Powering Innovation That Drives Human Advancement

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

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Slurm User Group
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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





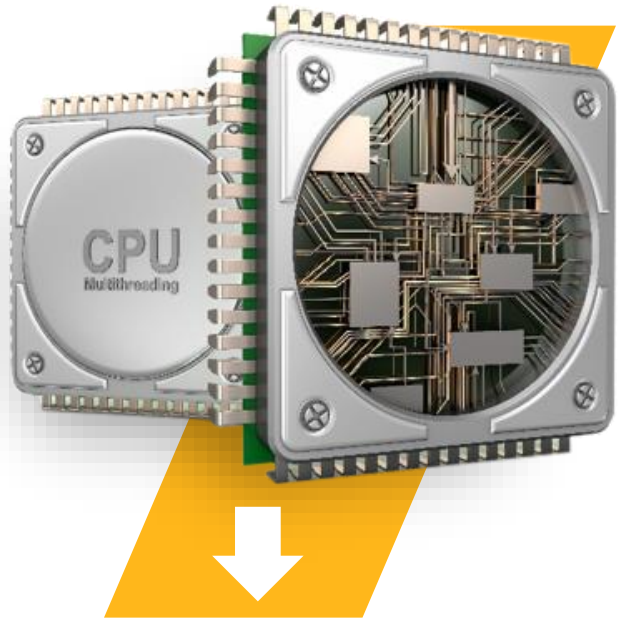






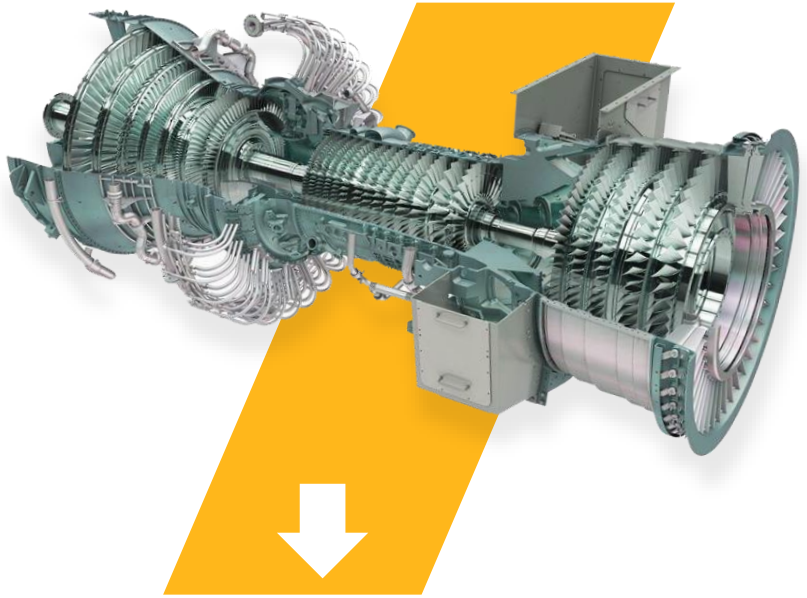


Increased pressure to deliver on the classic challenges



30%

Time-to-market



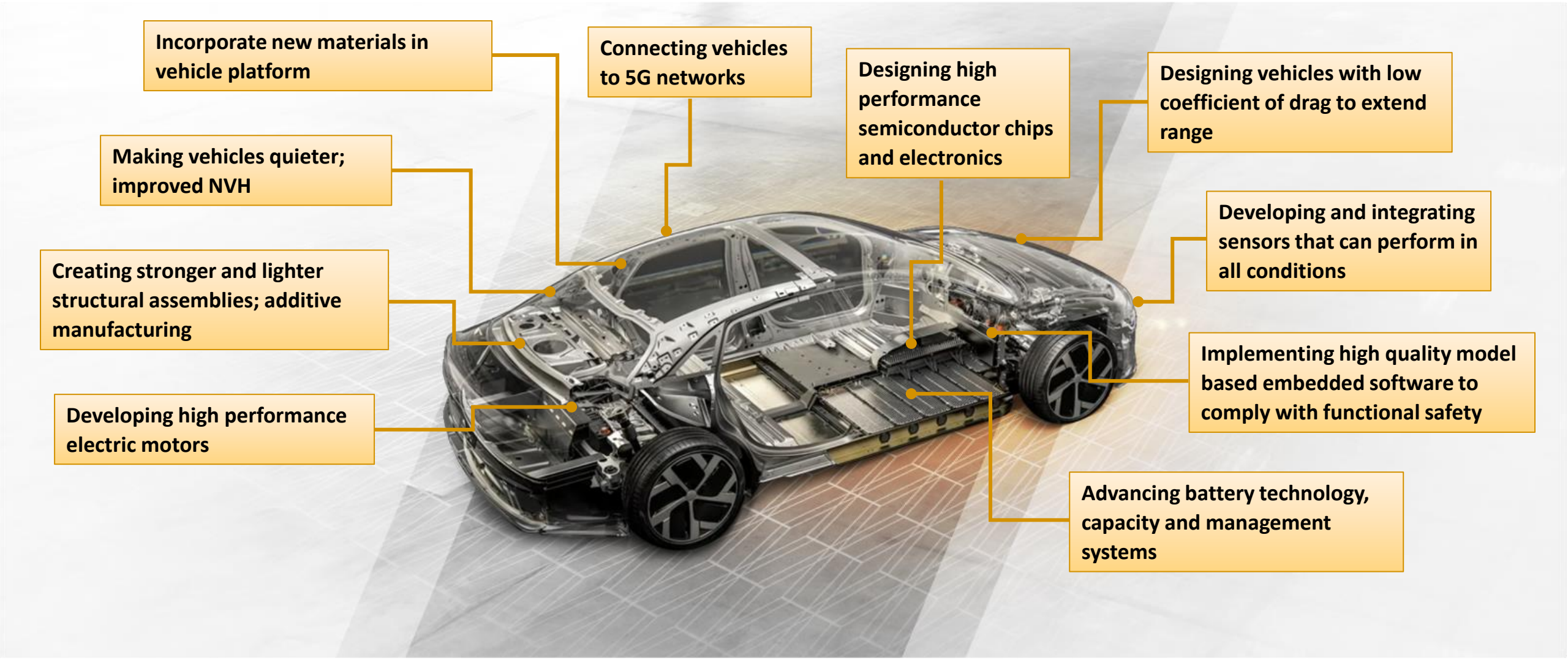
2 YEARS

Cycle times

66%

New product rollouts

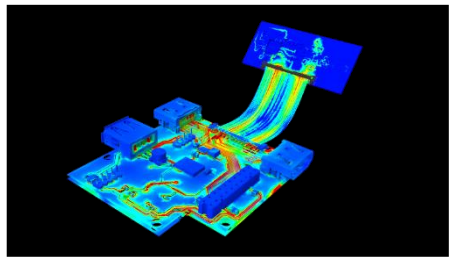
Strong need for faster innovation with better outcomes at lower costs



Ansys 5 pillars of innovation

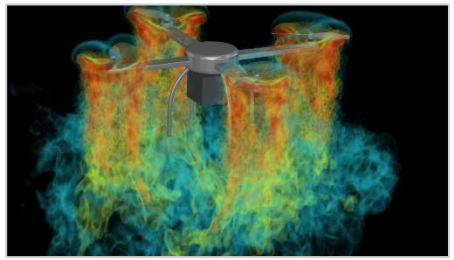
Driving your greatest innovations and solving your toughest challenges

NUMERICS



Multiphysics, multi-scale, connected workflows

HIGH-PERFORMANCE COMPUTING



Multiple products leveraging GPU for solver acceleration

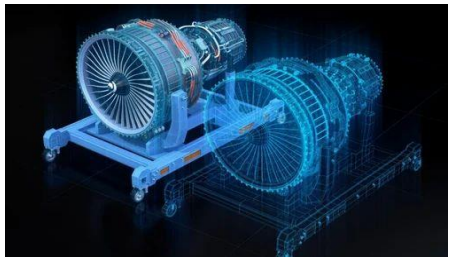
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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

Ansys / CLOUD PLATFORM

/ 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

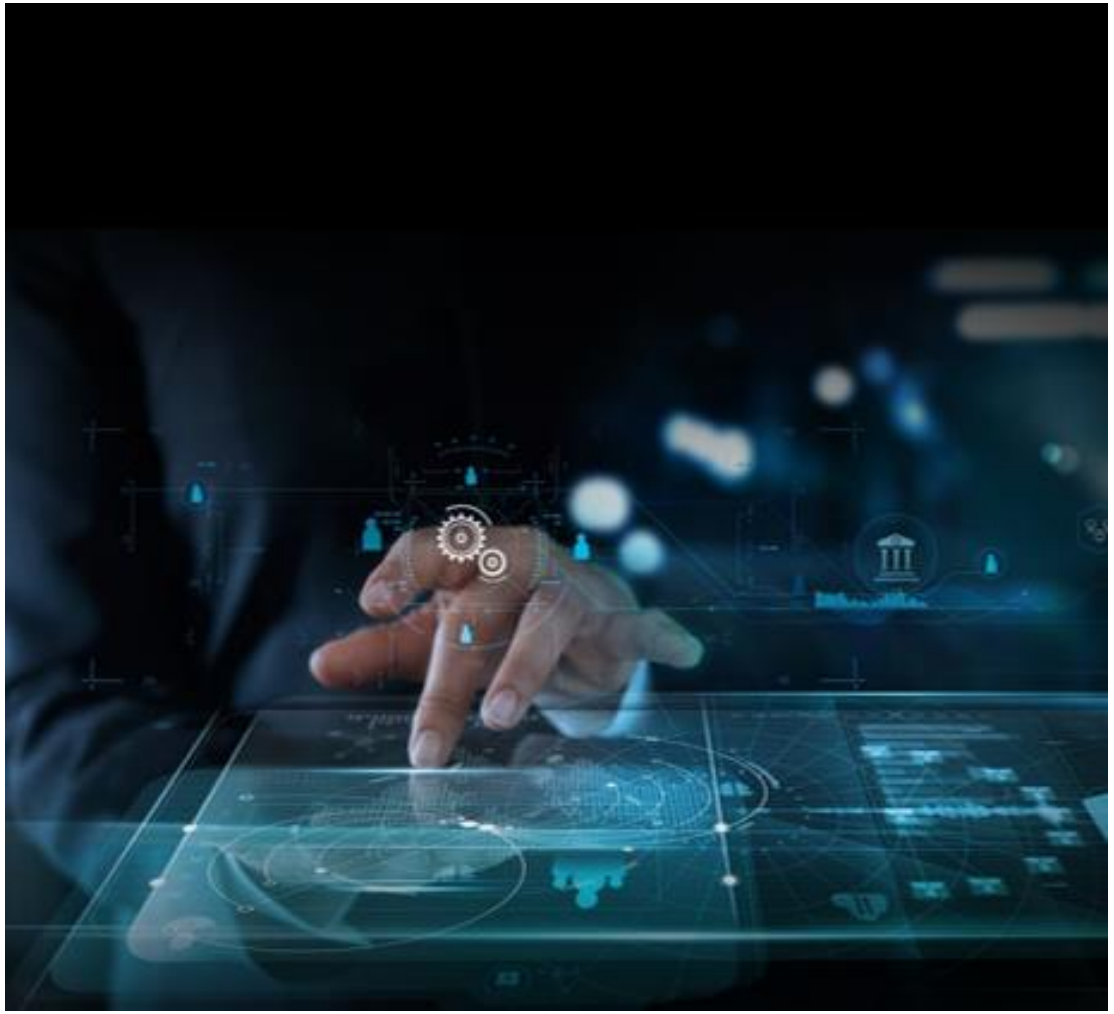
Cloud Connected

- 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

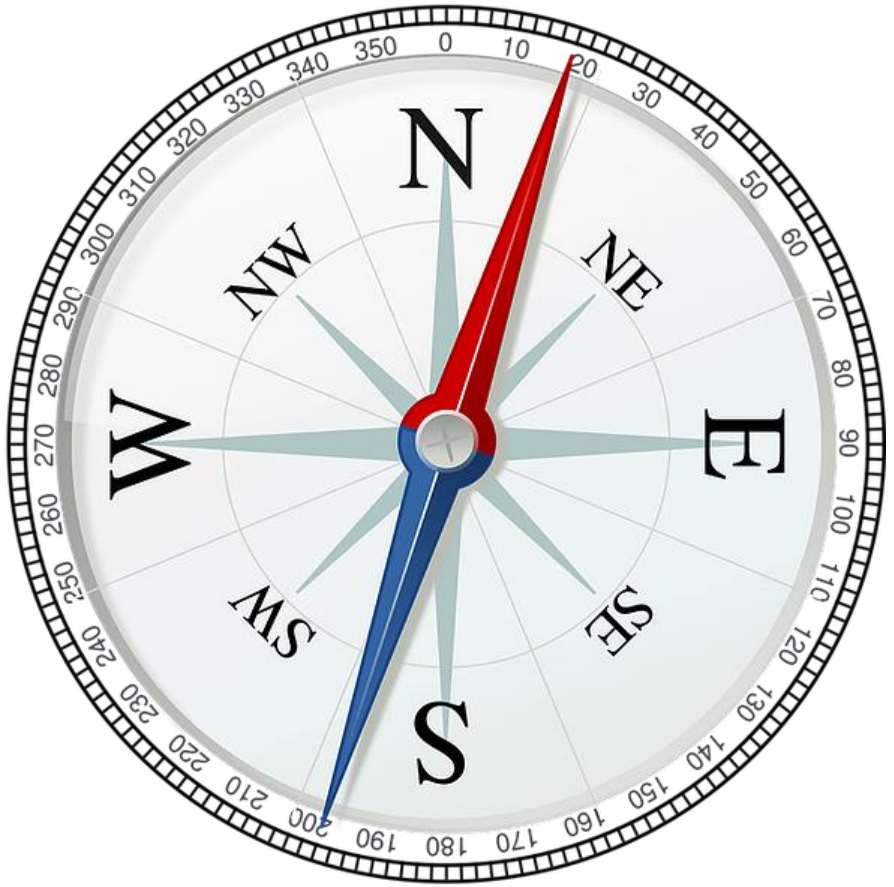
- For SMB accounts lacking IT staff, hardware and CapEx; for Enterprises where in-house HPC is at max capacity and cloud is a corporate initiative
- Usual compute-optimized or memory-optimized Virtual Machine (VM) instances; sometimes bare-metal instances
- Hardware characteristics:
  - Virtually unlimited 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

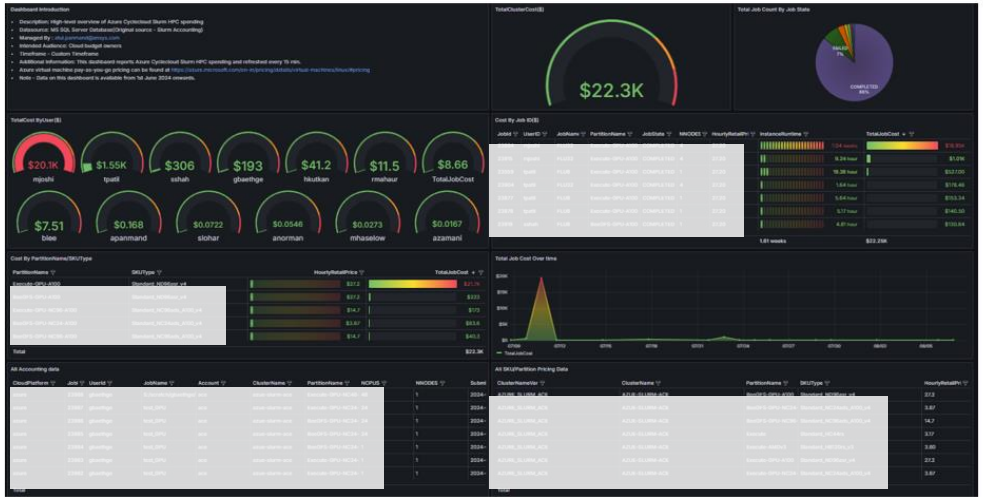
Observability with Slurm Exporter

If Slurm Exporter is down, reporting integrity is compromised:

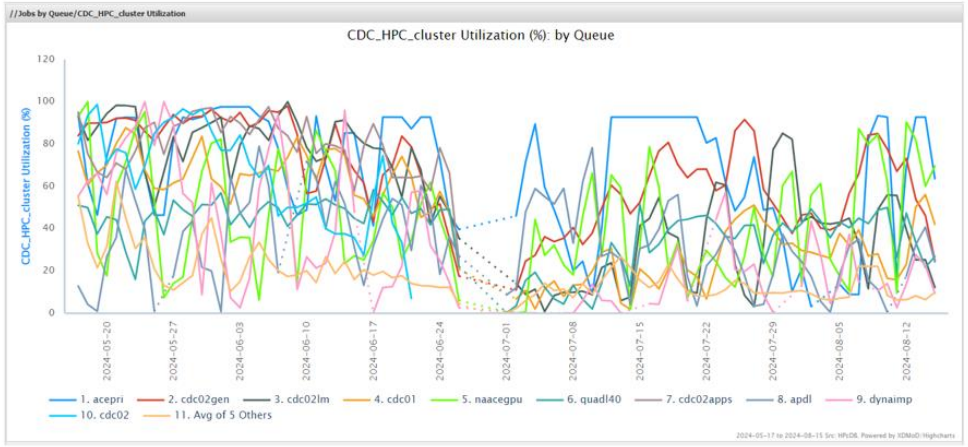
1. Cluster allocation
2. Cores allocation
3. Nodes allocation
4. Job wait time

Slurm Exporter downtime is monitored as Level 2 operational metric.

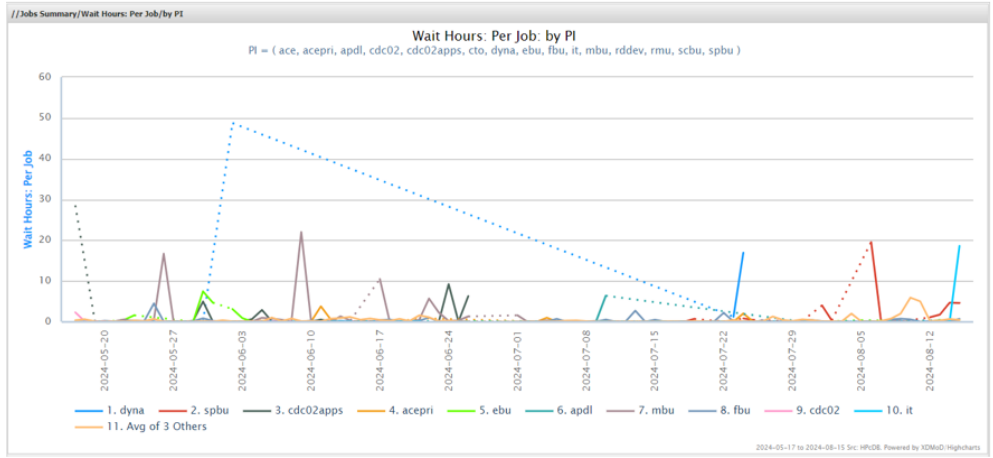
Observability with Grafana dashboards – Cloud vendor A – Costing



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

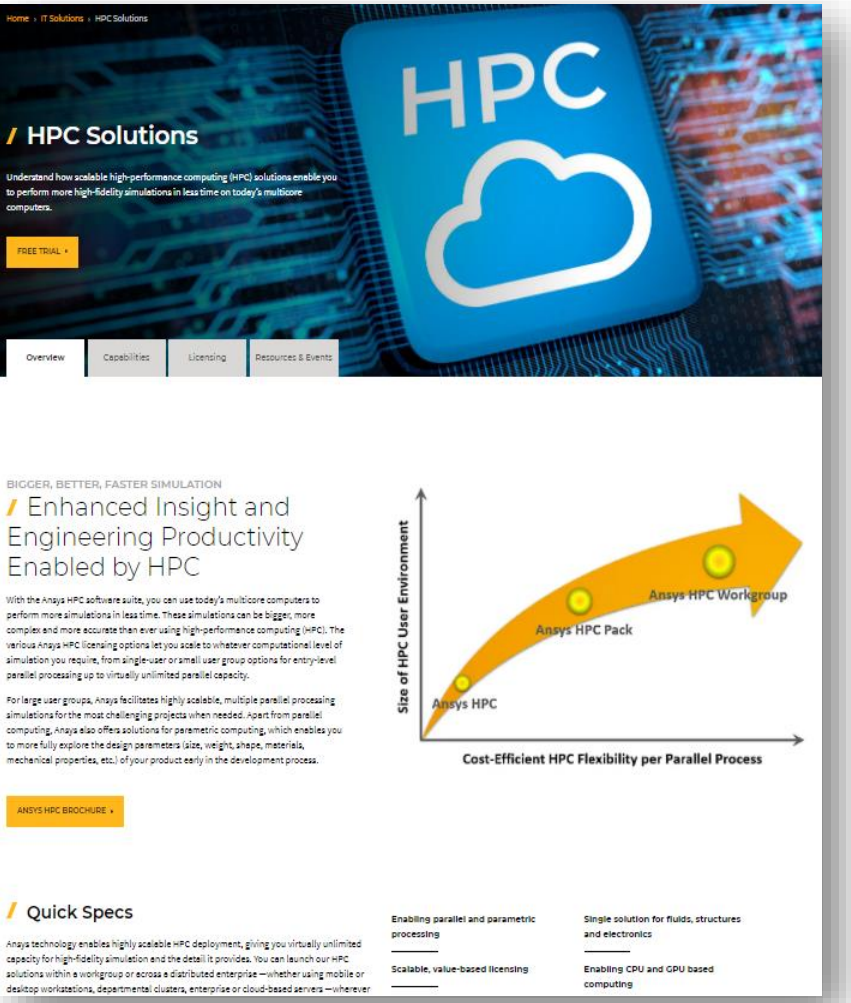
HPC Trends

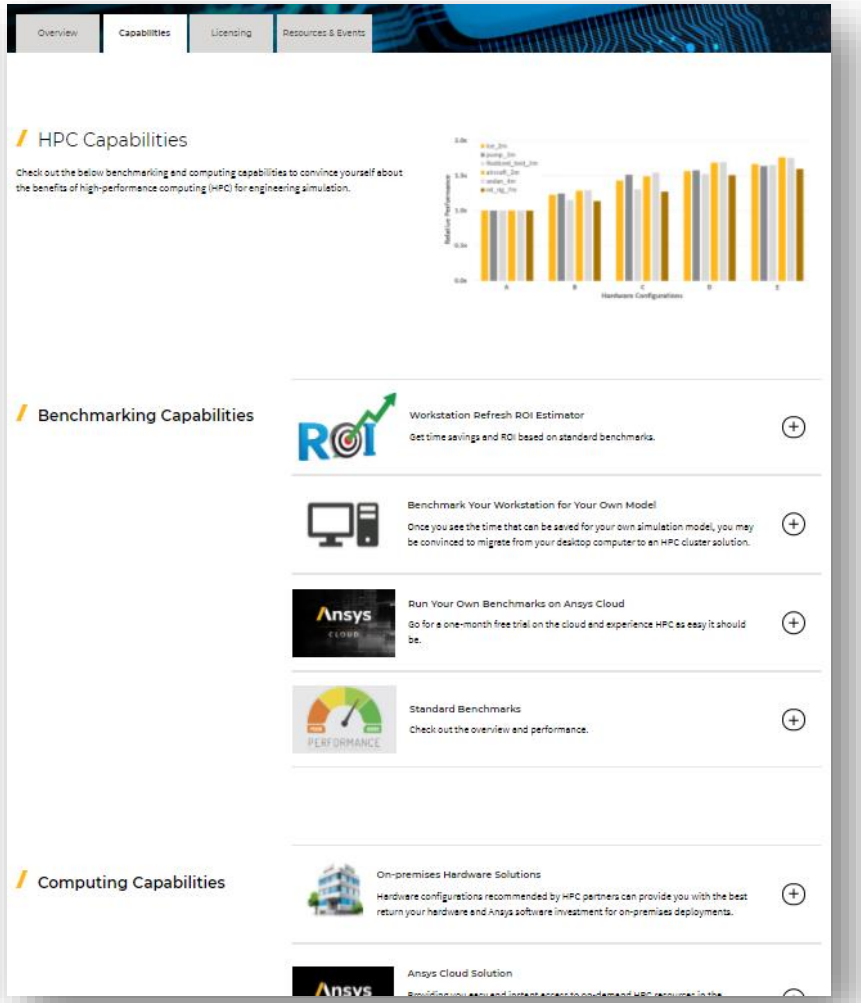
- Increased Engineering Productivity
- Increased Product Complexity
- Increased Product Integrity
- Emerging Cloud Adoption
- Heterogeneous HPC environment
- Increased demand for GPU computing

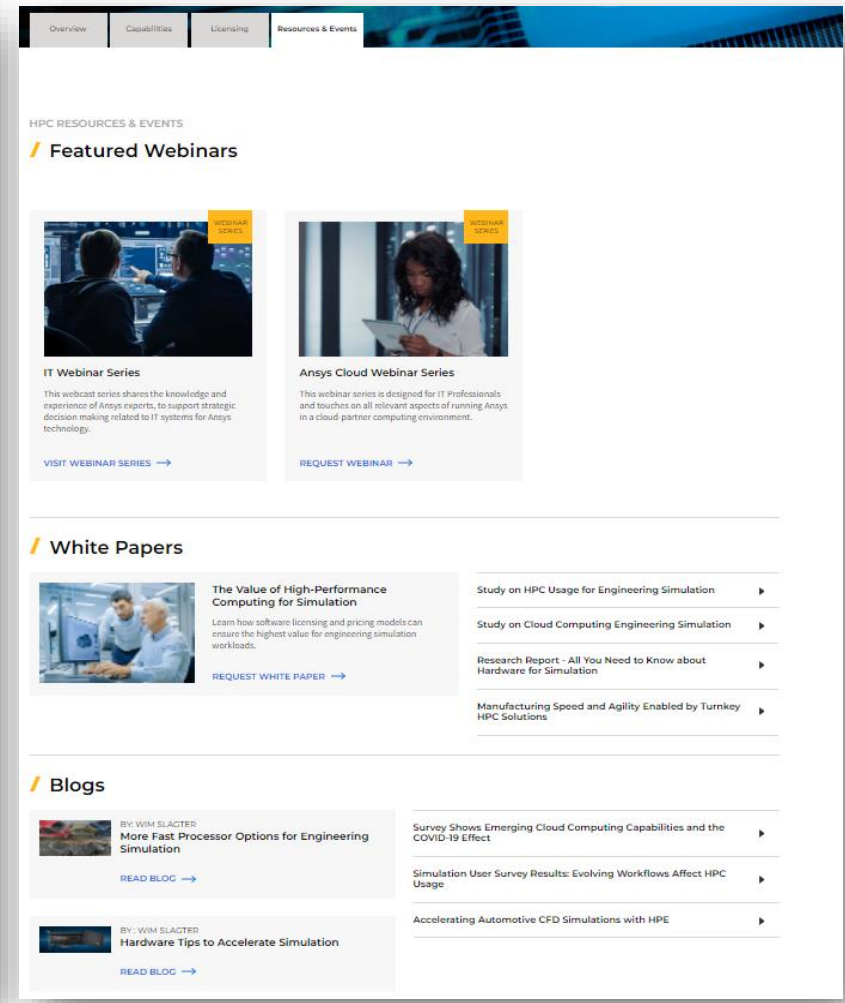
Conclusion

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

Come see us at www.ansys.com and at SC24








Ansys