High Performance Computing: Powering Scientific and Industrial Innovation at Scale

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What You Will Learn Today

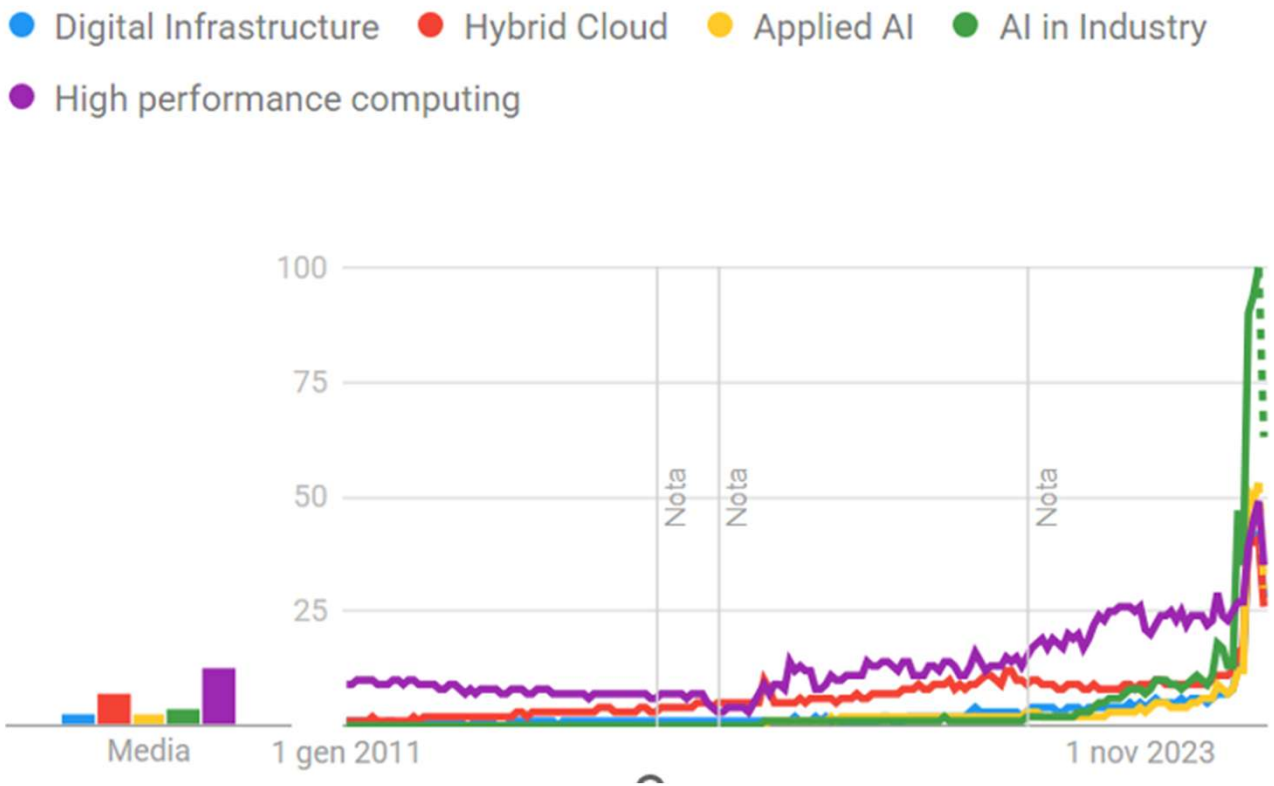
By the end of this session, students will be able to:

- **Understand** why HPC matters for engineering.
- **Explore** how HPC enables AI, digital twins, and advanced simulations.
- **Discover** HPC architecture basics (CPU/GPU, interconnects).
- **See** real-world applications in aerospace, mechanical, and civil engineering.
- **Imagine** how these technologies could impact your future projects.

The Turning Point

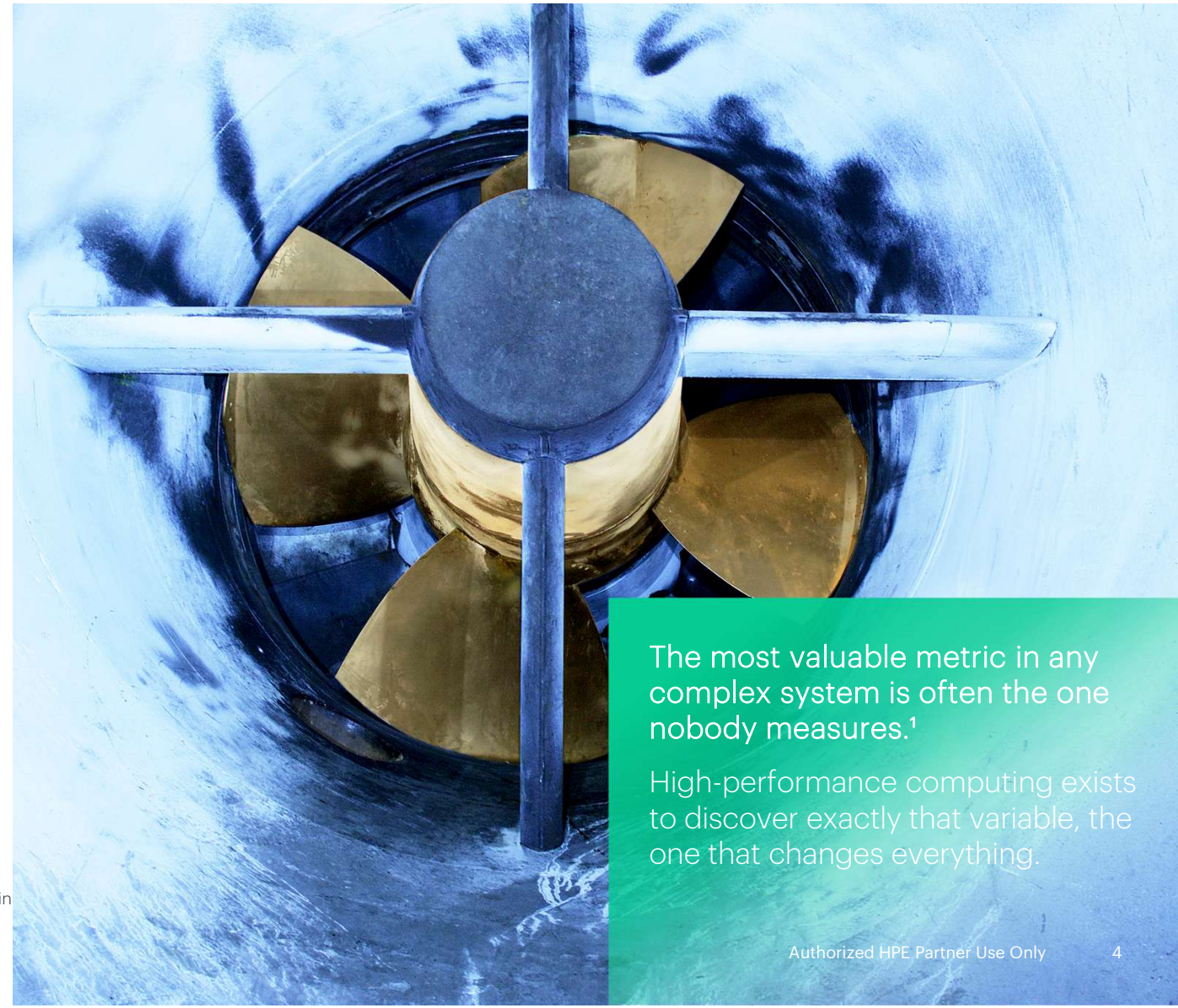
AI Adoption and Infrastructure Convergence

- Data Explosion
- AI Evolution
- HPC Backbone



Why HPC matters

- Complexity
- Parallelism
- Impact



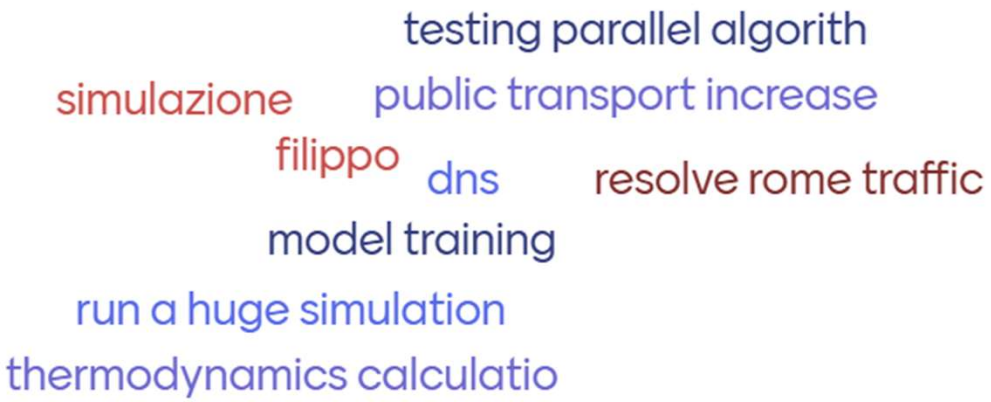
[1]Hubbard, D., Budzier, A., & Leed, A. B. (2025). How to Measure Anything in Project Management (1st ed.). Wiley.

Let’s Break the Ice – Your Voice First

- If you had access to a supercomputer for one day, what would you do?

Participants' Voice: Main Outcomes

If you had access to a supercomputer for one day, what would you do?

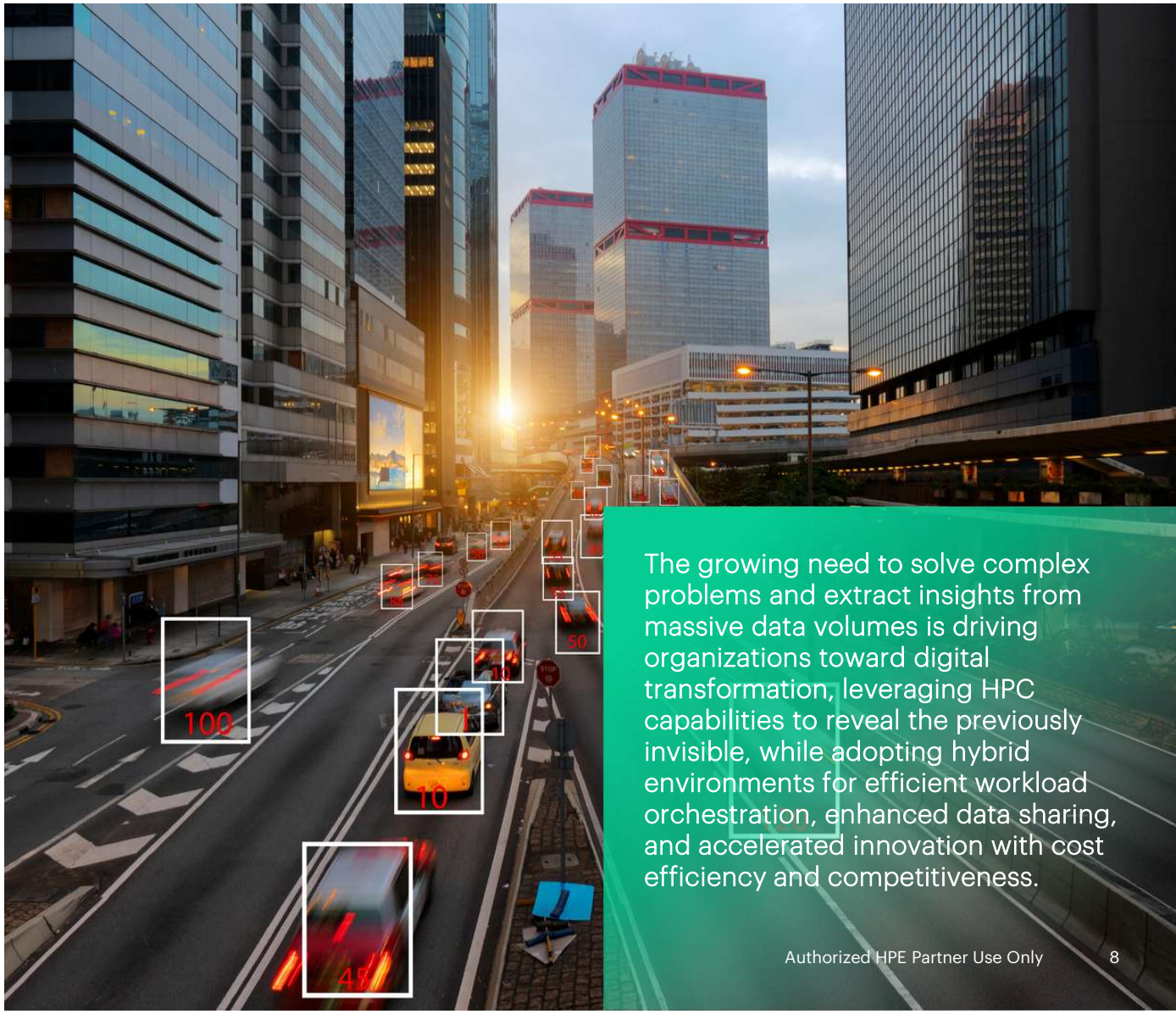


Digital Infrastructure and Current Context

Overview

What Are the Market Drivers?

- Cost Reduction
- Data Sharing and Collaboration
- Demand for Digital Transformation
- Increasing Complexity



The growing need to solve complex problems and extract insights from massive data volumes is driving organizations toward digital transformation, leveraging HPC capabilities to reveal the previously invisible, while adopting hybrid environments for efficient workload orchestration, enhanced data sharing, and accelerated innovation with cost efficiency and competitiveness.

Minimum Viable Product (MVP) Methodology

Example environments

Successful digital transformation is complex

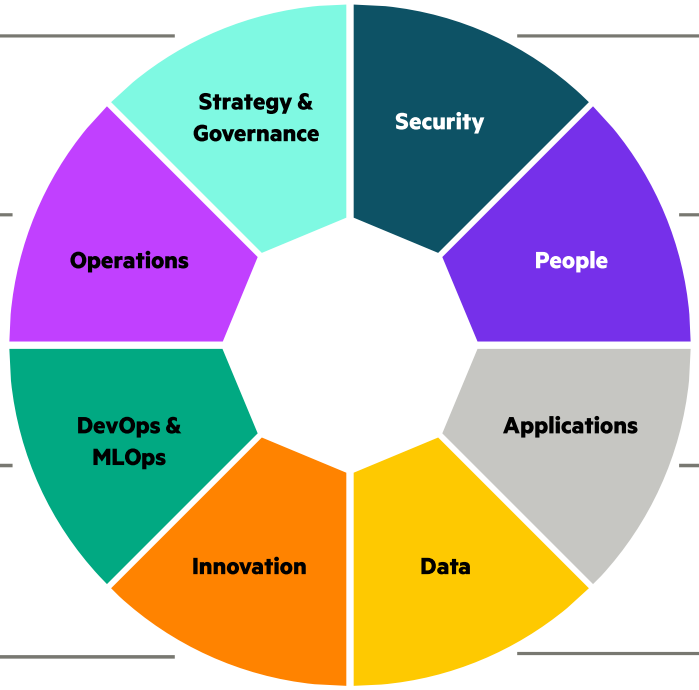
Align people, processes, and technology

- Cloud vision
- Transformation roadmap
- Governance
- Economics

- Hybrid it
- Automation & patterns
- Compliance, cost & vendor management

- Automation, tools, & IAC
- CI/CD
- Code pipelines
- Culture of continuous improvement

- Culture of innovation
- Innovation ideation
- Enabling hypothesis testing



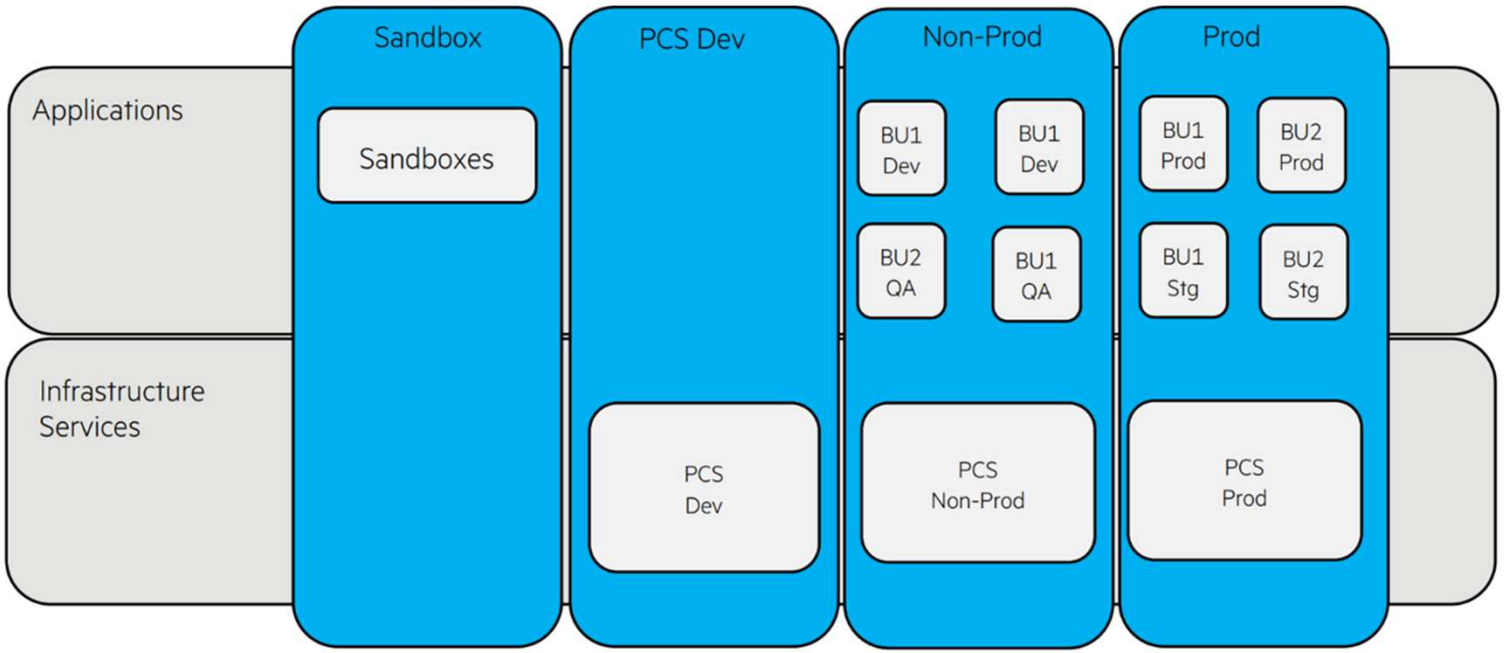
- Visibility and transparency
- Audit and governance
- Compliance and risk
- Automation, tools & software

- Culture
- Organizational change management
- Talent enablement
- Communications

- App modernization
- App refactoring
- Cloud native
- Containers

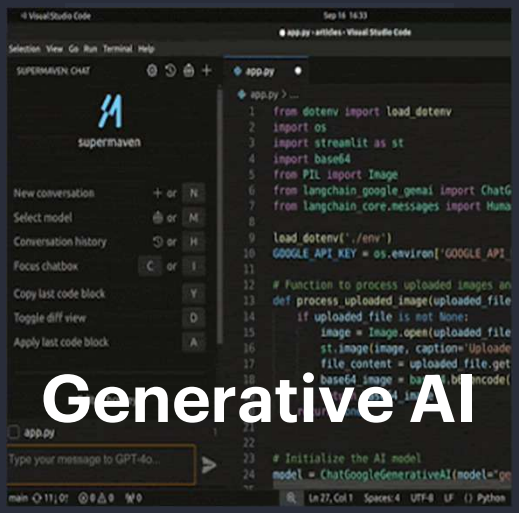
- Governance
- Analytics & AI
- Management

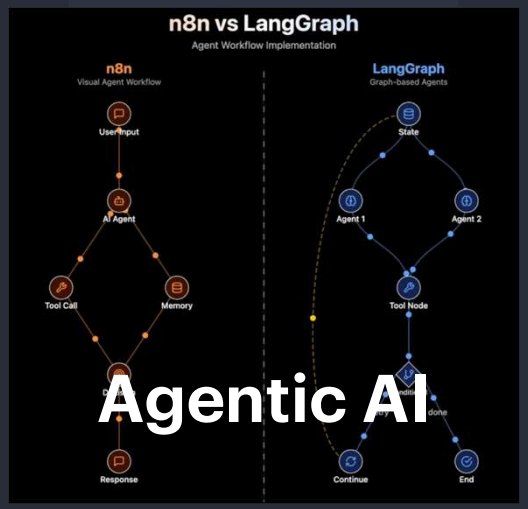
Target environment: Swimlanes

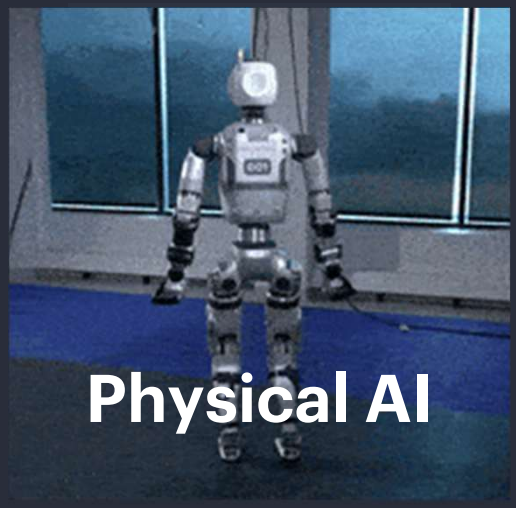


A new era of

AI-DRIVEN TRANSFORMATION



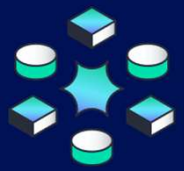




The essential building blocks for modern IT

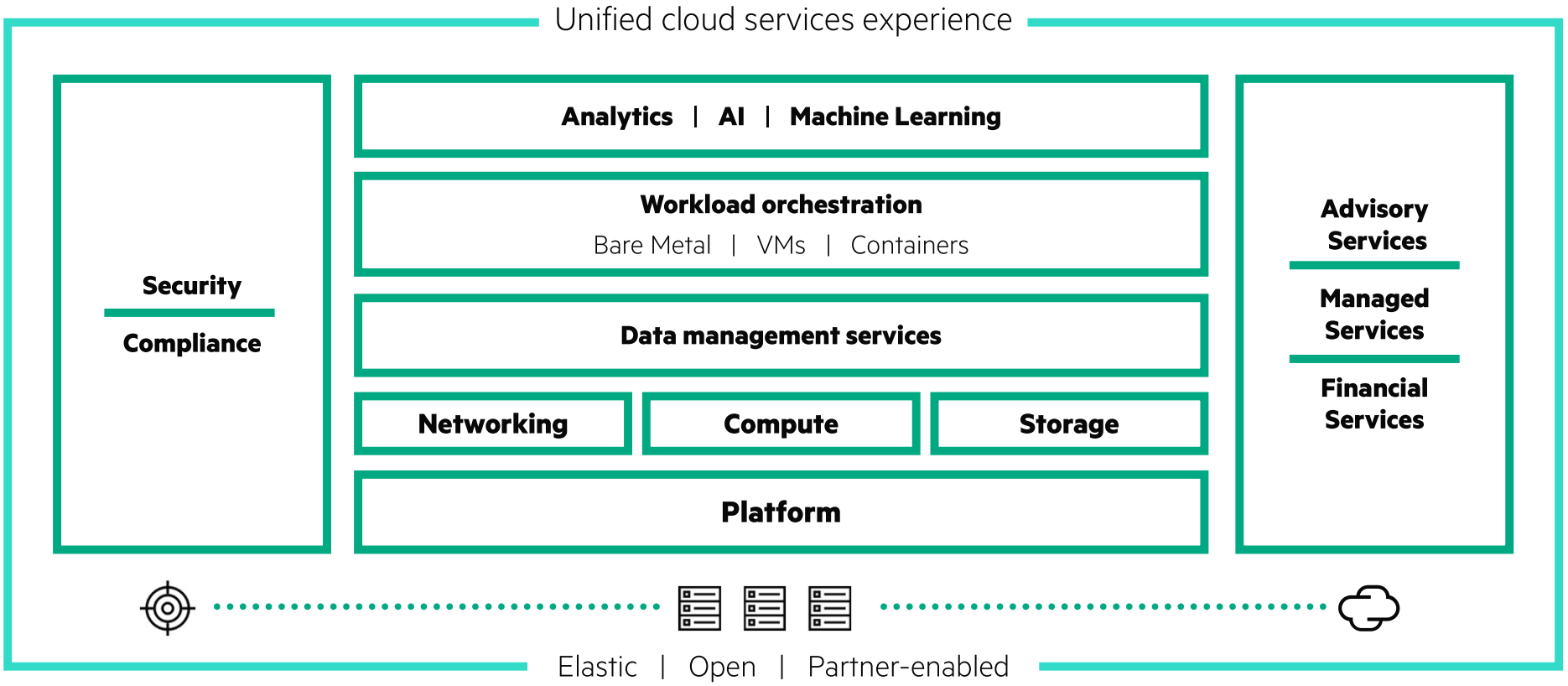
AI to help you unlock the full value of your data to accelerate outcomes

Cloud to give you flexibility to run workloads where it makes the most sense



Networking to connect your people and data more securely and efficiently

Hybrid Cloud Architecture

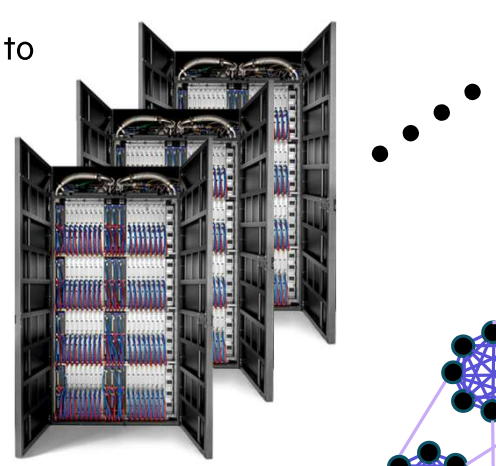


Modern HPC Architectures

This is how it looks in reality

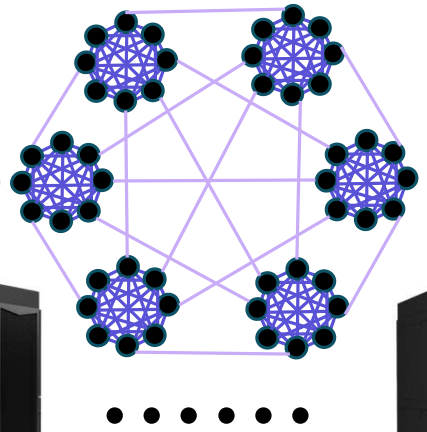
Blueprint for a modern supercomputer for national research and Sovereign AI

CPU partition with up to 98,304 cores per cabinet

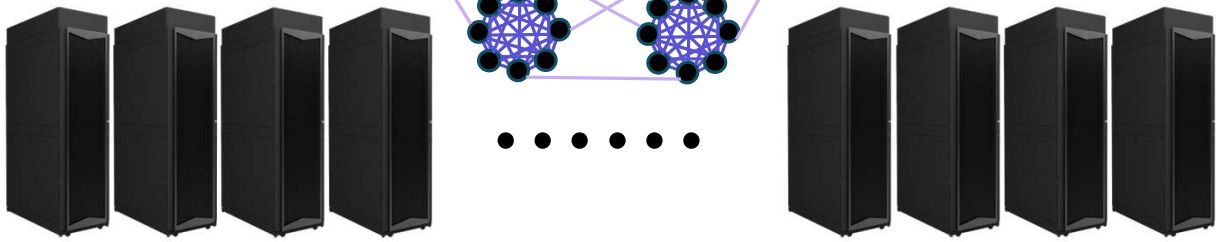


GPU partition with up to 448 GPUs per cabinet

HPE Slingshot interconnect



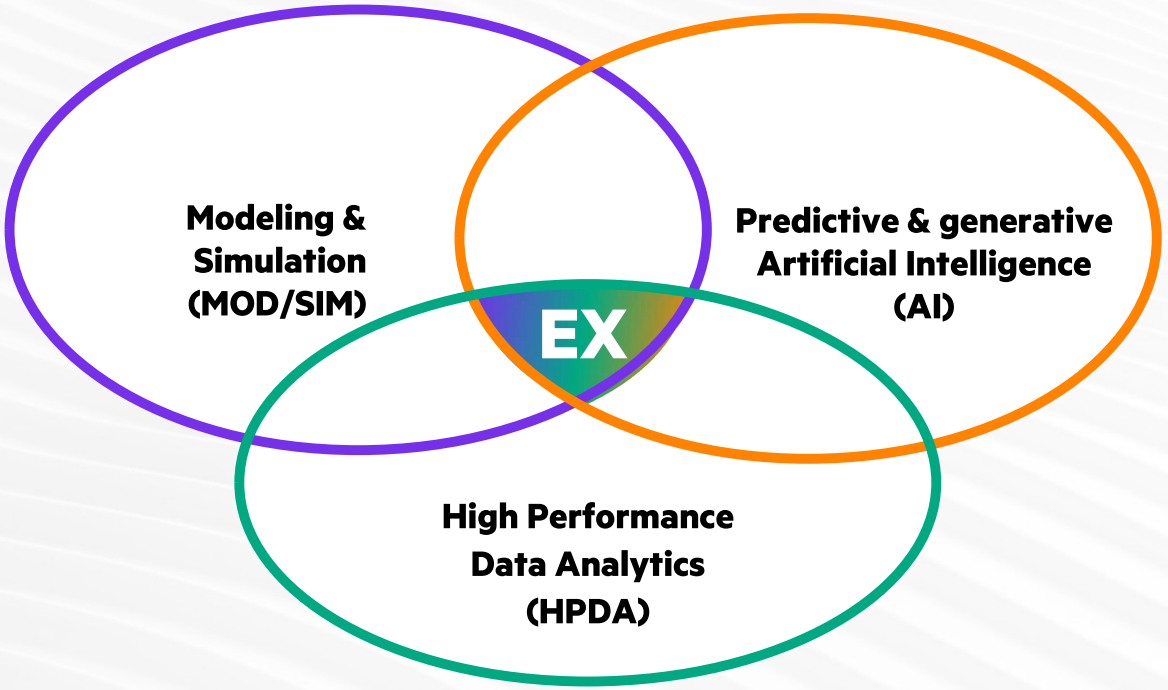
for superlinear performance



HPE Cray SC Storage Systems E2000 with multiple TB/sec I/O performance per rack

What do the workloads running on the supercomputer have in common?

They all have long-running jobs that need to be checkpointed regularly

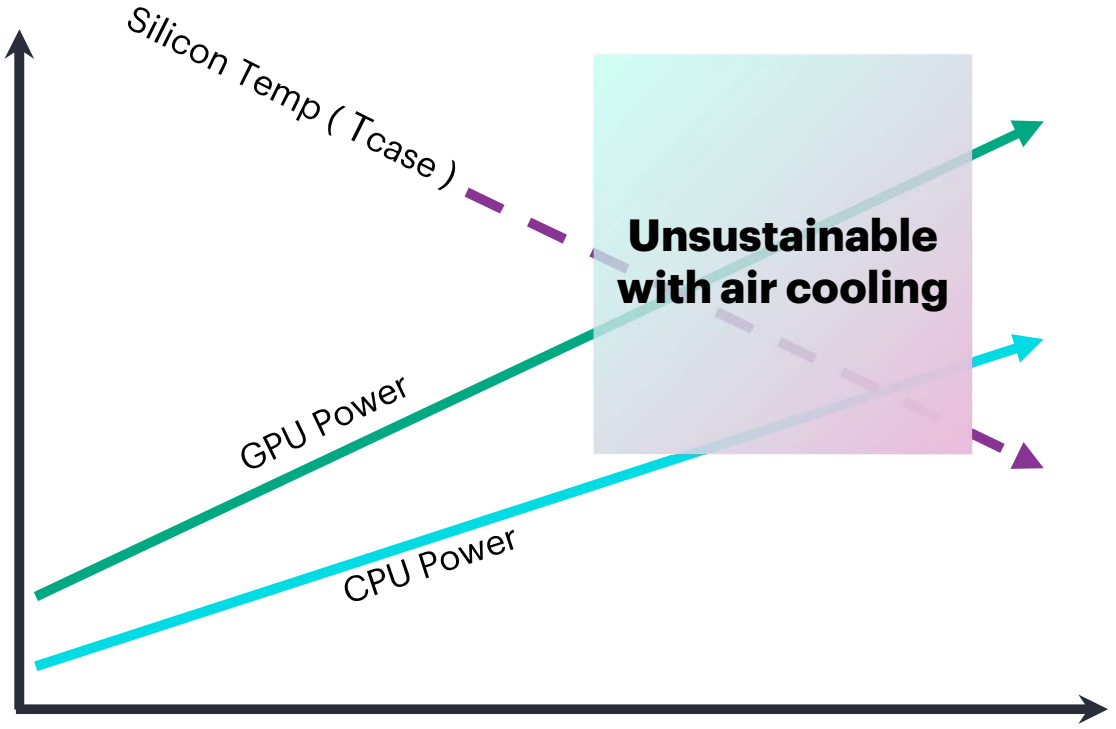


The faster your file system can write data, the less time your compute nodes sit idle waiting for the checkpoint to complete ->

Increased asset utilization of your CPU/GPU compute node investments.

The cooling dilemma

Increasing chip density is outpacing air cooling

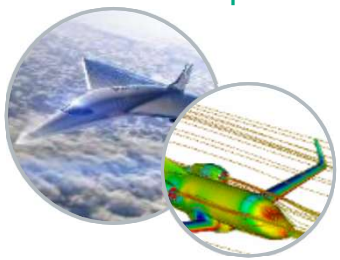


Case Studies and Real-World Impact

Overview

Industry Verticals and Use Cases

Aerospace



Propulsion

Aerodynamics

Acoustics

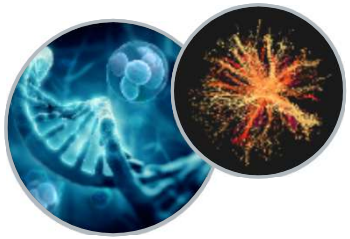
Automotive

Crash Safety

Advanced Driver Assistance Systems

Combustion

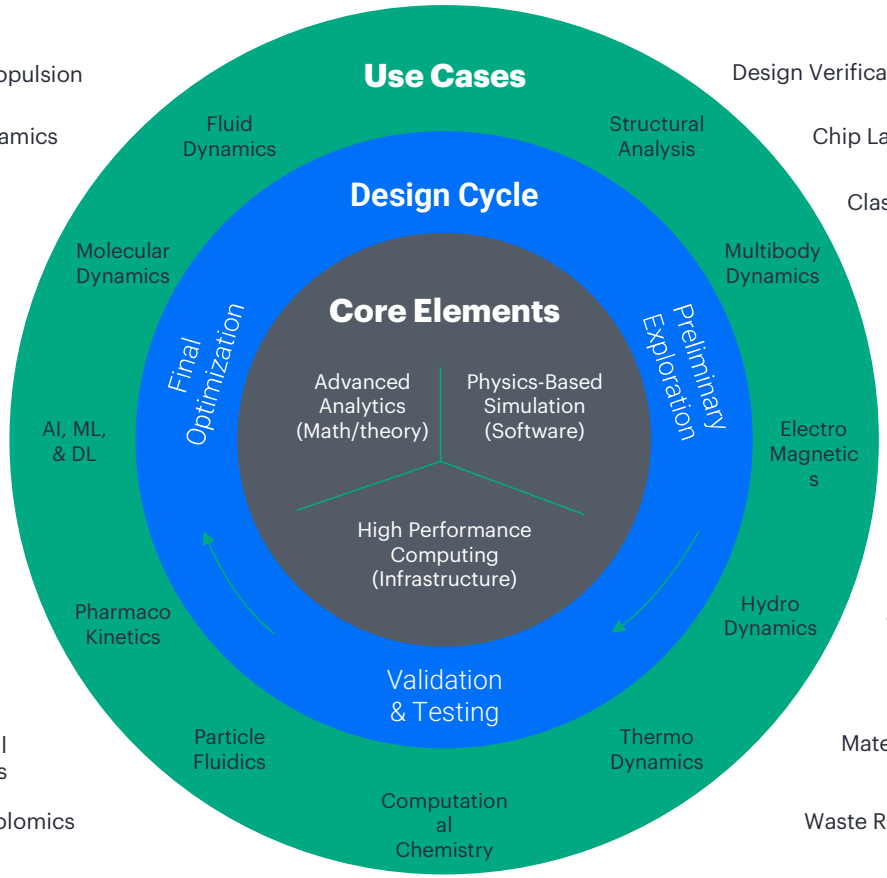
Life Sciences



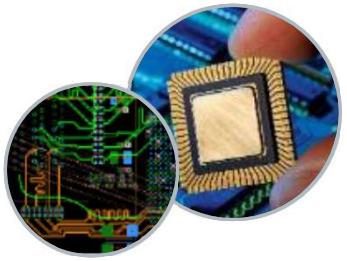
Medical Devices

Metabolomics

Drug Discovery



Semiconductor & EDA



Design Verification

Chip Layout

Classification

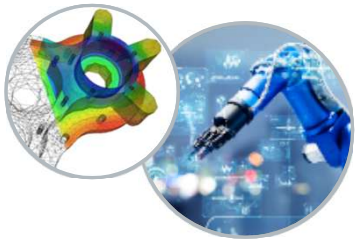
Earth Science & Energy

Climate & Weather Modeling

Drill & Pipeline Safety

Seismic & Reservoir

Manufacturing



Materials Testing

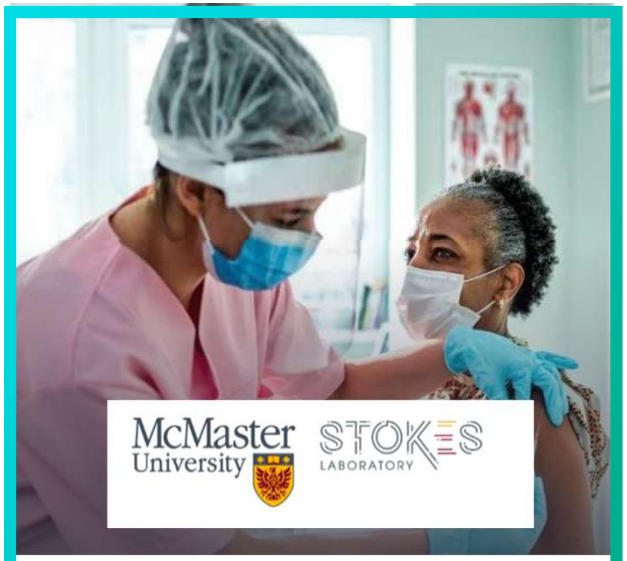
Waste Reduction

Factory Optimization

HPE helps customers exceed the boundaries of what's possible

Together with HPE, Carnegie Clean Energy is working quickly to harness the power of the ocean. They use HPE Cray supercomputing systems design buoys and AI to learn more from each passing wave and maximize energy output. [1]

Through precise modeling powered by supercomputing, the Destination Earth initiative will assist in anticipating environmental disasters and offer crucial insights across energy, food, and public health, empowering informed decisions that proactively mitigate the impacts of climate change. [2]



Researchers are utilizing generative AI to achieve a breakthrough in antibiotic design that can generate synthesizable molecules with wet lab success rates of more than 10% — 10x higher than standard laboratory screening, potentially cutting the time and costs of antibiotic development in half. [3]

[1] "A new wave of renewable energy – Carnegie Clean Energy," HPE, December 2020 and The Energy Crisis: Can Technology Scale To Power The World?, February 2022
[2] "Powering climate solutions through Earth's high-precision digital twin"
[3] "Revolutionizing antibiotic discovery with generative AI "

Conclusion and Pathways Forward

Subtitle here only if needed

Why CAE matters

- Largest HPC driver in engineering
- Enables complex simulations (CFD, FEA, multiphysics)
- Accelerates innovation & reduces cost

CAE solutions cover a wide range of disciplines, but broadly they span these four application categories:

Computational Structural Mechanics (CSM) for Implicit Finite Element Analysis (FEA)

Computational Structural Mechanics (CSM) for Explicit FEA

Computational Fluid Dynamics (CFD)

Computational Electromagnetics (CEM)

HPC Skills and Opportunities Roadmap

Start small, think big: HPC skills open doors to cutting-edge engineering and research.

Career Opportunities

- HPC Engineer / Specialist → Setup & tuning HPC clusters → HPC Architect, Infrastructure Manager
- Computational Scientist / Research Engineer → Senior Research Scientist, HPC Lab Director
- HPC + AI Engineer → ML/HPC Architect, Head of AI Infrastructure
- Industry Applications → CAE, CFD, FEA in automotive, aerospace, pharma → Innovation Manager, Solution Architect HPC

How to Start Today

- Learn the Basics: Parallel computing, Linux, Python
- Try Open-Source Tools: OpenFOAM, Code_Aster, ParaView
- Free Resources: Ansys Student (CAE, OpenFOAM tutorials, HPC Carpentry (training)
- Explore EU Initiatives: EUMaster4HPC, EuroHPC Joint Undertaking

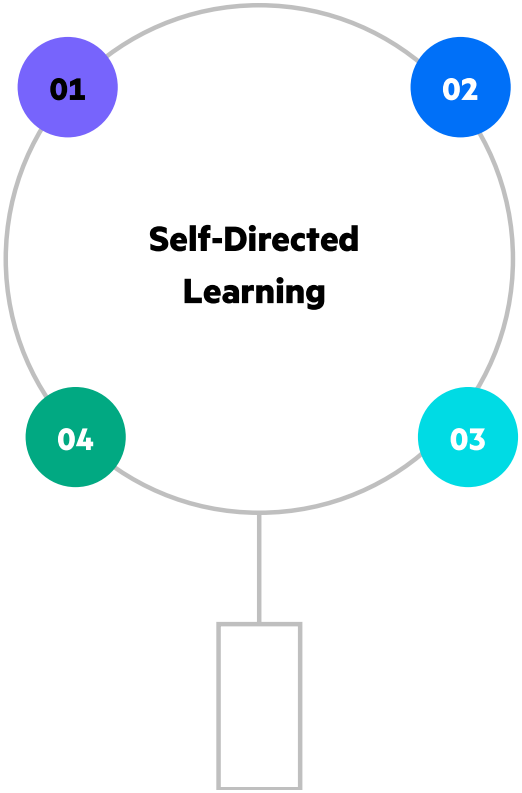
Self-Directed Learning: Focus area

Personal Improvement

Personal Mastery

Team Empowerment

High Performing Team



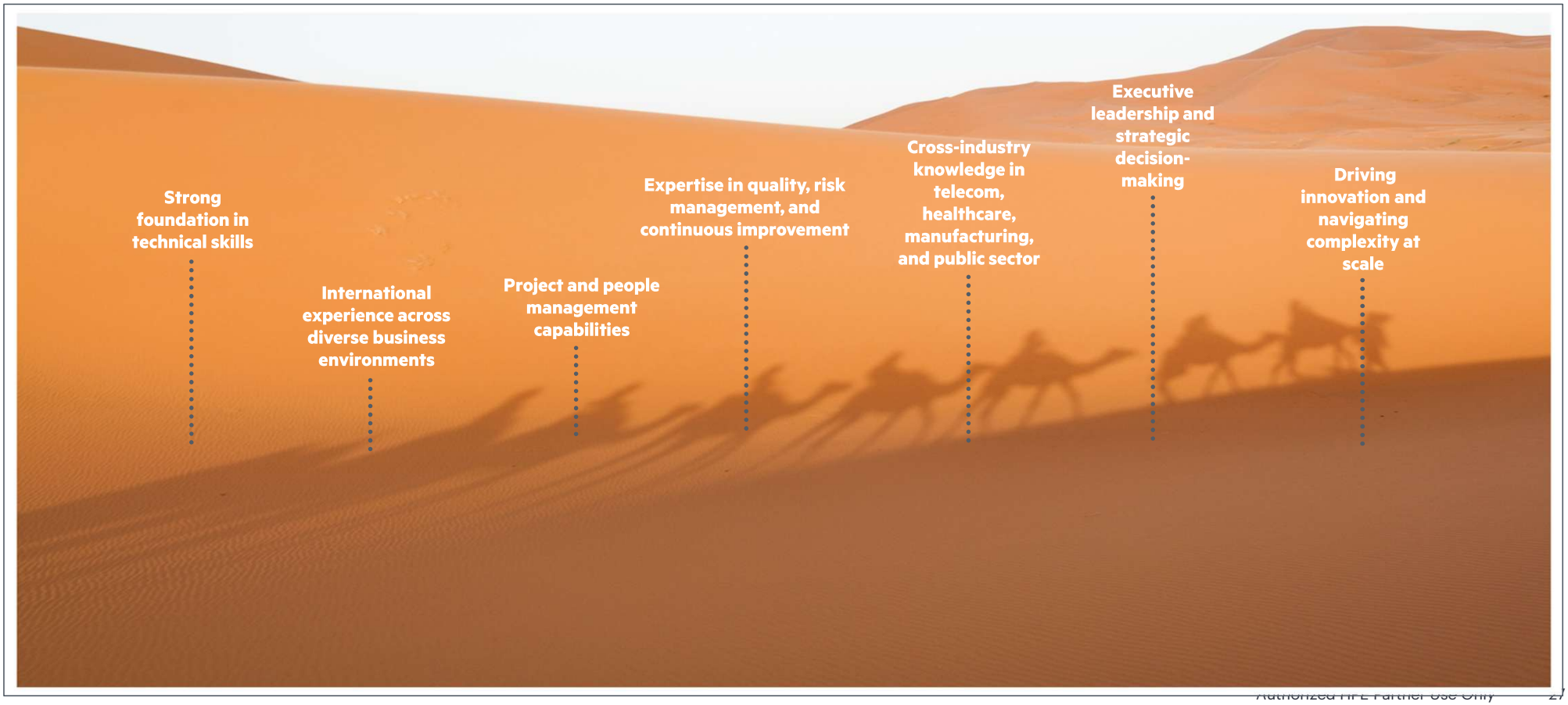
Business Development

Understand the external environment and develop strategic thinking

Organization Performance

Work effectively with the organization as a whole

The journey toward mastering complexity



Wrap-Up: HPC Architectures -Driving Scientific and Industrial Innovation

- ✓ HPC accelerates discovery in science, engineering, and AI.
- ✓ Modern architectures enable flexibility and scalability.
- ✓ Real-world impact: robotics, medical innovation, national security.
- ✓ Future-ready skills: HPC is key for simulation, optimization, and AI-driven design.
- ✓ Your challenge: imagine how HPC could transform your field.

Next Steps

- Let’s connect LinkedIn
- Reading #1: Consulting is more that givin advice
- Reading #2: Taming scope creep to keep projects on track
- PM Infinity

Thank You

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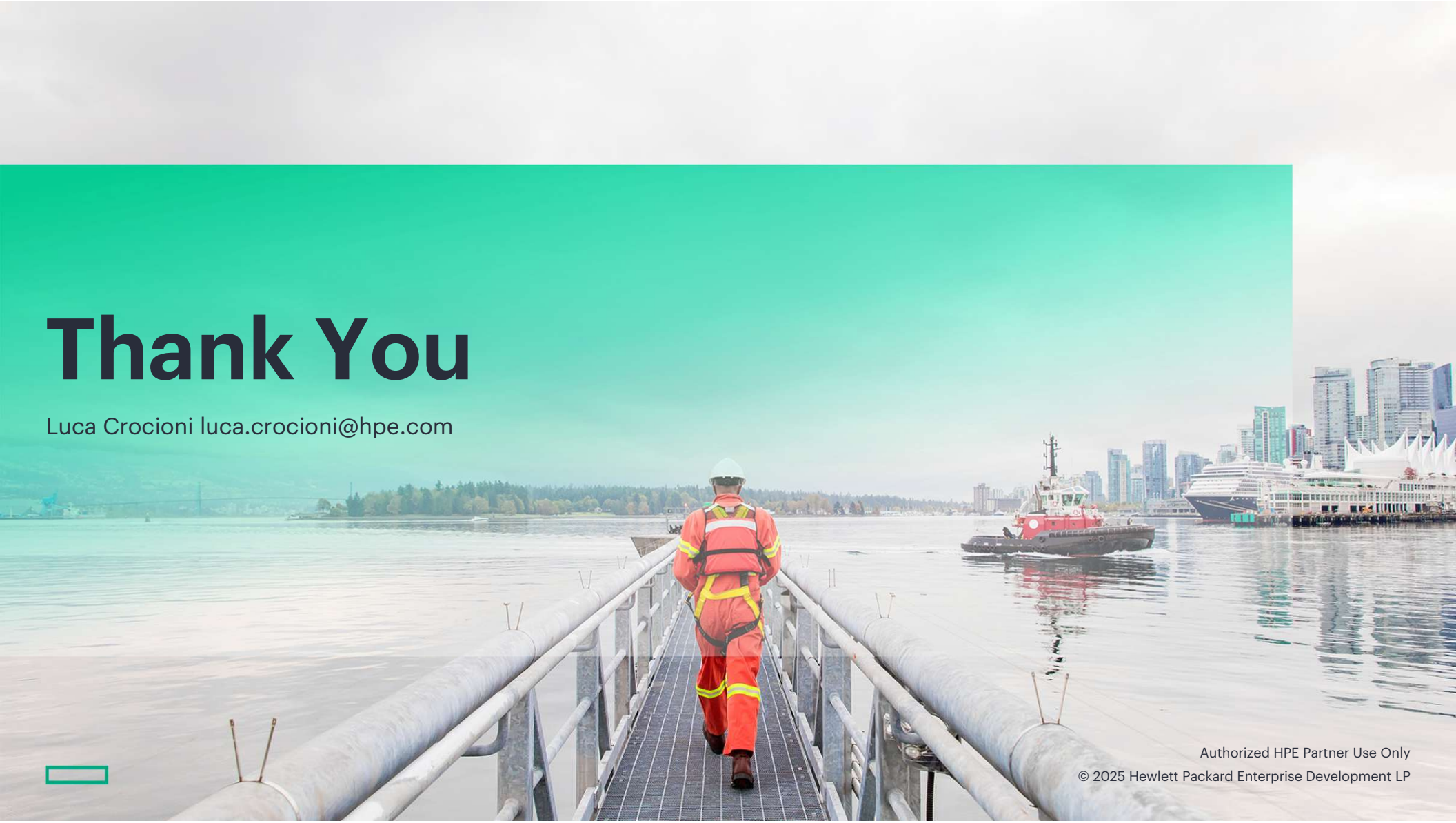

Glossary: What You Need to Know

Digital Twin: A virtual replica of a physical object or system that uses real-time data and simulation to predict performance, optimize design, and reduce risk.

Generative AI: AI models that can create new content, such as text, images, or simulations, by learning patterns from large datasets. Example: AI generating aerodynamic shapes for aircraft design.

High-Performance Computing (HPC): Extremely powerful computing systems designed to solve complex problems that ordinary computers cannot handle, using thousands of processors working in parallel.

Hybrid Cloud: Public + private + edge to run workload efficiently.

Physical AI: Artificial Intelligence applied to physical systems, such as robotics, autonomous vehicles, or industrial automation, where AI interacts with the real world.

Workload: A specific computational task or set of tasks executed on a computer system. In HPC, workloads include simulations such as CFD (fluid dynamics) and FEA (structural analysis), as well as AI training jobs.

Enabling performance gains across industries

Weather

Perform detailed weather modeling to achieve accurate predictions and issue advanced warnings for severe events.

Manufacturing

Exceed the boundaries of what's possible with optimized, end-to-end solutions purpose-built for HPC and AI.

Energy

Model energy systems to analyze sustainable solutions and optimize energy distribution.