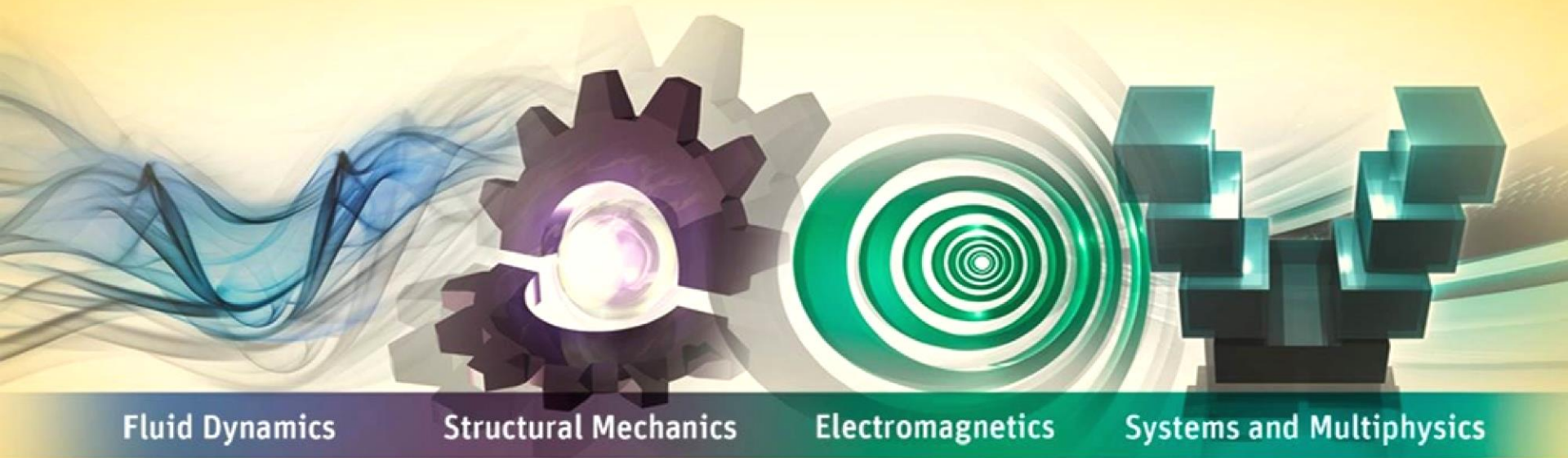


How NVIDIA GPUs Enhance ANSYS Simulation Productivity



Fluid Dynamics

Structural Mechanics

Electromagnetics

Systems and Multiphysics

Timothy Kwan
Regional Business Manager
CAD-IT Consultants

Introduction to ANSYS, Inc and CAD-IT

Why, What and How to Leverage Your Computing Power

How NVIDIA GPUs Enhance ANSYS Simulation Productivity

Summary

Simulation technology enables you to **predict with confidence** that your products will **thrive** in the real world.

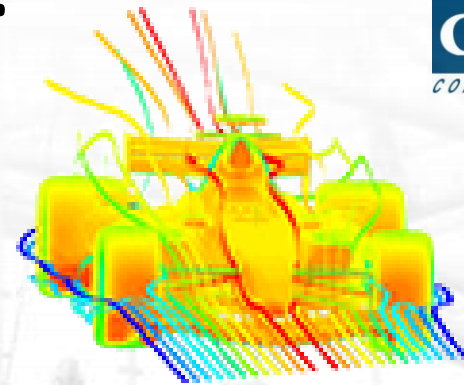
Why?

- Extreme Performance
- Increasing Product Complexity
- Harsh Environments
- Breakthrough Innovation



Predict With Confidence... Extreme Performance

750 HP
330 km/h
1000°C Exhaust
2500 kg Downforce
80,000 Parts



INFINITI
Red Bull
RACING

ANSYS, Inc - Our Strengths

Focused

Simulation is all we do.

Leading product technologies in all physics areas

Largest development team focused on simulation

Capable

2,500+ employees

75 locations, 40 countries

Trusted

96 of top 100 *FORTUNE* 500 industrials

ISO 9001 and NQA-1 certified

Proven

Recognized as one of the world's most innovative and fastest-growing companies*

Independent

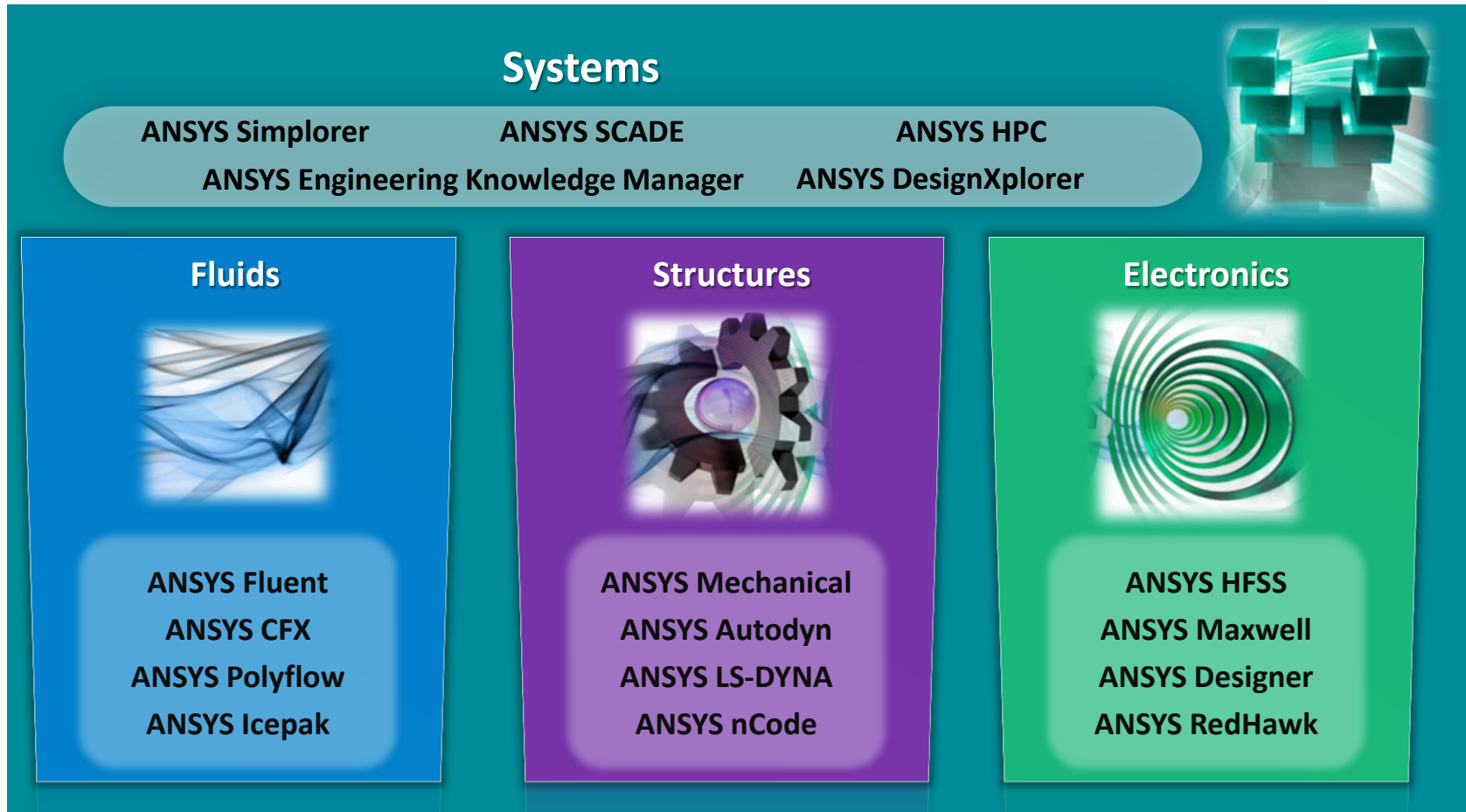
Long-term financial stability

CAD agnostic



Products Overview: Leaders in the Field

ANSYS provides market-leading depth and breadth of capabilities in one discipline, while allowing for integrated simulation across all disciplines



CAD-IT Consultants

Bringing you tomorrow's technology... today!

CAD-IT's Vision & Mission

Vision

Our Vision is to be the preferred Design and Manufacturing Partner to our valued customers and a key contributor to the successful use of innovation and technology in the Asia Pacific region with a Christ-centered company culture.

Mission

Our Mission is to provide world-class design and manufacturing solutions, thereby helping our customers and their supply chains achieve greater innovation, quality and productivity, reduced costs and time-to-market, by being good stewards of the resources that God has entrusted us with.

About CAD-IT Group

- Founded in 1991, CAD-IT has grown into a group comprising 10 companies, 2 manufacturing plants (250K sq ft) and 12 offices in 7 countries including China, SEA, Europe, UK and recently USA.
- CAD-IT group has since built a customer base of over 2,000 engineering companies employing over 100,000 engineering professionals and has trained over 10,000 professionals.
- CAD-IT has a headcount of close to 500 staff with annual group sales revenues of over S\$ 40M.



About CAD-IT Group

- CAD-IT has received over 77 International and National Awards for Entrepreneurship excellence its professionalism in the training, service and support of its customers.
- We are proud that as a Singaporean company, CAD-IT Consultants has firmly established ourselves as the preferred Brand of choice for PLM software and commitment to excellence.



Recent Achievements

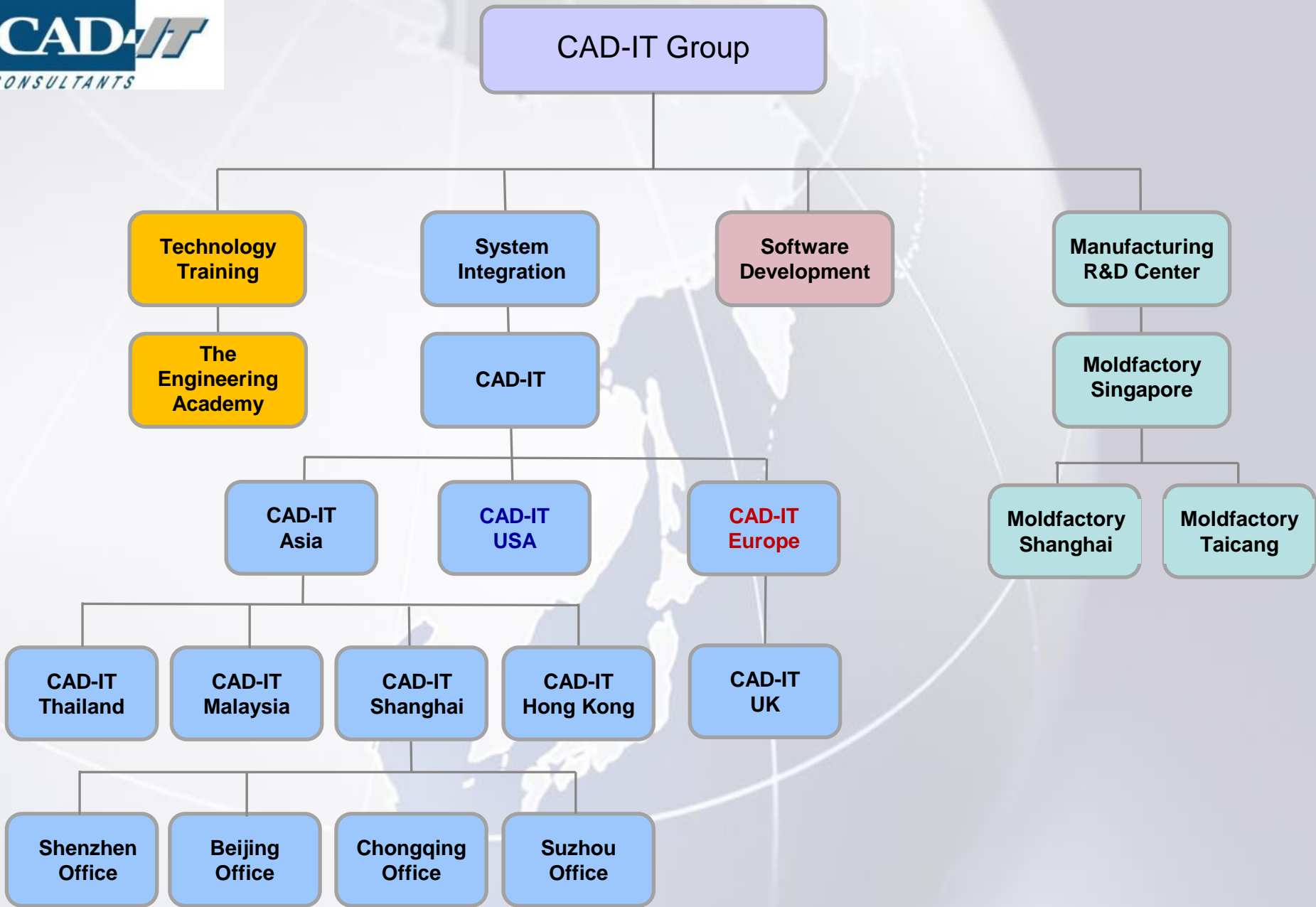
CAD-IT

- Singapore E50 2013, 2012
- Singapore SME 1000 2013, 2012, 2011
- ANSYS, Inc Outstanding Sales Performance 2012, 2011, 2010
- SPBA Established Brand Award 2012, 2011, 2010 & 2009
- SPBA Regional Brand Award 2012
- SPBA Hall of Fame 2012

MOLDFACTORY

- Singapore E50 2012
- Singapore SME 1000 2013, 2012, 2011
- Singapore International 100 2013





Partnership with ANSYS

As an exclusive partner of ANSYS, Inc, the world's leading engineering simulation developer, in the ASEAN region, CAD-IT has a proven track record of success and is extremely honored to have received **12 ANSYS Outstanding Performance Awards** since 1996, in recognition of her excellence in marketing, provision of training, consulting and technical support of the entire range of ANSYS solutions.

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Summary

ANSYS HPC for Mechanical Applications
— Enabling...

- Faster** → Impact product design
Enable large models
Allow parametric studies
- Larger** → Assemblies
CAD-to-mesh
Capture fidelity
- Extend** → Modal
Nonlinear
Multiphysics
Dynamics
- More** → Multiple design ideas
Optimize the design
Ensure product integrity

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ANSYS HPC for CFD Applications
— Enabling...

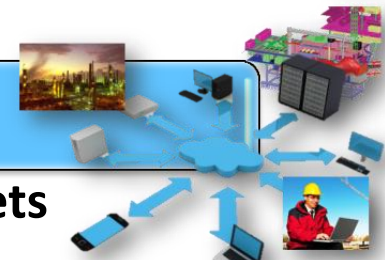
- Faster** → Impact product design
Enable large models
Allow parametric studies
- Larger** → Assemblies
CAD-to-mesh
Capture fidelity
- Extend** → Turbulence
Combustion
Particle Tracking
- More** → Multiple design ideas
Optimize the design
Ensure product integrity

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Why: Various Industry Trends Driving HPC Innovation

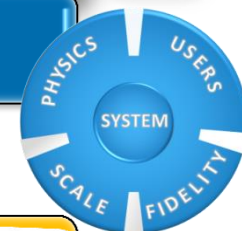
Cost-Effective and Scalable IT

- Driving greater utility from HPC hardware and software assets



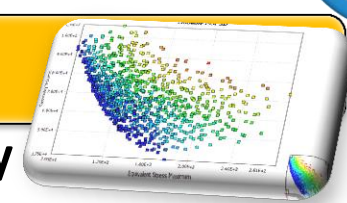
Smart Products

- Simulating complex models and complete systems faster with HPC



Product Integrity through Robust Design

- Exploring numerous variations with HPC & IT technology



Collaboration and Data Management

- Leveraging HPC and IT investments



Amplify Engineering

- Driving engineering productivity through HPC



Summary

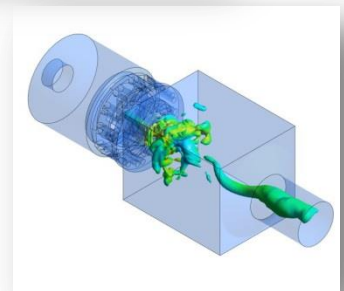
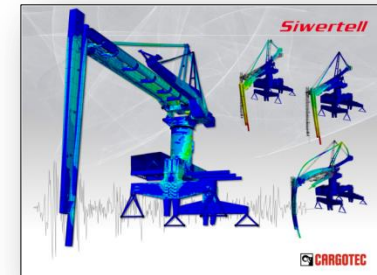
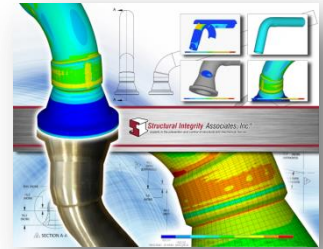
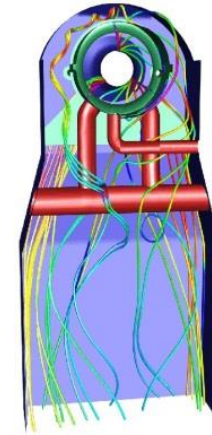
Using today's multicore computers is key for companies to remain competitive. ANSYS HPC product suite allows scalability to whatever computational level required, from single-user or small user group options at entry-level up to virtually unlimited parallel capacity or large user group options at enterprise level.

Design Impact

Reduce turnaround time

Examine more design variants faster

Simulate larger or more complex models



How: Take Advantage of the HPC Revolution

Recent advancements have revolutionized the computational speed available on the desktop

- Multi-core processors
 - Every core is really an independent processor
- Large amounts of RAM
- SSDs
- GPUs



How: CAE Partner Selection

2013

2010 - 2013

- ▶ Ideal scaling to 4096 cores (fluids)
- ▶ Hybrid parallelization (fluids)
- ▶ Network-aware partitioning (fluids)
- ▶ DDM for finite antenna arrays (HFSS 14)
- ▶ GPU acceleration with DMP(structures), AMG solver (fluids), and HFSS-Transient

2009

2010 - 2013

- ▶ Ideal scaling to 4096 cores (fluids)
- ▶ Hybrid parallelization (fluids)
- ▶ Network-aware partitioning (fluids)
- ▶ DDM for finite antenna arrays (HFSS 14)
- ▶ GPU acceleration with DMP(structures), AMG solver (fluids), and HFSS-Transient

2007 - 2008

- ▶ Optimized performance on multicore processors
- ▶ 1st One Billion cell fluids simulation

2005 - 2007

- ▶ Distributed sparse solver
- ▶ GPU acceleration with DMP solver
- ▶ Technology

1998-1999

- ▶ Integrated
- ▶ Support for Linux clusters, low latency interconnects
- ▶ 10M cell fluids

DANSYS released

2004

- ▶ 100M structural DOF

1994 - 1995

- ▶ Parallel dynamic mesh refinement and coarsening

1999 - 2000

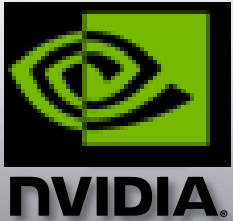
Today's multi-core / many-core hardware evolution makes HPC a software development imperative. Long-term commitment is required to maintain HPC technology leadership.

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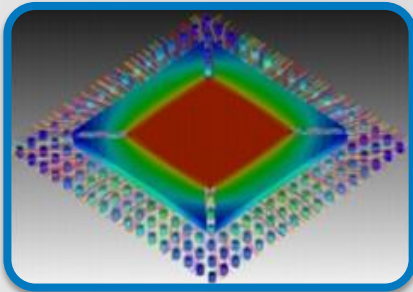
How NVIDIA GPUs Enhance ANSYS Simulation Productivity

Summary



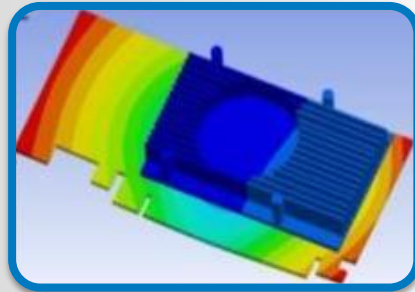
NVIDIA transformed Manufacturing Design and Engineering when it invented the GPU in 1999. The company has since expanded to many areas, including **accelerating simulations** in compute clusters and on workstations.

NVIDIA Use of ANSYS in Product Engineering



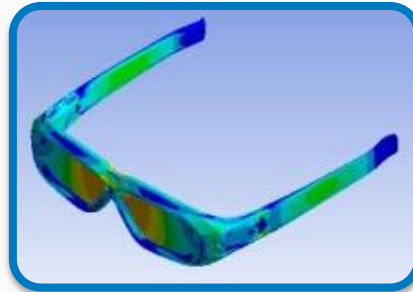
ANSYS Icepak

Active and
passive
cooling of IC
packages



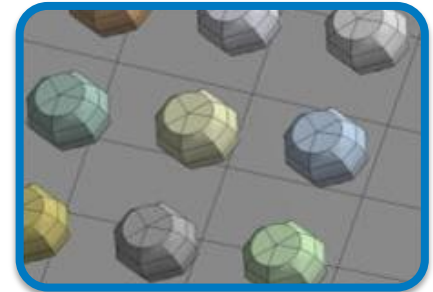
ANSYS Mechanical

Large
deflection
bending of
PCBs



ANSYS Mechanical

Comfort
and fit of 3D
emitter
glasses



ANSYS Mechanical

Shock and
vibration of
solder ball
assemblies

GPUs are accelerators and can significantly speed up your simulations

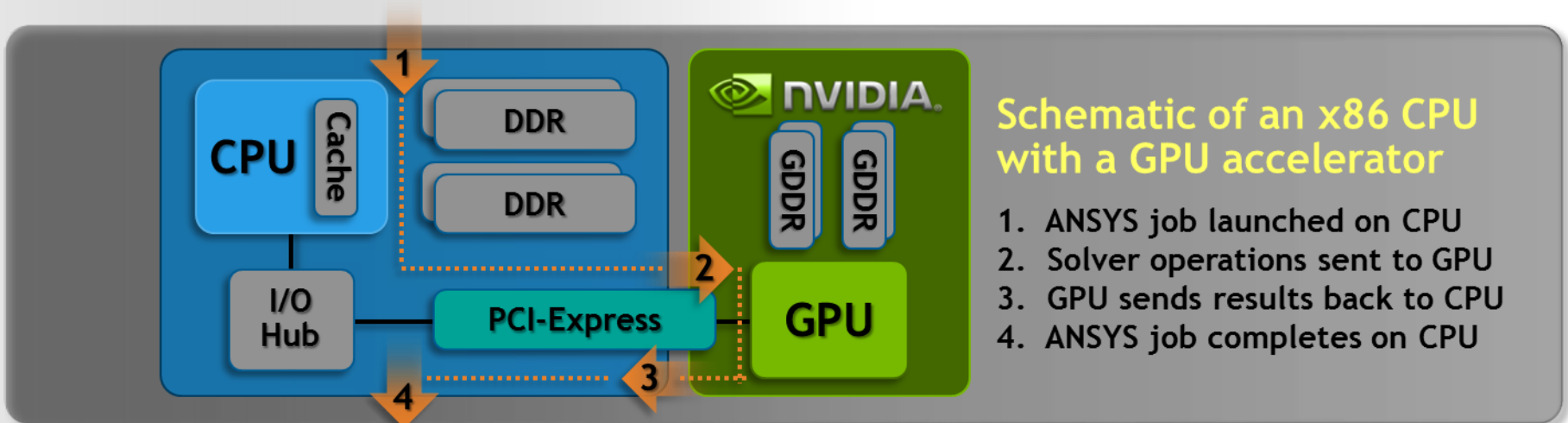
- GPUs work hand in hand with CPUs

Most ANSYS GPU acceleration is user-transparent

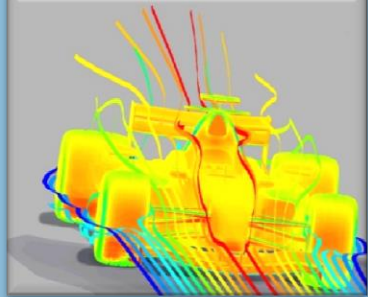
- Only requirement is to inform ANSYS of how many GPUs to use

Schematic of a CPU with an attached GPU accelerator

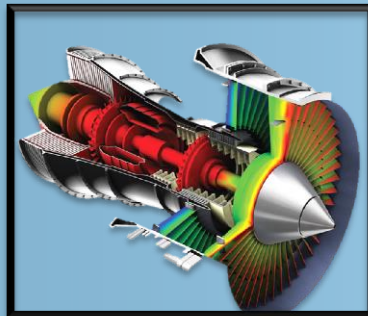
- CPU begins/ends job, GPU manages heavy computations



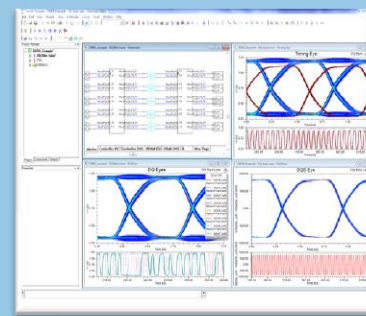
T
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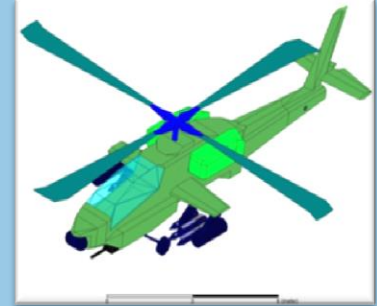
Fluent[®]



Mechanical[™]

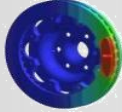




Nexxim[™]



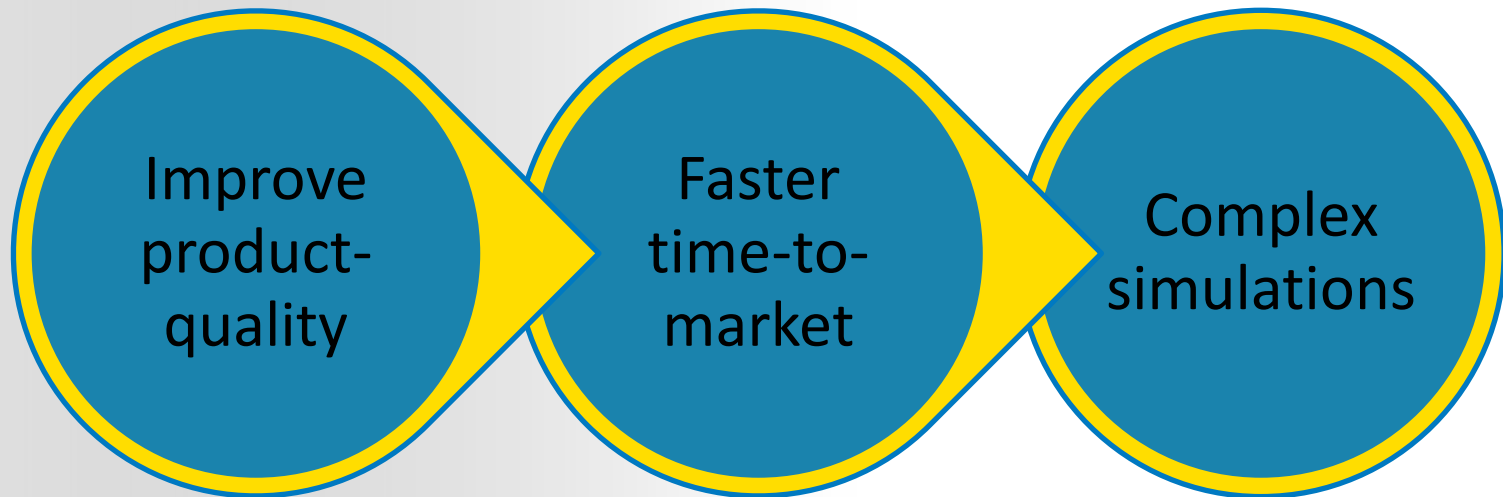
HFSS[™]

ANSYS and NVIDIA Collaboration Roadmap

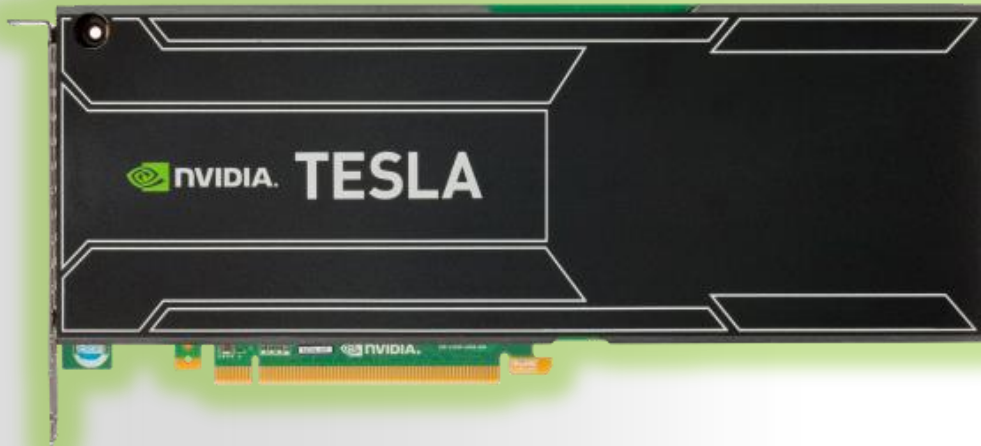
Release	ANSYS Mechanical 	ANSYS Fluent 	ANSYS EM 
13.0 Dec 2010	SMP, Single GPU, Sparse and PCG/JCG Solvers		ANSYS Nexxim
14.0 Dec 2011	+ Distributed ANSYS; + Multi-node Support	Radiation Heat Transfer (beta)	ANSYS Nexxim
14.5 Nov 2012	+ Multi-GPU Support; + Hybrid PCG; + Kepler GPU Support	+ Radiation HT; + GPU AMG Solver (beta), Single GPU	ANSYS Nexxim
15.0 Dec 2013	+ CUDA 5 Kepler Tuning	+ Multi-GPU AMG Solver; + CUDA 5 Kepler Tuning	ANSYS Nexxim ANSYS HFSS (Transient)

Benefits of GPU-accelerated Simulations

- More simulations in the same amount of time

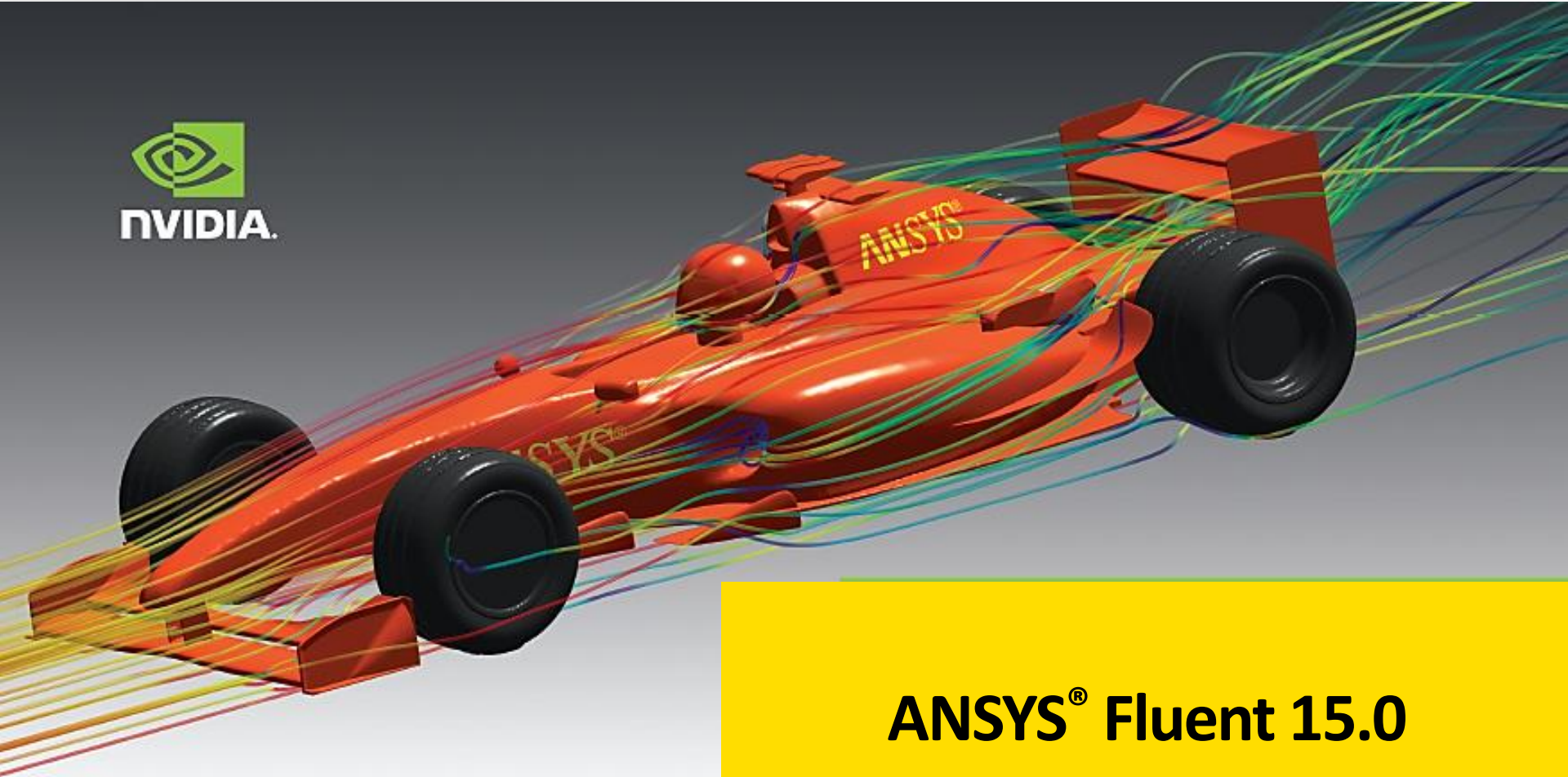


Treats each GPU socket as a CPU core, which significantly increases simulation productivity of your HPC licenses

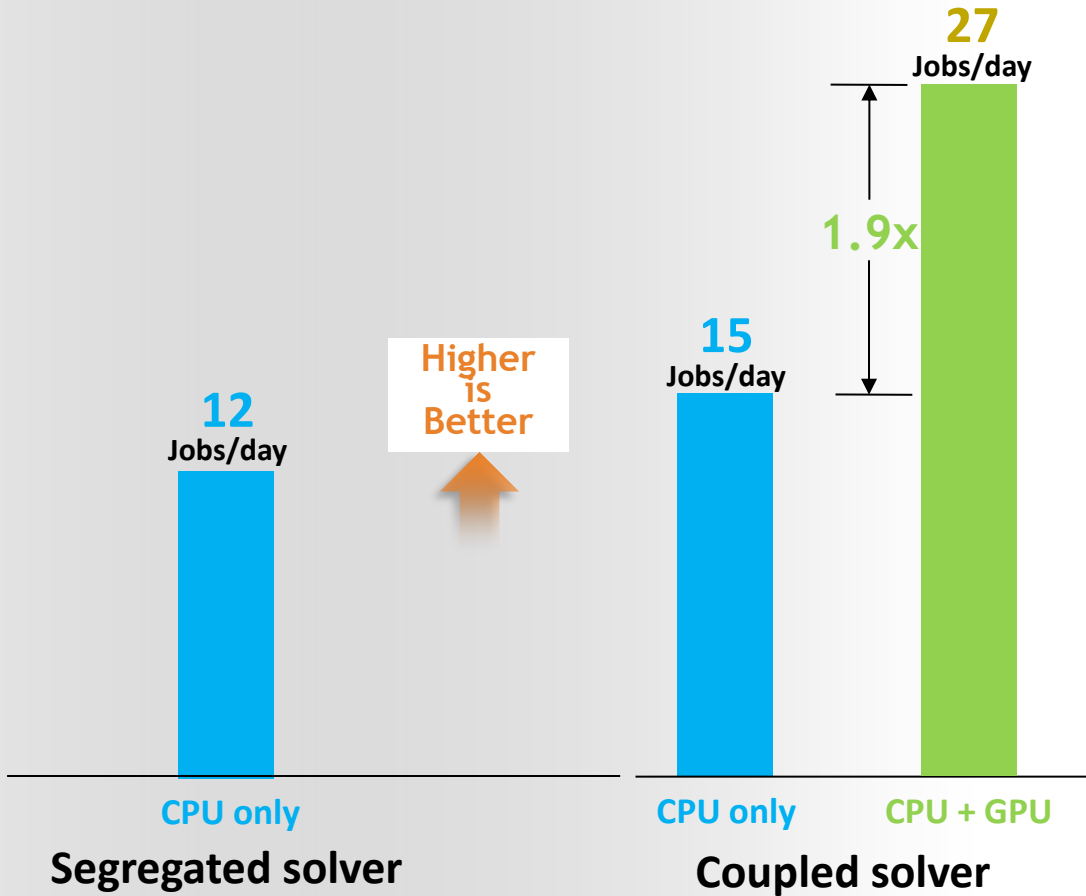


Needs 1 HPC task to enable a GPU

All ANSYS HPC products unlock GPUs in 15.0, including HPC, HPC Pack, HPC Workgroup, and HPC Enterprise products.



ANSYS[®] Fluent 15.0



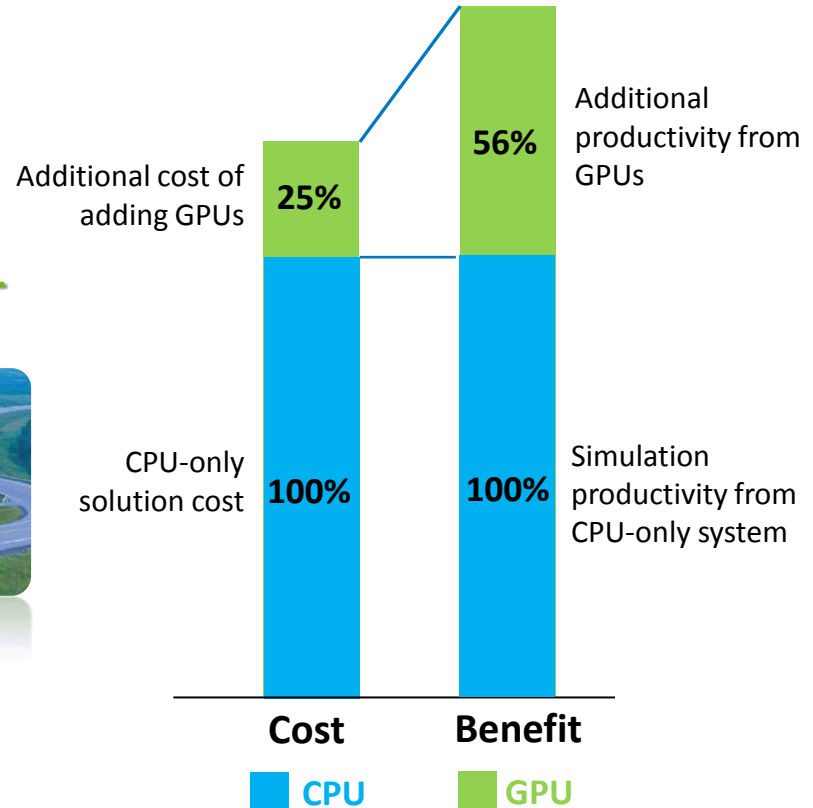
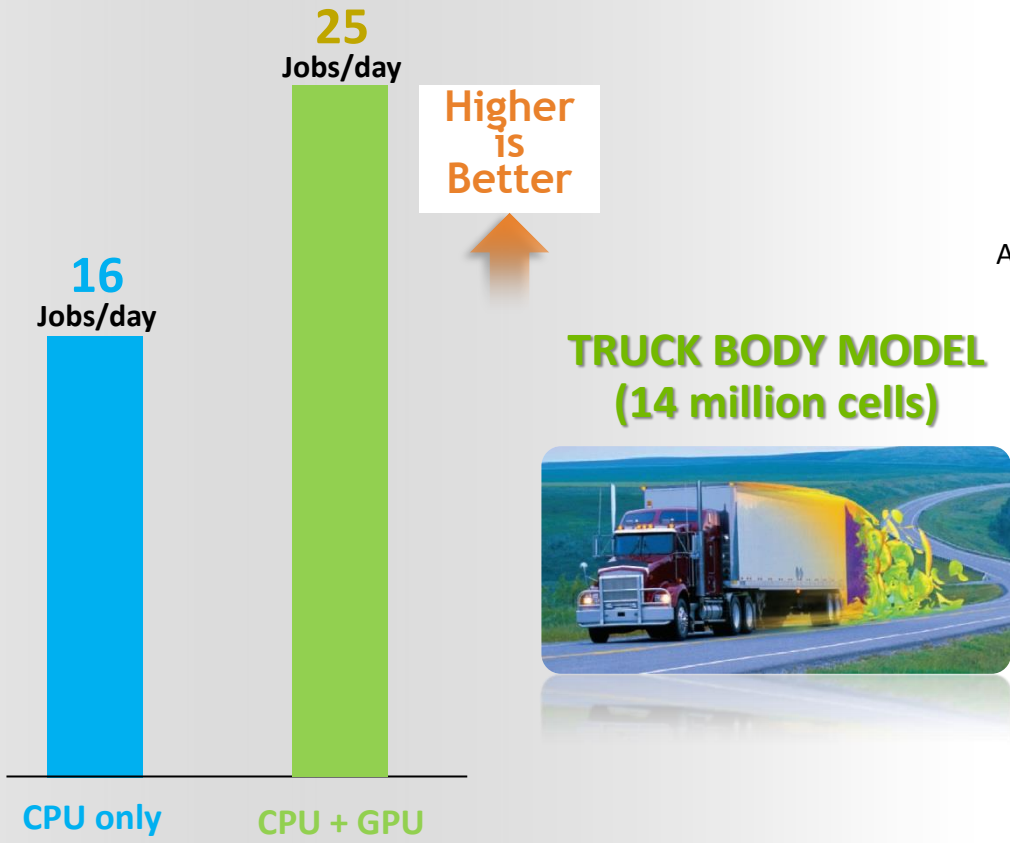
Convergence criteria: 10e-03 for all variables; No of iterations until convergence: segregated CPU-2798 iterations (7070 secs); coupled CPU-967 iterations (5900 secs); coupled 985 iterations (3150 secs)

Sedan Model

- Sedan geometry
- 3.6M mixed cells
- Steady, turbulent
- External aerodynamics
- Coupled PBNS, DP
- CPU: Intel Xeon E5-2680; 8 cores
- GPU: 2 X Tesla K40

NOTE: Times for total solution until convergence

ANSYS Fluent 15.0 on GPU Performance of Pressure-Based Solver



All results are based on turbulent flow over a truck case (14-million cells) until convergence; steady-state, pressure-based coupled solver with double-precision; No. of iterations to reach convergence: CPU-531; CPU+GPU-566; The solution cost is approximated and includes both hardware and software license costs. Productivity is based on number of completed Fluent jobs/day in a multi-user cluster environment. Hardware: Intel Xeon E5-2680 (64 CPU cores on 8 sockets) 8 Tesla K40 GPUs. License: ANSYS Fluent and ANSYS HPC Workgroup 64.

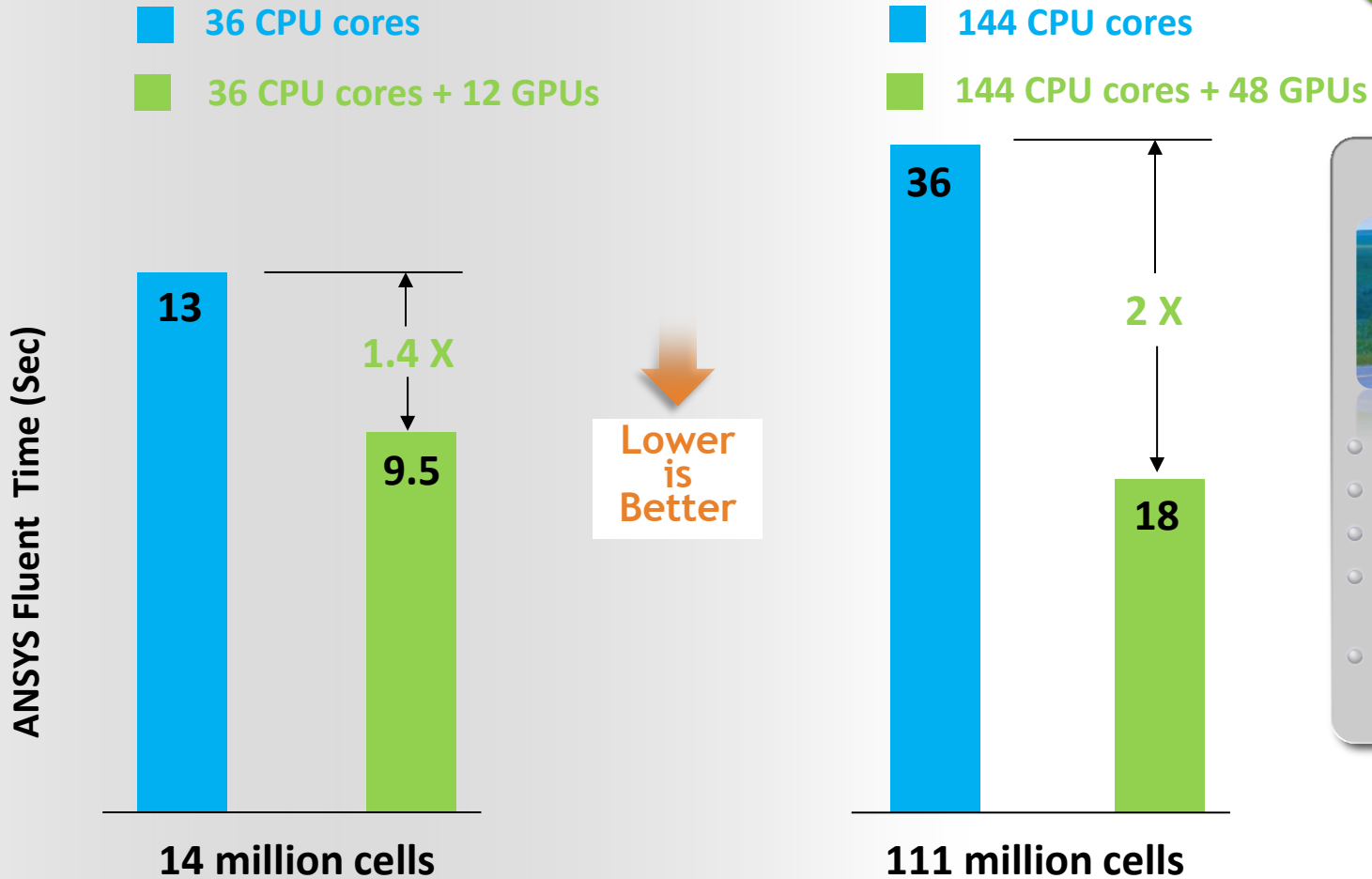
CPU-only solution cost is approximated and includes both hardware and software license costs. Benefit/productivity is based on the number of completed Fluent jobs/day in a multi-user cluster environment.

ANSYS Fluent 15.0 on GPU Better Speedup on Larger Models

ANSYS

CAD-IT
CONSULTANTS

NVIDIA



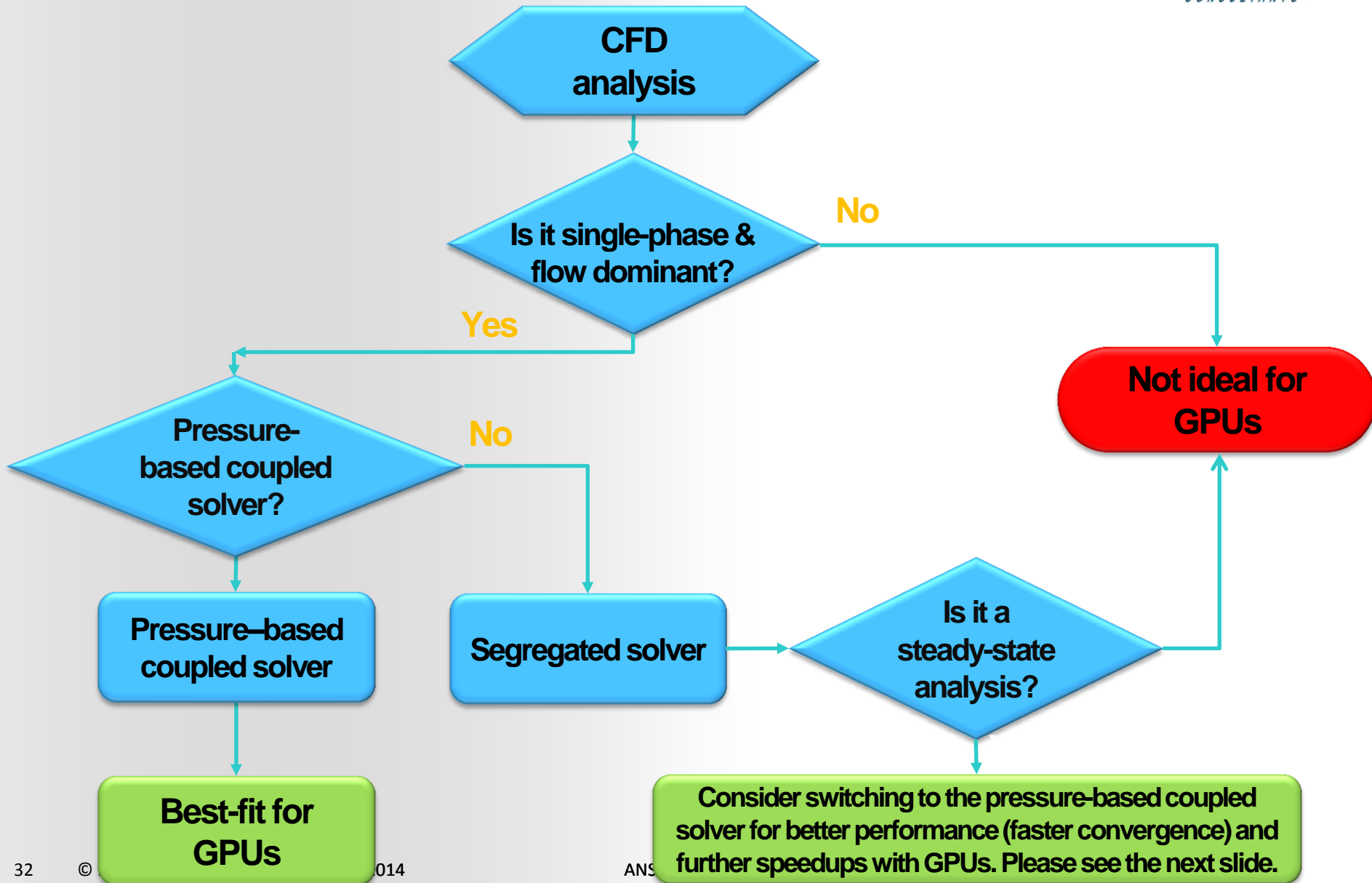
Truck Model

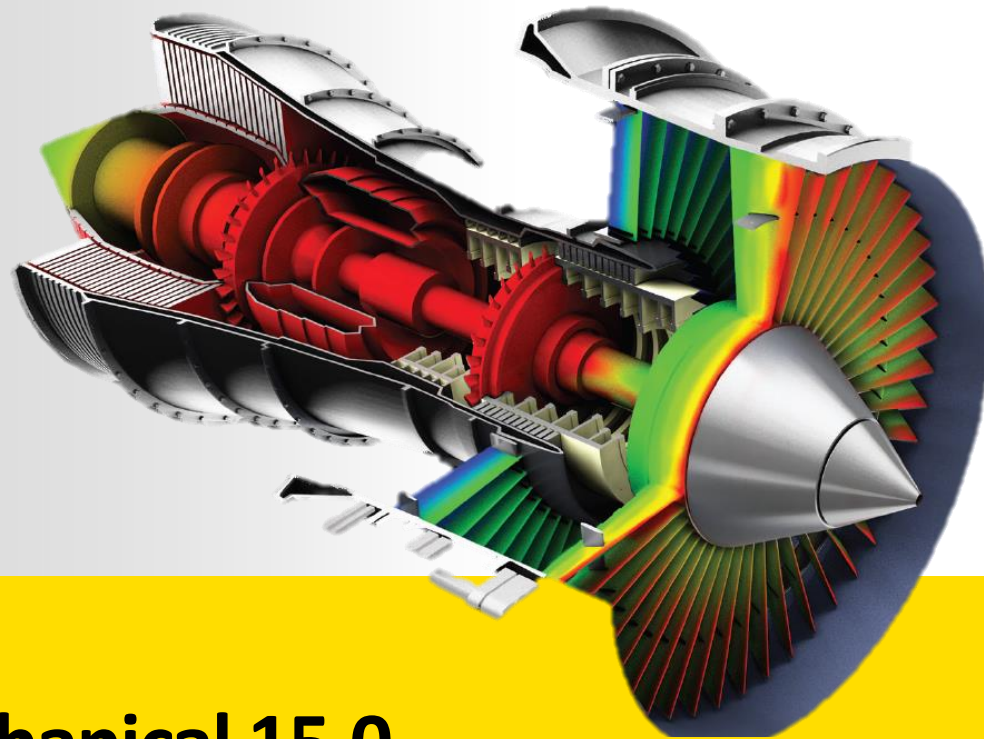


- External aerodynamics
- Steady, k-ε turbulence
- Double-precision solver
- CPU: Intel Xeon E5-2667; 12 cores per node
- GPU: Tesla K40, 4 per node

NOTE: Reported times are per iteration

NVIDIA-GPU Solution Fit for ANSYS Fluent



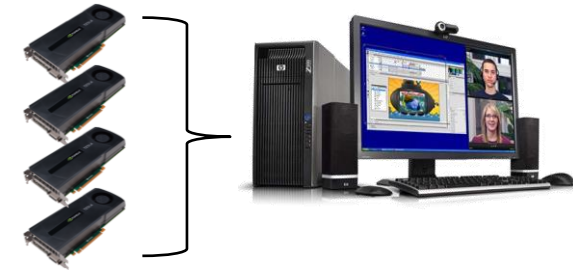


ANSYS[®] Mechanical 15.0

GPU Accelerator Capability - ANSYS Mechanical

Supports majority of ANSYS structural mechanics solvers:

- Covers both sparse direct and PCG iterative solvers
- Only a few minor limitations

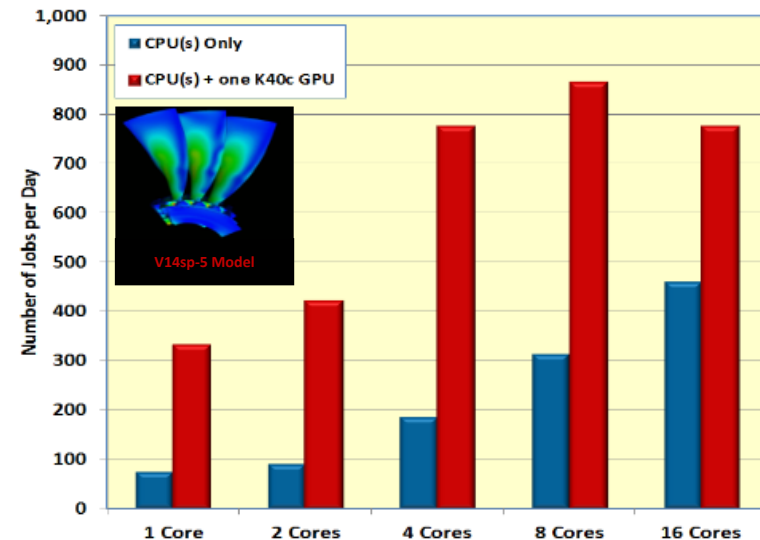


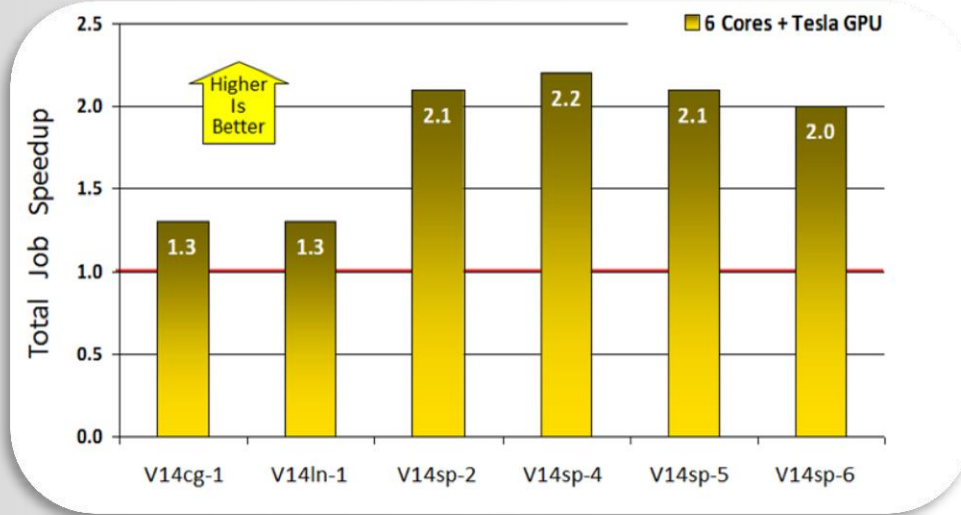
Ease of use:

- Requires at least one supported GPU card to be installed
- No rebuild, no additional installation steps

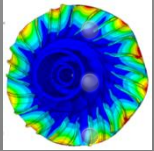
Performance:

- Offer significantly faster time to solution
- Should never slow down your simulation

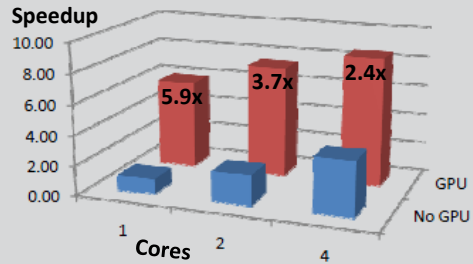




ANSYS Mechanical Model – Impeller

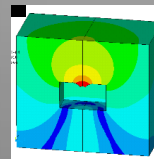


Impeller geometry of ~2M DOF, solid FEs
Normal modes analysis using cyclic symmetry
ANSYS Mechanical SMP and Block-Lanczos solver

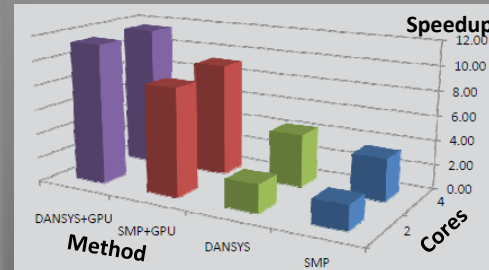


**Impeller 2M DOF
Normal modes
4 cores + GPU
= 2.4x speedup
vs. 4 cores**

ANSYS Mechanical Model – Speaker

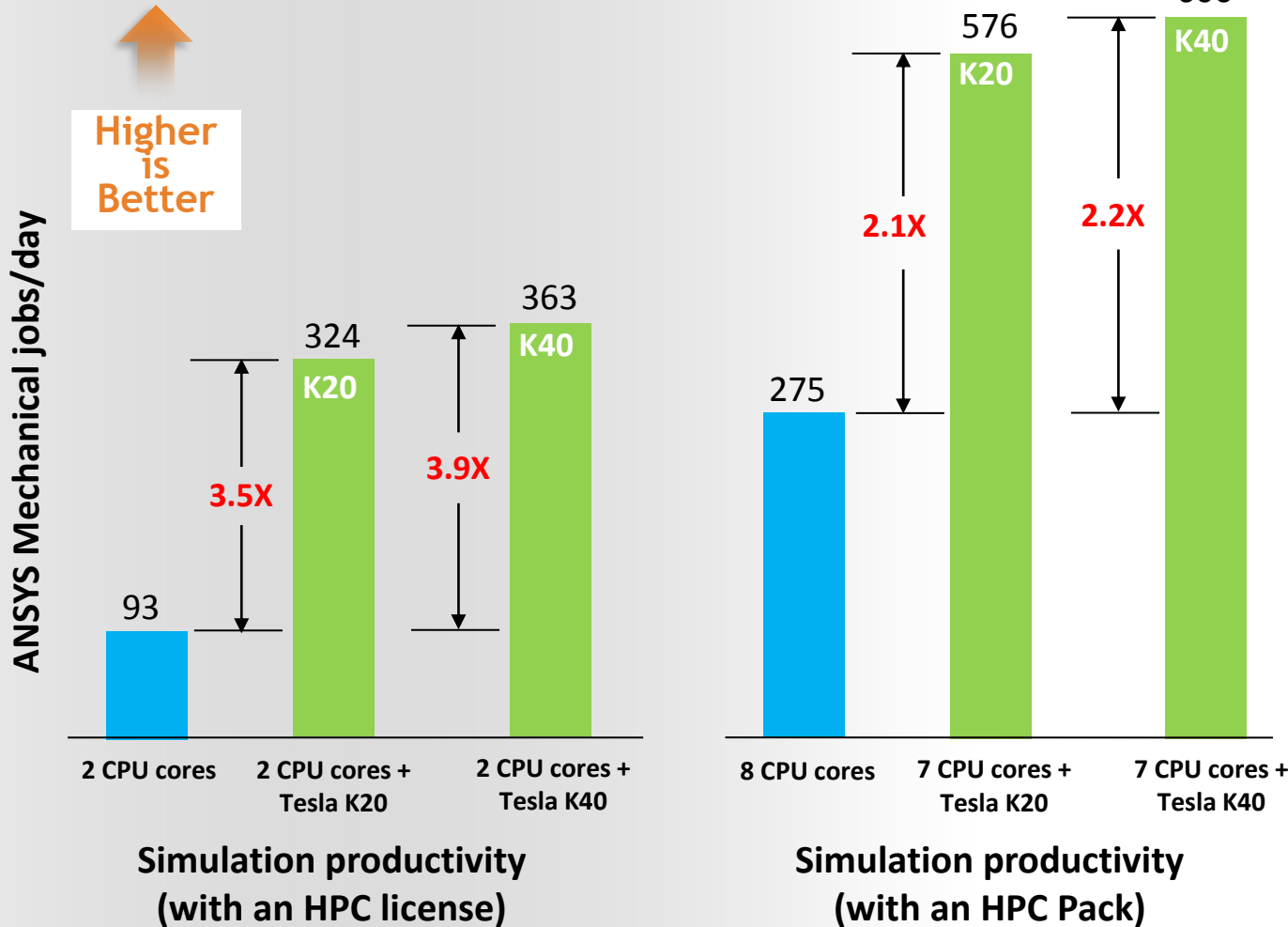


Speaker geometry of ~0.7M DOF, solid FEs
Vibroacoustic harmonic analysis for one frequency
ANSYS Mechanical distributed sparse solver



**Speaker 0.7M DOF
Harmonic analysis
4 cores + GPU
= 2.7x speedup
vs. 4 cores**

ANSYS Mechanical 15.0 Supporting Newest GPUs

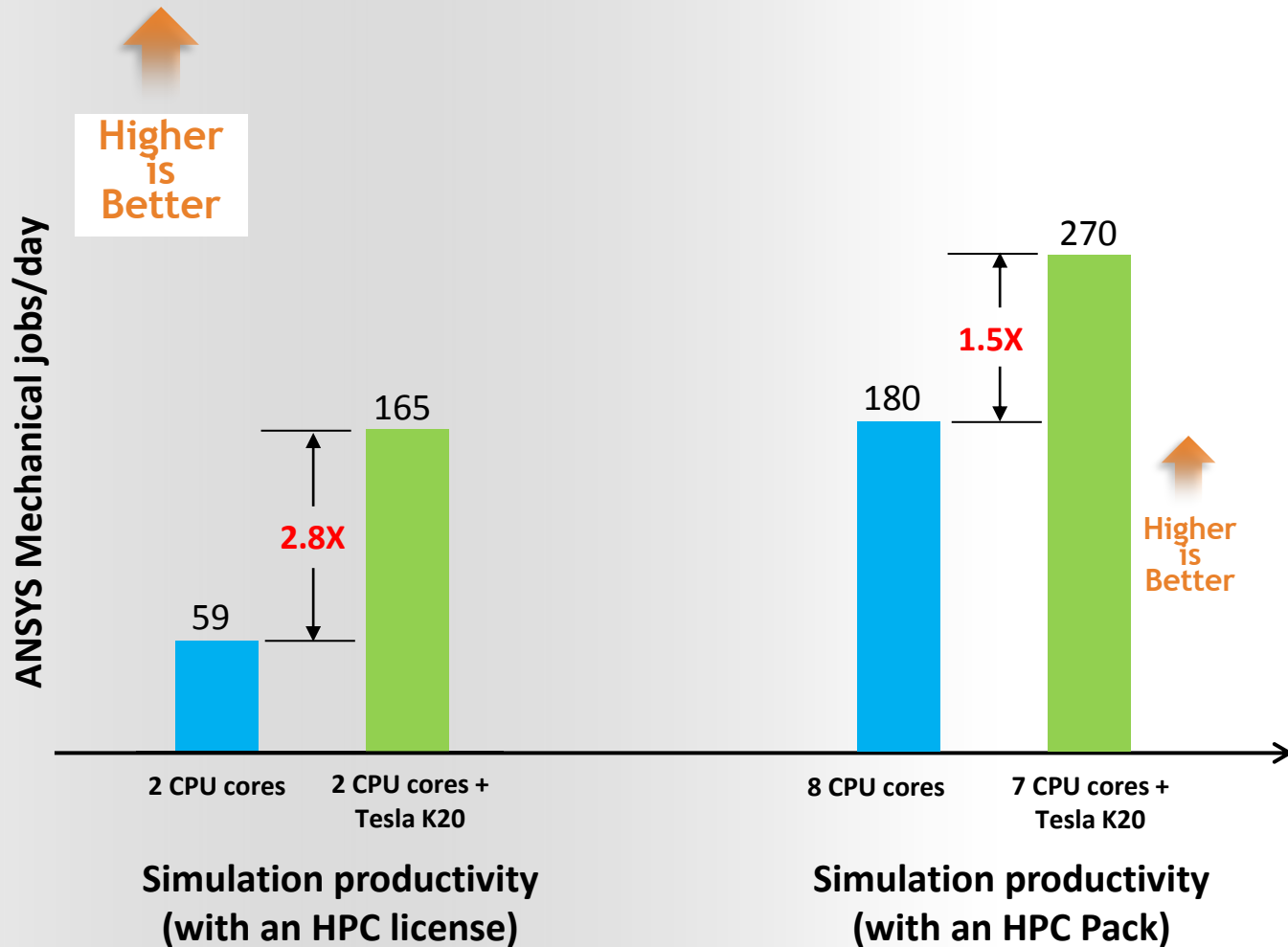


V14sp-5 Model

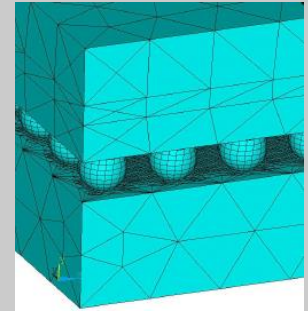
- Turbine geometry
- 2.1 million DOF
- SOLID187 elements
- Static, nonlinear analysis
- One iteration
- Sparse direct solver



ANSYS Mechanical 15.0 Supporting Newest GPUs



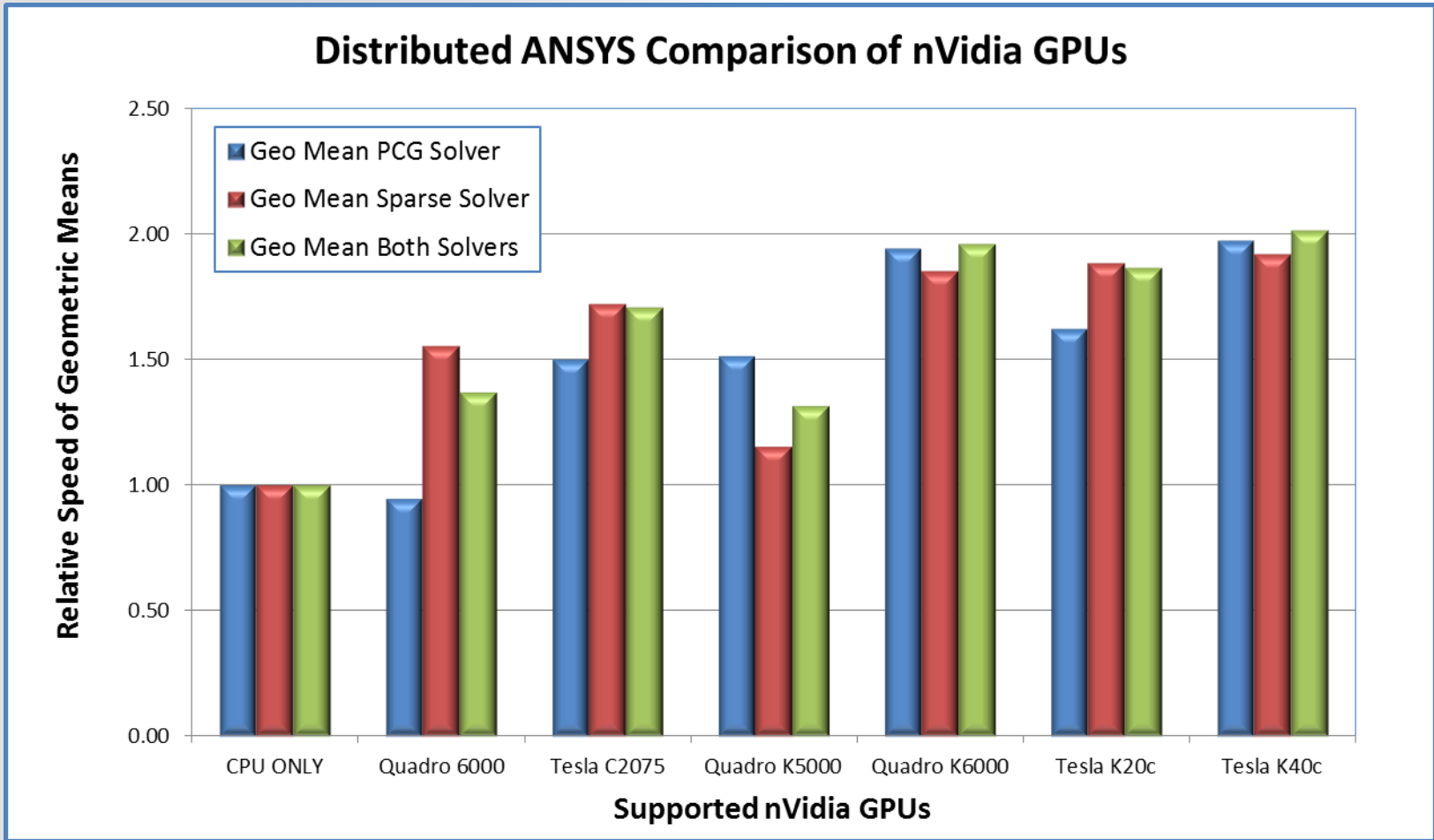
V14sp-6 Model



- 4.9 million DOF
- Static, nonlinear analysis
- One iteration
- Sparse direct solver

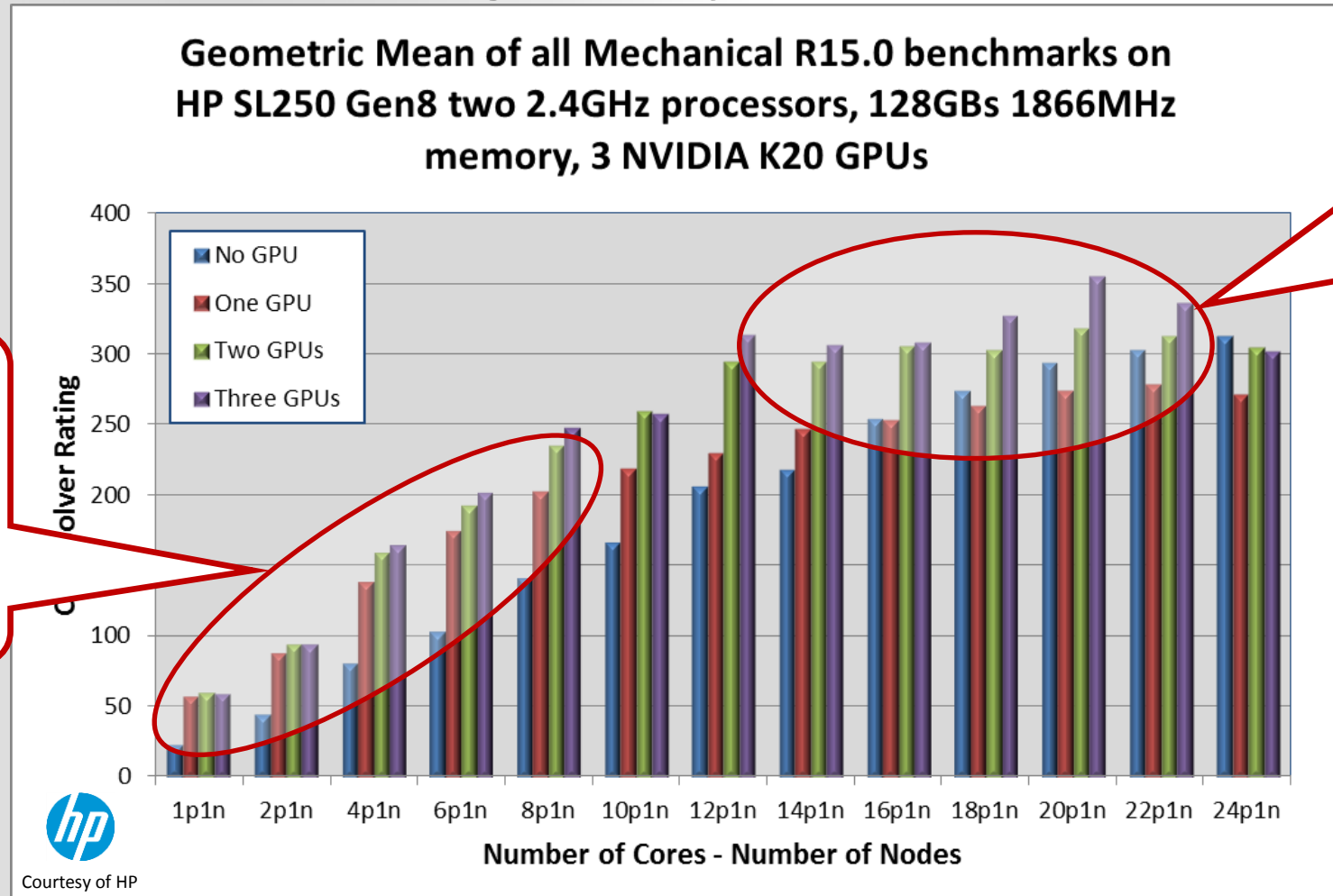


ANSYS Mechanical 15.0 Supporting Newest GPUs



ANSYS Mechanical 15.0 Supporting Newest GPUs

GPUs can offer significantly faster time to solution



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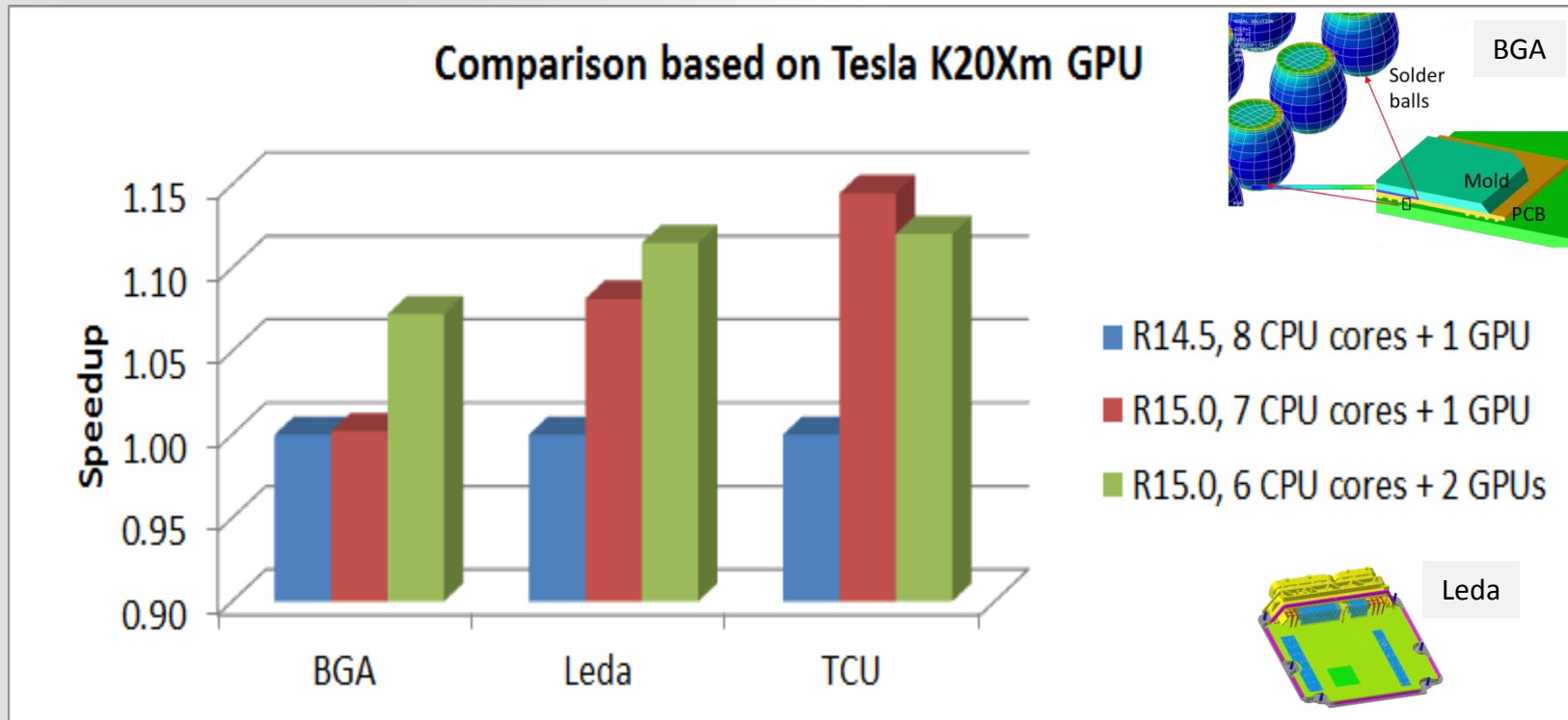
How NVIDIA GPUs Enhance ANSYS Simulation Productivity

Summary

ANSYS 15.0 License Scheme for GPUs

- Implication of New HPC Pack Licensing

- With R14.5, you could run up to 8 CPU cores and 1 GPU.
- With R15.0, you can run up to 7 CPU cores and 1 GPU, or 6C + 2G, etc.



Results Courtesy of MicroConsult Engineering, GmbH

Some lessons learned

Productivity gains depend on:

- Hardware and its configuration
 - Memory bandwidth
 - Load-balancing
 - I/O level
 - **GPUs**
- HPC licensing solution

Leverage NVIDIA GPUs and ANSYS HPC for productivity gains!

Thank You!

Timothy Kwan

Email: timothy.kwan@cadit.com.sg

URL: www.cadit.com.sg