Dell Validated Design for HPC Digital Manufacturing with Ansys Fluent

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White Paper

Abstract

This white paper presents the Dell Validated Design for HPC Digital Manufacturing with performance benchmarking results for Ansys Fluent.

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Introduction

Executive summary

The Dell Validated Design for HPC Digital Manufacturing is designed specifically for Computer Aided Engineering (CAE) applications that are commonly used for virtual product development and engineering. This design uses a flexible building block approach, where individual building blocks can be combined to build High-Performance Computing (HPC) systems, which are optimized for specific workloads and use cases.

Document purpose

The purpose of this document is to provide guidance for designing HPC systems for use with various CAE software, including Ansys Fluent.

Audience

This document is intended for decision makers influencing, purchasing, or managing CAE resources for product engineering and design organizations.

Business challenges

Market environment

The recent developments in the worldwide economy have placed increased pressure on manufacturers to accelerate product development to serve a broad, rapidly changing market. Coupled with this demand, complying with the wide range of regulations required with a global customer base has added to the complexity of the product development process. Manufacturers are increasingly relying on CAE to improve the speed and quality of their product development. As HPC integrates new technologies to meet this demand for IT resources, Dell Technologies has focused on creating holistic, integrated HPC CAE solutions to assist these customers. Dell Validated Designs provide assurance that customers can keep pace with their virtual product development needs, focusing less on IT and more on the business of bringing products to market.

Solution overview

Introduction

The Dell Validated Design for HPC Digital Manufacturing is designed specifically for CAE applications, which are commonly used for virtual product development and engineering. The solution is designed using a flexible building block architecture. This architecture allows an HPC system to be optimally configured for specific end-user requirements, while still using standardized, domain-specific system recommendations.

The building blocks consist of infrastructure servers, storage, networking, and compute servers. Configuration recommendations are provided for each of the building blocks, which are appropriate for the Ansys Fluent software application.

With this flexible building block approach, appropriately sized HPC clusters can be designed based on specific workloads and use-case requirements.

Solution architecture

Infrastructure servers

Infrastructure servers are used to administer the system and provide user access. They are not typically involved in computation, but they provide services that are critical to the overall HPC system. These servers are used as the management nodes and the login nodes. For small-sized clusters, a single physical server can provide the necessary system management functions. Infrastructure servers can also be used to provide storage services, by using NFS, in which case they must be configured with additional disk drives or an external storage array. One management server is necessary for an HPC system to deploy and manage the system. If high-availability (HA) management functionality is required, two management servers are necessary. Login nodes are optional, and one login server per 30 to 100 users is recommended.

A recommended base configuration for infrastructure servers includes:

- Dell PowerEdge R6515 server
- AMD EPYC 7402P processor
- 128 GB of RAM (8 x 16 GB 3200 MTps DIMMs)
- PERC H330 RAID controller
- 2 x 480 GB Mixed-Use SATA SSD RAID 1
- Dell iDRAC Enterprise
- 2 x 550 W power supply units (PSUs)
- NVIDIA ConnectX-6 InfiniBand HCA (optional)

The PowerEdge R6515 server is suited for this role. Typical HPC clusters only use a few infrastructure servers; therefore, density is not a priority, but manageability is important. The AMD EPYC 7402P processor, with 24 cores per socket, is recommended for this role. If the infrastructure server is used for CPU-intensive tasks, such as compiling software or processing data, a more capable processor might be appropriate. For example, 256 GB of RAM provided by eight 16 GB DIMMs provides sufficient memory capacity, with minimal cost per GB, while also providing good memory bandwidth. These servers are not expected to perform considerable I/O, so mixed-use SATA SSDs configured with RAID 1 are sufficient for the operating system. For most systems, HDR InfiniBand is the data

interconnect of choice. It provides a high-throughput, low-latency fabric for node-to-node communications or to access file storage.

Compute servers

Compute servers provide the computational resources for the HPC system. These servers are used to run the engineering workloads such as Ansys software applications. The best configuration for the compute servers depends on the specific applications in use and the simulation requirements. Because the best configuration might be different for each use case, a table of recommended options that are appropriate for these servers is provided. A specific configuration can be selected to match the requirements of the workloads and use cases. The application performance section of this white paper discussed the relevant criteria to consider before selecting a compute server configuration. The following table provides recommended configuration options for the compute servers:

Table 1. Compute server configuration options

Component	Details
Platforms	• Dell PowerEdge C6525 • Dell PowerEdge R6525 • Dell PowerEdge R7525
Processors	• Dual AMD EPYC 7532 (32 cores per socket) • Dual AMD EPYC 7543 (32 cores per socket) • Dual AMD EPYC 7573X (32 cores per socket)
Memory options	• 256 GB (16 x 16 GB 3200 MTps DIMMs) • 512 GB (16 x 32 GB 3200 MTps DIMMs) • 1024 GB (16 x 64 GB 3200 MTps DIMMs)
Storage options	• PERC H330 or H740p RAID controller • 2 x 480 GB Mixed-Use SATA SSD RAID 0 • 4 x 480 GB Mixed-Use SATA SSD RAID 0
iDRAC	• iDRAC Enterprise (R6525 and R7525) • iDRAC Express (C6525)
Power supplies	• 2 x 1100 W PSU (R6525 and R7525) • 2 x 2400 W PSU (C6525)
Networking	• NVIDIA ConnectX-6 HDR100 InfiniBand adapter • NVIDIA ConnectX-6 HDR InfiniBand adapter

Storage

Dell Technologies offers a wide range of general-purpose and HPC storage solutions. For a general overview of the Dell HPC solution portfolio, go to www.dell.com/hpc.

For a general-purpose NAS storage solution, the Dell PowerScale A300 is recommended. PowerScale A300 provides raw storage capacity of 120 TB to 75 PB and sufficient performance for modest-sized HPC systems. For larger HPC systems, the Dell PowerScale F600 all-flash NAS, with raw storage capacity of 15.36 TB to 122.8 TB, provides a significant performance benefit compared to the PowerScale A300. For HPC systems requiring a high-performance parallel file system, the Dell Validated Design for BeeGFS storage in the high-performance configuration is recommended. This solution provides 25.6 TB of raw storage capacity per storage server and can be expanded to any required storage capacity.

System networks

Most HPC systems are configured with two networks—an administration network and a high-speed/low-latency switched fabric. The administration network is typically Gigabit Ethernet that connects to the onboard LOM/NDC of every server in the cluster. This network is used for provisioning, management, and administration. On the compute servers, this network is also used for BMC management. For infrastructure and storage servers, the iDRAC Enterprise ports may be connected to this network for OOB server management. The management network typically uses the Dell PowerSwitch N3248TE-ON Ethernet switch. If there is more than one switch in the system, multiple switches can be stacked with 10 Gigabit Ethernet cables.

A high-speed/low-latency fabric is recommended for clusters with more than four servers. The current recommendation is an HDR InfiniBand fabric. The fabric is typically assembled using NVIDIA QM8790 40-port HDR InfiniBand switches. The number of switches required depends on the size of the cluster and the blocking ratio of the fabric.

Cluster management software

Bright Cluster Manager (BCM) is the recommended cluster management software for installing and monitoring the HPC system.

Reference system

System configuration

Performance benchmarking was performed in the Dell HPC & AI Innovation Lab using the system configurations listed in the following table:

Table 2. Benchmark system configurations

Building block	Quantity
• Computational server • PowerEdge C6525 server • Dual AMD EPYC 7532 • 256 GB RAM 16x16GB 3200 MTps DIMMs • NVIDIA ConnectX-6 HDR adapter	1
• Computational server • PowerEdge R6525 server • Dual AMD EPYC 7543 • 512 GB RAM 16x32GB 3200 MTps DIMMs • NVIDIA ConnectX-6 HDR adapter	1
• Computational Server • PowerEdge R6525 server • Dual AMD EPYC 7573X • 512 GB RAM 16x32GB 3200 MTps DIMMs • NVIDIA ConnectX-6 HDR adapter	1
• NVIDIA QM8790 InfiniBand Switch	1

The following table lists the BIOS configuration options used for the reference system:

Table 3. BIOS configuration

BIOS Option	Setting
Logical processor	Disabled
Virtualization technology	Disabled
System profile	Performance Profile
NUMA per socket	4

The following table lists the software versions used for the reference system:

Table 4. Software versions

Component	Version
Operating system	Red Hat Enterprise Linux 8.4
Kernel	4.18.0-305.el8.x86_64
OFED	NVIDIA Mellanox 5.5-1.0.3.2
Bright Cluster Manager	9.1
Ansys Fluent	2022 R1

Benchmark disclaimer

Note the following constraints:

- Benchmark results are highly dependent on workload, specific application requirements, and system design and implementation. Relative system performance varies as a result of these and other factors. Do not use this workload as a substitute for a specific customer application benchmark when critical capacity planning and product evaluation decisions are contemplated.
- All performance data contained in this report was obtained in a rigorously controlled environment. Results obtained in other operating environments might vary significantly. Dell Technologies does not warrant or represent that a user can or will achieve similar performance results.

Ansys Fluent performance

Ansys Fluent is a Computational Fluid Dynamics (CFD) software application commonly used for a wide range of CFD and multiphysics simulations. CFD applications typically scale well across multiple processor cores and servers, have modest memory capacity requirements, and typically perform minimal disk I/O while solving. However, some simulations might have greater I/O demands, such as large transient analysis. We evaluated 15 benchmark problems from the Fluent benchmark suite on the reference system. For a description of the benchmark cases, see the Ansys Benchmarks Overview.

The Solver Rating metric, which is the number of 25 iteration solves that can be completed in a day, measures the Fluent benchmark performance. The metric is (total seconds in a day)/(25 iteration solve time in seconds). A larger value represents better performance.

Single-server performance

The following figure shows measured performance for five of the Ansys Fluent benchmarks using Ansys Fluent 2022 R1 on a single server:

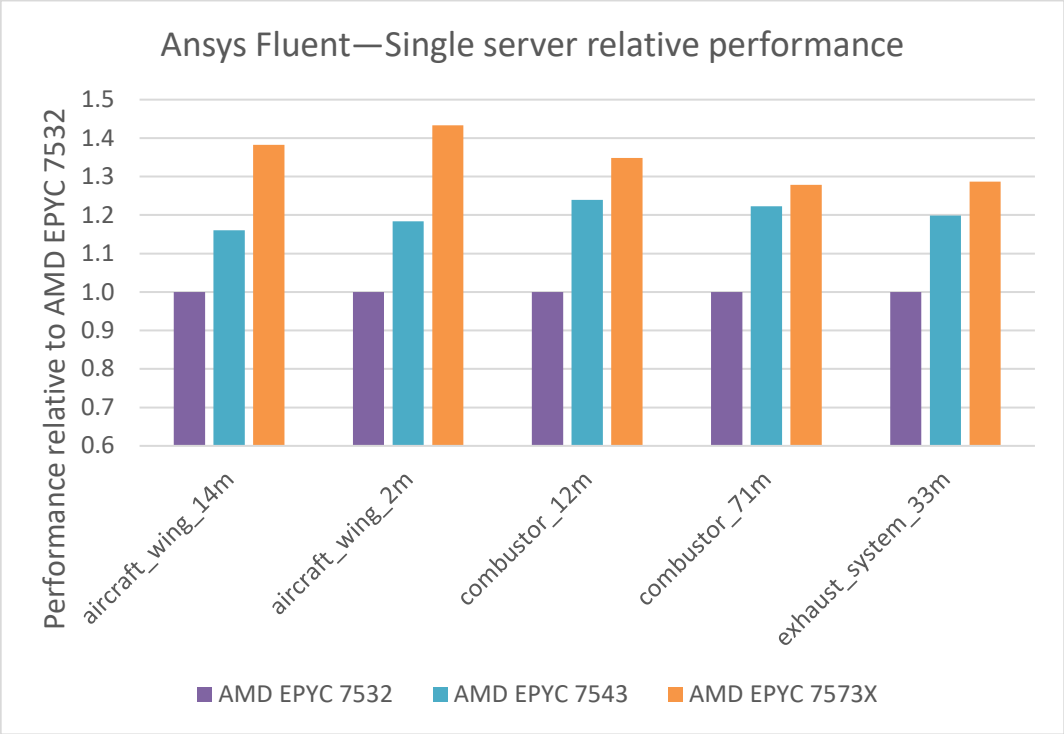

Figure 1. Ansys Fluent—Single-server relative performance

The results are plotted relative to the performance of a single server configured with AMD EPYC 7532 processors. Larger results indicate better performance. These results show the performance advantage available with AMD EPYC 7003 series processors.

Multiserver scalability

The following figure shows the parallel scalability of the Fluent benchmark models using up to four servers configured with AMD EPYC 7573X processors. The performance is presented relative to the performance of a single server.

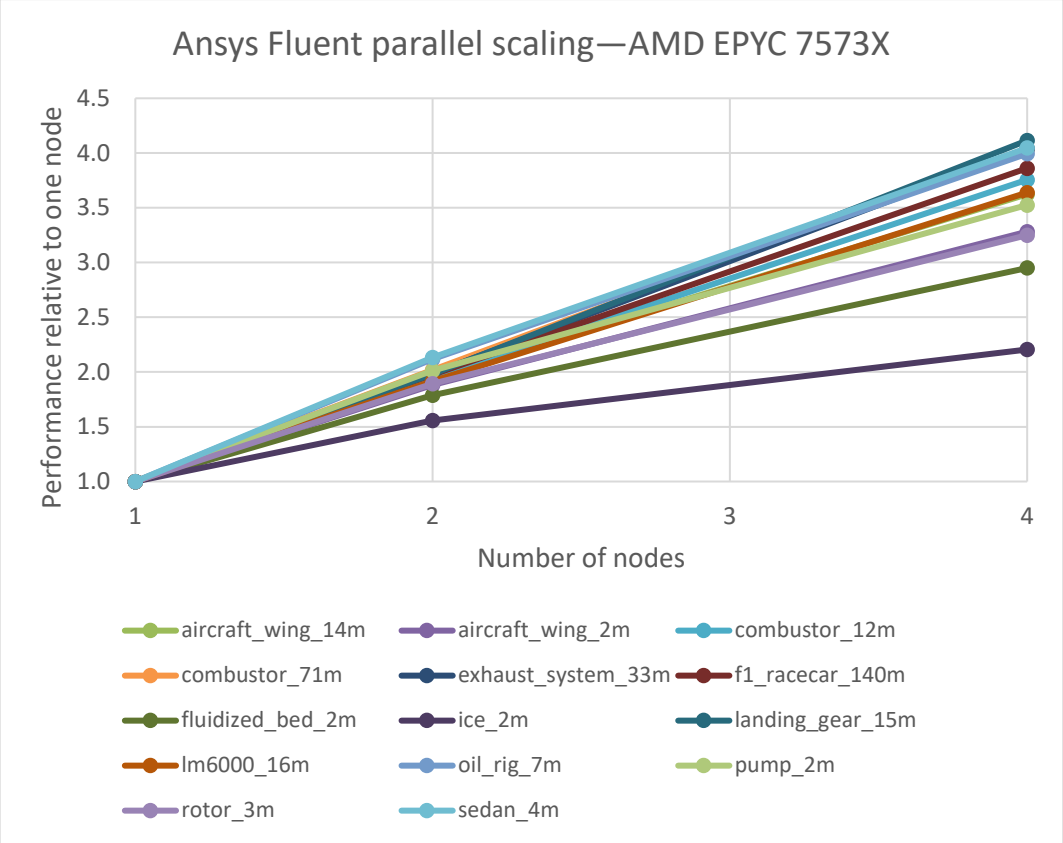

Figure 2. Ansys Fluent parallel scaling—AMD EPYC 7573X

The parallel scalability for most of these benchmark models is good, with the models scaling as expected. The ice_2m benchmark does not scale as well as the other benchmarks. This result is expected as it is a small model that includes dynamic mesh and combustion simulation.

Conclusion

This technical white paper presents the Dell Validated Design for HPC Digital Manufacturing with Ansys Fluent performance benchmarks. This Dell Validated Design is architected for a specific purpose—to provide a comprehensive HPC solution for CAE software. Use of the building block approach allows customers to easily deploy an HPC system optimized for specific workload requirements. The design addresses computation, storage, networking, and software requirements, and provides a solution that is easy to install, configure and manage, with installation services and support readily available. The performance benchmarking substantiates the solution design, demonstrating the performance of the solution with Ansys Fluent software.

We value your feedback

Dell Technologies and the authors of this document welcome your feedback on the solution and the solution documentation. Contact the Dell Technologies Solutions team by email.