HIGH PERFORMANCE COMPUTING

AMD EPYC™ 7002 SERIES PROCESSORS
ANSYS® Fluent® SOLVING REAL WORLD PROBLEMS

AUGUST 2019

AMD EPYC for HPC

Utilizing the x86 architecture, and built on 7nm technology, the AMD EPYC™ 7002 Series processors bring together high core counts, large memory capacity, extreme memory bandwidth and massive I/O with the right ratios to enable exceptional HPC workload performance.

Standards-Based Architecture

Continuing AMD's commitment to industry standards, AMD EPYC™ 7002 Series processors offer you a choice in x86 architecture. x86 compatibility means you can run most x86-based applications on AMD EPYC processors.

Exceptional Scalability

Scaling is critical to HPC applications. AMD EPYC 7002 Series processors provide high bandwidth between nodes with support for PCIe Gen 4 enabled network devices. Within a node, take advantage of up to 64 cores per socket, including 8 memory channels utilizing speeds up to DDR4-3200[2]. Add incredible floating point and integer compute within each core and the AMD EPYC 7002 series delivers exceptional performance and scalability for HPC.

Fully Tested and Validated

AMD's broad partner ecosystem and collaborative engineering provide tested and validated solutions that help lower your risk and total cost of ownership.

ANSYS Fluent: Simulating complex real-world problems

ANSYS Fluent is a general-purpose computational fluid dynamics (CFD) and multi-physics tool that empowers you to go further and faster as you optimize your product's performance.

AMD EPYC™ 7002 Processors: Architectural Innovations Deliver Exceptional Performance and Scalability

The high-performance computing (HPC) market has grown to a point where it is a critical component of new technology advancements in academia and a wide array of industries in both the public and private sectors. Scientific research, public health, climate modeling, and oil and gas exploration are just a few examples where HPC is the driving force behind new innovations and knowledge discovery.

7 nm	PCIe® Gen 4	DDR4 3200
64 Cores per socket	**128** PCIe® Gen 4 lanes per socket	**8** Memory channels per socket
World's first 7 nm x86 server CPU Highest available core count[1] to maximize parallelism	World's first PCIe® Gen 4 ready x86 server CPU Doubles the bandwidth of the previous generation	World's first x86 architecture with DRR4 3200[2] Up to 4 TB of memory capacity per socket

The second generation of the AMD EPYC™ processor extends AMD's innovation leadership for HPC. Built with leading-edge 7nm technology, the AMD EPYC™ SoC offers a consistent set of features across a range of choices from 8 to 64 cores, including 128 lanes of PCIe® Gen 4[2] and 8 memory channels with access to up to 4 TB of high-speed memory.

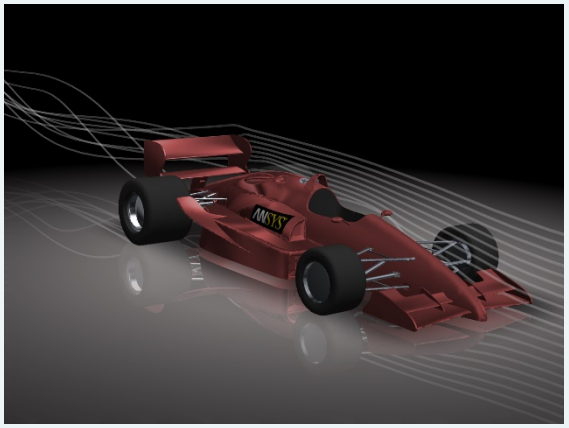
The AMD EPYC™ 7002 Series processor's innovative architecture translates to tremendous performance and scalability for HPC applications, offering you a choice in x86 architecture while optimizing total cost of ownership.

ANSYS Fluent

ANSYS Fluent is a general-purpose computational fluid dynamics (CFD) and multi-physics tool that empowers you to go further and faster as you optimize your product's performance. Fluent software contains the broad physical modeling capabilities needed to model flow, turbulence, heat transfer, and reactions for industrial applications—ranging from air flow over an aircraft wing to combustion in a furnace, from bubble columns to oil platforms,

from blood flow to semiconductor manufacturing, and from clean room design to wastewater treatment plants.

Fluent covers a broad reach, including special models with capabilities to model in-cylinder combustion, aero-acoustics, turbomachinery and multiphase systems. AMD and ANSYS have an ongoing partnership to deliver exceptional performance for customers.



Power without Compromise

Memory bandwidth is a critical factor in maximizing performance of Computational Fluid Dynamics (CFD) workloads. AMD EPYC server processors' exceptional memory bandwidth helps ensure that you get the most out of your system, optimizing execution time and overall utilization of your deployment.

Many high-performance compute (HPC) workloads require you to balance performance vs per-core license costs to manage your overall cost. AMD EPYC processors offer a consistent set of features across the product line, allowing users to optimize the number of cores required for their workloads without sacrificing features, memory channels, memory capacity, or I/O lanes. Regardless of the number of physical cores per socket, you will have access to 8 channels of memory per processor across all EPYC server processors.

As workloads demand more processor cores, communication between processor cores becomes critical to efficiently solving the complex problems faced by customers. As cluster sizes increase, the communication requirements between nodes rise quickly and can limit scaling at large node counts. AMD and ANSYS have collaborated to offer solutions for CFD workloads, enabling exceptional performance and low implementation costs.

Performance Benchmarks and Testing

This document focuses on performance and scaling of the EPYC 7002 Series Processors. Testing was performed on a cluster of dual-socket EPYC™ 7742-based systems and dual-socket EPYC™ 7542-based systems.

Each EPYC 7742 processor has 64 cores with a base frequency of 2.25 GHz and a boost frequency of 3.4 GHz. Each 7542 processor has 32 cores with a base frequency of 2.9 GHz and boost of 3.4 GHz.

The compute nodes in the cluster are each populated with 1 DIMM per channel of 64-GB, dual-rank, DDR4-3200 DIMMs from Micron®, for a total of 1TB of memory per node.

A Mellanox® ConnectX-6 200 Gb/s HDR InfiniBand adapter, utilizing EPYC processors' support for PCIe Gen 4, is also populated on each EPYC processor-based system.

Single-node testing was performed across all platform configurations and multi-node scaling was tested on the EPYC 7742 processor.

Testing was also run on single-node instances of Intel® Xeon® Gold 6248 and Intel Xeon Platinum 8280-based platforms. Both Intel platforms were populated with DDR4-2933 memory, matching the maximum memory speed supported for each processor.

The ANSYS Fluent Release 19.0 benchmark suite provides standardized test cases in order to evaluate system/cluster performance. The benchmark's input data sets are scaled to various sizes in order to represent a sampling of the wide variety of cases that Fluent can solve. The ANSYS Fluent benchmark cases range in size from a few hundred-thousand cells to more than 200 million cells. The suite contains both pressure-based (segregated and coupled) and density-based implicit solver cases using a variety of cell types and a range of physics.

Scale-out performance was run on the 7 largest benchmarks in the suite, ranging from 14 million cells up to 280 million cells per model.

More information on the benchmark suite can also be found at this link:
https://www.ansys.com/solutions/solutions-by-role/it-professionals/platform-support/benchmarks-overview/ansys-fluent-benchmarks

Tested Hardware and Software Configuration

AMD Compute Nodes		
CPUs	2 x EPYC 7742	2 x EPYC 7542
Cores	64 cores per socket (128 per node)	32 cores per socket (64 per node)
Memory	Micron 1 TB (16x) Dual-Rank DDR4-3200, 1DPC	
Network Adapter	Mellanox ConnectX-6 HDR 200Gb/s Infiniband x16 PCIe® Gen 4	
Storage: OS | Data	1 x Micron 1100 256 GB SATA | 1 x 1 TB NVMe	
Software		
OS	RHEL 7.6 (3.10.0-862.el7.x86_64)	
Mellanox OFED Driver	MLNX_OFED_LINUX-4.5-1.0.1.0 (OFED-4.5-1.0.1)	
Network		
Switch	Mellanox 200Gb/s HDR InfiniBand Switch (MQM8790)	
Configuration Options		
BIOS Setting	NPS = NPS4, SMT = Off, Boost = On, X2APIC = On, Determinism Slider = Performance, Preferred IO=Enabled	
OS Settings	Governor=Performance, CC6 = Disabled	

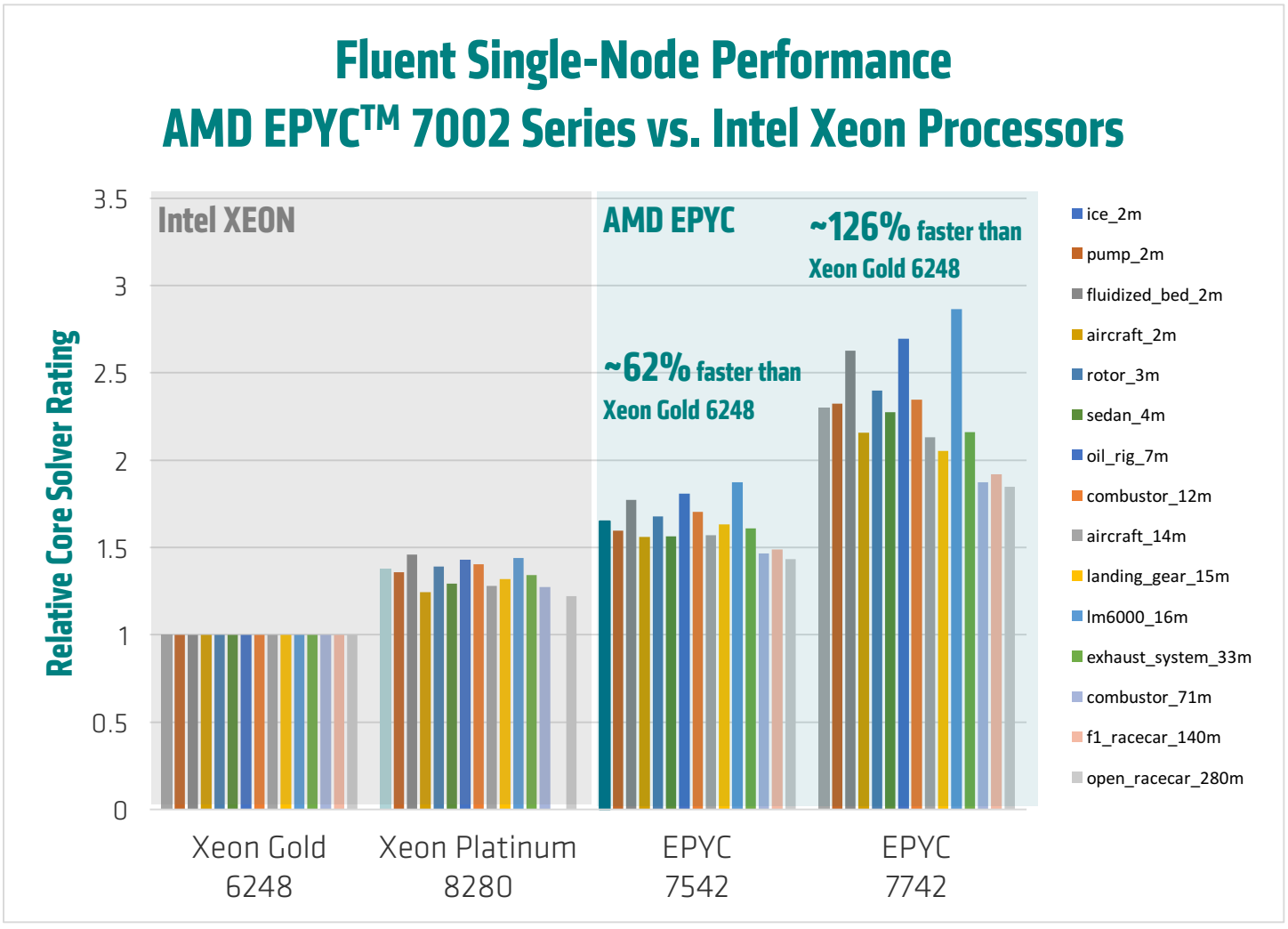
Intel-based Compute Nodes		
CPUs	2 x Intel Xeon Gold 6248	2 x Intel Xeon Platinum 8280
Cores	20 cores per socket (40 per node)	28 cores per socket (56 per node)
Memory	768 GB (12x) Dual-Rank DDR4-2933, 1 DPC (Samsung)	384 GB (12x) Dual-Rank DDR4-2933, 1 DPC (Micron)
Storage: OS | Data	1 x 240 GB SATA | 1 x 500 GB NVMe	
Software		
OS	RHEL 7.6 (3.10.0-862.el7.x86_64)	
Configuration Options		
BIOS Setting	Default, plus: Power Management = Max Performance, Hyper-threading=Off, SNC=On, ADDDC=Off	
OS Settings	Overridden by BIOS Power Management Settings	

ANSYS Fluent: Single-node Performance

Single-node performance is a critical starting point for evaluating a cluster. The AMD EPYC 7002 Series processors show exceptional performance on both the 32-core AMD EPYC 7542 and on the 64-core AMD EPYC 7742.

AMD EPYC 7542 is up to 62% faster than the Intel Xeon Gold 6248, on average across all Fluent benchmarks. The highest performance advantage was shown on the lm6000 (Flow through Combustor) benchmark, with a performance advantage of ~88% faster than Intel Xeon Gold 6248. This benchmark case has around 16 million hexahedral cells and uses the LES, Partially Premixed Combustion, PDF model and the Pressure based segregated solver, Green Gauss cell based, Unsteady solver.

AMD EPYC 7742 is up to 126% faster than the Intel Xeon Gold 6248, on average across all Fluent benchmarks. Again, the highest performance advantage was on the lm6000 (Flow through Combustor) benchmark, the 5th largest model in the suite. On this model, the AMD EPYC 7742 performed ~187% faster than the Intel Xeon Gold 6248.



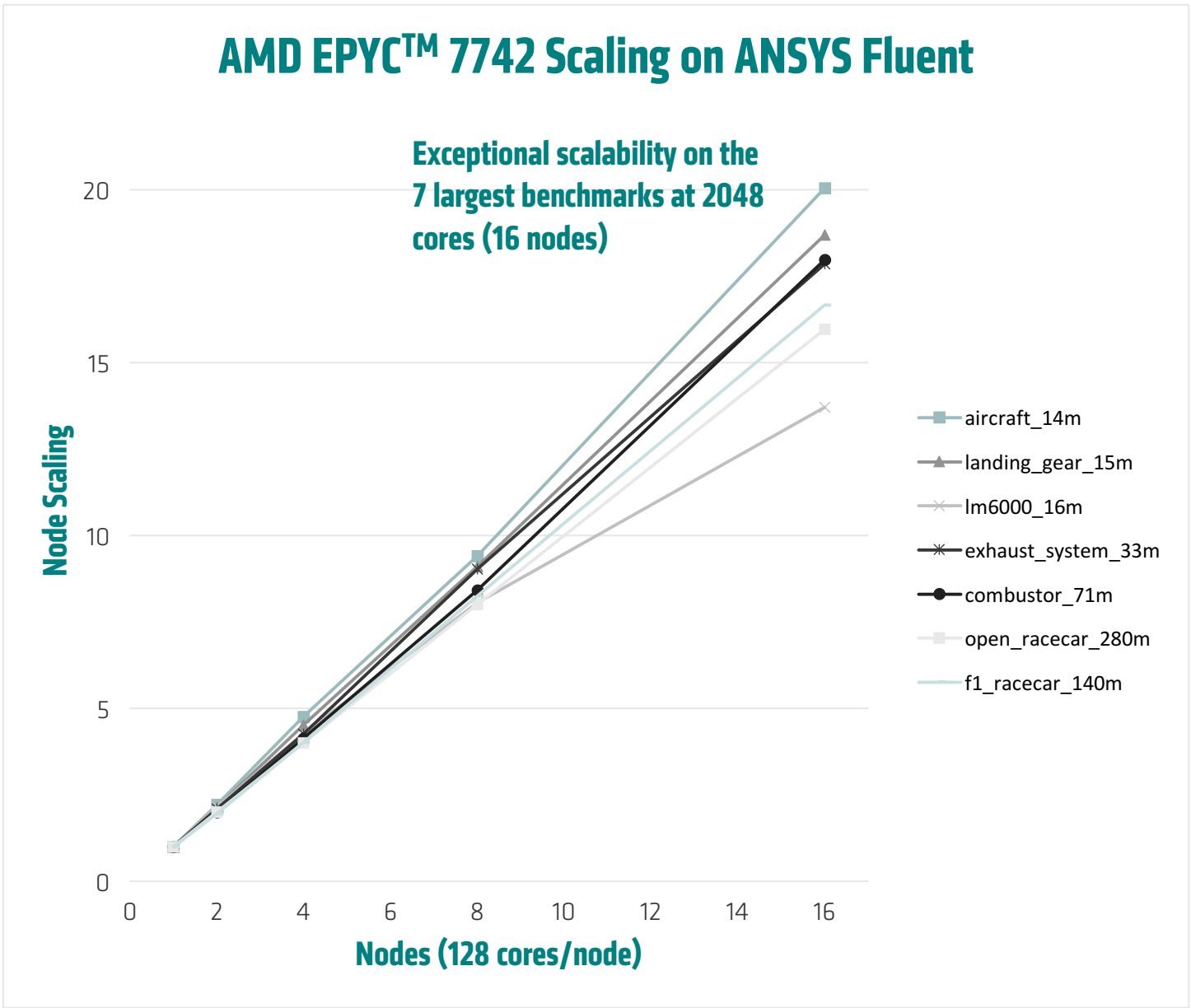
ANSYS Fluent: Multi-node Scaling

ANSYS Fluent benchmarks scale exceptionally well on AMD EPYC™ 7002 Series processors. The chart below shows scaling of the AMD EPYC 7742 in two-socket platforms, scaling up to 16 nodes. At 64-cores per processor, each node has 128 physical cores for a total of 2048 cores at 16 nodes.

On the 7 largest models in the Fluent benchmark suite, 2nd Gen AMD EPYC 7742 showed exceptional scaling at 16 nodes. The highest was emp_30M (14M cells) with ~20X performance at 16X nodes. The average across all 7 benchmarks was ~17.3X performance at 16 nodes. Open Racecar (280M cells) was near perfect scaling with performance of ~15.97X at 16 nodes.

Super-linear speedup of Fluent is often caused by the availability and use of larger amounts of "fast" memory (e.g. cache or local memory).

Combining the exceptional single-node numbers above with the super-linear scaling results below shows a highly efficient and productive cluster.



Conclusion

Single-node performance of the AMD EPYC 7702 Series processors shows impressive performance advantages over the Intel Xeon Gold 6248, with the EPYC 7742 reaching a peak advantage of up to 187%, and an average advantage of up to 126% faster across the entire benchmark suite.

Scale-out testing on the 16-node AMD EPYC 7742 cluster shows impressive results. The exceptional scaling shows that the AMD EPYC 7002 Series processors are well suited for scale-out HPC applications. ANSYS Fluent's ability to scale to efficiently consume 2048 cores on 16-nodes is equally impressive.

ANSYS Fluent Computational Fluid Dynamics (CFD) application is architected to deliver accuracy, performance, and scalability to meet your CFD needs, empowering you to go further and faster as you optimize your product's performance. Fluent includes well-validated physical modeling capabilities to deliver fast, accurate results across the widest range of CFD and multi-physics applications.

Together, AMD and ANSYS empower the development of fast, accurate Computational Fluid Dynamics simulations running on cost-effective clustered systems.

For more information about AMD's EPYC line of processors visit: http://www.amd.com/epyc

For more information about ANSYS visit: http://www.ANSYS.com

FOOTNOTES

1. Best-in-class based on industry-standard pin-based (LGA) X86 processors. EPYC-08.
2. Some supported features and functionality of second-generation AMD EPYC™ processors (codenamed "Rome") require a BIOS update from your server manufacturer when used with a motherboard designed for the first-generation AMD EPYC 7000 series processor. A motherboard designed for "Rome" processors is required to enable all available functionality. ROM-06.