

# SIEMENS SIMCENTER STAR-CCM+™ ON MICROSOFT® AZURE® HBv3 VIRTUAL MACHINES FEATURING AMD 3D V-CACHE™ TECHNOLOGY

## COMPUTATIONAL FLUID DYNAMICS

AMD EPYC™ 7003 Series Processors with AMD 3D V-Cache technology deliver outstanding scale-out performance running Siemens® Simcenter STAR-CCM+™ on Microsoft® Azure® HBv3 virtual machines.

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### Purpose Built for Technical Computing

Azure HBv3 virtual machines are available in various sizes to meet your workload requirements. AMD 3D V-Cache technology can improve the performance of memory-bound workloads.<sup>1,2</sup>

### 3rd GEN AMD EPYC™ Processors with AMD 3D V-Cache™ Technology

AMD EPYC™ 7003 Series processors with AMD 3D V-Cache™ help technical computing workloads scale to enable supercomputer-scale MPI workloads for your time-sensitive projects.<sup>2</sup> Scaling is critical for technical computing applications, and AMD EPYC 7003 Series processors with AMD 3D V-Cache technology provide high bandwidth between VMs with support for PCIe® Gen 4 enabled network devices and accelerators.

### Siemens®

Siemens focuses on industry, infrastructure, transport, and healthcare. Siemens creates technologies for more resource-efficient factories, resilient supply chains, and smarter buildings and grids, cleaner and more comfortable transportation, and advanced healthcare to add real value for customers.

### Simcenter STAR-CCM+™

Simcenter STAR-CCM+™ is a leading computational fluid dynamics (CFD) software application for fast, accurate simulation of almost any engineering problem that involves the fluids, structures, and all the associated physics. The single integrated environment includes CAD, automated meshing, multiphysics CFD, sophisticated post-processing, and design exploration.<sup>3</sup>

## Microsoft Azure VMs Powered by AMD EPYC™ 7003 Series Processors

Microsoft Azure delivers leadership-class performance, Message Passing Interface (MPI) scalability, and cost efficiency for a variety of real-world HPC workloads with HPC optimized Azure HBv3-series VMs, powered by AMD EPYC™ 7003 processors with AMD 3D V-Cache™ technology. HBv3 VMs come in multiple VM sizes so customers can choose whether to optimize for per-core or per-VM performance and system attributes.<sup>2</sup>

Technology  
Partner

Digital Industries  
Software

SIEMENS

## AMD EPYC Processors with AMD 3D V-Cache Technology

AMD EPYC 7003 Series processors with AMD 3D V-Cache die-stacking technology extend the 3rd Gen AMD EPYC processor family by enabling denser, more efficient chiplet integration. AMD 3D chiplet architecture stacks L3 cache tiles vertically to provide 768MB of L3 cache per socket (with 96MB of L3 cache per CCD). Applications that take advantage of AMD 3D V-Cache can see significant performance gains and lower overall Total Cost of Ownership (TCO) for memory-bound technical computing workloads.<sup>1</sup>

3rd Gen AMD EPYC processors with AMD 3D V-Cache technology continue the innovations in x86 architecture and extend the tradition of performance leadership defined by the [record-setting](#) 2nd Gen and 3rd Gen AMD EPYC processors. 3rd Gen AMD EPYC™ processors with AMD 3D V-Cache technology provide high frequencies, high core-counts, high memory bandwidth, and 768MB of L3 cache to unleash exceptional HPC performance. The extra-large L3 cache enables exceptional performance and scalability on many key workloads.

3rd Gen AMD EPYC processors support 8 channels (up to 4TB) of DDR4-3200 memory to handle very large datasets. Synchronizing the data fabric clock to match the memory clock speeds further improves both memory bandwidth and latency. 3rd Gen AMD EPYC 7003 Series processors empower faster time-to-value by delivering performance and scalability, while also helping keep your data secure with AMD Infinity Guard technology.<sup>4</sup>

## CFD with Simcenter STAR-CCM+™ on Azure HBv3 VMs

Siemens® Digital Industries Software distributes the Simcenter STAR-CCM+™ multiphysics computational fluid dynamics (CFD) application for simulating product operation under real-world conditions. Simcenter STAR-CCM+ uniquely brings automated design exploration and optimization to the CFD simulation toolkit of every engineer. Azure HBv3-series VMs powered by AMD EPYC 7003 Series processors with AMD 3D V-Cache technology deliver high performance for CFD applications, such as Simcenter STAR-CCM+.<sup>2,3</sup>

This performance brief shows Simcenter STAR-CCM+ 2021.3's superlinear scaling<sup>5</sup> running two standard benchmark models on Azure HBv3 VMs featuring AMD EPYC 7003 Series processors with AMD 3D V-Cache technology. The multi-VM scaling is more pronounced on new Azure HBv3 VMs powered by AMD EPYC 7003 Series processors with AMD 3D V-Cache technology when compared to Azure HBv2 VMs powered by AMD EPYC 7002 Series processors. Each VM includes 120 physical CPU cores with AMD Simultaneous Multithreading [SMT] disabled; 200 Gb HDR InfiniBand RDMA networking supports fast inter-node communication and MPI scaling to tens of thousands of CPU cores. Tables 1 and 2 list details about the test configuration.

Figures 1 and 2 illustrate Simcenter STAR-CCM+ superlinear scaling on Azure HBv3 VMs using the LeMans\_Poly\_17M and LeMans\_100M\_Coupled benchmark models.

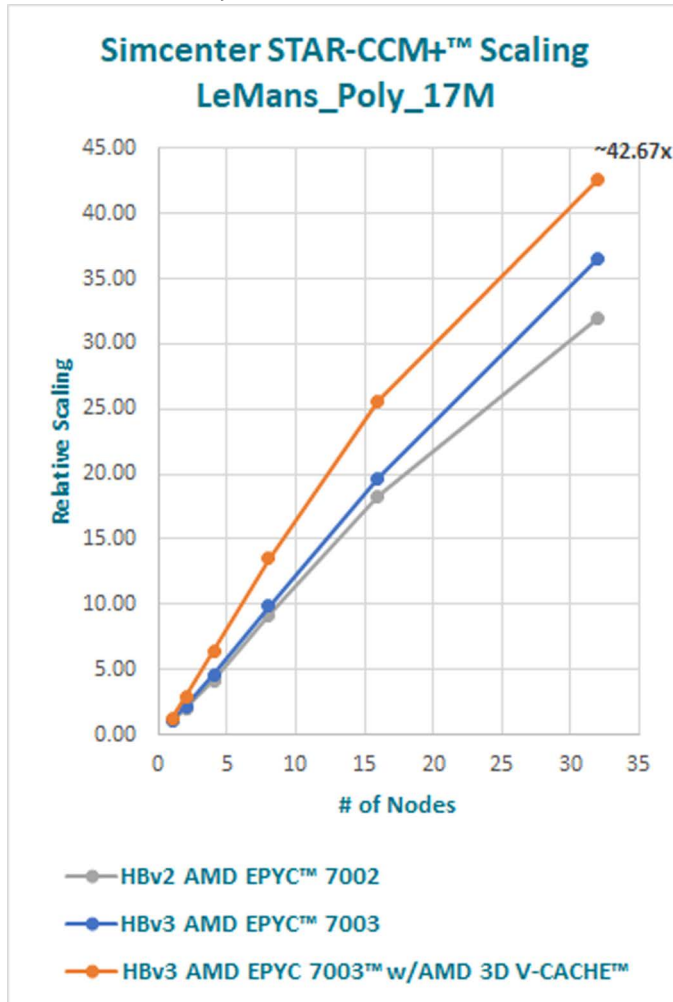


Figure 1: Simcenter STAR-CCM+ superlinear scale-out performance on smaller models with Azure HBv3 VMs

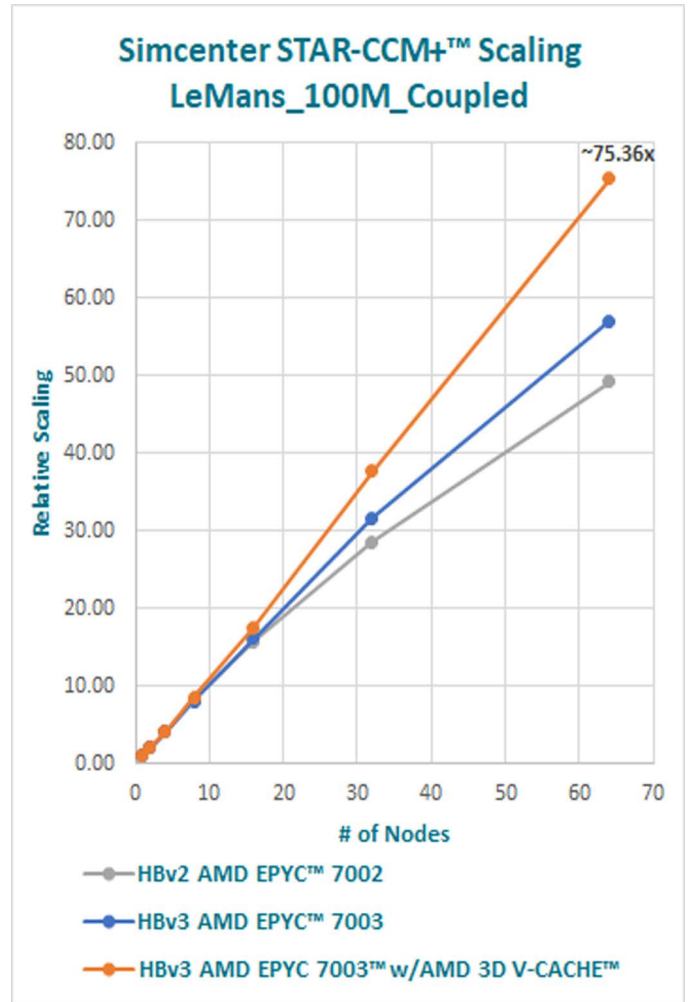


Figure 2: Simcenter STAR-CCM+ superlinear scale-out performance on larger models with Azure HBv3 VMs

At 32 VMs (3,840 CPU cores), the LeMans\_Poly\_17M benchmark model scales linearly with a ~32x speedup on Azure HBv2 and superlinearly with a speedup of 36x on previous<sup>6</sup> Azure HBv3 VMs. The same model exhibits a much higher superlinear speedup of ~43x on new Azure HBv3 VMs powered by AMD EPYC 7003 Series processors with AMD 3D V-Cache technology.

At 64 VMs (7,680 CPU cores), the LeMans\_100M\_Coupled model scales with a ~49x speedup on Azure HBv2 and ~57x on previous<sup>6</sup> Azure HBv3 VMs. The same model exhibits a much higher superlinear speedup of ~75x on new Azure HBv3 VMs powered by AMD EPYC 7003 Series processors with AMD 3D V-Cache technology.

In both cases, this increase in relative scaling occurs because AMD EPYC 7003 Series processors with AMD 3D V-Cache technology have a larger cache that facilitates higher cache hit rates and higher effective memory bandwidth.

## Azure HBv3 and HBv2 VM Software Configuration

| Software |                            |
|----------|----------------------------|
| Solver   | Simcenter STAR-CCM+ 2021.3 |
| MPI      | HPC-X MPI-2.8.3            |
| OS       | CentOS 8.1                 |

Table 1: Azure HBv3 and HBv2 test environment

## Azure HBv3 and HBv2 VM Specifications

| Size                   | CPU Cores | Memory (GiB) | Memory per Core (GiB) | L3 Cache (MB) | NVMe SSD   | InfiniBand RDMA Network |
|------------------------|-----------|--------------|-----------------------|---------------|------------|-------------------------|
| Standard_HB120-16rs_v3 | 16        | 448          | 28                    | 1536          | 2 * 960 GB | 200 Gbps                |
| Standard_HB120-32rs_v3 | 32        | 448          | 14                    | 1536          | 2 * 960 GB | 200 Gbps                |
| Standard_HB120-64rs_v3 | 64        | 448          | 7                     | 1536          | 2 * 960 GB | 200 Gbps                |
| Standard_HB120-96rs_v3 | 96        | 448          | 4.67                  | 1536          | 2 * 960 GB | 200 Gbps                |
| Standard_HB120rs_v3    | 120       | 448          | 3.75                  | 1536          | 2 * 960 GB | 200 Gbps                |
| Standard_HB120rs_v2    | 120       | 456          | 3.87                  | 512           | 1 * 960 GB | 200 Gbps                |

Table 2: Azure HBv3 and HBv2 VM specifications

## Conclusion

Azure HBv3 VMs powered by AMD EPYC 7003 Series processors with AMD 3D V-Cache offer excellent performance and scalability for running technical computing workloads. The test results shown above show Simcenter STAR-CCM+ achieving a superlinear speedup of ~43x for 32 VMs (42.67/32, or ~133% scaling efficiency) on the LeMans\_Poly\_17M benchmark model, and ~75x on the LeMans\_100M\_Coupled model for 64 VMs (75.36/64, or ~118% scaling efficiency).

Azure HBv3 VMs introduce several targeted features to deliver cost and performance optimizations for customers running tightly-coupled technical computing workloads, including ample storage capacities and fast inter-VM communications. Azure is among the earliest Cloud Service Providers to adopt AMD EPYC 7003 Series processors with AMD 3D V-Cache technology in support of technical computing customers, who have achieved some outstanding successes with Azure VMs powered by 3rd Gen AMD EPYC processors. As a result, more and more engineers, researchers, and scientists are turning to these Azure VMs to help them tackle challenges related to our environment, financial services, energy exploration, and health research.

## 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. Please see <https://docs.microsoft.com/en-us/azure/virtual-machines/HBv3-series> for more details about Azure HBv3 VMs.
3. Please see <https://www.plm.automation.siemens.com/global/en/products/simcenter/STAR-CCM.html> for detailed information about Simcenter STAR-CCM+.
4. 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
5. AMD defines “linear scaling” as an equal and proportionate application performance uplift relative to single VM performance; that is, when scaling out to 2 VMs results in 2x the performance of a single VM, scaling out to 4 VMs results in 4x the performance of a single VM, and so forth. “Superlinear” scaling is when the performance uplift achieved by adding one or more VM(s) is greater than linear. AMD allows a +/- of 2% margin of error when claiming linear or super linear scaling. GD-205
6. HBv3 VMs powered by AMD EPYC 7003 Series processors are being replaced by a new HBv3 series powered by AMD EPYC 7003 Series processors with AMD 3D V-Cache technology.

## Acknowledgments

Sai Kovouri and Sylvester Rajasekaran contributed to this brief.

### Related Links

- [Azure HBv3 virtual machines\\*](#)
- [Simcenter STAR-CCM+\\*](#)
- [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.*

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