

Lenovo Workstations: Enabling ANSYS Users To Do More

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Technical Sales Manager,
Lenovo ThinkStation

GLOBAL PRODUCT DATA INTEROPERABILITY **SUMMIT** 2015



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Darker Aerospace

NORTHROP GRUMMAN

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Agenda

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- **Workstation products offered/ choices**
- **Getting the best workstation performance**
 - **Lenovo performance settings/unique advantages**
 - **Processor selections– when cores help/ don't help**
 - **When to use Nvidia Tesla and how many**
 - **ThinkPad Mobile Workstation performance**
- **Servers**
- **Questions**

Question...

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How many workstations would you need to get the following?

- 36 cores @ 2.3GHz
- 1TB DDR4 memory
- 36GB GDDR5 discrete video with over 9,000 CUDA cores
- 1TB NVMe PCIe SSD @ 32Gbps
- 4TB SSD storage
- 16TB 7200PRM SATA storage
- 2x 10Gb connections + 2x 1Gb connections

Answer: Just one, if it's a **ThinkStation P900**.

Another question...

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What kinds of workloads could you handle with this workstation configuration?

- 4-core Intel Xeon processor at 2.9GHz
- 64GB ECC DDR4 memory
- 8GB GDDR5 discrete video memory with over 1,500 CUDA cores
- 1TB NVMe PCIe SSD @ 32Gbps
- 2TB SSD storage

...What if I told you that you could close it and carry it home with you?

Oh yeah, and it also has a 17" 4K display, Thunderbolt/USB3.1, and an integrated Pantone color calibrator...

Lenovo Workstations

Enabling good engineers to become great

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P SERIES
ThinkStation Power



W550s

P50

P70

P SERIES
ThinkPad Strength

P70

ANSYS Mechanical Benchmarks

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- ANSYS Mechanical Benchmarks
- **Release 16.0 Test Cases**
 - Power Supply Module (V16cg-1)
 - Tractor Rear Axle (V16cg-2)
 - Engine Block (V16cg-3)
 - Gear Box (V16ln-1)
 - Radial Impeller (V16ln-2)
 - Peltier Cooling Block (V65sp-1)
 - Semi-Submersible (V16sp-2)
 - Speaker (V16sp-3)
 - Turbine (V16sp-4)
 - BGA (V16sp-5)

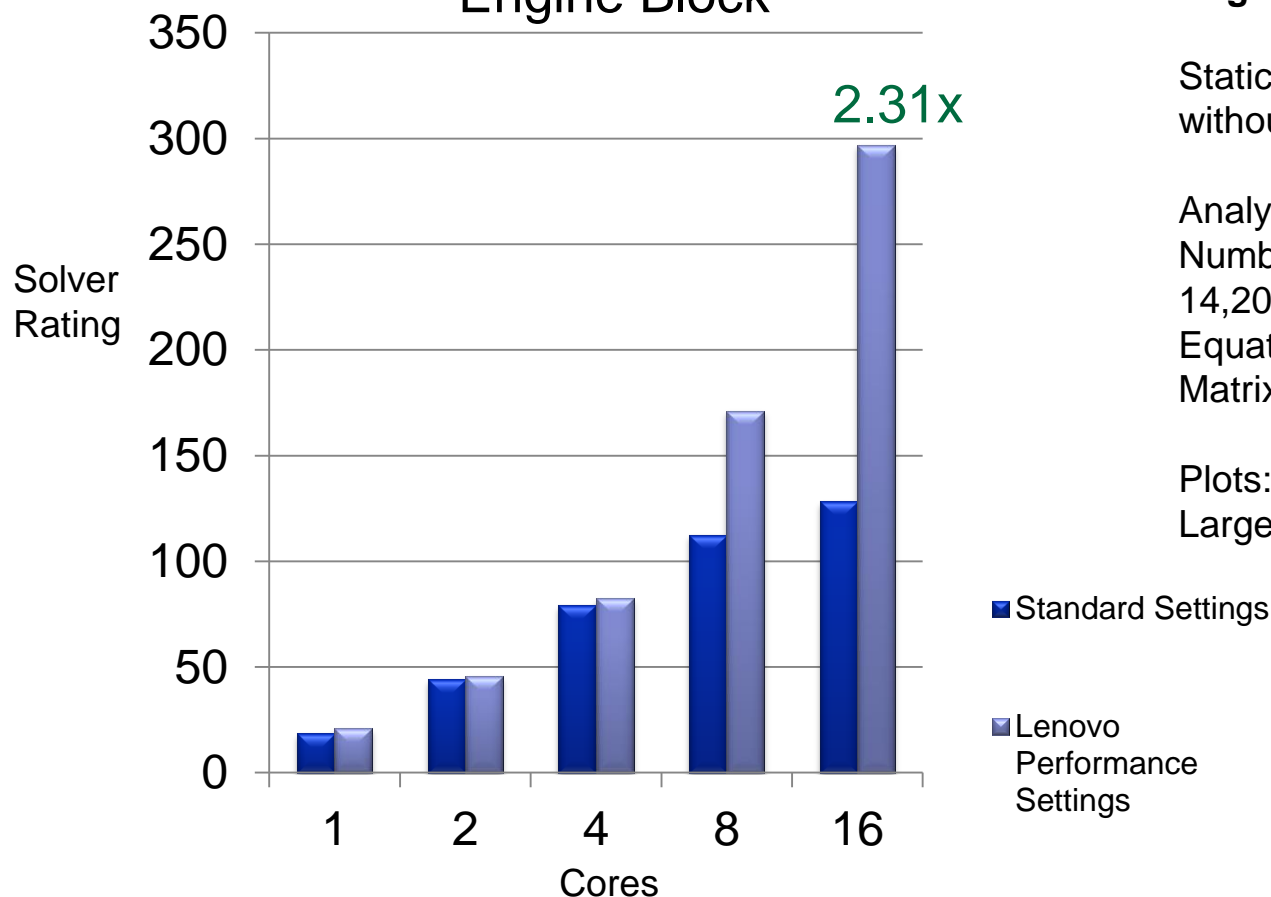
Backup data will have all benchmarks shown

Impact of Lenovo Performance Settings

Comparison of Standard Settings to Lenovo Performance Settings

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Engine Block



Release 16.0 Test Cases Benchmarks – Engine Block V16cg-3

Static structural analysis of an engine block without the internal components

Analysis Type: Static Linear Structural

Number of Degrees of Freedom:

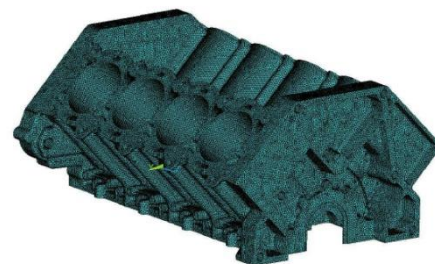
14,200,000

Equation Solver: PCG

Matrix: Symmetric

Plots: Core Solver Rating

Large size job for iterative solvers

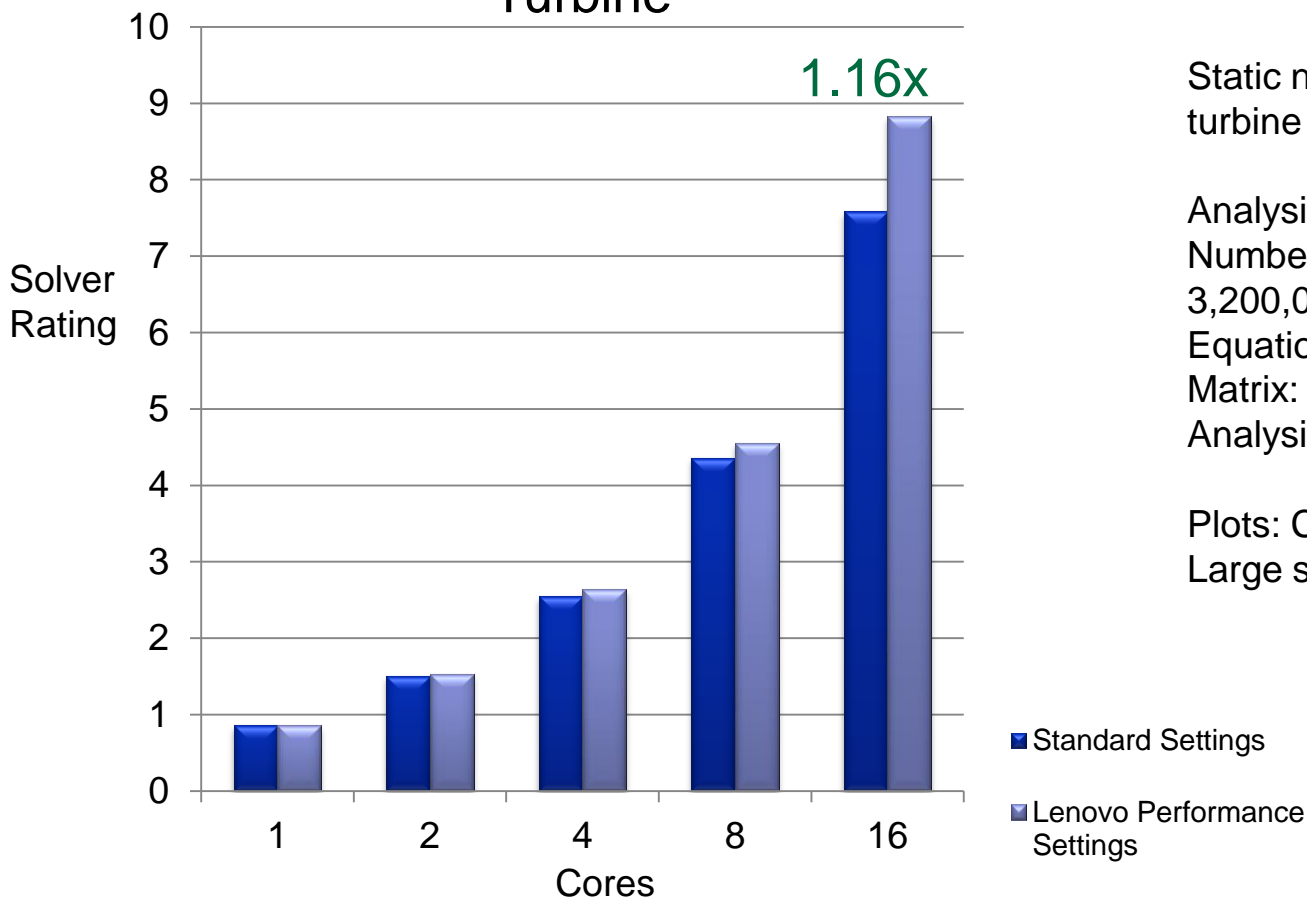


V16cg-3 Benchmark Model

Comparison of Standard Settings to Lenovo Performance Settings

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Turbine



Release 16.0 Test Cases Benchmarks – Turbine V16sp-4

Static nonlinear structural analysis of a turbine blade as found in aircraft engines

Analysis Type: Static Nonlinear Structural

Number of Degrees of Freedom:

3,200,000

Equation Solver: Sparse

Matrix: Symmetric

Analysis with 1 iteration

Plots: Core Solver Rating

Large size job for direct solvers

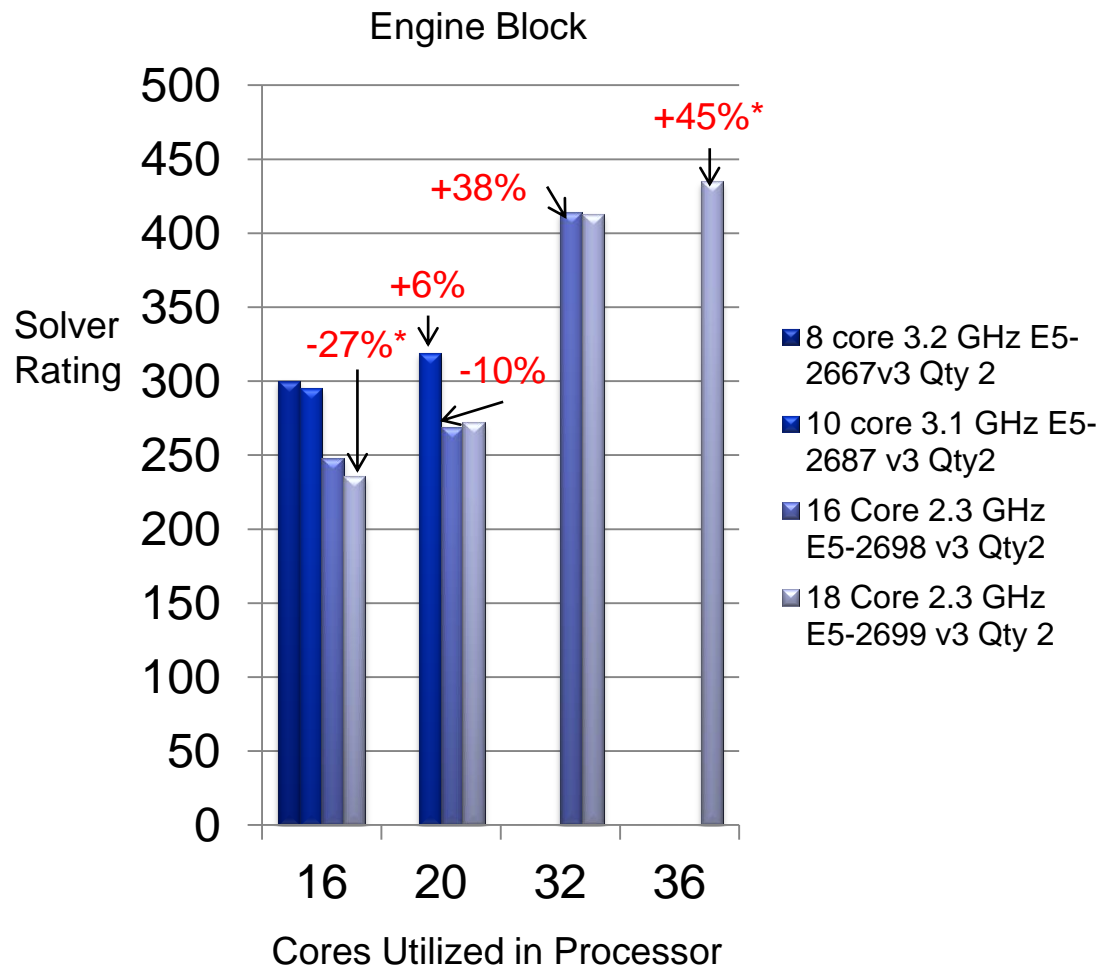


V16sp-4 Benchmark Model

Processor speed versus core count

Comparing Cores Used Per Processor

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* Percentage compares the 2 18 core processors to the 2 8 core processors

Release 16.0 Test Cases Benchmarks – Engine Block V16cg-3

Static structural analysis of an engine block without the internal components

Analysis Type: Static Linear Structural

Number of Degrees of Freedom: 14,200,000

Equation Solver: PCG

Matrix: Symmetric

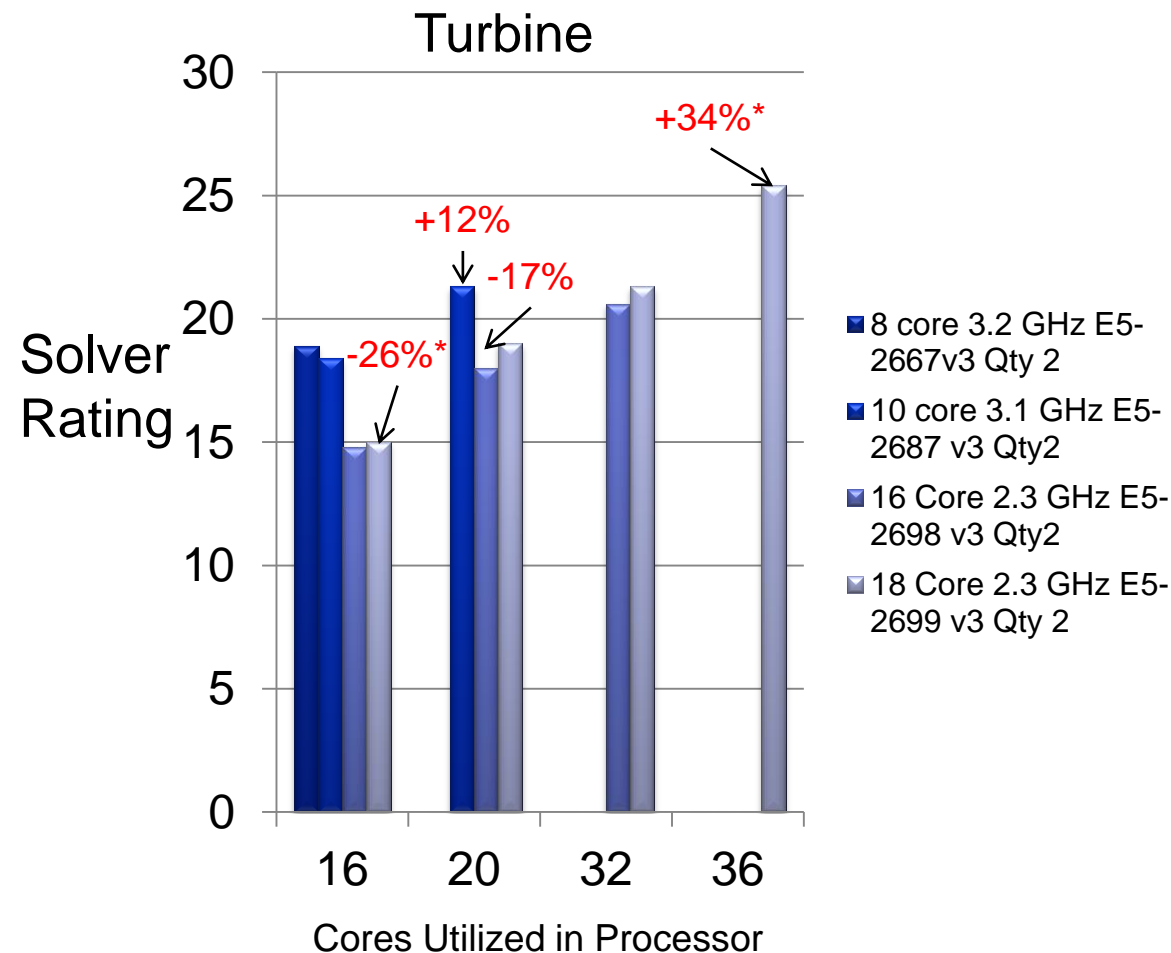
Plots: Core Solver Rating

Large size job for iterative solvers

Recommendation:
Run on all cores available
Frequency still important

Comparing Cores Used Per Processor

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* Percentage compares the 2 18 core processors to the 2 8 core processors

Release 16.0 Test Cases Benchmarks – Turbine V16sp-4

Static nonlinear structural analysis of a turbine blade as found in aircraft engines

Analysis Type: Static Nonlinear Structural
Number of Degrees of Freedom: 3,200,000
Equation Solver: Sparse
Matrix: Symmetric

Plots: Core Solver Rating
Large size job for direct solvers

Recommendation: Run on all cores available
Frequency still important

Processor Decisions

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Cores vs. Clock speed

- Generally more cores give better performance.
- **Average Improvement going from 16 to 32 cores is 26%**
- Size your core selection to your expected usage.
- Performance improvement is not linearly proportional to cores added.
- Generally recommend the maximum cores per processor
 - Some minor performance anomalies exist,
 - 2 out of 10 benchmarks don't run the fastest on 2 18 core processors (V16ln-2 Radial Impeller & V16sp-2 Semi-Submersible)

NVidia Tesla impact on performance

ThinkStation P900

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UNMATCHED

PERFORMANCE

EXCLUSIVE TO LENOVO

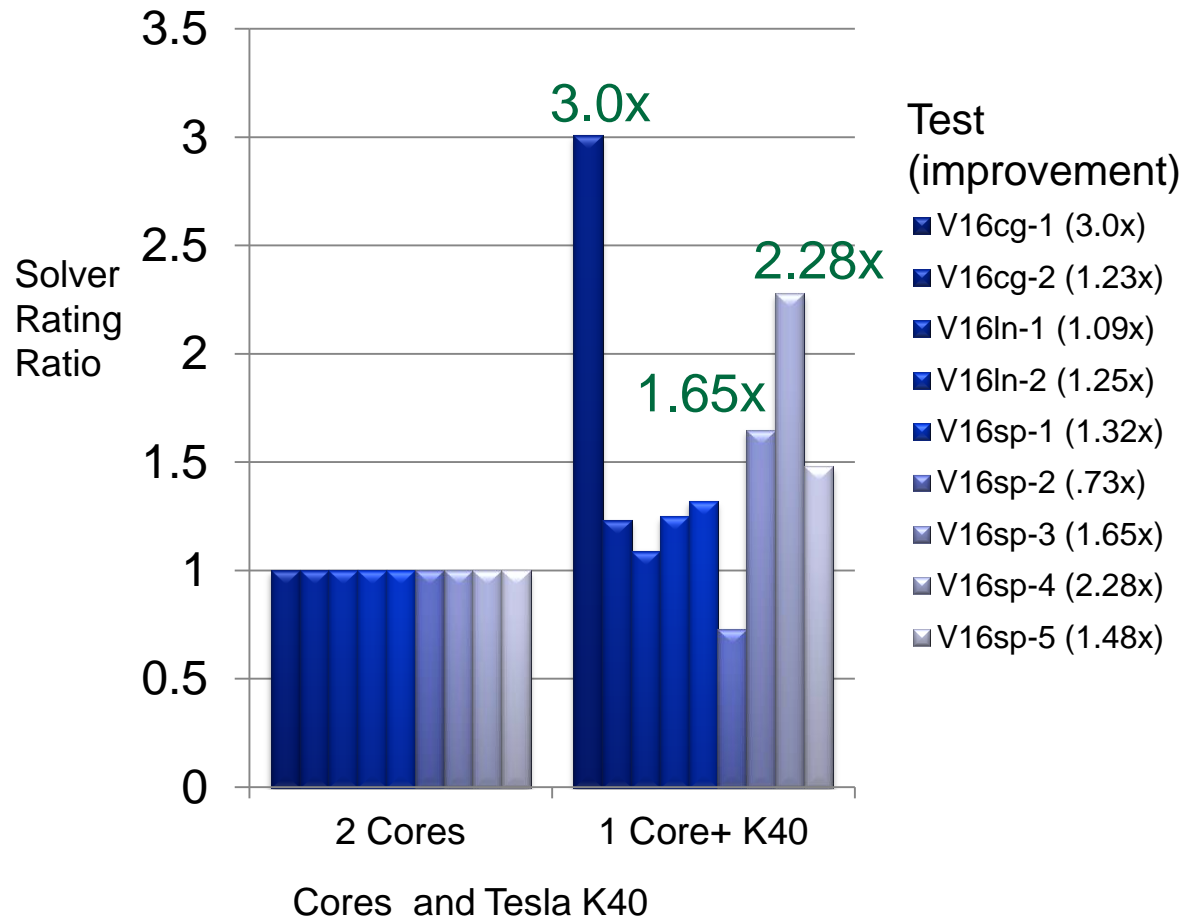
Unique advantage

The ThinkStation P900 is the only workstation on the market today that can support Up to 3 NVIDIA Quadro M6000 or 3 Tesla K40 graphics cards

Improvement from Nvidia Tesla K40

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Main License – 2 core utilization



Release 16.0 Test Cases Benchmarks

Note: V16cg-3 not supported on Tesla

Performance improvement in all cases except V16sp-2

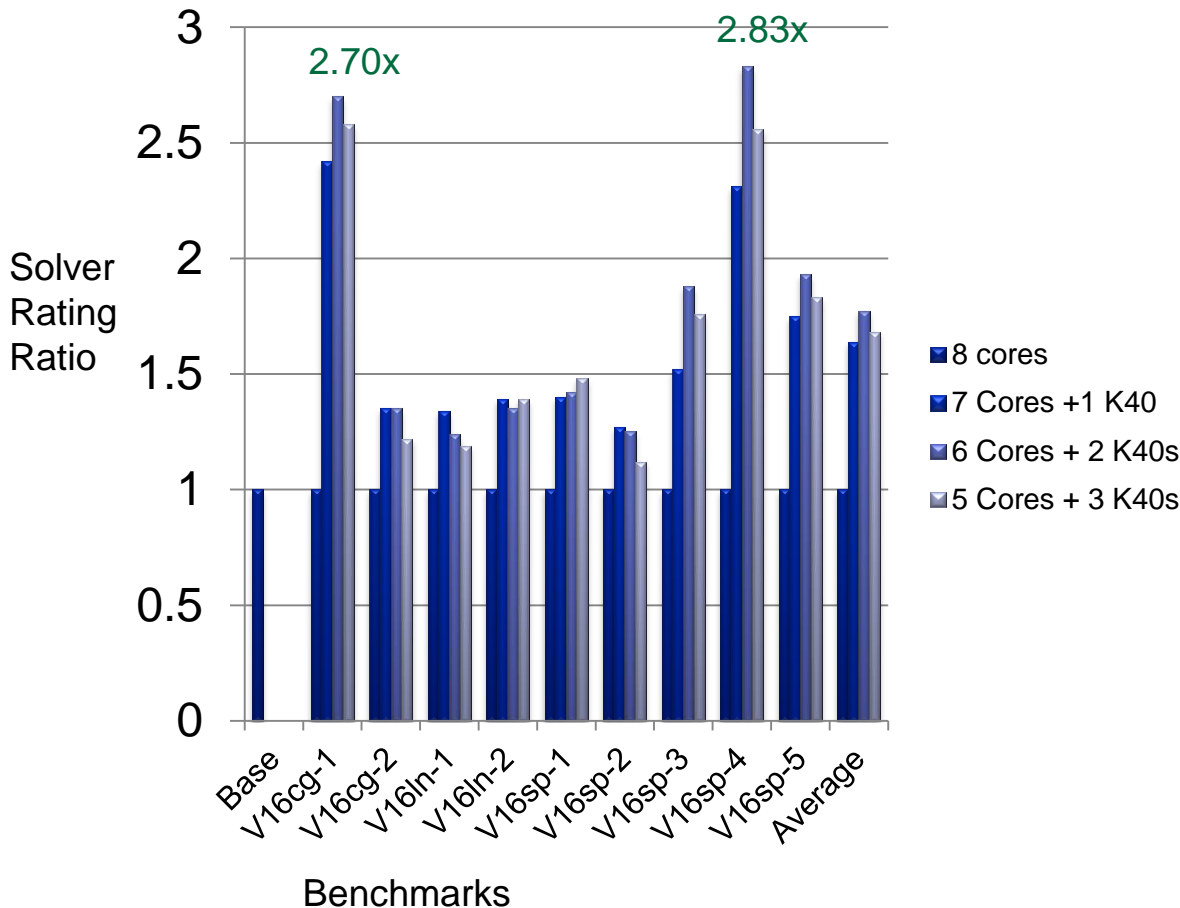
Average improvement= 55%

Recommend 1 Nvidia K40 Tesla for those who only have a base license (2 cores)

Improvement from Nvidia Tesla K40

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Main License + 1 HPC Pack



Release 16.0 Test Cases Benchmarks

Note: V16cg-3 not supported on Tesla

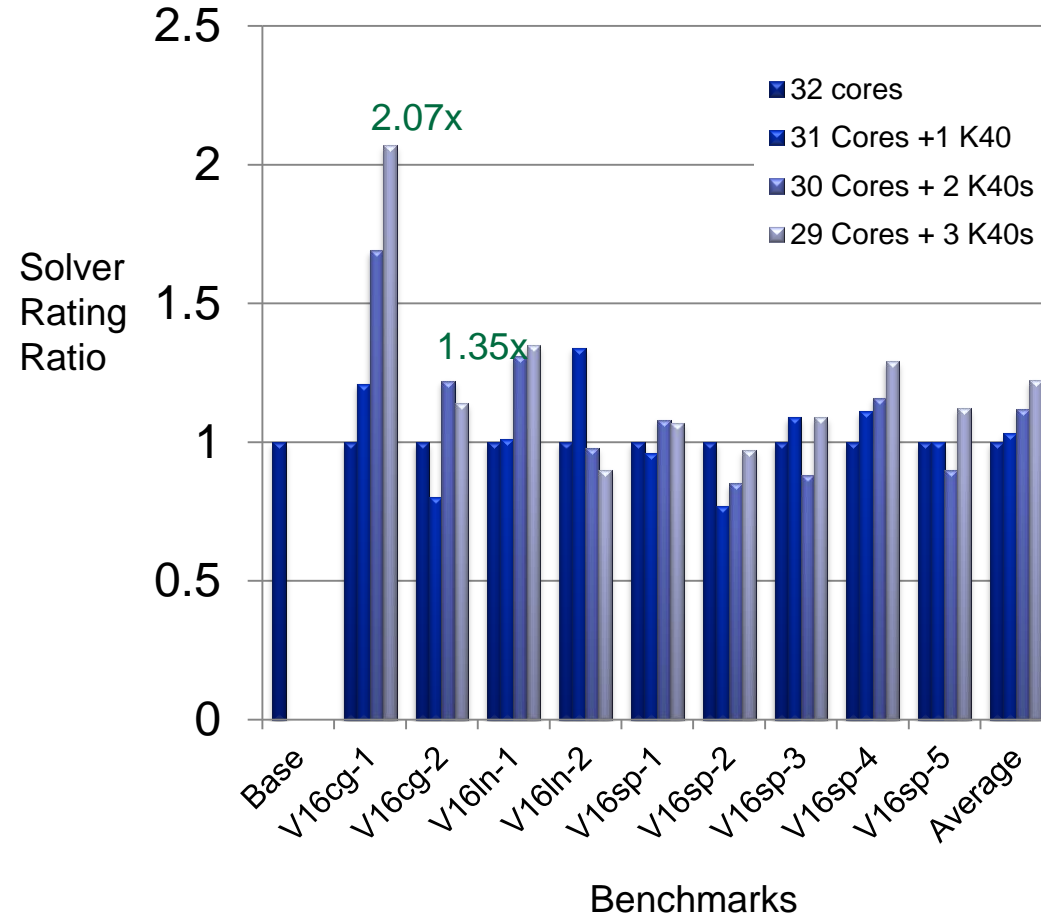
- 1 Tesla is significant gain (1.27x to 2.42x) Average =63%
- 2 Teslas are a significant gain (1.24x to 2.83x)
- Average = 77%, cg1=+12%, SP3=+23%, SP4=+22%
- 3 Teslas provide no gain

For those that have a Main License and 1 HPC pack
We recommend 1 Nvidia K40 Tesla, or 2 K40s for cg-1, sp-3 and sp-4.

Improvement from Nvidia Tesla K40

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Main License + 2 HPC Packs



Release 16.0 Test Cases Benchmarks

Note: V16cg-3 not supported on Tesla

- 1 Tesla average gain is 3%
(cg-1= 21%, ln-2=34%, sp-3=9%, sp-4=11%)
- 2 Teslas average gain is 11%
(cg-1= 69%, cg-2 = 22%, ln-1=31%, sp-1=8%, sp-4=16%)
- 3 Teslas average gain is 22%
(cg-1= 107%, ln-1=35%, sp-4=8%, sp-5=12%)

For those that have a Main License and 2 HPC packs
Recommendation – Number of Nvidia K40 Teslas recommended is dependent on your problem set

Is there a mobile workstation recommended for ANSYS?

Most Powerful Mobile Workstation ever

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Lenovo ThinkPad P70 Mobile Workstation

- Nvidia Quadro M graphics with GPU power
- Intel® Core™ and mobile Xeon processors
- Memory: up to 64 GB with ECC option
- Unique FLEX dual fan cooling
 - Enables Turbo Boost
- 17 inch 4K IPS Display, touch option
- NVMe PCIe Storage

17"

Cooling design
exclusive to
Lenovo



New Use Cases – GPU/CUDA

- much faster rendering, analysis, simulation

MEET THINKPAD P70

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The Complete P70 Picture Power Defined

A machine for designers and engineers who need the highest performing CPU along with the highest performing GPU available in a mobile device. Also for power users who just want a large screen and screaming fast CPU and storage.

P70 - Why is it “Power Defined?”

■ Designed for Designers and Engineers

- Intel 6th Gen Core i CPUs & Fastest Available **Mobile Xeon**
- All new **NVIDIA Maxwell GPUs**
- PCIe storage that is up to **9x faster than HDD**
- DDR4 Memory **up to 64GB**
- **4k Display** with 92% Color Gamut
- All new **Color Calibrator** for absolute accurate colors
- Intel Thunderbolt port for the **fastest possible connection**
- **ISV Certified**



P70 – Design Features

BIGGER, FASTER, and more POWERFUL

- <30mm thin and 7.55lbs
- Dual cooling fans
- Mil Spec Tough

Continued Evolution of User Interaction

- New 3+3 button Touchpad specific to MWS users
- High resolution 4k panels for more accurate designs
- Legendary ThinkPad Keyboard

ThinkPad Precision Backlit Keyboard

Award winning keyboard design now enhanced backlit for better experience.



ThinkPad P

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Parker

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MEET THINKPAD P50

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The Complete **P50** Picture Next Level Performance

A machine for designers and engineers who need a balance of portability and performance with top level CPU offerings and mid-range GPU offerings coupled with the ISV certifications they require to run their resource intensive applications.

P50 - Why is it “Next Level Performance?”

Designed for Designers and Engineers

- Intel 6th Gen Core i CPUs & **Mobile Xeon**
- All new **NVIDIA Maxwell GPUs**
- PCIe storage that is up to **5x faster than HDD**
- DDR4 Memory **up to 64GB**
- **4k Display** with 100% Color Gamut
- All new **Color Calibrator** for absolute accurate colors
- Intel Thunderbolt port for the **fastest possible connection**
- **ISV Certified**



P50

P50 – Design Features

THINNER, LIGHTER, and more CONNECTED

- <25mm thin and 5.6lbs
- Dual Cooling fans
- Mil Spec Tough

Continued Evolution of User Interaction

- New 3+3 button Touchpad specific to MWS users
- High resolution 4k panels for more accurate designs
- Legendary ThinkPad Keyboard

ThinkPad Precision Backlit Keyboard

Award winning keyboard design now enhanced backlit for better experience.



ThinkPad **P**

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Lenovo server solutions

Lenovo Datacenter Solutions

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	RACK & TOWER	MISSION-CRITICAL	BLADES/CONVERGED	HIGH DENSITY
Perfect for	<p>General purpose server capabilities for organizations of all sizes</p> <ul style="list-style-type: none"> File and print sharing Web hosting and content streaming Collaboration and email Entry virtualization Low-end database 	<p>Large workloads that gain advantage by running on a single machine</p> <ul style="list-style-type: none"> Back-office applications Virtualization and cloud Data center hosting Big data, business analytics, and data warehousing Mission-critical scalable databases 	<p>Customers focused more on total cost of ownership and operational expenses</p> <ul style="list-style-type: none"> Data center applications Back-office applications HPC and high-performance database Big data, data analytics, and data warehousing 	<p>Ideal for workloads where high performance and extreme compute density are required</p> <ul style="list-style-type: none"> Grid computing Cloud computing Data analytics HPC Data center infrastructure Desktop virtualization
Key features	<ul style="list-style-type: none"> Extreme hard drive density Solid state drive support Hot-swap and redundant power and cooling GPU support 	<ul style="list-style-type: none"> Extreme performance and scalability Tool-less, lid-less modular book design Can be serviced and upgraded in the rack 	<ul style="list-style-type: none"> Great density with up to 8-socket nodes Simpler system management High performance networking options 	<ul style="list-style-type: none"> Dense packaging, advanced cooling, and highly efficient power distribution Water-cooled technology available, providing tremendous energy efficiency
Benefits	<ul style="list-style-type: none"> Reliable and expandable Among the quietest servers in the industry with leading storage flexibility and capacity 	<ul style="list-style-type: none"> Easy manageability Flexibility to grow infrastructure as technology needs dictate Resilient to maximize application uptime 	<ul style="list-style-type: none"> Optimized for energy, space, and thermal efficiency Unmatched scalability 	<ul style="list-style-type: none"> Maximum density Easy to deploy with Lenovo's Intelligent Cluster Services

Thank you!!!

Backup charts

ANSYS Performance

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- This section compares typical performance of ANSYS Mechanical running on a Lenovo P900 ThinkStation with standard settings to a P900 ThinkStation with special settings for ANSYS.
- ANSYS Standard Benchmarks are used V16
- The hardware configuration is the same except for the change in set up. P900, 2xE5-2667v3's (8 core/ 3.2 GHz), 128 GB, K2200, RAID 0 with 4x Intel 240GB SSDs, Windows 7 64 Bit. Hyper-threading set to off.
- All testing is done in Lenovo Performance labs by William Otto and team.

ANSYS Mechanical Benchmarks

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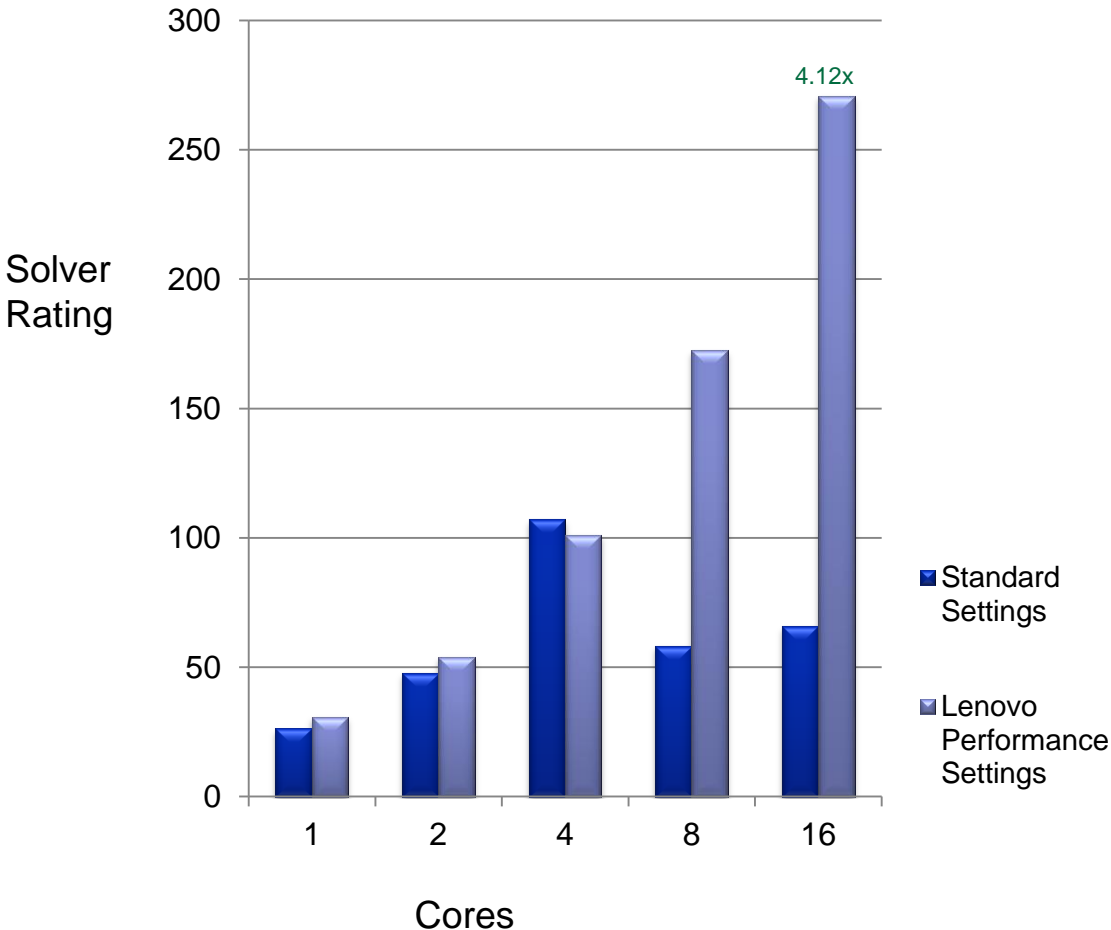
- ANSYS Mechanical Benchmarks
- **Release 16.0 Test Cases**
 - Power Supply Module (V16cg-1)
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 - Semi-Submersible (V16sp-2)
 - Speaker (V16sp-3)
 - Turbine (V16sp-4)
 - BGA (V16sp-5)

Results from Lenovo Performance Settings

V16cg-1 ANSYS Benchmark - Power Supply Module

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – Power Supply Module

Thermal analysis power supply module

Analysis Type: Static Linear Thermal Analysis

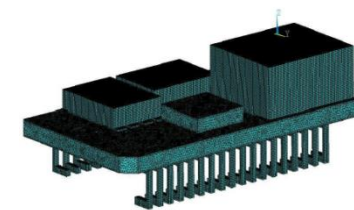
Number of Degrees of Freedom: 5,300,000

Equation Solver: JCG

Matrix: Symmetric

Plots: Core Solver Rating

Medium size job for iterative solvers

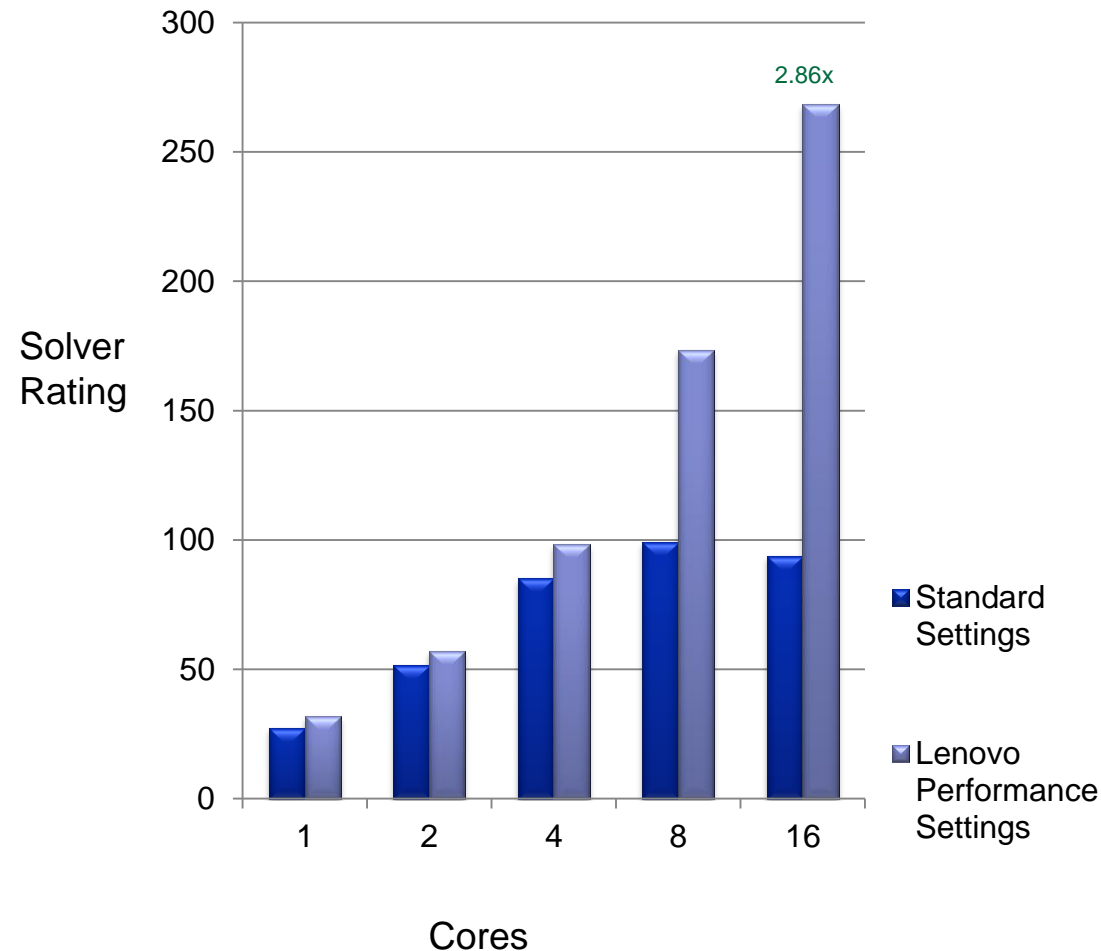


V16cg-1 Benchmark Model

V16cg-2 ANSYS Benchmark - Tractor Rear Axle

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – Tractor Rear Axle

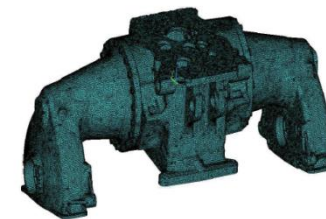
Static structural analysis of a farm tractor rear axle assemble

Analysis Type: Static Linear Structural

Number of Degrees of Freedom: 12,300,000

Equation Solver: PCG
Matrix: Symmetric

Plots: Core Solver Rating
Large size job for iterative solvers

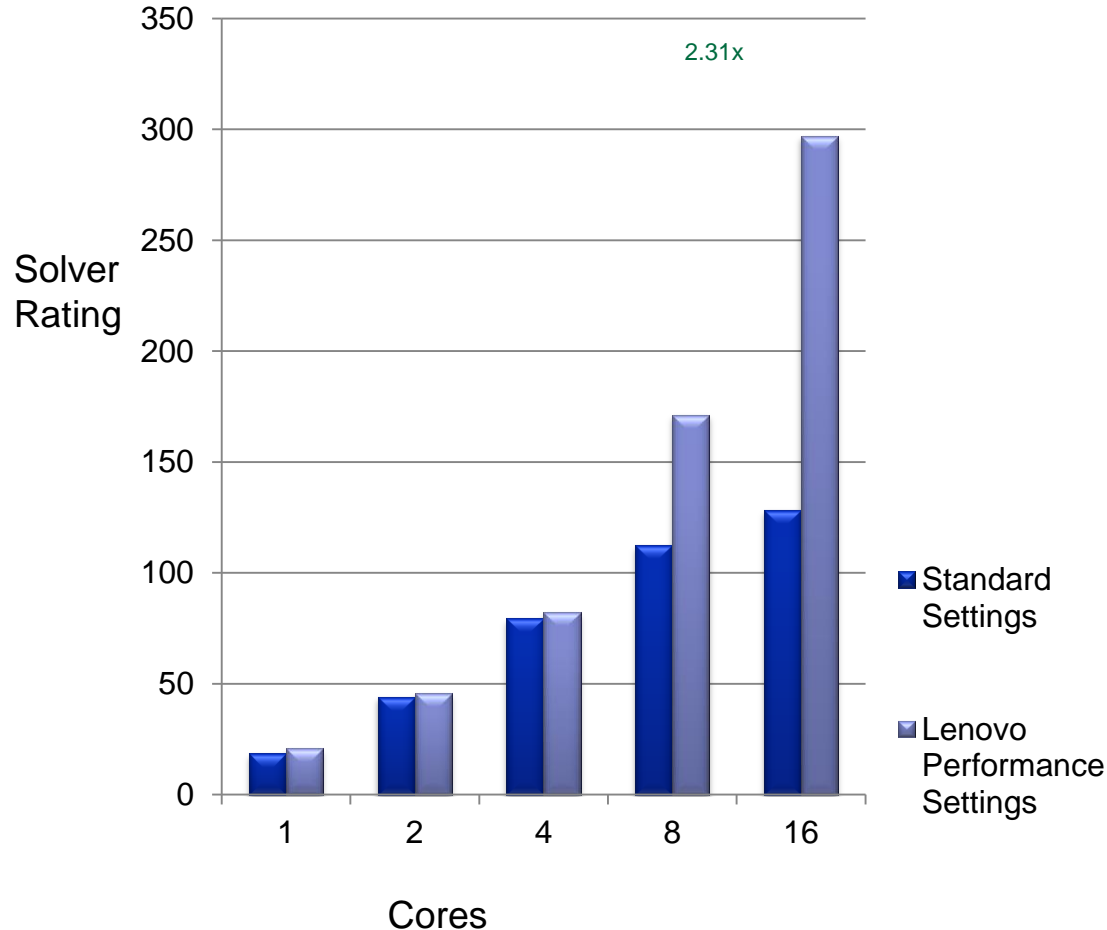


V16cg-2 Benchmark Model

V16cg-3 ANSYS Benchmark - Engine Block

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – Engine Block

Static structural analysis of an engine block without the internal components

Analysis Type: Static Linear Structural

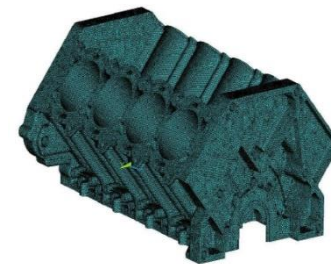
Number of Degrees of Freedom: 14,200,000

Equation Solver: PCG

Matrix: Symmetric

Plots: Core Solver Rating

Large size job for iterative solvers

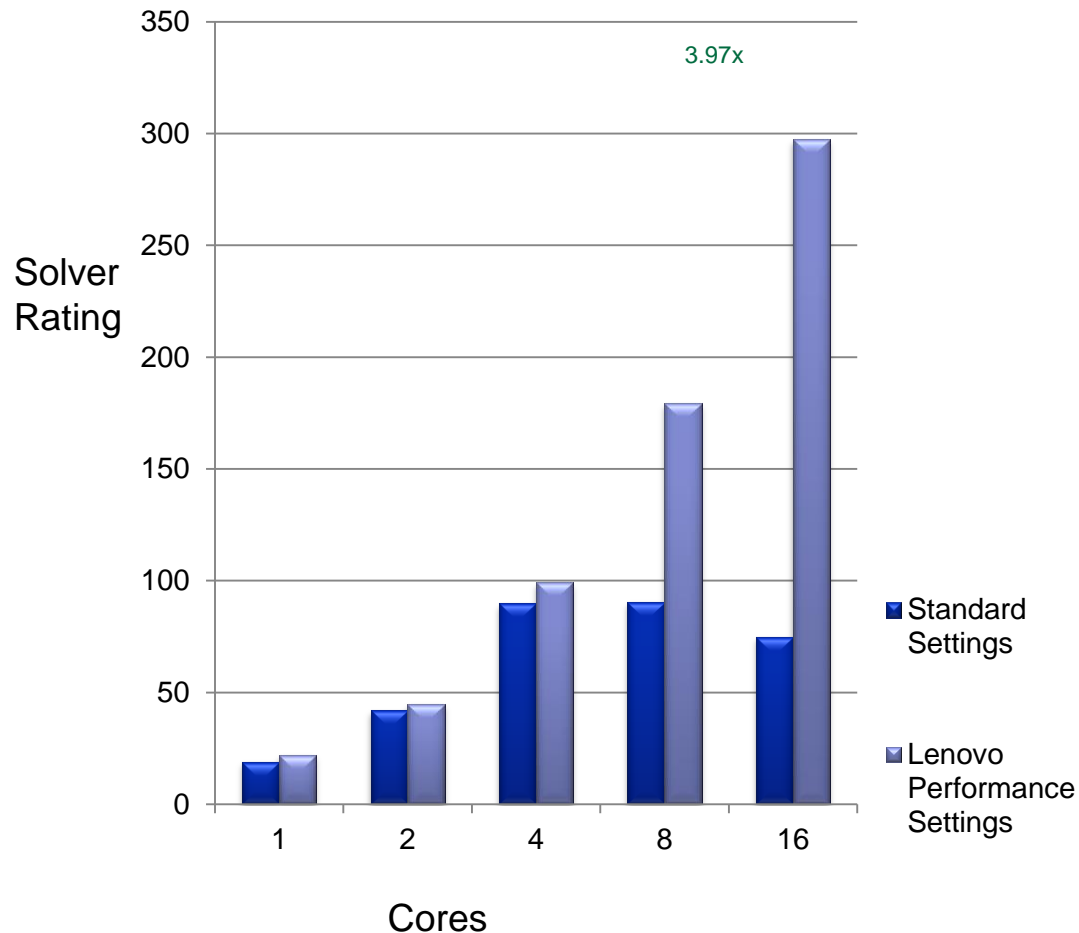


V16cg-3 Benchmark Model

V16In-1 ANSYS Benchmark - Gear Box

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – Gear Box

Modal analysis of a transmission housing without the internal components

Analysis Type: Modal Linear Structural

Number of Degrees of Freedom: 7,700,000

Equation Solver: PCG Lancros eigensolver

Matrix: Symmetric

Analysis requesting 10 modes

Plots: Core Solver Rating

Medium size job for iterative solvers

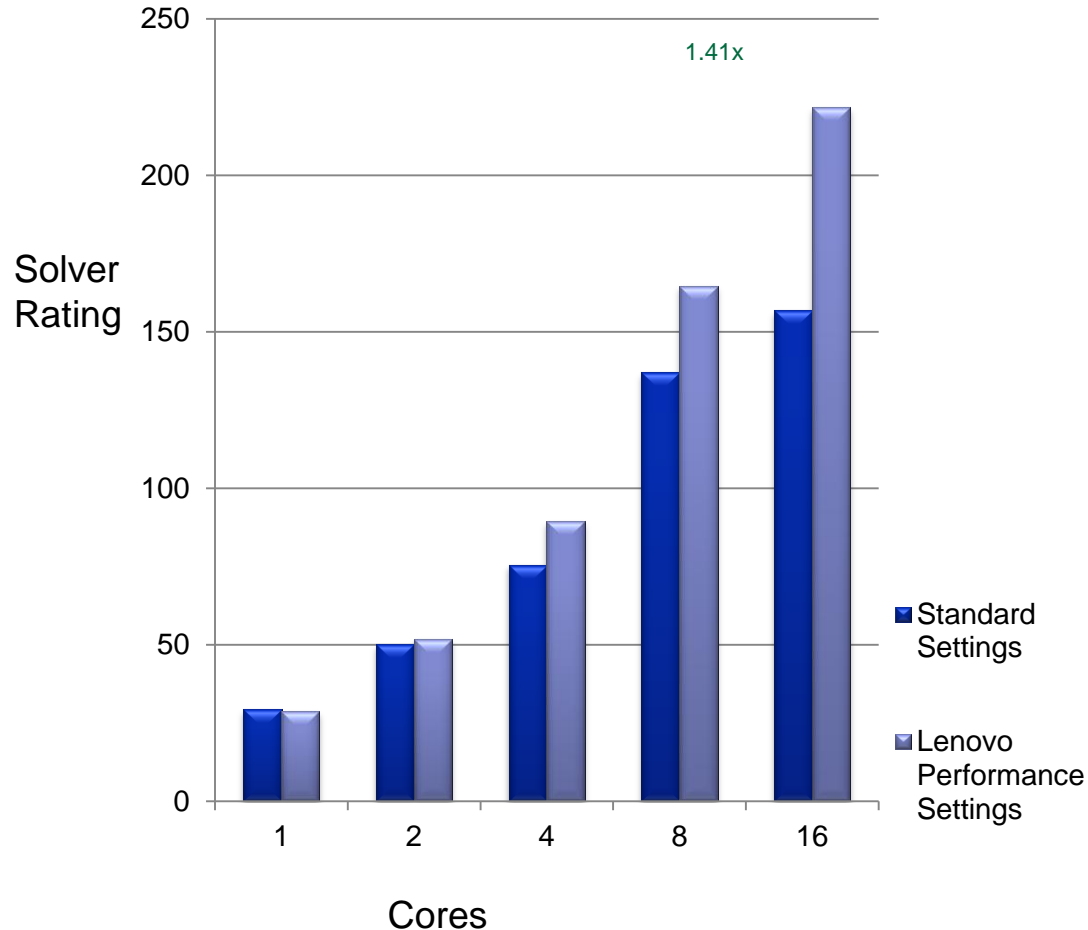


V16In-1 Benchmark Model

V16In-2 ANSYS Benchmark - Radial Impeller

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – Radial Impeller

Cyclic symmetric modal analysis of a single blade of an impeller

Analysis Type: Modal--Cyclic

Symmetry, Linear Structural

Number of Degrees of Freedom:

2,000,000

Equation Solver: Subspace eigensolver

Matrix: Symmetric

Analysis requesting 50 modes

Plots: Core Solver Rating

Medium size job for direct solvers

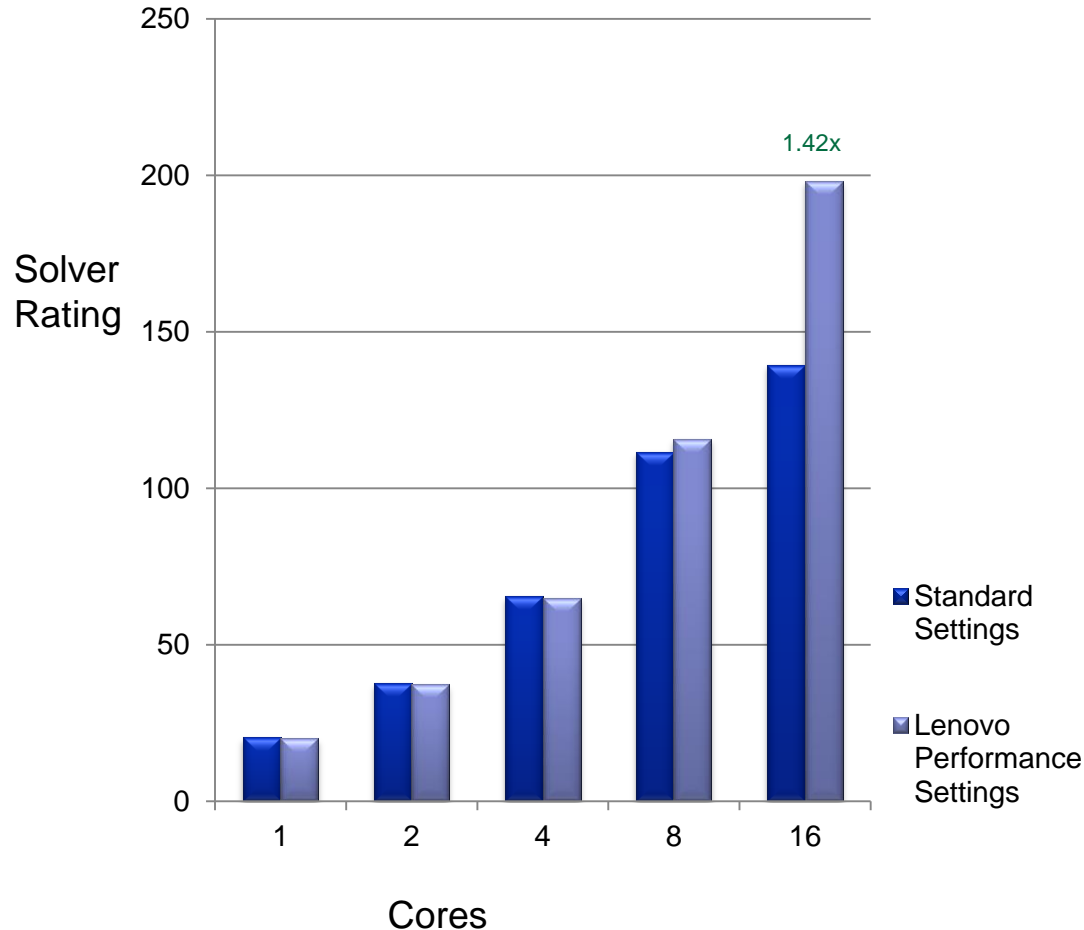


V16In-2 Benchmark Model

V16sp-1 ANSYS Benchmark - Peltier Cooling Block

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Comparison of Standard Settings to Lenovo Performance Settings

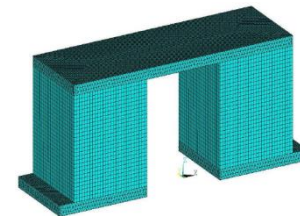


Release 16.0 Test Cases Benchmarks – Peltier Cooling Block

Static nonlinear thermal-electric coupled field analysis of a Pelletier cooling block

Analysis Type: Static Nonlinear Thermal-Electric Coupled Field
Number of Degrees of Freedom: 650,000
Equation Solver: Sparse
Matrix: Non-symmetric (Unsymmetrical)

Plots: Core Solver Rating
Medium size job for direct solvers

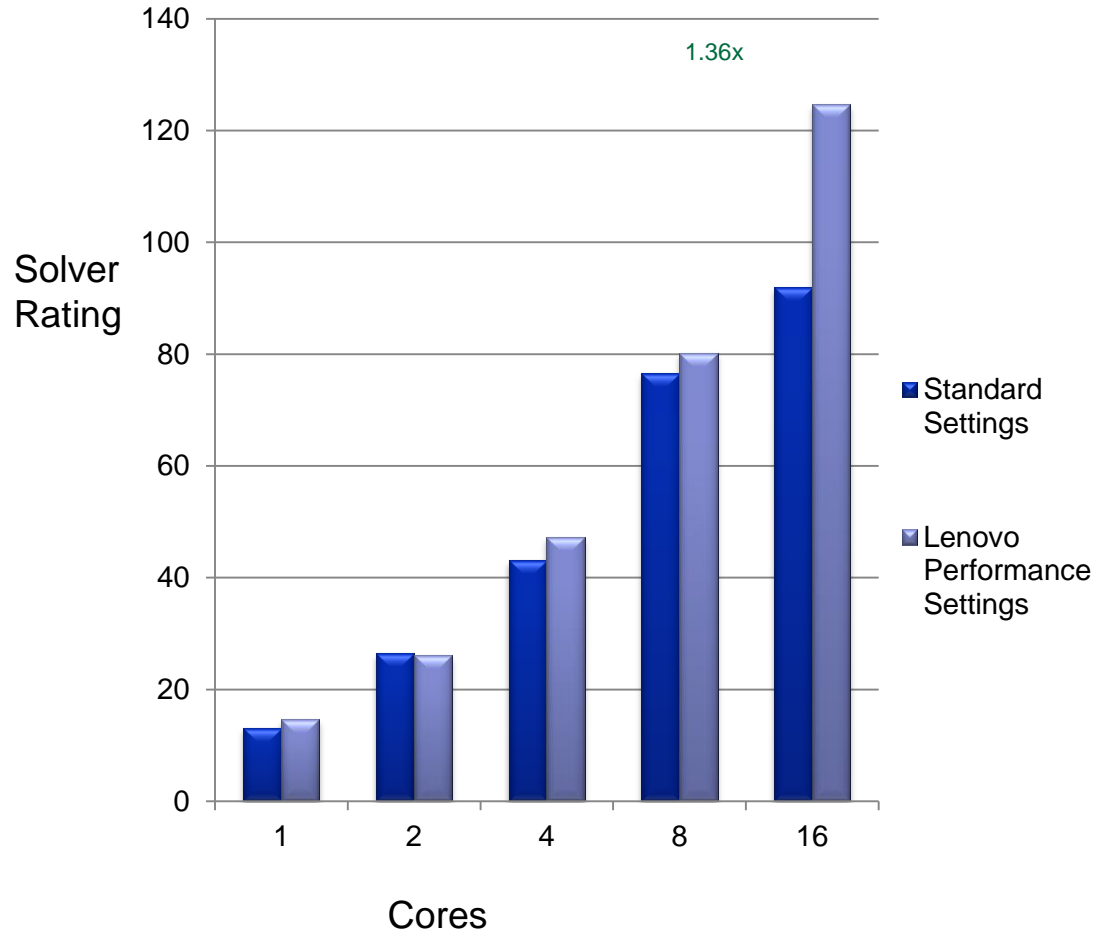


V16sp-1 Benchmark Model

V16sp-2 ANSYS Benchmark - Semi-Submersible

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – Semi-Submersible

Transient nonlinear structural analysis of a submersible drilling rig

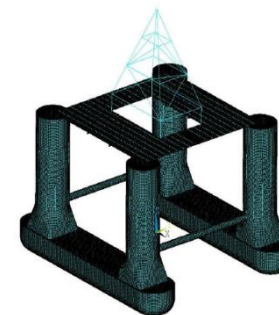
Analysis Type: Transient Nonlinear Structural

Number of Degrees of Freedom: 4,700,000

Equation Solver: Sparse
Matrix: Symmetric

Plots: Core Solver Rating

Medium size job for direct solvers

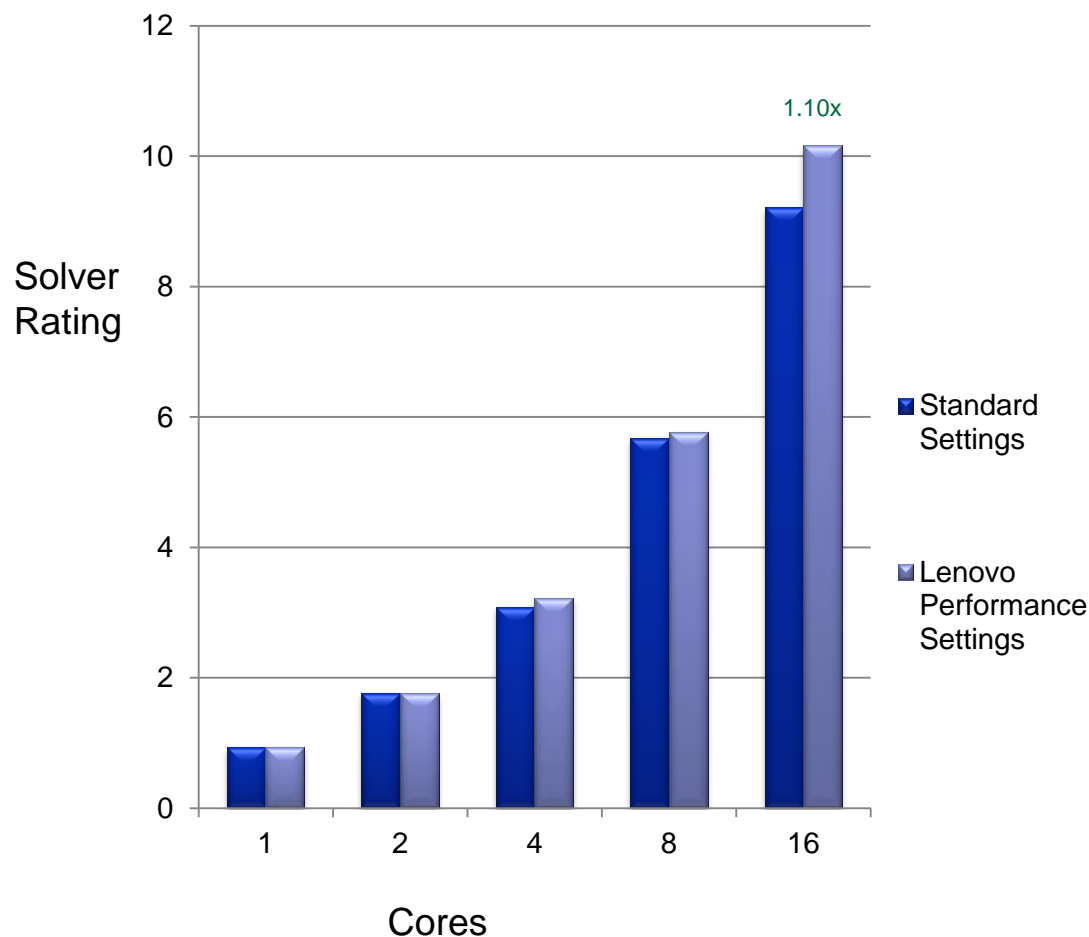


V16sp-2 Benchmark Model

V16sp-3 ANSYS Benchmark - Speaker

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – Speaker

Harmonic linear structural analysis of a speaker and its surroundings

Analysis Type: Harmonic Linear Structural

Number of Degrees of Freedom:

1,700,000

Equation Solver: Sparse

Matrix: Symmetric

Requesting 1 Frequency

Plots: Core Solver Rating

Medium size job for direct solvers

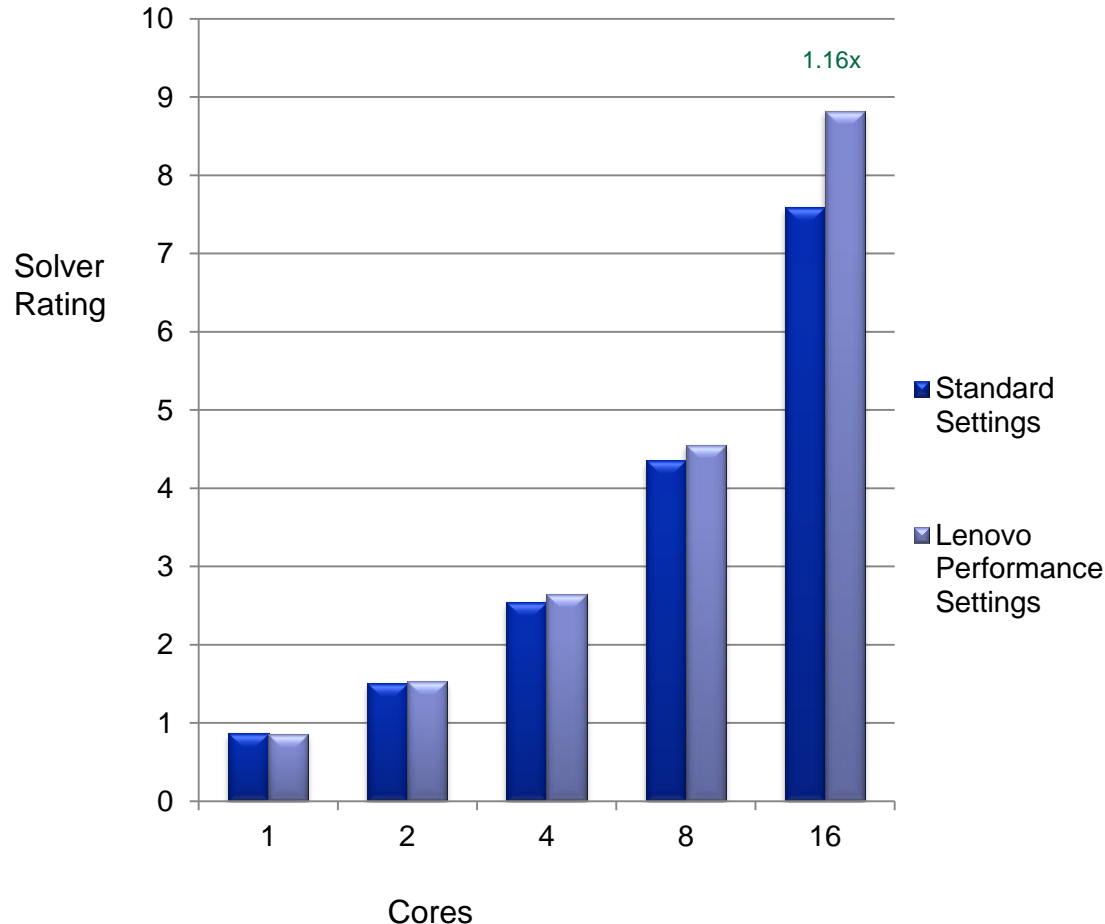


V16sp-3 Benchmark Mode

V16sp-4 ANSYS Benchmark - Turbine

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – Turbine

Static nonlinear structural analysis of a turbine blade as found in aircraft engines

Analysis Type: Static Nonlinear Structural

Number of Degrees of Freedom:

3,200,000

Equation Solver: Sparse

Matrix: Symmetric

Analysis with 1 iteration

Plots: Core Solver Rating

Large size job for direct solvers

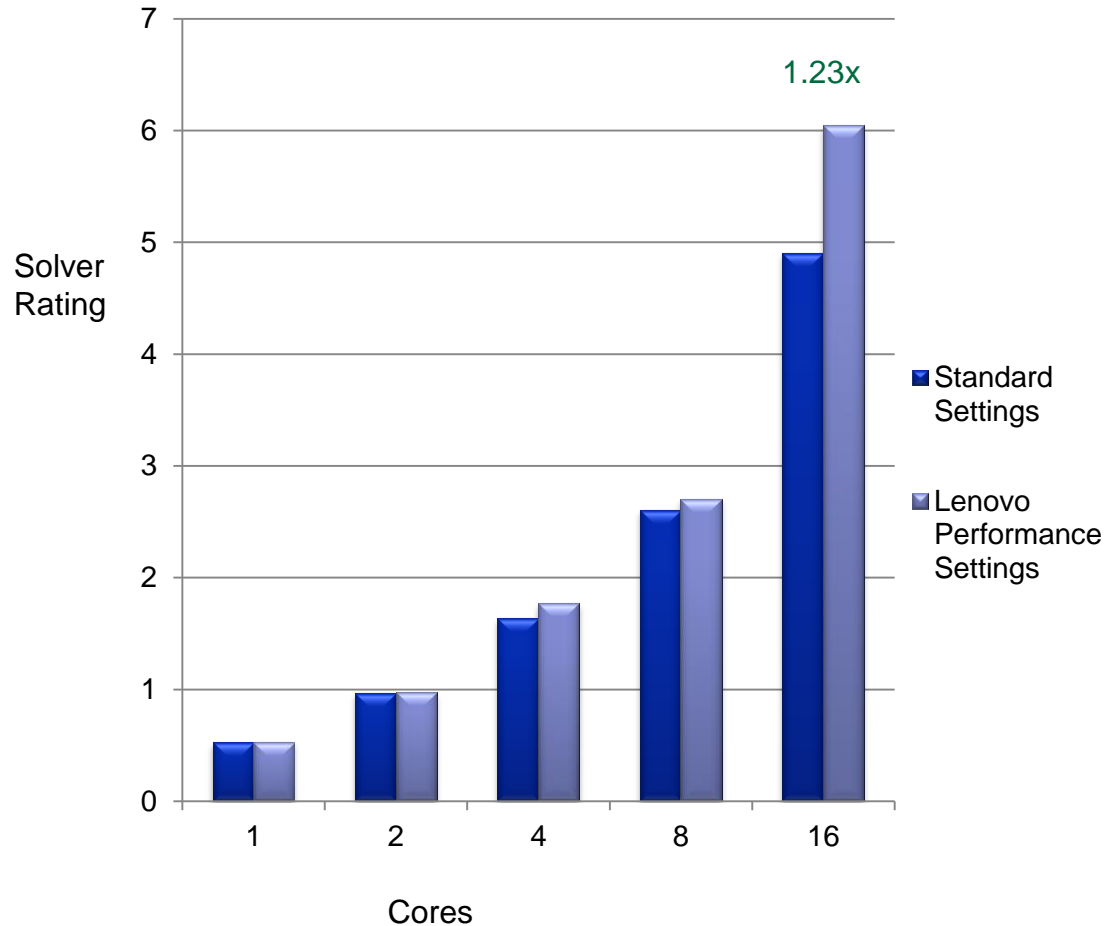


V16sp-4 Benchmark Model

V16sp-5 ANSYS Benchmark - BGA

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Comparison of Standard Settings to Lenovo Performance Settings



Release 16.0 Test Cases Benchmarks – BGA

Transient nonlinear structural analysis of a electronic ball grid array

Analysis Type: Static Nonlinear Structural

Number of Degrees of Freedom:

6,000,000

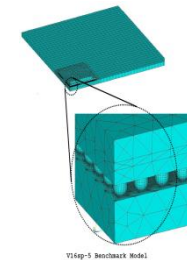
Equation Solver: Sparse

Matrix: Symmetric

Analysis with 1 iteration

Plots: Core Solver Rating

Large size job for direct solvers



Conclusions

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- **Lenovo Performance Settings**
 - Significantly help in all situations where 8 or more cores are used.
 - The average improvement at 16 cores is 2.1x the performance without the tuned settings.
 - Performance settings do not degrade any of the benchmark examples
 - At 16 cores the performance improvement ranges from 1.1 x to 4.12x with the iterative solvers greater than 2x improvement.

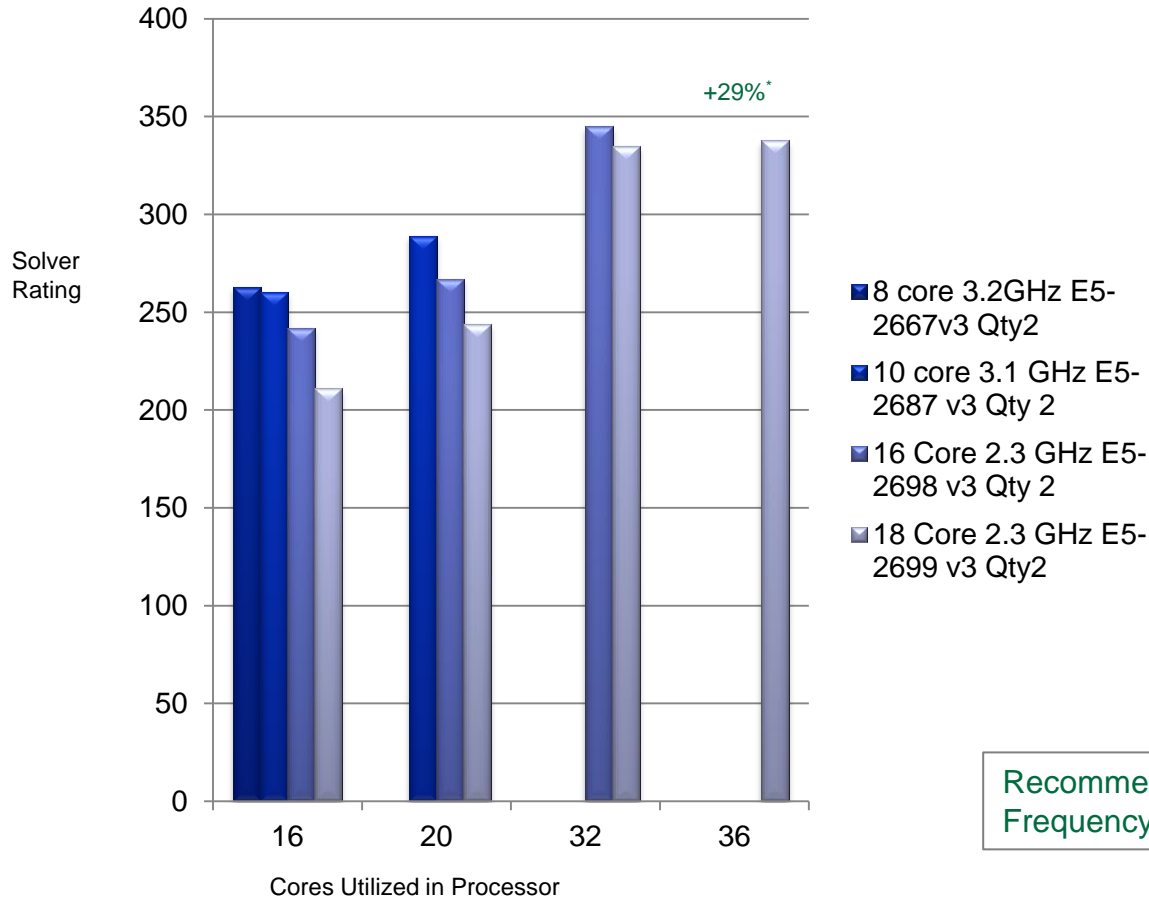
Recommendation: Lenovo Performance Settings for all ANSYS use cases

Processor clock speed vs. core count

V16cg-1 ANSYS Benchmark - Power Supply Module

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Comparing Cores Used Per Processor



Release 16.0 Test Cases Benchmarks - Power Supply Module

Steady state thermal analysis of
a power supply module

Analysis Type: Steady State
Thermal

Number of Degrees of
Freedom: 5,300,000

Equation Solver: JCG

Matrix: Symmetric

Plots: Core Solver Rating

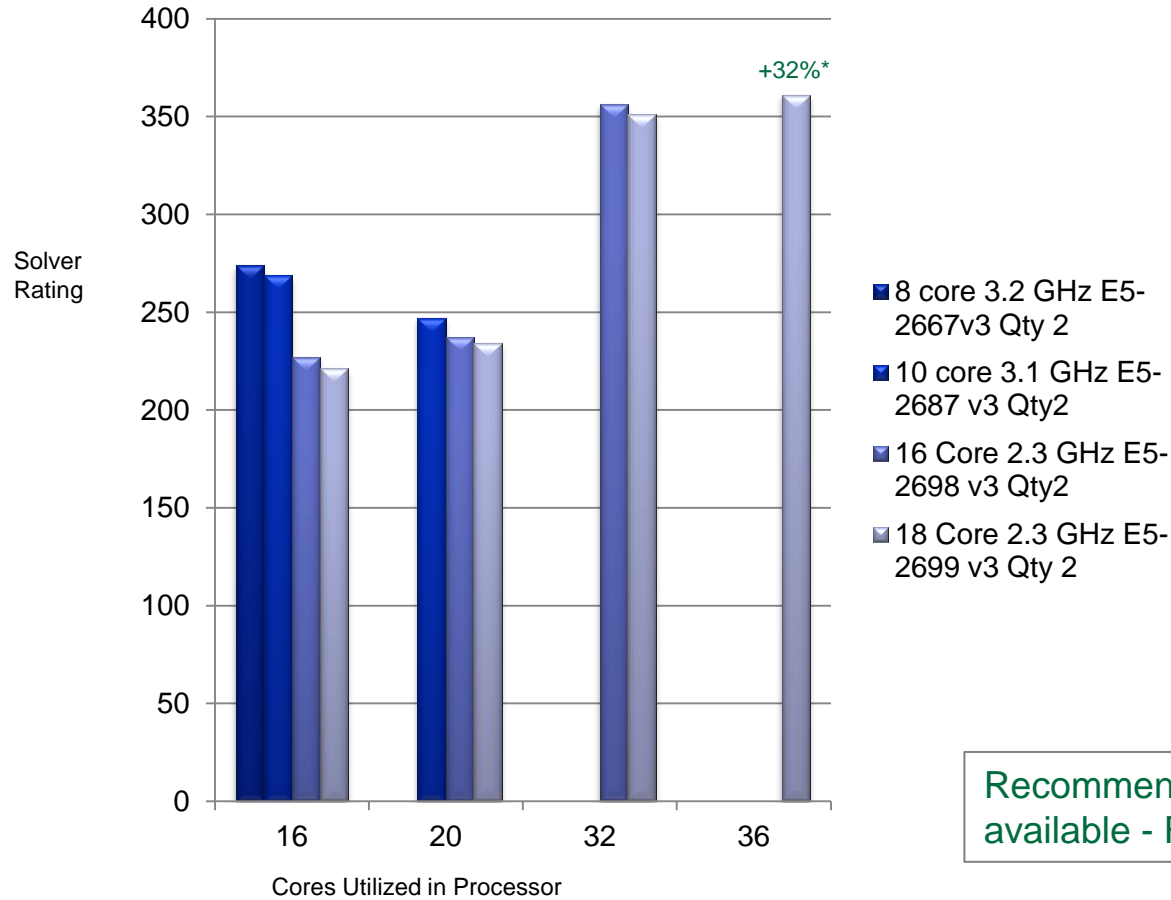
Recommendation: Run ANSYS on all cores available -
Frequency still important

* Percentage compares the 2 18 core processors to the 2 8 core processors

V16cg-2 ANSYS Benchmark - Tractor Rear Axle

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Comparing Cores Used Per Processor



Release 16.0 Test Cases Benchmarks – Tractor Rear Axle

Static structural analysis of a farm tractor rear axle assemble

Analysis Type: Static Linear Structural
Number of Degrees of Freedom: 12,300,000
Equation Solver: PCG
Matrix: Symmetric

Plots: Core Solver Rating

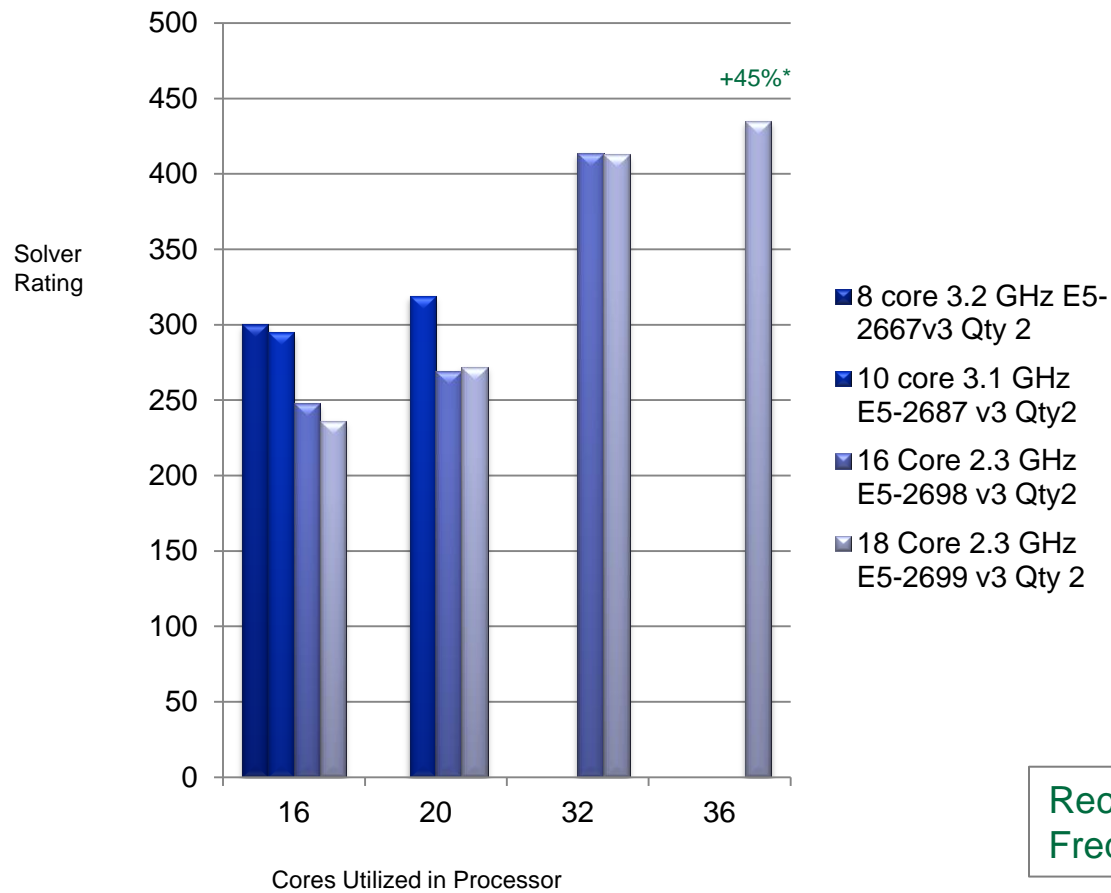
Recommendation: Run ANSYS on all cores available - Frequency still important

* Percentage compares the 2 18 core processors to the 2 8 core processors

V16cg-3 ANSYS Benchmark - Engine Block

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Comparing Cores Used Per Processor



Release 16.0 Test Cases Benchmarks – Engine Block

Static structural analysis of an engine block without the internal components

Analysis Type: Static Linear Structural

Number of Degrees of Freedom: 14,200,000

Equation Solver: PCG
Matrix: Symmetric

Plots: Core Solver Rating

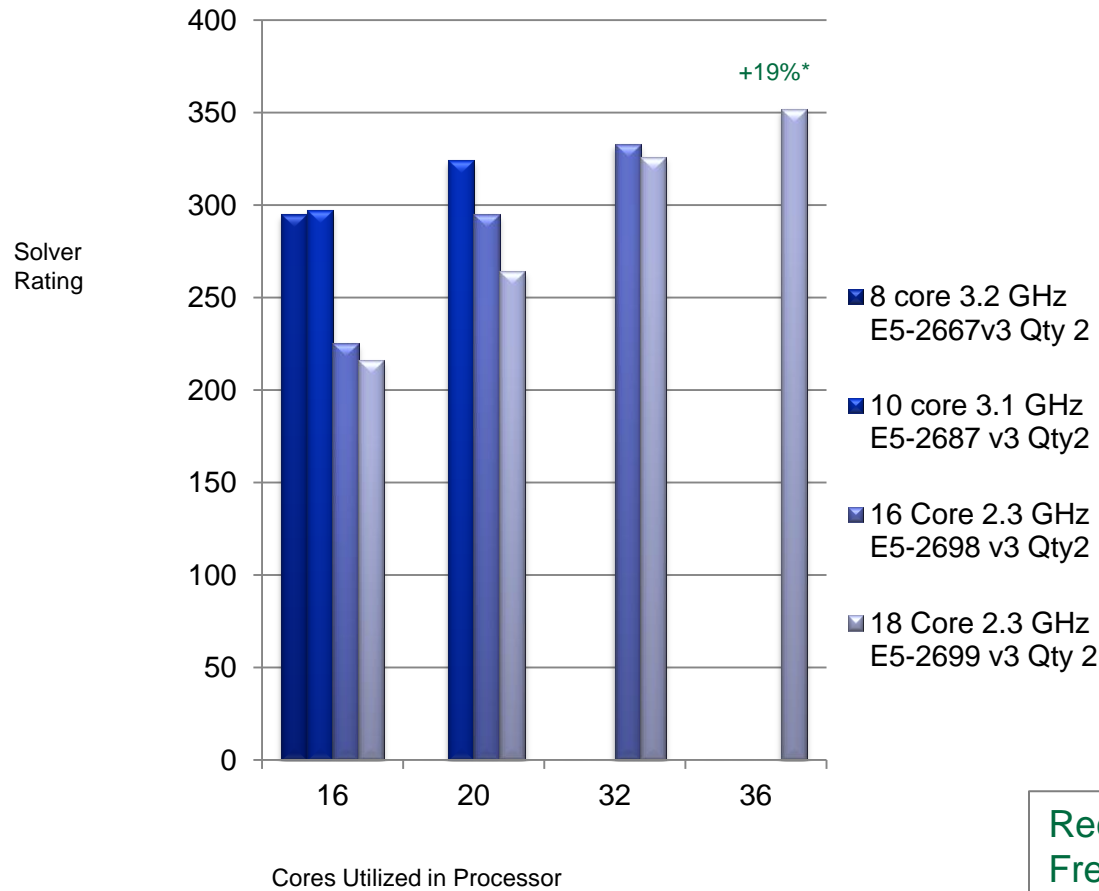
Recommendation: Run on all cores available
Frequency still important

* Percentage compares the 2 18 core processors to the 2 8 core processors

V16In-1 ANSYS Benchmark - Gear Box

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Comparing Cores Used Per Processor



Release 16.0 Test Cases Benchmarks – Gear Box

Modal analysis of a transmission housing without the internal components

Analysis Type: Modal Structural
Number of Degrees of Freedom: 7,700,000
Equation Solver: PCG
Matrix: Symmetric

Plots: Core Solver Rating

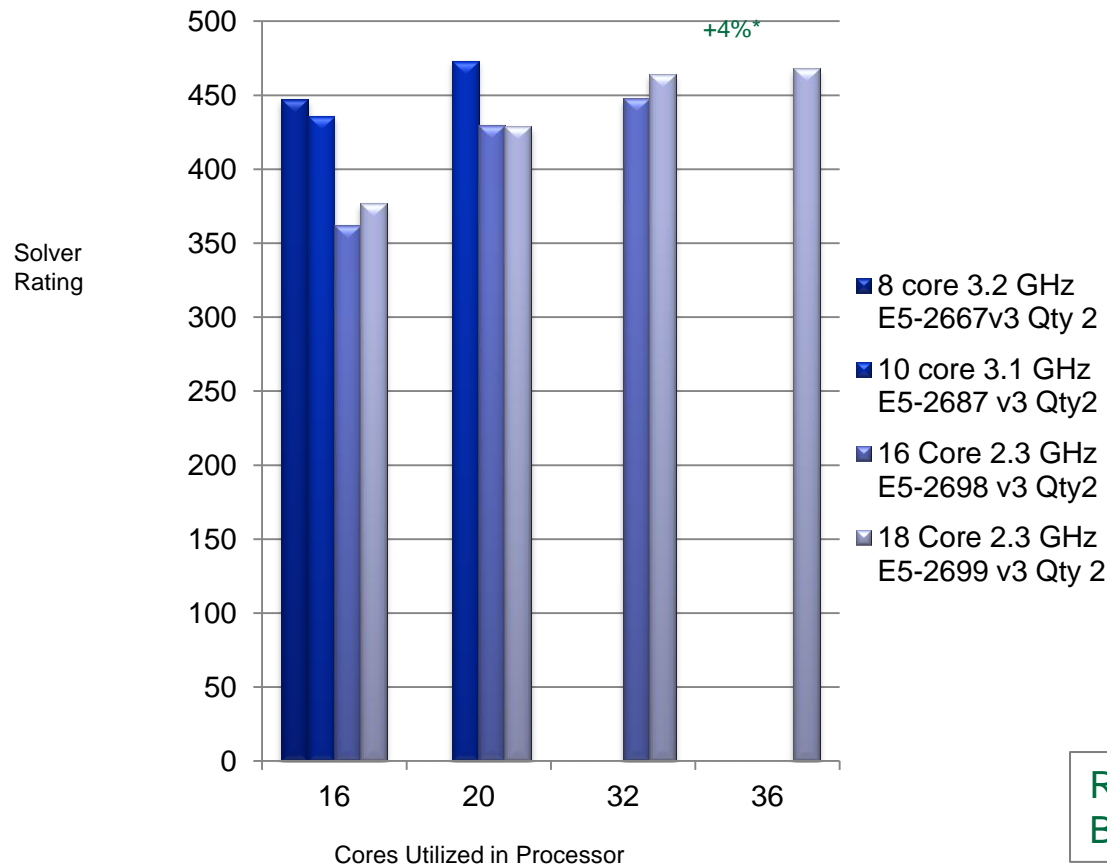
Recommendation: Run on all cores available
Frequency still important

* Percentage compares the 2 18 core processors to the 2 8 core processors

V16In-2 ANSYS Benchmark - Radial Impeller

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Comparing Cores Used Per Processor



Release 16.0 Test Cases Benchmarks – Radial Impeller

Cyclic symmetric modal analysis of
a single blade of an impeller

Analysis Type: Modal - Cyclic
Symmetry, Structural
Number of Degrees of Freedom:
2,000,000
Equation Solver: Block Lanczos
Matrix: Symmetric

Plots: Core Solver Rating

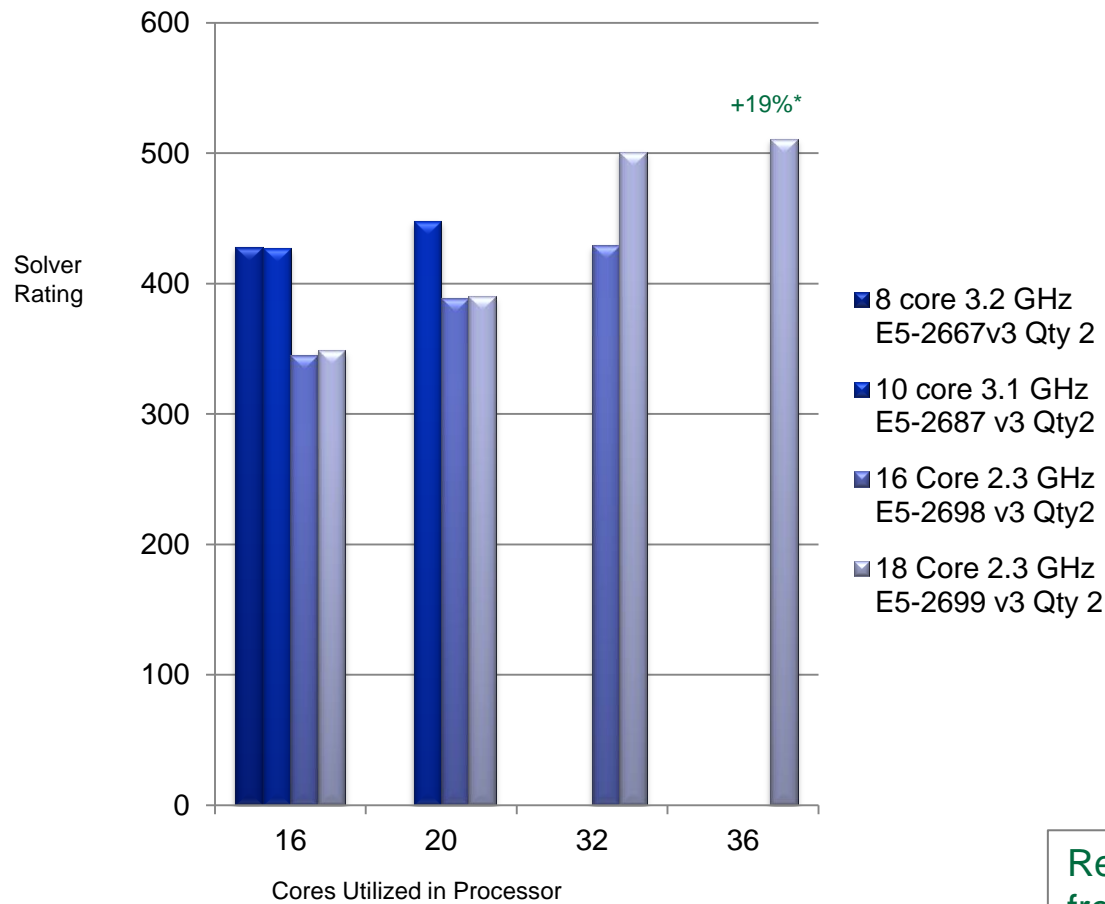
Recommendation: Run on all cores available
Best performer is 2x10 core processor

* Percentage compares the 2 18 core processors to the 2 8 core processors

Block V16sp-1 ANSYS Benchmark - Peltier Cooling

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Comparing Cores Used Per Processor



* Percentage compares the 2 18 core processors to the 2 8 core processors

Release 16.0 Test Cases Benchmarks – Peltier Cooling Block

Static nonlinear thermal-electric coupled field analysis of a Pelletier cooling block

Analysis Type: Static Nonlinear Thermal-Electric Coupled Field
Number of Degrees of Freedom: 650,000

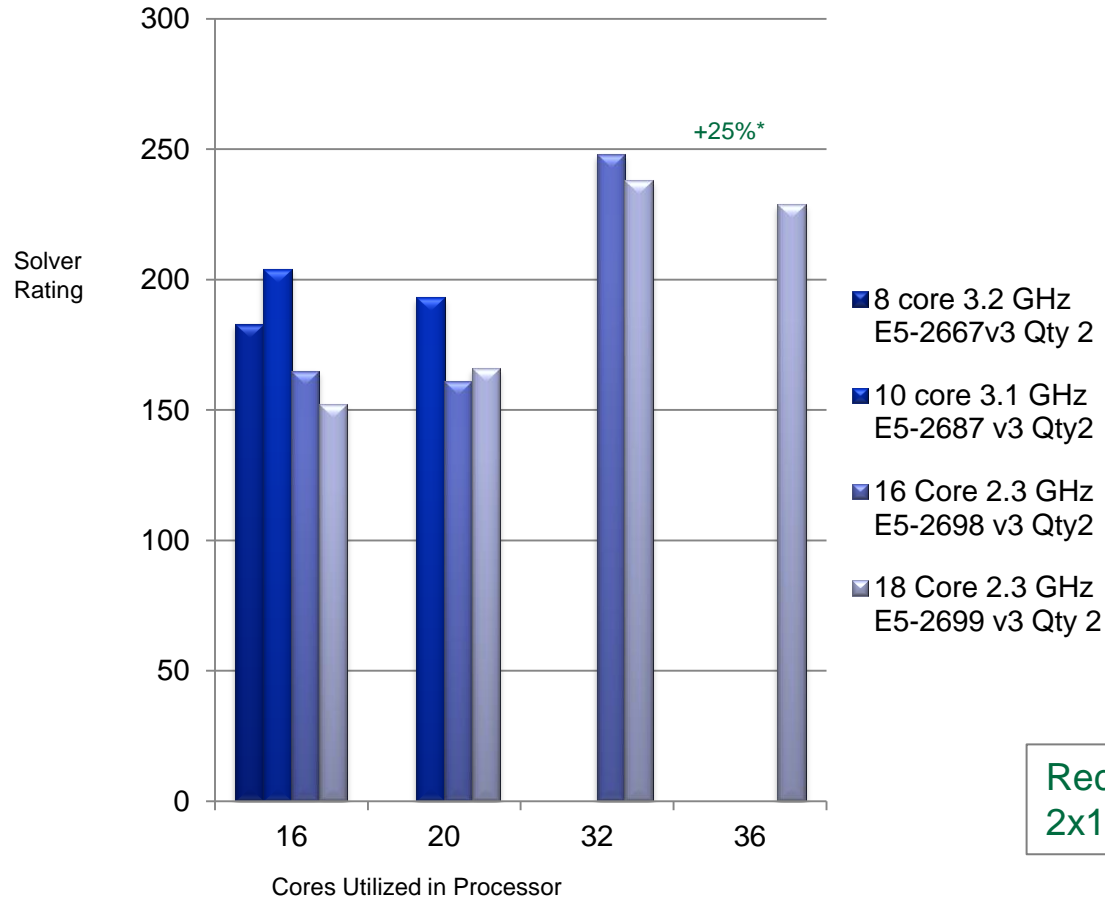
Equation Solver: Sparse
Matrix: Non-symmetric (Unsymmetrical)

Plots: Core Solver Rating

Recommendation: Run on all cores available, frequency still important

V16sp-2 ANSYS Benchmark - Semi-Submersible

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Release 16.0 Test Cases Benchmarks – Semi-Submersible

Transient nonlinear structural
analysis of a submersible drilling rig

Analysis Type: Transient Nonlinear
Structural

Number of Degrees of Freedom:
4,700,000

Equation Solver: Sparse
Matrix: Symmetric

Plots: Core Solver Rating

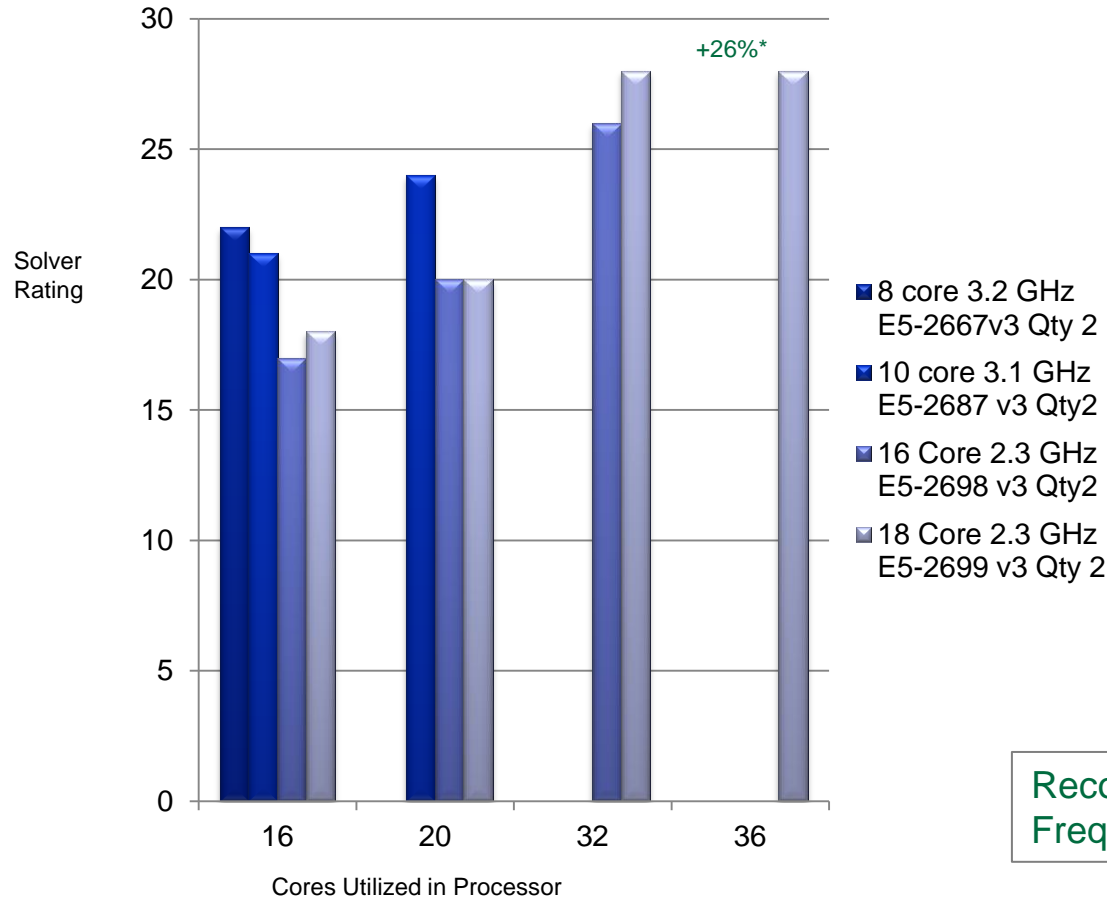
**Recommendation: Run on all cores available
2x16 core processors run the fastest**

* Percentage compares the 2 18 core processors to the 2 8 core processors

V16sp-3 ANSYS Benchmark - Speaker

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Comparing Cores Used Per Processor



Release 16.0 Test Cases Benchmarks – Speaker

Harmonic structural analysis of a speaker and it's surroundings

Analysis Type: Harmonic Linear Structural

Number of Degrees of Freedom: 1,700,000

Equation Solver: Sparse
Matrix: Symmetric

Plots: Core Solver Rating

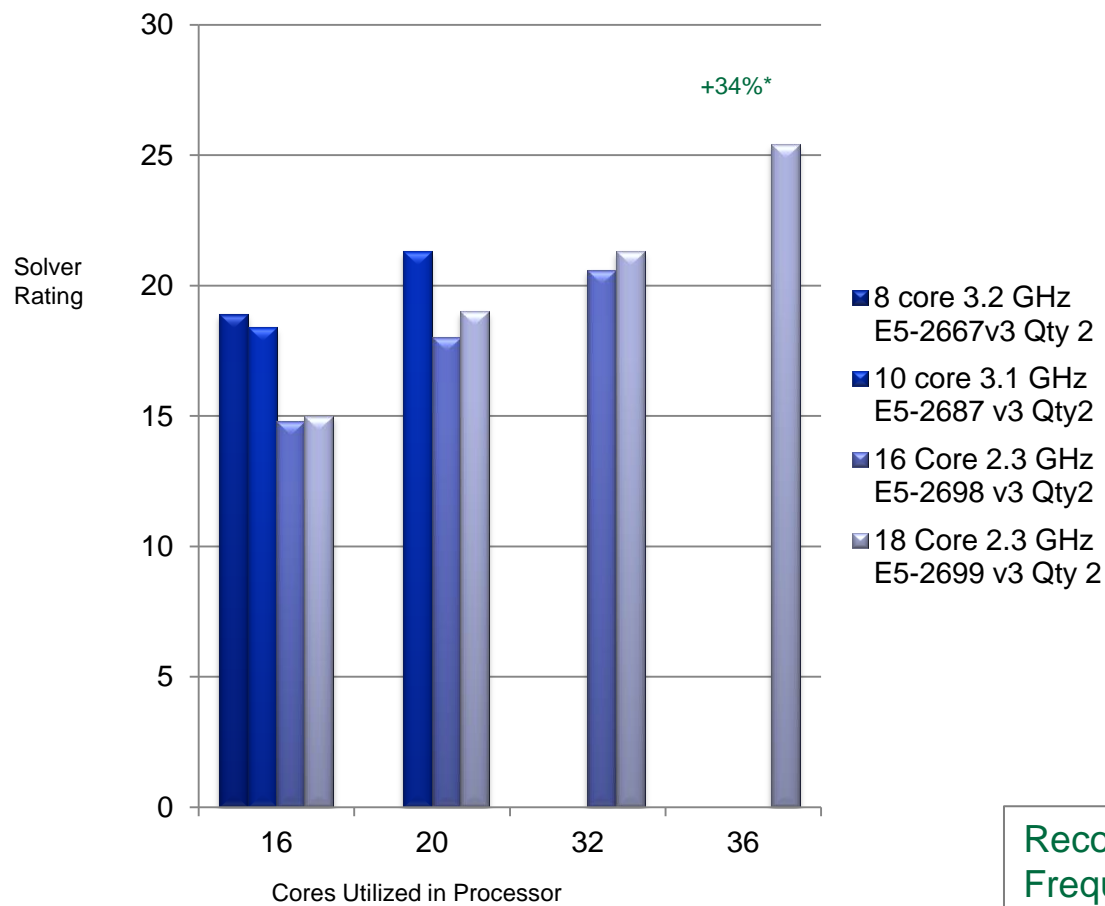
Recommendation: Run on all cores available
Frequency still important

* Percentage compares the 2 18 core processors to the 2 8 core processors

V16sp-4 ANSYS Benchmark - Turbine

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Comparing Cores Used Per Processor



Release 16.0 Test Cases Benchmarks – Turbine

Static nonlinear structural analysis of a turbine blade as found in aircraft engines

Analysis Type: Static Nonlinear Structural

Number of Degrees of Freedom: 3,200,000

Equation Solver: Sparse
Matrix: Symmetric

Plots: Core Solver Rating

Recommendation: Run on all cores available
Frequency still important

* Percentage compares the 2 18 core processors to the 2 8 core processors

Conclusions

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• Cores vs. Clock speed

- Performance improvement based upon core increase is not directly proportional to cores added.
- Generally more cores give better performance.
- Size you core selection to your expected usage/licenses available to maximize frequency.
- Generally recommend the maximum cores per processor
 - Some minor performance anomalies exist,
 - 2 out of 10 benchmarks don't run the fastest on 2 18 core processors (V16ln-2 & V16sp-2)

NVidia Tesla impact on performance

NVidia Tesla Comparisons

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- **Nvidia Tesla K40 counts as 1 license core**
- **We will compare**
 - **Main License = 2 cores - Will compare 2 cores verses 1 core + K40**
 - **1st HPC Pack = 8 cores**
 - **Will compare 8 cores verses 7 core +K40 and 6 cores + 2 K40s**
 - **2nd HPC Pack = 32 cores**
 - **Will compare 16 cores verses 16 cores + K40 and 16 cores + 2 K40s**
 - **Will compare 32 cores verses 31 cores + K40 and 30 cores + 2 K40s**
 - **3rd HPC Pack = 128 cores**
 - **Will compare 36 cores verses 36 cores +K40 and 36 cores + 2 K40s**

Configuration used to test

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The hardware configuration is the same for each test, except for the change in Processors, and Nvidia K40 Teslas

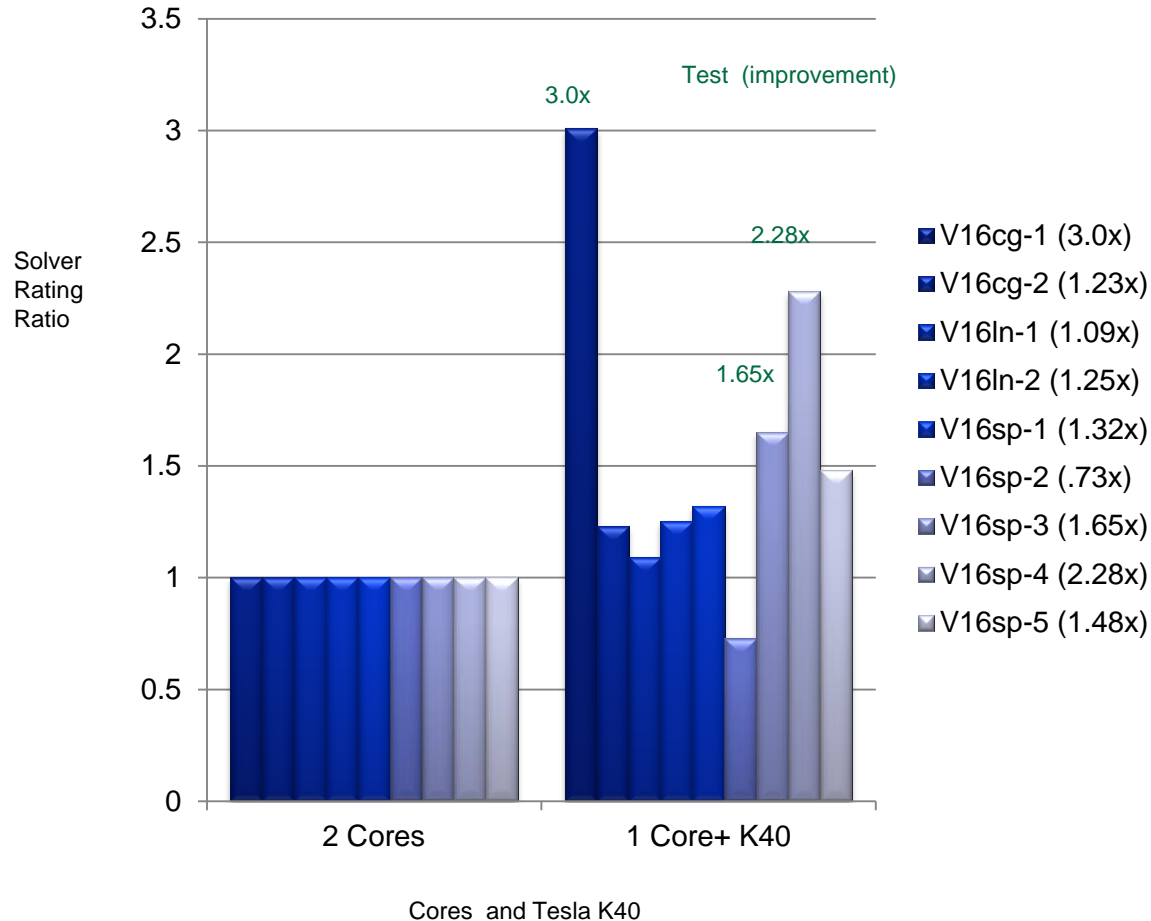
Lenovo P900 ThinkStation

- 2x Intel Xeon E5-2698v3s (16 cores per cpu, 2.3 GHz) (Unless otherwise specified)
- 128 GB Memory
- Nvidia Quadro K2200,
- Nvidia K40 Teslas as indicated in the chart
- M.2 PCIe drive (OS)
- Intel 240 GB Temple Star SSD
- Windows 7 64 Bit.
- Hyper-threading set to off.
- Lenovo Performance settings on

ANSYS V16 Benchmarks – Main License only (2cores)

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Solve Rating Improvement from Nvidia Tesla K40



Release 16.0 Test Cases Benchmarks

Note: V16cg-3 not supported on Tesla

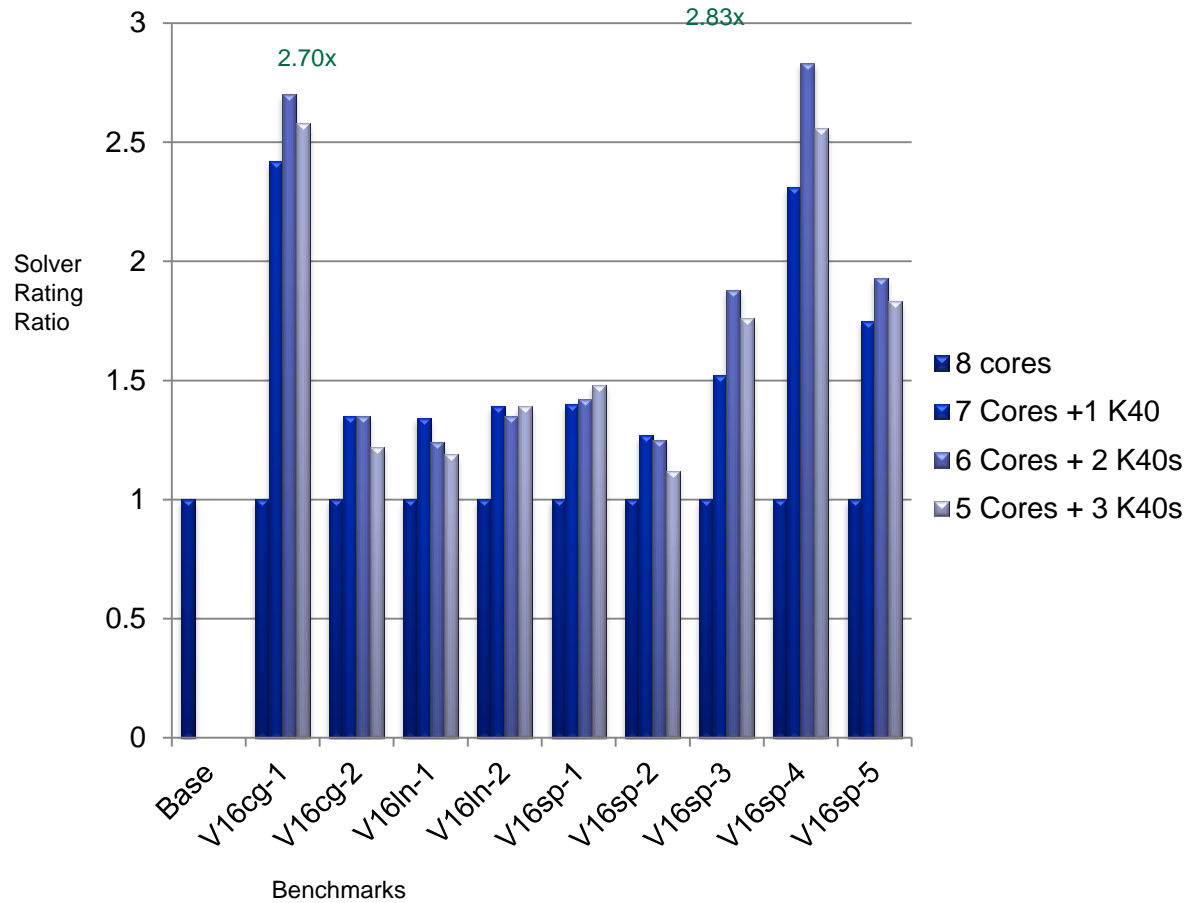
Performance improvement in all cases except V16sp-2

Recommend 1 Nvidia K40 Tesla for those who only have a base license (2 cores)

ANSYS V16 Benchmarks - Main License + 1 HPC Pack

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Solve Rating Improvement from Nvidia Tesla K40s



Release 16.0 Test Cases Benchmarks

Note: V16cg-3 not supported on Tesla

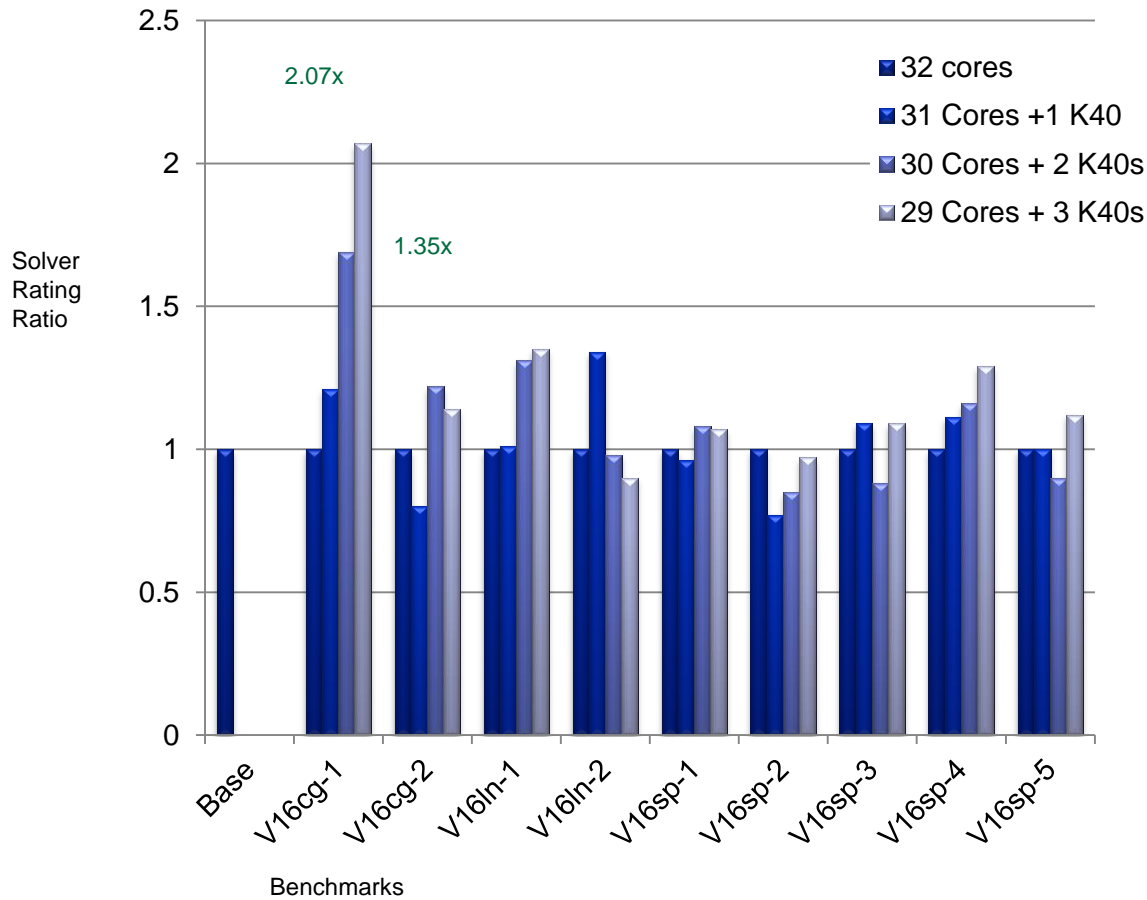
- 1 Tesla is significant gain (1.27x to 2.42x)
- 2 Teslas are a significant gain (1.61x to 4.04x)
- 3 Teslas are a significant gain in 5 out of 9 cases (2.26x to 4.96x)

For those that have a Main License and 1 HPC pack, we recommend 1 Nvidia K40 Tesla, or 2 K40s for cg-1 or sp-4.

ANSYS V16 Benchmarks - Main License + 2 HPC Packs

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Solve Rating Improvement from Nvidia Tesla K40s



Release 16.0 Test Cases Benchmarks

Note: V16cg-3 not supported on Tesla

- 1 Tesla is a gain in 4 benchmarks
- 2 Teslas are a gain in 4 benchmarks
- 3 Teslas are a gain in 4 benchmarks 9 cases
- This is Still in development

For those that have a Main License and 2 HPC packs
Recommendation – Number of Nvidia K40 Teslas recommended is dependent on your problem set

Lenovo™