

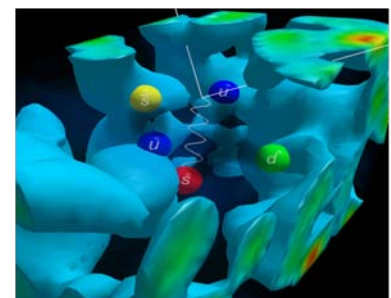
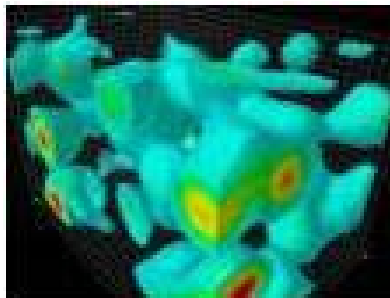
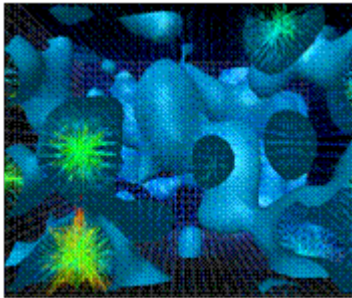
BQCD Performance Benchmark and Profiling

July 2010



- **The following research was performed under the HPC Advisory Council activities**
 - Participating vendors: Intel, Dell, Mellanox
 - Compute resource - HPC Advisory Council Cluster Center
- **For more info please refer to**
 - www.mellanox.com, www.dell.com/hpc, www.intel.com,
<http://www.deisa.eu/science/benchmarking/codes/bqcd>

- **BQCD (Berlin Quantum ChromoDynamics program)**
 - A hybrid Monte-Carlo code
 - The kernel of the program is a standard conjugate gradient solver
 - Simulates Quantum Chromodynamics with dynamical standard Wilson fermions
- **Developed by Dr. Hinnerk Stueben from Konrad-Zuse-Zentrum fuer. Infomationstechnik Berlin**
 - Open source software



- **The presented research was done to provide best practices**
 - BQCD performance benchmarking
 - MPI Library performance comparisons
 - Interconnect performance comparisons
 - Understanding BQCD communication patterns
 - Power-efficient simulations
- **The presented results will demonstrate**
 - The scalability of the compute environment to provide good application scalability
 - Considerations for power saving through balanced system configuration

- **Dell™ PowerEdge™ M610 14-node cluster**
 - Six-Core Intel X5670 @ 2.93 GHz CPUs
 - OS: CentOS5U4, OFED 1.5.1 InfiniBand SW stack
- **Intel Cluster Ready certified clusters**
- **Mellanox ConnectX2 QDR InfiniBand mezzanine card**
- **Mellanox M3601Q 32-Port Quad Data Rate (QDR-40Gb) InfiniBand Switch**
- **Memory: 24GB memory per node**
- **MPI: OpenMPI-1.4.1, MVAPICH2-1.4, Platform MPI 7.1, Intel MPI 4.0**
- **Application: BQCD**
- **Benchmark Workload**
 - Lattice size: 48x24x24x48

- **Intel® Cluster Ready systems make it practical to use a cluster to increase your simulation and modeling productivity**
 - Simplifies selection, deployment, and operation of a cluster
- **A single architecture platform supported by many OEMs, ISVs, cluster provisioning vendors, and interconnect providers**
 - Focus on your work productivity, spend less management time on the cluster
- **Select Intel Cluster Ready**
 - Where the cluster is delivered ready to run
 - Hardware and software are integrated and configured together
 - Applications are registered, validating execution on the Intel Cluster Ready architecture
 - Includes Intel® Cluster Checker tool, to verify functionality and periodically check cluster health.



- **System Structure and Sizing Guidelines**

- 14-node cluster build with Dell PowerEdge™ M610 blades server
- Servers optimized for High Performance Computing environments
- Building Block Foundations for best price/performance and performance/watt

- **Dell HPC Solutions**

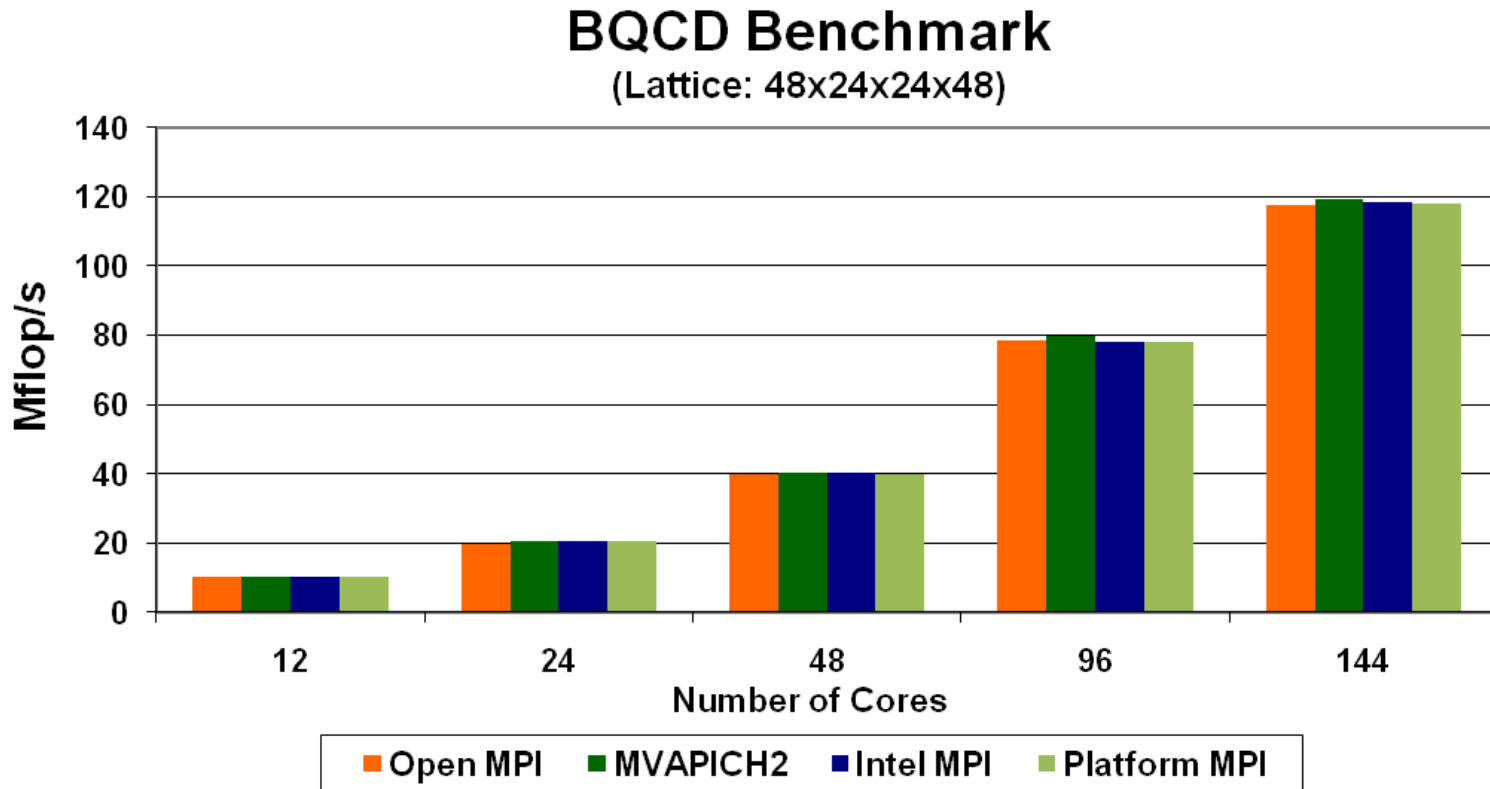
- Scalable Architectures for High Performance and Productivity
- Dell's comprehensive HPC services help manage the lifecycle requirements.
- Integrated, Tested and Validated Architectures

- **Workload Modeling**

- Optimized System Size, Configuration and Workloads
- Test-bed Benchmarks
- ISV Applications Characterization
- Best Practices & Usage Analysis



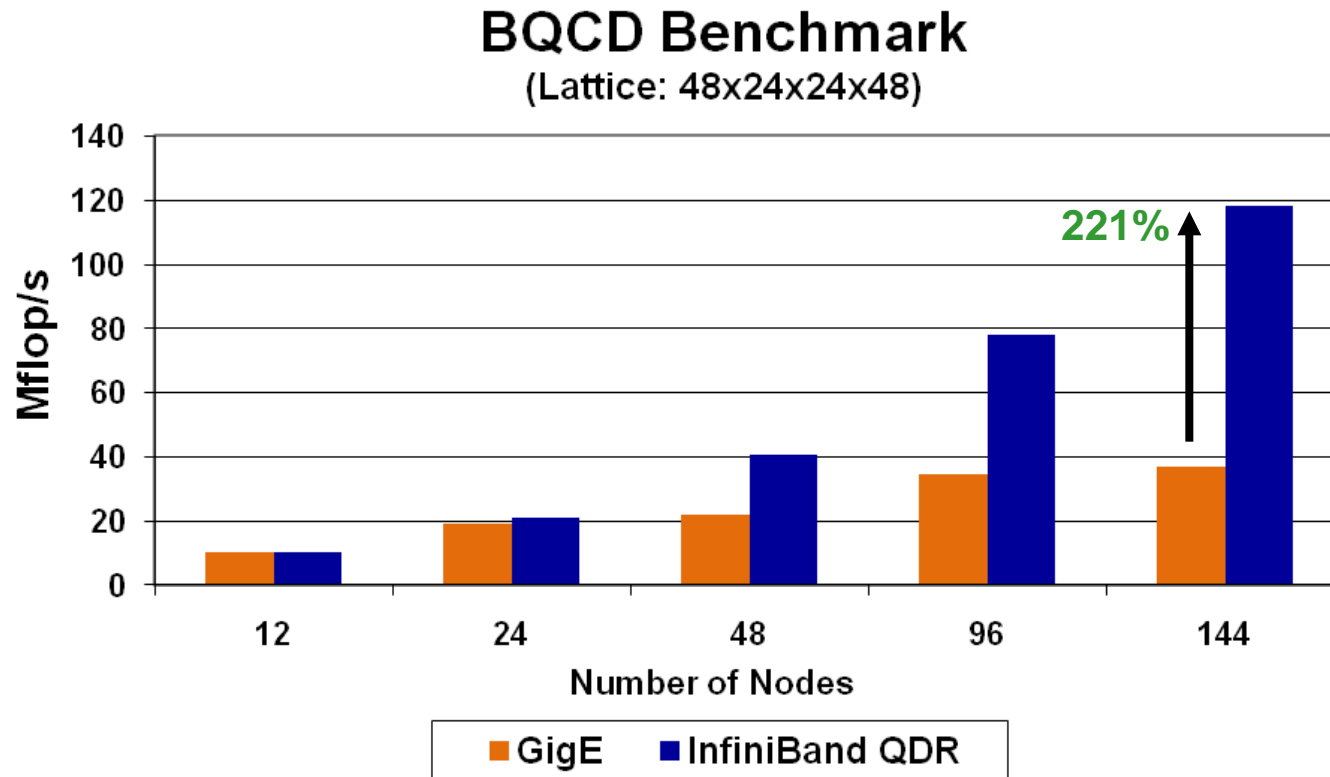
- All tested MPIs provide similar performance



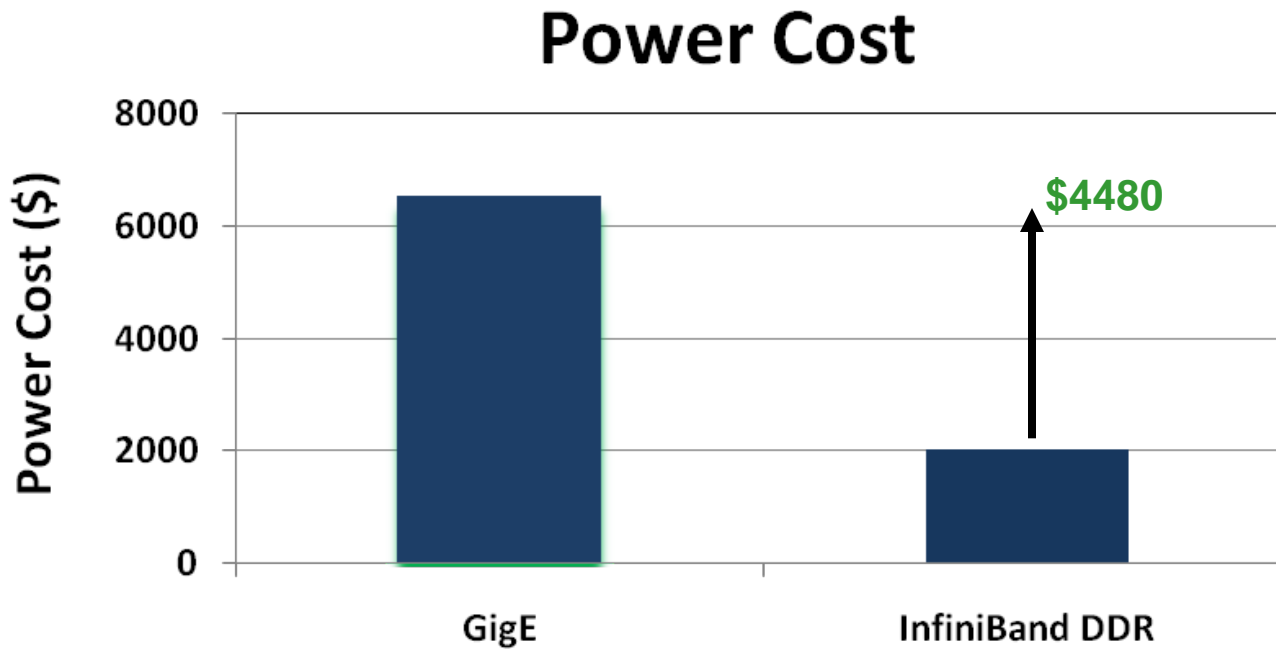
Higher is better

12-cores per node

- **InfiniBand enables better application performance and scalability**
 - Up to 221% higher performance than GigE
 - GigE stops scaling after 8 nodes
- **Application performance over InfiniBand scales as cluster size increases**



- **InfiniBand saves up to \$4480 power compared to GigE**
 - To finish the same number of BQCD jobs
 - Yearly based for 14-node cluster
- **As cluster size increases, more power can be saved**

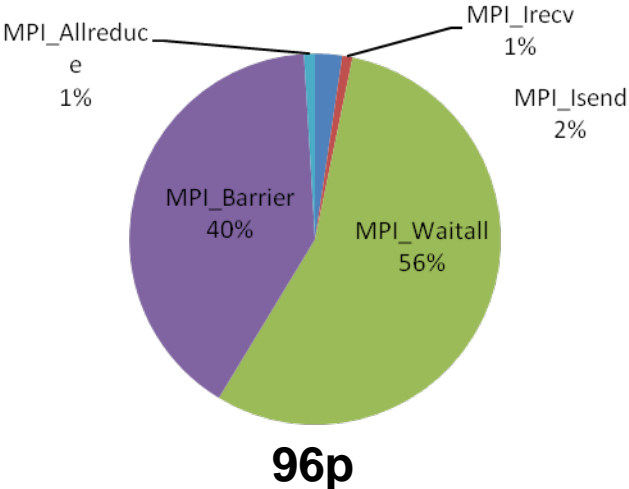
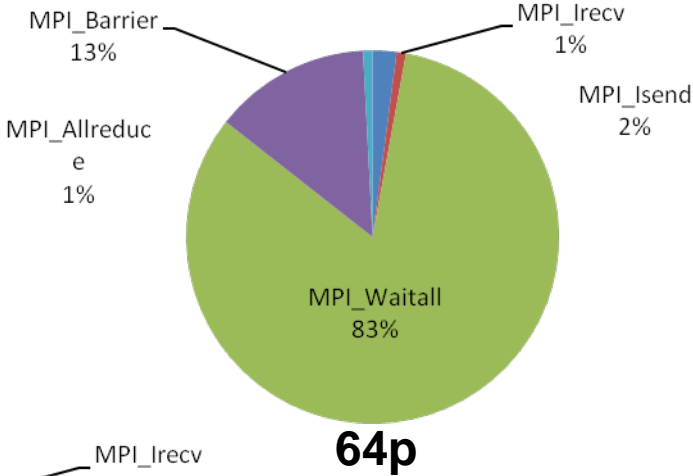
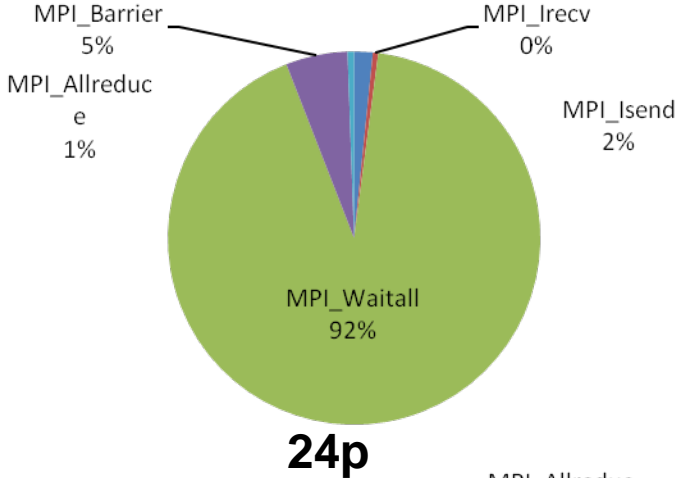


$\$/KWh = KWh * \0.20

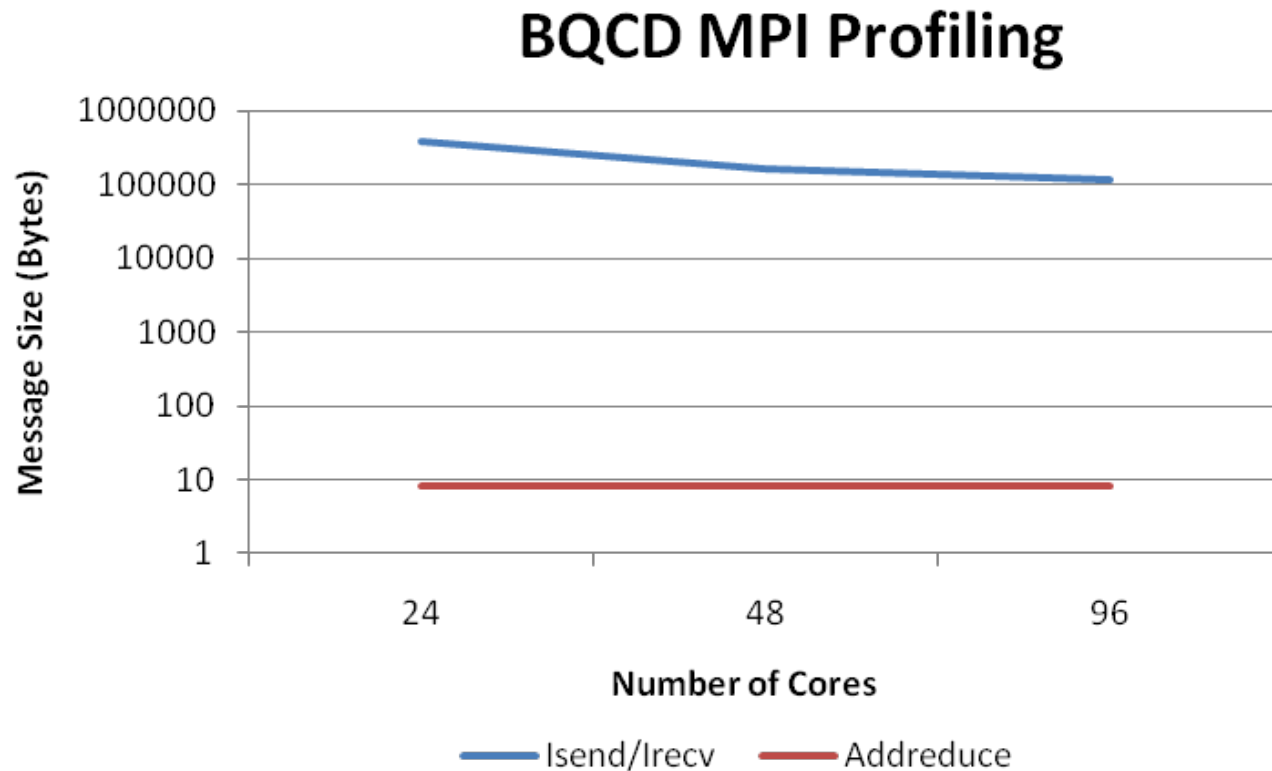
For more information - <http://enterprise.amd.com/Downloads/svrpwrusecompletefinal.pdf>

- **Balanced system – CPU, memory, Interconnect that match each other capabilities - is essential for providing application efficiency**
- **Performance Optimization**
 - All tested MPIs enable similar performance
- **Interconnect Characterization**
 - InfiniBand delivers superior performance across all system sizes
 - GigE scalability is limited beyond 8 nodes
- **Power Analysis**
 - System architecture can yield nearly \$5K annually in power savings

- **MPI P2P and MPI_Barrier consume more than 96% of total MPI time**



- **MPI P2P messages are large message size**
 - Message size becomes smaller as node number increases
- **MPI collective messages are small size**



- **BQCD was profiled to identify its communication patterns**
- **MPI P2P and MPI_Barrier functions dominate total MPI communication time**
 - MPI collective overhead grows faster relative to MPI P2P function
 - Total number of messages increases with cluster size
- **Interconnects effect to BQCD performance**
 - Both small and large messages are used by BQCD
 - Interconnect latency and bandwidth are critical to application performance
- **Balanced system – CPU, memory, Interconnect that match each other capabilities, is essential for providing application efficiency**

Productive Systems = Balanced System

- **Balanced system enables highest productivity**
 - Interconnect performance to match CPU capabilities
 - Memory bandwidth to match CPU performance
- **Applications scalability relies on balanced configuration**
 - “Bottleneck free”
 - Each system components can reach it’s highest capability
- **Dell M610 system integrates balanced components**
 - Intel “Westmere” CPUs and Mellanox InfiniBand QDR
 - Latency to memory and Interconnect latency at the same magnitude of order
 - Provide the leading productivity and power/performance system for Desmond simulations

Thank You

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