ANSYS® CFX® AND AMD 3D V-CACHE™ TECHNOLOGY
COMPUTATIONAL FLUID DYNAMICS

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

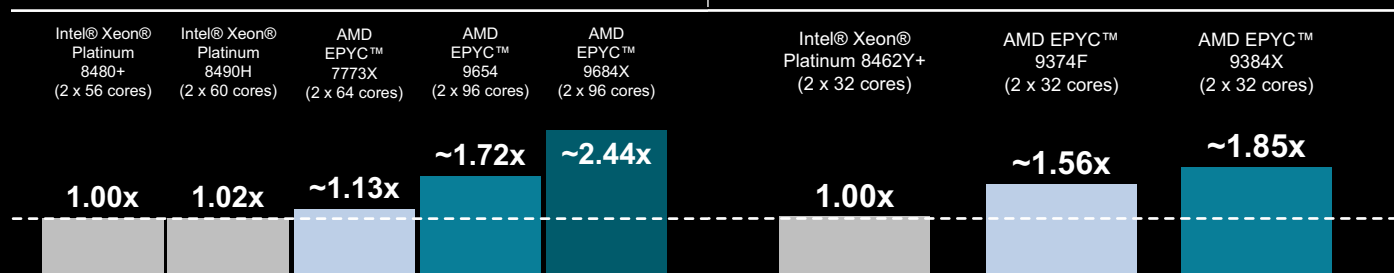**June 2023**

AT A GLANCE

2P systems powered by 32- and 96-core 4th Gen AMD EPYC™ processors with AMD 3D V-Cache™ technology demonstrate outstanding per-core and top of stack competitive and generational performance uplifts on Ansys® CFX®.

PERFORMANCE HIGHLIGHTS

A single 2P 96-core 4th Gen AMD EPYC 9684X system with AMD 3D V-Cache technology demonstrates a ~2.44x uplift vs. a single 2P Intel® Xeon® Platinum 8480+ system on a composite average of Ansys CFX workloads. On a per-core basis, a 2P 32c 9384X system outperforms a 2P 32-core Intel Xeon Platinum 8462Y+ system by an average of ~1.85x.

2P AMD EPYC™ 9684X vs. 2P Intel Xeon Platinum 8480+ (Top of stack - composite average, normalized to 8480+)					2P AMD EPYC™ 9384X vs. 2P Intel Xeon Platinum 8462Y+ (32-core - composite average, normalized to 8462Y+)		
Intel® Xeon® Platinum 8480+ (2 x 56 cores)	Intel® Xeon® Platinum 8490H (2 x 60 cores)	AMD EPYC™ 7773X (2 x 64 cores)	AMD EPYC™ 9654 (2 x 96 cores)	AMD EPYC™ 9684X (2 x 96 cores)	Intel® Xeon® Platinum 8462Y+ (2 x 32 cores)	AMD EPYC™ 9374F (2 x 32 cores)	AMD EPYC™ 9384X (2 x 32 cores)
1.00x	1.02x	~1.13x	~1.72x	~2.44x	1.00x	~1.56x	~1.85x

KEY TAKEAWAYS

Comparing 2P servers - one powered by AMD EPYC 9684X (96-core) processors and the other powered by a Intel Xeon Platinum 8480+ (56-core) or 8490H (60-core) processors delivered a composite average Ansys CFX competitive performance uplift of ~2.44x and ~2.39x (~2.59x and ~2.55x maximum on Airfoil 10m test case), respectively. On a per-core basis, a 2P server powered by 32-core AMD EPYC 9384X processors outperformed a 2P 32-core Intel Xeon Platinum 8462Y+ processors by ~1.85x on average (~2.03x maximum on Airfoil 10m 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[2].

IN THIS BRIEF

DETAILED SINGLE-NODE PERFORMANCE RESULTS

Figures 1 and 2 provide detailed performance uplift information on both a per-core basis for 32-core processors (AMD EPYC 9384X vs Intel Xeon Platinum 8462Y+) and high core count processors (AMD EPYC 9684X and Intel Xeon Platinum 8480+).
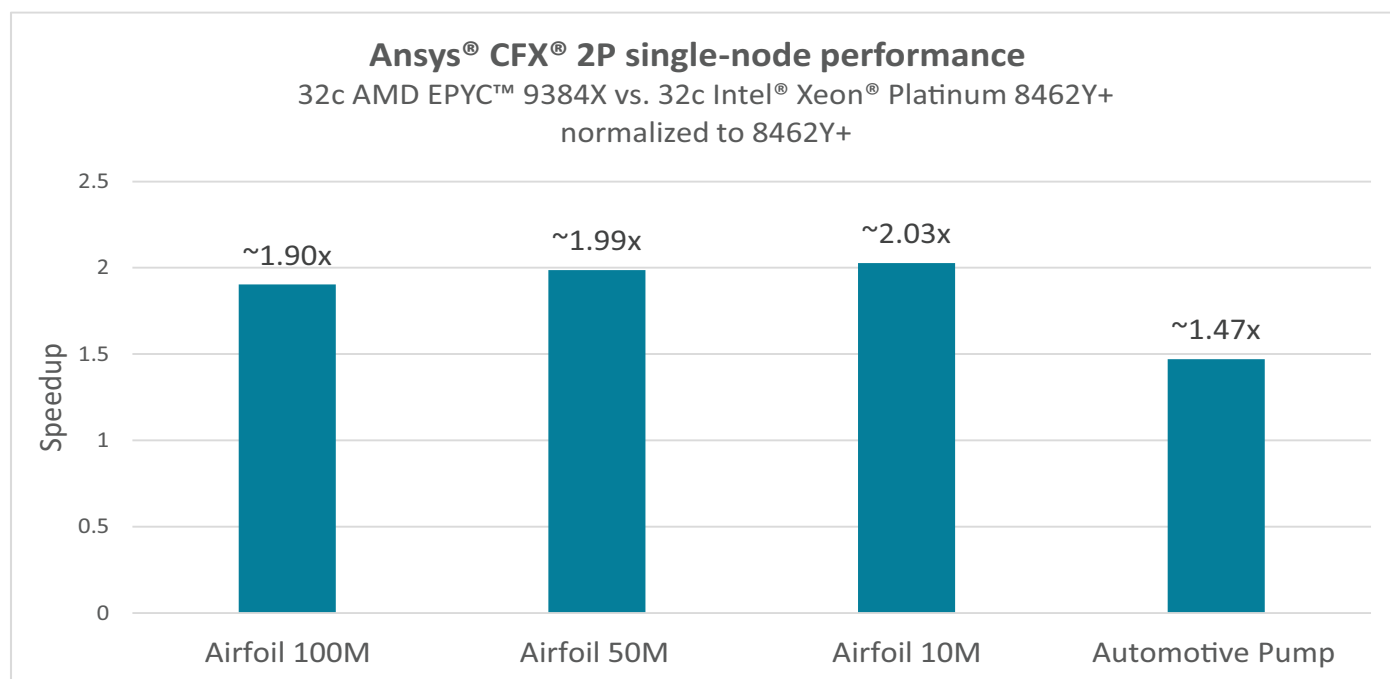
Ansys® CFX® 2P single-node performance
32c AMD EPYC™ 9384X vs. 32c Intel® Xeon® Platinum 8462Y+
normalized to 8462Y+

Benchmark	Speedup
Airfoil 100M	~1.90x
Airfoil 50M	~1.99x
Airfoil 10M	~2.03x
Automotive Pump	~1.47x

Figure 1: Detailed 2P single-node performance, 32c AMD EPYC 9384X vs. 32c Intel Xeon Platinum 8462Y+

Ansys® CFX® 2P single-node performance
High core count AMD EPYC™ 9684X (96c) vs. Intel® Xeon® Platinum 8480+ (56c)
normalized to 8480+

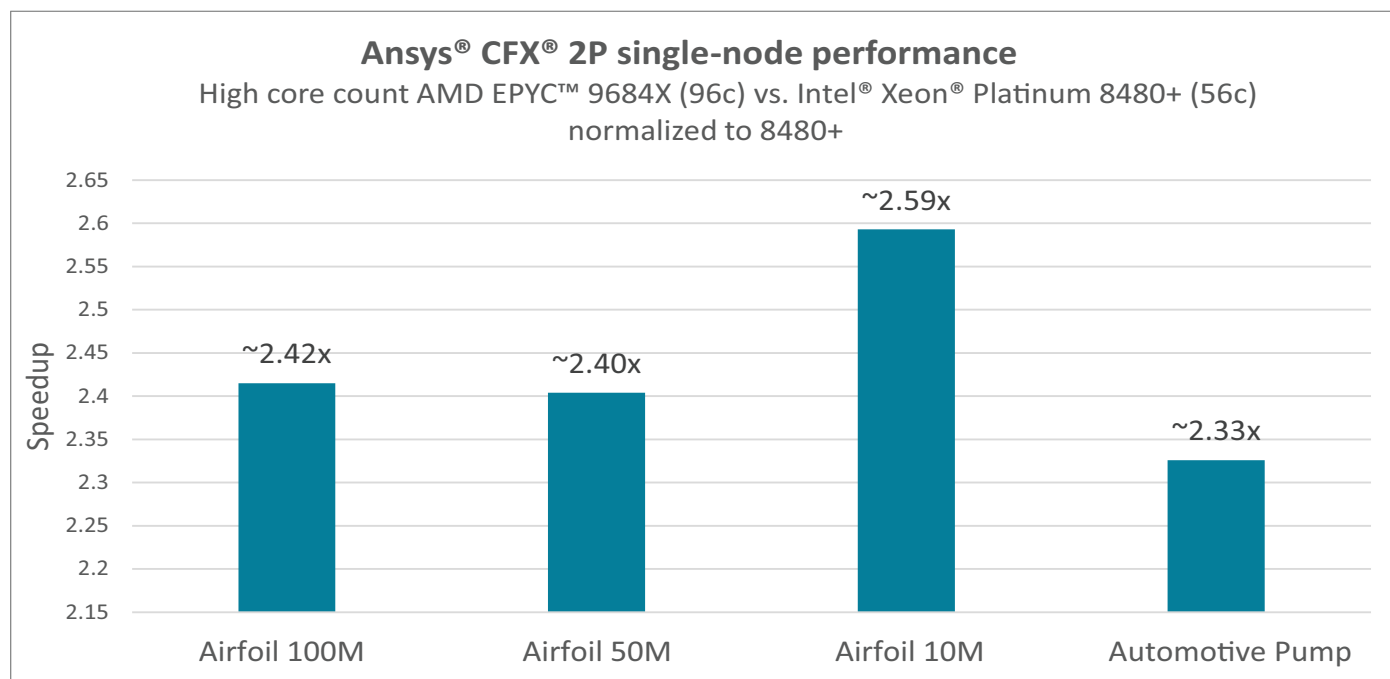| Benchmark	Speedup
Airfoil 100M	~2.42x
Airfoil 50M	~2.40x
Airfoil 10M	~2.59x
Automotive Pump	~2.33x

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

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),[3,4] which translates to lower latency, higher bandwidth, and greater power and thermal efficiencies.

SYSTEM CONFIGURATION

AMD SYSTEM CONFIGURATION					
CPUs	2x AMD EPYC 7773X	2 x AMD EPYC 9374F	2 x AMD EPYC 9384X	2x AMD EPYC 9654	2 x AMD EPYC 9684X
Frequency: Base | Boost[5]	2.20 GHz | 3.50 GHz (up to)	3.85 GHz | 4.10 GHz (up to)	3.10 GHz | 3.90 GHz (up to)	2.40 GHz | 3.55 GHz (up to)	2.55 GHz | 3.70 GHz (up to)
Cores	64 cores/socket (128 threads)	32 cores/socket (64 threads)	32 cores/socket (64 threads)	96 cores/socket (192 threads)	96 cores/socket (192 threads)
L3 Cache	768 MB per CPU	256 MB per CPU	768 MB per CPU	384 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 Platinum 8462Y+ processors are the *ref* systems, and the 3rd and 4th Gen AMD EPYC processors are the *sut*. The AMD EPYC processors tested include standard AMD EPYC 9004 and both AMD EPYC 7003 and AMD EPYC 9004 models 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 Airfoil 100M, Airfoil 50M, Airfoil 10M, and Automotive Pump benchmarks. 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. 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
3. 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
4. Based on AMD internal simulations and published Intel data on "Foveros" technology specifications. EPYC-027
5. 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 and AMD*
- Ansys CFX*
- Ansys HPC*
- AMD EPYC™ Processors
- AMD EPYC Technical Briefs and Tuning Guides

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 CFD

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 computational fluid dynamics tasks with groundbreaking high-performance computing and robust security features to deliver excellent results.

"ZEN 4" CORE & SECURITY FEATURESSUPPORT 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[2]

- Secure Boot

Encrypted memory with SME

ANSYS®

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

ANSYS® CFX®

Ansys® CFX® is a high-performance computational fluid dynamics (CFD) software tool that delivers robust, reliable, and accurate solutions quickly across a wide range of CFD and Multiphysics applications