Optimizing Ansys performance on the
Lenovo ThinkStation P620
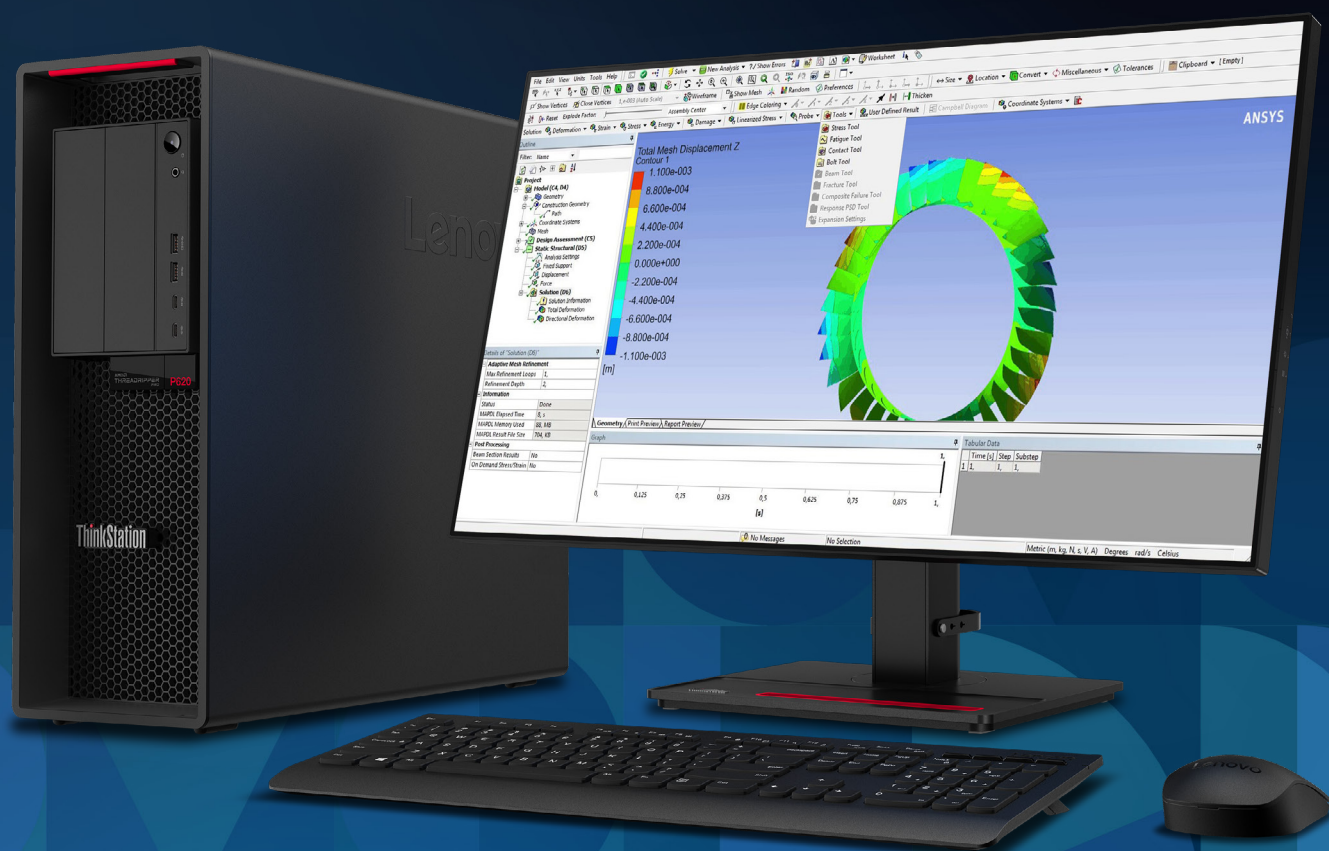
Introduction

Lenovo has partnered with AMD to create the world's first and only AMD Ryzen™ Threadripper™ PRO workstation: the ThinkStation P620. Delivering dual-CPU performance in a single-processor system, the P620 is performance-tuned and ISV certified for multithreaded application environments. With up to 64 cores, 128 PCIe lanes (Gen 4), 1TB of memory, and an 8-channel memory architecture, designers and engineers now have access to datacenter-like power on their desktop in a compact and economical package. Backed by enterprise-level features for seamless security, manageability, and support, the ThinkStation P620 is an ideal solution for enterprises and SMBs creating mission critical simulations.

Ansys® develops some of the most widely used multiphysics engineering simulation software solutions for product design, testing, and operation. With the ThinkStation P620, designers and engineers can run complex simulations on the desktop earlier in the design process to test and validate design ideas without tying up valuable data center resources.

The purpose of this whitepaper is twofold:

1. To illustrate how widely-used Ansys software solutions scale on the ThinkStation P620 family when the standard benchmarks are tested with 16, 32, and 64 core Threadripper PRO processors.

2. To explore optimization procedures to maximize the performance of these Ansys software solutions on the ThinkStation P620 family.

Ansys Software Solutions

Several widely-used Ansys software solutions were benchmarked in this study including:

• **Ansys® Mechanical™** - Finite element solver with structural, thermal, acoustic, transient, and nonlinear capabilities

• **Ansys® CFX®** - Computational Fluid Dynamics (CFD) software for turbomachinery applications

• **Ansys® Fluent®** - Fluid simulation software known for its advanced physics modeling capabilities and industry leading accuracy

Test Procedures

Ansys provides a set of standard benchmarks for Ansys CFX, Ansys Fluent, and Ansys Mechanical. These benchmark cases represent typical usage and cover a range of sizes and were used to test the performance of the 16, 32, and 64 core Threadripper PRO configurations of the P620. All tests were run by Lenovo unless otherwise stated. The following parameters were adjusted during tests.

• **NUMA Per Socket (NPS).** This BIOS feature enables a single socket Threadripper PRO processor to be divided into up to 4 NUMA nodes. Each NUMA node can only use its assigned memory controllers. The configuration options for NPS are AUTO, 1, 2, or 4. NPS=1 indicates that the AMD CPU is within a single NUMA domain (all the cores and all memory channels). Memory is interleaved across the eight memory channels. As a general rule, for applications that are highly threaded and use the Message Passing Interface (MPI) standard, NPS=4 delivers the highest memory throughput between local cores where the work is done and the memory channels used by those cores.

• **Simultaneous Multithreading (SMT).** When set to "ON", this BIOS feature allows each physical core to run two separate instruction streams simultaneously by presenting each physical core as two virtual (or logical) cores. When set to "OFF", each physical core is dedicated to running a single instruction stream.

• **Thread Pinning (TP).** In most simulation applications, workload performance can be optimized by evenly spreading processes across multiple cores by fixing or "pinning" processes to specific physical locations on the processor silicon. Thread pinning is influenced by how the software was written and by the settings of the Message Passing Interface (MPI) library installed. Thread pinning can be overridden and made to behave with more consistency by changing settings manually, through the use of automated scripts (e.g. PowerShell), or by using the Lenovo Performance Tuner application. AMD developed a PowerShell script that automates thread pinning for the Ansys applications discussed in this paper, delivering a consistent and improved performance result when running fewer cores than the number available on the processor or when running multiple concurrent instances of a simulation. The PowerShell script and testing methodology are available in a separate white paper from AMD.

• **AOCL.** AOCL is a set of numerical libraries tuned specifically for Threadripper PRO and other Zen-based AMD processor families. The tuned implementations of industry standard math libraries enable fast development of scientific and high-performance computing projects. Ansys Mechanical 2021 R2 now loads AOCL by default when an AMD processor is detected, thereby delivering performance improvements over the default legacy math libraries.

System Configurations

For this white paper, several different configurations of the ThinkStation P620 were used to test each Ansys benchmark.
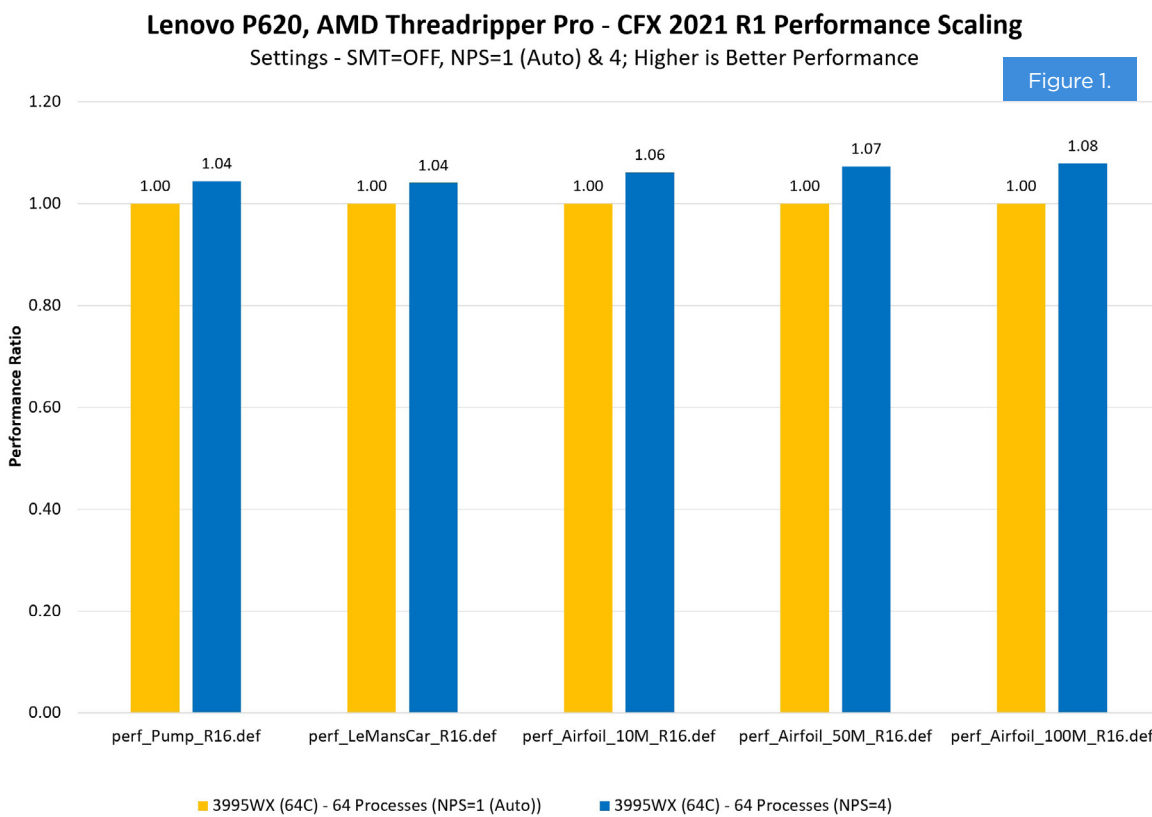
• **16 core system**
- ThinkStation P620 with Threadripper PRO 3955WX
- 256GB of memory (8 x 32GB 3200MHz DIMMs)
- Windows 10

• **32 core system**
- ThinkStation P620 with Threadripper PRO 3975WX
- 256GB of memory (8 x 32GB 3200MHz DIMMs)
- Windows 10

• **64 core system**
- ThinkStation P620 with Threadripper PRO 3995WX
- 256GB of memory (8 x 32GB 3200MHz DIMMs)
- 512GB of memory (8 x 64GB 3200MHz DIMMS)
  (for V21sp-5 benchmark model only)
- Windows 10

Performance Tuning

During our benchmark survey, we tested the performance of Ansys Fluent, Ansys CFX, and Ansys Mechanical with a variety of performance settings. When using 16 cores or more, greatest performance was achieved by setting SMT to OFF and NPS to 4. Since lower core counts may not be sufficient to solve the larger models in the standard Ansys benchmarks, 16 cores were used as a baseline throughout this study. When solving with a single job using fewer than 16 processes, set NPS to Auto for Ansys CFX and Fluent for optimum performance.

Ansys CFX

The Ansys CFX benchmark uses Core Solver Rating as a metric, to show relative performance scaling. A higher rating means better performance.

Lenovo P620, AMD Threadripper Pro - CFX 2021 R1 Performance Scaling
Settings - SMT=OFF, NPS=1 (Auto) & 4; Higher is Better Performance

Figure 1.

Figure 1 compares the Lenovo ThinkStation P620 (Threadripper PRO 3995WX) running several Ansys CFX benchmarks on 64 processes with NPS set to Auto and 4. With NPS set to 4, up to 8% performance gain was observed. Performance gains of up to 13.92% were observed with Ansys Fluent* and up to 19% with Ansys Mechanical. Results vary depending on model size, complexity, and system configuration.

*Data provided by Ansys for Ansys Fluent 2021 R1.

Benchmarks and Analysis

Ansys Mechanical

The Ansys Mechanical benchmark uses Core Solver Rating as a metric to show relative performance scaling. A higher rating means better performance. The following benchmarks were used:

- Power Supply Module (V21cg-1)
- Tractor Rear Axle (V21cg-2)
- Engine Block (V21cg-3)
- Gear Box (V21ln-1)
- Radial Impeller (V21ln-2)

- Peltier Cooling Block (V21sp-1)
- Semi-Submersible (V21sp-2)
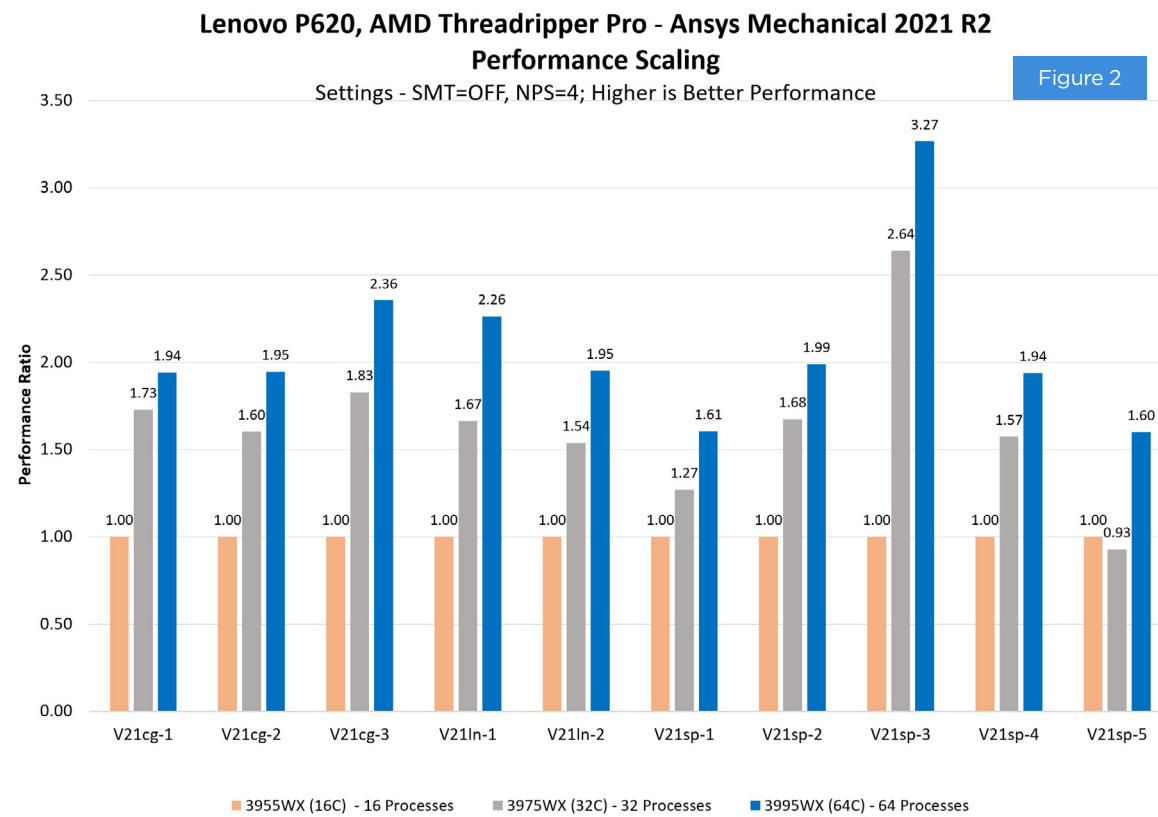- Speaker (V21sp-3)
- Turbine (V21sp-4)
- BGA (V21sp-5)

Lenovo P620, AMD Threadripper Pro - Ansys Mechanical 2021 R2 Performance Scaling
Settings - SMT=OFF, NPS=4; Higher is Better Performance

Figure 2

Figure 2 illustrates how Ansys Mechanical scales as core count doubles across 3 different processors. With the 16 core Threadripper PRO 3955WX running 16 processes as the baseline, we see performance scale between 27% and 164%, depending on model complexity, when compared to 32 processes run on the 32 core Threadripper PRO 3975WX. The 64 core Threadripper PRO 3995WX running 64 processes shows an additional performance gain, between 12% and 35%, over the same benchmark run on the 32 core Threadripper PRO 3975WX with 32 processes.

Lenovo P620, AMD Threadripper Pro - Ansys Mechanical 2021 R2 Performance Scaling

Settings - SMT=OFF, NPS=4; Higher is Better Performance

Figure 3

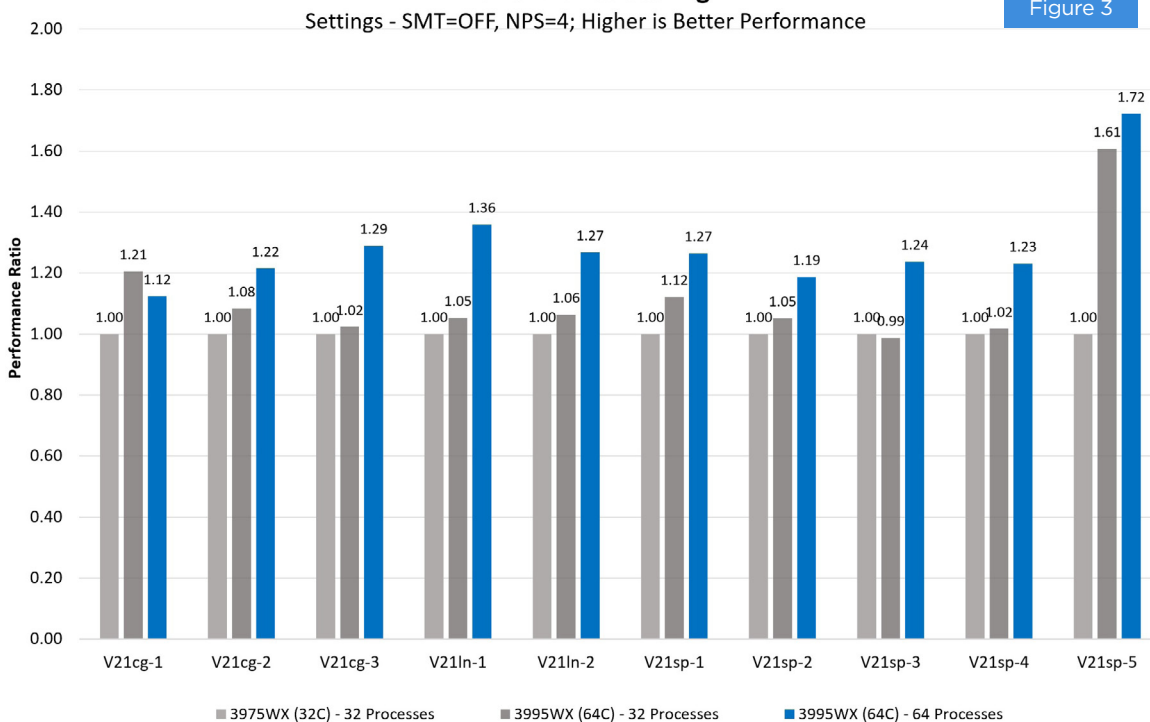Legend: 3975WX (32C) - 32 Processes · 3995WX (64C) - 32 Processes · 3995WX (64C) - 64 Processes

Figure 3 shows the impact of L3 cache on Ansys Mechanical performance. With the 32 core Threadripper PRO 3975WX running 32 processes as the baseline, we see performance scale between 2% and 21%, depending on model complexity, when compared to 32 processes run on the 64 core Threadripper PRO 3995WX. The 64 core Threadripper PRO 3995WX running 64 processes shows a performance gain between 13% and 30% over the same benchmark run with only 32 processes.

512GB of RAM was used to solve the V21sp-5 benchmark run on the Threadripper PRO 3995WX. Memory capacity plays an important role in delivering maximum performance when solving with higher core counts. It has been observed that for certain models and solvers, performance may decrease when utilizing all 64 cores on the 3995WX. Always test your specific model to find the optimal number of processes to run.

Conclusion

Overall, the ThinkStation P620 with the 64 core Threadripper PRO 3995WX delivers the highest performance for the Ansys Mechanical benchmarks tested. The additional cores are largely responsible for driving the incremental performance with most benchmarks tested. Depending on model size and complexity, however, processor cache and memory bandwidth also play an important role in delivering maximum performance when solving with higher core counts.

Ansys CFX

The Ansys CFX benchmark uses Core Solver Rating as a metric to show relative performance scaling. A higher rating means better performance. The following benchmarks were used:

- Automotive Pump
- LeMans Car
- Airfoil (10 million cells)
- Airfoil (50 million cells)
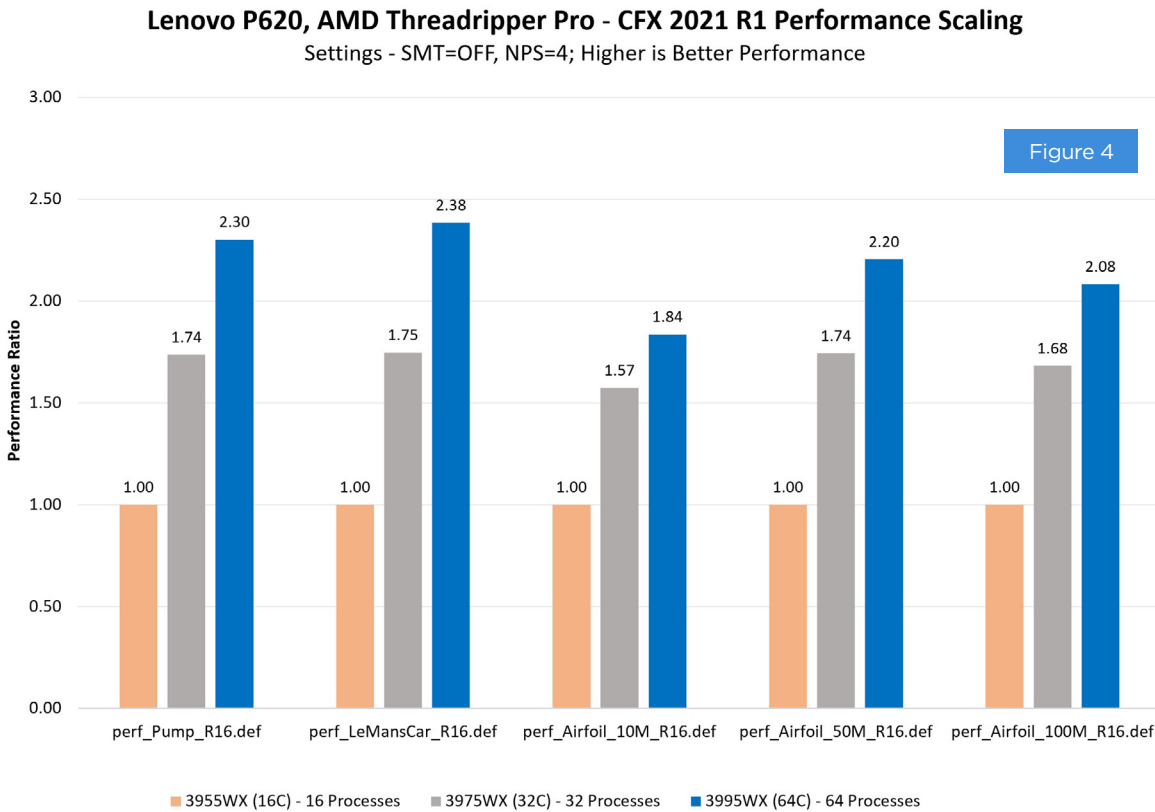- Airfoil (100 million cells)

Lenovo P620, AMD Threadripper Pro - CFX 2021 R1 Performance Scaling
Settings - SMT=OFF, NPS=4; Higher is Better Performance

Figure 4

Figure 4 illustrates how Ansys CFX scales as core count doubles across 3 different processors. With the 16 core Threadripper PRO 3955WX running 16 processes as the baseline, we see performance scale between 57% and 75%, depending on model complexity, when compared to 32 processes run on the 32 core Threadripper PRO 3975WX. The 64 core Threadripper PRO 3995WX running 64 processes shows an additional performance gain, between 17% and 36%, over the same benchmark run on the 32 core Threadripper PRO 3975WX with 32 processes.

The ThinkStation P620 with the 64 core Threadripper PRO 3995WX offers the greatest performance for Ansys CFX. However, cores do not tell the whole story. To better understand what is driving the incremental performance, we need to look at the influence of processor cache on performance.

Lenovo P620, AMD Threadripper Pro - CFX 2021 R1 Performance Scaling
Settings - SMT=OFF, NPS=4; Higher is Better Performance
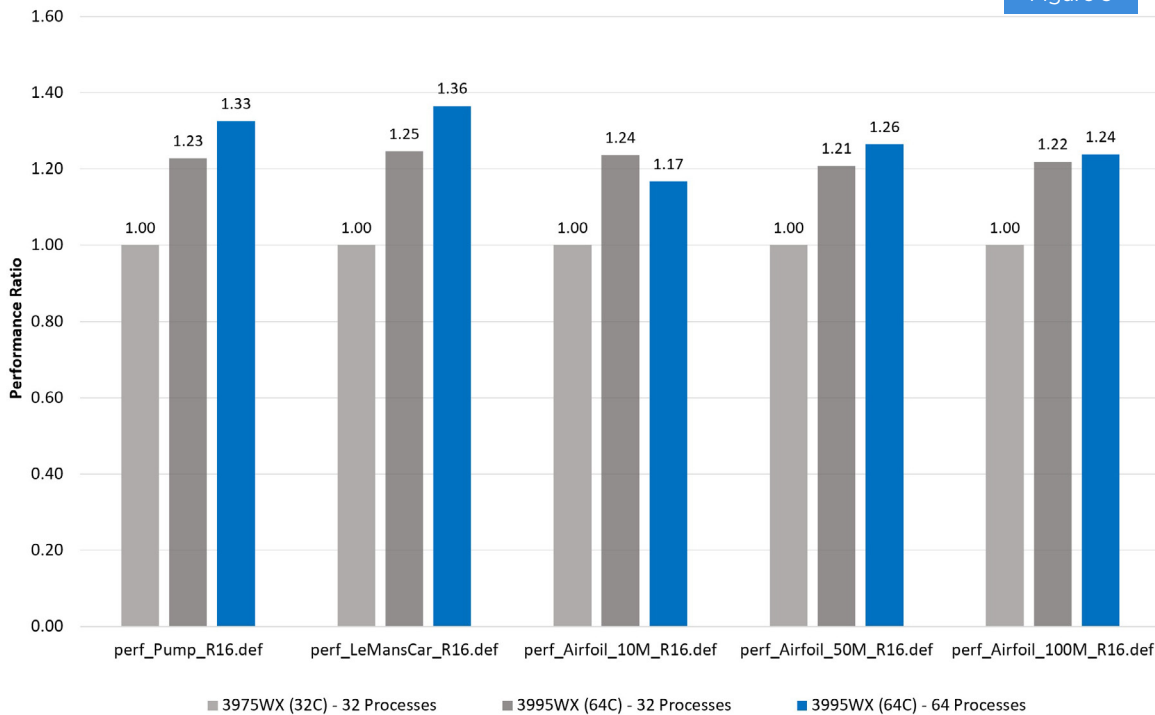
Figure 5

Figure 5 shows the impact of L3 cache on Ansys CFX performance. With the 32 core Threadripper PRO 3975WX running 32 processes as the baseline, we see performance scale between 21% and 25%, depending on model complexity, when compared to 32 processes run on the 64 core Threadripper PRO 3995WX. The 64 core Threadripper PRO 3995WX running 64 processes shows a nominal yet valuable performance gain, between 1.6% and 9%, over the same benchmark run with only 32 processes. It has been observed that for certain models and solvers, performance may decrease when utilizing all 64 cores on the 3995WX. Always test your specific model to find the optimal number of processes to run.

Conclusion

Ansys CFX is a cache intensive solver, and it is the additional cache available on the Threadripper PRO 3995WX that plays the dominant role in delivering the performance gain observed between 32 processes run on the 3975WX versus 32 processes run on the 64 core 3995WX. The large cache helps relieve the potential memory bandwidth bottleneck when using high core count CPUs. The Threadripper PRO 3995WX has 256MB L3 cache, which is double that of the Threadripper PRO 3975WX.

Ansys Fluent

The Ansys Fluent benchmark uses Core Solver Rating as a metric to show relative performance scaling. A higher rating means better performance. The following benchmarks were used:

- Pump (2 million cells)
- Aircraft Wing (2 million cells)
- Fluidized Bed (2 million cells)
- ICE (2 million cells)
- Rotor (3 million cells)
- Sedan (4 million cells)

- Oil rig (7 million cells)
- Combustor (12 million cells)
- Aircraft wing (14 million cells)
- Landing gear (15 million cells)
- LM 6000 (16 million cells)
- Exhaust system (33 million cells)

Lenovo P620, AMD Threadripper Pro - **Fluent 2021 R1 Performance Scaling**
Settings - SMT=OFF, NPS=4; Higher is Better Performance

Figure 6

Legend: 3955WX(16C) - 16 Processes | 3975WX(32C) - 32 Processes | 3995WX(64C) - 64 Processes
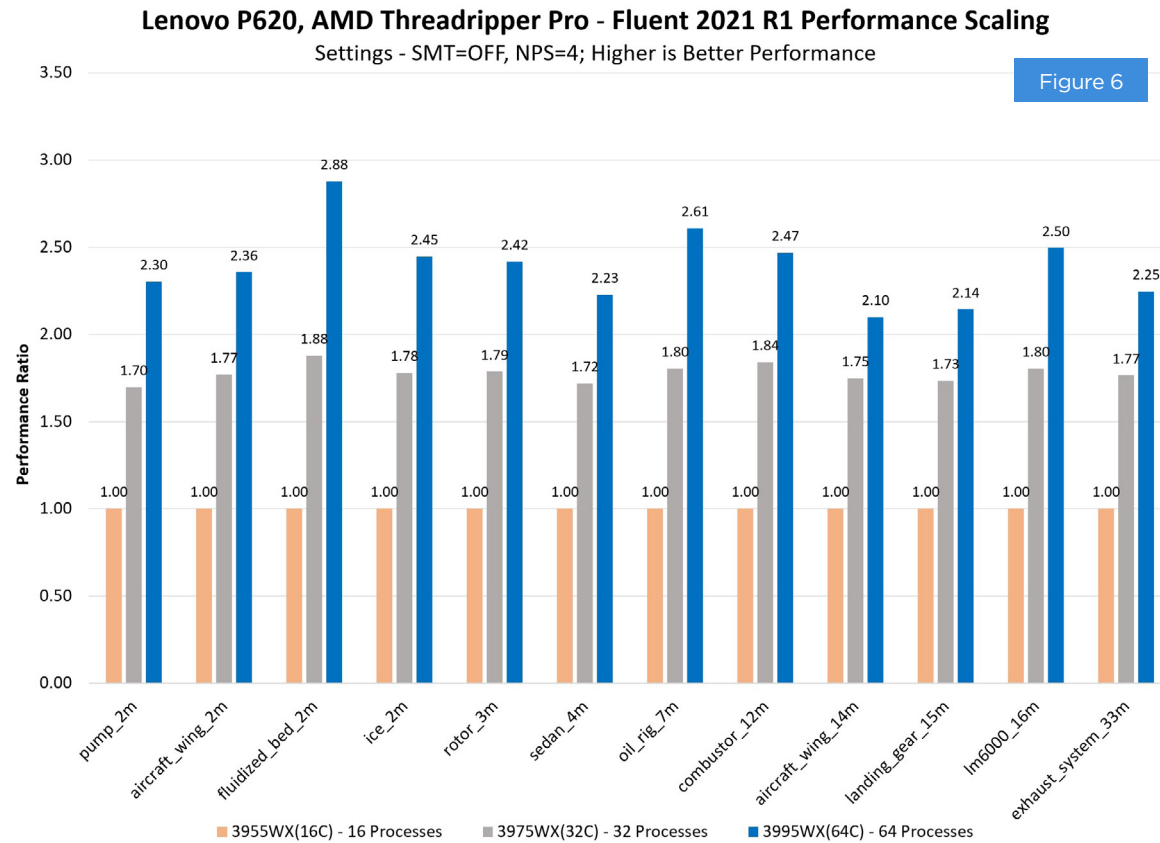
Figure 6 illustrates how Ansys Fluent scales as core count doubles across 3 different processors. With the 16 core Threadripper PRO 3955WX running 16 processes as the baseline, we see performance scale between 72% and 88%, depending on model complexity, when compared to 32 processes run on the 32 core Threadripper PRO 3975WX. The 64 core Threadripper PRO 3995WX running 64 processes shows an additional performance gain, between 20% and 53%, over the same benchmark run on the 32 core Threadripper PRO 3975WX with 32 processes.

The ThinkStation P620 with the 64 core Threadripper PRO 3995WX running 64 processes offers the greatest performance for Ansys Fluent in the ThinkStation P620 line-up when compared to the 3955WX and 3975WX. However, as observed with Ansys CFX, cores alone do not tell the whole story. To better understand what is driving the incremental performance we need to look at the influence of processor cache on performance.
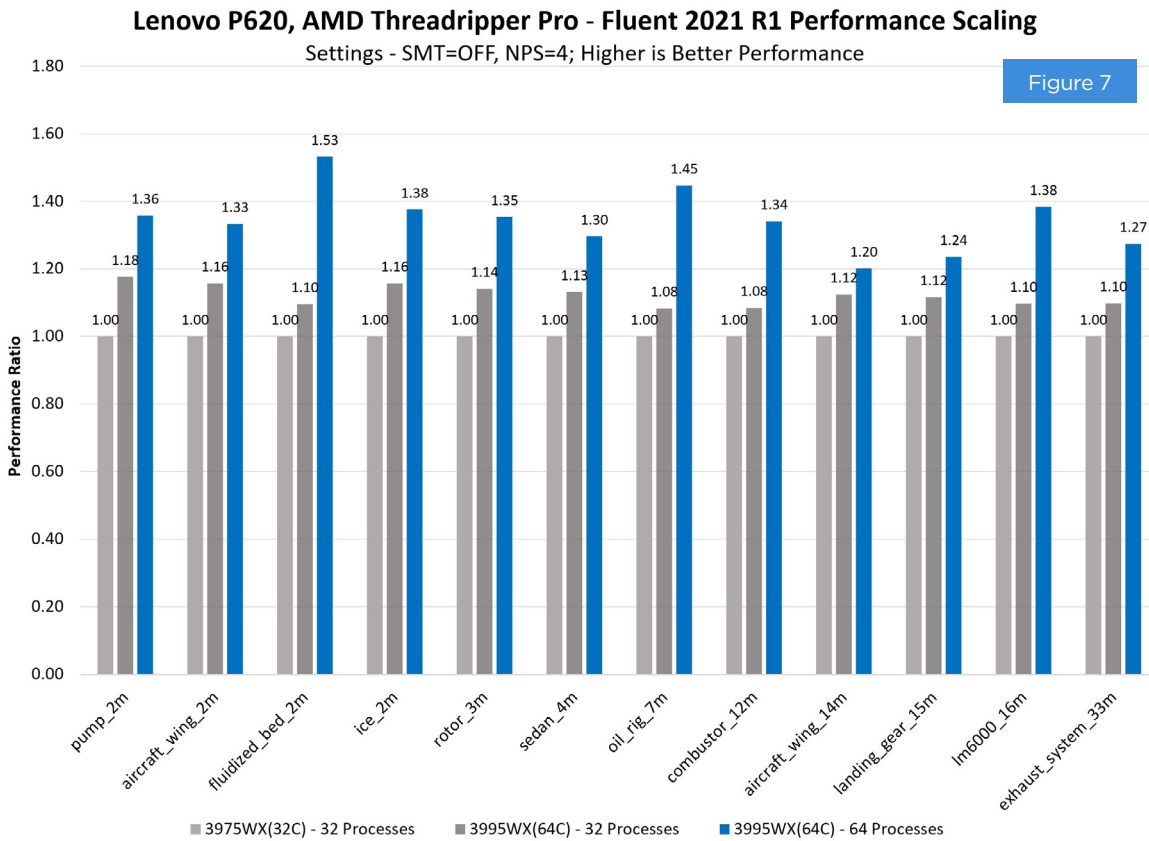
Lenovo P620, AMD Threadripper Pro - Fluent 2021 R1 Performance Scaling
Settings - SMT=OFF, NPS=4; Higher is Better Performance

Figure 7

Figure 7 shows the impact of L3 cache on Ansys Fluent performance. With the 32 core Threadripper PRO 3975WX running 32 processes as the baseline, we see performance scale between 8% and 13%, depending on model complexity, when compared to 32 processes run on the 64 core Threadripper PRO 3995WX. The 64 core Threadripper PRO 3995WX running 64 processes shows an even greater performance gain, between 7% and 39%, over the same benchmark run with 32 processes over 64 cores.

Conclusion

As with Ansys CFX, Ansys Fluent is a cache intensive solver and the additional cache available on the Threadripper PRO 3995WX plays an important role in delivering the incremental performance gains. However, it is the additional cores of the 3995WX that contribute the most to the performance increase.

Conclusion and Recommendations

Solution	Configuration	Settings*	Notes
Ansys Fluent	P620-3995WX	NPS 4, SMT Off	A combination of large cache and high core count delivers optimal performance.
Ansys CFX	P620-3975WX P620-3995WX	NPS 4, SMT Off	The 256MB of cache of the Threadripper PRO 3995WX helps relieve the potential memory bandwidth bottleneck if using high core counts.
Ansys Mechanical	P620-3995WX	NPS 4, SMT Off	A combination of high core count/frequency, cache, and memory help maximize performance. Increasing RAM improves performance for complex models, allowing the Threadripper PRO 3995WX to deliver maximum performance when solving with higher core counts.

*When solving with a single job using fewer than 16 processes, set NPS to Auto for optimum performance.

The ThinkStation P620 configured with the 64 core Threadripper PRO 3995WX delivered the highest overall scores for most of the Ansys benchmarks tested when utilizing all 64 cores. As we have seen, however, memory bandwidth and processor cache also play an important factor in optimizing performance.

For Ansys Mechanical, leveraging all 64 cores of the Threadripper PRO 3995WX to solve the benchmarks plays a significant role in delivering the top results. However, depending on model size and complexity, processor cache and memory bandwidth also play an important role in driving performance when solving with higher core counts.

Ansys CFX is a cache intensive solver. The additional cache available on the Threadripper PRO 3995WX plays the dominant role in maximizing performance.

Ansys Fluent is also a cache intensive solver and the additional cache available on the Threadripper PRO 3995WX plays an important role in delivering the incremental performance gains. However, it is the additional cores of the 3995WX that contribute the most to the performance increase.

The Lenovo ThinkStation P620 is the only professional workstation built around the AMD Ryzen Threadripper PRO processor family. With up to 64 cores, 128 PCIe lanes (Gen 4), 1TB of memory, and an 8-channel memory architecture, designers and engineers have access to datacenter-like power on their desktop in a compact and economical package.

AMD THREADRIPPER PRO

Ansys