processor SKUs are well-suited for running CFD workloads (see Table 2 for number of cores, frequencies, and other details):

- 6346. This processor is an excellent entry-level CAE SKU for performance per core, with strong core density and performance.
- 6336Y. This processor also has strong core density and performance and is a good choice for a general-purpose CAE cluster. It offers configuration flexibility with three performance profiles, which enables manufacturers to choose a configuration with low thermal design power (TDP) for use in power-constrained environments.
- 8358. This processor is a good choice for Ansys CFX and Ansys Fluent, both of whichbenefit from higher core counts.
- 8360Y. Like the 6336Y, this processor offers three performance profiles and is a good choice for a general-purpose CAE cluster. With more cores than the 6336Y, the 8360Y can be used for codes that demand more compute.

Ansys Structural Mechanics and Crash Analysis

Table 4. Ansys Finite Element Analysis (FEA) Workload Characteristics

Performance Factor	Importance
Frequency	High
Core Count	High
Fabric Latency	High
Memory Bandwidth	Medium

Ansys structural analysis concerns stress analysis on components and assemblies. Structural applications generally use FEA in two main numerical simulation approaches:

- Implicit FEA — Implicit analysis using sparse direct solver type models is used for longer duration, relatively static problems in which time dependency of the solution is not an important factor, such as analysis of forces on structures. As the problem size increases, implicit analysis usually uses much longer time steps but can require more computational resources.

- Explicit FEA — Explicit analysis using iterative direct solver type models is used for high-impact and short-duration simulations where each step takes into account forces like mass and inertia from the previous step. Examples of this type of analysis include crash, impact, and blast simulations. Such "nonlinear" events are modeled to predict cascading damage to structural and component integrity. Major users of crash testing include automotive manufacturers, who use it to save money by reducing the need for real-world crash tests.

Unlike Ansys CFD workloads, Ansys FEA workloads don't necessarily need high memory capacity, and memory bandwidth is of less importance. Instead, FEA workloads (see Table 4) require high clock speeds (3.4 GHz or more) and an appropriate core count (at least 32 cores on a two-socket system). These workloads are quite sensitive to network latency and fabric latency but are not I/O-constrained.

Four 3rd Gen Intel Xeon Scalable processor SKUs are well-suited for running Ansys FEA workloads (see Table 2 for number of cores, frequencies, and other details):

- 8352Y and 8360Y. With 32 cores and 36 cores respectively, these processors are tuned for a general-purpose CAE cluster but have the higher number of cores required by Ansys FEA workloads. They offer configuration flexibility with three performance profiles each, which enables manufacturers to choose a configuration with a TDP that suits their environment.
- 8358 and 8362. Also offering 32 cores but different frequencies, these processors provide good performance, especially for LS-DYNA.

Structural Analysis/Noise, Vibration, and Harshness (NVH)

Table 5. Ansys Finite Element Analysis (FEA) Workload Characteristics

Performance Factor	Importance
Frequency	Medium, High
Core Count	Medium
Memory Capacity	High
Memory Bandwidth	Medium, High
I/O Performance	Medium, High

NVH applications simulate acoustics to pinpoint indicators associated with quality such as squeak and rattle, vibration issues and external and internal noise levels heard within a vehicle. NVH solvers can be static or dynamic; the latter models involve millions of finite elements (1–40 million degrees of freedom) with thousands of components and properties.

All NVH workloads can benefit from large memory capacity, but higher core counts provide negligible benefits (see Table 5). In fact, Ansys Mechanical should use lower core counts. The other performance factors are harder to generalize for NVH than for other CAE disciplines because they have varying performance requirements.

The following 3rd Gen Intel Xeon Scalable processor SKUs are well-suited for running NVH workloads (see Table 2 for number of cores, frequencies, and other details):

- 6334. This processor is an excellent entry-level CAE SKU for performance per core.
- 6342. Depending on a manufacturer's core density and core frequency requirements, the 6342 is best suited for Ansys Mechanical.

/ DEPLOYING A SCALE-OUT PLATFORM FOR ANSYS

The previous discussion centered on choosing the appropriate processor for a specific type of Ansys workload, which is important, but it is only part of the picture. A best-fit processor alone cannot solve all the challenges facing CAE data centers, such as keeping server footprint to a minimum, lowering TCO, and reducing the cost to the environment (TCE) by shrinking energy consumption.

The HPE Apollo 2000 Gen10 Plus System is a dense, multi-server platform that packs substantial performance and workload flexibility into a small data center space, while delivering the efficiencies of a shared infrastructure. It is designed to provide a path to scale-out architecture for traditional data centers, so enterprise customers can achieve the space-saving value of density-optimized infrastructure in a cost-effective and nondisruptive manner. The HPE Apollo 2000 Gen10 Plus System also offers twice the density of traditional 1U rack mount systems, helping data centers to maximize the use of valuable data center space. For these reasons the HPE Apollo 2000 Gen10 Plus System is good choice for data center modernization as Ansys workloads climb.

/ RESULTS: RUN MORE JOBS PER DAY TO IMPROVE DESIGN AND SPEED TIME TO MARKET

Collaboration between HPE, Intel, and Ansys is producing impressive performance improvements across a wide variety of Ansys workloads. These improvements enable product design engineers to run more jobs and iterations per day using higher fidelity models. The results showcased here are standard Ansys benchmarks that represent real-world workloads. These performance improvements illustrate the power of hardware and software vendors working together to provide the best possible outcome for customers — improved workload performance resulting in faster time-to-market and more time for innovation.

Summary of Testing and Findings
A variety of Ansys benchmarks have been tested on a four-node cluster, comparing the performance of the 16-core, 3.4 GHz 2nd Gen Intel Xeon Scalable processor (35.75 MB L3 cache) and the 18-core, 3.0 GHz 3rd Gen Intel Xeon Scalable processor (39 MB L3 cache). The test results were used to determine how the new processor's improved memory, compute, and I/O features could benefit a range of Ansys workloads. For each benchmark, four iterations were run, varying the number of message passing interface (MPI) tasks from 1x to 4x the number of CPU cores.

Overall, the benchmark tests demonstrated that the majority of Ansys workloads — CFD, Mechanical, or LS-DYNA — can support more jobs per day and reduced wall-clock times using the latest Intel Xeon Scalable processor. These results are directly related to the newer processor's additional CPU cores, its IPC improvements, and its additional memory capacity and bandwidth. Running more jobs per day with lower wall-clock time translates directly to accelerated design and testing, which in turn can lead to product improvements and faster time to market.

Ansys Fluent

Fluent uses a cell-centered code capable of handling polyhedral mesh and cut-cell meshes. It offers both pressure-based and density-based options generally used for combustion, multiphase or chemically-reacting flows.

Over a dozen standard Fluent benchmarks were run — ranging from a gasoline direct injection model to a landing gear analysis to external flows over an aircraft wing and various types of cars. Figures 1 and 2 show a sampling of the results, illustrating a 13–18 percent improvement in jobs per day with consistently less wall-clock time using the latest Intel processor. The test also used Fluent's "-platform=intel" parameter, which provides optimizations specific to Intel architecture. With the 2021 R2 version of Fluent released in July 2021, Ansys and Intel worked together to further improve these optimizations.

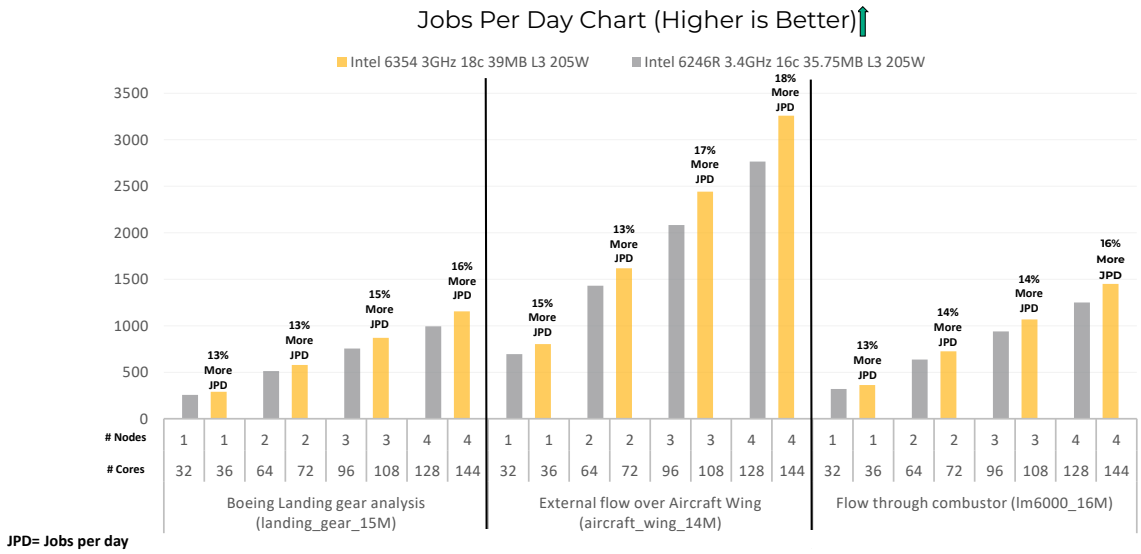

Figure 1. Ansys Fluent jobs-per-day results

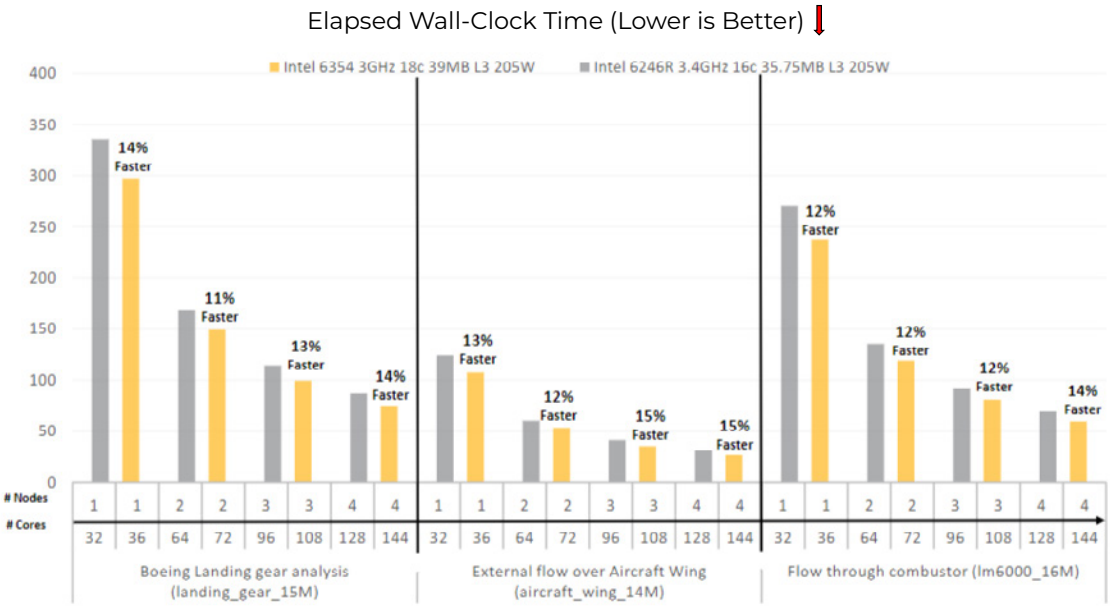

Figure 2. Ansys Fluent wall-clock time benchmark results

Ansys CFX

CFX is a fully implicit solver that requires quite a bit of storage. It uses a cell-vertex code, is pressure-based, and handles traditional tetra and hexa mesh topologies. This software is often used in turbomachinery analyses.

During analysis five standard CFX benchmarks were run: a LeMans race car, a pump, and three air foils. All benchmarks ran better on the 3rd Gen Intel Xeon Scalable processor. Figures 3 and 4 show a sampling of the results, illustrating jobs-per-day improvements ranging from 19 percent to 29 percent, and wall-clock times of up to 24 percent faster.

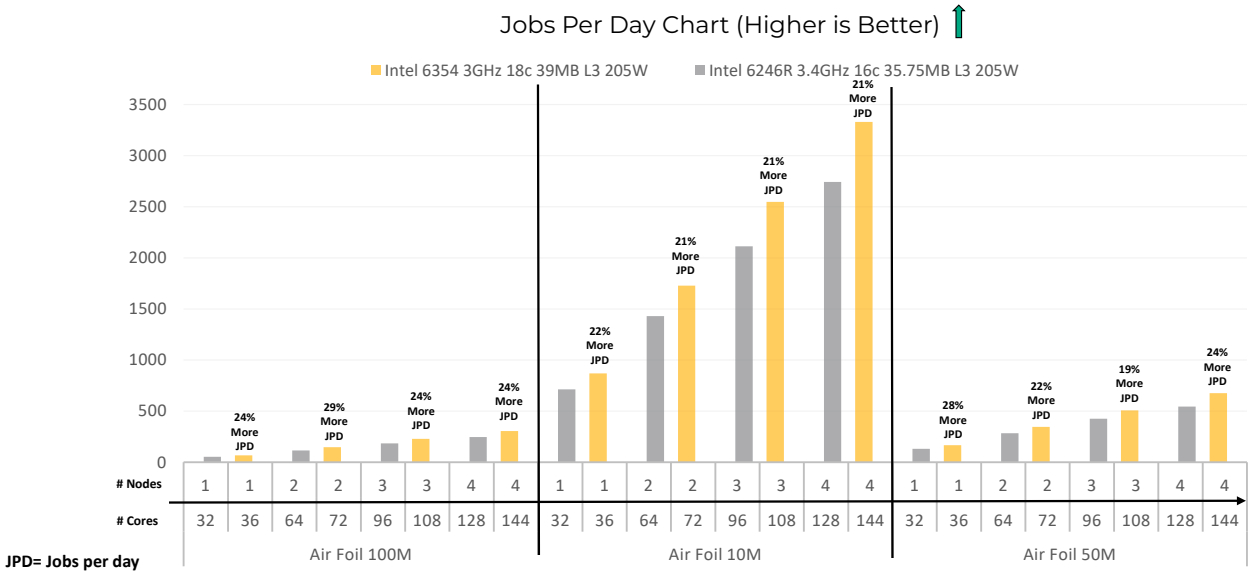

Figure 3. Ansys CFX jobs per day benchmark results

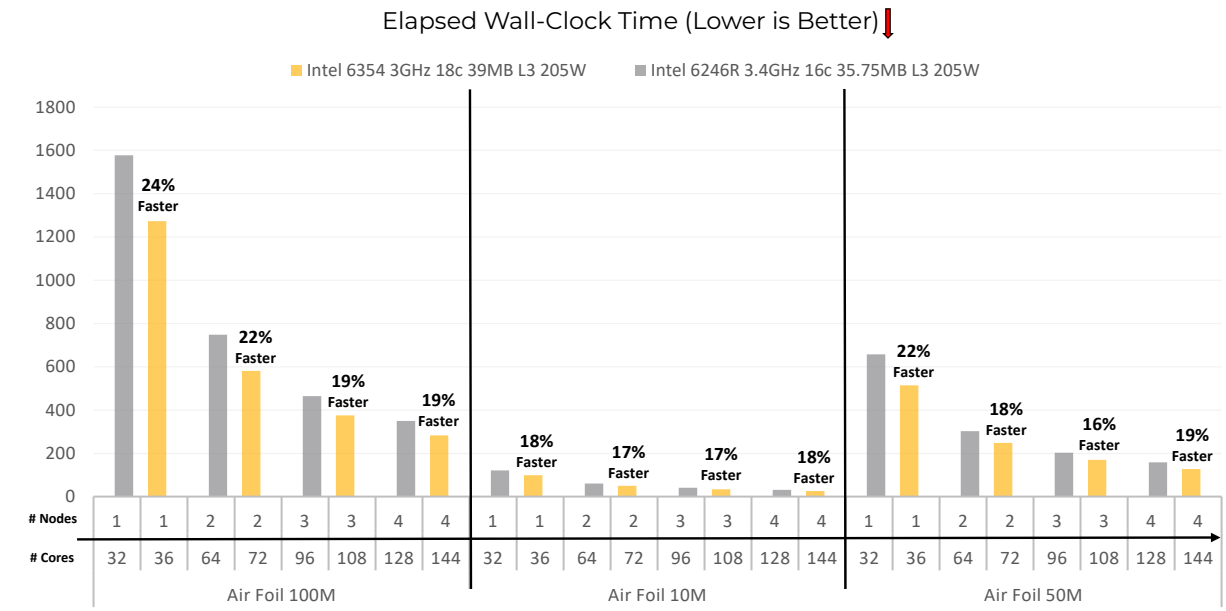

Figure 4. Ansys CFX wall-clock time benchmark results

Ansys LS-DYNA

LS-DYNA is a multiphysics simulation application that is used for drop tests, impact and penetration, smashes and crashes, occupant safety, and more.

During analysis, three types of crash simulations were run. The benchmarks all showed marked improvement in jobs per day on the 3rd Gen Intel Xeon Scalable processor — up to 41 percent. Wall-clock times were also consistently lower. Figures 5 and 6 show a sampling of the results.

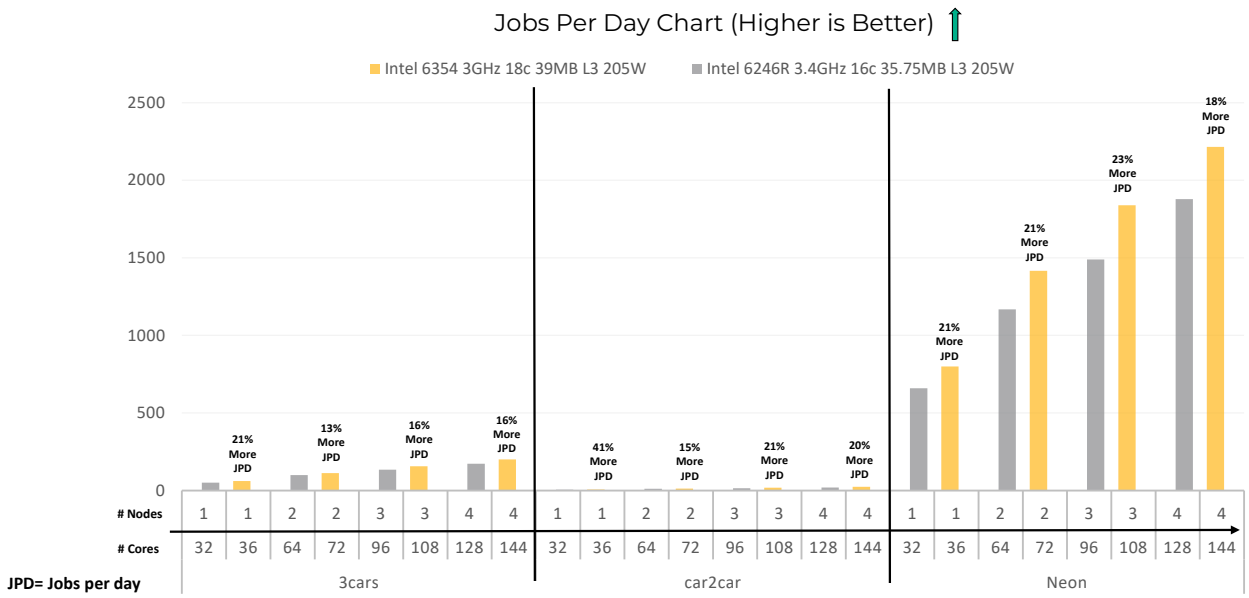

Figure 5. Ansys LS-DYNA jobs per day benchmark results

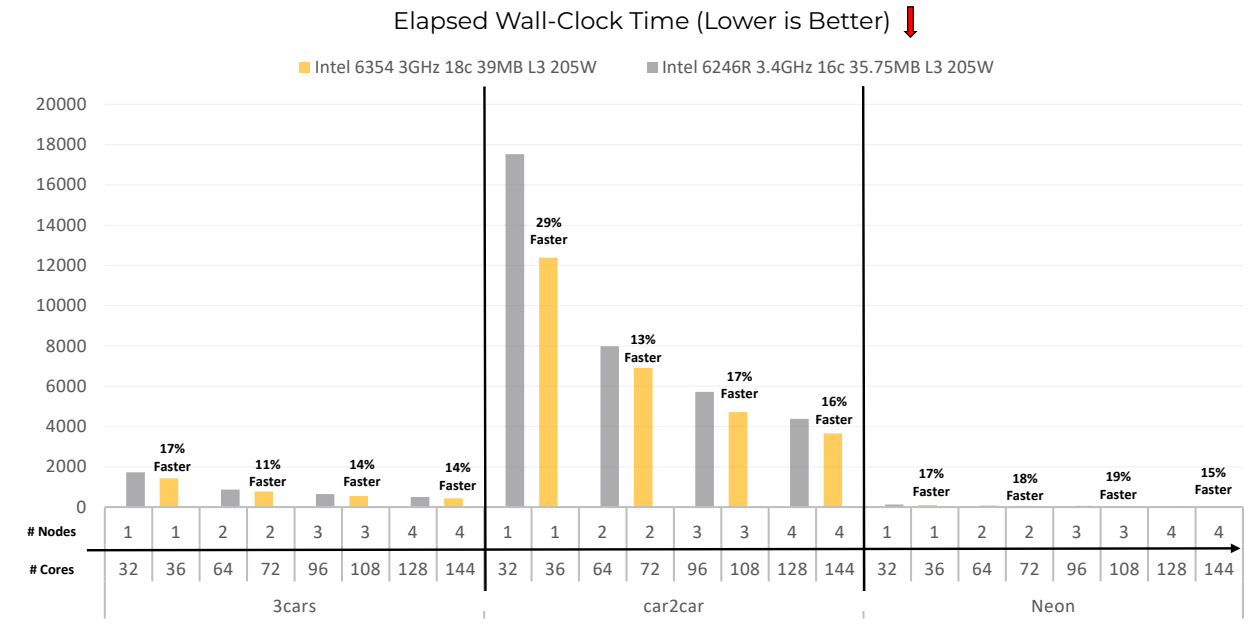

Figure 6. Ansys LS-DYNA wall-clock time benchmark results

/ CONCLUSION

HPE, Intel, and Ansys are collaborating to provide an optimal platform for product design. Memory enhancements in the latest generation of Intel Xeon Scalable processors, along with acceleration technology like Intel AVX-512, provide the raw horsepower needed for Ansys CFD, Mechanical, and LS-DYNA workloads. Ansys and Intel engineers also work closely to optimize code so that it can take advantage of Intel architecture. And by deploying Ansys applications on the HPE Apollo 2000 Gen10 Plus system, manufacturers can minimize server footprint, lower overall costs, and reduce energy consumption.

Ansys standard benchmarks show that this workload-optimized combination of hardware and software can substantially improve Ansys workload performance, as measured by number of jobs per day and elapsed wall-clock time. These performance improvements can be a significant differentiator for manufacturers because they can help them bring higher quality products to market more quickly.

/ ADDITIONAL RESOURCES

HPE Apollo 2000 Gen10 Plus System
https://www.hpe.com/psnow/doc/a00056110enw?jumpid=in_lit-psnow-red

3rd Generation Intel Xeon Scalable processors
https://www.intel.com/content/www/us/en/products/docs/processors/xeon/3rd-gen-xeon-scalable-processors-brief.html

Intel AVX-512
https://www.intel.com/content/www/us/en/architecture-and-technology/avx-512-overview.html

Ansys HPC
http://www.ansys.com/hpc

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