HPC ADVISORY COUNCIL

LS-DYNA Best Practices

June 2010

DELL intel LSTC Livermore Software Technology Corp. Mellanox TECHNOLOGIES

Note

- **The following research was performed under the HPC Advisory Council activities**
  - Participating vendors: Intel, Dell, Mellanox, LSTC
  - Compute resource - HPC Advisory Council Cluster Center
- **For more info please refer to**
  - www.mellanox.com, www.dell.com/hpc, www.intel.com, www.lstc.com

LS-DYNA

- **LS-DYNA**
  - A general purpose structural and fluid analysis simulation software package capable of simulating complex real world problems
  - Developed by the Livermore Software Technology Corporation (LSTC)
- **LS-DYNA used by**
  - Automobile
  - Aerospace
  - Construction
  - Military
  - Manufacturing
  - Bioengineering

Objectives

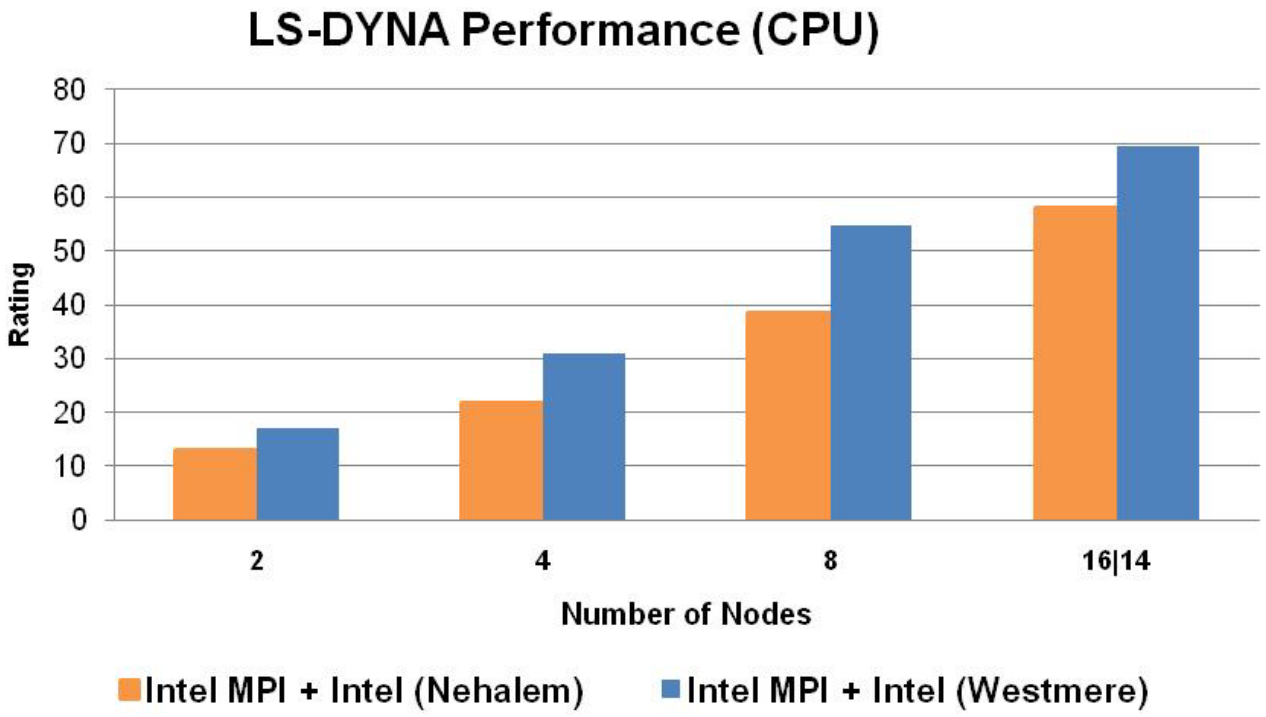
- **The presented research was done to provide best practices**
  - LS-DYNA performance benchmarking
    - MPI Library performance comparison
    - Interconnect performance comparison
    - CPUs comparison
    - Compilers comparison
- **The presented results will demonstrate**
  - The scalability of the compute environment/application
  - Considerations for higher productivity and efficiency

Test Clusters Configuration

- **Dell™ PowerEdge™ M610 14-node cluster (Maia)**
  - Six-Core Intel X5670 @ 2.93 GHz CPUs
  - OS: CentOS5U4, OFED 1.5.1 InfiniBand SW stack
- **Dell™ PowerEdge™ M610 16-node cluster (Janus)**
  - Quad-Core Intel X5570 @ 2.93 GHz CPUs
  - OS: RHEL5U3, OFED 1.5 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**
- **File system: local file systems**
- **MPI: Open MPI 1.2.9, Platform MPI 7.0.0, Intel MPI 4.0**
- **Application: LS-DYNA MPP971_s_R4.2.1**
- **Benchmark Workload: “3 Vehicle Collision” Test simulation**

LS-DYNA Benchmark Results – CPU

- **Intel X5670 (Westmere) CPUs outperforms Intel X5570 (Nehalem) CPUs**
  - 39% higher performance (rating) in average comparing nodes performance
    - Rating is measured as jobs per day
  - 14 nodes with Westmere outperforms 16 nodes with Nehalem

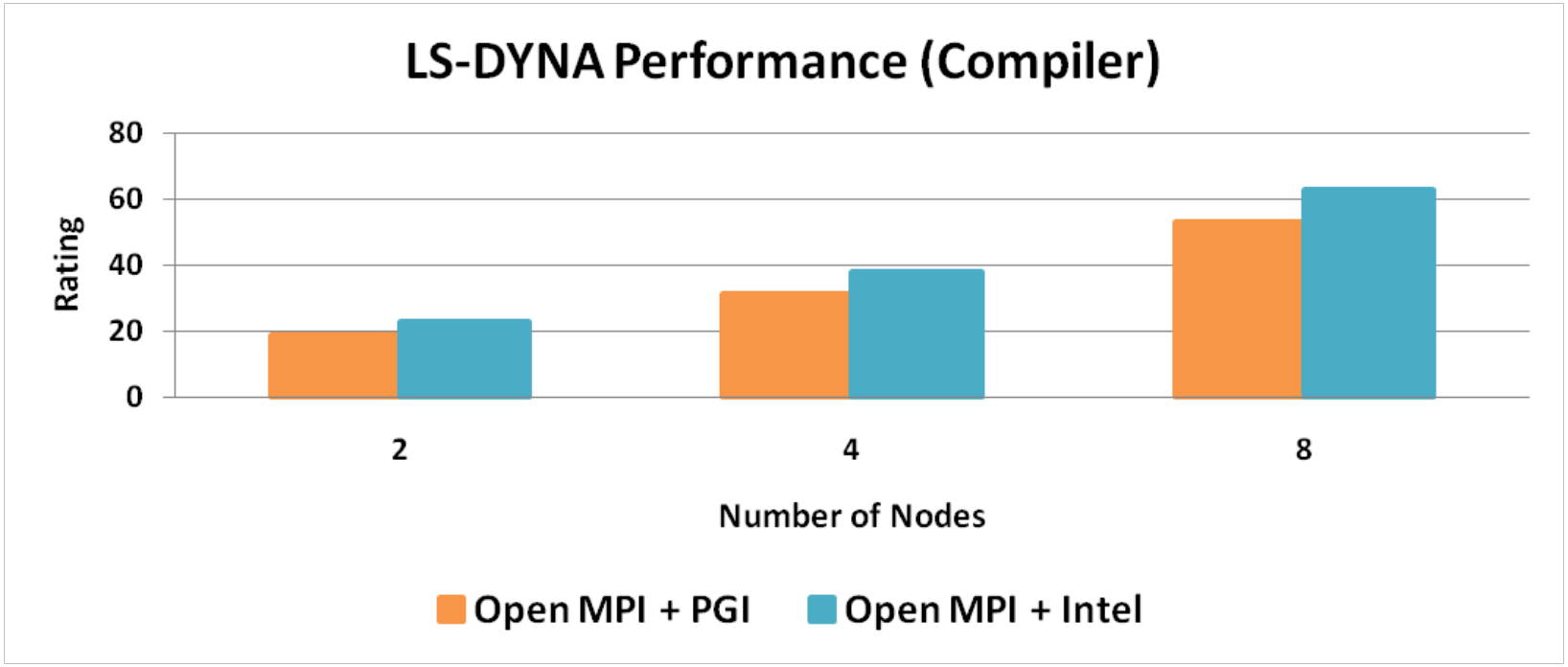


Higher is better

InfiniBand

LS-DYNA Benchmark Results – Compiler

- **Intel compiler enables higher performance comparing to PGI compiler**
  - Up to 21% higher performance

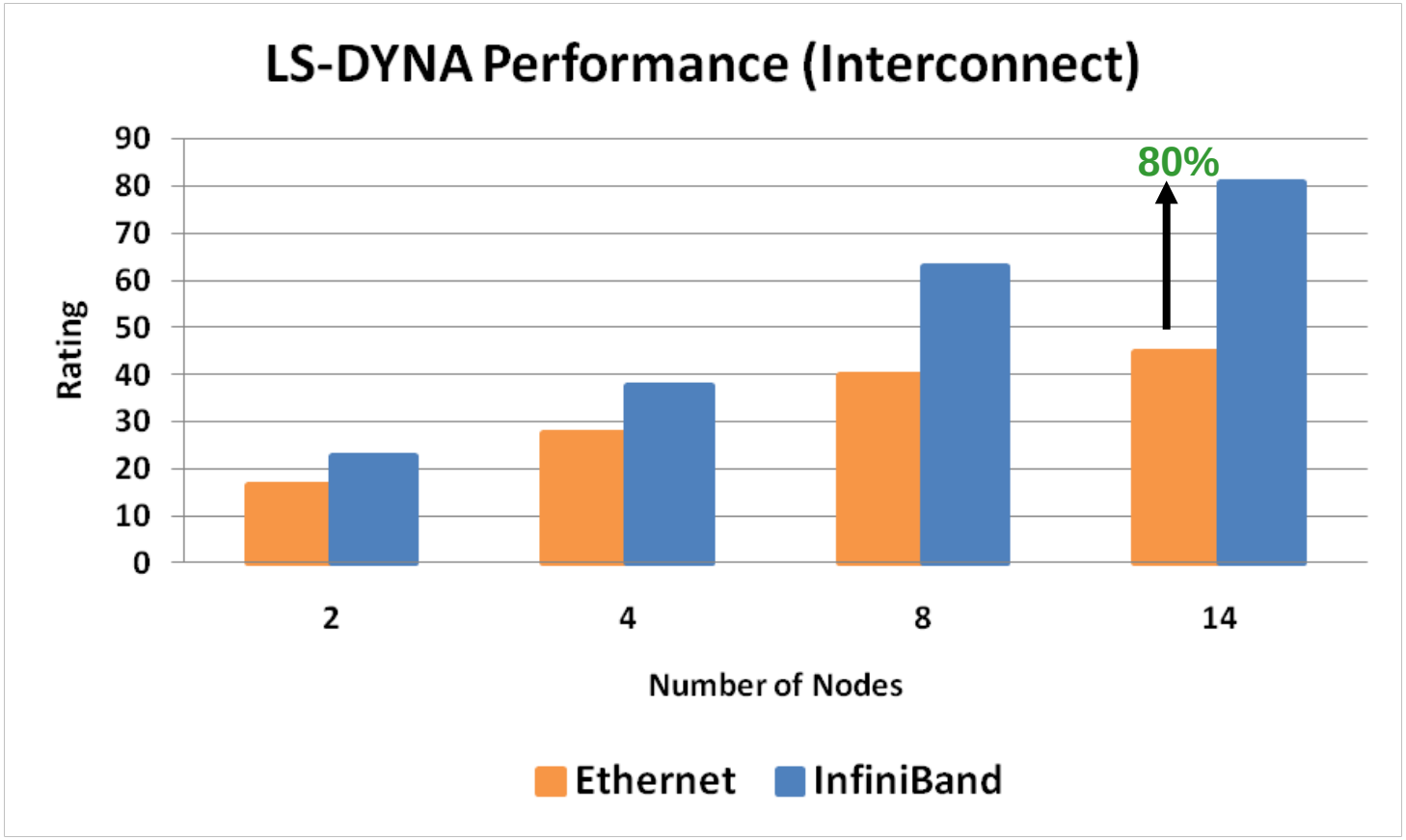


Higher is better

12-cores per node, InfiniBand

LS-DYNA Benchmark Results - Interconnects

- **The gap between InfiniBand and Ethernet can be significant**
  - Up to 80% performance difference at 14 nodes



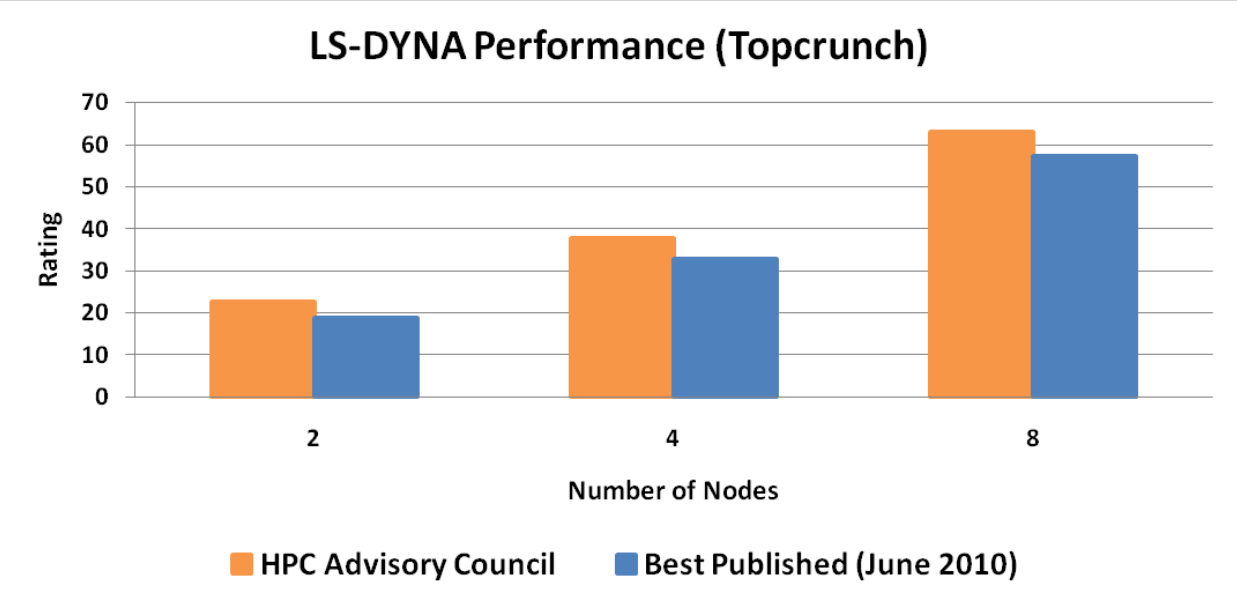
Higher is better

12-cores per node

LS-DYNA Benchmark Results - TopCrunch

- **HPC Advisory Council best particles performance results compared to published results**
  - www.topcrunch.org publish LS-DYNA performance results
  - Comparing same CPU/interconnect platforms (apples to apples)
  - 10% to 21% **higher** performance

- **Comparing to all platforms on TopCrunch**
  - HPC Advisory Council results are world best systems smaller than 16 nodes
  - Achieving higher performance compared to larger node count systems



Higher is better

12-cores per node, InfiniBand

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
- **HPC Advisory Council best practices**
  - Provides the needed information for maximizing system productivity

Thank You

HPC Advisory Council, www.hpcadvisorycouncil.com