InfiniBand Strengthens Leadership as the Interconnect Of Choice By Providing Best Return on Investment
TOP500 Performance Trends

- Explosive high-performance computing market growth
- Clusters continue to dominate with 86% of the TOP500 list

Mellanox InfiniBand solutions provide the highest systems utilization in the TOP500 for both high-performance computing and clouds
TOP500 Major Highlights

- InfiniBand is the de-facto Interconnect solution for High-Performance Computing
  - Positioned to continue and expand in Cloud and Web 2.0

- InfiniBand is the most used interconnect on the TOP500 list, connecting 225 systems
  - Increasing 8.7% year-over-year, from 207 system in Nov’13 to 225 in Nov’14

- FDR InfiniBand is the most used technology on the TOP500 list, connecting 141 systems
  - Grew 1.8X year-over-year from 80 systems in Nov’13 to 141 in Nov’14

- InfiniBand enables the most efficient system on the list with 99.8% efficiency – record!

- InfiniBand enables 24 out of the 25 most efficient systems (and the top 17 most efficient systems)

- InfiniBand is the most used interconnect for Petascale-performance systems with 24 systems
InfiniBand in the TOP500

- InfiniBand is the most used interconnect technology for high-performance computing
  - InfiniBand accelerates 225 systems, 45% of the list

- FDR InfiniBand connects the fastest InfiniBand systems
  - TACC (#7), Government (#10), NASA (#11), Eni (#12), LRZ (#14)

- InfiniBand connects the most powerful clusters
  - 24 of the Petascale-performance systems

- The most used interconnect solution in the TOP100, TOP200, TOP300, TOP400
  - Connects 48% (48 systems) of the TOP100 while Ethernet only 2% (2 system)
  - Connects 51.5% (103 systems) of the TOP200 while Ethernet only 15.5% (31 systems)
  - Connects 50.7% (152 systems) of the TOP300 while Ethernet only 24.3% (73 systems)
  - Connects 49% (196 systems) of the TOP400 while Ethernet only 29.8% (119 systems)
  - Connects 45% (225 systems) of the TOP500, Ethernet connects 37.4% (187 systems)

- InfiniBand is the interconnect of choice for accelerator-based systems
  - 80% of the accelerator-based systems are connected with InfiniBand

- Diverse set of applications
  - High-end HPC, commercial HPC, Cloud and enterprise data center
Mellanox in the TOP500

- **Mellanox FDR InfiniBand is the fastest interconnect solution on the TOP500**
  * More than 12GB/s throughput, less than 0.7usec latency
  * Being used in 141 systems on the TOP500 list – 1.8X increase from the Nov’13 list
  * Connects the fastest InfiniBand-based supercomputers
    - TACC (#7), Government (#10), NASA (#11), Eni (#12), LRZ (#14)

- **Mellanox InfiniBand is the most efficient interconnect technology on the list**
  * Enables the highest system utilization on the TOP500 – 99.8% system efficiency
  * Enables the top 17 and 24 out of 25 highest utilized systems on the TOP500 list

- **Mellanox InfiniBand is the only Petascale-proven, standard interconnect solution**
  * Connects 24 out of the 54 Petaflop-performance systems on the list
  * Connects 1.5X the number of Cray based systems in the Top100, 5X in TOP500

- **Mellanox’s end-to-end scalable solutions accelerate GPU-based systems**
  * GPUDirect RDMA technology enables faster communications and higher performance
InfiniBand is the de-facto interconnect solution for performance demanding applications.
Mellanox InfiniBand is the interconnect of choice for Petascale computing
- Overall 24 system of which 19 System use FDR InfiniBand
TOP100: Interconnect Trends

- InfiniBand is the most used interconnect solution in the TOP100
- The natural choice for world-leading supercomputers: performance, efficiency, scalability
TOP500 InfiniBand Accelerated Systems

Number of Mellanox FDR InfiniBand systems grew 1.8X from Nov’13 to Nov’14
• Accelerates 63% of the InfiniBand-based systems (141 systems out of 225)
InfiniBand is the most used interconnect of the TOP100, 200, 300, 400 supercomputers

Due to superior performance, scalability, efficiency and return-on-investment
InfiniBand is the high performance interconnect of choice
- Connects the most powerful clusters, and provides the highest system utilization

InfiniBand is the best price/performance interconnect for HPC systems
InfiniBand’s Unsurpassed System Efficiency

- TOP500 systems listed according to their efficiency
- InfiniBand is the key element responsible for the highest system efficiency; in average 30% higher than 10GbE
- Mellanox delivers efficiencies of up to 99.8% with InfiniBand

Average Efficiency
- InfiniBand: 87%
- Cray: 79%
- 10GbE: 67%
- GigE: 40%
- Mellanox InfiniBand connects the most efficient system on the list
  - 24 of the 25 most efficient systems
- Enabling a record system efficiency of 99.8%, only 0.2% less than the theoretical limit!
- InfiniBand systems account for 2.6X the performance of Ethernet systems
- The only scalable HPC interconnect solutions
- InfiniBand connected systems’ performance demonstrate highest growth rate
- InfiniBand responsible for 2.6X the performance versus Ethernet on the TOP500 list
InfiniBand Performance Trends

- InfiniBand-connected CPUs grew 28% from Nov‘13 to Nov‘14
- InfiniBand-based system performance grew 44% from Nov‘13 to Nov‘14
- Mellanox InfiniBand is the most efficient and scalable interconnect solution
- Driving factors: performance, efficiency, scalability, many-many cores
Mellanox Accelerated World-Leading HPC Systems

Connecting Half of the World’s Petascale Systems (examples)
Proud to Accelerate Future DOE Leadership Systems (“CORAL”)

“Summit” System

“Sierra” System

5X – 10X Higher Application Performance versus Current Systems
Mellanox EDR 100Gb/s InfiniBand, IBM POWER CPUs, NVIDIA Tesla GPUs

Mellanox EDR 100G Solutions Selected by the DOE for 2017 Leadership Systems
Deliver Superior Performance and Scalability over Current / Future Competition
# Interconnect Solutions Leadership – Software and Hardware

## Comprehensive End-to-End Interconnect Software Products

![Software Products Images]

## Comprehensive End-to-End InfiniBand and Ethernet Hardware Products

<table>
<thead>
<tr>
<th>ICs</th>
<th>Adapter Cards</th>
<th>Switches/Gateways</th>
<th>Metro / WAN</th>
<th>Cables/Modules</th>
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Highest Performance and Scalability for
X86, ARM, Power, GPU and FPGA-based Compute and Storage Platforms

Smart Interconnect to Unleash The Power of All Compute Architectures
Mellanox Delivers Highest Application Performance

World Record Performance with Mellanox Connect-IB and HPC-X

Achieve Higher Performance with 67% less compute infrastructure versus Cray

ANSYS Fluent 15.0.7 Performance
(Benchmark: eddy_417k)

- Dell PowerEdge, FDR InfiniBand, Intel Xeon 2680v2 at 2.8GHz
- Cray XC30, Aries interconnect, Intel Xeon 2690v2 at 3GHz
Technology Roadmap – One-Generation Lead over the Competition

Mellanox

20Gbs  40Gbs  56Gbs  100Gbs  200Gbs

Terascale

3rd

TOP500 2003
Virginia Tech (Apple)

Petascale

1st

“Roadrunner”
Mellanox Connected

Exascale

“Summit” System
“Sierra” System

Mellanox Interconnect Advantages

- Mellanox solutions provide a proven, scalable and high performance end-to-end connectivity
- Standards-based (InfiniBand, Ethernet), supported by large eco-system
- Flexible, support all compute architectures: x86, Power, ARM, GPU, FPGA etc.
- Backward and future compatible
- Proven, most used solution for Petascale systems and overall TOP500

Paving The Road to Exascale Computing
“Stampede” system
- 6,000+ nodes (Dell), 462462 cores, Intel Phi co-processors
- 5.2 Petaflops
- Mellanox end-to-end FDR InfiniBand
Pleiades system
SGI Altix ICE
20K InfiniBand nodes
3.4 sustained Petaflop performance
Mellanox end-to-end FDR and QDR InfiniBand
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 sustained Petaflop performance
Mellanox end-to-end FDR InfiniBand
IBM iDataPlex and Intel Sandy Bridge
147456 cores
Mellanox end-to-end FDR 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 40Gb/s InfiniBand
 “Cascade” system
 Atipa Visione IF442 Blade Server
 2.5 sustained Petaflop performance
 Mellanox end-to-end InfiniBand FDR
 Intel Xeon Phi 5110P accelerator
“Pangea” system
SGI Altix X system, 110400 cores
Mellanox FDR InfiniBand
2 sustained Petaflop performance
91% efficiency
- Occigen system
- 1.6 sustained Petaflop performance
- Bull bullx DLC
- Mellanox end-to-end FDR InfiniBand

Petaflop
Mellanox Connected
“Spirit” system
SGI Altix X system, 74584 cores
Mellanox FDR InfiniBand
1.4 sustained Petaflop performance
92.5% efficiency
- Bull Bullx B510, Intel Sandy Bridge
- 77184 cores
- Mellanox end-to-end FDR InfiniBand solutions
- 1.36 sustained Petaflop performance
Dawning TC3600 Blade Supercomputer
5200 nodes, 120640 cores, NVIDIA GPUs
Mellanox end-to-end 40Gb/s InfiniBand solutions
  • ConnectX-2 and IS5000 switches
1.27 sustained Petaflop performance
The first Petaflop systems in China
- “Yellowstone” system
- 72,288 processor cores, 4,518 nodes (IBM)
- Mellanox end-to-end FDR InfiniBand, full fat tree, single plane

Petaflop
Mellanox Connected
International Fusion Energy Research Centre (IFERC), EU(F4E) - Japan Broader Approach collaboration - #38

- Bull Bullx B510, Intel Sandy Bridge
- 70560 cores
- 1.24 sustained Petaflop performance
- Mellanox end-to-end InfiniBand solutions
Tera 100, first Petaflop system in Europe - 1.05 PF performance
4,300 Bull S Series servers
140,000 Intel® Xeon® 7500 processing cores
300TB of central memory, 20PB of storage
Mellanox 40Gb/s InfiniBand
- Fujitsu PRIMERGY CX250 S1
- Mellanox FDR 56Gb/s InfiniBand end-to-end
- 980 Tflops performance
“Conte” system
HP Cluster Platform SL250s Gen8
Intel Xeon E5-2670 8C 2.6GHz
Intel Xeon Phi 5110P accelerator
Total of 77,520 cores
Mellanox FDR 56Gb/s InfiniBand end-to-end
Mellanox Connect-IB InfiniBand adapters
Mellanox MetroX long Haul InfiniBand solution
980 Tflops performance
- “MareNostrum 3” system
- 1.1 Petaflops peak performance
- ~50K cores, 91% efficiency
- Mellanox FDR InfiniBand
Thank You