



Powering Innovation That Drives Human Advancement

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# **Maximizing HPC Efficiency for Ansys Simulations: Addressing Critical IT Concerns with Slurm Resource Management and Scheduling**

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Morten Loderup, Sr. Manager HPC IT

Slurm User Group  
13 Sept. 2024, University of Oslo

# Agenda

- Brief introduction to Ansys
- HPC at Ansys
- Conclusion
  - Lessons learned
  - HPC Trends



# Brief Introduction to Ansys

# Introduction to Ansys



Energy



Defense



Healthcare



Automotive  
Transportation & Mobility



Industrial Equipment



High Tech

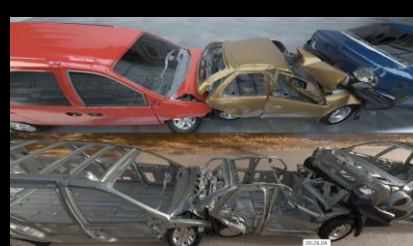


Aerospace

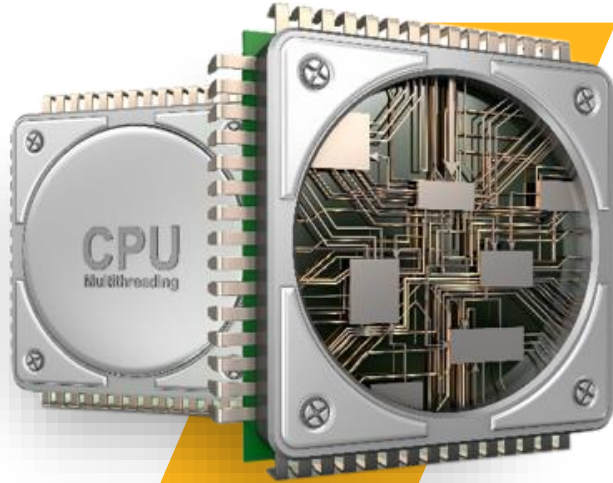
Founded 1970  
CAE/multiphysics engineering  
simulation software  
President: Ajei Gopal  
Employees: 6,300 (2024)  
HQ: Canonsburg, PA, USA  
2023 Revenue: \$2.27 B USD



# Ansys simulation of a 3 cars collision

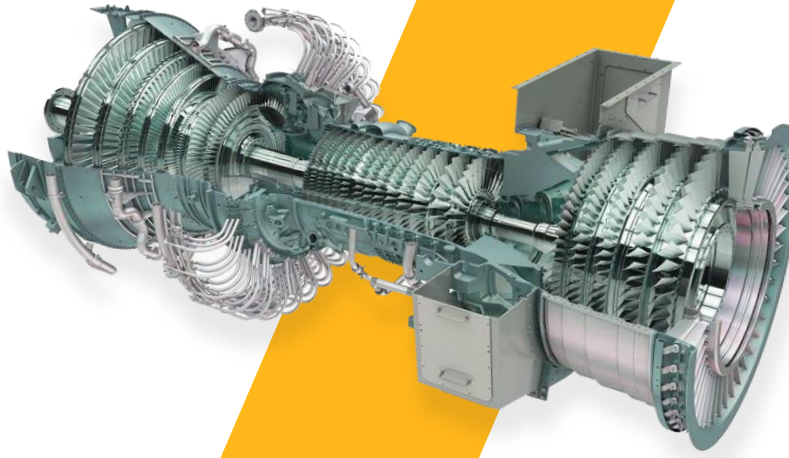


# Increased pressure to deliver on the classic challenges



**30%**

Time-to-market



**2 YEARS**

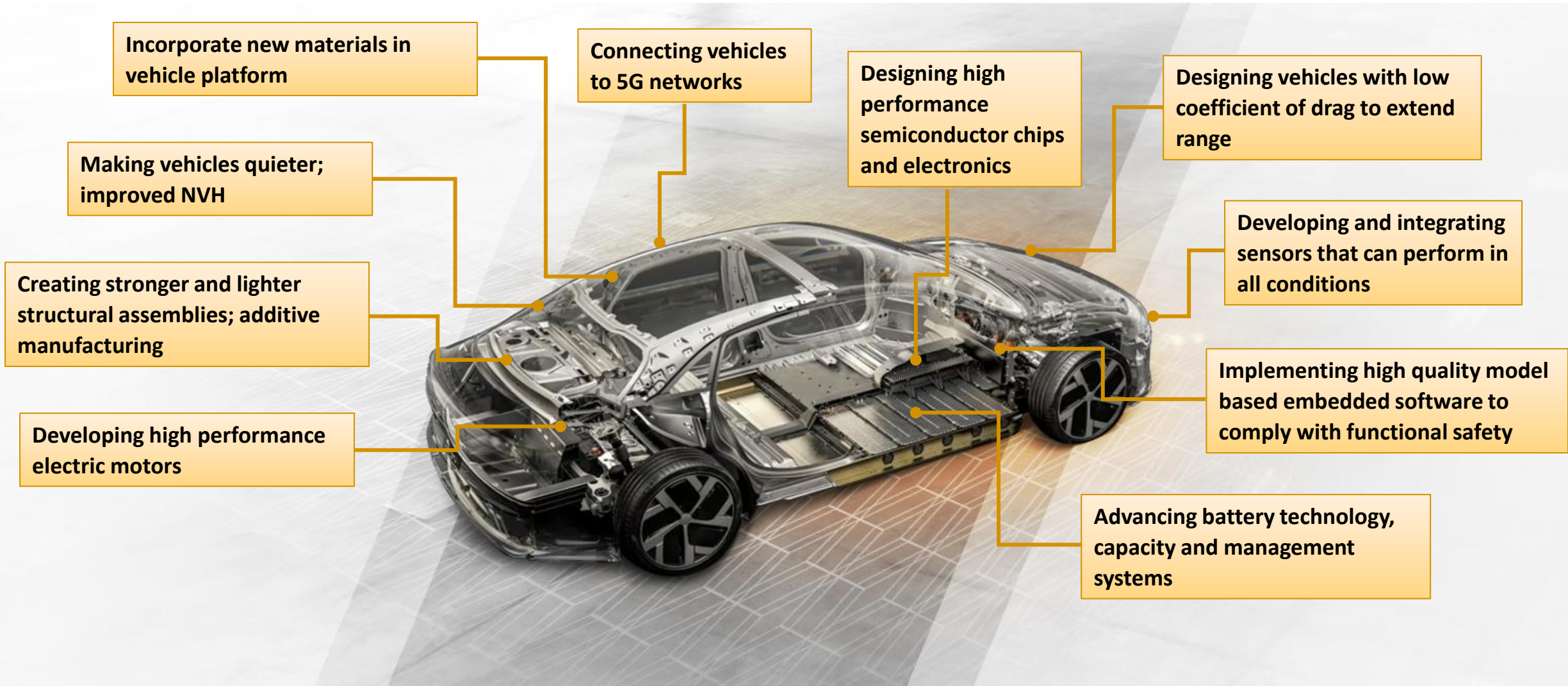
Cycle times



**66%**

New product rollouts

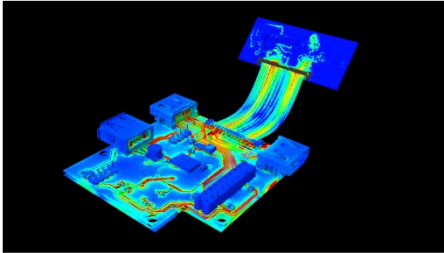
# Strong need for faster innovation with better outcomes at lower costs



# Ansys 5 pillars of innovation

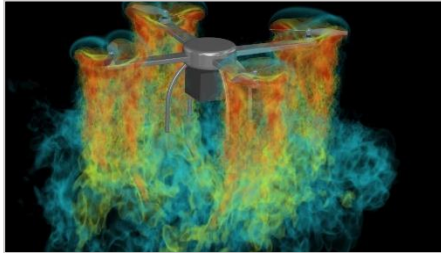
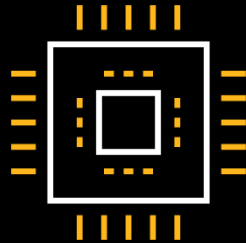
*Driving your greatest innovations and solving your toughest challenges*

## NUMERICS



Multiphysics, multi-scale, connected workflows

## HIGH-PERFORMANCE COMPUTING



Multiple products leveraging GPU for solver acceleration

## ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING



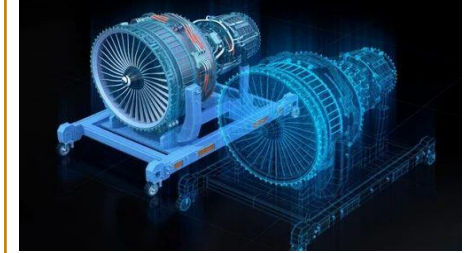
More than a half-dozen products leveraging AI/ML

## CLOUD AND EXPERIENCE



Fast, flexible and scalable for every user

## DIGITAL ENGINEERING



Model-based systems engineering, digital twins, SPDM

/ CLOUD OFFERS

Cloud Marketplace – BYOC

Ansys Gateway powered by AWS™

Ansys Access on Microsoft Azure™

Software as a Service (SaaS)

Ansys SimAI™

Ansys ConceptEV®

PRODUCT CAPABILITIES

Cloud Connected

 Storage

 Burst Compute

 Collaboration



# HPC at Ansys

# HPC at Ansys

- Our customers' goals
- Deployment models: Cloud and On-premises
- Nature of Ansys HPC simulation jobs
- HPC IT goals to address customer goals
- Challenges and solutions
- Observability of HPC Simulation jobs



# Our Customers' IT Simulation Goals

- Available HPC infrastructure to run large models with billions of cells
- Minimum wait time to submit jobs
- 'Fair' distribution of available HPC infrastructure
- Efficiency of simulation results (post processing analytics)
- Proper VDI (Virtual Desktop Interface) support
- Tackle longer transients and more complex physics in hours rather than in days of solve
- Reduce time with GPU computing
- Run multiple simulations in parallel
- Get higher-fidelity insight into how designs are going to work in the real world
- Container support

## Our Customers

Ansys Fluent®  
Semiconductor  
Ansys Mechanical™  
Ansys LS-DYNA®  
Ansys Dynamore™  
Ansys Lumerical™  
Ansys Speos®  
Others..

# HPC deployment models to support customer simulation needs

## Deployment 1: Multi-core desktop computer



- Usual starting point for most accounts, and most common deployment model
- Mostly Windows-based hardware with its own compute, storage and graphics
- Hardware characteristics:
  - Up to 10+ CPU cores
  - Up to 128 GB of RAM
  - 1 GPU
- Pros:
  - Good capability for pre- and postprocessing
  - Good performance for most Mechanical, HFSS and Maxwell applications (except for DOE studies)
  - Relatively easy to maintain by end user
- Cons:
  - Lack of performance for most Fluent and LS-DYNA applications
  - Tedious to maintain by IT in case of many other desktop computers
- HPC/hardware partners:
  - Dell, HP Inc., Lenovo, Supermicro, BOXX, Exxact Corp, Gen X, KOI Computers, 2CRSI

## Deployment 2: Multi-node server



- For accounts having multiple concurrent simulation users
- Mostly Linux-based hardware with remote storage, and graphics via Windows desktop computer
- Hardware characteristics:
  - Up to 10s of CPU cores
  - Up to 1TB of RAM
  - Up to 4 GPUs
- Pros:
  - Good performance for computational demanding products like Fluent and LS-DYNA
  - Affordable, scalable/expandable systems once computational demands or group of users increases
- Cons:
  - More complex to size, configure and maintain (but SIs among our HPC partners do help)
  - Challenging to meet both high fidelity and throughput demands for Fluent and LS-DYNA workloads
- HPC partners:
  - Hardware: HPE, Dell, Lenovo, Fujitsu, Supermicro, 2CRSI
  - SI for HPC: GNS Systems, Nor-Tech, TotalCAE, X-ISS

## Deployment 3: Datacenter



- For relatively large accounts with geographically distributed users
- Linux-based hardware with fast storage, compute and visualization nodes; despite use of VDI, often combined with desktop computer for interactive workflows
- Hardware characteristics:
  - More than 1000 of CPU cores
  - More than 1TB of RAM
  - More than 10 GPUs
  - Up to 400 Gbps network bandwidth
- Pros:
  - Adequate hardware capacity for both high fidelity and high throughput demands for Fluent and LS-DYNA workloads
  - Good IP protection and process traceability
- Cons:
  - Significant upfront CapEx required
  - Most complex to size, configure and maintain (but HPC OEMs and SIs among our HPC partners do help)
  - Challenging to meet intermittent workloads and heterogeneous workload requirements
- HPC partners:
  - Hardware: HPE, Dell, Lenovo, Fujitsu, 2CRSI
  - SI for HPC: Atos, GNS Systems, Nor-Tech, OCF, TotalCAE, X-ISS

## Deployment 4: Cloud



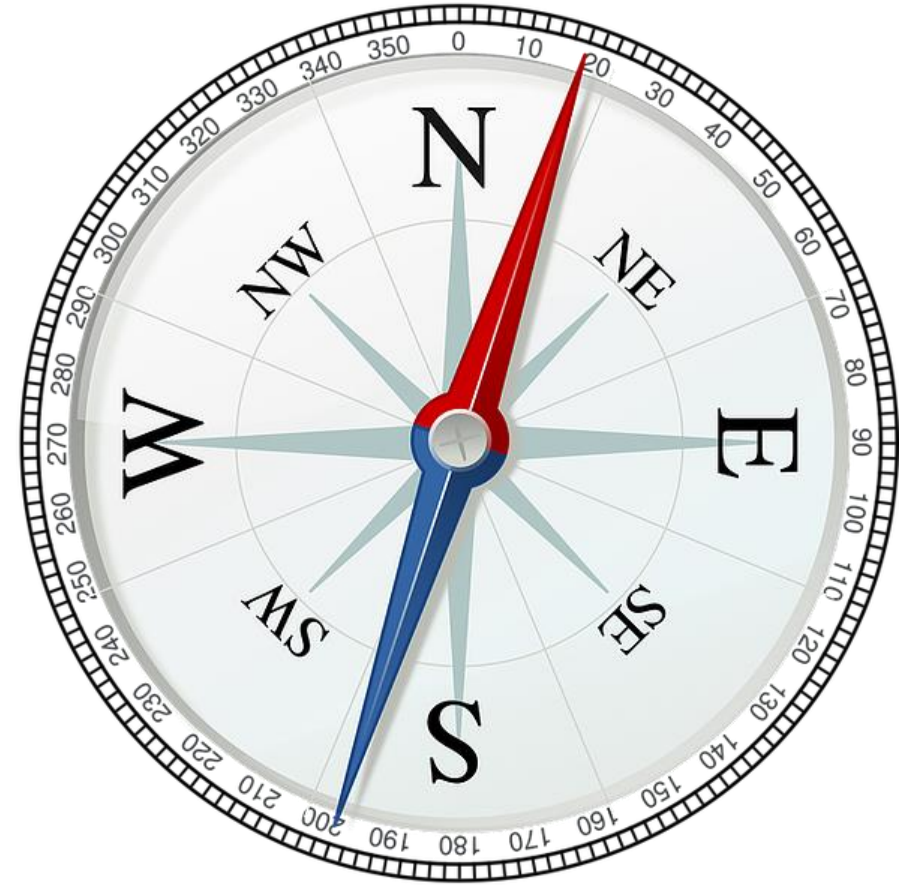
- For SMB accounts lacking IT staff, hardware and CapEx; for Enterprises where in-house HPC is at max capacity and cloud is a corporate initiative
- Usual compute-optimized or memory-optimized Virtual Machine (VM) instances; sometimes bare-metal instances
- Hardware characteristics:
  - Virtually unlimited capacity with 10,000s of CPU cores (from Intel, AMD or ARM), and GPU cores (from Nvidia, AMD)
  - Up to 1TB of RAM per node/instance
  - Up to 200 Gbps network bandwidth (e.g., AWS' Elastic Fabric Adapter)
- Pros:
  - Optimal for meeting intermittent workloads and heterogeneous workload requirements
  - Removal of IT barriers (i.e., no need to maintain the hardware and software; access to the latest generation of powerful hardware; hardly any upfront investment; access to HPC experts and data security specialists)
- Cons:
  - Data security is sometimes inadequate for customer's needs
  - Costs are relatively high compared to that of on-premises hardware at ~80% utilization
- Cloud partners:
  - CSP: AWS, Azure, GCP, and OCI
  - CHP: Atos/Nimbix, Rescale, UberCloud, Gridcore, Penguin Computing, Syncious
  - SI: Atos, Kalypso, Nextira, science+computing, Transition Technologies

# Nature of Ansys Simulation jobs

- Different approach to memory and cores
- Different usage of GPUs
- Good neighbor vs bad neighbor (can/cannot run in same partition)
- Different solvers
- Storage access
- IO utilization

# HPC IT goals to address customer needs

- Observability
- Shared resources
- Cost management
- Research and innovation
- Performance improvement
- Transparency and accountability
- BU alignment and cross-BU resource harmonization



# HPC Challenges and opportunities

- Observability and performance awareness (network, compute, storage)
- CPU core and memory allocation, utilization, and efficiency
- Cost overruns for cloud-based simulation jobs
- Automation

# Observability for our HPC environments

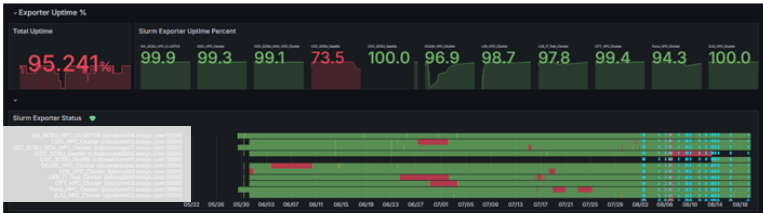
- Slurm Accounting database
- Native observability commands (sinfo -R -o )
- Slurm Exporter for Prometheus
- Grafana
- XDMoD
- ServiceNow Audit Tests (nodes, partition, clusters)
- Cloud HPC costing data

# Observability

## Observability with Slurm Exporter

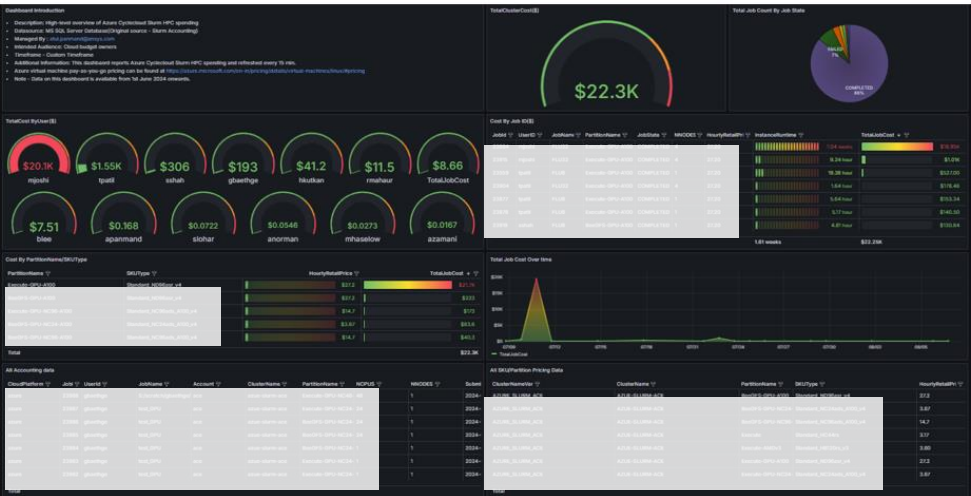
If Slurm Exporter is down, reporting integrity is compromised:

- 1. Cluster allocation
- 2. Cores allocation
- 3. Nodes allocation
- 4. Job wait time

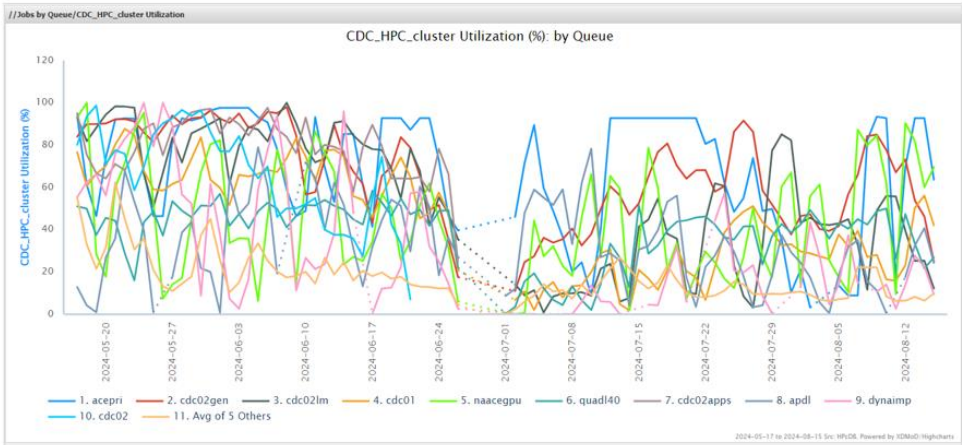


Slurm Exporter downtime is monitored as Level 2 operational metric.

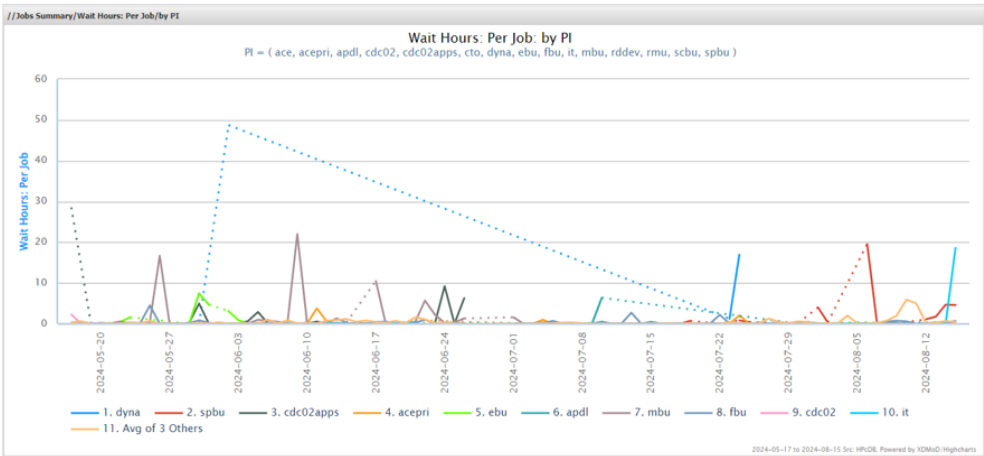
## Observability with Grafana dashboards – Cloud vendor A – Costing



## Observability with XDMoD: Partition Utilization – all partitions



## Observability with XDMoD: Wait time by Principal Investigator





# Lessons learned

# HPC IT Lessons Learned

- Listen to our customers and our customers' customers
- Identify sources of truth via telemetry
- Adopt SRE principles: SLOs, Monitor, Automate, Release Engineer, Simplicity, Embrace Risk



# Conclusion

# HPC Trends

- Increased Engineering Productivity
- Increased Product Complexity
- Increased Product Integrity
- Emerging Cloud Adoption
- Heterogeneous HPC environment
- Increased demand for GPU computing

# Conclusion

- Ansys implementation of Slurm
- HPC at Ansys is advancing
- Increased Engineering Productivity, Product Complexity, and Product Integrity

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Home > IT Solutions > HPC Solutions

## / HPC Solutions

Understand how scalable high-performance computing (HPC) solutions enable you to perform more high-fidelity simulations in less time on today's multicore computers.

[FREE TRIAL >](#)

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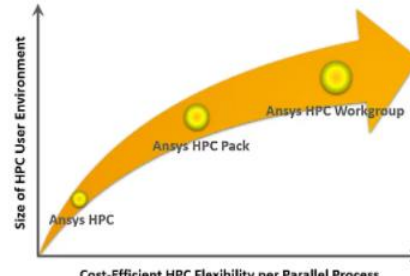


BIGGER, BETTER, FASTER SIMULATION

## / Enhanced Insight and Engineering Productivity Enabled by HPC

With the Ansys HPC software suite, you can use today's multicore computers to perform more simulations in less time. These simulations can be bigger, more complex and more accurate than ever using high-performance computing (HPC). The various Ansys HPC licensing options let you scale to whatever computational level of simulation you require, from single-user or small user group options for entry-level parallel processing up to virtually unlimited parallel capacity.

For large user groups, Ansys facilitates highly scalable, multiple parallel processing simulations for the most challenging projects when needed. Apart from parallel computing, Ansys also offers solutions for parametric computing, which enables you to more fully explore the design parameters (size, weight, shape, materials, mechanical properties, etc.) of your product early in the development process.



[ANSYS HPC BROCHURE >](#)

## / Quick Specs

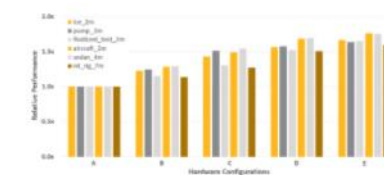
Ansys technology enables highly scalable HPC deployment, giving you virtually unlimited capacity for high-fidelity simulation and the detail it provides. You can launch our HPC solutions within a workgroup or across a distributed enterprise—whether using mobile or desktop workstations, departmental clusters, enterprise or cloud-based servers—wherever

|                                             |                                                        |
|---------------------------------------------|--------------------------------------------------------|
| Enabling parallel and parametric processing | Single solution for fluids, structures and electronics |
| Scalable, value-based licensing             | Enabling CPU and GPU based computing                   |

Overview Capabilities Licensing Resources & Events

## / HPC Capabilities

Check out the below benchmarking and computing capabilities to convince yourself about the benefits of high-performance computing (HPC) for engineering simulation.



## / Benchmarking Capabilities

**Workstation Refresh ROI Estimator**  
Get time savings and ROI based on standard benchmarks. [+](#)

**Benchmark Your Workstation for Your Own Model**  
Once you see the time that can be saved for your own simulation model, you may be convinced to migrate from your desktop computer to an HPC cluster solution. [+](#)

**Run Your Own Benchmarks on Ansys Cloud**  
Go for a one-month free trial on the cloud and experience HPC as easy it should be. [+](#)

**Standard Benchmarks**  
Check out the overview and performance. [+](#)

## / Computing Capabilities

**On-premises Hardware Solutions**  
Hardware configurations recommended by HPC partners can provide you with the best return your hardware and Ansys software investment for on-premises deployments. [+](#)

**Ansys Cloud Solution**  
Providing secure and instant access to on-demand HPC resources in the cloud. [+](#)

Overview Capabilities Licensing Resources & Events

## / HPC Resources & Events

### / Featured Webinars

**IT Webinar Series**  
This webcast series shares the knowledge and experience of Ansys experts, to support strategic decision making related to IT systems for Ansys technology. [VISIT WEBINAR SERIES >>](#)

**Ansys Cloud Webinar Series**  
This webinar series is designed for IT Professionals and touches on all relevant aspects of running Ansys in a cloud partner computing environment. [REQUEST WEBINAR >>](#)

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**The Value of High-Performance Computing for Simulation**  
Learn how software licensing and pricing models can ensure the highest value for engineering simulation workloads. [REQUEST WHITE PAPER >>](#)

- [Study on HPC Usage for Engineering Simulation >](#)
- [Study on Cloud Computing Engineering Simulation >](#)
- [Research Report - All You Need to Know about Hardware for Simulation >](#)
- [Manufacturing Speed and Agility Enabled by Turnkey HPC Solutions >](#)

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- [Survey Shows Emerging Cloud Computing Capabilities and the COVID-19 Effect >](#)
- [Simulation User Survey Results: Evolving Workflows Affect HPC Usage >](#)
- [Accelerating Automotive CFD Simulations with HPC >](#)

The Ansys logo, featuring a stylized yellow and black 'A' followed by the word 'nsys' in black.

