HYCOM Performance Benchmark and Profiling

Jan 2010

Acknowledgment:
- The DoD High Performance Computing Modernization Program

Note

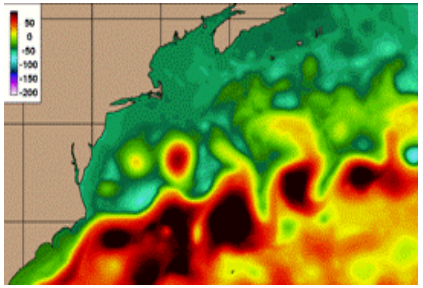
- **The following research was performed under the HPC Advisory Council activities**
  - Participating vendors: HP, Mellanox
  - Compute resource - HPC Advisory Council Cluster Center

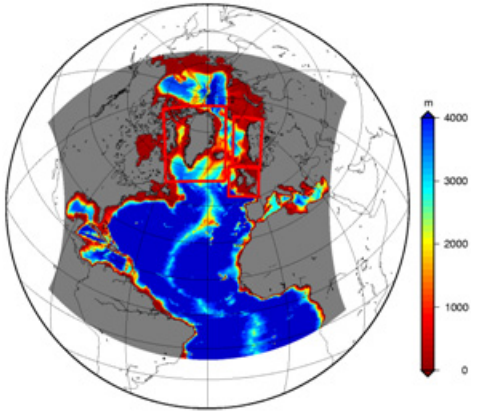
- **We would like to acknowledge**
  - The DoD High Performance Computing Modernization Program for providing access to the FY 2009 benchmark suite

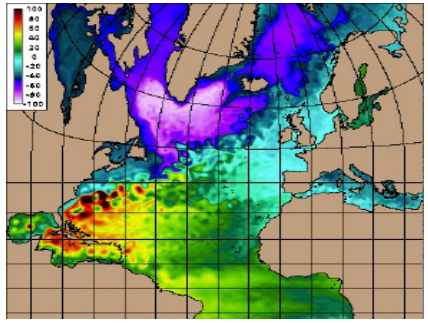
- **For more info please refer to**
  - www.mellanox.com, http://www.hp.com/go/hpc, http://www.hycom.org

HYCOM (HYbrid Coordinate Ocean Model)

- **A primitive equation ocean general circulation model**
  - Evolved from the Miami Isopycnic-Coordinate Ocean Model
- **HYCOM provides the capability of selecting several different vertical mixing schemes for**
  - The surface mixed layer
  - The comparatively weak interior diapycnal mixing
- **HYCOM is fully parallelized**
- **Open source and joined developed by:**
  - University of Miami, the Los Alamos National Laboratory, and the Naval Research Laboratory physics







Objectives

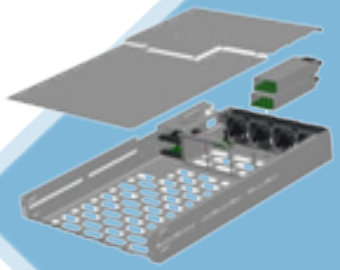
- **The presented research was done to provide best practices**
  - HYCOM performance benchmarking
    - Interconnect performance comparisons
    - File system performance comparisons
    - MPI libraries performance comparisons
  - Understanding HYCOM communication patterns
- **The presented results will demonstrate**
  - The scalability of the compute environment
  - Considerations for power saving through balanced system configuration

Test Clusters Configuration

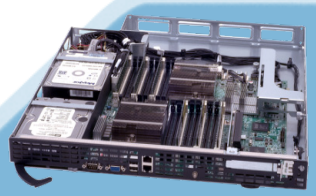
- **HP ProLiant SL170z G6 16-node cluster**
  - Six-Core Intel X5670 @ 2.93 GHz CPUs
  - Memory: 24GB per node
  - OS: CentOS5U4, OFED 1.5.2 InfiniBand SW stack
- **Intel Cluster Ready certified cluster**
- **Mellanox ConnectX2 InfiniBand adapters and switches**
- **MPI: OpenMPI-1.4.2, MVAPICH2-1.5.1, Intel MPI 4.0, Platform MPI 8.0**
- **Application: HYCOM 2.2.10**
- **Benchmark Workload**
  - **HYCOM standard benchmark dataset**
    - **26-layer 1/4 degree fully global HYCOM benchmark**

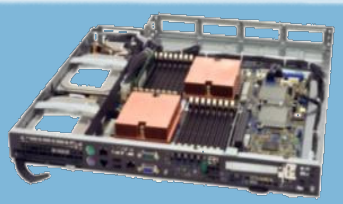
HP ProLiant SL6000 Scalable System

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

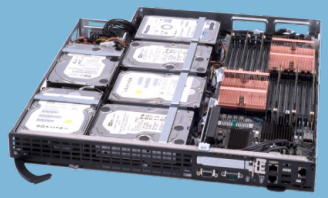


ProLiant z6000 chassis
Shared infrastructure
– fans, chassis, power

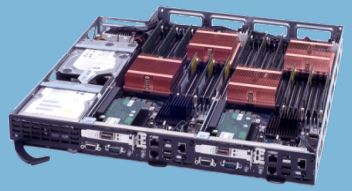




ProLiant SL160z G6 ProLiant SL165z G7
Large memory
-memory-cache apps



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

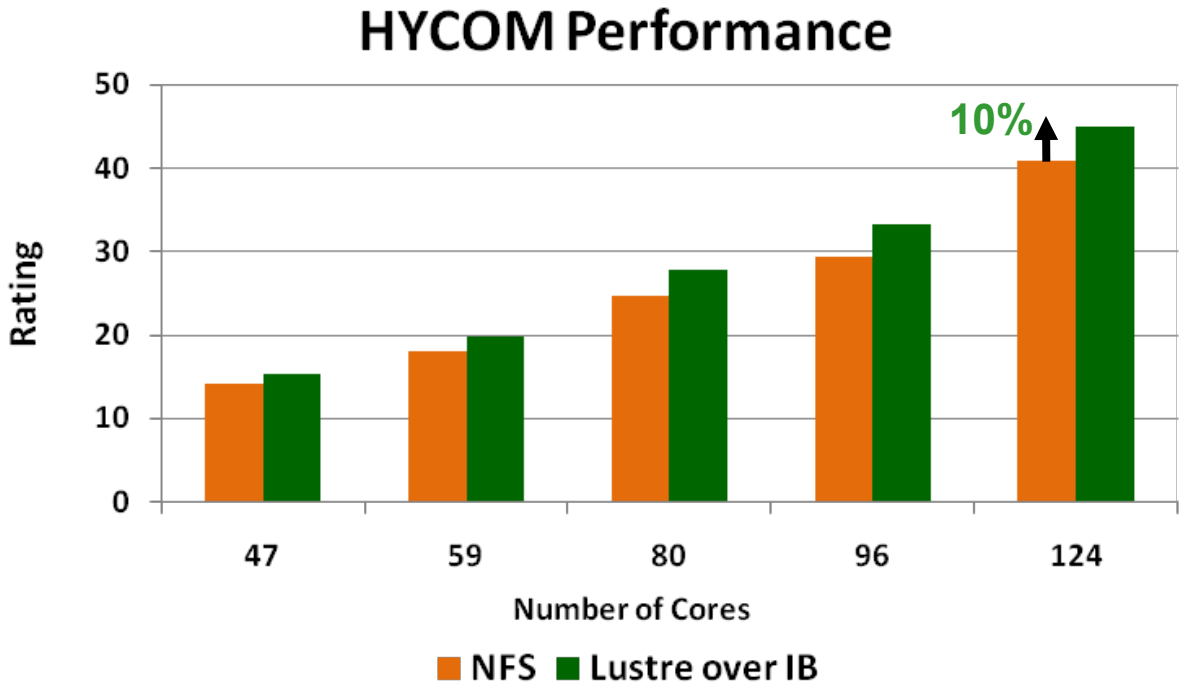
Deploy with confidence

#1 Power Efficiency*

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

HYCOM Benchmark Results – File System

- **Lustre over InfiniBand enables better application performance and scalability**
  - Up to 10% faster than NFS
  - Advantage increases as cluster scales

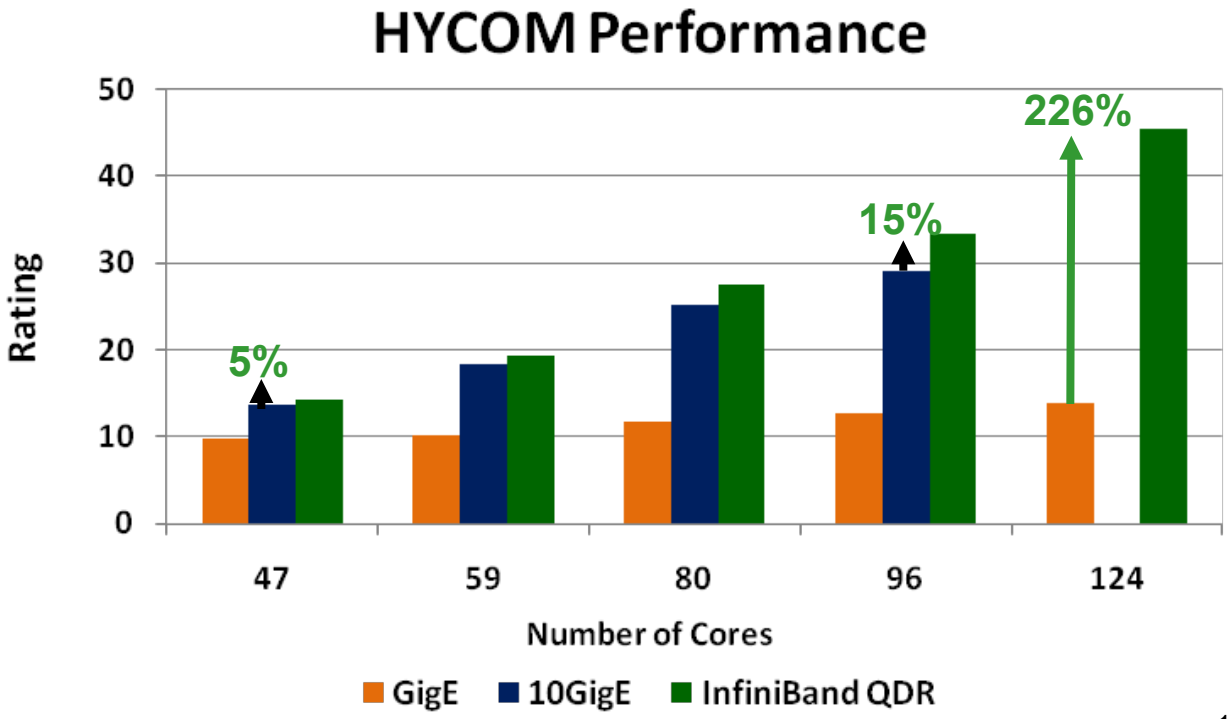


Higher is better

12-cores per node

HYCOM Benchmark Results – Interconnects

- **InfiniBand enables better application performance and scalability**
  - Up to 226% higher performance than GigE
  - 15% higher performance than 10GigE at 96 cores
    - 5% higher than 10GigE at 47 cores
    - Performance gap increases as core count grows
  - Application performance over InfiniBand scales as cluster size increases

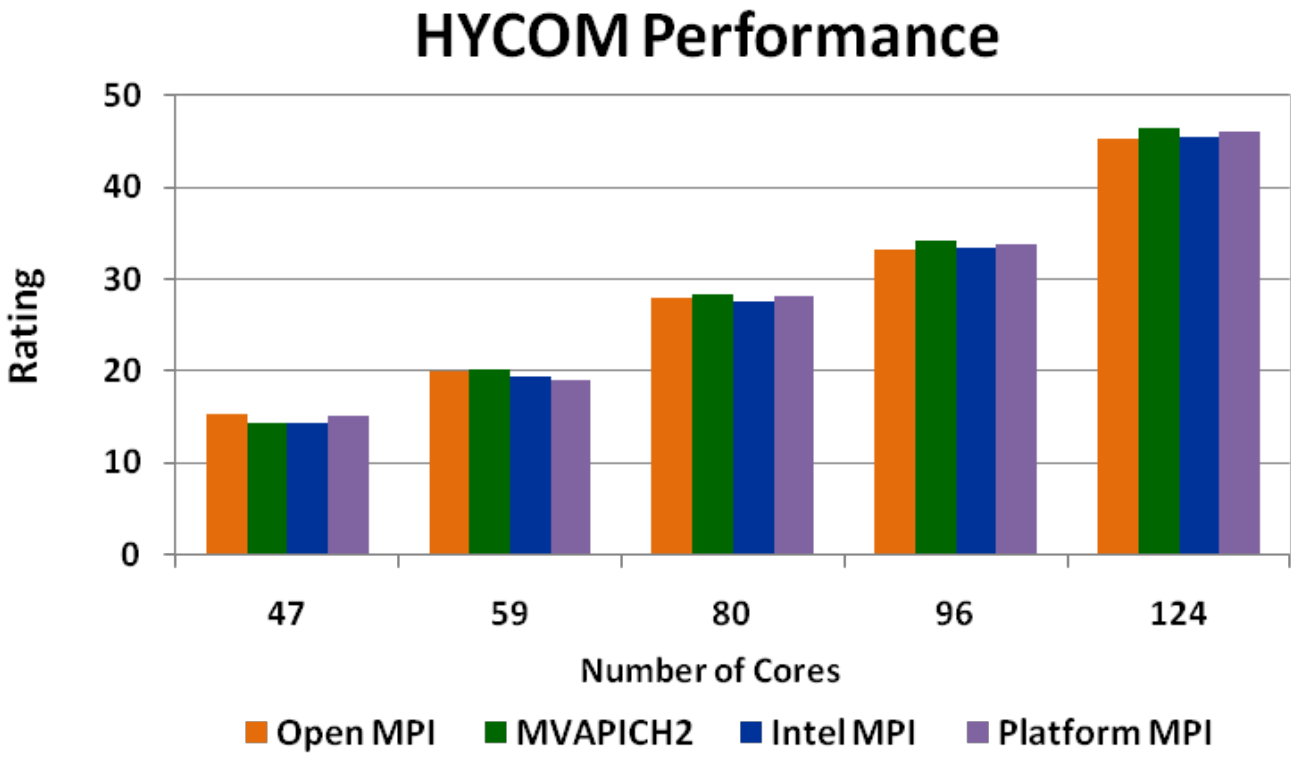


Higher is better

12-cores per node

HYCOM Benchmark Results – MPI Libraries

- **All MPIs show similar performance and scalability over InfiniBand**
  - MVAPICH2 is slightly better than others

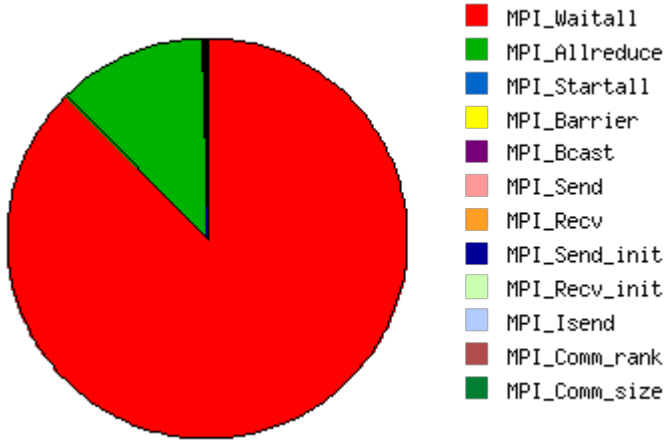


Higher is better

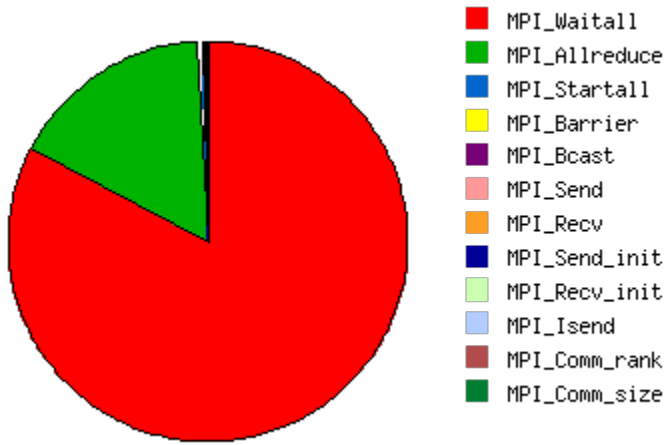
12-cores per node

HYCOM Profiling – MPI Overhead

- **MPI_Allreduce, MPI_Waitall are major functions**
  - MPI_Waitall generates largest overhead
  - Allreduce overhead grows faster than other functions as cluster size increases

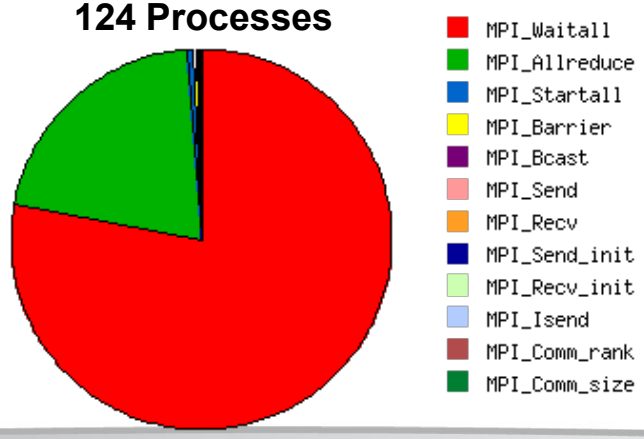


47 Processes



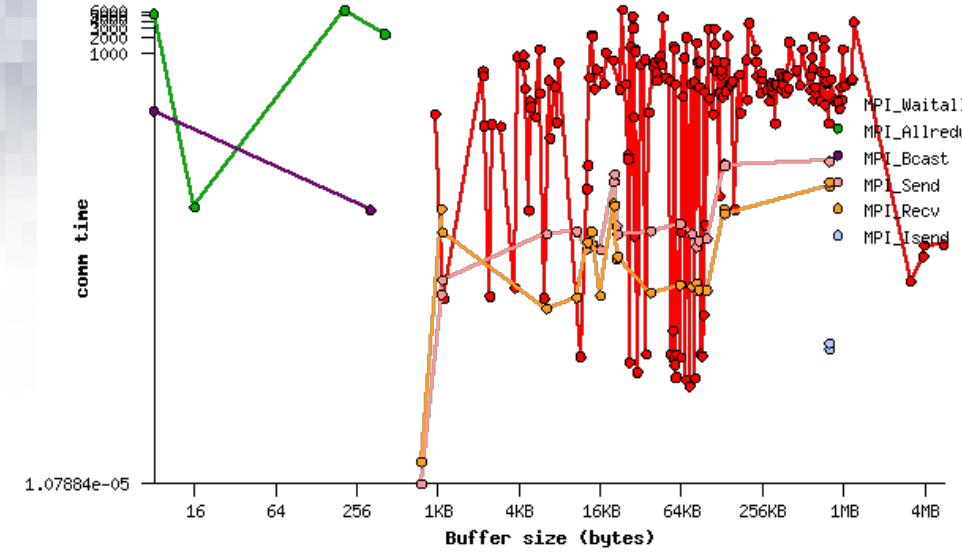
96 Processes

124 Processes



HYCOM Profiling – MPI Message Size

- **Majority MPI_Waitall messages are large size**
  - >64KB
- **MPI_Allreduce messages are small size**



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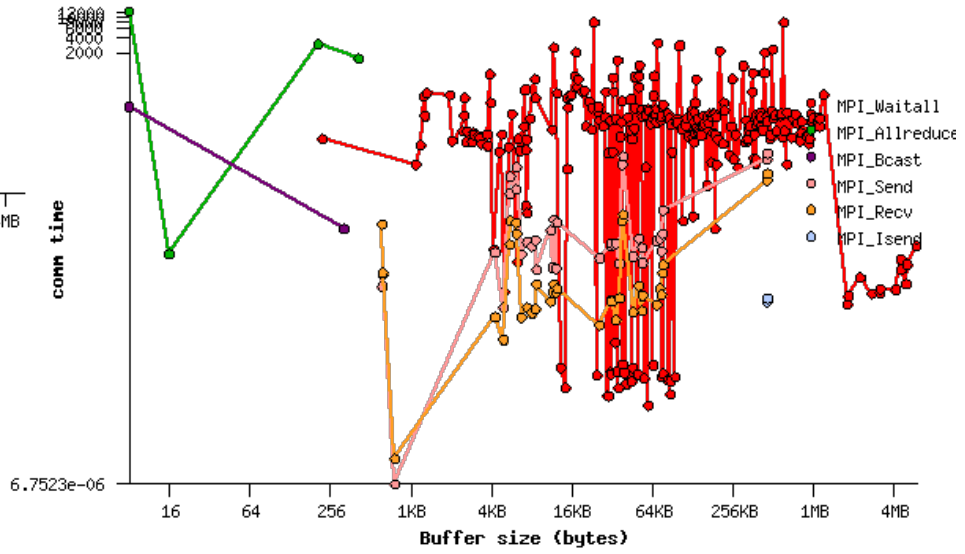

124 Processes

HYCOM Profiling Summary

- **HYCOM was profiled to identify its communication patterns**

- **MPI_Waitall and MPI_Allreduce generate most overhead**
  - Majority MPI_waitall messages are large size
  - MPI_allreduce messages are small size

- **Interconnect bandwidth is important for HYCOM performance**
  - As cluster scales, percentage of small messages increases
    - Hence interconnect latency becomes crucial too

Thank You

HPC Advisory Council