Hewlett Packard Enterprise

HPC User Forum Update

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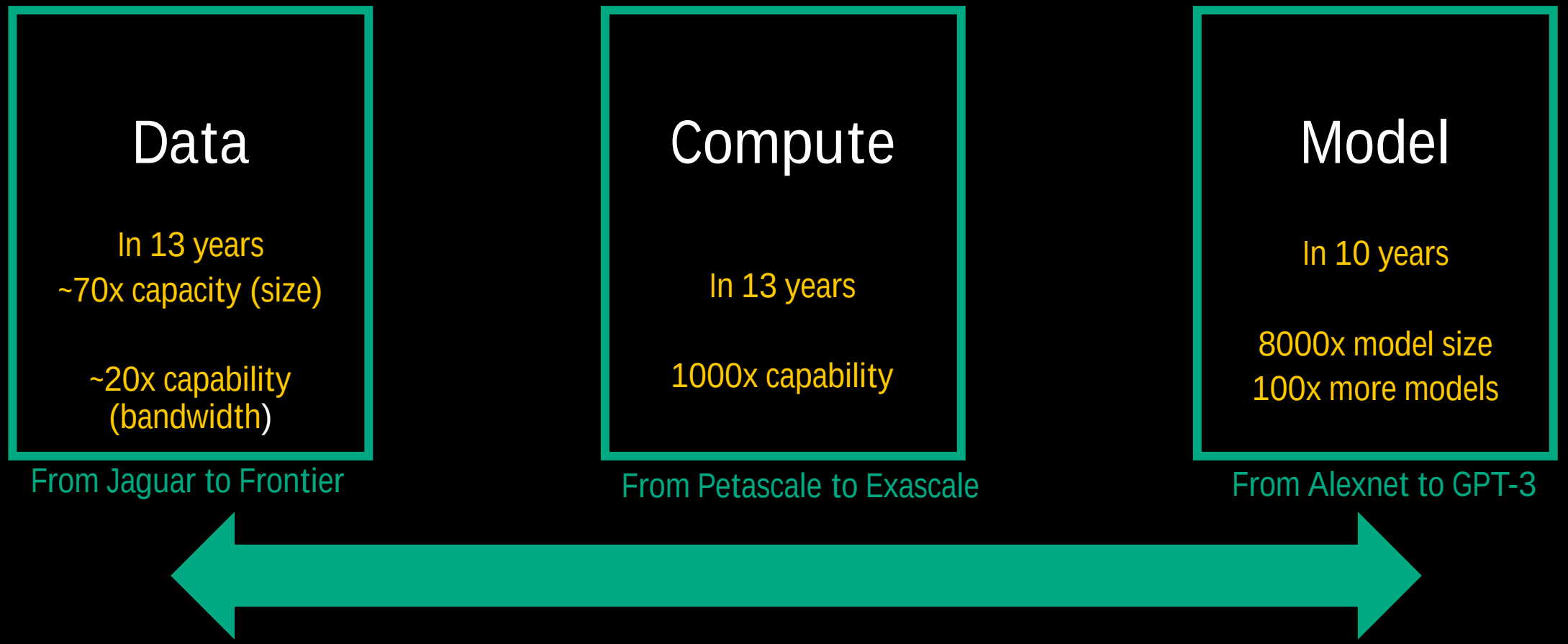
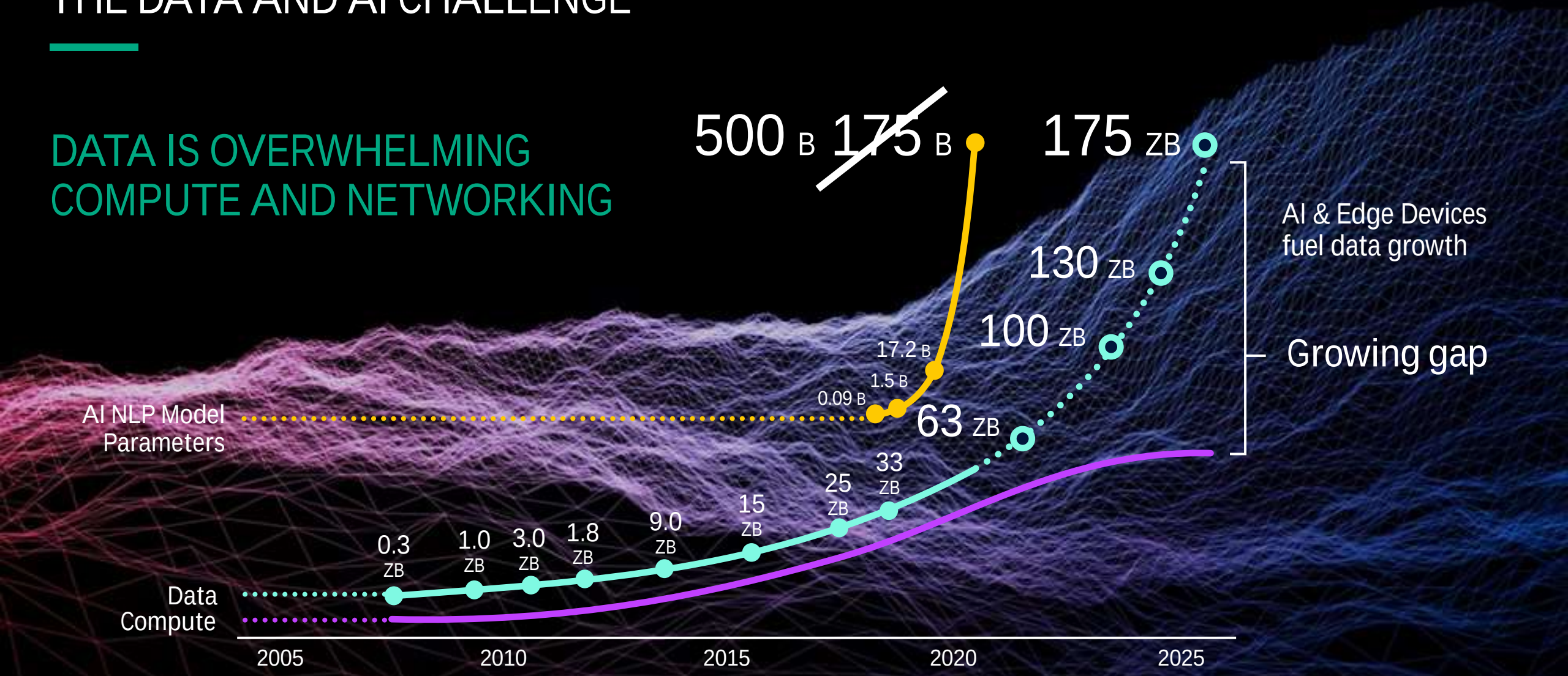
September 2023

POST-EXASCALE VISION: THE WHY ?

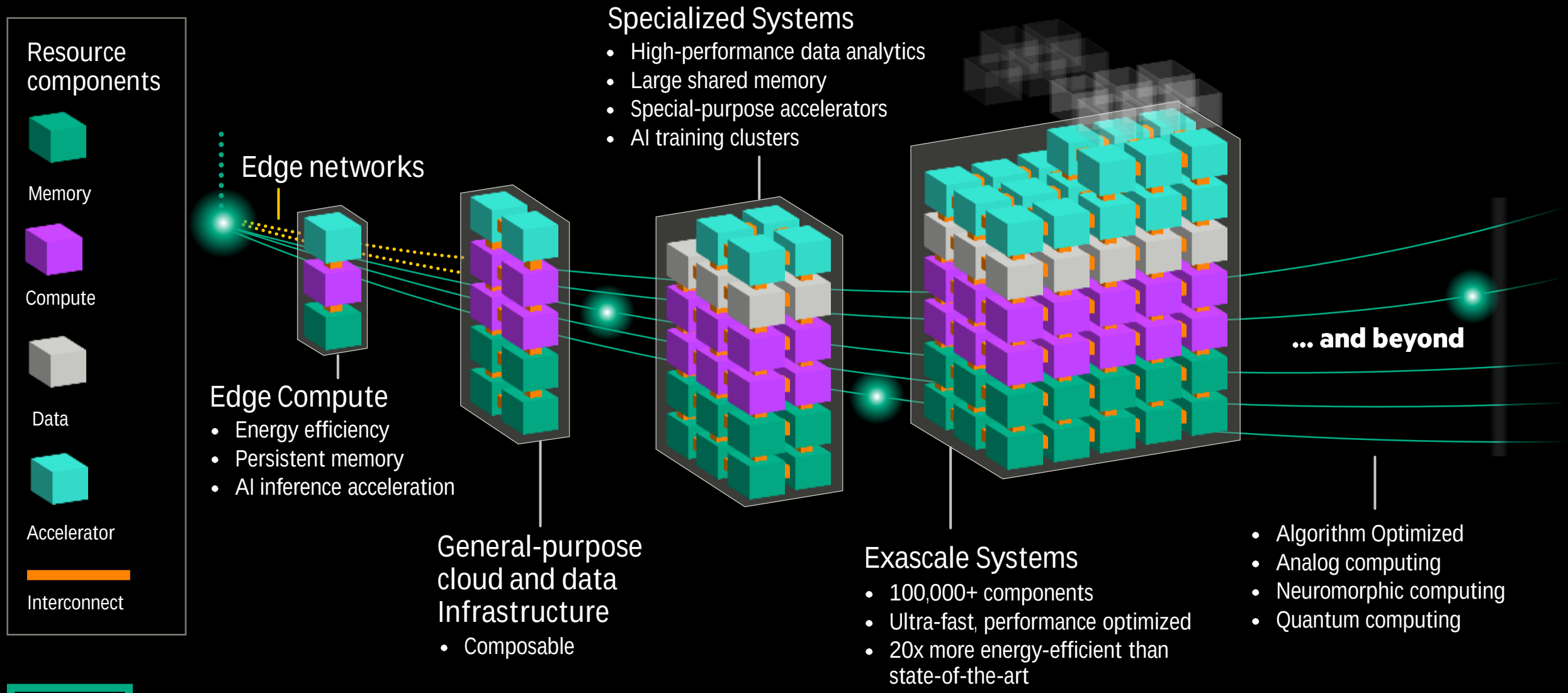


THE DATA AND AI CHALLENGE

DATA IS OVERWHELMING COMPUTE AND NETWORKING



HETEROGENEOUS COMPUTING



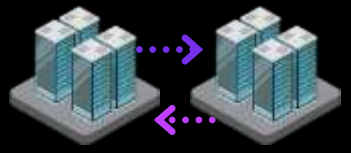
HPE VISION FOR MULTI-DIMENSIONAL WORKFLOWS

Today

Exascale supercomputer

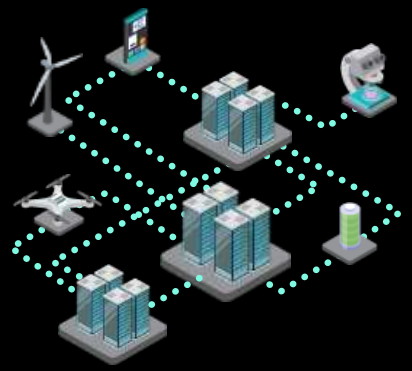
~10x Exascale

Productivity and agility for HPC and AI applications



Multi-dimensional, complex workflows

For modeling, simulation, data analytics, and artificial intelligence



Federated diverse systems

Integrate, automate, and optimize workflows that span multiple organizations, locations, and vendors

World's fastest Supercomputer

World's fastest Workflows

FUTURE-PROOFING MULTI-DIMENSIONAL SUPERCOMPUTING

System

Performance based on engineered design

- Infrastructure
- Interconnect
- Processor heterogeneity
- Storage

“Build systems that are more reliable and capable than today’s given a cost and power-**budget”**

Workflows

Performance based on availability and dynamic configurability

- Parallel/distributed programming
- Data management
- Federated orchestration
- Analytics and AI enablement

”Build tools that will make our workflows run the best – faster and efficient from edge-to-**cloud”**

Operations

Performance based on flexibility in consumption models

- Security
- Interoperability
- Energy efficiency
- Flexible –aaS consumption

”Provide on-demand knobs of accessible performance, energy **efficiency and productivity”**

Oak Ridge National Laboratory's Frontier Supercomputer

- 74 HPE Cray EX cabinets
- 9,408 AMD CPUs, 37,632 AMD GPUs
- 700 petabytes of storage capacity, peak write speeds of 5 terabytes per second using Cray ClusterStor storage system
- HPE Slingshot networking cables providing 100 GB/s network bandwidth.

TOP500

1

Built by HPE, **ORNL's Frontier** supercomputer is #1 on the TOP500.

1.1 exaflops of performance.

GREEN500

2

Built by HPE, **ORNL's TDS and** full system are ranked #2 & #6 on the Green500.

62.68 gigaflops/watt power efficiency for ORNL's TDS system, 52.23 gigaflops/watt power efficiency for full system.

HPL-MxP

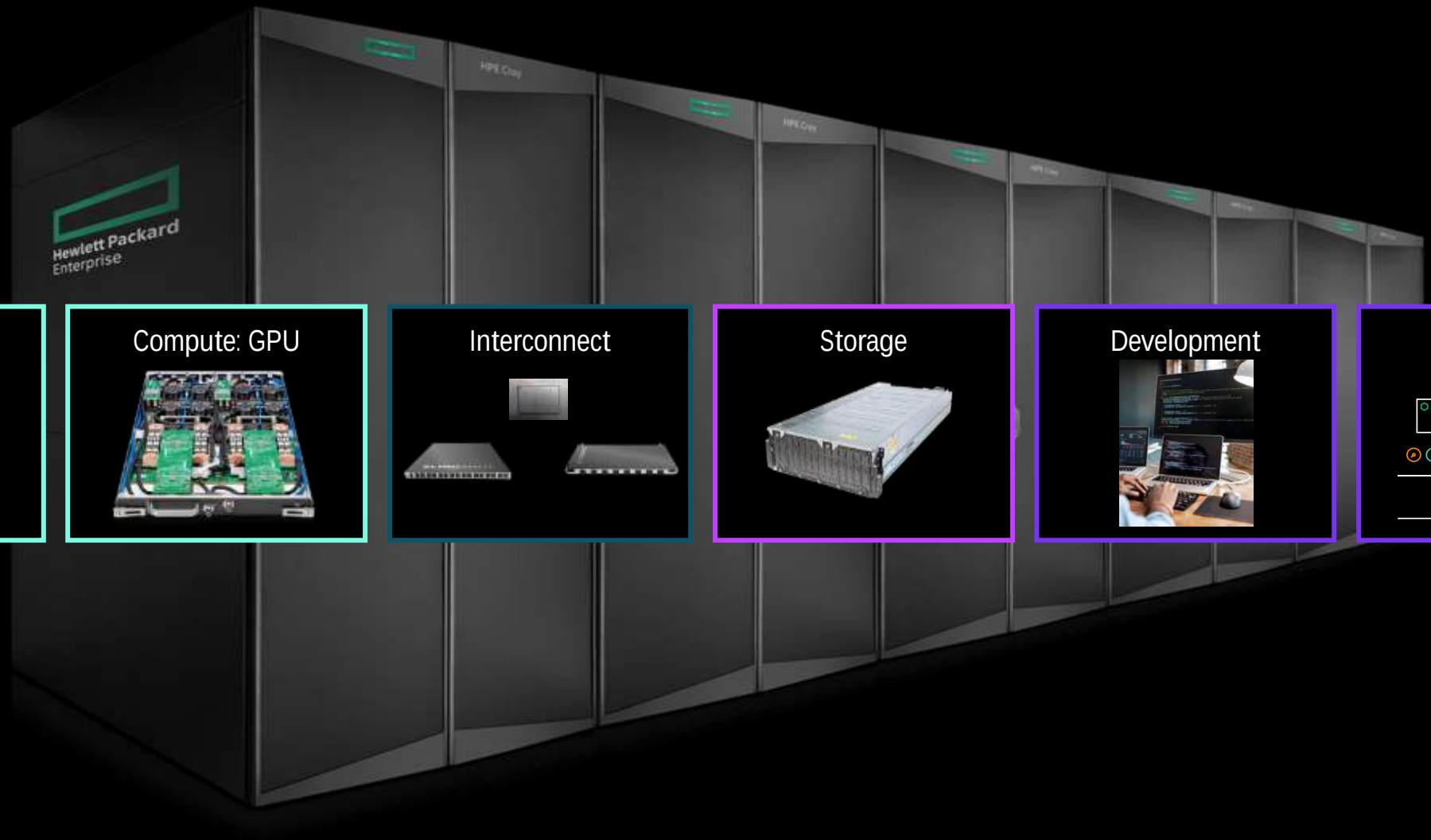
1

Built by HPE, **ORNL's Frontier** supercomputer is #1 on the HPL-MxP list.

7.9 exaflops on the HPL-MxP benchmark (formerly HPL-AI).

Source: November 2022 Top500 release, HPL-MxP mixed-precision benchmark (formerly HPL-AI).

FUTURE-PROOFING THE TECHNOLOGY UNDERPINNING



Compute: CPU

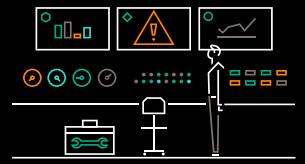
Compute: GPU

Interconnect

Storage

Development

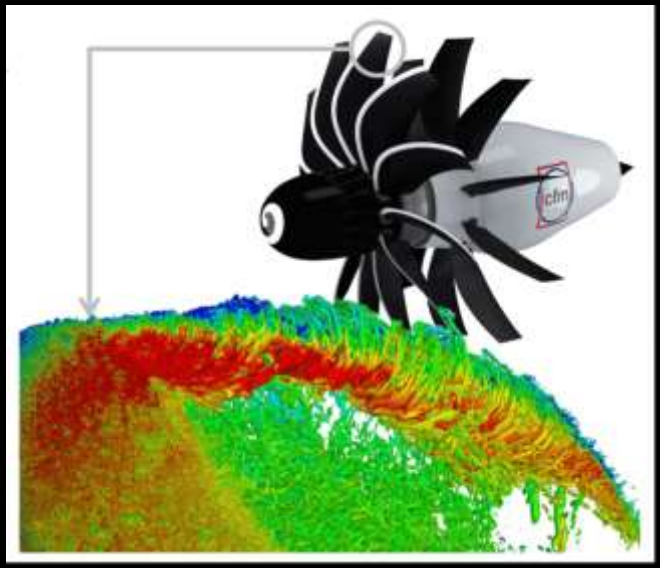
Management



GE Aero Success

- Exascale Drives Industry Innovation for a Better Future - Exascale Computing Project (exascaleproject.org)
- "Dave Kepczynski, chief information officer for GE Research and co-chair of ECP's Industry and Agency Council, says, "Exascale is a massive accelerator for technology, productivity, engineering, and science."

- "Recognizing the need for exascale-level computing to simulate important aspects of their design, GE Aerospace applied for and was awarded access to DOE's Frontier supercomputer through the agency's competitive peer-reviewed Advanced Scientific Computing Research Leadership Computing Challenge. "



HPE Slingshot Wins: Span Verticals, GEOGRAPHIES, and CPU/GPUs

Jun. '23 Top500 w/HPE Slingshot

#1	Frontier (Oak Ridge NL)
#3	LUMI (EuroHPC/CSC)
#8	Perlmutter (LBNL/NERSC)
#12	Adastra (GENCI-CINES)
#17	Setonix-GPU (Pawsey)
#18	Discovery5 (ExxonMobil)
#19	Polaris (Argonne NL)
#30	ARCHER2 (EPSRC/U. of Edinburgh)
#33	Ghawar-1 (Saudi Aramco)
#34	Frontier TDS (Oak Ridge NL)
#59	Derecho CPU Partition (NCAR)
#61	Cactus (GDIT/NOAA)
#62	Dogwood (GDIT/NOAA)
#77	Dardel GPU (KTH Royal Inst. Of Tech)
#79	LANTA (NSTDA)
#83	Narwhal (Navy DSRC)
#101	LUMI-C (EuroHPC/CSC)
#116	rzVernal (LLNL)
#130	Derecho GPU (NCAR)
#132	Tioga (LLNL)
#153	Dardel CPU (KTH)
#156	Warhawk (Air Force Res. Lab.)
#167	Delta (NCSA)
#168	Hotlum (HPE)
#194	Tenaya (LLNL)
#197	Aspire GPU (NSSC)

.... Plus 205, 229, 233, 314, 335, 418

"Frontier"
Oak Ridge National Laboratory

"Aurora"
Argonne National Laboratory

"El Capitan"
Lawrence Livermore Nat'l Laboratory

"LUMI"
EuroHPC JU

"Crossroads"
Tri-Labs

Shaheen KAUST

"Perlmutter"
NERSC

"Setonix"
Pawsey Supercomputing Ctr, Australia

"Alps"
Swiss National Computing Center

"Fawbush" and "Miller"
ORNL (US Air Force Weather)

"Dardel"
KTH Royal Institute of Technology

"Kestrel"
National Renewable Energy Lab (NREL)

Both HPE Cray EX **and Apollo** leadership systems!
Performance with both **HPE Slingshot NIC and Industry NICs**!

Light Blue = HPE Slingshot NIC
Dark Grey = CX5 NIC (demonstrating fabric performance at scale even with standard Ethernet)

ULTRA ETHERNET VISION

Deliver an Ethernet based open, interoperable, high performance, full-communications stack architecture to meet the growing network demands of AI & HPC at scale

THE NEW ERA NEEDS A NEW NETWORK

As **performant** as a supercomputing interconnect

As **ubiquitous** and **cost-effective** as Ethernet

As **scalable** as a cloud data center

FOUNDING MEMBERS

EX2500

- 100% Direct Liquid Cooled (DLC)
- Up to 96 nodes per rack
- Integrated Switches
- Redundant Cooling Distribution Units (CDUs)
- Efficient High Voltage Power distribution
- Support of the top bin fastest & latest in CPU & GPU Technology
- Slingshot: Exascale era interconnect

EX2500 RACK SPECIFICATIONS

EX2500 Specifications				
Rack	3225 lbs (fully loaded) 2000mm (42U) x 900mm wide x 1719mm (h x w x d) Floor Weight (max): 197.7 lbs/sqft or 964.8 kg/sqm			
Technologies Supported	All Blades supported on EX4000 will be supported on EX2500 Rack. (Rome/Milan, A100, SPR, SPR-HBM, Genoa, MI300A, MI200, etc.). See Roadmap.			
Target Inlet Temperature Support	Up to 32C for top bin CPUs and GPUs *(configuration dependent)*			
Density	96x 2P CPU nodes / rack 48x 4P GPU nodes / rack			
VOLTAGE	North American/Japan 480 VAC 3-phase 60Hz		International 380 or 400 VAC 3-phase 50/60Hz	
POWER	Up to 200 kW (NA) / Up to 130kW (Intl)			
POWER CIRCUIT RECEPTACLE	North America	North America	~~International~~	International
	480 VAC	480VAC	~~380 or 400 VAC~~	380 or 400 VAC
	3-phase	3-phase	~~3-phase~~	3-phase
	Qty 3 per rack	Qty 3 per rack		
	100A	60A	~~125A~~	63A
	Meltric 31-94243-K04	Hubbell 460C7W		Hubbell 463C6W
	Note: 208/230V at up to 20A needed for in-rack CDUs (Cooling Distribution Unit)			

HPE Cray Programming Environment

Comprehensive set of tools for developing, porting, debugging, and tuning of HPC applications on HPE & HPE Cray systems

Development

Programming Models

- HPE Cray MPI
- SHMEM
- OpenMP | OpenACC (Fortran)
- AMD ROCm HIP | NVIDIA CUDA
- UPC | Fortran co-arrays
- Global Arrays
- Chapel

Programming Environments

- Compiling Environment
  - GNU
  - Intel Programming Environment
  - AMD Programming Environment
  - NVIDIA HPC SDK

Programming Languages

- C
- C++
- Fortran
- Python
- R

Optimized Libraries

- LibSci (BLAS)
- LAPACK & ScaLAPACK
- LibSci_ACC
- Iterative Refinement Toolkit
- FFTW

I/O Libraries

- NetCDF
- HDF5

Debugging

Comparative Debugger
Compare two versions of an application

GDB for HPC
Parallelized gdb for HPC

Valgrind for HPC
Memory debugging at scale

Stack Trace Analysis Tool
Stack tracing at scale

Sanitizers for HPC
Detect memory and thread errors at scale

Tool for Abnormal Termination Processing
Manage core files at scale

- TotalView
- DDT

Performance Analysis & Optimization

Performance Analysis Tool (PAT)
Whole program performance analysis, exposing wide set of indicators, identifying bottlenecks and automatically generating suggestions to improve performance.

Visualization Tool
Complements text reports with summary of performance data in graphs and charts, allowing users to drill down and resolve issues

Code Parallelization Assistant
Reveal hidden potential of an application via code restructuring

Setup & Runtime

Environment Setup

- Tool Enablement (for Spack, CMake, EasyBuild, etc)
- Modules/Lmod

Supported systems:

- HPE Cray EX
- HPE Apollo
- HPE Cray XD
- HPE ProLiant DL

HPE—authored | HPE Added-value to 3rd party | 3rd party

Chapel Parallel Programming Language

Chapel is a language designed for productive parallel programming, particularly on large-scale systems. Chapel is …

Easy to Use	"*We ask students at the master's degree to do stuff that would take 2 years and they do it in 3 months.*" Professor Eric Laurendeau at CHIUW 2022
Portable	HPE Cray EX, HPE Apollo, Cray XC, most *nix systems, Mac, NVIDIA and AMD GPUs
Fast & Scalable	Achieved 8,500 GiB/s when sorting 256 TiB in 31 seconds on 8192 HPE Cray EX Nodes
GPU-Ready	On NVIDIA H100 and AMD MI250X, matching performance of CUDA and HIP reference versions of the Stream Triad benchmark on large problem sizes
Open source	Team at HPE actively interacts with Chapel community at chapel-lang.org

HPE GREENLAKE
EDGE-TO-CLOUD PLATFORM

Self-service | Pay-per-use[1] | Scale up and down | Managed for you

THE CLOUD THAT COMES TO YOU

[1] Reserve may apply

POST-EXASCALE VISION

The ”Interconnect” is the supercomputer

”Workflows” are the new applications

The way forward

HPE has a unique vantage point rooted in our own sustainability journey

Commitment to be a net-zero enterprise across our entire value chain by 2040 with near-term goals by 2030

#1

HPE Cray Supercomputer Frontier in Top 500 and #6 in Green500 list

7

HPE supercomputers on Top 10 of the Green500 list

101

HPE supercomputers on the Green500 list of the world's most energy-efficient supercomputers

~50%

of renewable electricity sourced in our operations on our way to 100% by 2030[1]

85%

of tech returned to HPE is upcycled and put back into active use[2]

6000+

patents for transformational low-carbon technologies filed since 2000[3]

>500

Social and Environmental Responsibility audits conducted with suppliers

[1]HPE Living Progress Report, 2021
[2]HPE Financial Services Technology Renewal Center information
[3] Based on HPE internal records
[4] 2021 Living Progress Data Summary, 2022

Talk to HPE about bringing the technology that drives leadership computing & AI-at-scale to your HPC systems

Thank you

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