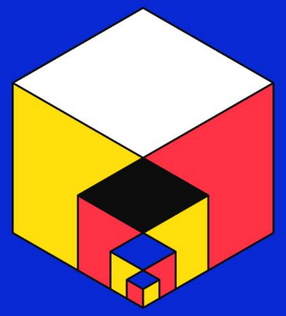
EUROHPC SUMMIT 2024



ANTWERP

UNLEASHING THE POWER OF EUROPEAN HPC AND QUANTUM COMPUTING

European System Architecture Advancements

Hans-Christian Hoppe, Forschungszentrum Jülich

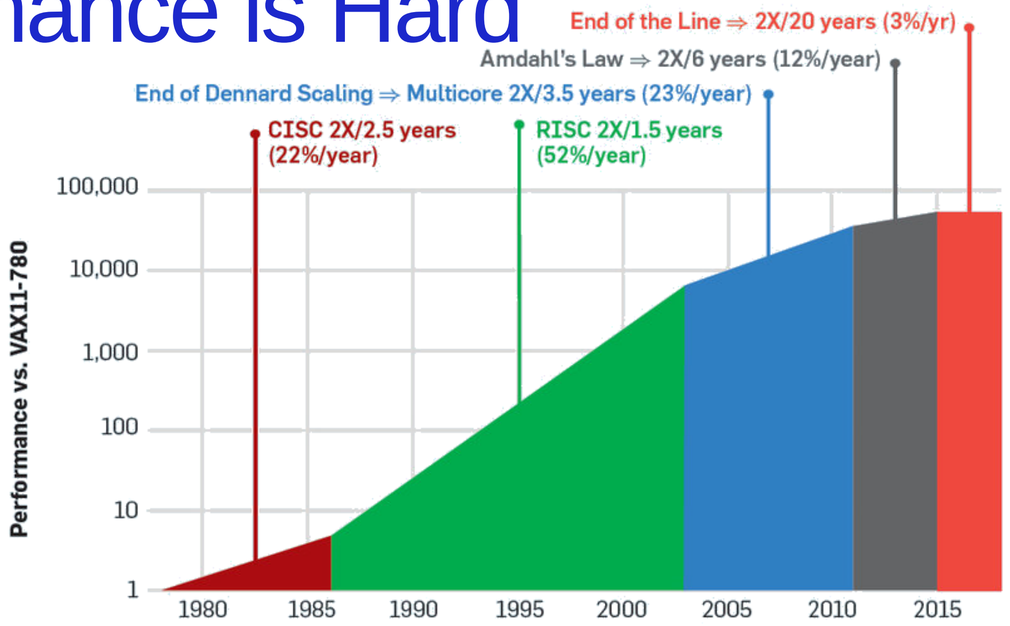
DEEP-SEA EUPEX European Pilot for Exascale IO-SEA RED SEA textarossa

Reaching Exascale Levels of Performance is Hard

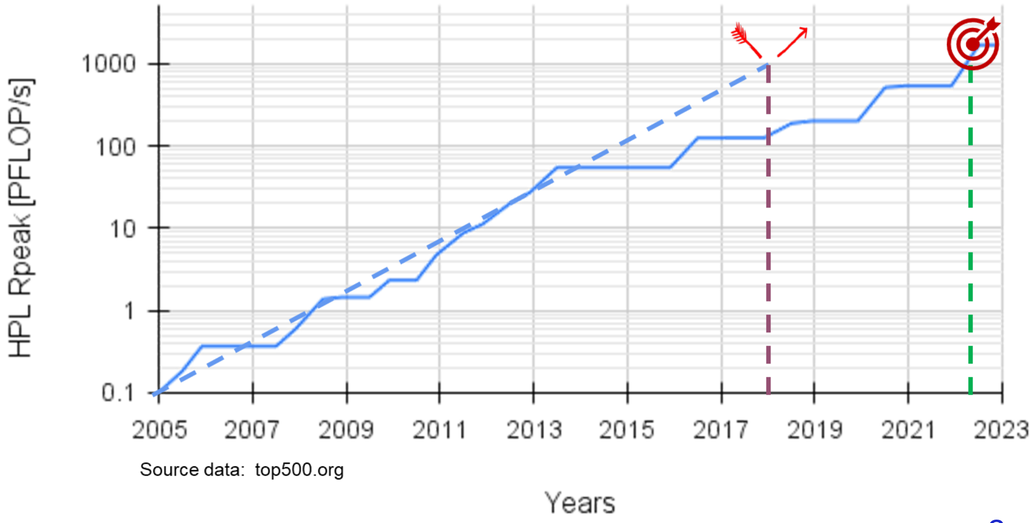
”Free lunch” no longer served by Moore’s Law

Challenges include

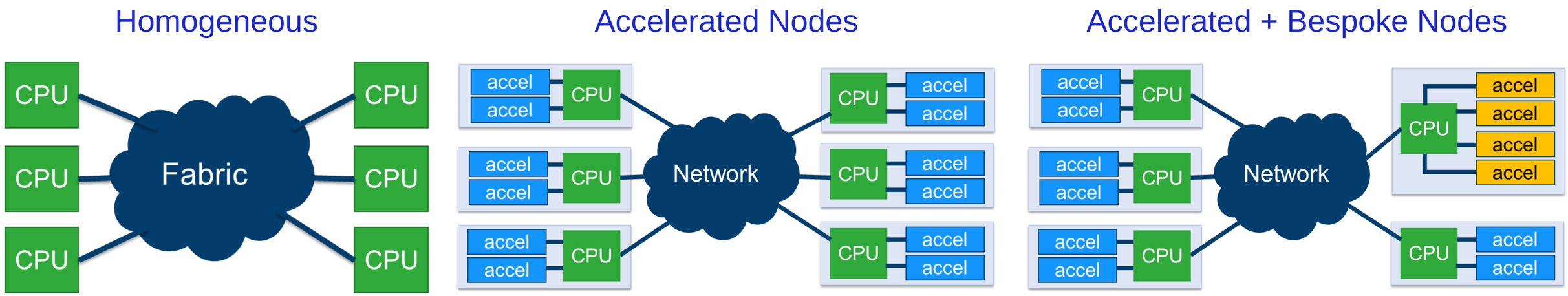
- Highest application parallelism
  - Algorithms and portable parallel programming
- Truly scalable systems
  - (Much) faster interconnect fabrics
- Highest energy efficiency
  - Accelerators and heterogeneous systems
  - Efficient cooling
- Memory and Storage
  - Close performance gap to compute engines
- Diversity of applications requirements
  - Deployed systems must support a huge set of applications with very different system requirements



https://www.researchgate.net/publication/343096513_Energy_Efficient_Computing_Systems_Architectures_Abstractions_and_Modeling_to_Techniques_and_Standards



Making Heterogenous Systems Flexible

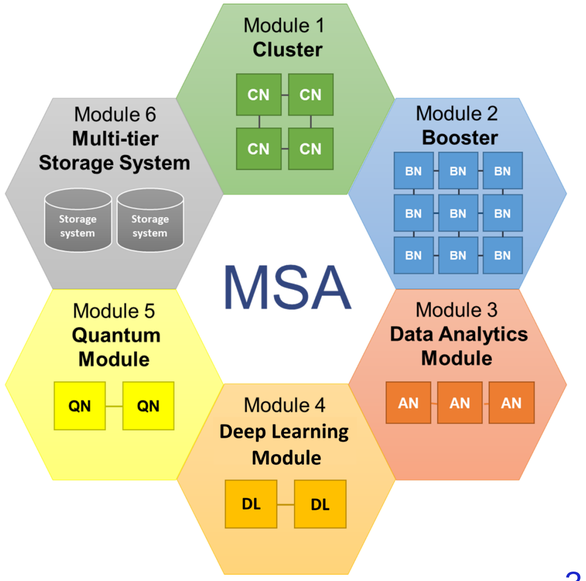


Accelerated nodes fix ratio of CPUs vs. accelerators, complicate sharing resources across nodes

- Many applications will not use all resources, and capital & energy is wasted

Really want to aggregate different compute, storage and network resources according to dynamic demand

Adding „bespoke nodes“ for special tasks does not provide this flexibility



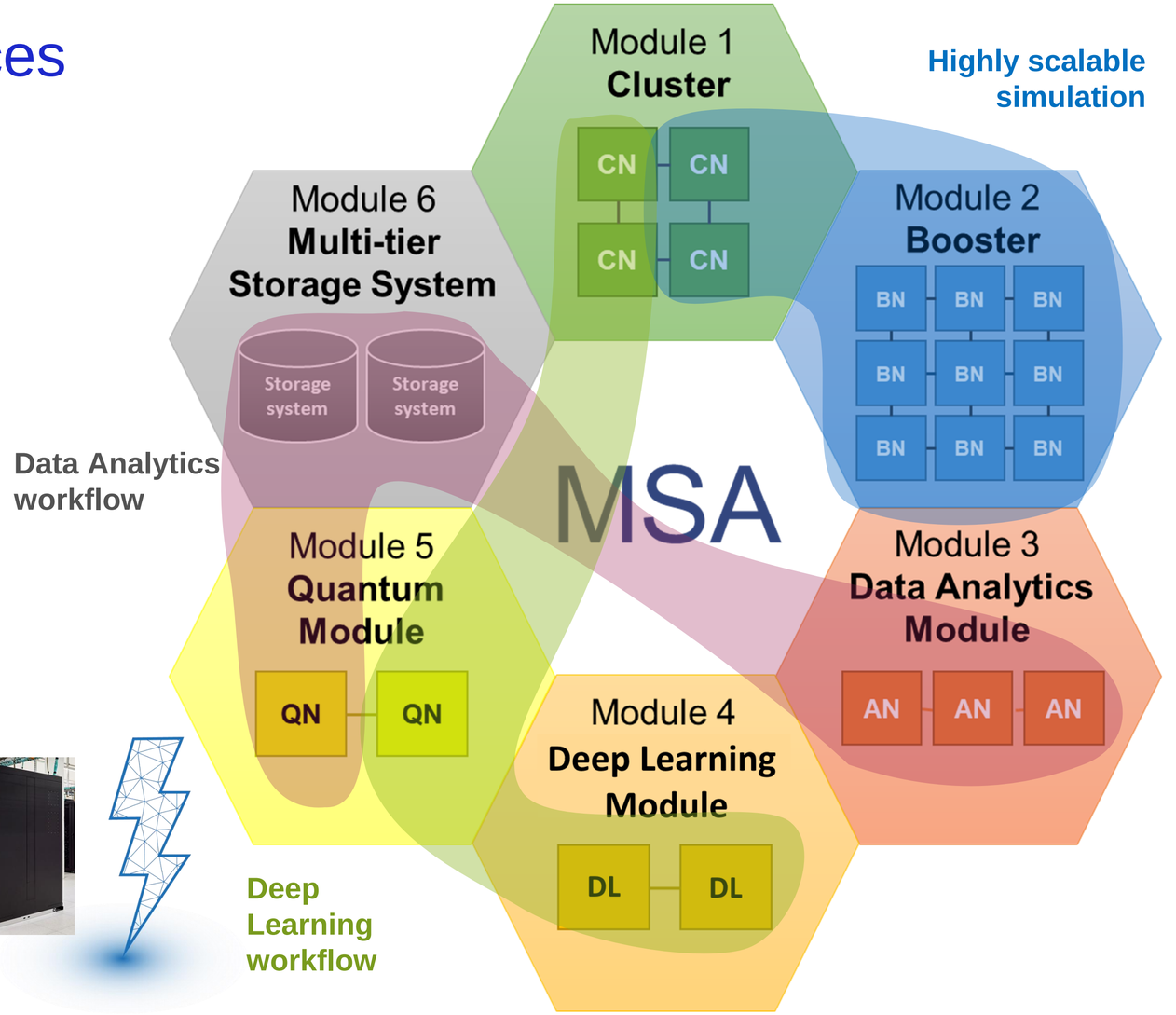
Modular Supercomputing Architecture

The MSA achieves composability of resources

- Cost-effective scaling
- Effective resource-sharing
- Match workload diversity

E. Suarez, N. Eicker, T. Moschny, S. Pickartz, C. Clauss, V. Plugaru, A. Herten, Kristel Michielsen, T. Lippert, *"Modular Supercomputing Architecture – A Success Story of European R&D",* ETP4HPC White Paper. (2022) Available at https://www.etp4hpc.eu/white-papers.html#msa.

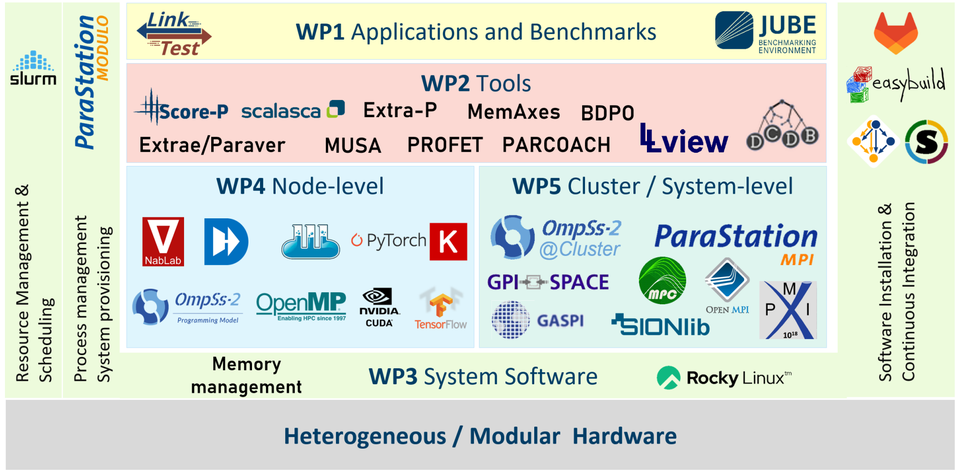
E. Suarez, N. Eicker, Th. Lippert, "*Modular Supercomputing Architecture: from idea to production*", Chapter 9 in Contemporary High Performance Computing: from Petascale toward Exascale, Volume 3, p 223-251, CRC Press. (2019)

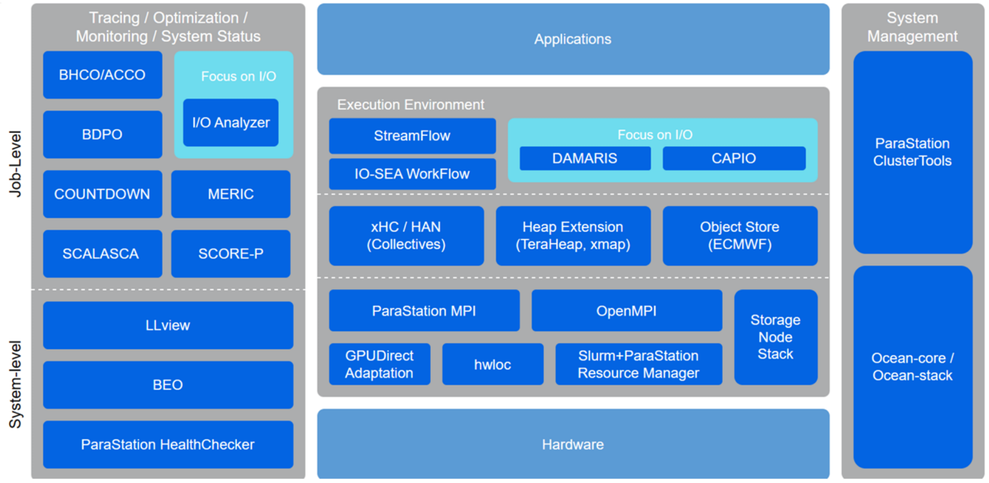


DEEP-SEA & EUPEX SW Stacks

Cross-project collaboration towards a common, integrated European SW stack for HPC and AI

- DEEP-SEA provides a full set of programming models, APIs and tools for programming and operating heterogeneous systems
- EUPEX adds support for workflows and additional I/O components from IO-SEA and ports to the SiPearl Rhea CPU
- RED-SEA contributes optimized communication libraries for BXI
- Most SW components freely available, early access to EUPEX platform

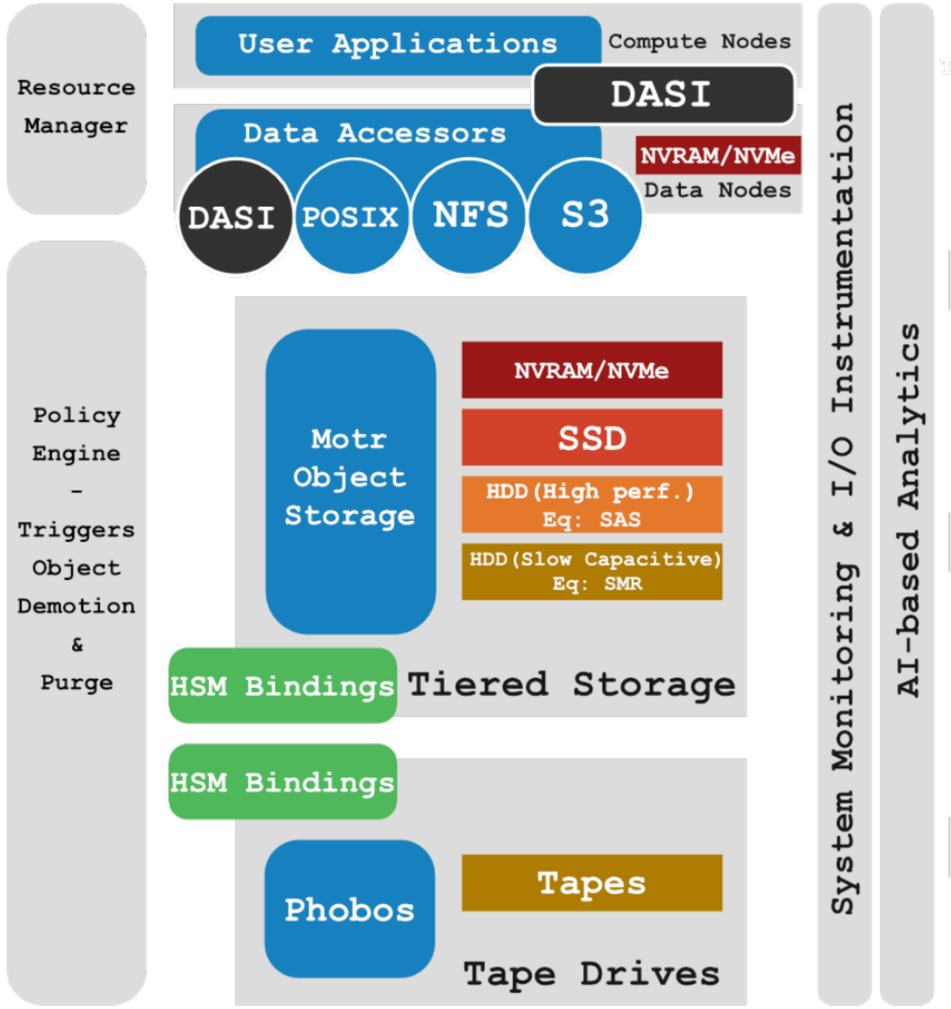




IO-SEA Storage Architecture & Services

IO-SEA adds an integrated storage system to the MSA

- Implemented as storage modules within an MSA system
- Covering the full range from ad-hoc storage on SSDs/NVM to archive storage on tape drives
- DASI semantic interface to scientific data
- Ephemeral storage services support applications on demand
- Fully integrated with MSA resource management, scheduling and operational management



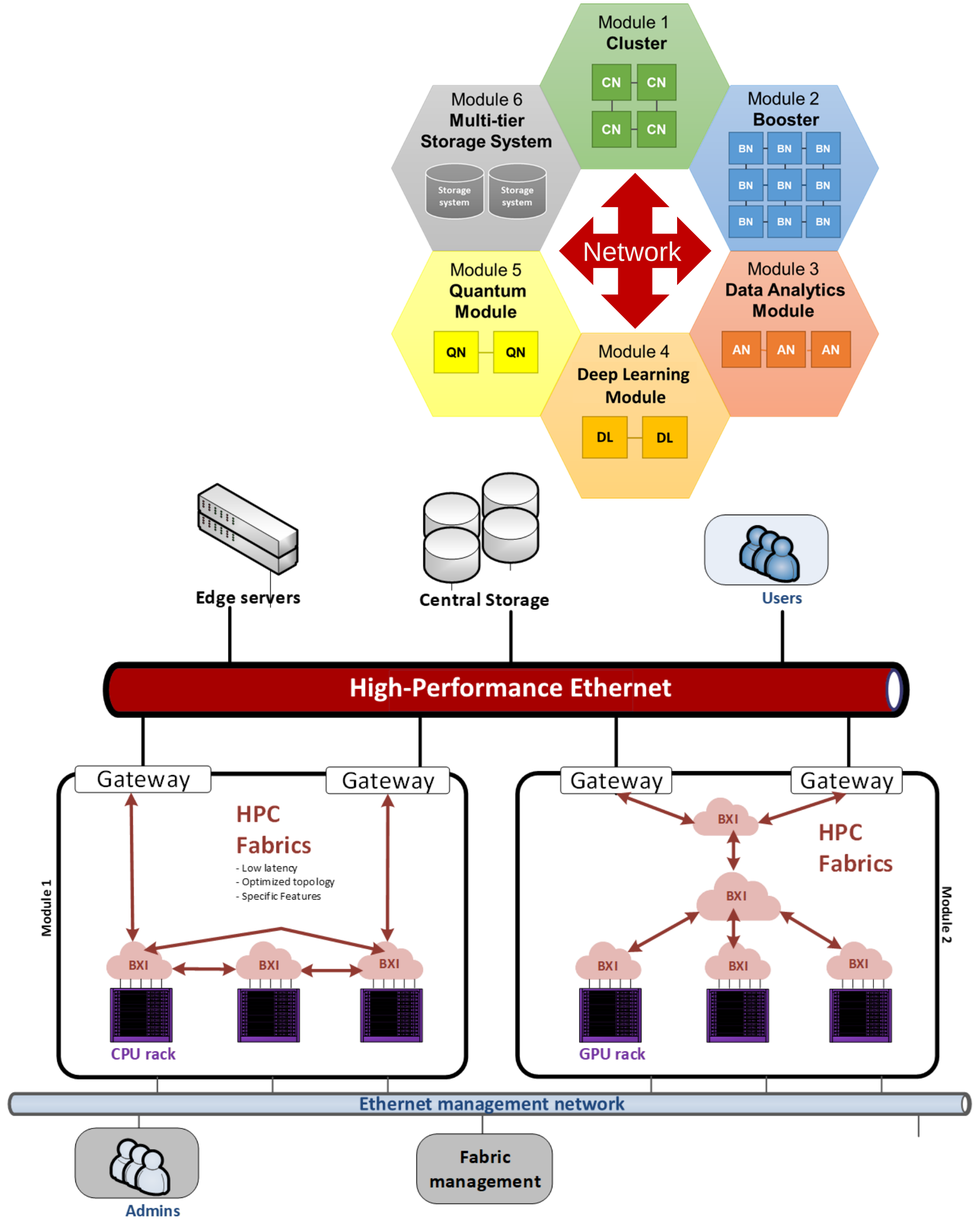
RED-SEA Interconnect

High performance Ethernet as *federation network* with state-of-the-art low latency RDMA communication

Bull eXascale Interconnect (BXI) as *HPC fabric* built from BXI NICs and BXI switches

Zero-copy protocols and on-NIC message matching enable superior performance for message passing, RDMA and partitioned global address spaces

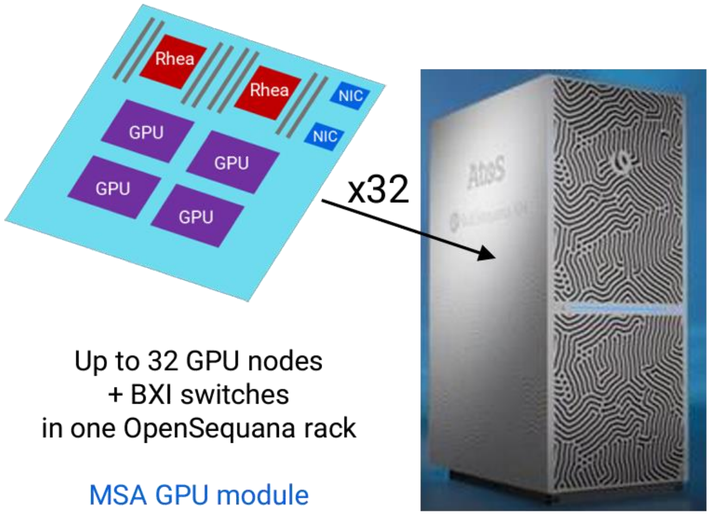
- Fully satisfies requirements of HPC, AI and data analytics



EUPEX & TEXTAROSSA Node Architecture & Cooling

EUPEX

- Compute module node using SiPearl (EPI) Rhea CPUs and NVIDIA GPUs as accelerators
- Eviden BXI V3 (Enhanced by RED-SEA) as module interconnect
- Fully integrated with Eviden BullSequana XH3000 platform

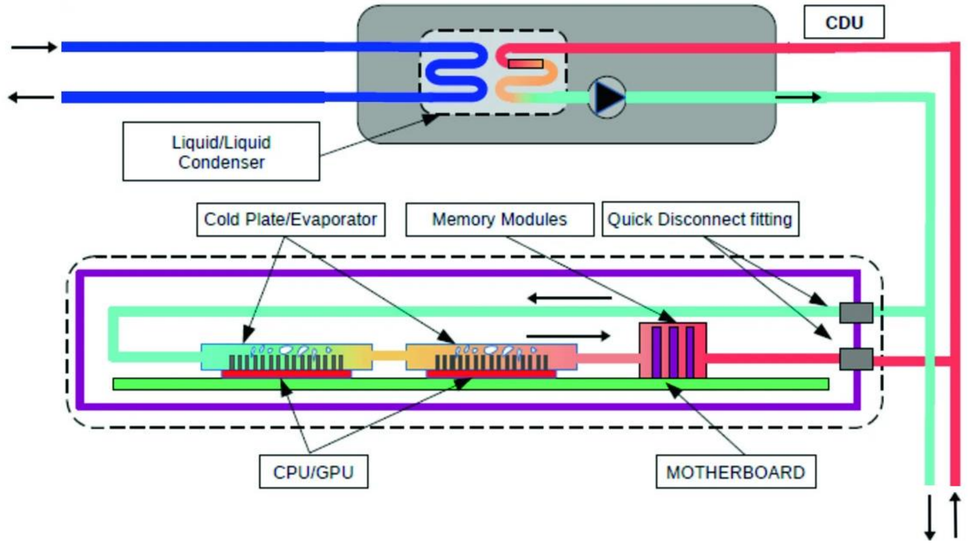


Up to 32 GPU nodes
+ BXI switches
in one OpenSequana rack

MSA GPU module

TEXTAROSSA

- Innovative multi-level thermal management and two-phase cooling
- Covers node and rack level
- Fully integrated with energy optimizing resource management



EUPEX European Pilot for Exascale

textarossa

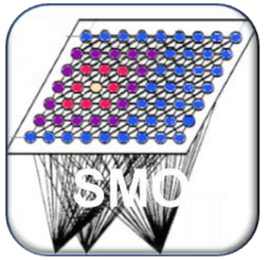
Co-Design Applications

Astrophysics

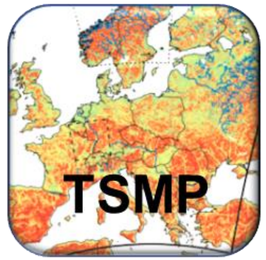
Atomistic Simulations

Brain Simulation

CFD



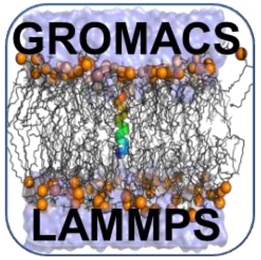
Deep Learning



Earth System Modeling

Drug Design

Finite Elements



Molecular Dynamics

Neutron Transport

Precision Agriculture

QCD

Remote Sensing

Seismic Imaging

Space Weather

Weather Climate

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THANK YOU