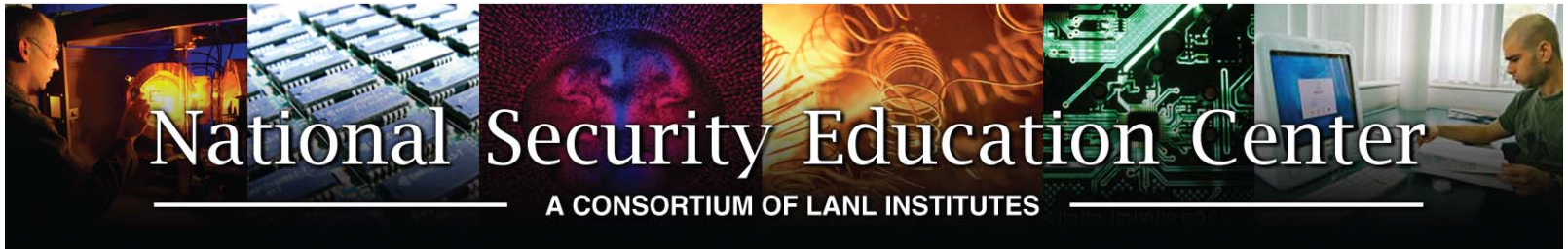

Los Alamos NATIONAL LABORATORY

LA-UR 10-05188

ISTI INFORMATION SCIENCE & TECHNOLOGY INSTITUTE

IMPLEMENTATION & COMPARISON OF RDMA OVER ETHERNET

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Summary

- Background
- Objective
- Testing Environment
- Methodology
- Results
- Conclusion
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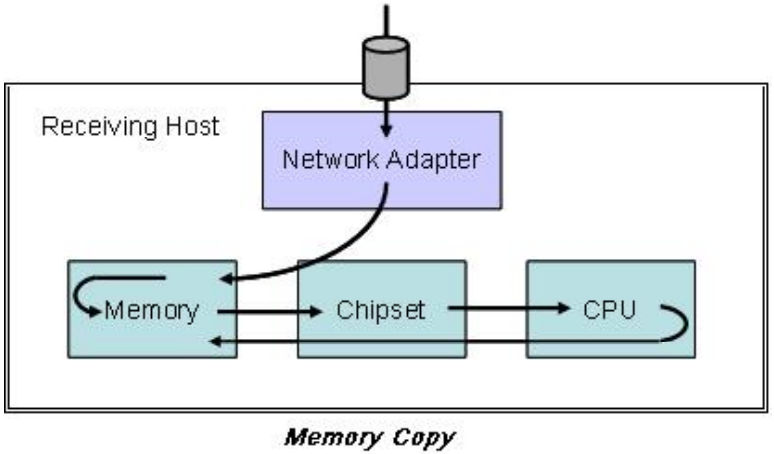
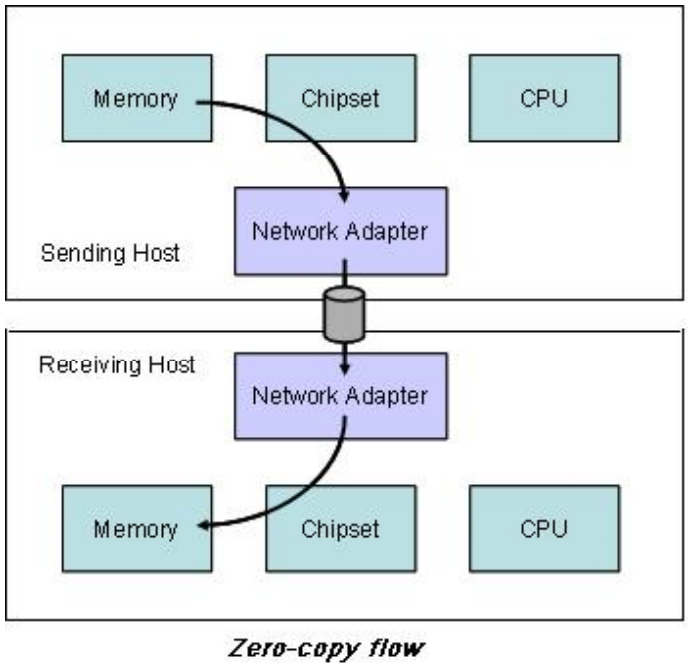
- Challenges
- Lessons Learned
- Acknowledgments
- References & Links
- Questions

Background : Remote Direct Memory Access (RDMA)

- RDMA provides high-throughput, low-latency networking:
  - Reduce consumption of CPU cycles
  - Reduce communication latency



Memory Copy



Zero-copy flow

Images courtesy of http://www.hpcwire.com/features/17888274.html

Background : InfiniBand

- Infiniband is a switched fabric communication link designed for HPC:
  - High throughput
  - Low latency
  - Quality of service
  - Failover
  - Scalability
  - Reliable transport
- How do we interface this high performance link with existing Ethernet infrastructure?

Background : RDMA over Converged Ethernet (RoCE)

- Provide Infiniband-like performance and efficiency to ubiquitous Ethernet infrastructure.
  - Utilize the same transport and network layers from IB stack and swap the link layer for Ethernet.
  - Implement IB verbs over Ethernet.
- Not quite IB strength, but it's getting close.
- As of OFED 1.5.1, code written for OFED RDMA auto-magically works with RoCE.

Objective

We would like to answer the following questions:

- What kind of performance can we get out of RoCE on our cluster?
- Can we implement RoCE in software (Soft RoCE) and how does it compare with hardware RoCE?

Testing Environment

Hardware:

- HP ProLiant DL160 G6 servers
- Mellanox MNPH29B-XTC 10GbE adapters
- 50/125 OFNR cabling

Operating System:

- CentOS 5.3
- 2.6.32.16 kernel

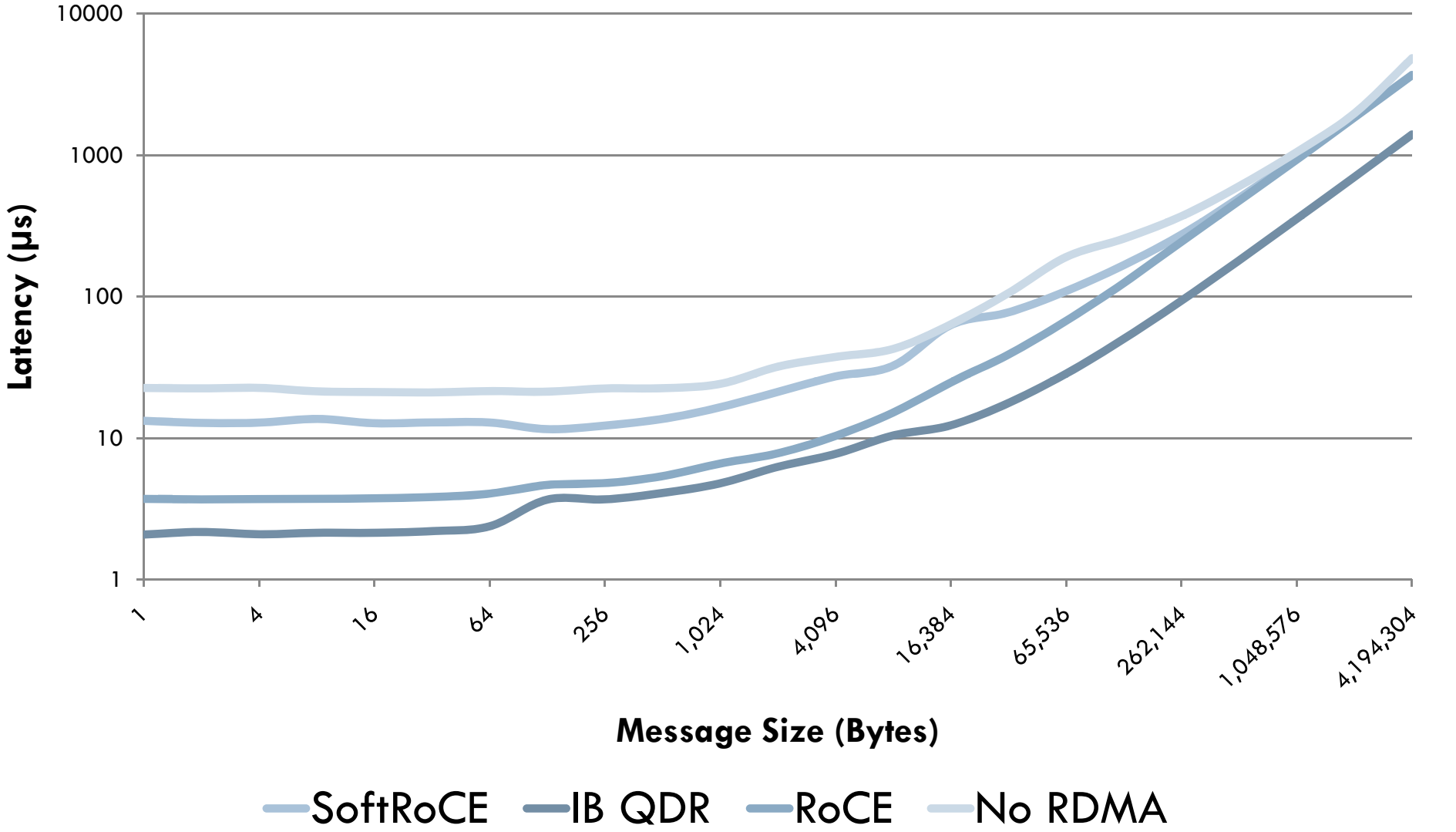
Software/Drivers:

- Open Fabrics Enterprise Distribution (OFED) 1.5.2-rc2 (RoCE) & 1.5.1-rxe (Soft RoCE)
- OSU Micro Benchmarks (OMB) 3.1.1
- OpenMPI 1.4.2

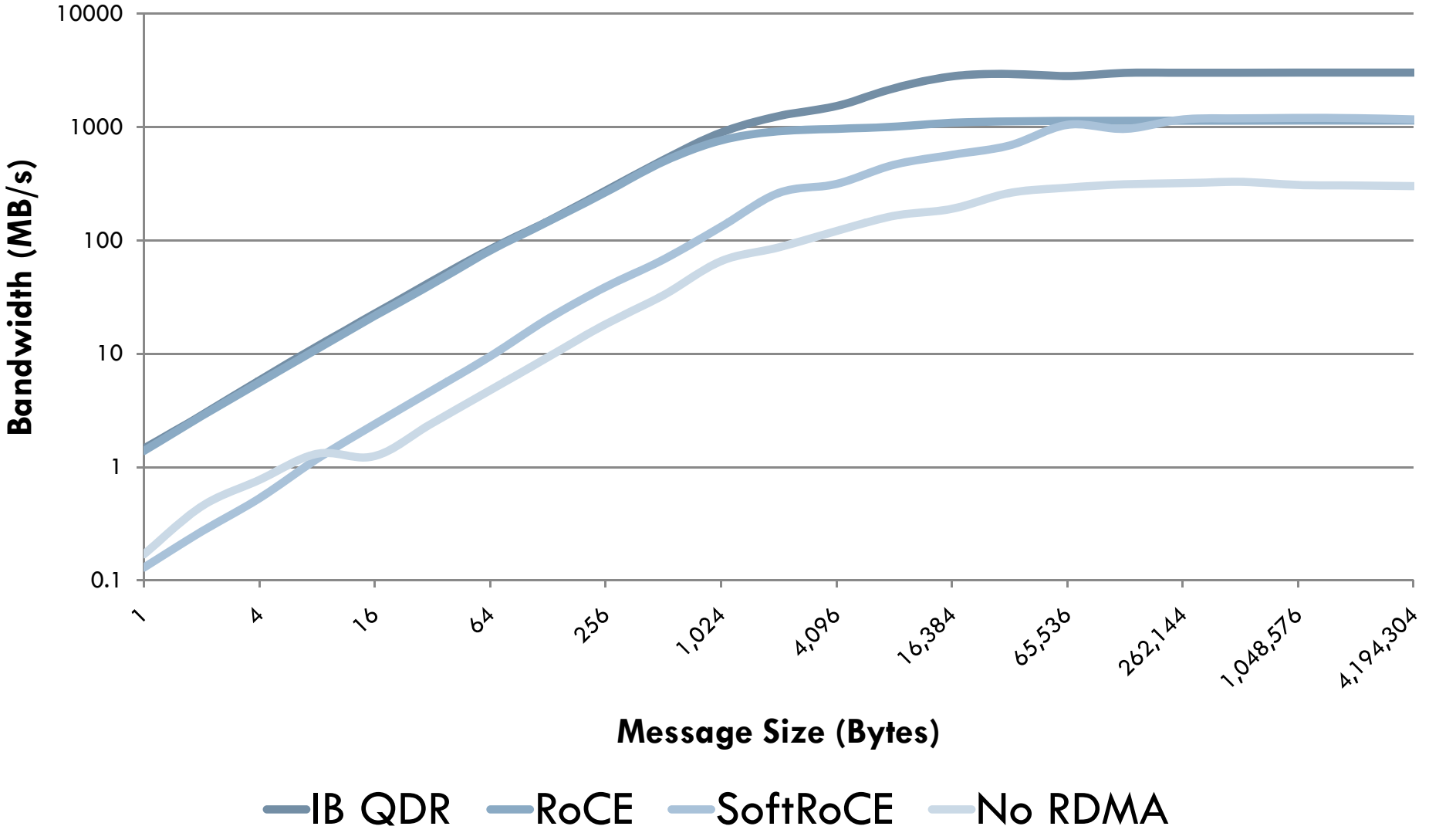
Methodology

- Set up a pair of nodes for each technology:
  - IB, RoCE, Soft RoCE, and no RDMA
- Install, configure & run minimal services on test nodes to maximize machine performance.
- Directly connect nodes to maximize network performance.
- Acquire latency benchmarks
  - OSU MPI Latency Test
- Acquire bandwidth benchmarks
  - OSU MPI Uni-Directional Bandwidth Test
  - OSU MPI Bi-Directional Bandwidth Test
- Script it all to perform many repetitions

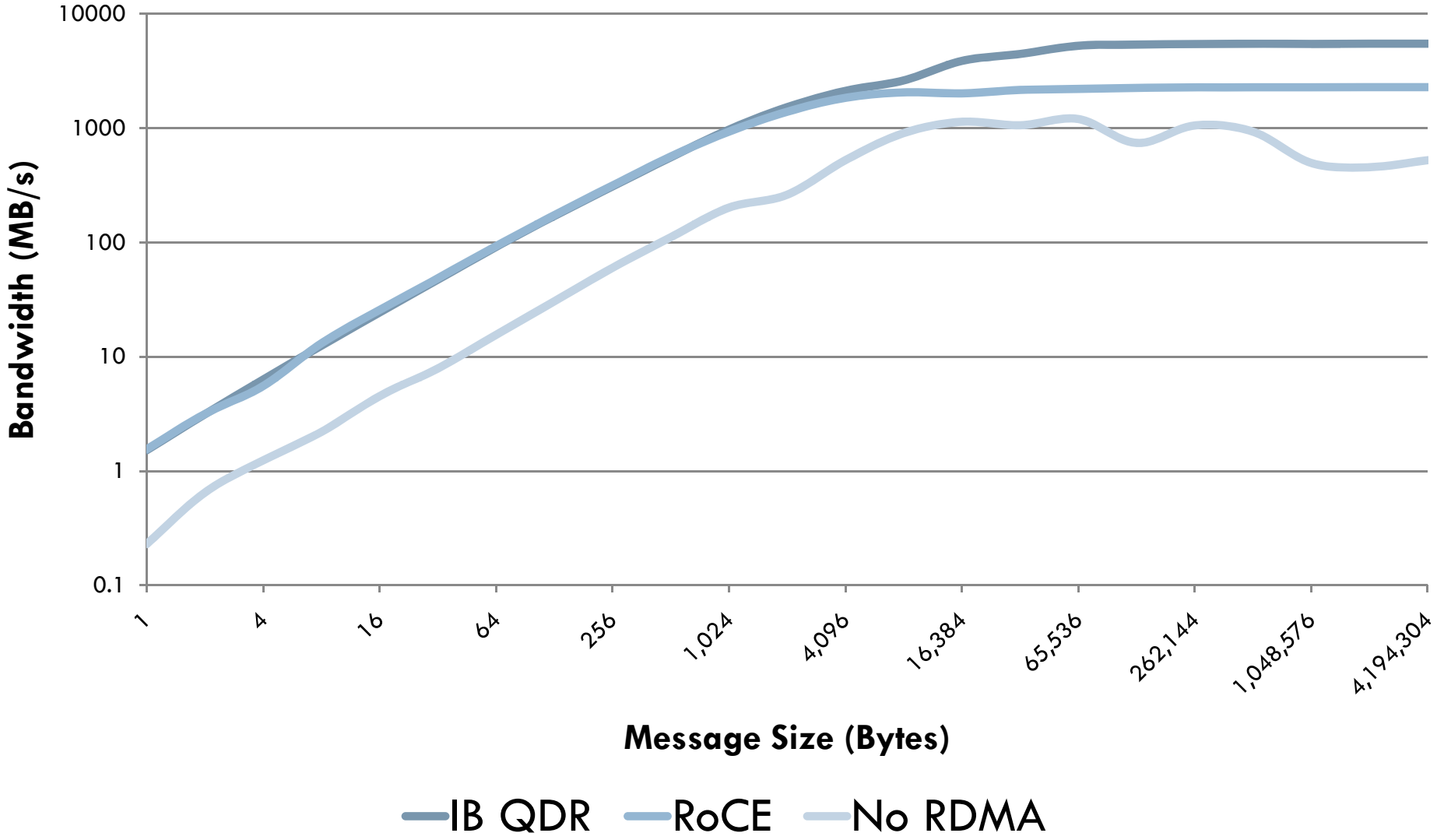
Results : Latency



Results : Uni-directional Bandwidth



Results : Bi-directional Bandwidth



Results : Analysis

Peak Values	IB QDR	RoCE	Soft RoCE	No RDMA
Latency (µs)	1.96	3.7	11.6	21.09
Two-way BW (MB/s)	5481.9	2284.7	-	1136.1

- RoCE performance gains over 10GbE:
  - Up to 5.7x speedup in latency
  - Up to 3.7x increase in bandwidth
- IB QDR vs. RoCE:
  - IB less than 1µs faster than RoCE at 128-byte message.
  - IB peak bandwidth is 2-2.5x greater than RoCE.

Conclusion

- RoCE is capable of providing near-Infiniband QDR performance for:
  - Latency-critical applications at message sizes from 128B to 8KB
  - Bandwidth-intensive applications for messages <1KB.
- Soft RoCE is comparable to hardware RoCE at message sizes above 65KB.
- Soft RoCE can improve performance where RoCE-enabled hardware is unavailable.

Further Work & Questions

- How does RoCE perform over collectives?
- Can we further optimize RoCE configuration to yield better performance?
- Can we stabilize the Soft RoCE configuration?
- How much does Soft RoCE affect the compute nodes ability to perform?
- How does RoCE compare with iWARP?

Challenges

- Finding an OS that works with OFED & RDMA:
  - Fedora 13 was too new.
  - Ubuntu 10 wasn't supported.
  - CentOS 5.5 was missing some drivers.
- Had to compile a new kernel with IB/RoCE support.
- Built OpenMPI 1.4.2 from source, but wasn't configured for RDMA; used OpenMPI 1.4.1 supplied with OFED instead.
- The machines communicating via Soft RoCE frequently lock up during OSU bandwidth tests.

Lessons Learned

- Installing and configuring HPC clusters
- Building, installing, and fixing Linux kernel, modules, and drivers
- Working with IB, 10GbE, and RDMA technologies
- Using tools such as OMB-3.1.1 and netperf for benchmarking performance

Acknowledgments

Andree Jacobson

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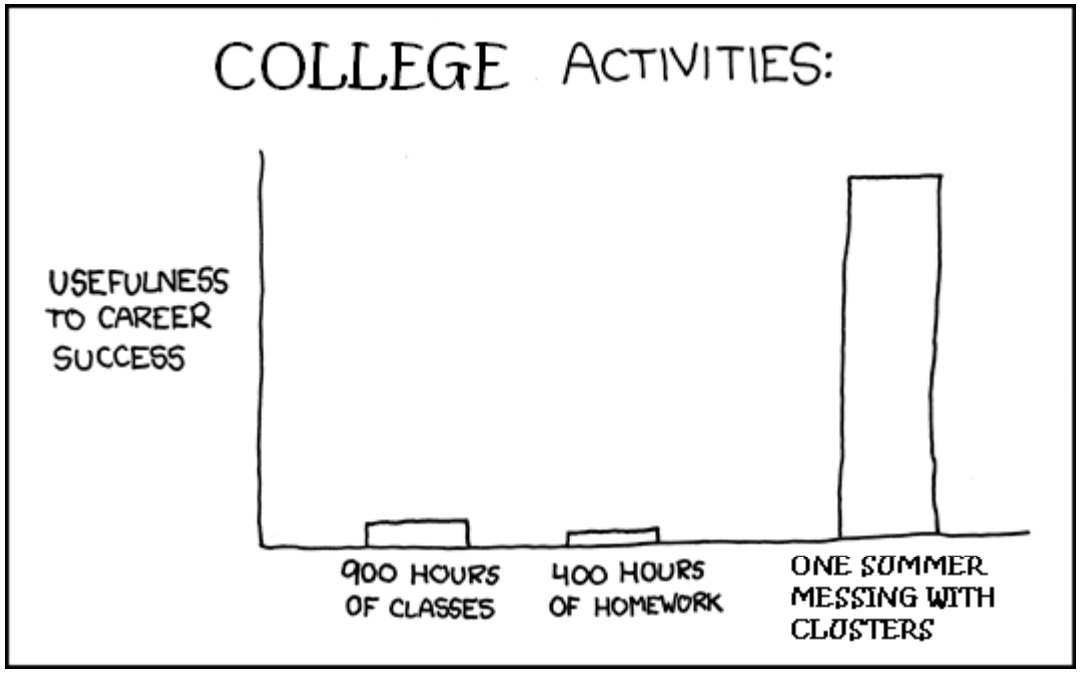
Sam Gutierrez

Bob Pearson

Questions?


COLLEGE ACTIVITIES:
USEFULNESS TO CAREER SUCCESS
900 HOURS OF CLASSES
400 HOURS OF HOMEWORK
ONE SUMMER MESSING WITH CLUSTERS

References & Links

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