



Interconnect Your Future
Enabling the Best Datacenter Return on Investment

TOP500 Supercomputers, June 2016

 **Mellanox**
TECHNOLOGIES
Connect. Accelerate. Outperform.™

Most Deployed Interconnect in High Performance Computing Platforms

The TOP500 List has Evolved

Includes HPC & Cloud / Web2.0 Hyperscale Systems *(Mainly APAC-based)*

- Mellanox connects the World's Fastest Supercomputer*, 93 Petaflops of performance delivered
- Mellanox connects 41.2% of overall TOP500 systems, and 70.4% of the TOP500 HPC platforms
- Mellanox connects 46 Petascale systems, Nearly 50% of the total Petascale systems on the TOP500

* Source: "Report on the Sunway TaihuLight System", Jack Dongarra (University of Tennessee) , June 20, 2016 (Tech Report UT-EECS-16-742)

Mellanox Connects the World's Fastest Supercomputer*



National Supercomputing Center in Wuxi, China - #1 on the TOP500 List

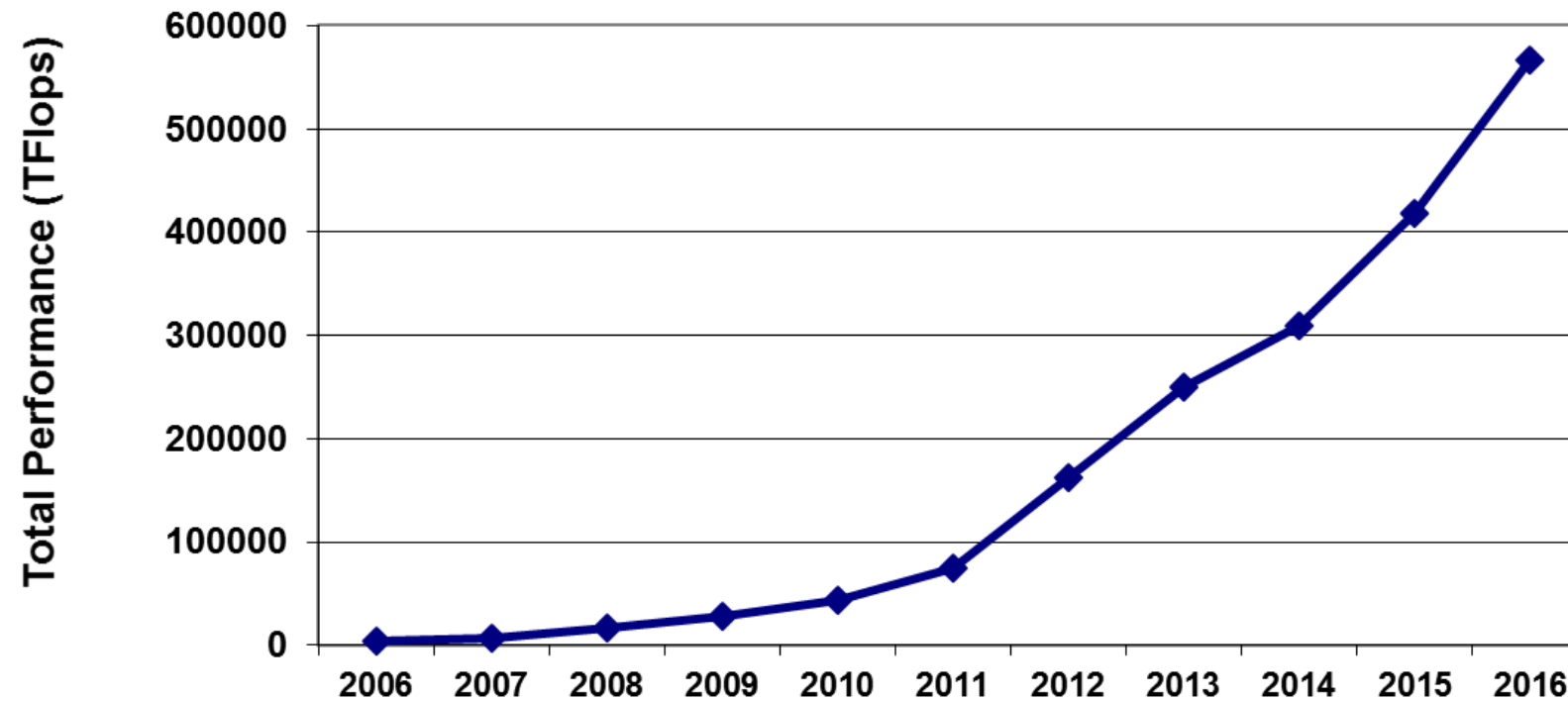
- 93 Petaflop performance, 3X higher versus #2 on the TOP500
- 40K nodes, 10 million cores, 256 cores per CPU
- Mellanox adapter and switch solutions

* Source: "Report on the Sunway TaihuLight System", Jack Dongarra (University of Tennessee) , June 20, 2016 (Tech Report UT-EECS-16-742)

- Connects the world fastest supercomputer
 - 93 Petaflops, 41 thousand nodes, and more than 10 million CPU cores
- Fastest Interconnect Solution
 - 100Gb/s throughput, 150 million messages per second, 0.6usec end-to-end latency
- Broadest Adoption in HPC Platforms
 - Connects 70.4% of the HPC platforms, and 41.2% of the overall TOP500 systems
- Preferred Solution in Petascale Systems
 - Connects 46 Petascale systems, nearly 50% of the total Petascale systems on the TOP500 list
- Most Efficient Interconnect Solution
 - Enables the highest system utilization on the TOP500 – 99.8% system efficiency
- Petascale-Proven, Only Standard Interconnect Solution
 - Connects 1.4X the number of Cray based systems in the TOP100, 5X in TOP500
- Most Used Interconnect on the TOP500 for TOP 100, 200 and TOP 300 systems

Paving The Road to Exascale Performance

Total Performance of the TOP500

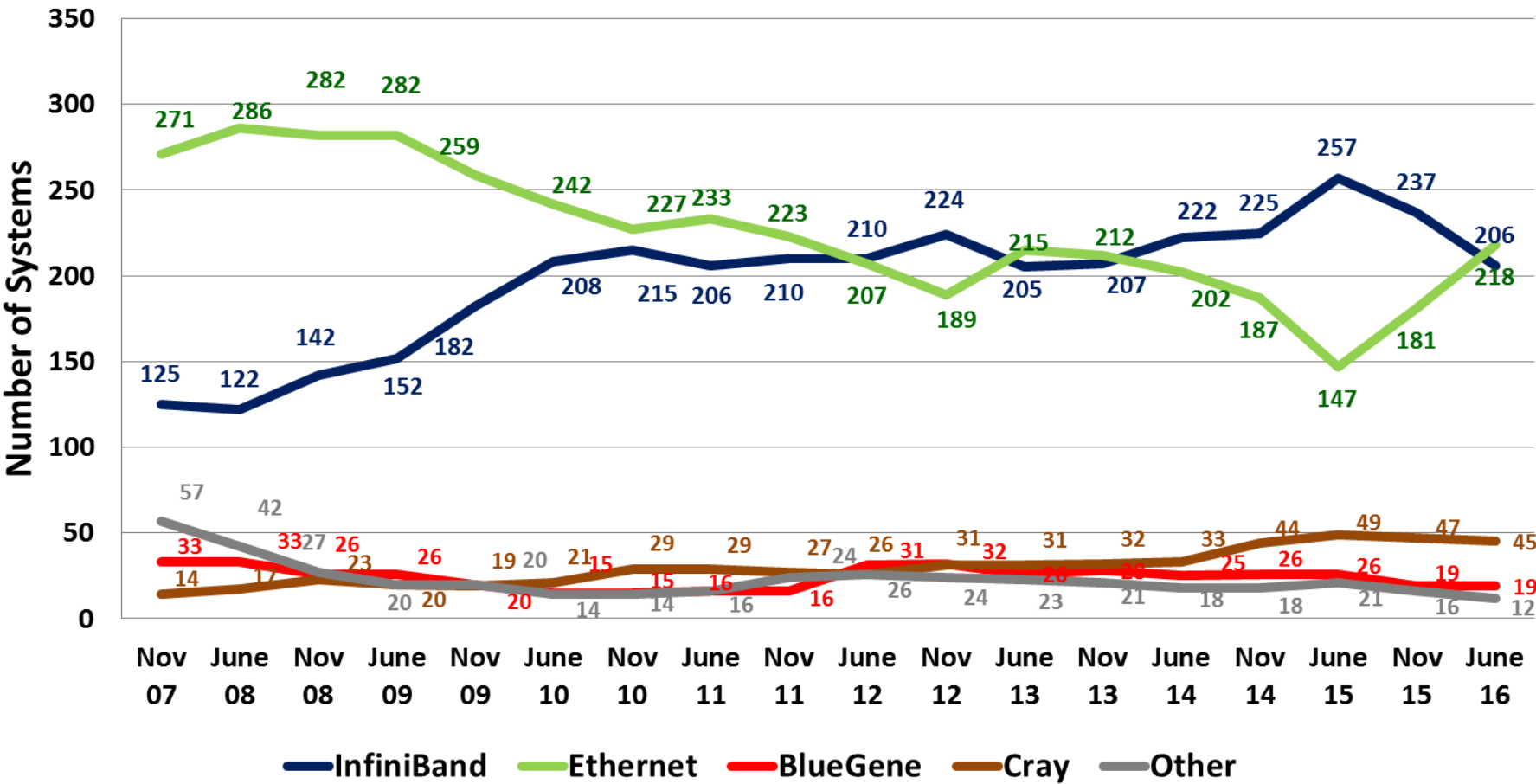


- Explosive market growth
- Clusters continue to dominate with 86% systems of the TOP500 list

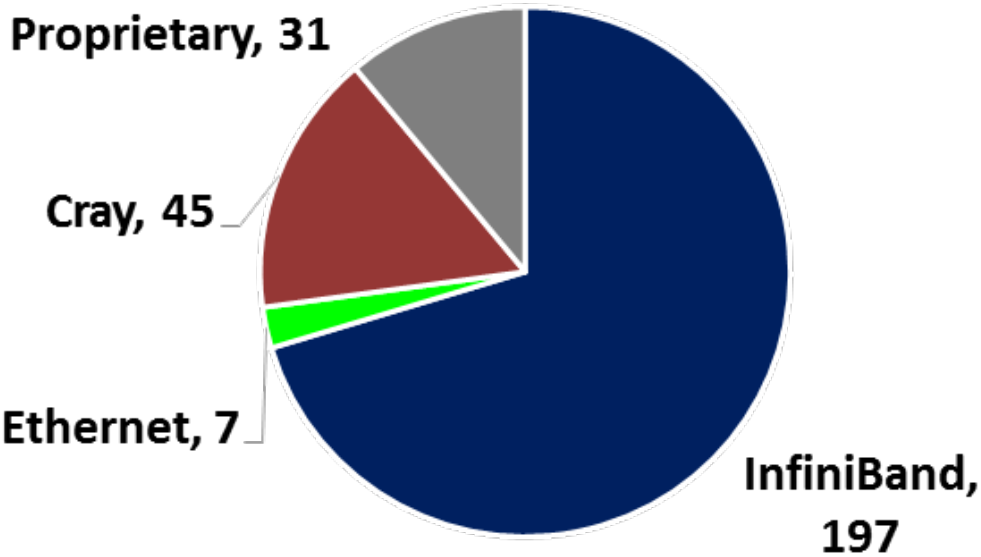
Mellanox InfiniBand Solutions Provide the Highest Systems Utilization on the TOP500



TOP500 Interconnect Trends

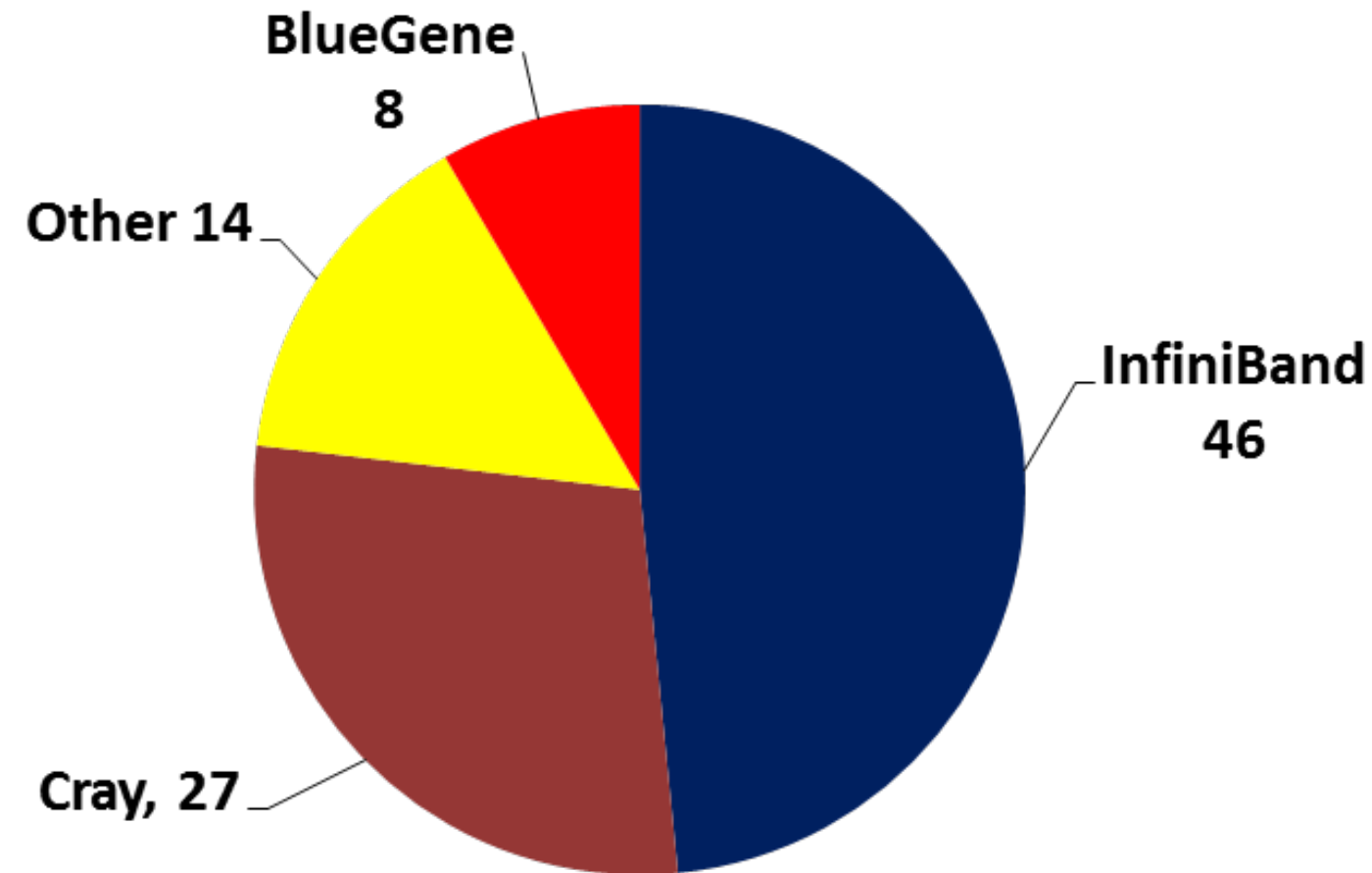


TOP500 - HPC Systems



The TOP500 List has Evolved to Include Both HPC and Cloud / Web2.0 Hyperscale (Mainly APAC-based) Platforms. For the HPC Platforms, InfiniBand Continues it's Leadership as the Most Used Interconnect Solution for High-Performance Compute and Storage Infrastructures

PetaFlops Systems on the TOP500 list



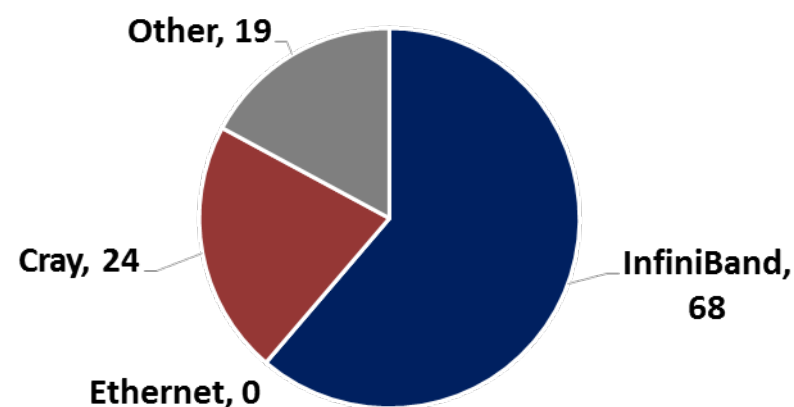
InfiniBand is the Interconnect of Choice for Petascale Computing

Accelerates Nearly 50% of the Petaflop Systems

TOP500: Overall Market Segments (Major Industries)

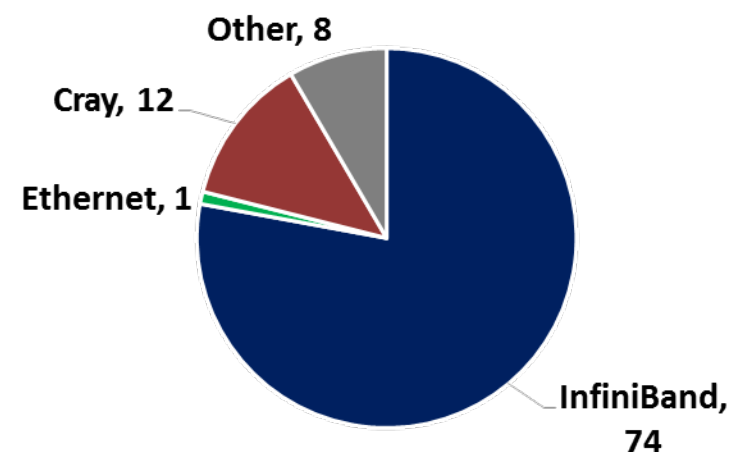


TOP500 Market Segment - Research



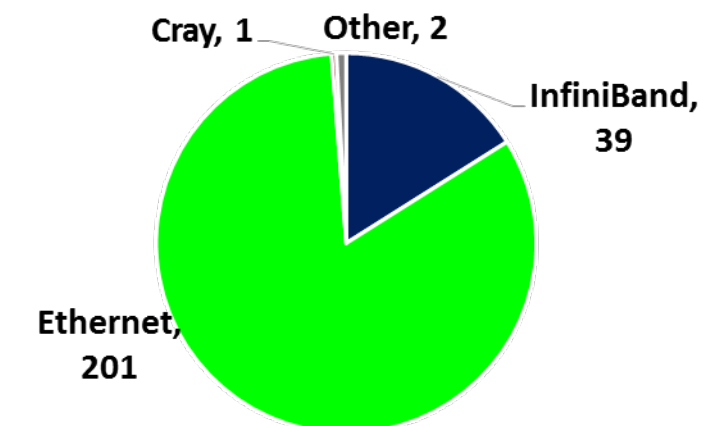
**InfiniBand Accelerates 61%
of HPC Research Systems**

TOP500 Market Segment - Academic



**InfiniBand Accelerates 78%
of HPC Academic Systems**

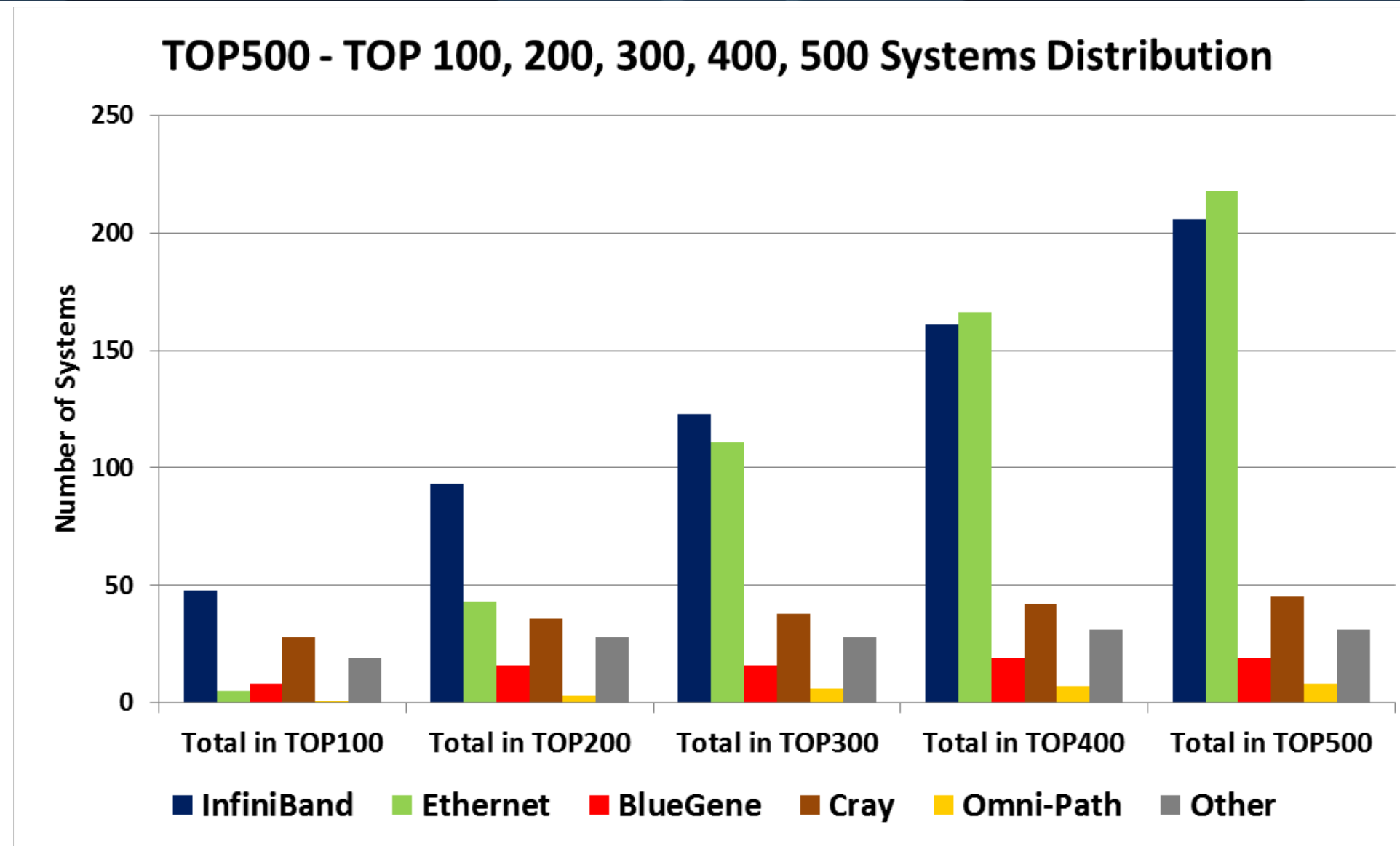
TOP500 Market Segment - Industry



**InfiniBand Accelerates 17%
of Cloud, Web2.0 etc.
Industry Systems**

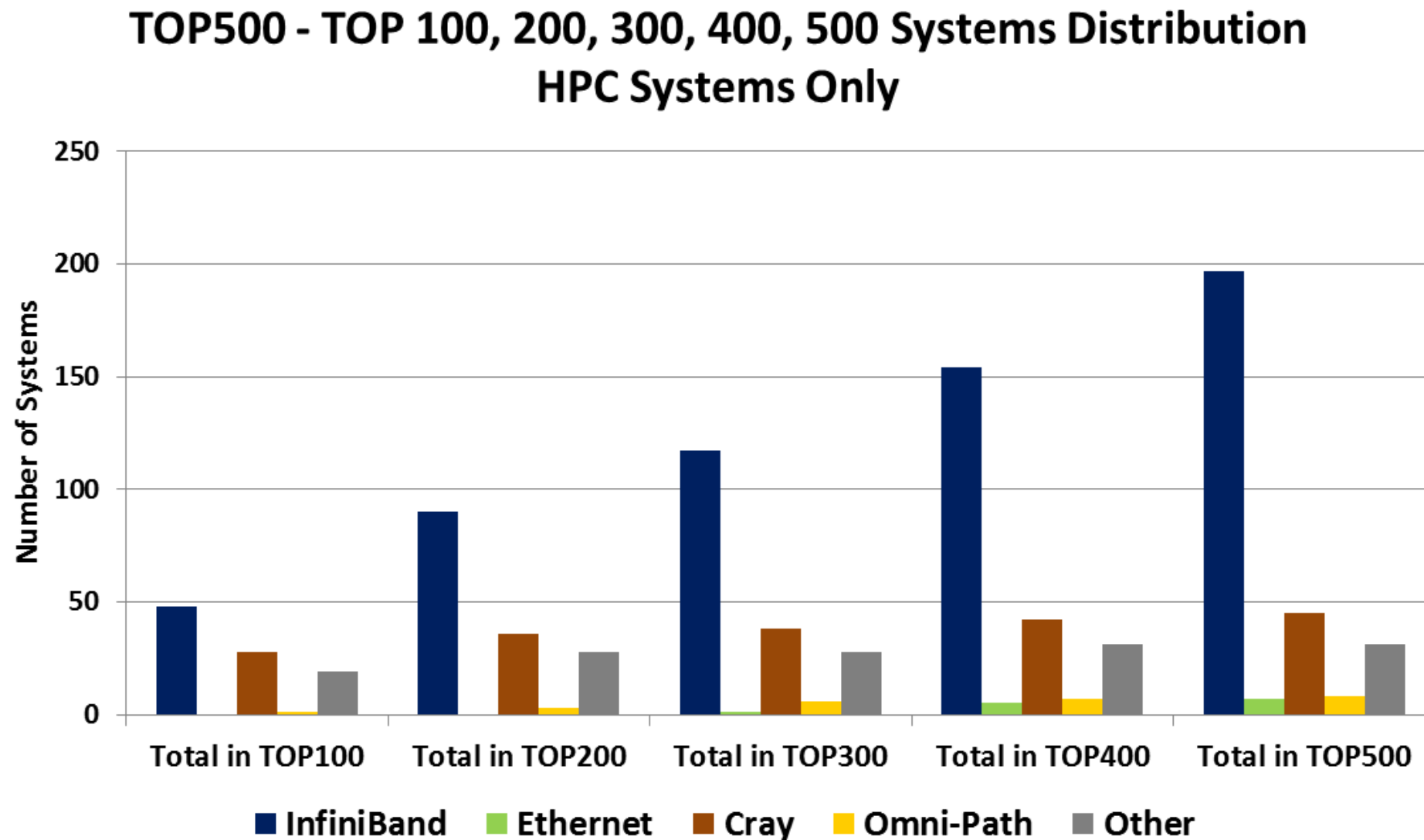
Mellanox InfiniBand is the Interconnect of Choice for HPC Infrastructures

InfiniBand versus Ethernet – TOP100, 200, 300, 400, 500



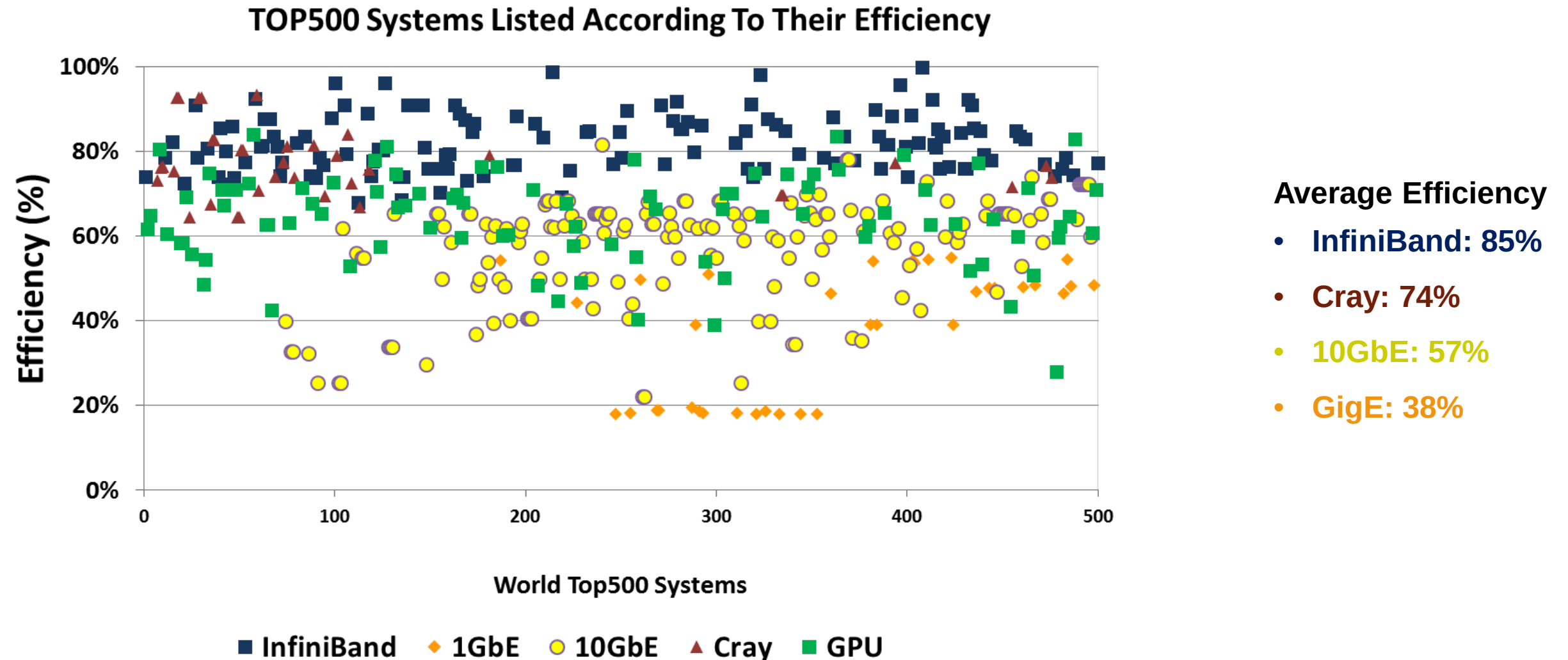
InfiniBand is The Most Used Interconnect of the TOP100, 200, 300 Supercomputers
Superior Performance, Scalability, Efficiency and Return-On-Investment

InfiniBand versus Ethernet – TOP100, 200, 300, 400, 500 HPC Systems Only (Excluding Cloud, Web2.0 etc. Systems)



InfiniBand is The Most Used Interconnect For HPC Systems
Superior Performance, Scalability, Efficiency and Return-On-Investment

InfiniBand's Unsurpassed System Efficiency



InfiniBand is Key For the System Efficiency

Mellanox Delivers Highest Systems Efficiency of 99.8% with InfiniBand

Maximum Efficiency and Return on Investment



- Mellanox Smart Interconnect Solutions Enables In-Network Computing & CPU-Offloading
- Critical with CPU accelerators and higher scale deployments
- Ensures Highest system efficiency and overall return on investment

InfiniBand

System name: JURECA
TOP500 Rank: 57
CPU Accelerator: Yes
System Efficiency: 84%

Number of TOP500 Systems with CPU Accelerators: 63

53% Higher System Efficiency!

Omni-Path

System name: Stampede-KNL
TOP500 Rank: 116
CPU Accelerator : Yes
System Efficiency: 55%

Number of TOP500 Systems with CPU Accelerators: 1

45% System Resources not Utilized!

HPC CPAR (Cost Per Application Rating) Benchmark (\$/Performance)



Application	InfiniBand		Omni-Path		InfiniBand Performance Advantage	InfiniBand CPAR Advantage
	Performance (Rating – Number of Simulation per Day, Higher better)	CPAR (\$ per Rating, Lower Better)	Performance (Rating – Number of Simulations per Day, Higher better)	CPAR (\$ per Rating, Lower Better)		
LS-DYNA (Neon-Refined-Revised)	2009.302	\$58.47	1234.286	\$89.45	63%	35%
LS-DYNA (3-cars)	285.1485	\$690.66	200.9302	\$932.86	42%	26%
WIEN2k	192	\$519.89	143.2255	\$651.34	34%	20%
Quantum ESPRESSO	1443.567	\$69.15	1016.112	\$91.81	42%	25%
Average					45%	27%

InfiniBand Enables Higher Applications Performance with Lower System Cost!

Accelerating DOE Leadership Systems (“CORAL”)



“Summit” System



“Sierra” System



Proud to Pave the Path to Exascale

Highest-Performance 100Gb/s Interconnect Solutions

Adapters

ConnectX[®] 5

100Gb/s Adapter, 0.6us latency
200 million messages per second
(10 / 25 / 40 / 50 / 56 / 100Gb/s)



Switch

SwitchIB[™] 2

36 EDR (100Gb/s) Ports, <90ns Latency
Throughput of 7.2Tb/s
7.02 Billion msg/sec (195M msg/sec/port)



Switch

Spectrum[™]

32 100GbE Ports, 64 25/50GbE Ports
(10 / 25 / 40 / 50 / 100GbE)
Throughput of 6.4Tb/s



Interconnect

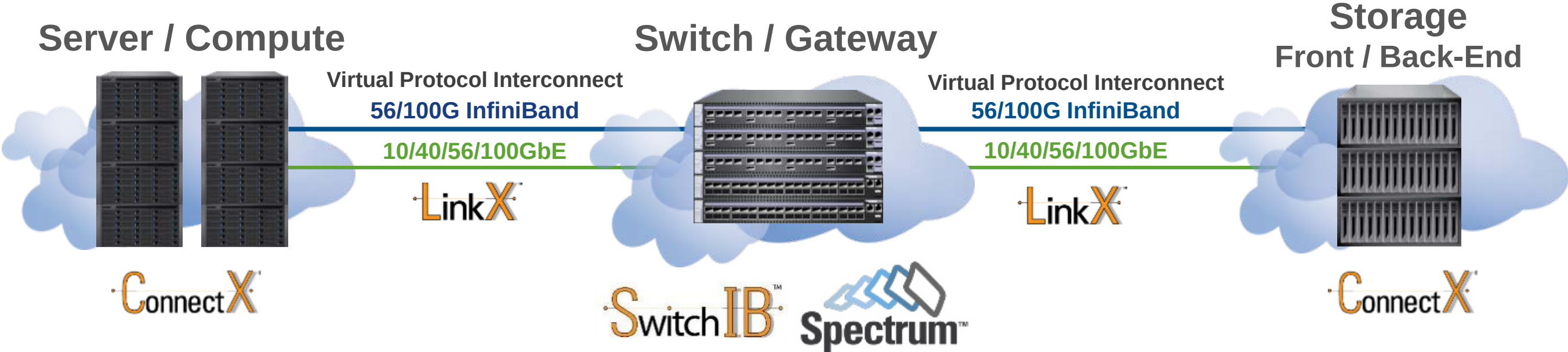
LinkX[™]

Transceivers
Active Optical and Copper Cables
(10 / 25 / 40 / 50 / 56 / 100Gb/s)



VCSELs, Silicon Photonics and Copper

Leading Supplier of End-to-End Interconnect Solutions

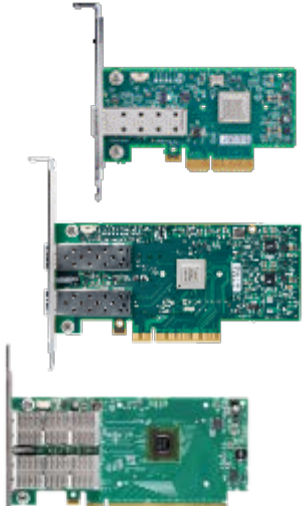


Comprehensive End-to-End InfiniBand and Ethernet Portfolio (VPI)

NIC ICs



Adapter Cards



NPU & Multicore



Switches/Gateways



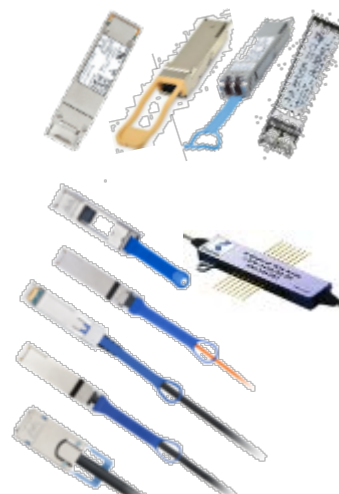
Software



Metro / WAN



Cables/Modules



Smart Network For Smart Systems

RDMA, Acceleration Engines, Programmability

Higher Performance
Unlimited Scalability
Higher Resiliency
Proven!



100
Gb/s
Link Speed

2014



200
Gb/s
Link Speed

2017

Gain Competitive Advantage Today
Protect Your Future

Message Rate

68%
Higher

Latency

20%
Lower

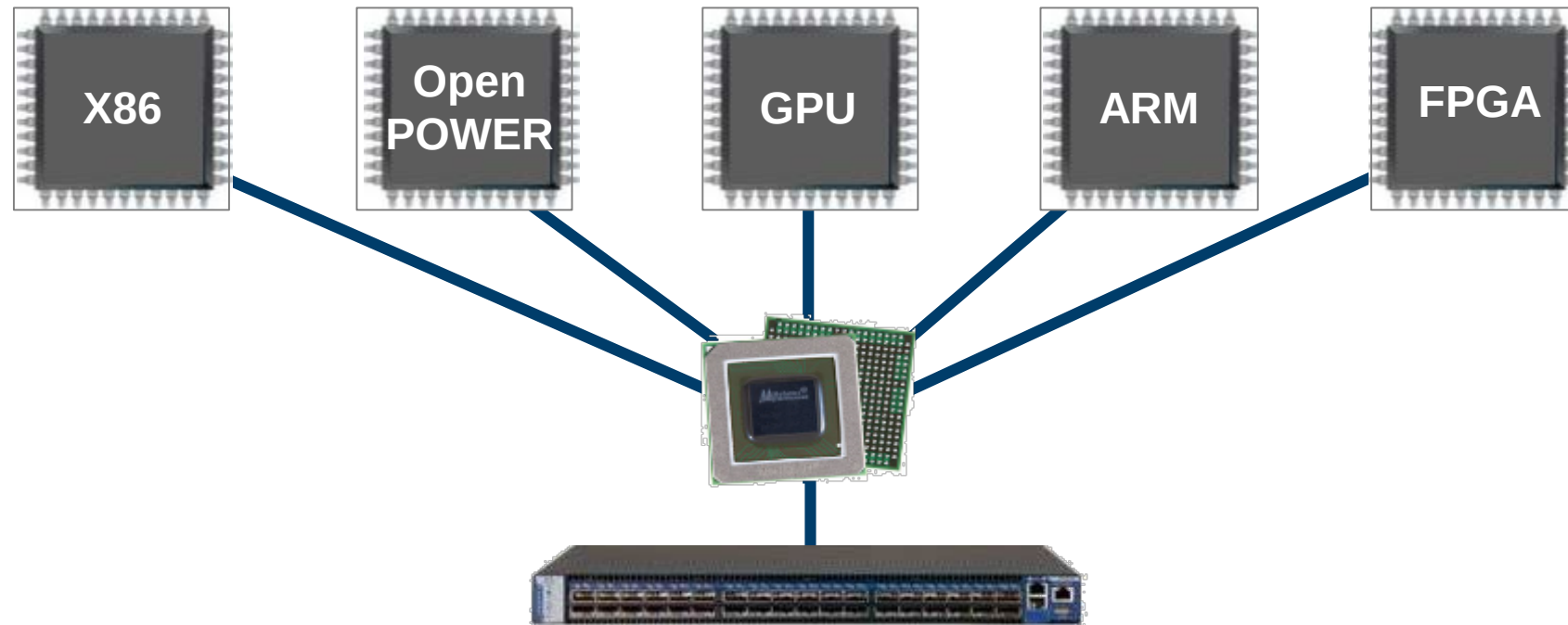
Application
Performance

34-62%
Higher

Cost/Performance
(CPAR - \$/Performance)

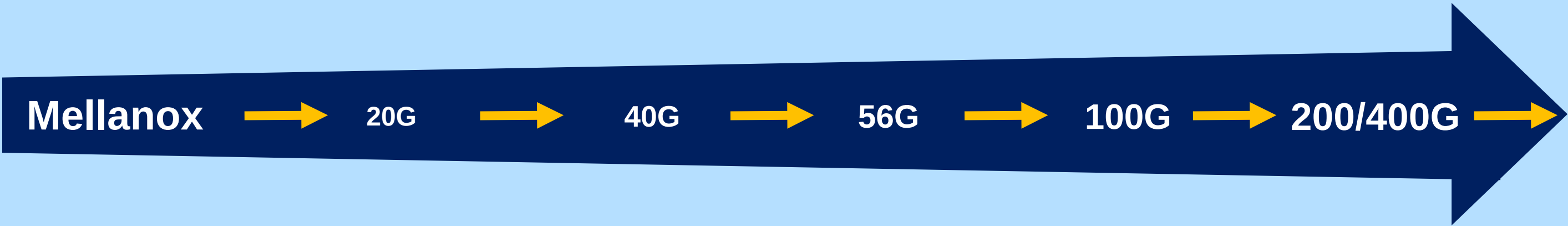
20-35%
Lower

Highest Performance and Scalability for X86, Power, GPU, ARM and FPGA-based Compute and Storage Platforms 10, 20, 25, 40, 50, 56 and 100Gb/s Speeds



Smart Interconnect to Unleash The Power of All Compute Architectures

Technology Roadmap – One-Generation Lead over the Competition



Terascale

3rd



TOP500 2003
Virginia Tech (Apple)

1st



"Roadrunner"
Mellanox Connected

Petascale



Exascale

OAK RIDGE
National Laboratory

"Summit" System

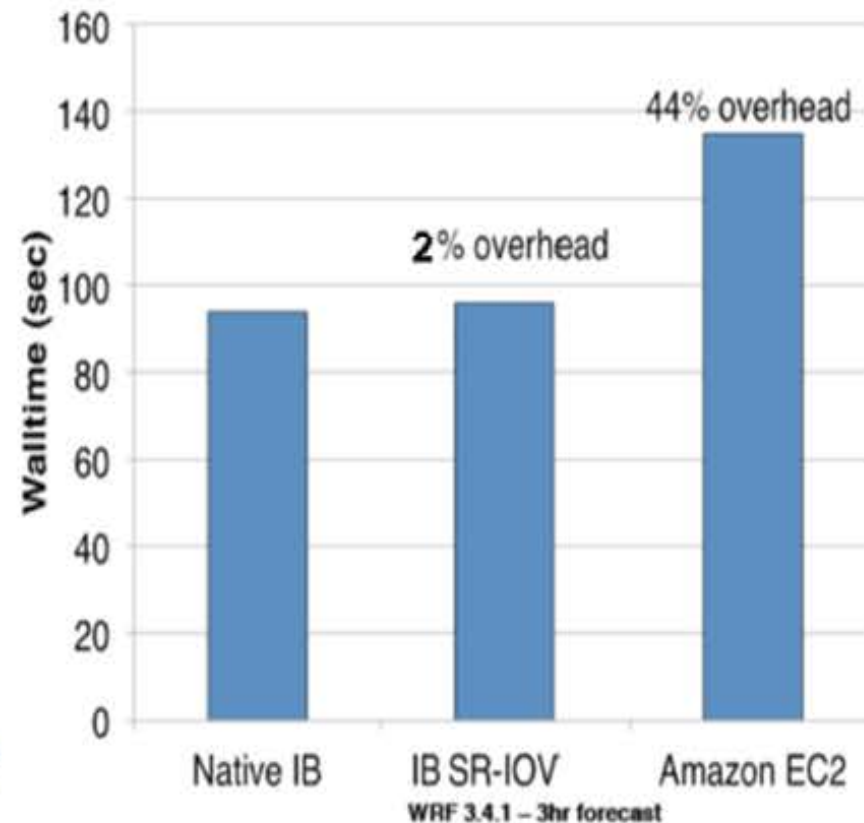
Lawrence Livermore
National Laboratory

"Sierra" System

2000 2005 2010 2015 2020

WRF Weather Modeling

SR-IOV incurs
modest (2%)
performance hit

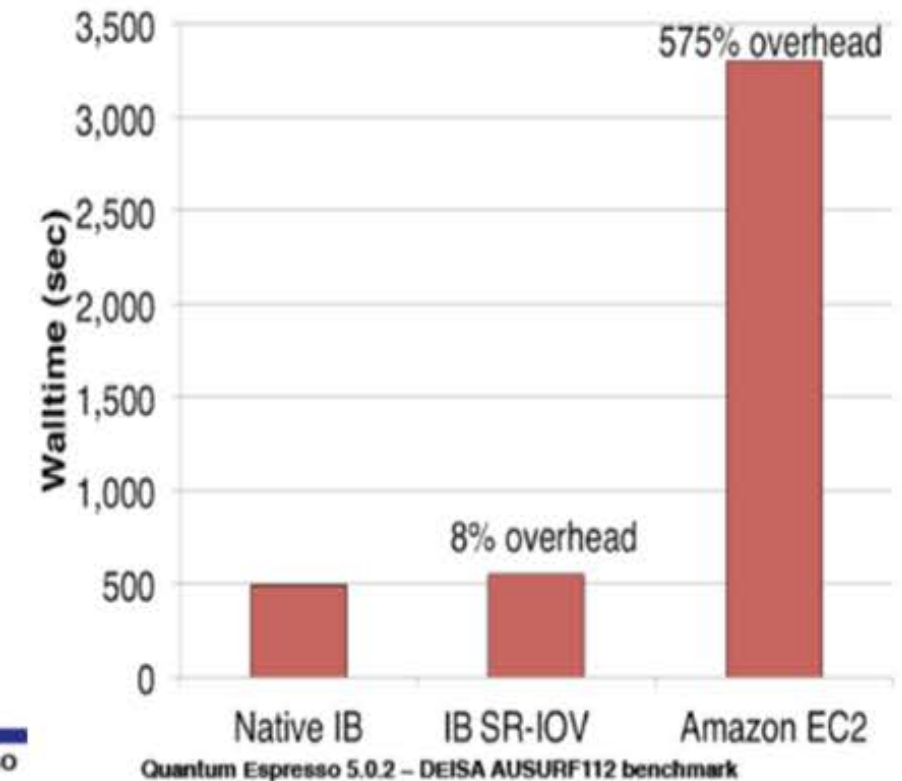


SDSC

SAN DIEGO SUPERCOMPUTER CENTER
at the UNIVERSITY OF CALIFORNIA; SAN DIEGO

Quantum ESPRESSO

8% slower
w/ SR-IOV vs
native IB



SDSC

SAN DIEGO SUPERCOMPUTER CENTER
at the UNIVERSITY OF CALIFORNIA; SAN DIEGO

**San Diego Supercomputing Center “Comet” Connects HPC Cloud
With Mellanox InfiniBand**

- Scalable, flexible, high performance, end-to-end connectivity
- Standards-based (InfiniBand, Ethernet), supported by large eco-system
- Supports all compute architectures: x86, Power, ARM, GPU, FPGA etc.
- Offloading architecture: RDMA, application acceleration engines, etc.
- Flexible topologies: Fat Tree, Mesh, 3D Torus, Dragonfly+, etc.
- Converged I/O: compute, storage, management on single fabric
- Backward and future compatible

**Speed-Up Your Present, Protect Your Future
Pave the Path to Exascale Together**

Wuxi Supercomputing Center – World's Fastest Supercomputer



- 93 Petaflop performance, 3X higher versus #2 on the TOP500
- 40K nodes, 10 million cores, 256 cores per CPU
- Mellanox adapter and switch solutions

Petaflop
Mellanox Connected



“Pangea” system

- SGI Altix X system, 220K cores
- Mellanox InfiniBand
- 5.3 Petaflops (sustained performance)
- 80% efficiency



Petaflop
Mellanox Connected



“Stampede” system

- Mellanox InfiniBand
- 5.2 Petaflops
- 6,000+ Dell nodes
- 462462 cores, Intel Phi co-processors

TACC

Petaflop
Mellanox Connected



Pleiades system

- 20K Mellanox InfiniBand nodes
- 4 Petaflops (sustained performance)
- SGI Altix ICE
- Supports variety of scientific and engineering projects
 - Coupled atmosphere-ocean models
 - Future space vehicle design
 - Large-scale dark matter halos and galaxy evolution



Petaflop
Mellanox Connected



“HPC2” system

- IBM iDataPlex DX360M4
- NVIDIA K20x GPUs
- 3.2 Petaflops
- Mellanox InfiniBand

Petaflop
Mellanox Connected



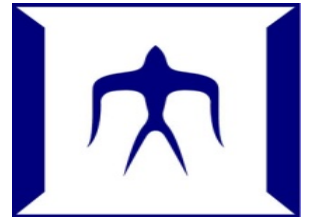
IBM iDataPlex and Intel Sandy Bridge

- 147456 cores
- Mellanox InfiniBand solutions
- 2.9 sustained Petaflop performance
- The fastest supercomputer in Europe
- 91% efficiency

Petaflop
Mellanox Connected



- TSUBAME 2.0, first Petaflop system in Japan
- 2.8 PF performance
- HP ProLiant SL390s G7 1400 servers
- Mellanox InfiniBand



“Cascade” system

- Mellanox InfiniBand
- 2.5 sustained Petaflop performance
- Atipa Visione IF442 Blade Server
- Intel Xeon Phi 5110P accelerator



Pacific Northwest
NATIONAL LABORATORY

Petaflop
Mellanox Connected



Occigen system

- Mellanox InfiniBand
- 1.6 sustained Petaflop performance
- Bull bullx DLC



Petaflop
Mellanox Connected



“Spirit” system

- Mellanox InfiniBand
- 1.4 sustained Petaflop performance
- SGI Altix X system, 74584 cores
- 92.5% efficiency



Petaflop
Mellanox Connected



- Mellanox InfiniBand solutions
- 1.36 sustained Petaflop performance
- Bull Bullx B510
- 77184 cores Intel Sandy Bridge



Petaflop
Mellanox Connected



- Mellanox InfiniBand solutions
- 1.3 sustained Petaflop performance
- IBM iDataPlex DX360M4



Petaflop
Mellanox Connected



The first Petaflop systems in China

- Mellanox InfiniBand solutions
 - ConnectX-2 and IS5000 switches
- 1.27 sustained Petaflop performance
- Dawning TC3600 Blade Supercomputer
- 5200 nodes, 120640 cores, NVIDIA GPUs



Shenzhen Institutes of Advanced Technology

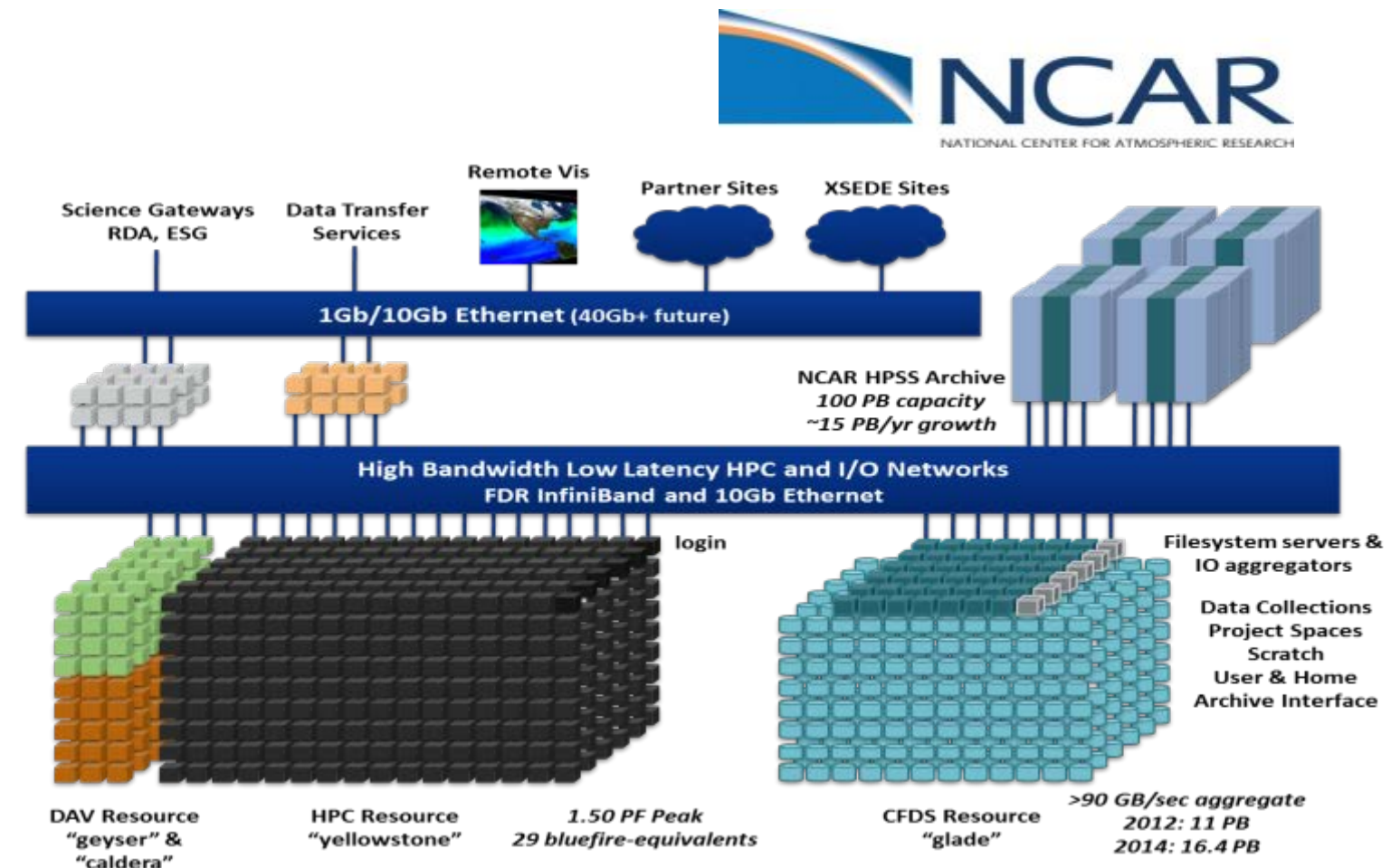


“Yellowstone” system

- Mellanox InfiniBand, full fat tree, single plane
- 1.3 sustained Petaflop performance
- 72,288 processor cores, 4,518 nodes (IBM)



Petaflop
Mellanox Connected



International Fusion Energy Research Centre (IFERC), EU(F4E) - Japan Broader Approach collaboration



- Mellanox InfiniBand solutions
- 1.24 sustained Petaflop performance
- Bull Bullx B510
- 70560 cores Intel Sandy Bridge



Petaflop
Mellanox Connected

The “Cartesius” system - the Dutch supercomputer

- Mellanox InfiniBand solutions
- 1.05 sustained Petaflop performance
- Bull Bullx DLC B710/B720 system



Tera 100, first Petaflop system in Europe

- Mellanox InfiniBand
- 1.05 PF performance
- 4,300 Bull S Series servers
- 140,000 Intel® Xeon® 7500 processing cores
- 300TB of central memory, 20PB of storage



Petaflop
Mellanox Connected



Fujitsu PRIMERGY CX250 S1

- Mellanox InfiniBand
- 980 Tflops performance



THE AUSTRALIAN NATIONAL UNIVERSITY



“MareNostrum 3” system

- Mellanox InfiniBand
- 1.1 Petaflops peak performance
- ~50K cores, 91% efficiency



**Barcelona
Supercomputing
Center**

Centro Nacional de Supercomputación



Thank You