# ANSYS® LS-DYNA® AND AMD 3D V-CACHE™ TECHNOLOGY
## FINITE ELEMENT ANALYSIS

Powered by 4th Gen AMD EPYC™ Processors with AMD 3D V-Cache™ technology

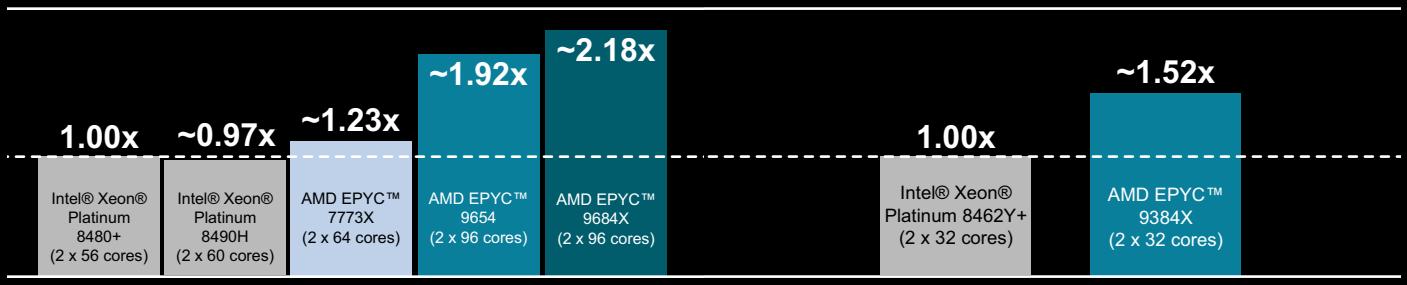
**June 2023**

### AT A GLANCE

1P and 2P systems powered by 96-core 4th Gen AMD EPYC™ processors with AMD 3D V-Cache™ technology demonstrate outstanding top of stack competitive and generational performance uplifts on Ansys® LS-DYNA®.[2]

## PERFORMANCE HIGHLIGHTS

Comparing 2P servers - one powered by AMD EPYC 9684X (96-core) processors compared to a 2P server powered by a Intel Xeon Platinum 8480+ (56-core) or 8490H (60-core) processors delivered a composite average LS-DYNA competitive performance uplift of ~2.18x and ~2.25x (~2.86x and ~2.87x maximum on 3 cars crash sim test case), respectively.




## KEY TAKEAWAYS

Comparing 2P servers - one powered by AMD EPYC 9684X (96-core) processors compared to a 2P server powered by a Intel Xeon Platinum 8480+ (56-core) or 8490H (60-core) processors delivered a composite average Ansys LS-DYNA competitive performance uplift of ~2.18x and ~2.25x (~2.86x and ~2.87x maximum on 3cars test case), respectively. On a per-core basis, a 2P server powered by 32-core AMD EPYC 9384X processors outperformed a 2P server powered by 32-core Intel Xeon Platinum 8462Y+ processors by ~1.52x on average (~1.89x maximum on 3cars test case). 4th Gen AMD EPYC 9004X processors with AMD 3D V-Cache technology are available in 1P and 2P configurations and feature:

- Up to 1,152MB L3 cache vs. 384MB in standard 4th Gen AMD EPYC processors.
- Up to 4 links of Gen 3 Infinity Fabric™ at up to 32 Gbps.
- 12 memory channels that support up to 6TB of DDR5-4800 memory.
- Support for PCIe® Gen 5 at up to 32 Gbps.
- AVX-512 instruction support for enhanced HPC and ML performance.
- AMD Infinity Guard technology to defend your data.[3]

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## DETAILED SINGLE-NODE PERFORMANCE RESULTS

Figures 1 and 2 provide detailed performance uplift information for high core count processors (AMD EPYC 9684X and Intel Xeon Platinum 8480+) and 32-core processors (AMD EPYC 9384X and Intel Xeon Platinum 8462Y+).

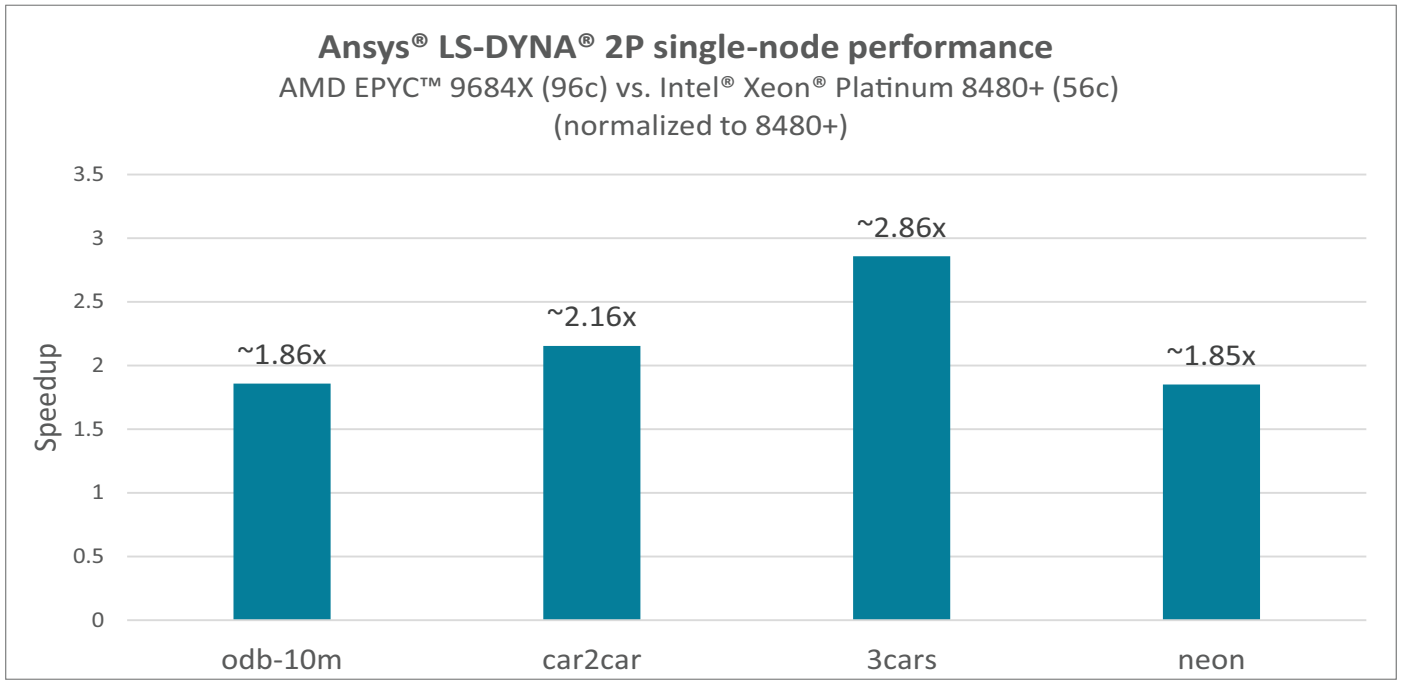


*Figure 1: Detailed 2P single-node performance, 96c AMD EPYC 9684X vs. 56c Intel Xeon Platinum 8480+*

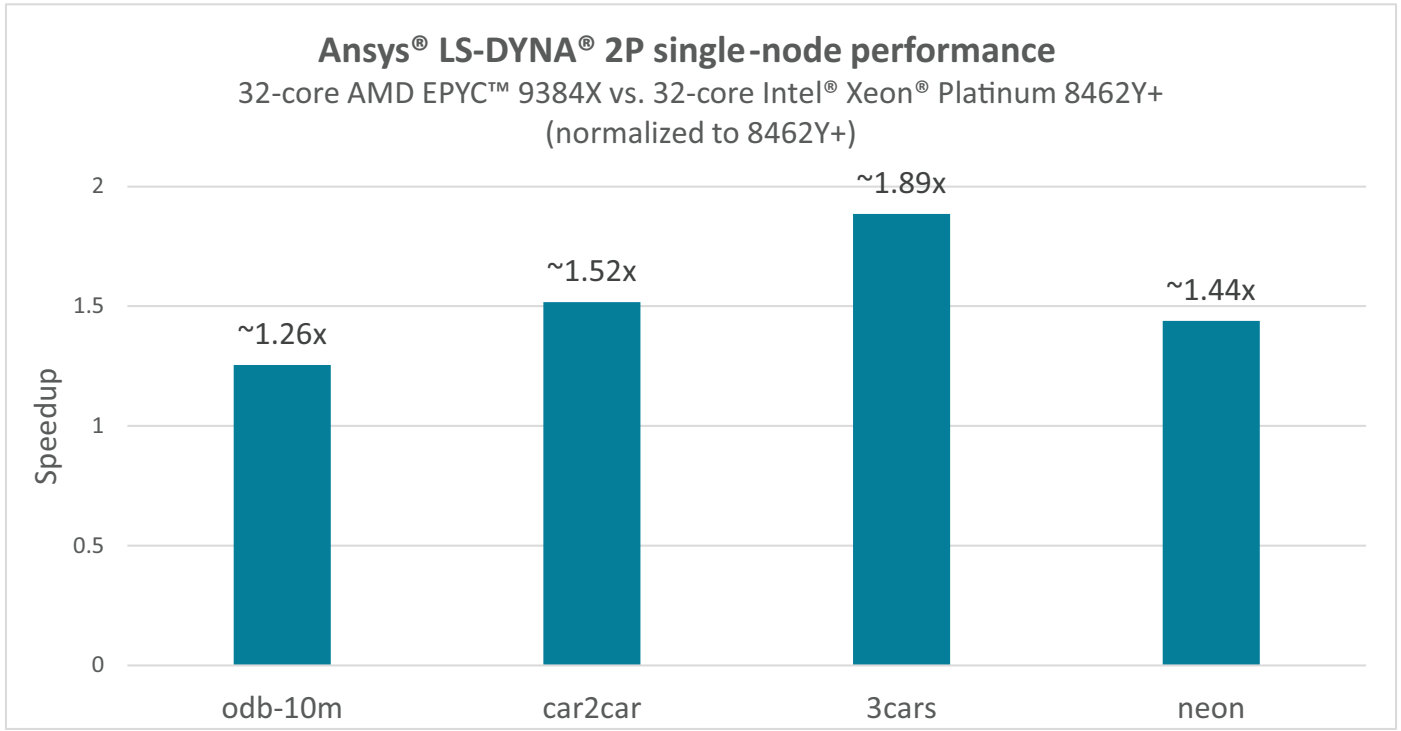


*Figure 2: Detailed 2P single-node performance, 32c AMD EPYC 9384X vs. 32core Intel Xeon Platinum 8462Y+*

## AMD 3D V-CACHE™ TECHNOLOGY

Some AMD EPYC 9004 Series Processors include AMD 3D V-Cache™ die stacking technology that enables more efficient chiplet integration. AMD 3D Chiplet architecture stacks L3 cache tiles vertically to provide up to 96MB of L3 cache per die (and up to 1152 MB L3 Cache per socket) while still providing socket compatibility with standard AMD EPYC™ 9004 Series Processor models.

AMD EPYC 9004 Series Processors with AMD 3D V-Cache technology employ industry-leading logic stacking based on copper-to-copper hybrid bonding "bumpless" chip-on-wafer process to enable over 200X the interconnect densities of current 2D technologies (and over 15X the interconnect densities of other 3D technologies using solder bumps),[4,5] which translates to lower latency, higher bandwidth, and greater power and thermal efficiencies.

## SYSTEM CONFIGURATION

| AMD SYSTEM CONFIGURATION | | | | |
|---|---|---|---|---|
| CPUs | 2x AMD EPYC 7773X | 2x AMD EPYC 9654 | 2 x AMD EPYC 9384X | 2 x AMD EPYC 9684X |
| Frequency: Base \| Boost[6] | 2.20 GHz \| 3.50 GHz (up to) | 2.40 GHz \| 3.55 GHz (up to) | 3.10 GHz \| 3.90 GHz (up to) | 2.55 GHz \| 3.70 GHz (up to) |
| Cores | 64 cores/socket (128 threads) | 96 cores/socket (192 threads) | 32 cores/socket (64 threads) | 96 cores/socket (192 threads) |
| L3 Cache | 768 MB per CPU | 384 MB per CPU | 768 MB per CPU | 1152 MB per CPU |
| Memory | 1.0 TB (16x) Dual-Rank DDR4 3200 64 GB DIMMs 1 DPC | 1.5 TB (24x) Dual-Rank DDR5 4800 64 GB DIMMs 1 DPC | | |
| NIC | 25 Gb Ethernet CCX512-A ConnectX-5 (fw 16.35.2000) | | | |
| InfiniBand | 200 Gb HDR ConnectX-6 VPI (fw 20.35.2000) | | | |
| Storage: OS \| Data | Samsung MZQL21T9HCJR-00A07 1.92 TB | | | |
| BIOS Version | 1009B | 1007D | | |
| BIOS Settings | SMT=OFF; NPS=4; Determinism=Power | | | |
| OS | RHEL 8.7 (kernel 4.18.0-425.3.1.el8.x86_64) | | | |
| OS Settings | amd_iommu=ON; iommu=pt; mitigations=off; clear caches; NUMA balancing=0; THP=on; CPU governor=Performance; C2 states=disabled | | | |

*Table 1: AMD system configurations*

| INTEL SYSTEM CONFIGURATION | | | |
|---|---|---|---|
| CPUs | 2x Intel Xeon Platinum 8462Y+ | 2x Intel Xeon Platinum 8480+ | 2x Intel Xeon Platinum 8490H |
| Frequency: Base \| Boost | 2.40 GHz \| 4.10 GHz (up to) | 2.00 GHz \| 3.80 GHz (up to) | 1.90 GHz \| 3.50 GHz (up to) |
| Cores | 32 cores per socket (64 threads) | 56 cores per socket (112 threads) | 60 cores per socket (120 threads) |
| L3 Cache | 60 MB per CPU | 105 MB per CPU | 112.5 MB per CPU |
| Memory | 1.0 TB (16x) Dual-Rank DDR5 4800 64 GB DIMMs 2 DPC | | |
| NIC | 25 Gb Ethernet CCX512-A ConnectX-5 (fw 16.35.2000) | | |
| InfiniBand | 200 Gb HDR ConnectX-6 VPI (fw 20.35.2000) | | |
| Storage: OS \| Data | Samsung MZQL21T9HCJR-00A07 1.92 TB | | |
| BIOS Version | ESE110Q-1.10 | | |
| BIOS Settings | Hyperthreading=Off, Profile = Maximum Performance | | |
| OS | RHEL 8.7 (kernel 4.18.0-425.3.1.el8.x86_64) | | |
| OS Settings | processor.max_cstate=1; intel_idle.max_cstate=0; iommu=pt mitigations=off; clear caches; NUMA Balancing=0; randomize_va_space 0; THP=ON; CPU Governor=Performance | | |

*Table 2: Intel system configurations*

## TEST METHODOLOGY

Ansys provides a standard set of benchmarks that evaluate the performance of different platforms running Ansys applications. These benchmark cases represent typical usage and cover a range of sizes. The uplift is calculated as the ratio of the systems under test (*sut*) to the reference systems (*ref*). In this Performance Brief, the Intel Xeon Platinum 8480+ and Intel Xeon 8462Y processors are the *ref* systems, and the AMD EPYC processors are the *sut*. The AMD EPYC processors tested include AMD EPYC 9004 and both 3rd Gen AMD EPYC 7003 and AMD EPYC 9004 processors with AMD 3D V-Cache technology. The total amount of variability between individual runs was <1%. The results presented in this Performance Brief are the composite average per-processor uplifts running the odb10m, 3cars, car2car, and neon. The systems tested were configured as shown in Tables 1 and 2, above.

## FOR ADDITIONAL INFORMATION

Please see the following additional resources for more information about 4th Gen AMD EPYC features, architecture, and available models:

- AMD EPYC™ 9004 Series Processors
- AMD EPYC™ Tuning Guides
- AMD EPYC™ Products
- AMD and Ansys*

## REFERENCES


1. "Technical Computing" or "Technical Computing Workloads" as defined by AMD can include: electronic design automation, computational fluid dynamics, finite element analysis, seismic tomography, weather forecasting, quantum mechanics, climate research, molecular modeling, or similar workloads. GD-204
2. See https://www.ansys.com/products/fluids/ansys-LS-DYNA.
3. AMD Infinity Guard features vary by EPYC™ Processor generations. Infinity Guard security features must be enabled by server OEMs and/or Cloud Service Providers to operate. Check with your OEM or provider to confirm support of these features. Learn more about Infinity Guard at https://www.amd.com/en/technologies/infinity-guard. GD-183
4. Based on calculated areal density and based on bump pitch between AMD hybrid bond AMD 3D V-Cache stacked technology ccompared to AMD 2D chiplet technology and Intel 3D stacked micro-bump technology. EPYC-026
5. Based on AMD internal simulations and published Intel data on "Foveros" technology specifications. EPYC-027
6. Maximum boost for AMD EPYC processors is the maximum frequency achievable by any single core on the processor under normal operating conditions for server systems. EPYC-18

**AUTHORS**
Alvaro Fernandez and Ashok Manikonda contributed to this Performance Brief.

## RELATED LINKS

- Ansys*
- Ansys LS-DYNA*
- AMD and Ansys*
- Ansys HPC
- AMD EPYC Processors
- AMD EPYC Technical Briefs

**Links to third party sites are provided for convenience and unless explicitly stated, AMD is not responsible for the contents of such linked sites and no endorsement is implied.*

## AMD EPYC 9004 FOR FEA

4th Gen AMD EPYC CPUs deliver excellent per-core performance by taking advantage of fast CPU frequencies, low latency memory, and a unified cache structure. Design engineers can use AMD EPYC processors to perform complex finite element analysis tasks with ground-breaking high-performance computing and robust security features to deliver excellent results.

## "ZEN 4" CORE & SECURITY FEATURES

Support for up to:

- 96 physical cores, 192 threads
- 1152 MB of L3 cache per CPU
- 96 MB of L3 cache per CCD
- 6 TB of DDR5-4800 memory
- Up to 128 1P, up to 160 2P PCIe® Gen 5 lanes

Infinity Guard security features[3]

- Secure Boot
- Encrypted memory with SME

## ANSYS

Ansys offers a broad portfolio of engineering simulation software that enables customers to solve complex design challenges, rapidly innovate and easily validate design ideas, and predict the performance of future products.

## ANSYS LS-DYNA

Ansys® LS-DYNA® is a widely-used explicit simulation program that is capable of simulating complex real-world short-duration events in the automotive, aerospace, construction, military, manufacturing, and bioengineering industries. For example, the automotive industry uses LS-DYNA to analyze vehicle designs and predict both a car's behavior in a collision and how that collision affects the car's occupants.