

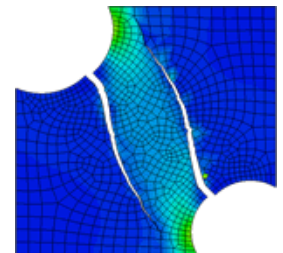
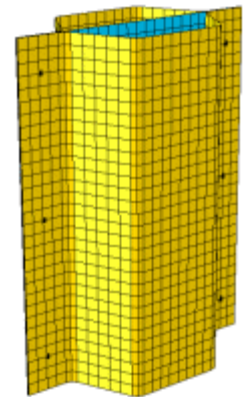
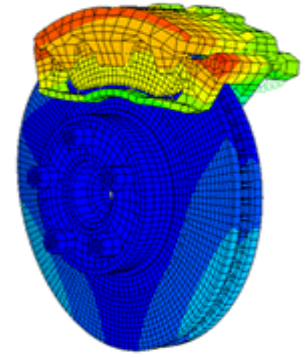
Abaqus Performance Benchmark and Profiling

Feb 2011



- **The following research was performed under the HPC Advisory Council activities**
 - Participating vendors: HP, SIMULIA, Mellanox
 - Compute resource - HPC Advisory Council Cluster Center
- **The participating members would like to thank SIMULIA for their support and guidelines**
- **For more info please refer to**
 - www.mellanox.com, <http://www.hp.com/go/hpc>,
<http://www.simulia.com>

- **Abaqus Unified FEA product suite offers powerful and complete solutions for both routine and sophisticated engineering problems covering a vast spectrum of industrial applications. The Abaqus analysis products listed below focus on:**
 - Nonlinear finite element analysis (FEA)
 - Advanced linear and dynamics application problems
- **Abaqus/Standard** provides general-purpose FEA that includes a broad range of analysis capabilities
- **Abaqus/Explicit** provides nonlinear, transient, dynamic analysis of solids and structures using explicit time integration



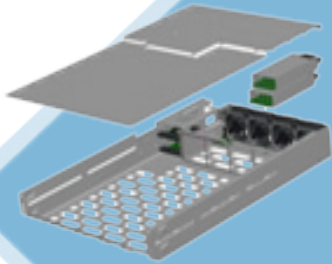
- **The presented research was done to provide best practices**
 - Abaqus performance benchmarking
 - Interconnect performance comparisons
 - Understanding Abaqus communication patterns
 - Power-efficient simulations

- **The presented results will demonstrate**
 - The scalability of the compute environment
 - Considerations for power saving through balanced system configuration

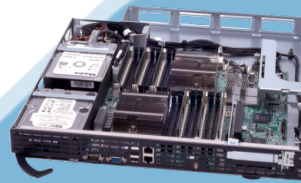
- **HP ProLiant SL2x170z G6 8-node cluster**
 - Six-Core Intel X5670 @ 2.93 GHz CPUs
 - Memory: 24GB per node
 - OS: CentOS5U4, OFED 1.5.1 InfiniBand SW stack
- **Mellanox ConnectX-2 adapters and switches**
- **Fulcrum based 10GigE switch**
- **MPI: Platform MPI 8.1**
- **Application: Abaqus 6.10-3**
- **Benchmark Workload**
 - Abaqus/Standard benchmark

About HP ProLiant SL6000 Scalable System

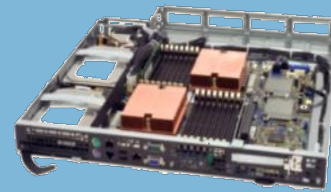
- **Solution-optimized for extreme scale out**



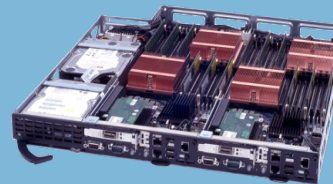
ProLiant z6000 chassis
Shared infrastructure
– fans, chassis, power



ProLiant SL160z G6 ProLiant SL165z G7
Large memory
-memory-cache apps



ProLiant SL170z G6
Large storage
-Web search and database apps



ProLiant SL2x170z G6
Highly dense
- HPC compute and
web front-end apps

Save on cost and
energy -- per node,
rack and data
center

Mix and match
configurations

Deploy with
confidence

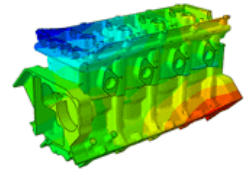
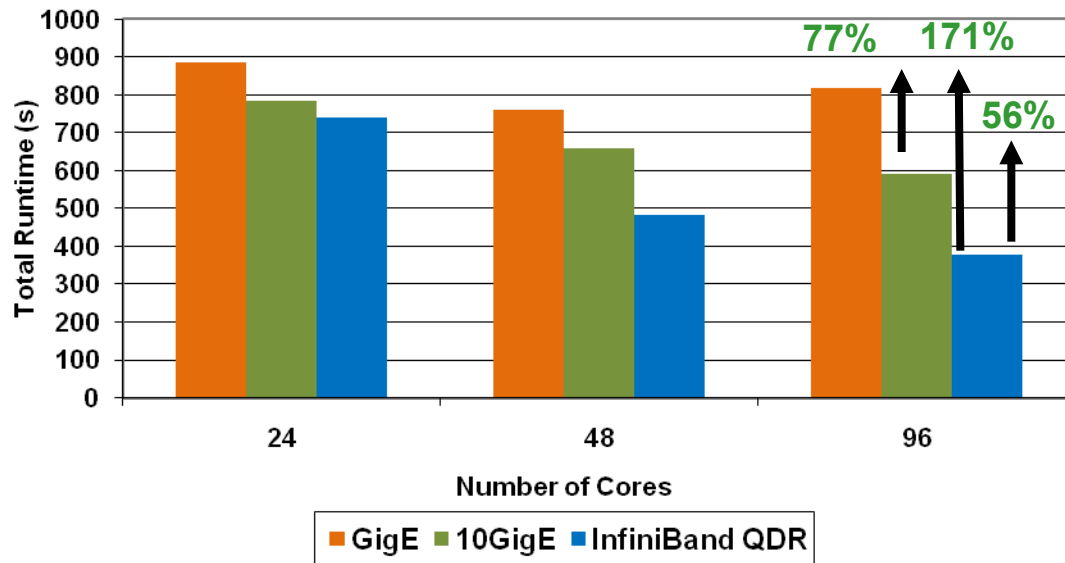
#1
Power
Efficiency*

* SPECpower_ssj2008
www.spec.org
17 June 2010, 13:28

Abaqus/Standard Benchmark Results

- **Input Dataset: S4B**
 - Cylinder head bolt-up
- **InfiniBand provides higher utilization, performance and scalability**
 - Up to 117% higher performance versus GigE and 56% versus 10GigE
- **InfiniBand reduces electrical energy/job**
 - by 54% or more compared to GigE and 36% compared to 10GigE

Abaqus/Standard Benchmark
(S4B)

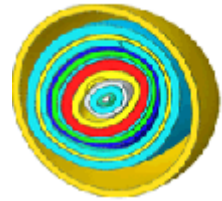
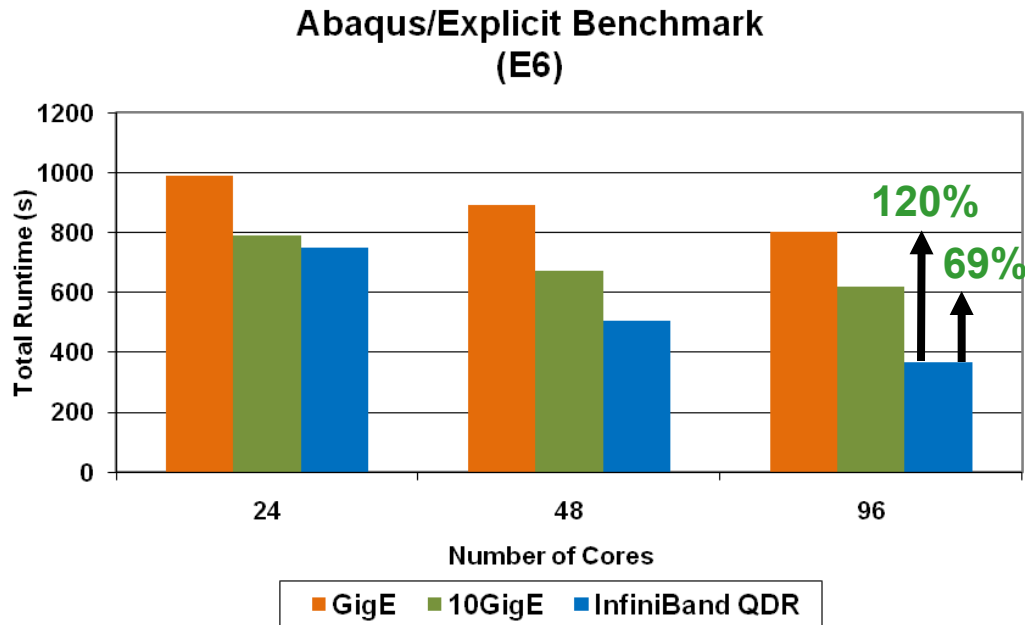


Lower is better

12-cores per node

Abaqus/Explicit Benchmark Results

- **Input Dataset: E6**
 - Blast loaded plate
- **InfiniBand provides higher utilization, performance and scalability**
 - Up to 120% higher performance versus GigE and 69% versus 10GigE
- **InfiniBand reduces electrical energy/job**
 - by 54% or more compared to GigE and 41% compared to 10GigE

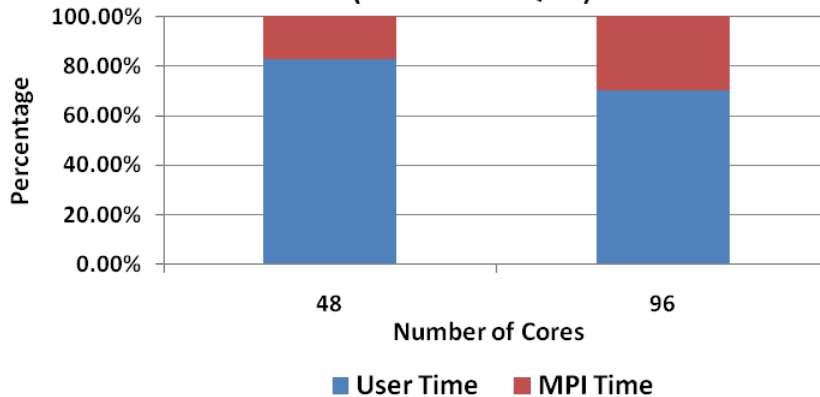


Lower is better

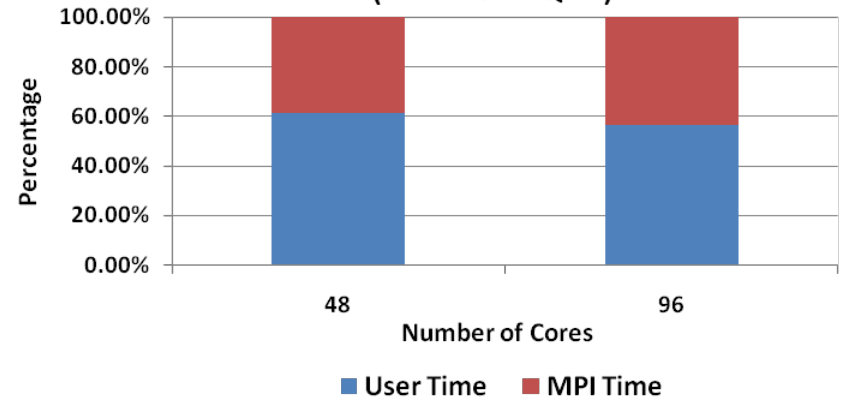
12-cores per node

- **MPI time percentage increases as cluster scales**
 - More MPI time is spent with S4B benchmark than E6

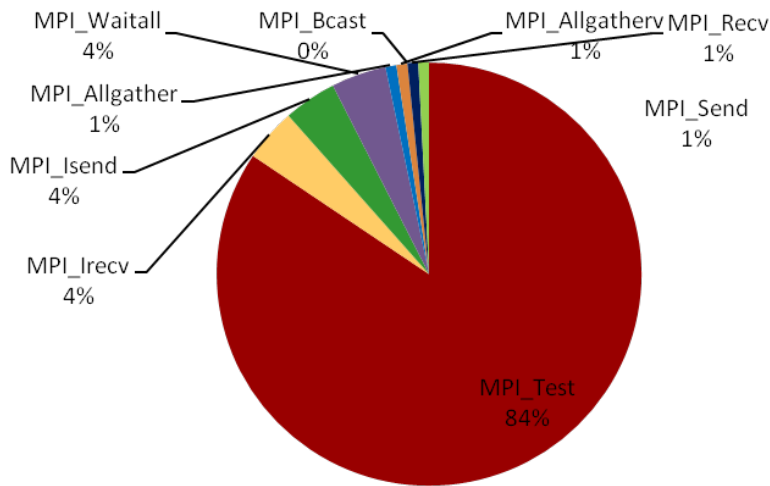
E6 Runtime Distribution
(InfiniBand QDR)



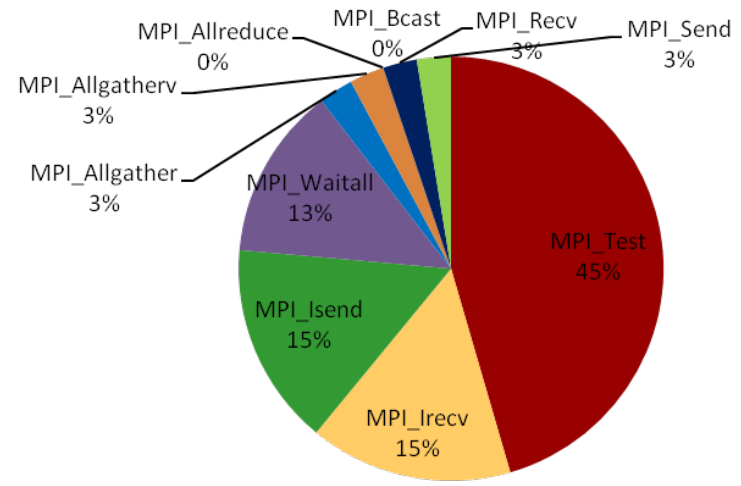
S4B Runtime Distribution
(InfiniBand QDR)



- **Limited use of MPI_Allgather and MPI_AllgatherV collectives operations**
 - Usage increases with cluster size

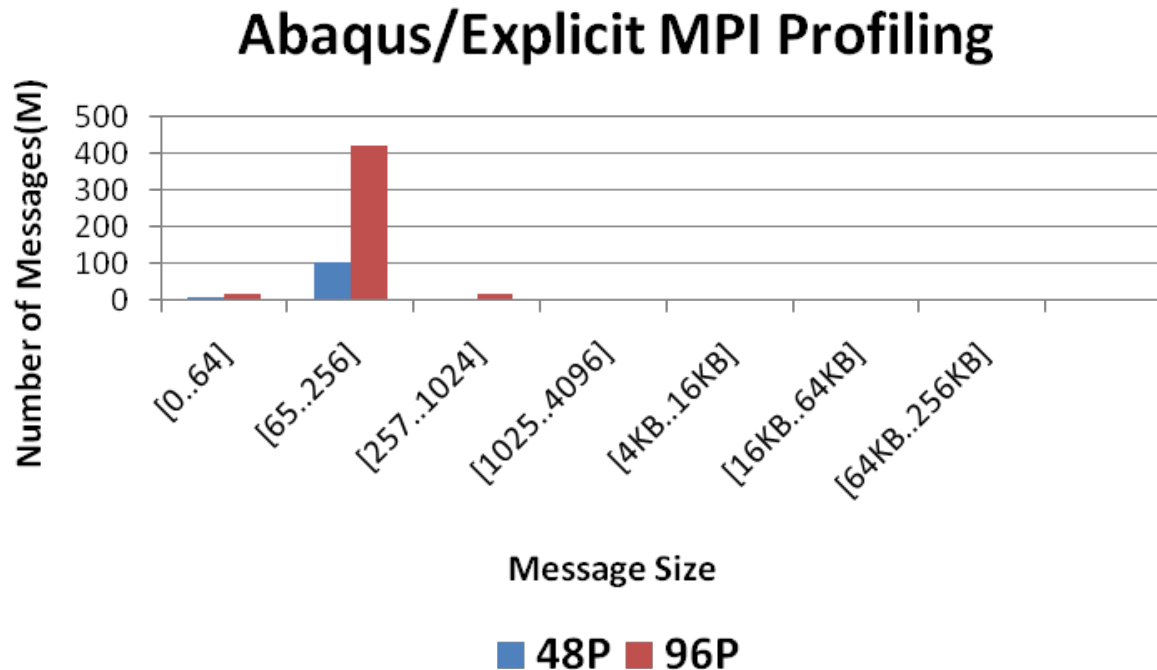


48 Processes



96 Processes

- Majority messages are from 64 to 256 bytes
- Number of messages increase with cluster size, so as communication time



- **Interconnect comparison shows**
 - Low latency InfiniBand enables higher scalability than 10GigE and GigE
 - GigE stops scaling at 48 cores with Abaqus Standard
- **InfiniBand QDR saves power**
 - Reduces power consumption/job by
 - 54% or more compared to GigE
 - 41% or more compared to 10GigE
- **With balanced platform, Abaqus shows good scalability**

Thank You

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