HIGH PERFORMANCE COMPUTING

AMD EPYC™ 7002 SERIES PROCESSORS STRUCTURAL ANALYSIS WITH ALTAIR RADIOSS™

AMD EPYC

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 your 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 and 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.

Altair Radioss™

Altair Radioss is a leading structural analysis solver for highly non-linear problems under dynamic loadings. Radioss has established itself as a leader and an industry standard for automotive crash, drop and impact analysis, terminal ballistics, blast and explosion effects, and high velocity impacts.

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	**128**	**8**
Cores per socket	PCIe® Gen 4 lanes per socket	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.

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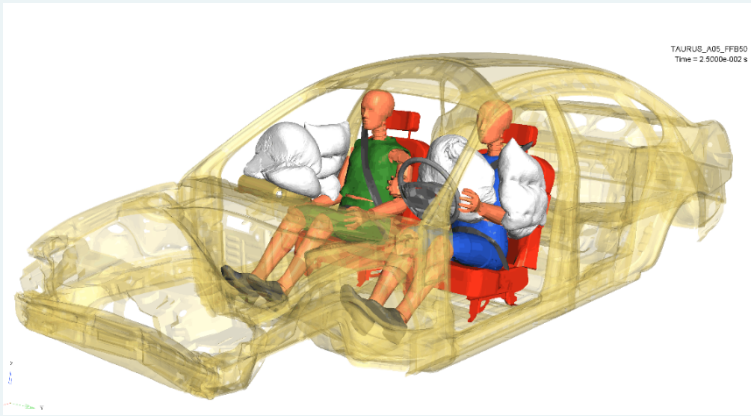
With a sophisticated customer base that values performance, reliability, safety, and innovation, Altair's Radioss team is committed to supporting the most up-to-date, advanced computing architectures and integrating new technologies to improve performance, scalability, and usability. Radioss leads the industry in unlocking state-of-the-art computing hardware's potential for powering complex simulation software applications and environments.

AMD and Altair have an ongoing partnership and AMD EPYC is fully supported on Altair products.



Power without Compromise

Memory bandwidth is a critical factor in maximizing the performance of explicit structural analysis 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. Whether you need 8 or 64 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 rises quickly and can limit scaling at large node counts. AMD and Altair have collaborated to offer solutions for structural analysis workloads enabling exceptional performance and low implementation cost.

Altair PBS Professional™ is a fast, powerful workload manager designed to improve productivity, optimize utilization and efficiency, and simplify administration for HPC clusters, clouds, and supercomputers. PBS Professional can help maximize the utilization of an AMD cluster and increase Radioss job throughput.

The EPYC Advantage: AMD EPYC server processors offer 8 memory channels of DDR4-3200[2] and support for up to 4 TB of memory per processor, yielding exceptional memory bandwidth and capacity.

Performance Benchmarks and Testing

This document focuses on performance and scaling of the EPYC 7002 Series Processors. AMD engineers performed testing 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 EPYC™ 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 specified for each processor.

Altair Radioss benchmarks provide hardware performance data measured using sets of benchmark problems selected to represent typical usage. These tests were run with MPI. Planned future testing will include hybrid MPI/OpenMP.

The Radioss benchmark cases provide 2 workloads to predict performance on large and small models. The small model, 1M11, has approximately 1 million elements and the large model, T10M, has approximately 10 million elements. More information on the benchmarks is available at https://altairhyperworks.com/Benchmark.aspx.

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 HDR 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	

Altair Radioss: Single-node Performance

The Taurus FFB50, or T10M, is the larger of the two benchmark models with approximately 10 million elements. Altair Radioss Structural Explicit solver was run with the T10M model with 120 ms of simulation time.

The NEON FE benchmark simulates a frontal crash of a 1996 Chrysler Neon traveling at 50km/h colliding with a rigid wall. This analysis simulates the performance of the Neon (with refined mesh) through the first 80 ms of the crash event. The complete model includes approximately 1 million elements and is considered a small model by today's standards.

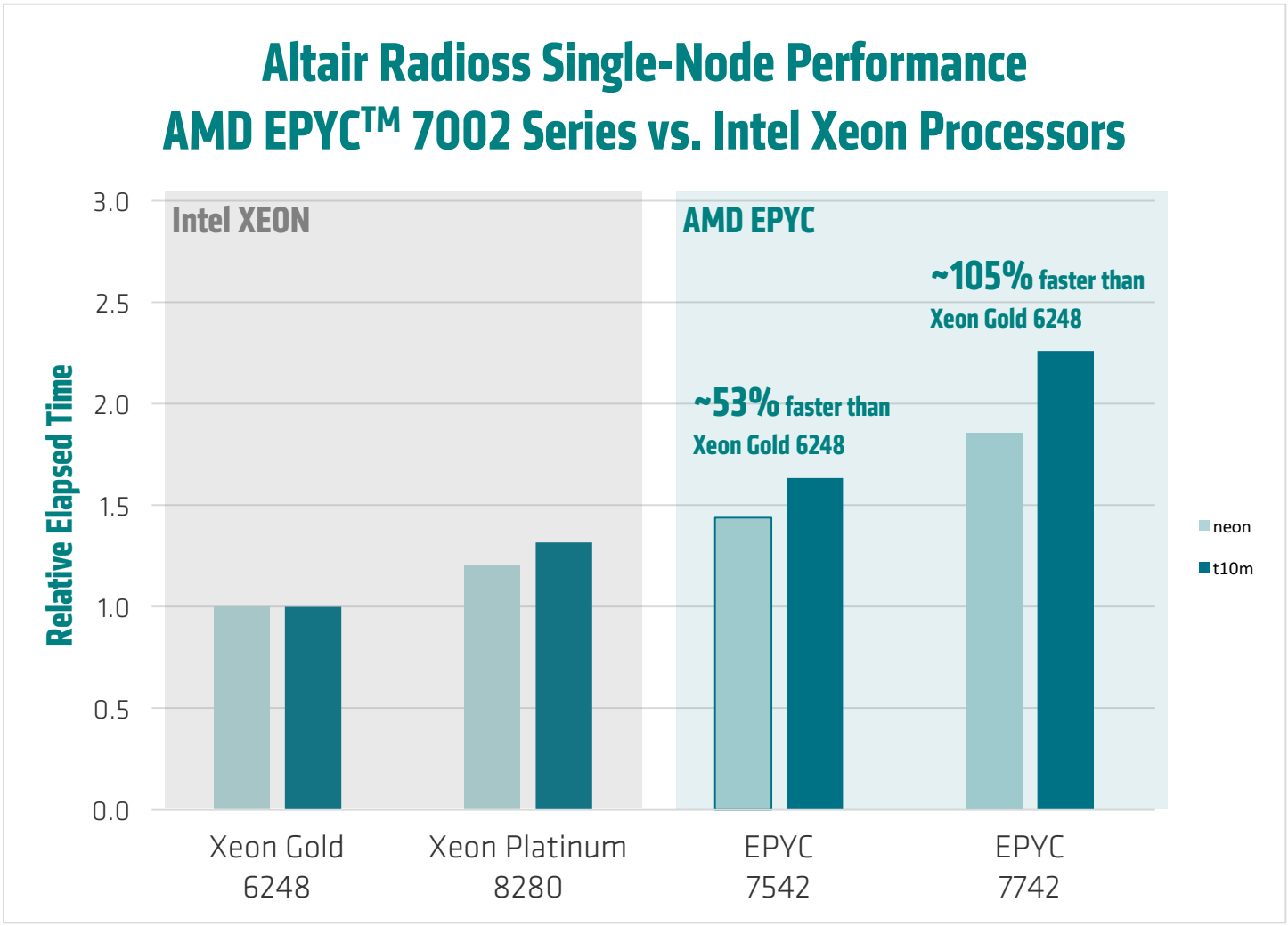


Figure 1: AMD EPYC 7002 Series Processors vs. Intel Xeon Processors

As Figure 1 shows, AMD EPYC 7742 processors far exceed the performance of both the Intel Xeon Gold 6248 and the Intel Xeon Platinum 8280. They maintain a performance advantage over the Xeon Gold 6248 of ~105% averaged across both models, and a ~126% advantage over the larger T10M model. The AMD EPYC 7542 also maintains a dominant performance advantage against both Intel processors.

High compute performance, along with high-speed Infinity Fabric™ between sockets and enough memory bandwidth to keep the cores fully utilized, delivers outstanding performance.

Altair Radioss: Multi-node Scaling

Scaling can be a challenge for finite element analysis (FEA) explicit codes. Radioss accepts the challenge and delivers truly exceptional scalability. Delivering ~93% scaling efficiency at 256 cores (2 nodes), ~90% scaling efficiency at 384 (3 nodes), ~86% scaling efficiency at 512 (4 nodes), and even maintaining ~79% scaling efficiency at 768 cores (6 nodes), is a solid performance, especially in a pure MPI configuration. Planned future testing of Radioss on 2nd Generation EPYC processors will include hybrid MPI/OpenMP to further push scalability.

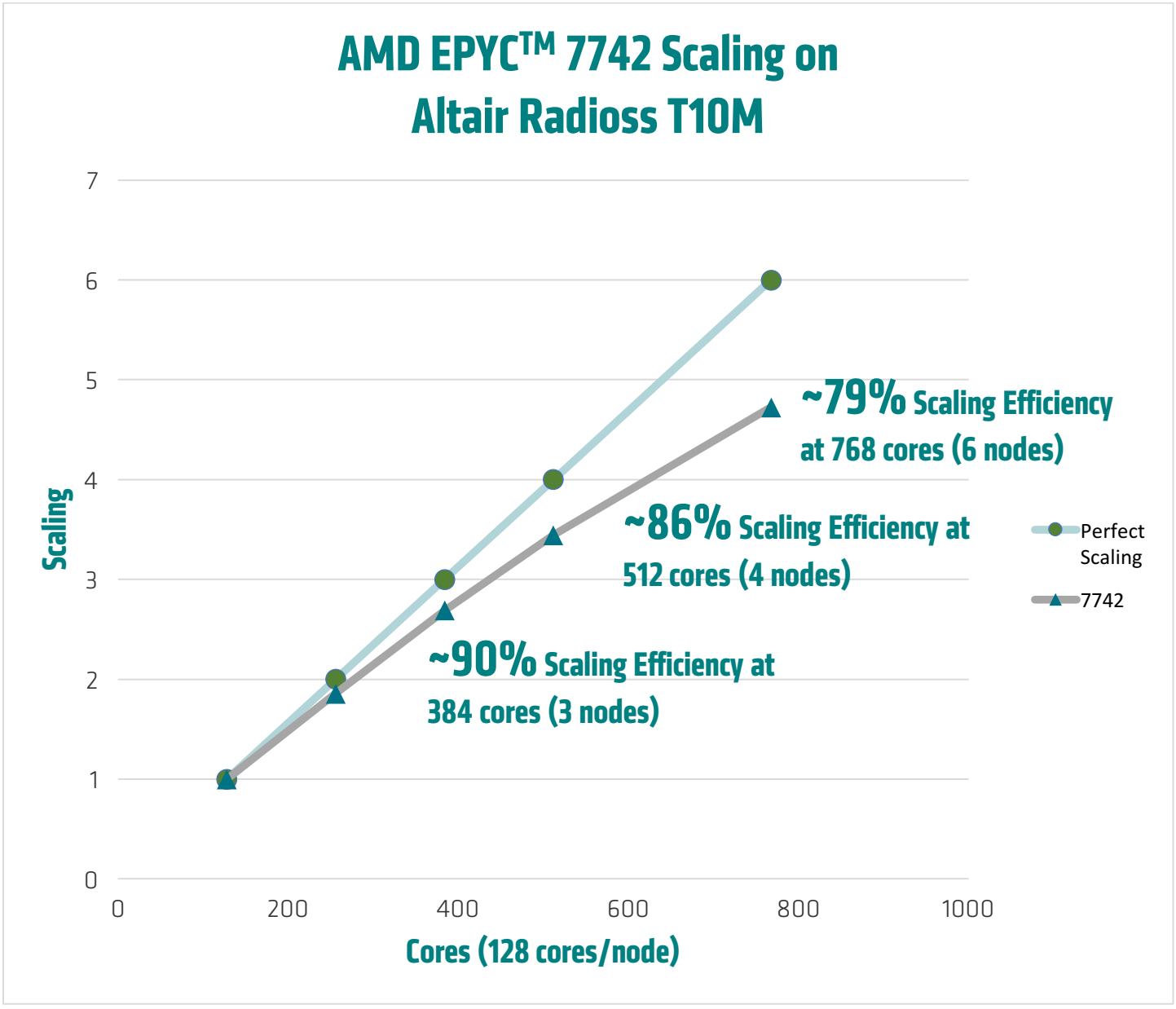


Figure 2

Combining a dominating single node performance with exceptional scalability delivers true value to customers looking to run larger, more granular simulations in less time.

Conclusion

Single-node tests delivered a dominating performance on Radioss for 2nd Gen AMD EPYC processors. Scale-out testing pushed that advantage even further with exceptional scaling through 512 cores and beyond. Combining the efficiency of Altair Radioss, AMD EPYC 7002 Series processors, Micron Memory, and Mellanox ConnectX-6 HDR fabric, deliver outstanding performance for FEA Explicit workloads.

The Altair Radioss structural analysis application is architected to deliver accuracy, performance, and scalability to meet the most demanding structural analysis needs, enabling organizations to go further and faster in optimizing product performance. Radioss includes well-validated physical modeling capabilities to deliver fast, accurate results across the widest range of structural analysis applications.

Together, AMD and Altair empower the development of fast, accurate structural analysis 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 Altair visit: https://www.altair.com

FOOTNOTES

1. Best-in-class based on industry-standard pin-based (LGA) X86 processors. NAP-166.
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.