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

TOP500 Supercomputers, July 2015
TOP500 Performance Trends

- Explosive high-performance computing market growth
- Clusters continue to dominate with 87% of the TOP500 list

Mellanox InfiniBand solutions provide the highest systems utilization in the TOP500 for both high-performance computing and clouds
InfiniBand is the de-facto Interconnect solution for High-Performance Computing
  • Positioned to continue and expand in Cloud and Web 2.0

InfiniBand connects the majority of the systems on the TOP500 list, with 257 systems
  • Increasing 15.8% year-over-year, from 222 systems in June’14 to 257 in June’15

FDR InfiniBand is the most used technology on the TOP500 list, connecting 156 systems

EDR InfiniBand has entered the list with 3 systems

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

InfiniBand enables the top 17 most efficient systems on the list

InfiniBand is the most used interconnect for Petascale systems with 33 systems
InfiniBand in the TOP500

- InfiniBand is the most used interconnect technology for high-performance computing
  - InfiniBand accelerates 257 systems, 51.4% of the list

- FDR InfiniBand connects the fastest InfiniBand systems
  - TACC (#8), NASA (#11), Government (#13, #14), Tulip Trading (#15), EDRC (#16), Eni (#17), AFRL (#19), LRZ (#20)

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

- InfiniBand is the most used interconnect technology in each category - TOP100, TOP200, TOP300, TOP400
  - Connects 50% (50 systems) of the TOP100 while Ethernet connect no systems
  - Connects 55% (110 systems) of the TOP200 while Ethernet only 10% (20 systems)
  - Connects 55% (165 systems) of the TOP300 while Ethernet only 18.7% (56 systems)
  - Connects 55% (220 systems) of the TOP400 while Ethernet only 23.8% (95 systems)
  - Connects 51.4% (257 systems) of the TOP500, Ethernet connects 29.4% (147 systems)

- InfiniBand is the interconnect of choice for accelerator-based systems
  - 77% of the accelerator-based systems are connected with InfiniBand

- Diverse set of applications
  - High-end HPC, commercial HPC, Cloud and enterprise data center
Mellanox EDR InfiniBand is the fastest interconnect solution on the TOP500
- 100Gb/s throughput, 150 million messages per second, less than 0.7 usec latency
- Introduced to the list with 3 systems on the TOP500 list

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 highest utilized systems on the TOP500 list

Mellanox InfiniBand is the only Petascale-proven, standard interconnect solution
- Connects 33 out of the 66 Petaflop-performance systems on the list (50%)
- Connects 2X the number of Cray based systems in the Top100, 5.3X 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 33 system of which 26 Systems use FDR InfiniBand
- InfiniBand is the most used interconnect solution in the TOP100
- The natural choice for world-leading supercomputers: performance, efficiency, scalability
- Number of Mellanox FDR InfiniBand systems grew 23% from June’14 to June’15
- EDR InfiniBand entered the list with 3 systems
- 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
- Mellanox delivers efficiencies of up to 99.8% with InfiniBand

Average Efficiency
- InfiniBand: 85%
- Cray: 74%
- 10GbE: 66%
- GigE: 43%
- 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 57% from June’14 to June‘15
- InfiniBand-based system performance grew 64% from June’14 to June‘15
- Mellanox InfiniBand is the most efficient and scalable interconnect solution
- Driving factors: performance, efficiency, scalability, many-many cores
Proud to Accelerate Future DOE Leadership Systems ("CORAL")

"Summit" System

"Sierra" System

Paving the Road to Exascale
Entering the Era of 100Gb/s (InfiniBand, Ethernet)

**Adapters**
- ConnectX-4
  - 100Gb/s Adapter, 0.7us latency
  - 150 million messages per second
  - (10 / 25 / 40 / 50 / 56 / 100Gb/s)

**Switch**
- SwitchIB
  - 36 EDR (100Gb/s) Ports, <90ns Latency
  - Throughput of 7.2Tb/s
  - Adaptive Routing, InfiniBand Router

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

**Interconnect**
- LinkX
  - Copper (Passive, Active)
  - Optical Cables (VCSEL)
  - Silicon Photonics

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Interconnect Solutions Leadership – Software and Hardware

Comprehensive End-to-End Interconnect Software Products

Comprehensive End-to-End InfiniBand and Ethernet Portfolio

ICs

Adapter Cards

Switches/Gateways

Software and Services

Metro / WAN

Cables/Modules

At the Speeds of 10, 25, 40, 50, 56 and 100 Gigabit per Second
End-to-End Interconnect Solutions for All Platforms

Highest Performance and Scalability for X86, Power, GPU, ARM and FPGA-based Compute and Storage Platforms

Smart Interconnect to Unleash The Power of All Compute Architectures
HPC Clouds – Performance Demands Mellanox Solutions

San Diego Supercomputing Center “Comet” System (2015) to Leverage Mellanox Solutions and Technology to Build HPC Cloud
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

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“LENOX“, EDR InfiniBand connected system at the Lenovo HPC innovation center, Germany

EDR InfiniBand provides ~25% higher system performance versus FDR InfiniBand on Graph500
  • At 128nodes
Magic Cube II supercomputer
#237 on the TOP500 list
Sugon Cluster TC4600E system
Mellanox end-to-end EDR InfiniBand
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

Speed-Up Your Present, Protect Your Future
Paving The Road to Exascale Computing Together
“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
“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
- 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
- “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
- IBM iDataPlex DX360M4
- Mellanox end-to-end FDR InfiniBand solutions
- 1.3 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
- 1.3 sustained Petaflop performance
- 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 - #51

- Bull Bullx B510, Intel Sandy Bridge
- 70560 cores
- 1.24 sustained Petaflop performance
- Mellanox end-to-end InfiniBand solutions
- The “Cartesius” system - the Dutch supercomputer
- Bull Bullx DLC B710/B720 system
- Mellanox end-to-end InfiniBand solutions
- 1.05 sustained Petaflop performance
- 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