Tecnologie e progetti innovativi in HPC e Cloud: alcune soluzioni e esperienze in Lenovo

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Workshop di CCR
LNGS, 22-26 Maggio, 2017

Agenda

- HPC segment and trends
- Solution components
- Technology trends
- Over 20PF@CINECA

Target Segments - Key Requirements

Cloud Computing

Key Requirements:
- Mid-high bin EP processors
- Lots of memory (>256GB/node) for virtualization
- 1Gb/10/25/40 Ethernet

Data Analytics

Key Requirements:
- Mid-high bin EP processors
- Lots of memory (>256GB per node)
- 1Gb / 10Gb Ethernet
- 1-2 SS drives for boot

High Performance Computing

Key Requirements:
- High bin EP processors for maximum performance
- High performing memory
- Infiniband
- GPU support

Data Center Infrastructure

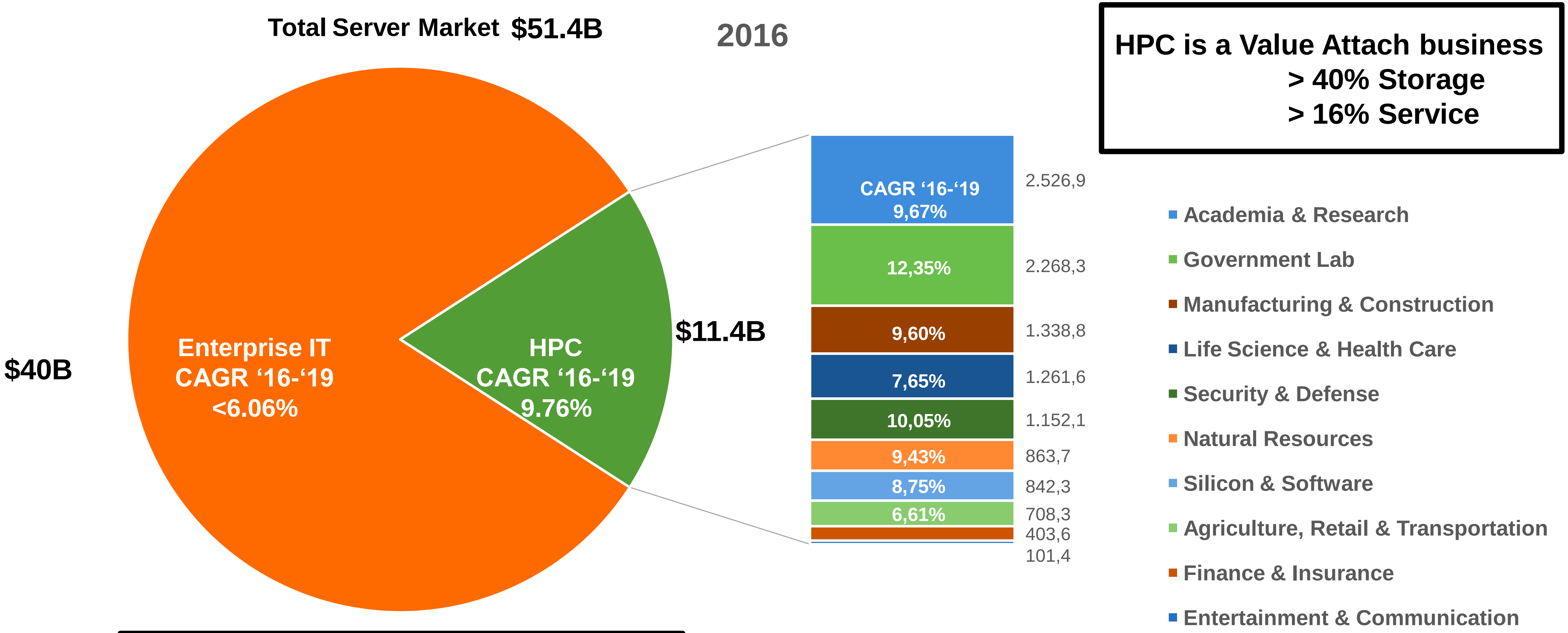
Key Requirements:
- Low-bin processors (low cost)
- Smaller memory (low cost)
- 1/10Gb Ethernet

Virtual Desktop

Key Requirements:
- Lots of memory (> 256GB per node) for virtualization
- GPU support

HPC – Fast Growing Opportunities

$11.4B Opportunity with 9.76% CAGR

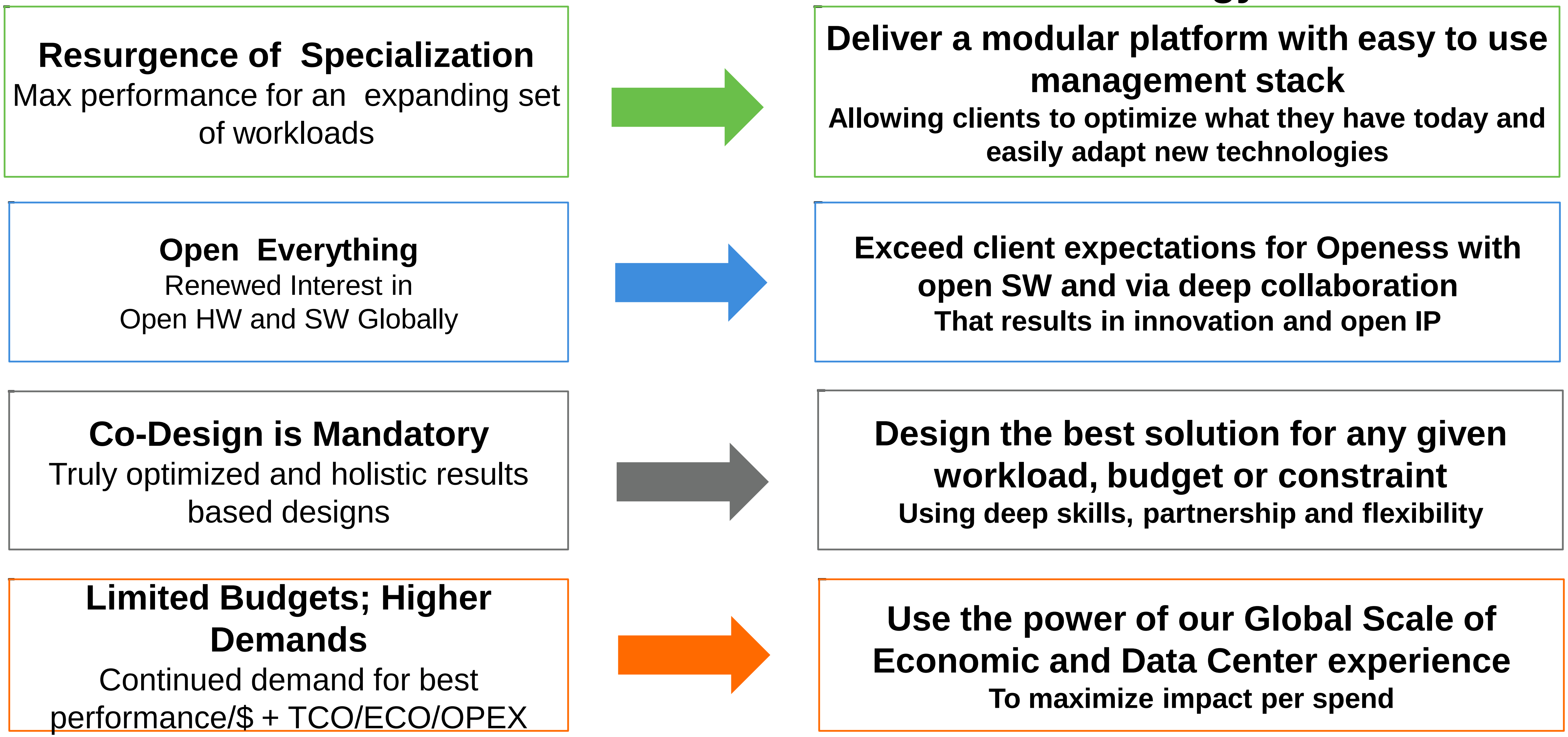


HPC is a Value Attach business
> 40% Storage
> 16% Service

>$1 of every $5 x86 spend is HPC

IDC 2015/16

HPC Market Trends and our Strategy



Trends

Resurgence of Specialization
Max performance for an expanding set of workloads

Open Everything
Renewed Interest in
Open HW and SW Globally

Co-Design is Mandatory
Truly optimized and holistic results based designs

Limited Budgets; Higher Demands
Continued demand for best performance/$ + TCO/ECO/OPEX

Strategy

Deliver a modular platform with easy to use management stack
Allowing clients to optimize what they have today and easily adapt new technologies

Exceed client expectations for Openess with open SW and via deep collaboration
That results in innovation and open IP

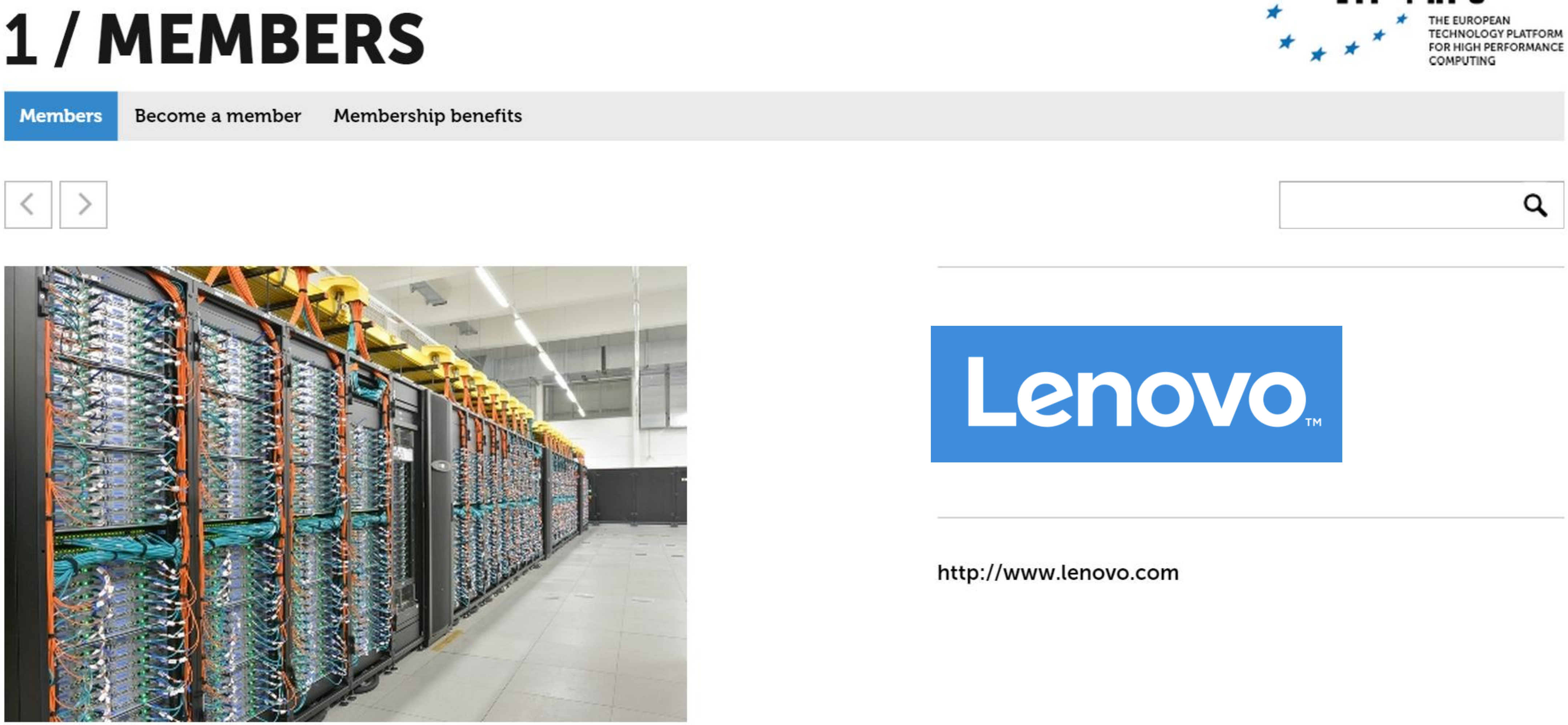
Design the best solution for any given workload, budget or constraint
Using deep skills, partnership and flexibility

Use the power of our Global Scale of Economic and Data Center experience
To maximize impact per spend

LENOVO IS A FULL MEMBER ON THE EUROPEAN TECHNOLOGY PLATFORM 4 HPC

ETP4HPC will define research priorities for the development of a globally competitive HPC technology ecosystem in Europe. It will propose and help to implement a Strategic Research Agenda, while acting as the “one voice” of the European HPC industry in relations with the European Commission and national authorities.

ETP 4 HPC
THE EUROPEAN TECHNOLOGY PLATFORM FOR HIGH PERFORMANCE COMPUTING

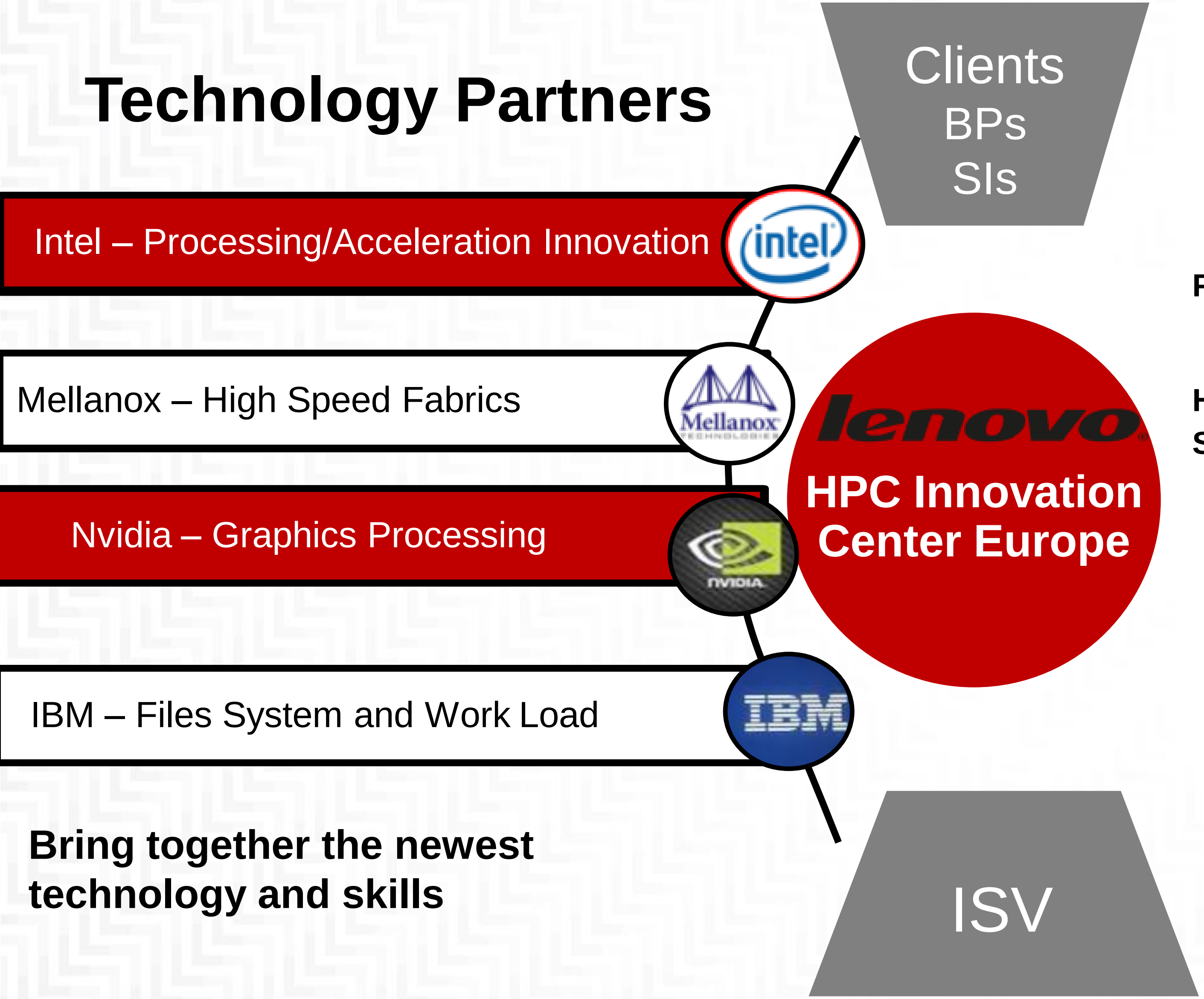


1 / MEMBERS

Lenovo™

http://www.lenovo.com

Technology Partners


Clients
BPs
SIs
Intel – Processing/Acceleration Innovation
Mellanox – High Speed Fabrics
Nvidia – Graphics Processing
IBM – Files System and Work Load
lenovo
HPC Innovation Center Europe
ISV

Bring together the newest technology and skills

Core Client Partners

FZJ	LRZ	RZG	CINECA	BSC	STFC Hartree
HPC Storage	Energy Efficient Systems and Software	Advancing Material Science	Big Data and Many Cores	Extreme Application Scaling	HPC Software and Optimizatio

Focused knowledge and deep skills advance the science of HPC

http://news.lenovo.com/news+releases/first-global-hpc-innovation-centre.htm

2 X 3 PFlops SuperMUC systems at LRZ Phase 1 and Phase 2

Phase 1

- Fastest Computer in Europe on Top 500, June 2012
  - 9324 Nodes with 2 Intel Sandy Bridge EP CPUs
  - HPL = 2.9 PetaFLOP/s
  - Infiniband FDR10 Interconnect
  - Large File Space for multiple purpose
    - 10 PetaByte File Space based on IBM GPFS with 200GigaByte/s I/O bw
- Innovative Technology for Energy Effective Computing
  - Hot Water Cooling
  - Energy Aware Scheduling
- Most Energy Efficient high End HPC System
  - PUE 1.1
  - Total Power consumption over 5 years to be reduced by ~ 37% from 27.6 M€ to 17.4 M€

Ranked 20 and 21 in Top500 June 2015

Phase 2

- Acceptance completed
  - 3096 nx360m5 compute nodes Haswell EP CPUs
  - HPL = 2.8 PetaFLOP/s
  - Direct Hot Water Cooled, Energy Aware Scheduling
  - Infiniband FDR14
  - GPFS, 10 x GSS26, 7.5 PB capacity , 100 GB/s IO bw

Lenovo™

inside

- System A:
- 1512 Lenovo nx360M5 (2 Petaflops)
  - 21 racks
  - 126 NeXtScale WCT Chassis
  - 3,024 Intel Broadwell-EP E5-2697v4 (2.3GHz, 145W)
  - 54.432Processor Cores
  - 12.096 16GB DIMMs
- 3600 Adamspass KNL nodes (11 Petaflops)
  - 50 Racks with 72 KNL nodes in Each Rack
  - 3.600 120GB SSD‘s
  - 244.800 cores
  - 345.600 GB RAM in 21.600 16GB DIMMs
  - 1.680 Optical cables

- 1512 Lenovo Stark nodes (>4 Petaflops)
  - 21 racks
  - 3,024 Intel SkyLake 24c@2,1GHz
- Over 60.000m Optical Cables
- 6 GSS26 16PB raw in total >100GB/s

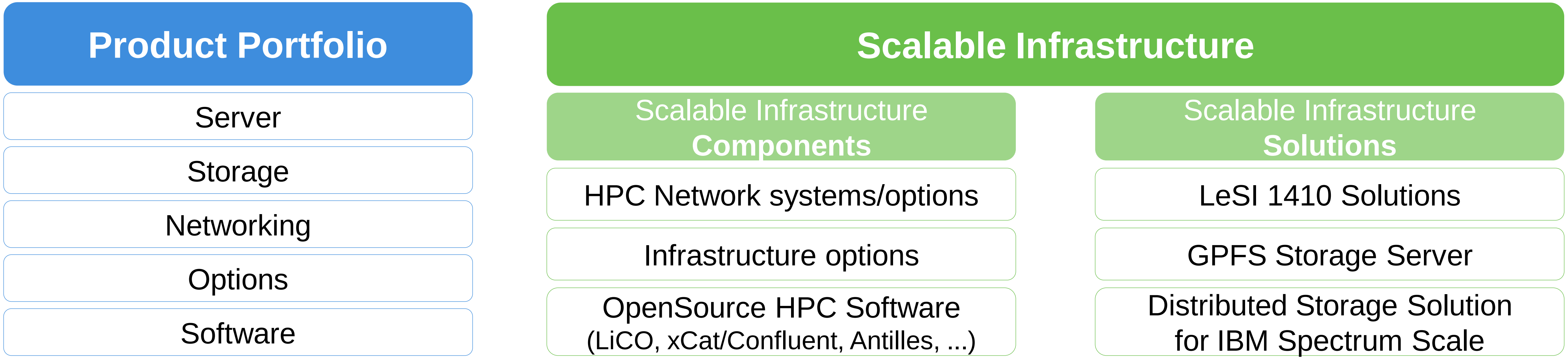
SOLUTION COMPONENTS

Think even bigger

Lenovo Scalable Infrastructure (LeSI)

Lenovo Scalable Infrastructure (LeSI) is a framework for development, configuration, build, delivery and support of integrated data center solutions

- Complete HPC data center portfolio with the best-of-breed partner technology
- Collaborate on OpenSource HPC software in true commitment to Openess
- End-to-end expert-designed, tested, integrated and supported HPC solutions



Product Portfolio

- Server
- Storage
- Networking
- Options
- Software

Scalable Infrastructure

Scalable Infrastructure **Components**

- HPC Network systems/options
- Infrastructure options
- OpenSource HPC Software (LiCO, xCat/Confluent, Antilles, ...)

Scalable Infrastructure **Solutions**

- LeSI 1410 Solutions
- GPFS Storage Server
- Distributed Storage Solution for IBM Spectrum Scale

The Combined x86 Portfolio – Delivering more choice

High-end systems

4 socket+ enterprise-class x86 performance, resiliency, security

Converged/Blade systems

Integration across Lenovo assets in systems and SW for maximum client optimization and value

Storage

Simple, Efficient, Reliable storage solutions : DAS, SAN, Tapes

Switches

System Networking & SAN switches for Data Centers & Virtualization needs

Dense systems

Optimize space-constrained data centers with extreme performance and energy efficiency

1P & 2P Rack & Tower systems

Broad rack and tower portfolio to meet a wide range of client needs from infrastructure to technical computing

ThinkServer

System x

Services

Warranty upgrade, maintenance, installation services, SW support, …

SOLUTIONS

Cloud	Analytics	Technical Computing

Management Standalone or Integration with VMware and Microsoft

HPC Storage

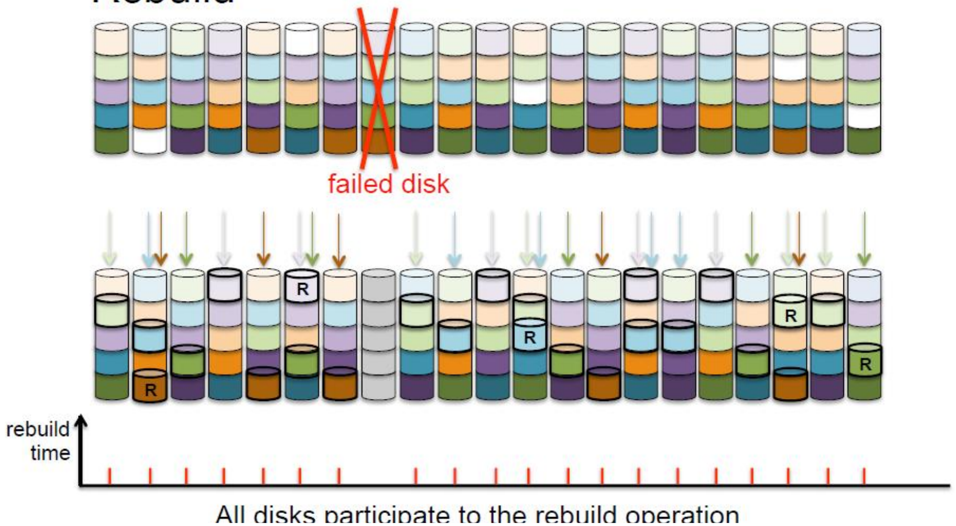
Lenovo DSS-G

Solution design

- **Embedded GPFS filesystem**
- **RAID support at filesystem level**
- **Fast data reconstruction by declustered RAID**
- **40GbE, FDR, EDR, OPA support**
- **Up-to 5PB raw in a system**
- **2 to 6 high density Jbod attached to two servers**
- **Reduced maintenance costs due to HW semplification**

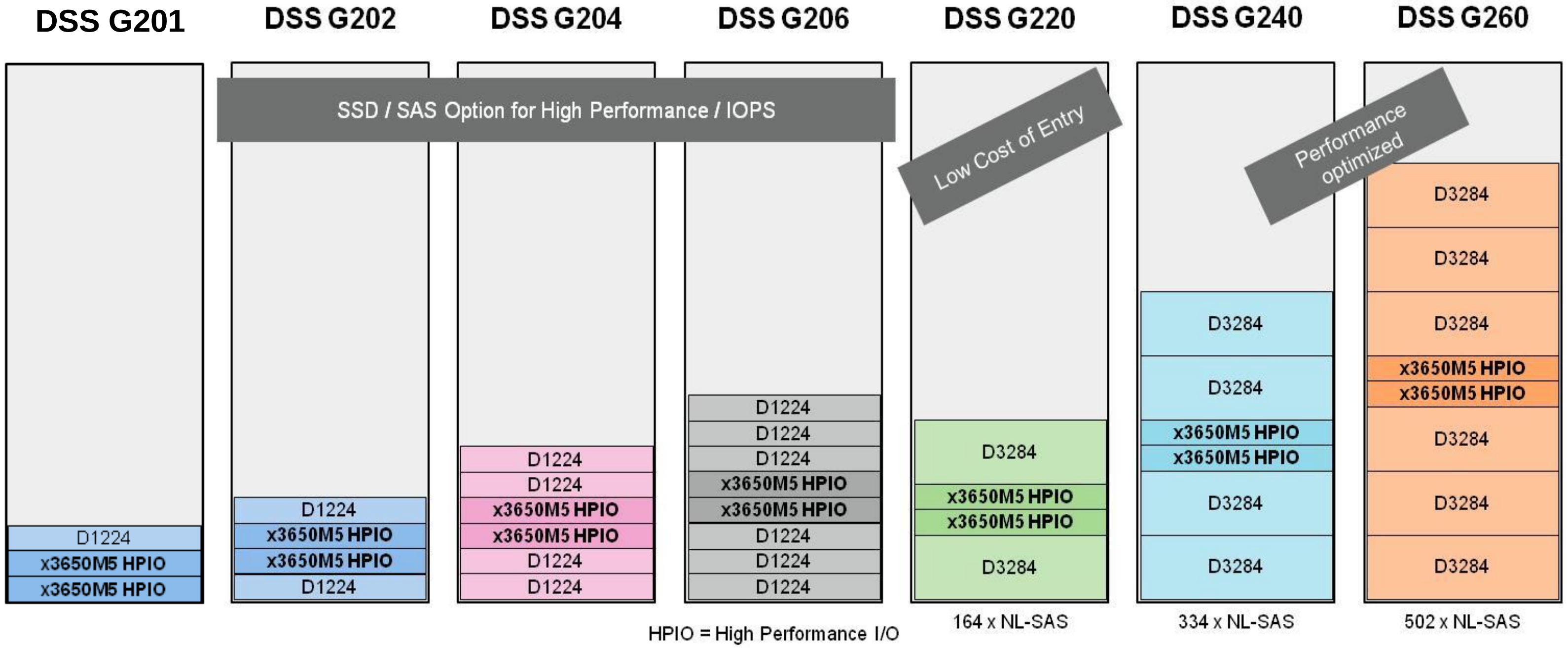
Declustered RAID – How it works

- Rebuild



DSS–G Storage Available in Either D3284 or D1224

- Lenovo D3284 JBODs (5U84)
- Lenovo D1224 JBODs (2U24)
- Two x3650M5 servers
  - SAS p2p connections to JBODs (12Gbps)
  - HPC interconnect: Ethernet, IB, OPA
- 2, 4 or 6 D3284 JBODs (5U84, 12Gbps)
  - 3.5” choice of 4,6,8,**10** TB NL-SAS disks
  - Up to **5 PB raw capacity**
- 1, 2, 4 or 6 D1224 JBODs (2U24, 12Gbps)
  - 2.5”, choice of:
    - 15K - 600GB or 300GB
    - 10K - 1.8TB , 1.2TB, 900GB,600GB
    - 7.2K - 2TB NL-SAS, 1TB NL-SAS
    - SSD - 1.6TB 3 DWD, 800GB 3 DWD, 400GB 3 DWD



SSD / SAS Option for High Performance / IOPS

Low Cost of Entry

Performance optimized

DSS G201
D1224
x3650M5 HPIO
x3650M5 HPIO

DSS G202
D1224
x3650M5 HPIO
x3650M5 HPIO
D1224

DSS G204
D1224
D1224
x3650M5 HPIO
x3650M5 HPIO
D1224
D1224

DSS G206
D1224
D1224
D1224
x3650M5 HPIO
x3650M5 HPIO
D1224
D1224
D1224

DSS G220
D3284
x3650M5 HPIO
x3650M5 HPIO
D3284
164 x NL-SAS

DSS G240
D3284
D3284
x3650M5 HPIO
x3650M5 HPIO
D3284
D3284
334 x NL-SAS

DSS G260
D3284
D3284
D3284
x3650M5 HPIO
x3650M5 HPIO
D3284
D3284
D3284
502 x NL-SAS

HPIO = High Performance I/O

Lenovo Cloud Network Operating System (CNOS)

Enables Enterprise networks to scale in cloud environments

Resilient

- Event driven Multi process architecture
- Fault isolation for control plane stability
- High availability features

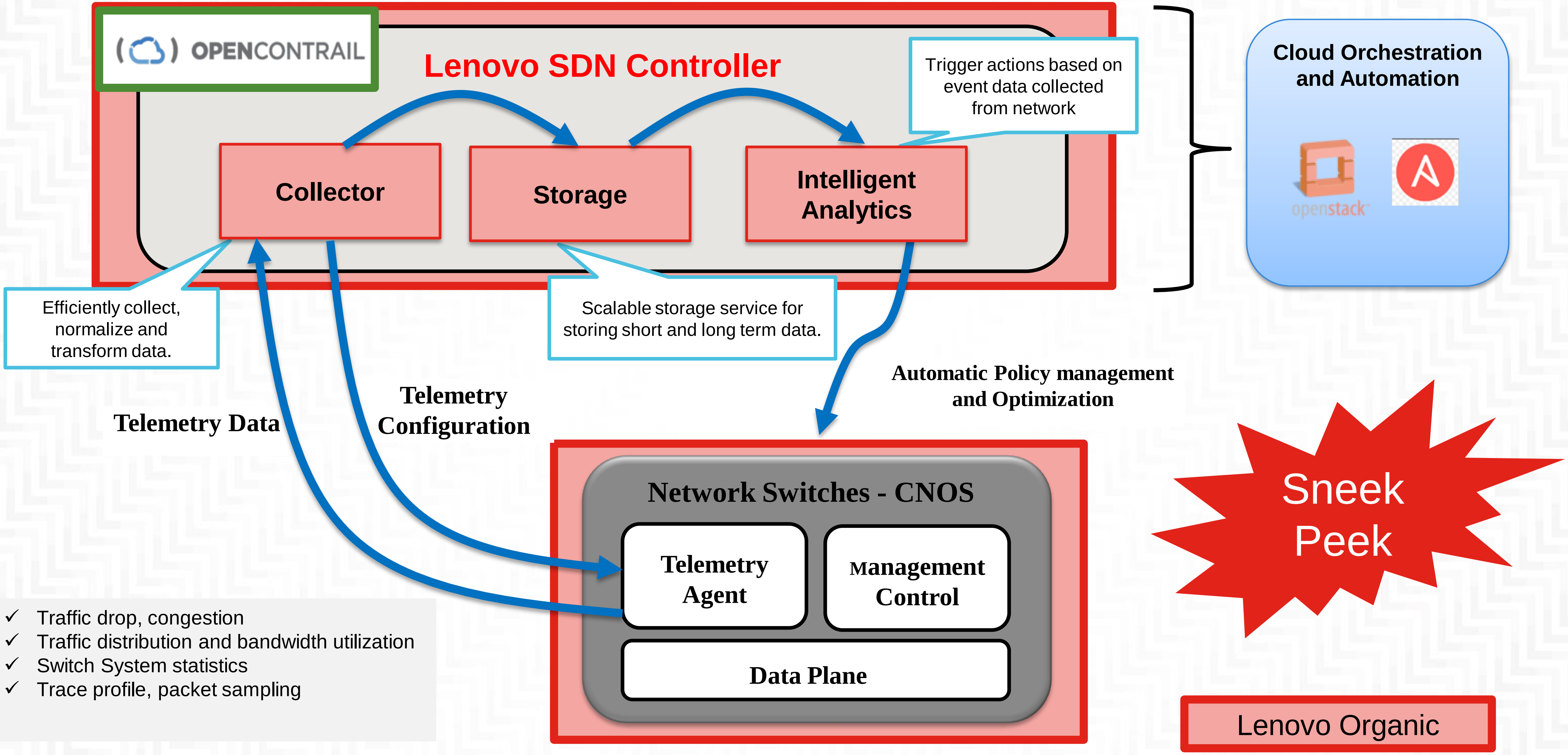
Cloud Scale

- State of the art routing protocol stack
- 32-way multipath scale out Clos fabric
- Multi-tenant aware

Programmable

- Enable automation at large scale
- DevOps innovation
- Native Linux shell access for server/network tools integration

SDN/CLOUD DATA CENTER ECO-SYSTEM



OPENCONTRAIL

Lenovo SDN Controller

Collector

Storage

Intelligent Analytics

Trigger actions based on event data collected from network

Cloud Orchestration and Automation

Efficiently collect, normalize and transform data.

Scalable storage service for storing short and long term data.

Telemetry Data

Telemetry Configuration

Automatic Policy management and Optimization

Network Switches - CNOS

Telemetry Agent

Management Control

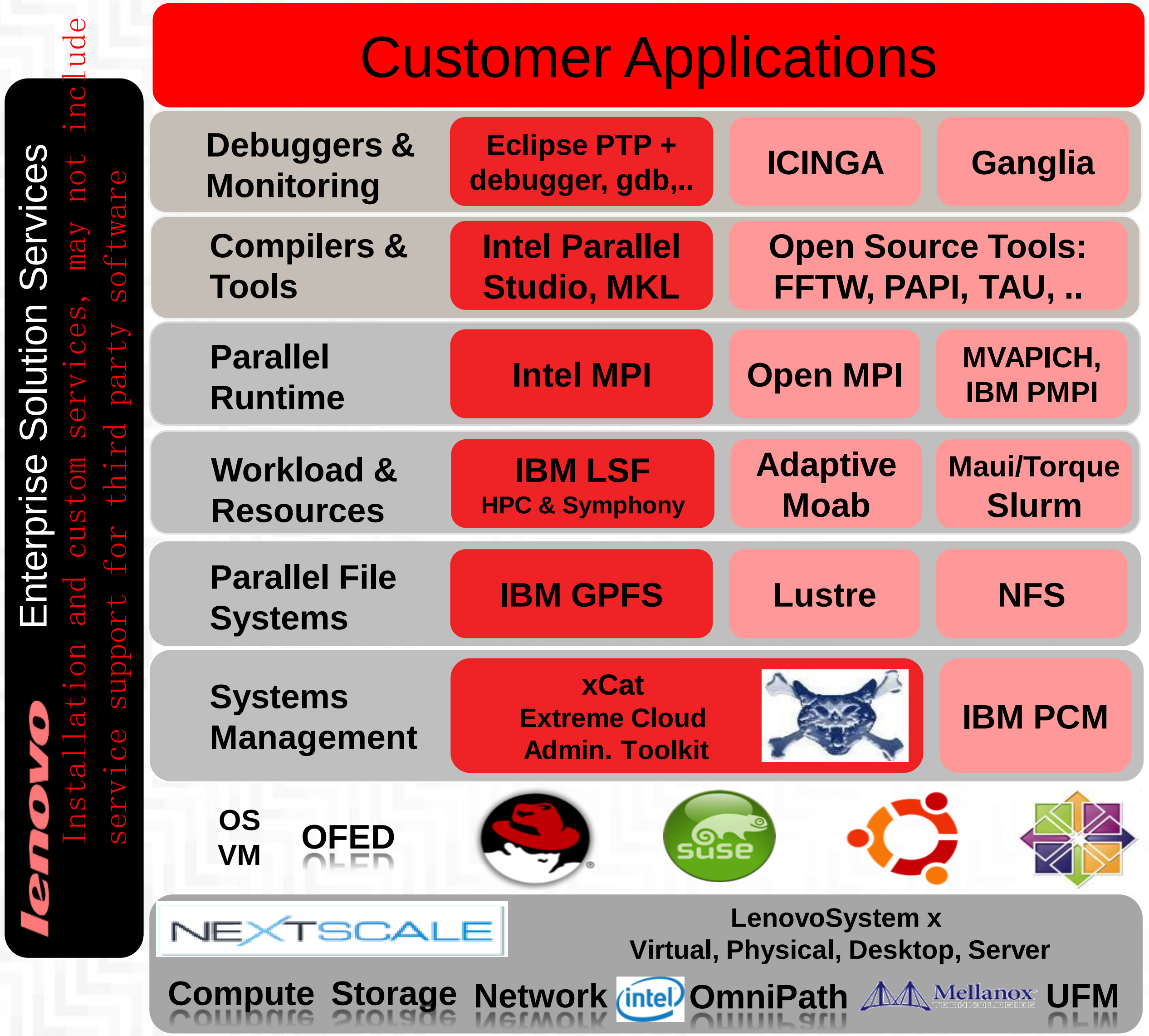
Data Plane

Sneek Peek

Lenovo Organic

- ✓ Traffic drop, congestion
- ✓ Traffic distribution and bandwidth utilization
- ✓ Switch System statistics
- ✓ Trace profile, packet sampling

Current Lenovo HPC Software Solutions



Enterprise Solution Services

Installation and custom services, may not include service support for third party software

Customer Applications

Debuggers & Monitoring	Eclipse PTP + debugger, gdb,..	ICINGA	Ganglia
Compilers & Tools	Intel Parallel Studio, MKL	Open Source Tools: FFTW, PAPI, TAU, ..	
Parallel Runtime	Intel MPI	Open MPI	MVAPICH, IBM PMPI
Workload & Resources	IBM LSF HPC & Symphony	Adaptive Moab	Maui/Torque Slurm
Parallel File Systems	IBM GPFS	Lustre	NFS
Systems Management	xCat Extreme Cloud Admin. Toolkit		IBM PCM

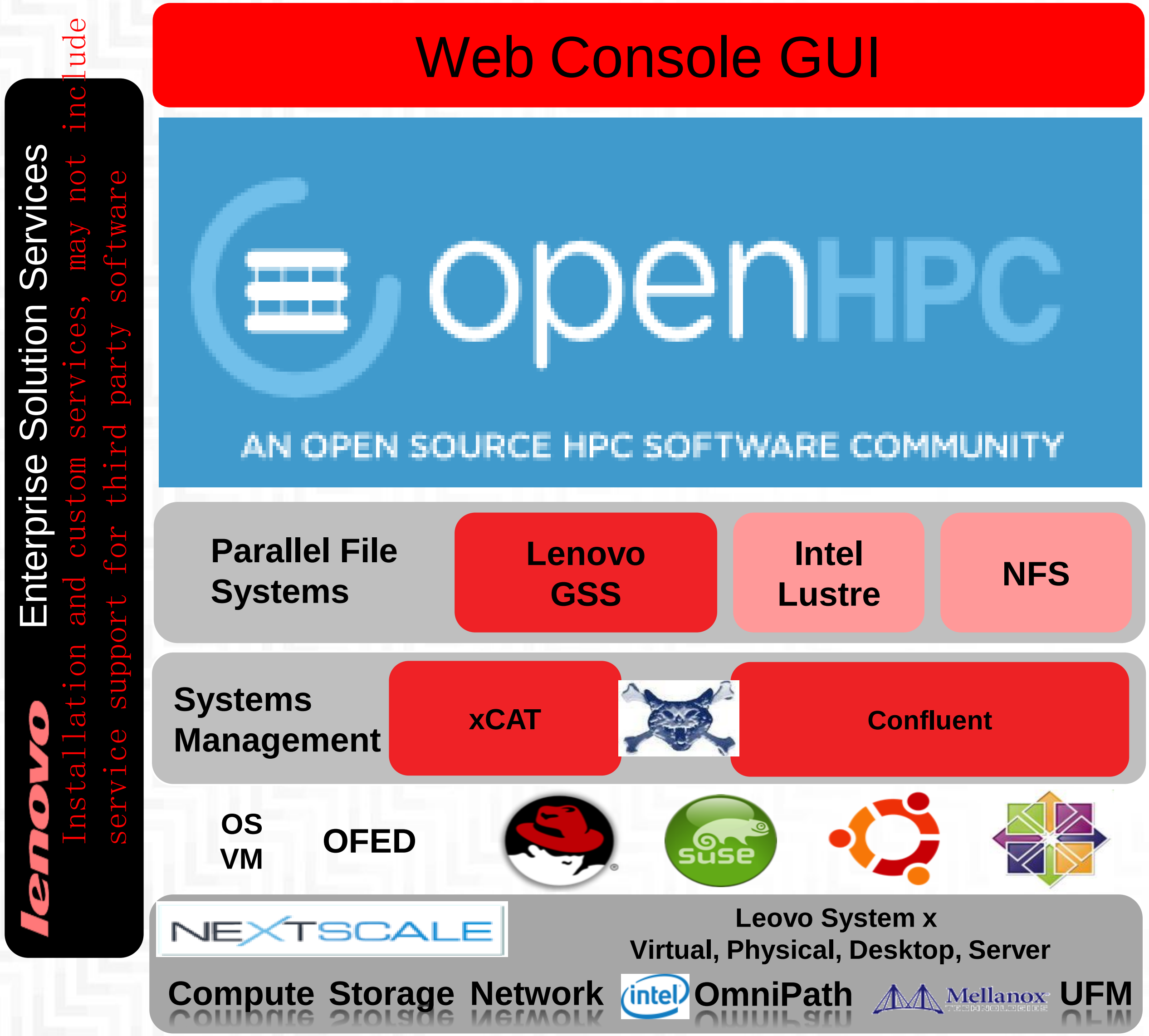
OS VM OFED

NEXTSCALE LenovoSystem x Virtual, Physical, Desktop, Server

Compute Storage Network intel OmniPath Mellanox UFM

- **Building Partnerships to provide the "Best In-Class" HPC Cluster Solutions for our customers**
- Collaborating with software vendors to provide features that optimizes customer workloads
- Leveraging "Open Source" components that are production ready
- Contributing to "Open Source" (i.e. xCAT, Confluent, OpenStack) to enhance our platforms
- Providing "Services" to help customers deploy and optimize their clusters

Future HPC Open Source Management Stack



Enterprise Solution Services

Installation and custom services, may not include service support for third party software

Web Console GUI

openHPC

AN OPEN SOURCE HPC SOFTWARE COMMUNITY

Parallel File Systems | Lenovo GSS | Intel Lustre | NFS

Systems Management | xCAT | Confluent

OS VM | OFED

NEXTSCALE

Leovo System x
Virtual, Physical, Desktop, Server

Compute Storage Network | intel OmniPath | Mellanox UFM

- Adding new features to the stack
  - Web Console GUI
  - xCAT
    - Heat Map of servers/racks
    - Fluid Return Temperature /Flow rate of CDU
  - Energy Awareness
    - scheduler independent

TECHNOLOGY TRENDS

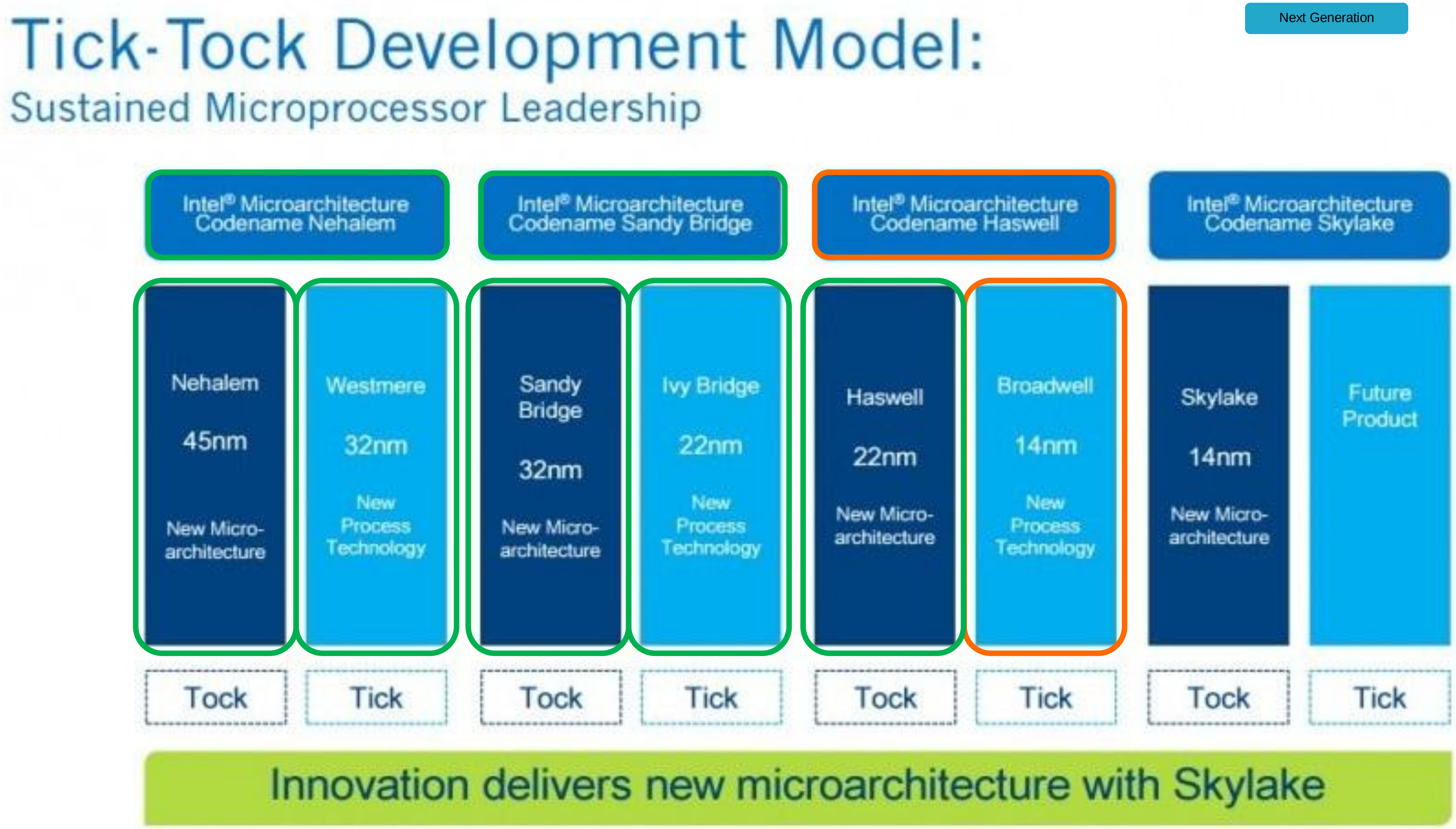
Think even bigger

Intel processors Development Model

Previous Generation

Current generation

Next Generation



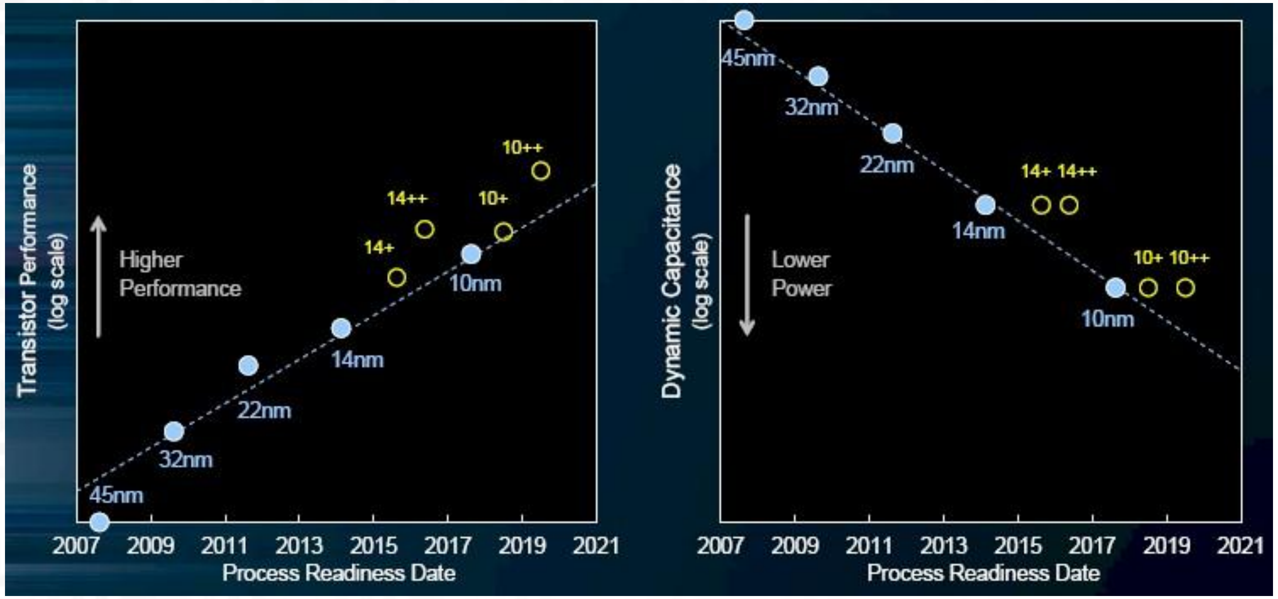
Tick-Tock Development Model:

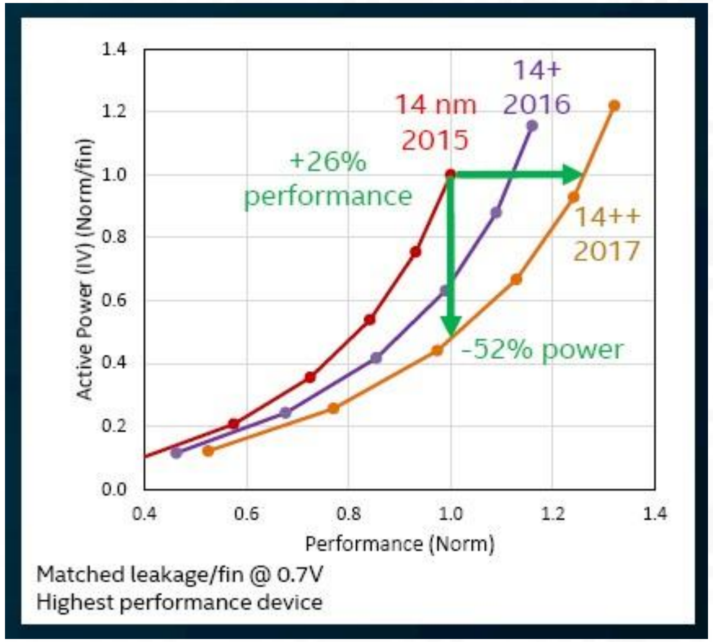
Sustained Microprocessor Leadership

Intel® Microarchitecture Codename Nehalem		Intel® Microarchitecture Codename Sandy Bridge		Intel® Microarchitecture Codename Haswell		Intel® Microarchitecture Codename Skylake	
Nehalem 45nm New Micro-architecture	Westmere 32nm New Process Technology	Sandy Bridge 32nm New Micro-architecture	Ivy Bridge 22nm New Process Technology	Haswell 22nm New Micro-architecture	Broadwell 14nm New Process Technology	Skylake 14nm New Micro-architecture	Future Product
Tock	Tick	Tock	Tick	Tock	Tick	Tock	Tick

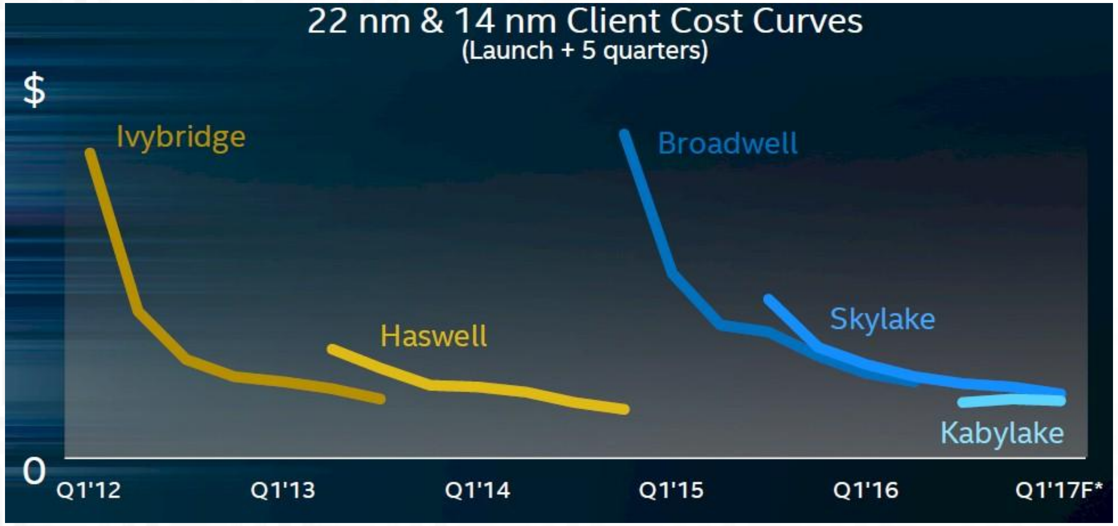
Innovation delivers new microarchitecture with Skylake

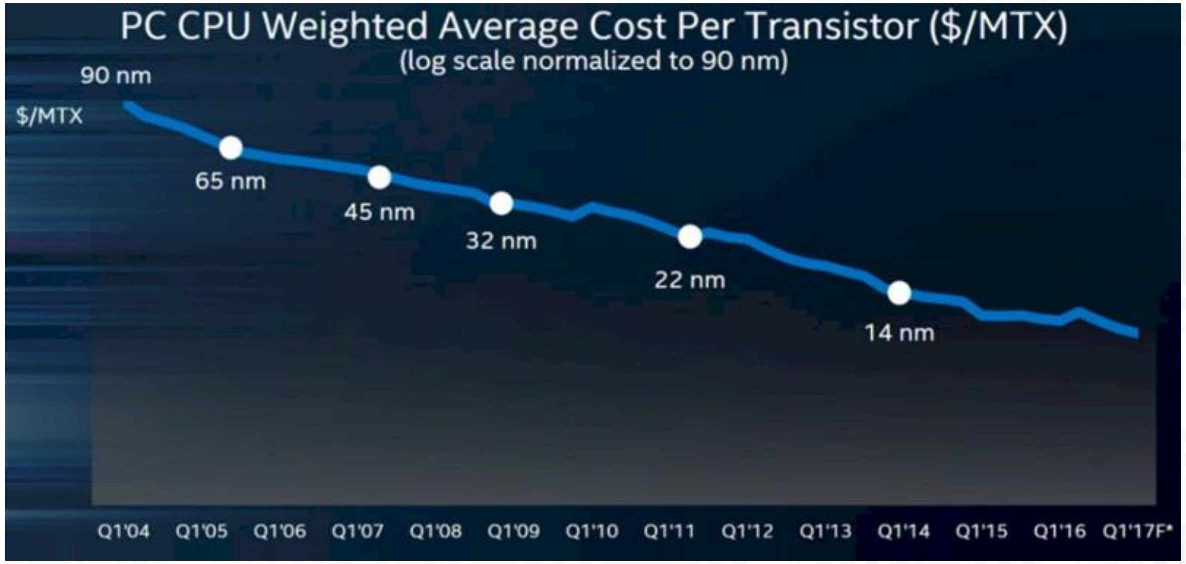
Intel processors Development Model



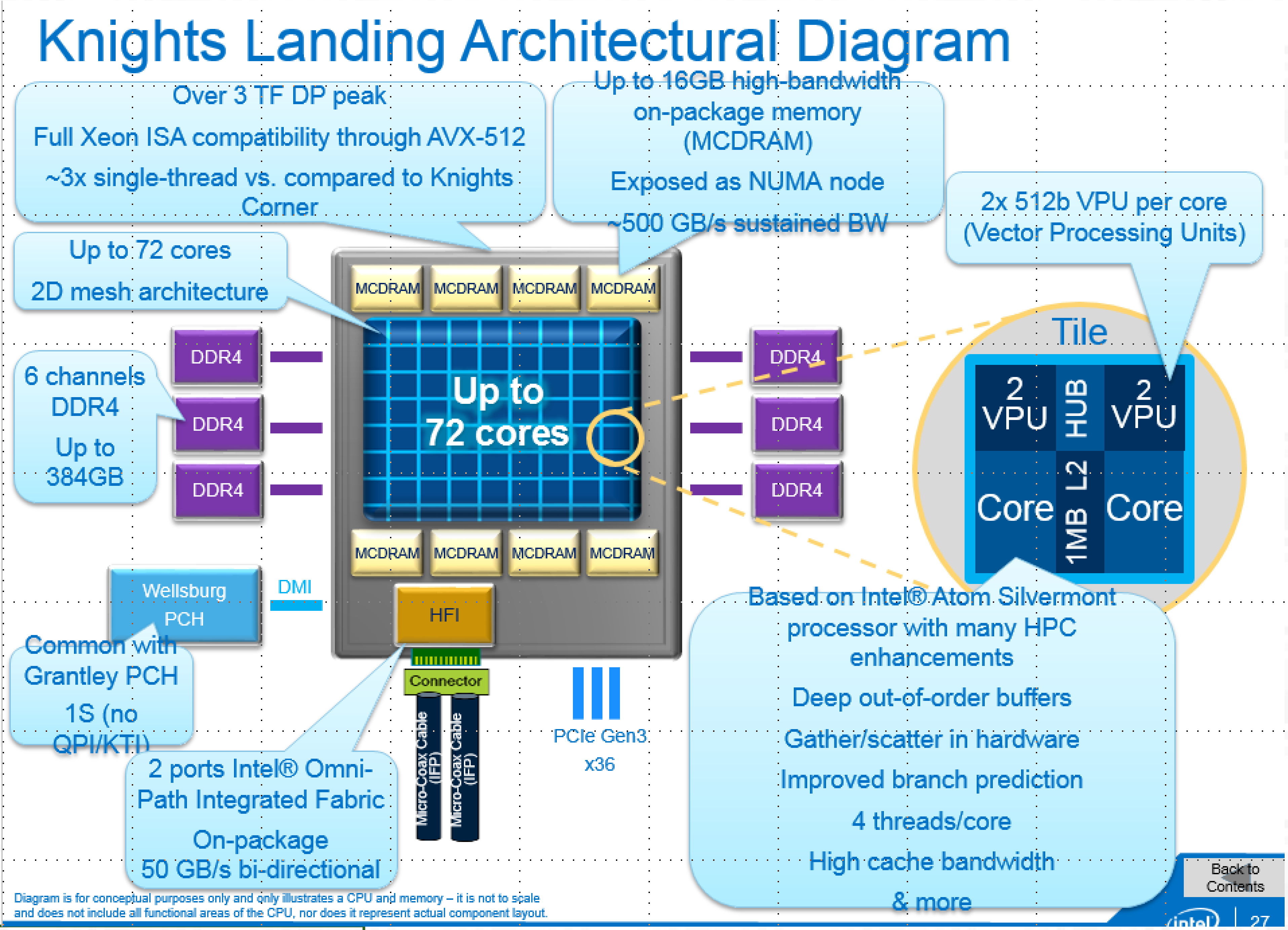


Matched leakage/fin @ 0.7V
Highest performance device


22 nm & 14 nm Client Cost Curves
(Launch + 5 quarters)


PC CPU Weighted Average Cost Per Transistor ($/MTX)
(log scale normalized to 90 nm)

details



Knights Landing Architectural Diagram

Over 3 TF DP peak

Full Xeon ISA compatibility through AVX-512

~3x single-thread vs. compared to Knights Corner

Up to 16GB high-bandwidth on-package memory (MCDRAM)

Exposed as NUMA node

~500 GB/s sustained BW

2x 512b VPU per core (Vector Processing Units)

Up to 72 cores

2D mesh architecture

6 channels DDR4

Up to 384GB

Common with Grantley PCH

1S (no QPI/KTI)

2 ports Intel® Omni-Path Integrated Fabric

On-package

50 GB/s bi-directional

Based on Intel® Atom Silvermont processor with many HPC enhancements

Deep out-of-order buffers

Gather/scatter in hardware

Improved branch prediction

4 threads/core

High cache bandwidth

& more

Diagram is for conceptual purposes only and only illustrates a CPU and memory – it is not to scale and does not include all functional areas of the CPU, nor does it represent actual component layout.

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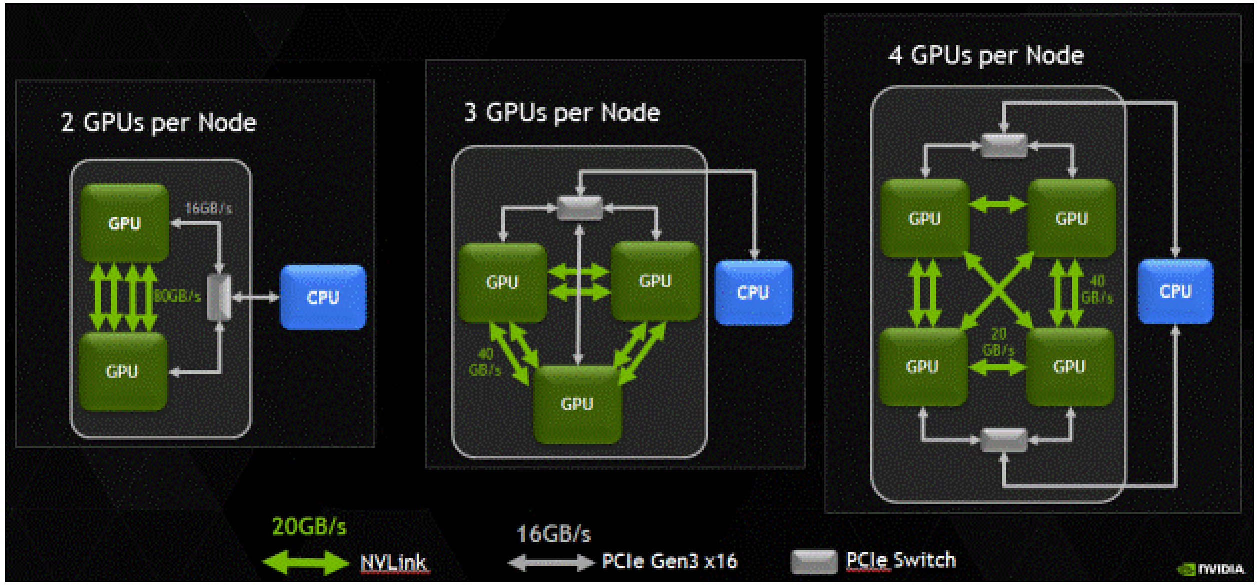
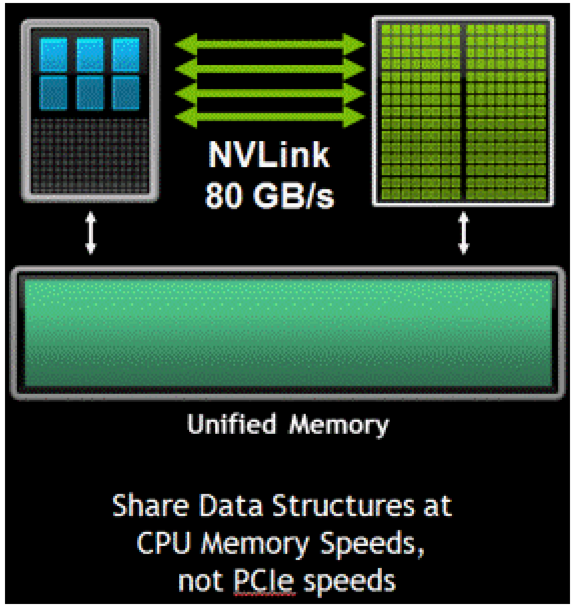
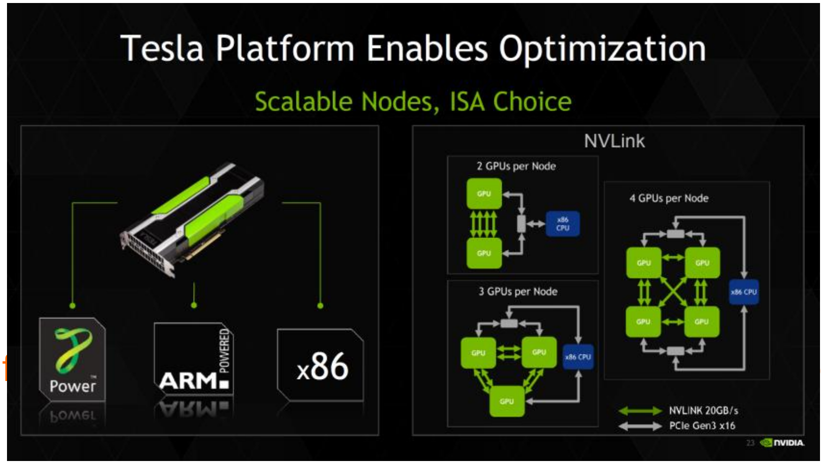
NVIDIA NVLink architecture

1st Generation



2nd Generation



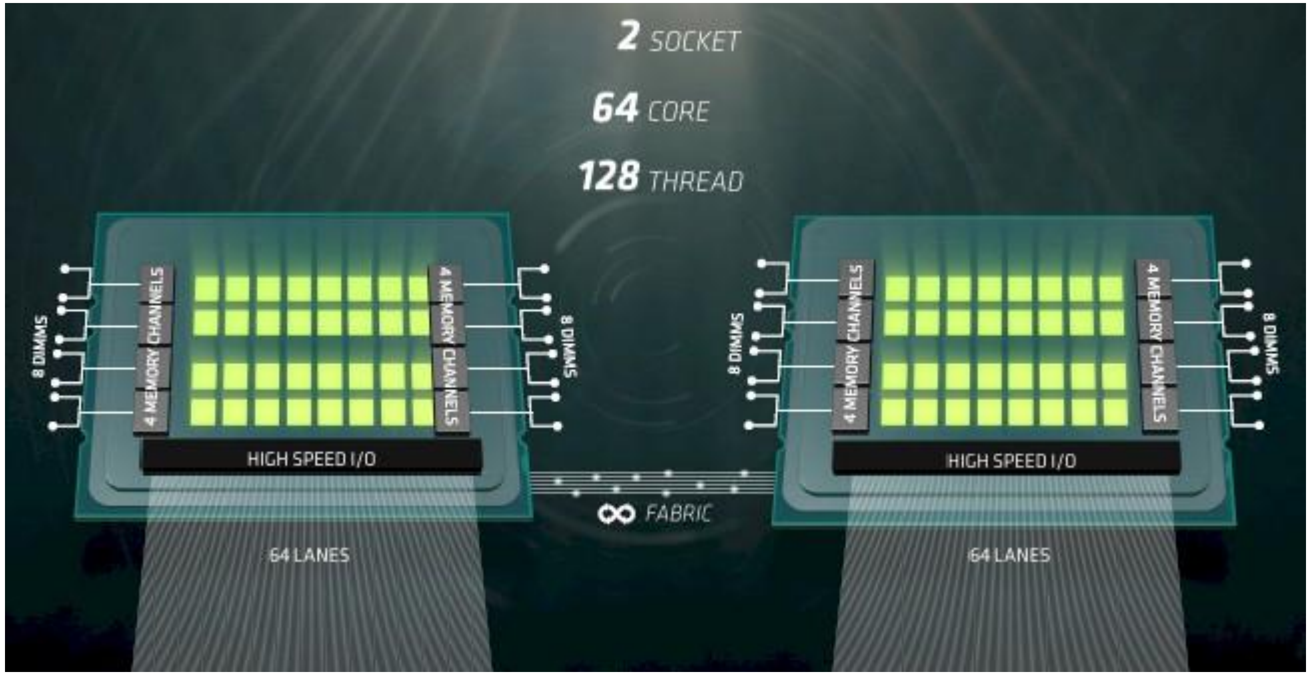


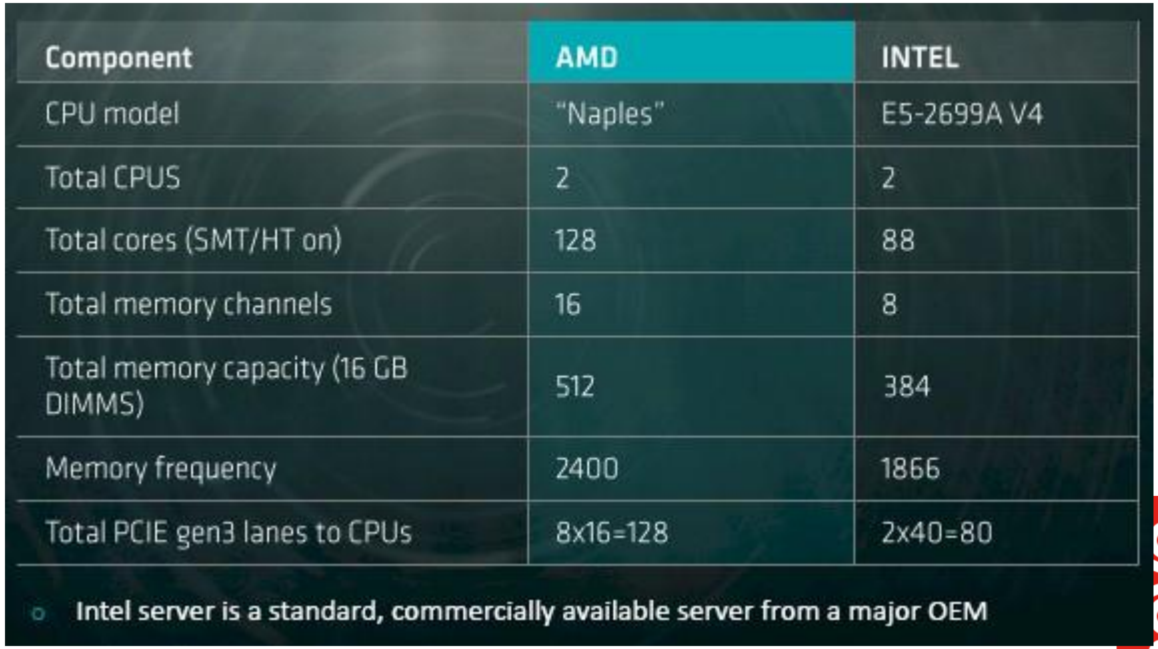
Tesla Platform Enables Optimization

Scalable Nodes, ISA Choice

http://devblogs.nvidia.com/parallel u-computing/

AMD Naples and multicores – 1P or 2P in HPC?





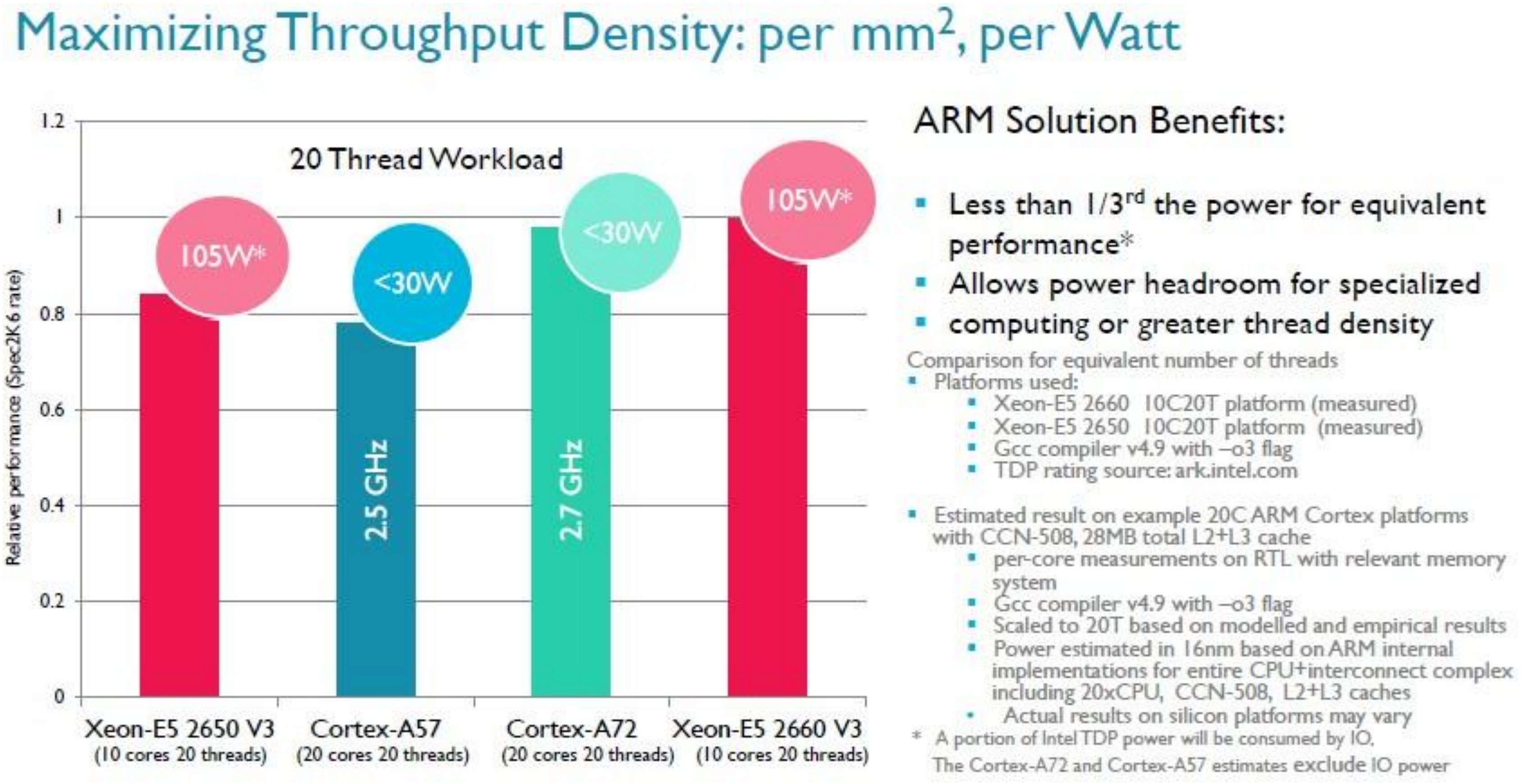
Component	AMD	INTEL
CPU model	"Naples"	E5-2699A V4
Total CPUS	2	2
Total cores (SMT/HT on)	128	88
Total memory channels	16	8
Total memory capacity (16 GB DIMMS)	512	384
Memory frequency	2400	1866
Total PCIE gen3 lanes to CPUs	8x16=128	2x40=80

- Intel server is a standard, commercially available server from a major OEM

https://www.nextplatform.com/2017/05/17/amd-disrupts-two-socket-server-status-quo/

AMD Naples and multicores – 1P or 2P in HPC?

ARM solution from mobile to server to offer a solution at lower power consumption



Maximizing Throughput Density: per mm^2, per Watt

ARM Solution Benefits:

- Less than 1/3rd the power for equivalent performance*
- Allows power headroom for specialized
- computing or greater thread density

Comparison for equivalent number of threads

- Platforms used:
  - Xeon-E5 2660 10C20T platform (measured)
  - Xeon-E5 2650 10C20T platform (measured)
  - Gcc compiler v4.9 with –o3 flag
  - TDP rating source: ark.intel.com

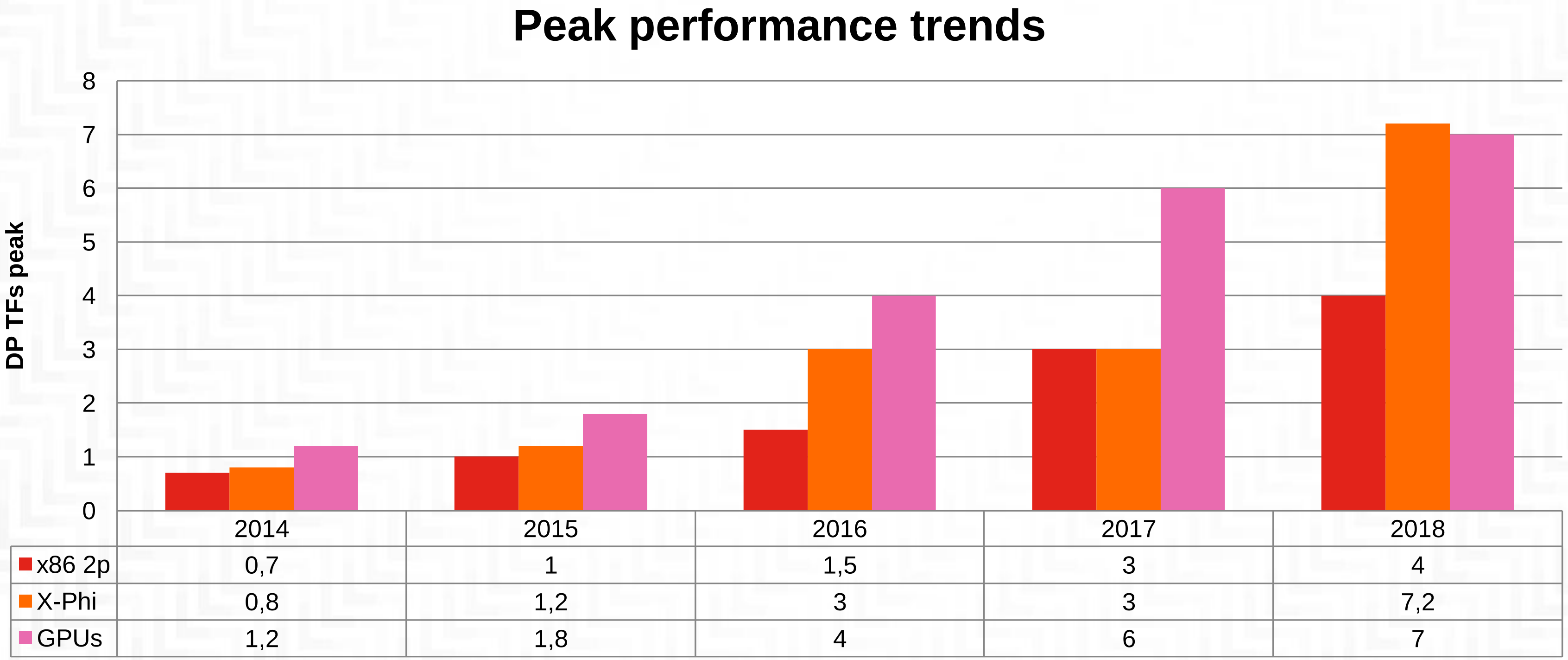
- Estimated result on example 20C ARM Cortex platforms with CCN-508, 28MB total L2+L3 cache
  - per-core measurements on RTL with relevant memory system
  - Gcc compiler v4.9 with –o3 flag
  - Scaled to 20T based on modelled and empirical results
  - Power estimated in 16nm based on ARM internal implementations for entire CPU+interconnect complex including 20xCPU, CCN-508, L2+L3 caches
  - Actual results on silicon platforms may vary

* A portion of Intel TDP power will be consumed by IO.
The Cortex-A72 and Cortex-A57 estimates exclude IO power

https://www.nextplatform.com/2017/03/21/new-arm-architecture-offers-dynamiq-response-compute/

Performance trends in a server

- **Technology evolution determines a significant performance growth in the next 3yrs**
- **From 2015 to 2018 peak performances double at least on x86, X-Phi, GPUs**
- **Technology solutions to hundreds of PFs is not so evident and will depend by several conditions:**
  - **Peak performance vs cost**
  - **Peak performance vs power consumption (GFs/W)**
  - **Sustained performances vs power consumption and TCO**



Peak performance trends

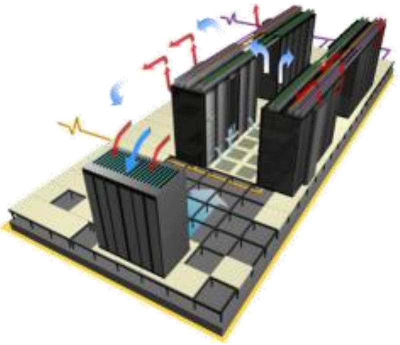
	2014	2015	2016	2017	2018
🟥 x86 2p	0,7	1	1,5	3	4
🟧 X-Phi	0,8	1,2	3	3	7,2
🟪 GPUs	1,2	1,8	4	6	7

COOLING TECHNOLOGY AND TCO

Think even bigger

Choice of Cooling

Air Cooled



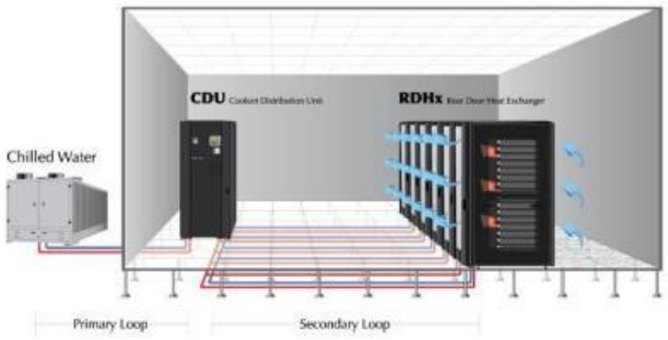
- Standard air flow with internal fans
- Fits in any datacenter
- Maximum flexibility
- Broadest choice of configurable options supported
- Supports Native Expansion nodes (Storage NeX, PCI NeX)

PUE ~1.5

ERE ~ 1.5

Choose for broadest choice of customizable options

Air Cooled with Rear Door Heat Exchangers



- Air cool, supplemented with RDHX door on rack
- Uses chilled water with economizer (18C water)
- Enables extremely tight rack placement

PUE ~1.2

ERE ~ 1.2

Choose for balance between configuration flexibility and energy efficiency

Direct Water Cooled

- Direct water cooling with no internal fans
- Higher performance per watt
- Free cooling (45C water)
- **Energy re-use**
- Densest footprint
- Ideal for geos with high electricity costs and new data centers
- Supports highest wattage processors

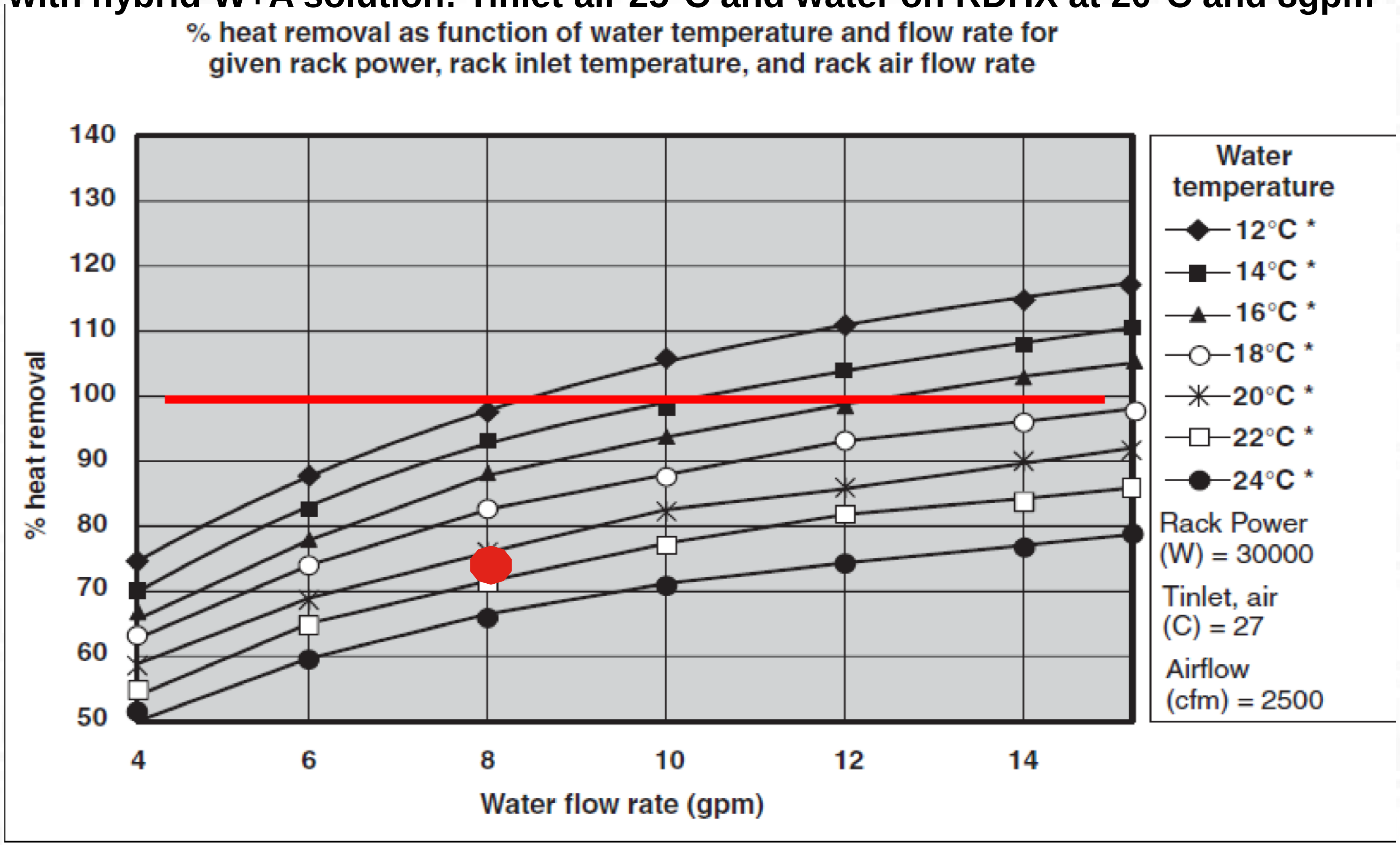
PUE <= 1.1

ERE ~ 0.3 with hot water

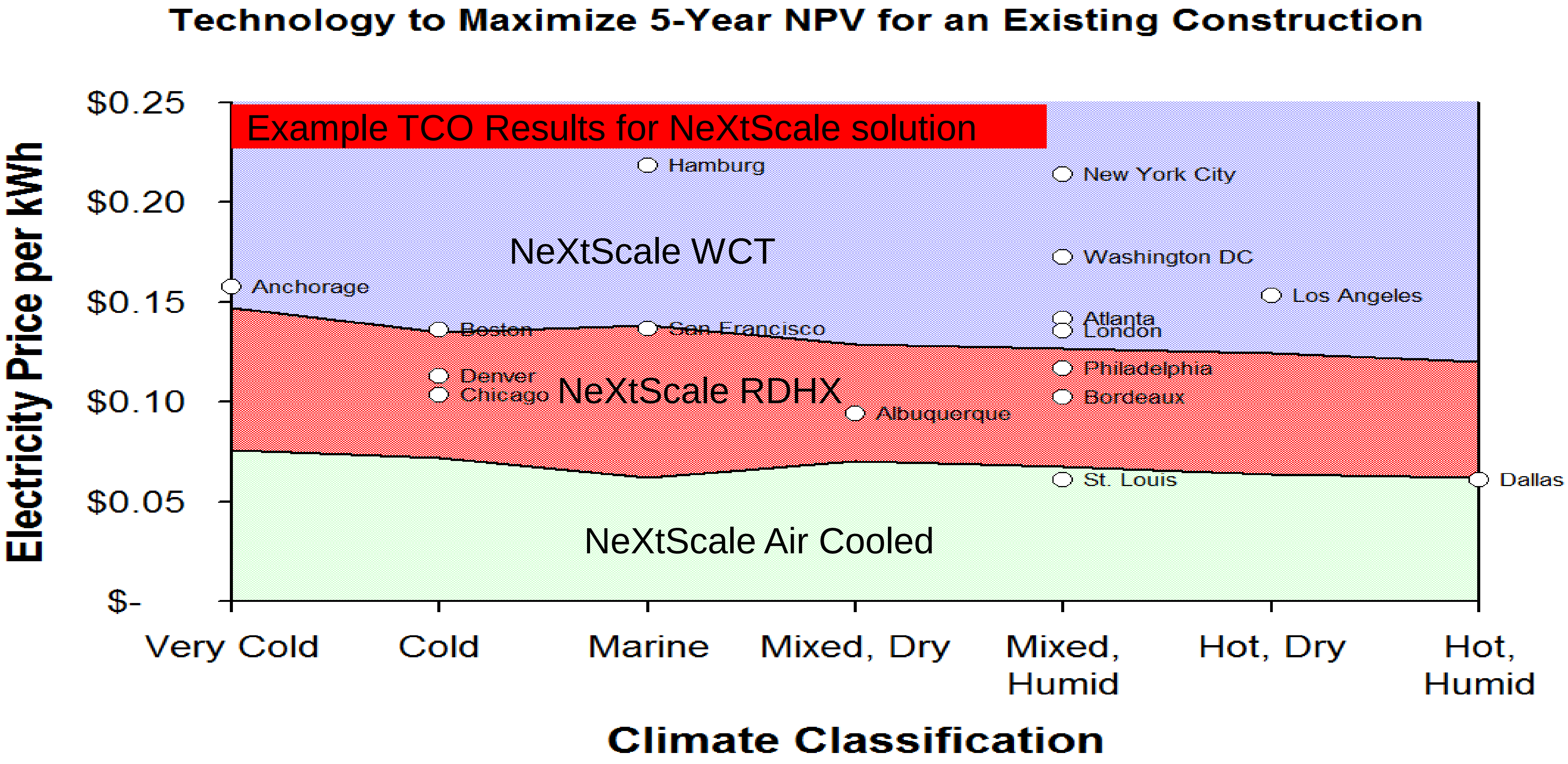
Choose for highest performance and energy efficiency

Power cooling using RDHX

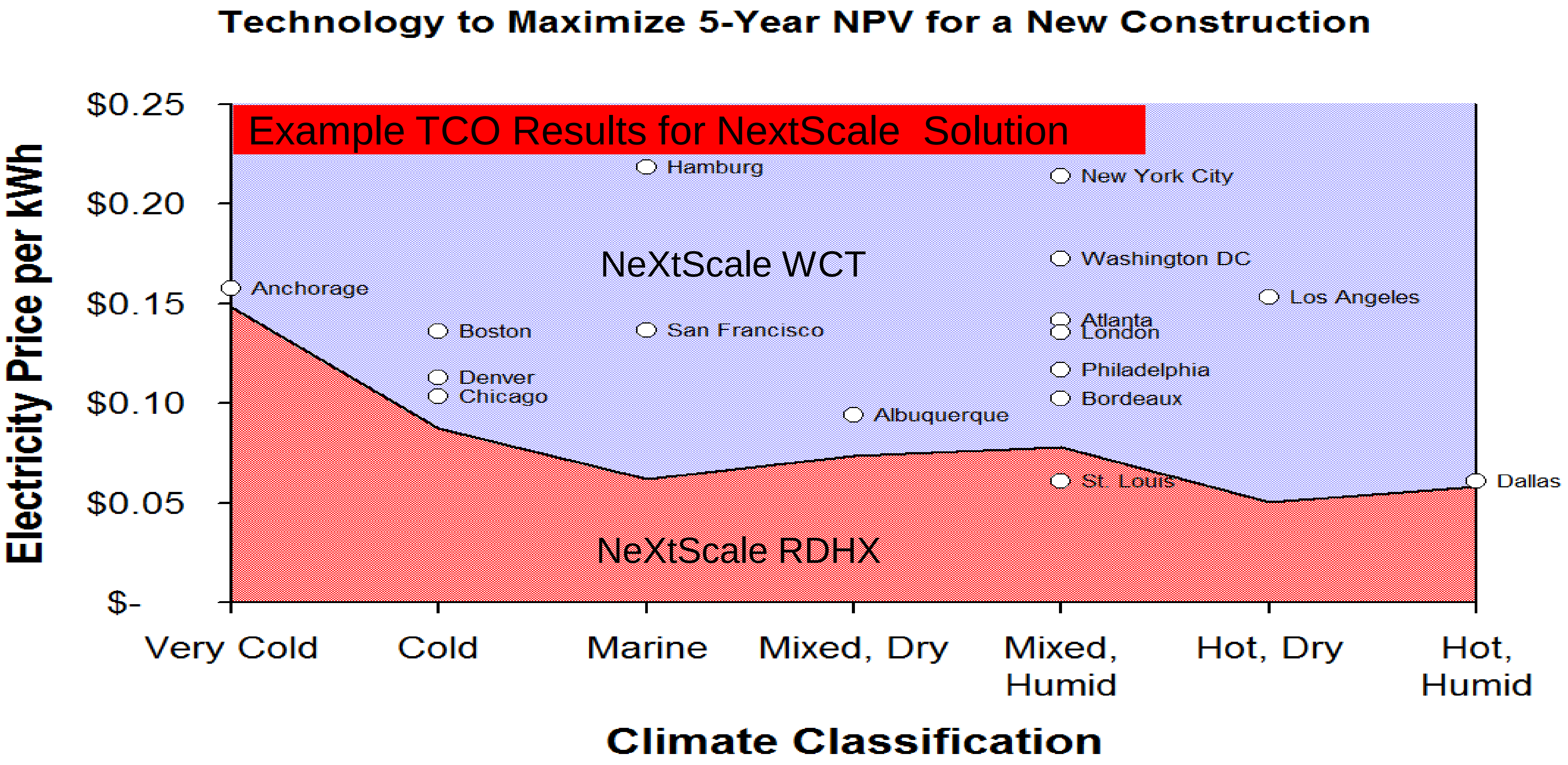
Power cooling with hybrid W+A solution: Tinlet air 25°C and water on RDHX at 20°C and 8gpm



Technology Selection for an Existing Data Center Installation



Technology Selection for a New Data Center Installation



How to manage power

- Report
  - temperature and power consumption per node / per chassis
  - power consumption and energy per job
- Optimize
  - Reduce power of inactive nodes
  - Reduce power of active nodes

OVER 20PF@CINECA

Think even bigger

CINECA OBJECTIVES AND TECHNOLOGIES

Several phases

- A1: 2 PFs peak convential architecture
- A2: >10 PFs peak non conventional architecture
- A3: >4 PF peak
- Interconnect : >40Gbs bidi between 2 nodes
- Storage :
  - S1: 10PB, >100 GB/s
- Power < 2.0 megawatts all inclusive

Technologies

- A1: BRDW in Lenovo NeXtScale
- A2: KNL in Intel AdamsPass and RDHX
- A3: SKL with Lenovo Stark and RDHX
- Single OPA fabric and 2:1 blocking ratio
- Storage
  - S1: 6xGSS26 with 8 TB drive

LENOVO ECO SYSTEM FOR CINECA

Compute Platforms	intel inside XEON PHI intel Xeon inside NVIDIA TESLA
Software Environments	CentOS xcat Altair PBS Works™
Interconnects	intel Mellanox TECHNOLOGIES
Storage Subsystems	DDN IBM Spectrum Scale
Infrastructure	Lenovo EMERSON

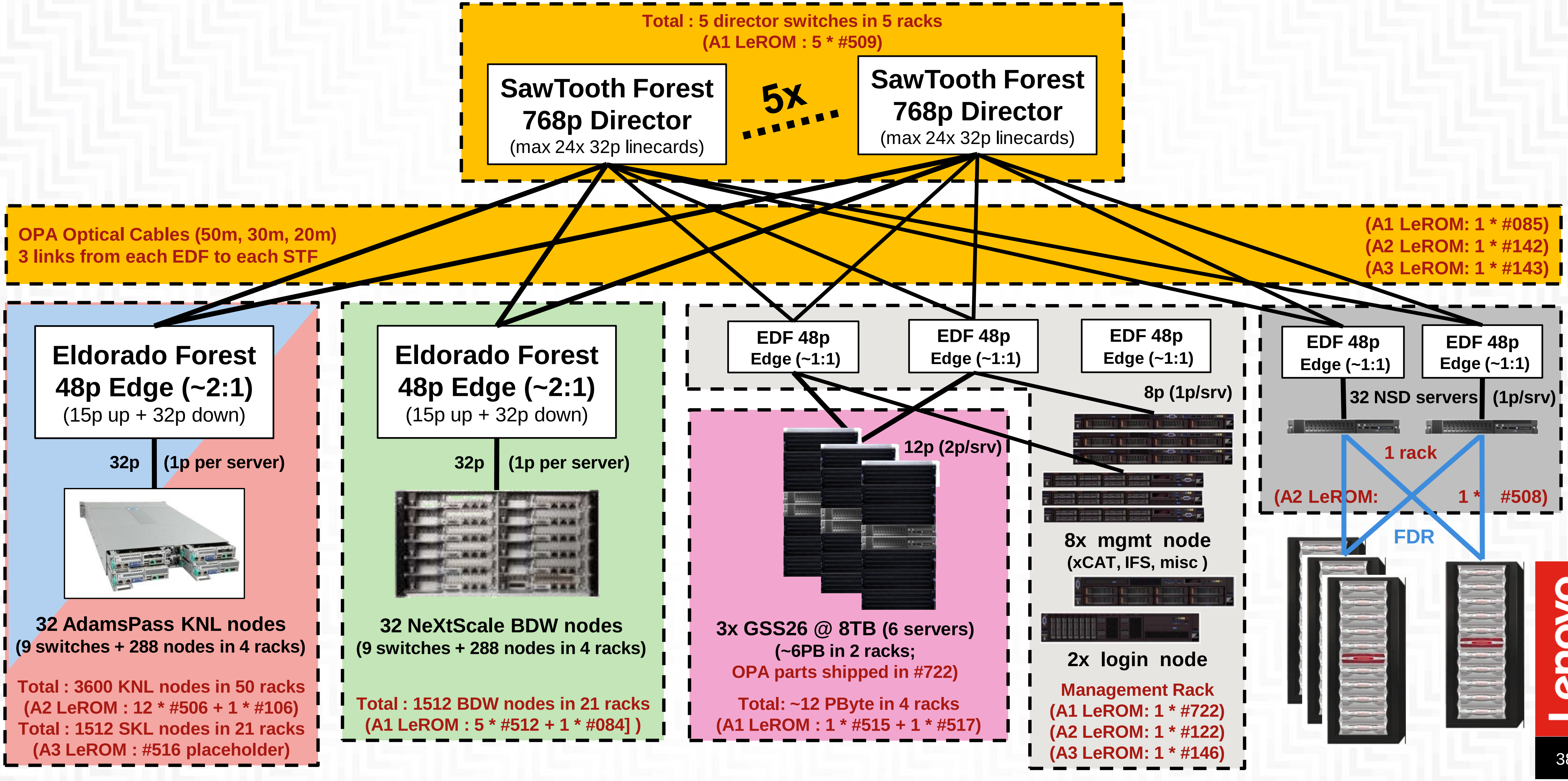
Lenovo Services

- ✓Design
- ✓Architecture
- ✓Project Mgmt.
- ✓Optimization

BRW vs. KNL vs. SKL (based on Cineca)

	BRW (2PFL)	KNL (11PFL)	SKL (>4,5PFL)
Nodes	1512	3600	1512
CPU/node	2	1	2
TFlop/node	1.3	3	3.2
Price/node			
CPU	E5-2697v4 18c@2,3GHz	7250 68c@1.4GHz	8160 24c@2,1GHz
TFlop/Socket	0.65	3	1.6

CINECA – OMNI-PATH FABRIC ARCHITECTURE (SINGLE FABRIC, WITH 32:15 BLOCKING)



Total : 5 director switches in 5 racks
(A1 LeROM : 5 * #509)

SawTooth Forest
768p Director
(max 24x 32p linecards)

5x

SawTooth Forest
768p Director
(max 24x 32p linecards)

OPA Optical Cables (50m, 30m, 20m)
3 links from each EDF to each STF

(A1 LeROM: 1 * #085)
(A2 LeROM: 1 * #142)
(A3 LeROM: 1 * #143)

Eldorado Forest
48p Edge (~2:1)
(15p up + 32p down)

32p (1p per server)

32 AdamsPass KNL nodes
(9 switches + 288 nodes in 4 racks)

Total : 3600 KNL nodes in 50 racks
(A2 LeROM : 12 * #506 + 1 * #106)
Total : 1512 SKL nodes in 21 racks
(A3 LeROM : #516 placeholder)

Eldorado Forest
48p Edge (~2:1)
(15p up + 32p down)

32p (1p per server)

32 NeXtScale BDW nodes
(9 switches + 288 nodes in 4 racks)

Total : 1512 BDW nodes in 21 racks
(A1 LeROM : 5 * #512 + 1 * #084])

EDF 48p
Edge (~1:1)

EDF 48p
Edge (~1:1)

EDF 48p
Edge (~1:1)

12p (2p/srv)

3x GSS26 @ 8TB (6 servers)
(~6PB in 2 racks;
OPA parts shipped in #722)

Total: ~12 PByte in 4 racks
(A1 LeROM : 1 * #515 + 1 * #517)

8p (1p/srv)

8x mgmt node
(xCAT, IFS, misc)

2x login node

Management Rack
(A1 LeROM: 1 * #722)
(A2 LeROM: 1 * #122)
(A3 LeROM: 1 * #146)

EDF 48p
Edge (~1:1)

EDF 48p
Edge (~1:1)

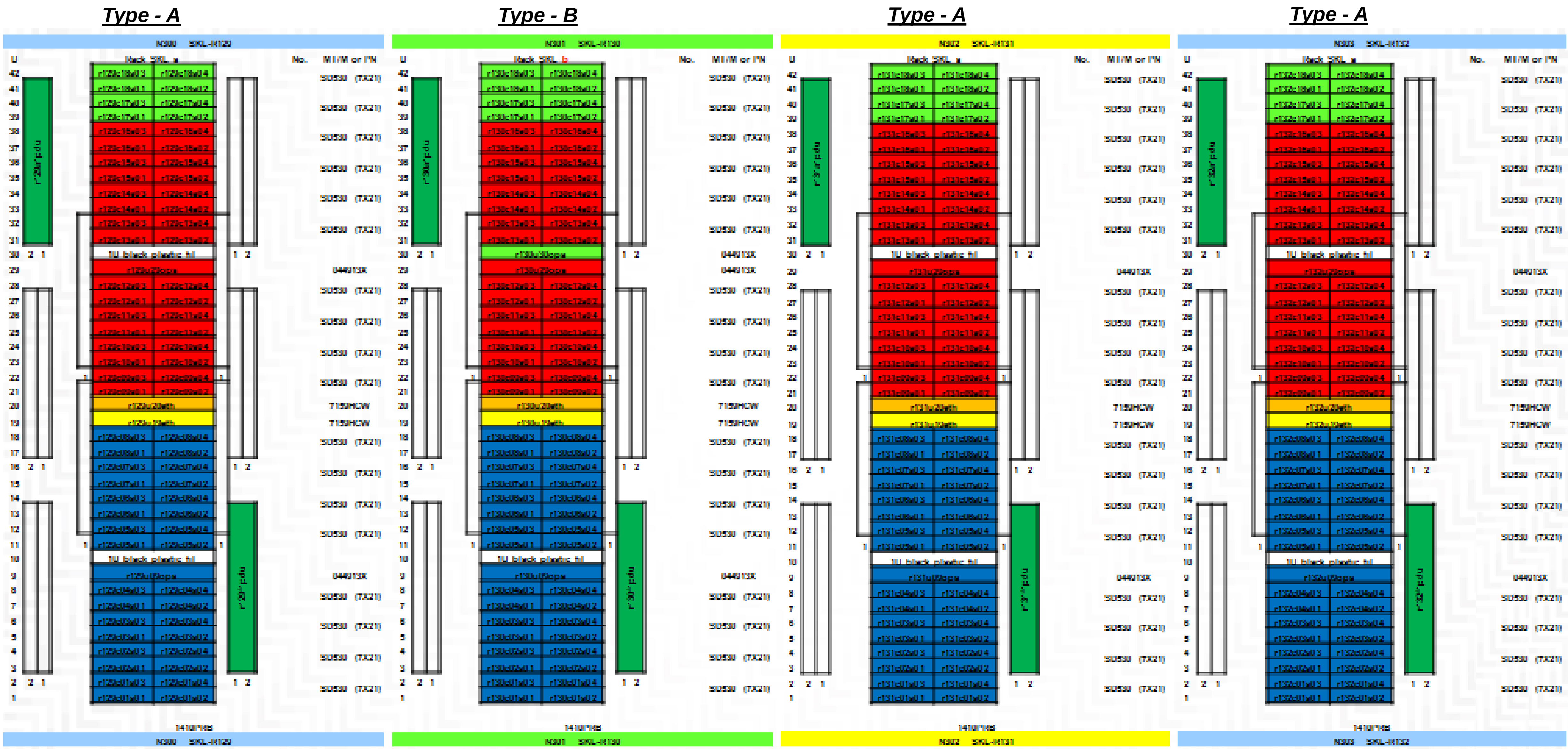
32 NSD servers (1p/srv)

1 rack

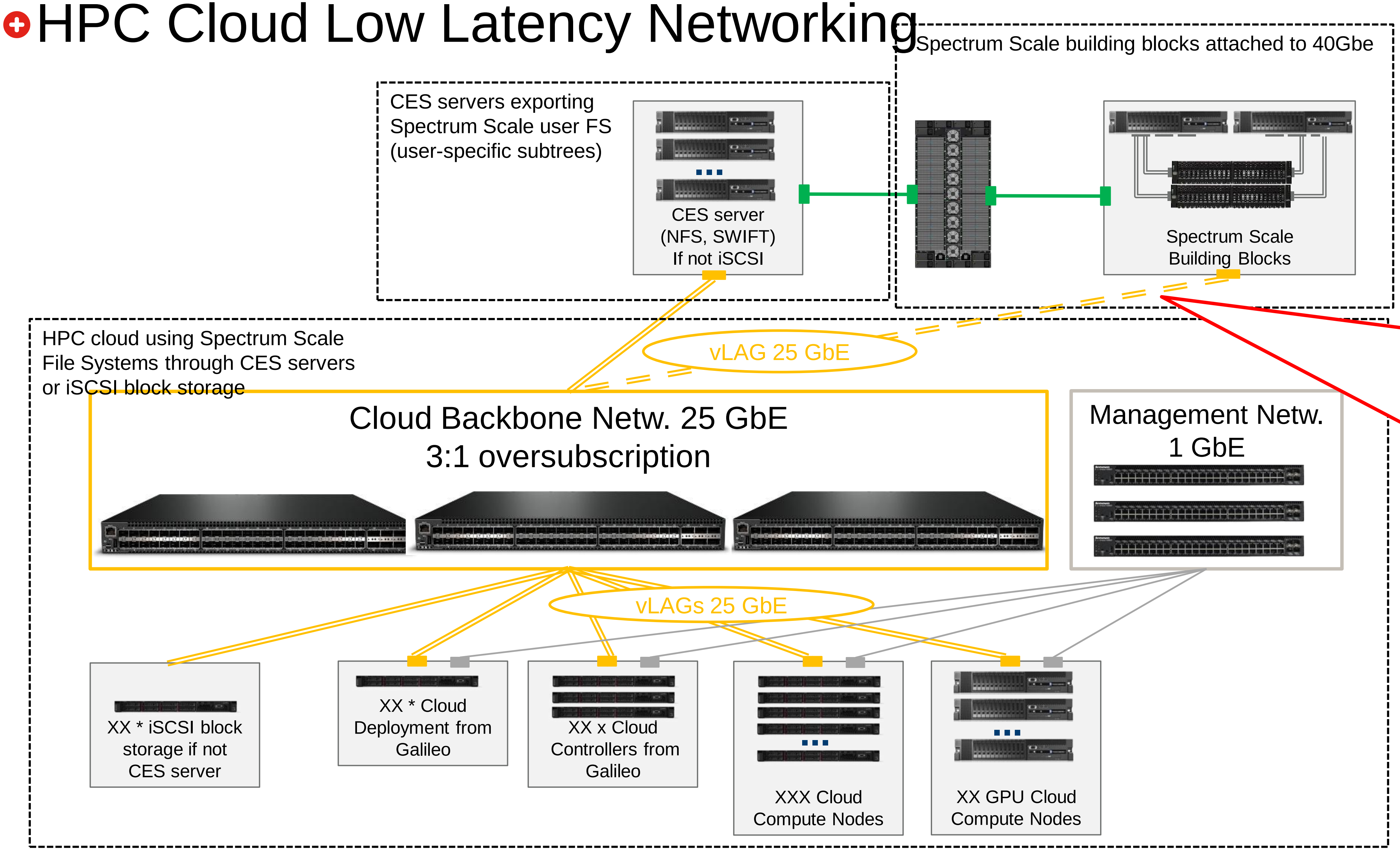
(A2 LeROM: 1 * #508)

FDR

Cineca 4 Racks Building Block Diagram – 4 x 72 servers in OPA 2:1 oversubscription



HPC Cloud Low Latency Networking



Spectrum Scale building blocks attached to 40Gbe

CES servers exporting Spectrum Scale user FS (user-specific subtrees)

CES server (NFS, SWIFT) If not iSCSI

Spectrum Scale Building Blocks

HPC cloud using Spectrum Scale File Systems through CES servers or iSCSI block storage

vLAG 25 GbE

Cloud Backbone Netw. 25 GbE 3:1 oversubscription

Management Netw. 1 GbE

vLAGs 25 GbE

XX * iSCSI block storage if not CES server

XX * Cloud Deployment from Galileo

XX x Cloud Controllers from Galileo

XXX Cloud Compute Nodes

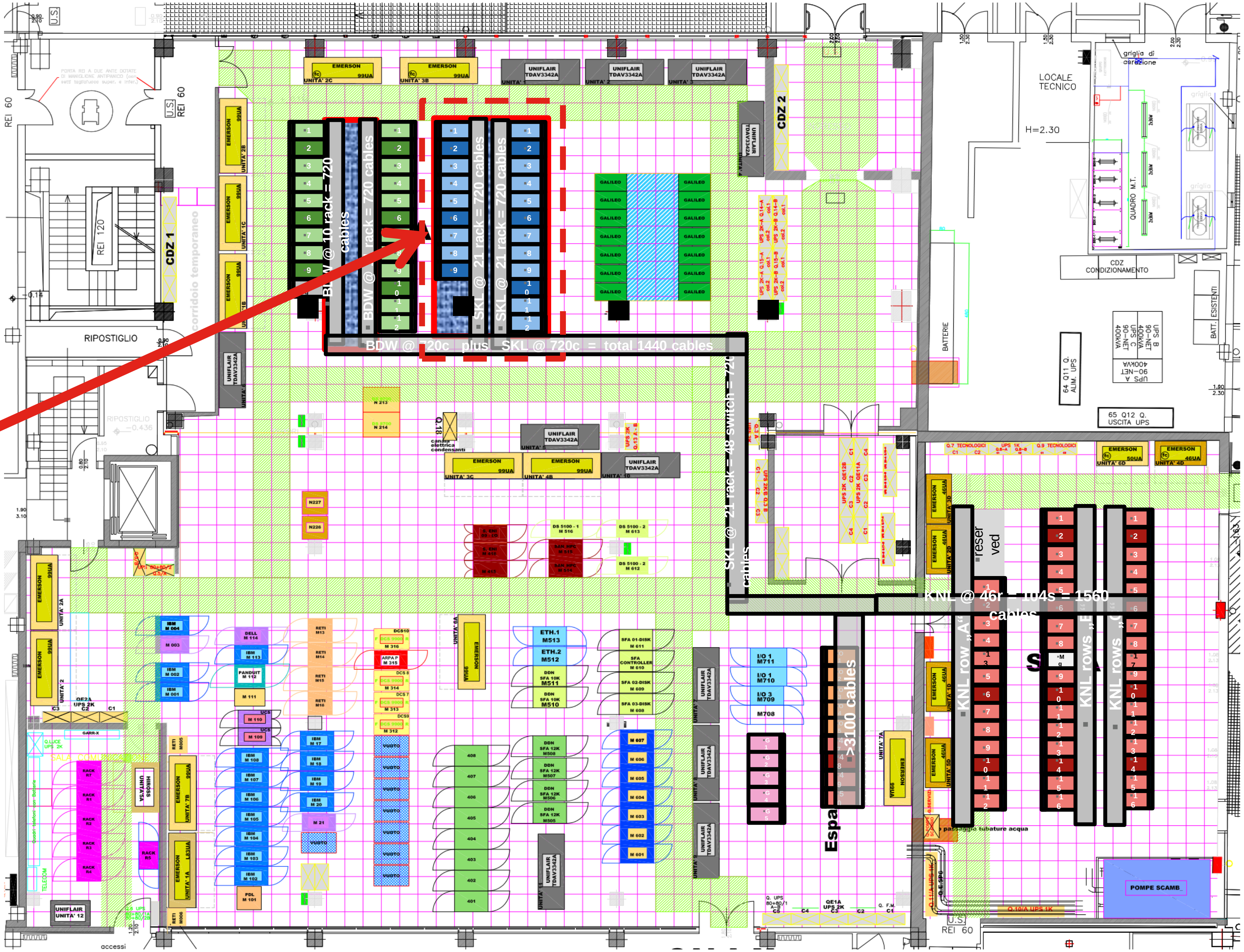
XX GPU Cloud Compute Nodes

Optionally, for using existing Spectrum Scale storage as Cloud backend storage for Block (Cinder), Image (Glance), Compute (Nova), Cloud controllers as well as compute nodes have to be part of a Spectrum Scale cluster and mount Specific file systems / file Sets for this purpose

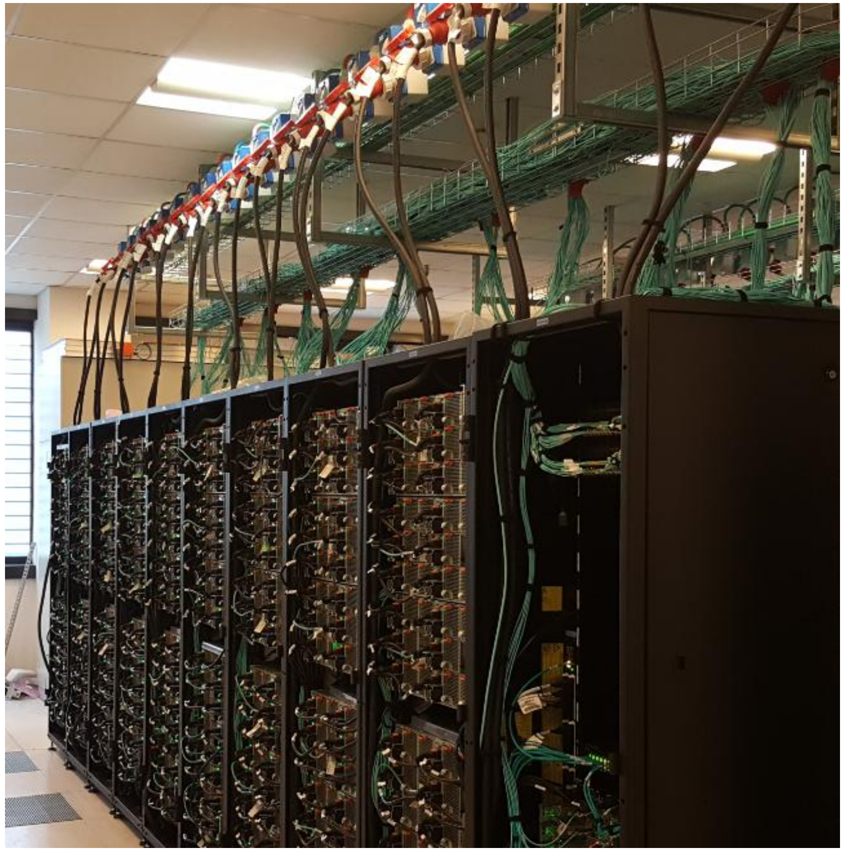
Cineca A3 Floor Plan

A3

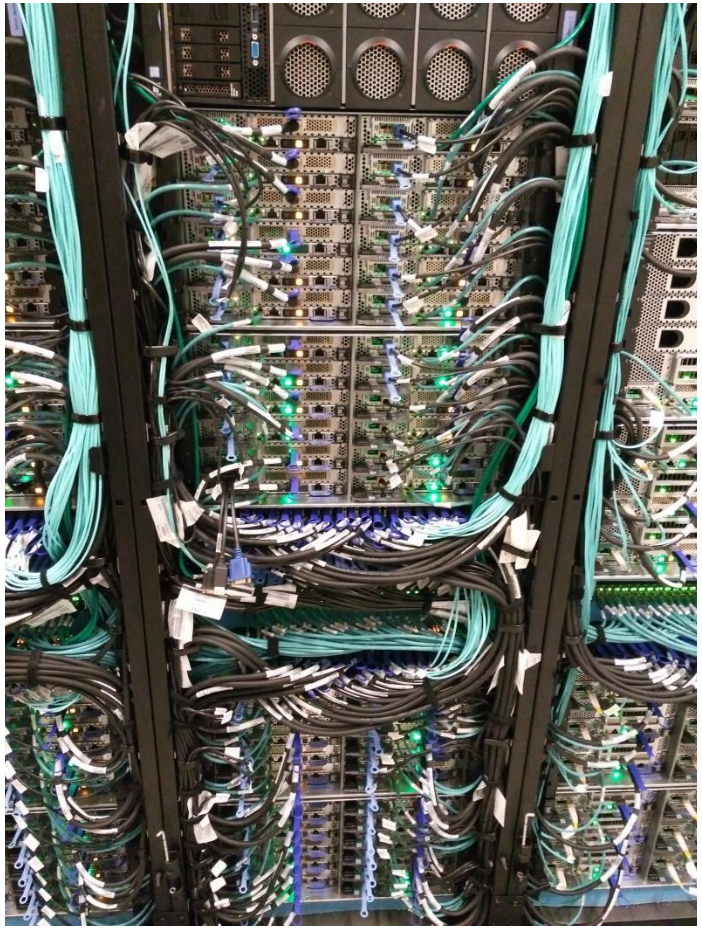
skl-r129 (N300)			skl-r138 (N400)
skl-r130 (N301)			skl-r139 (N401)
skl-r131 (N302)			skl-r140 (N402)
skl-r132 (N303)			skl-r141 (N403)
skl-r133 (N304)			skl-r142 (N404)
skl-r134 (N305)			skl-r142 (N405)
skl-r135 (N306)			skl-r144 (N406)
skl-r136 (N307)			skl-r145 (N407)
skl-r137 (N308)			skl-r146 (N408)
			skl-r147 (N409)
pillar			skl-r148 (N410)
			skl-r149 (N411)


BDW @ 10 rack = 720 cables
BDW @ 10 rack = 720 cables
SKL @ 21 rack = 720 cables
SKL @ 21 rack = 720 cables
BDW @ 720c plus SKL @ 720c = total 1440 cables
SKL @ 21 rack = 48 switch = 720 cables
KNL @ 46r = 104s = 1560 cables
>3100 cables
KNL row „A"
KNL rows „B"
KNL rows „C"
reserved
CDZ 1
CDZ 2
RIPOSTIGLIO
LOCALE TECNICO
H=2.30
BATTERIE
POMPE SCAMB
accessi

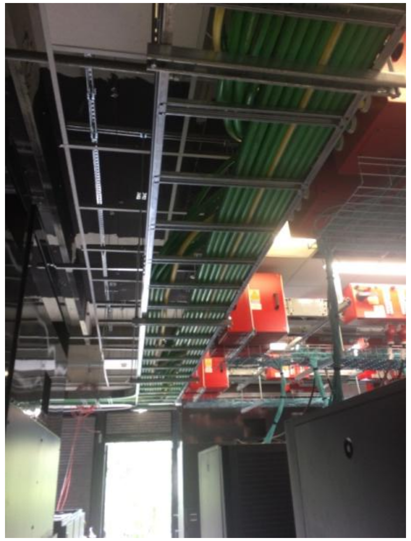
Installation Pictures – A1 Broadwell

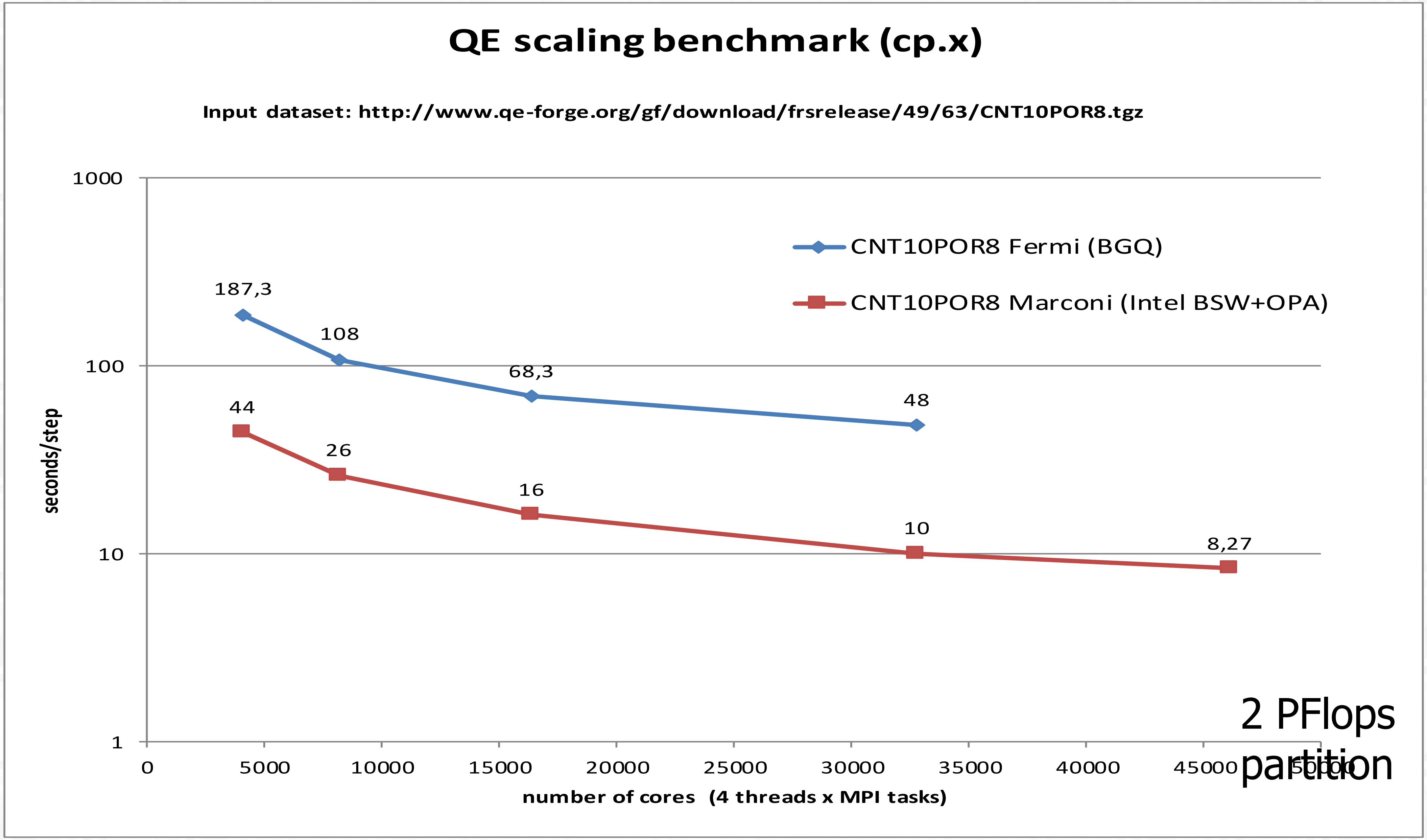


Mgmt & Compute Racks (hot aisle)



Installation Pictures – A2 KNL





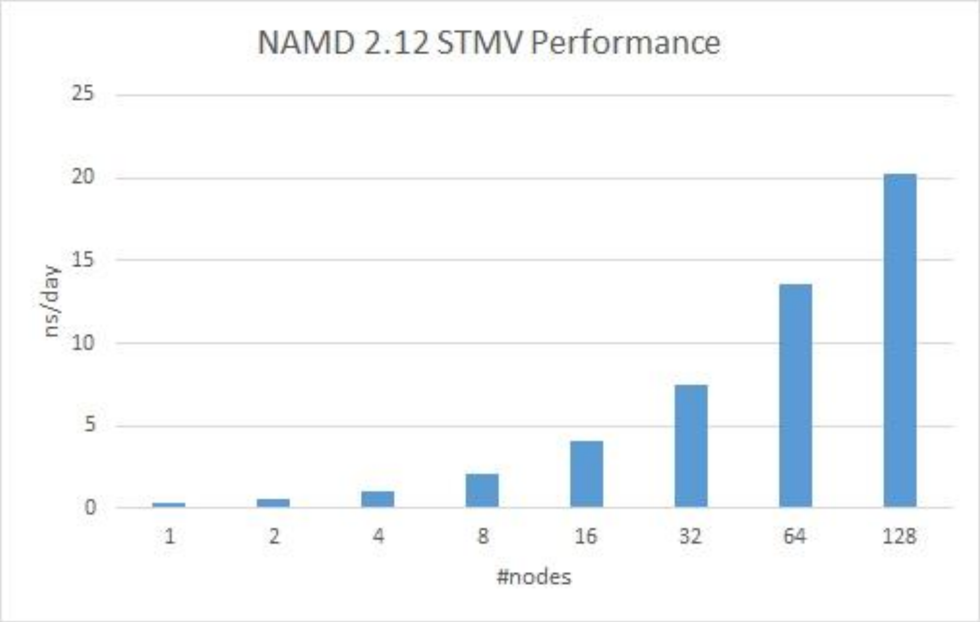
QE scaling benchmark (cp.x)

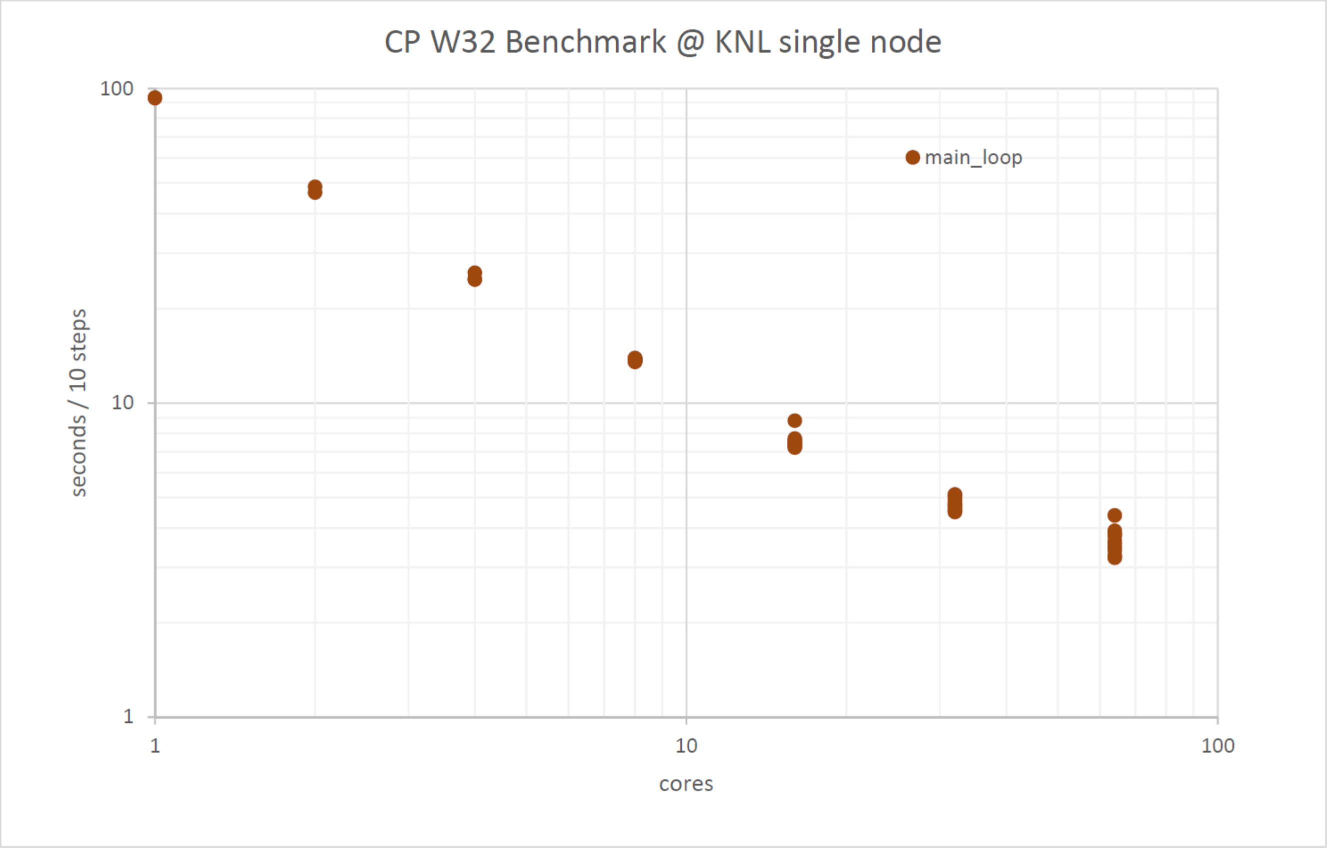
Input dataset: http://www.qe-forge.org/gf/download/frsrelease/49/63/CNT10POR8.tgz

2 PFlops partition

Courtesy by Carlo Cavazzoni - CINECA

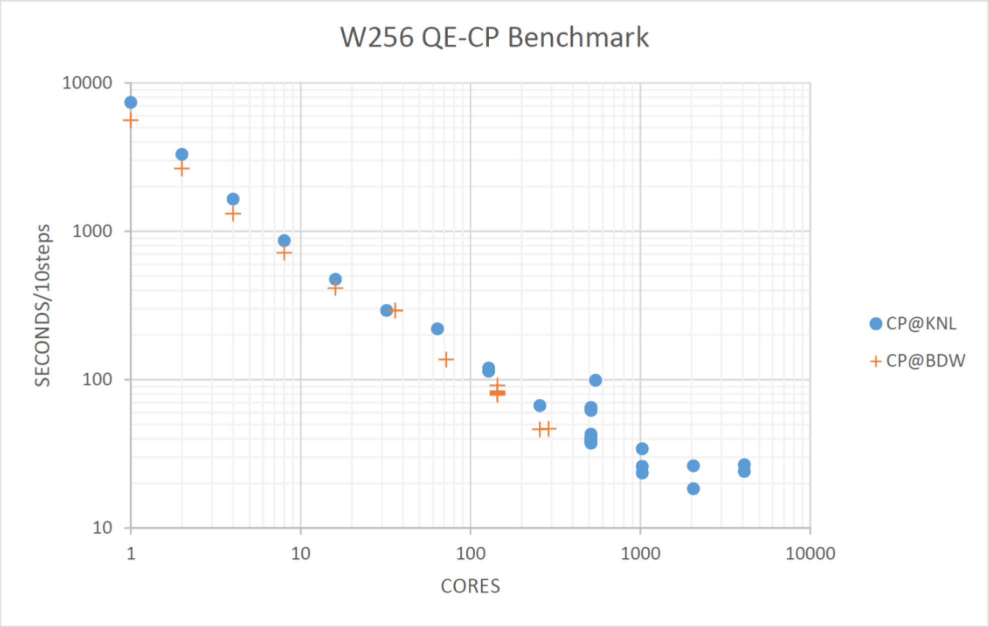
NAMD on A1 Broadwell and CP on A2 KNL single node

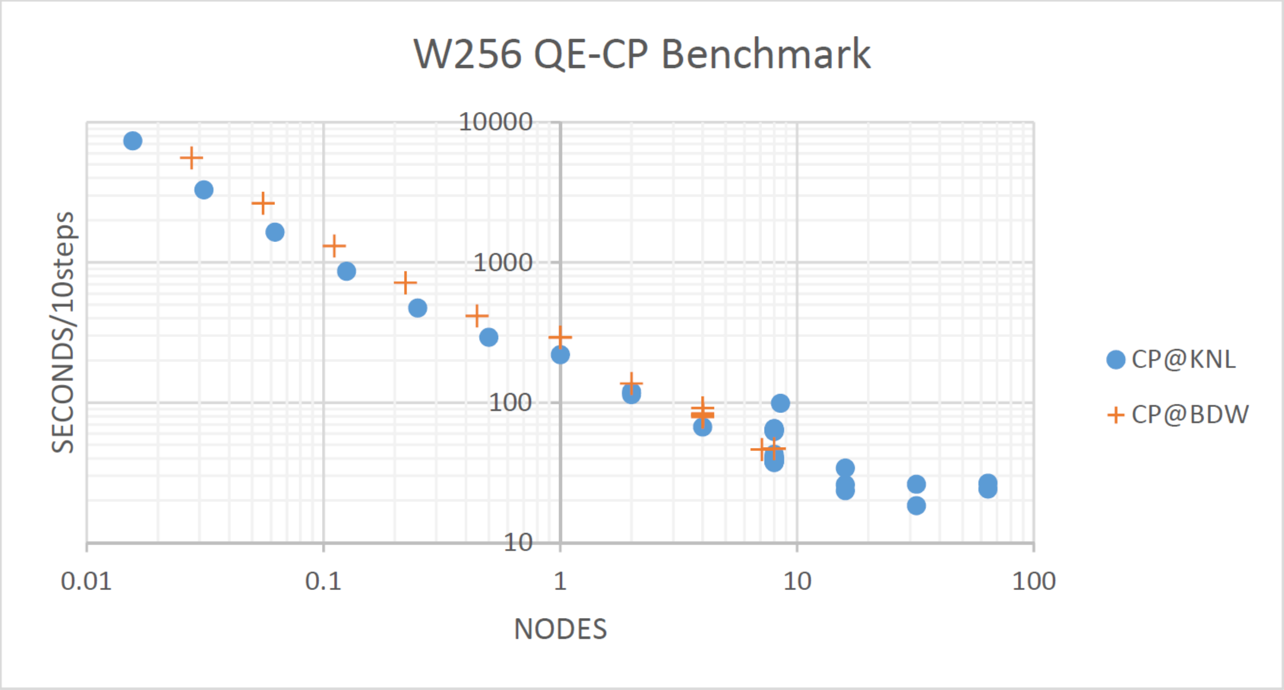




Courtesy by Carlo Cavazzoni - CINECA

QE-CP: A1 Broadwell vs A2 KNL





Courtesy by Carlo Cavazzoni - CINECA

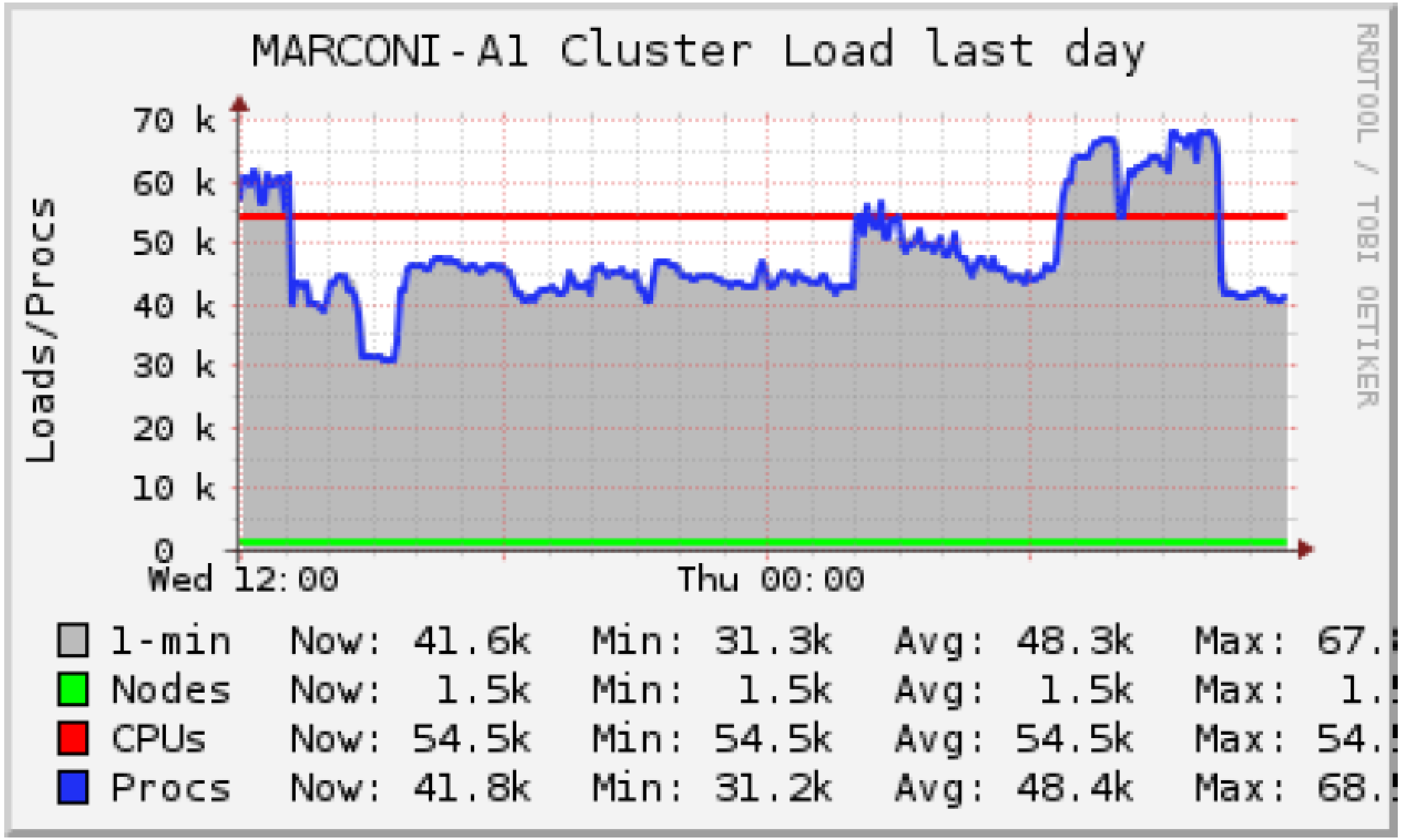
MARCONI-A1 (physical view)

CPUs Total:	**54524**
Hosts up:	**1520**
Hosts down:	**0**

Current Load Avg (15, 5, 1m):
76%, 76%, 76%

Avg Utilization (last day):
89%

Localtime:
2017-01-19 10:50



▨	1-min	Now: 41.6k	Min: 31.3k	Avg: 48.3k	Max: 67.
🟩	Nodes	Now: 1.5k	Min: 1.5k	Avg: 1.5k	Max: 1.
🟥	CPUs	Now: 54.5k	Min: 54.5k	Avg: 54.5k	Max: 54.
🟦	Procs	Now: 41.8k	Min: 31.2k	Avg: 48.4k	Max: 68.

Courtesy

THANK YOU

DAKUJEM DANK BEDANKT MERCI TAKK 谢谢

ありがとう СПАСИБО GRACIAS DZIĘKUJĘ DANKE

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