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Red Hat Enterprise MRG Messaging Performance Seminar

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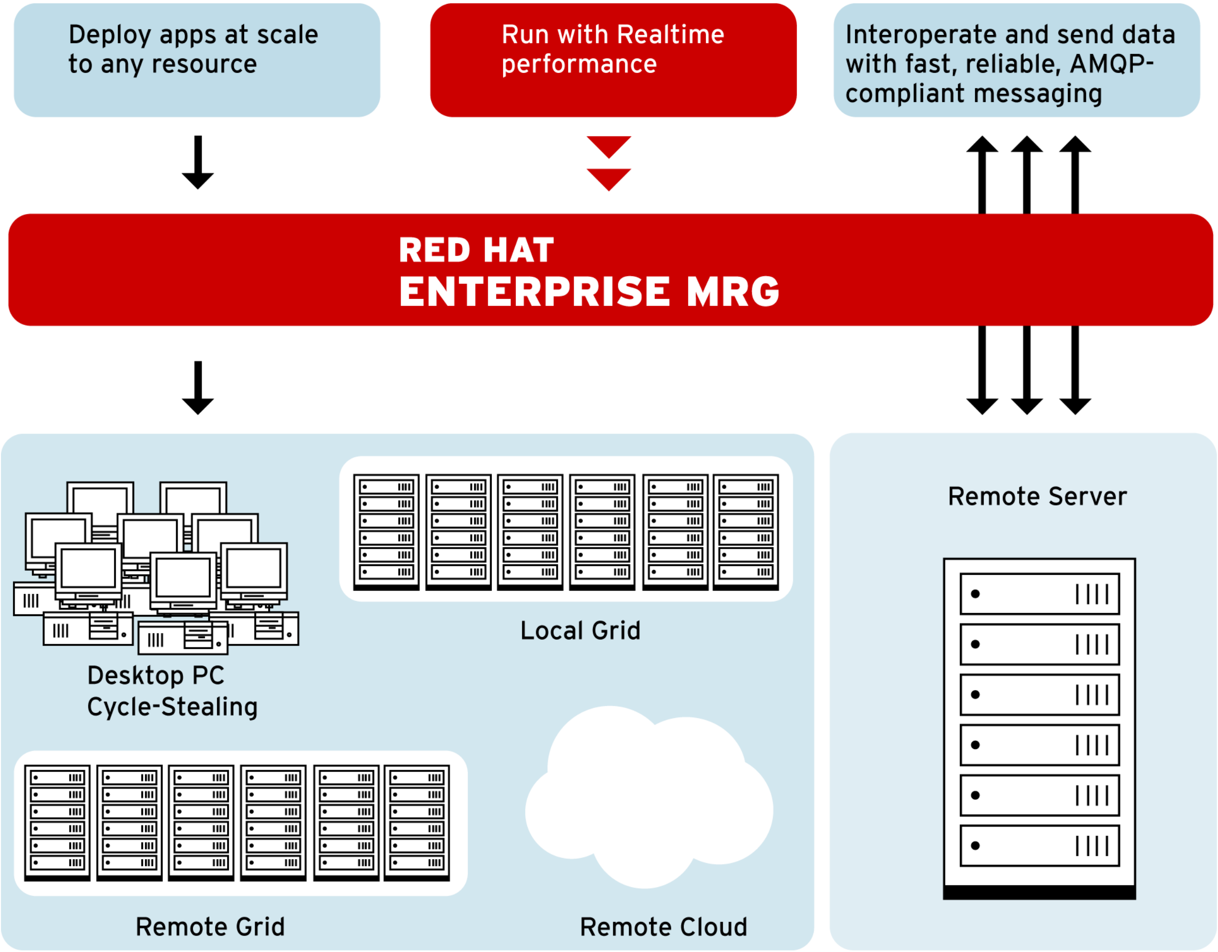
June 25, 2010

Overview

- Brief overview of MRG
- Guidelines for tuning Red Hat Enterprise MRG Messaging
- Understanding differences between technologies
  - 1GB / 10GB / IB / RDMA
  - SCSI / SATA / Fibre / FusionIO
- Best practices - Enterprise MRG in various configurations
  - Standalone/ Cluster / Grid
- The updated benchmark data across the newest platforms
- Open source performance tools for Red Hat Enterprise MRG

Red Hat Enterprise MRG



Deploy apps at scale to any resource

Run with Realtime performance

Interoperate and send data with fast, reliable, AMQP-compliant messaging

RED HAT ENTERPRISE MRG

Messaging

MRG Messaging

Enterprise Messaging System that

Implements AMQP (Advanced Message Queuing Protocol), the first open messaging standard

Participation from Red Hat, JPMC, Goldman, Credit Suisse, Deutsche Borse, Barclays, Bank of America, Microsoft, Cisco, etc

Spans many use cases in one implementation to consolidate architectural silos (fast messaging, reliable messaging, large file transfer, publish/subscribe, eventing, etc)

Uses Linux-specific optimizations to achieve breakthrough performance on Red Hat Enterprise Linux and MRG Realtime

Runs on non-Linux platforms without the full performance and quality of service benefits that Red Hat Enterprise Linux provides

Provides open, high performance system for everything from financial exchanges to infrastructure management

MRG Messaging Feature Highlights

Core Messaging

P2P, fanout, pub-sub, sync, async

Reliable messaging

Transactions local to dtx

Multiple clients (C++, Java, JMS, .NET Python, Ruby, {WCF})

High Performance

C++ broker, optimized for RHEL

O-direct AIO for high-speed durablity

RDMA support for ultra low latency

Management tools

- Web-based GUI, cmd line tools
- AMQP-based framework & APIs (QMF)

Advanced Features

Queue Semantics: Ring Queue, Last Value Queue, TTL, Initial Value Exchange, etc

Routing patterns, including XML XQuery

Federation with dynamic routes

High Availability

Active-Standby/Active-Active Broker Clustering

Federated disaster recovery

Security

SASL authentication

SSL/TLS/ Kerberos encryption

Role-based Access Control (ACL)

MRG 1.3 / RHEL6, what is new with regard to 'M'

Updated clients

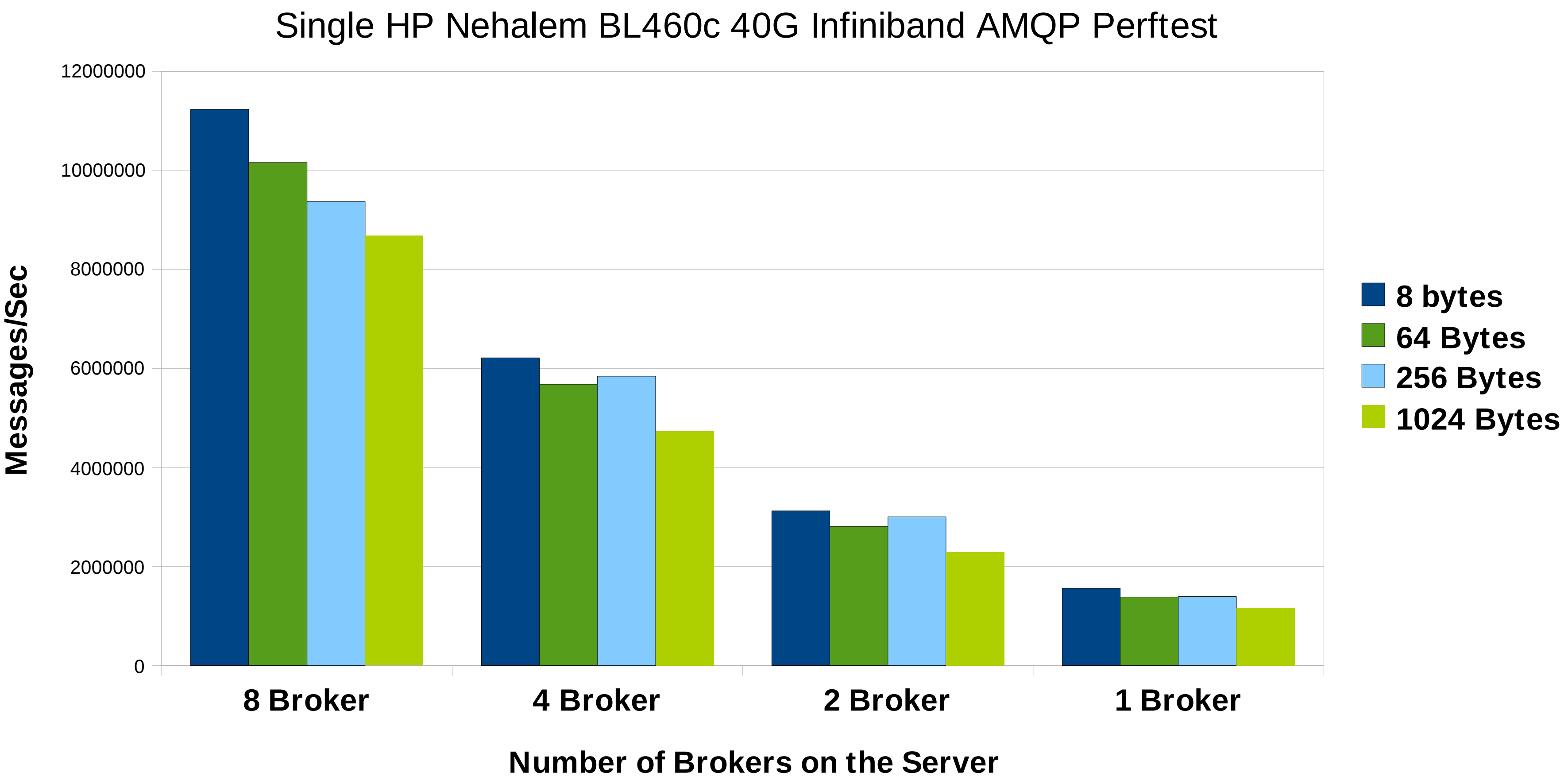
- New protocol-independent C++ and Python clients
- Additional python & ruby clients that wrap a native C implementation for improved performance
- Windows C++ client support (including .NET support) & Python
- Additional QMF APIs
- Map message support
- JBoss SOA-P and EAP certification

Broker

- Addition of iWARP, & RoCE in conjunction with RHEL 6
- RDMA for openAIS/corosync in conjunction with RHEL 6
- Offline Storage Management
- And much more... (includes ~300 updates/ improvements)

(Go to Bryan Che's presentation for full roadmap details)

MRG 1.2 / AMQP Scale up.



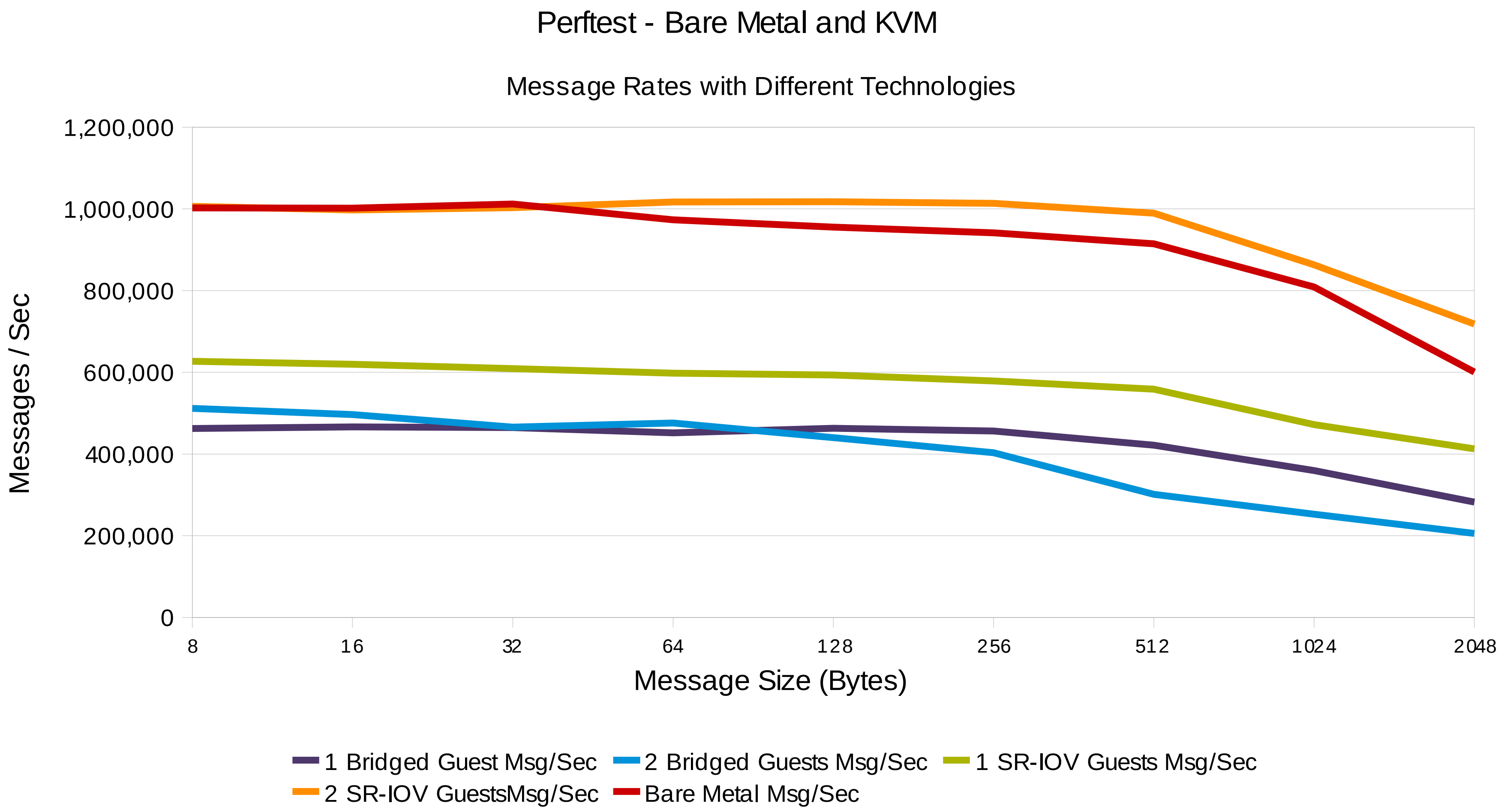
2 Intel(R) Xeon(R) CPU X5570 @ 2.93GHz per blade (Nehalem) (2.93 GHz, 8MB L3 cache, 95W,

Memory 24GB(6x4GB) , Memory Type DDR3-1333, HT, Turbo 2/2/3/3)

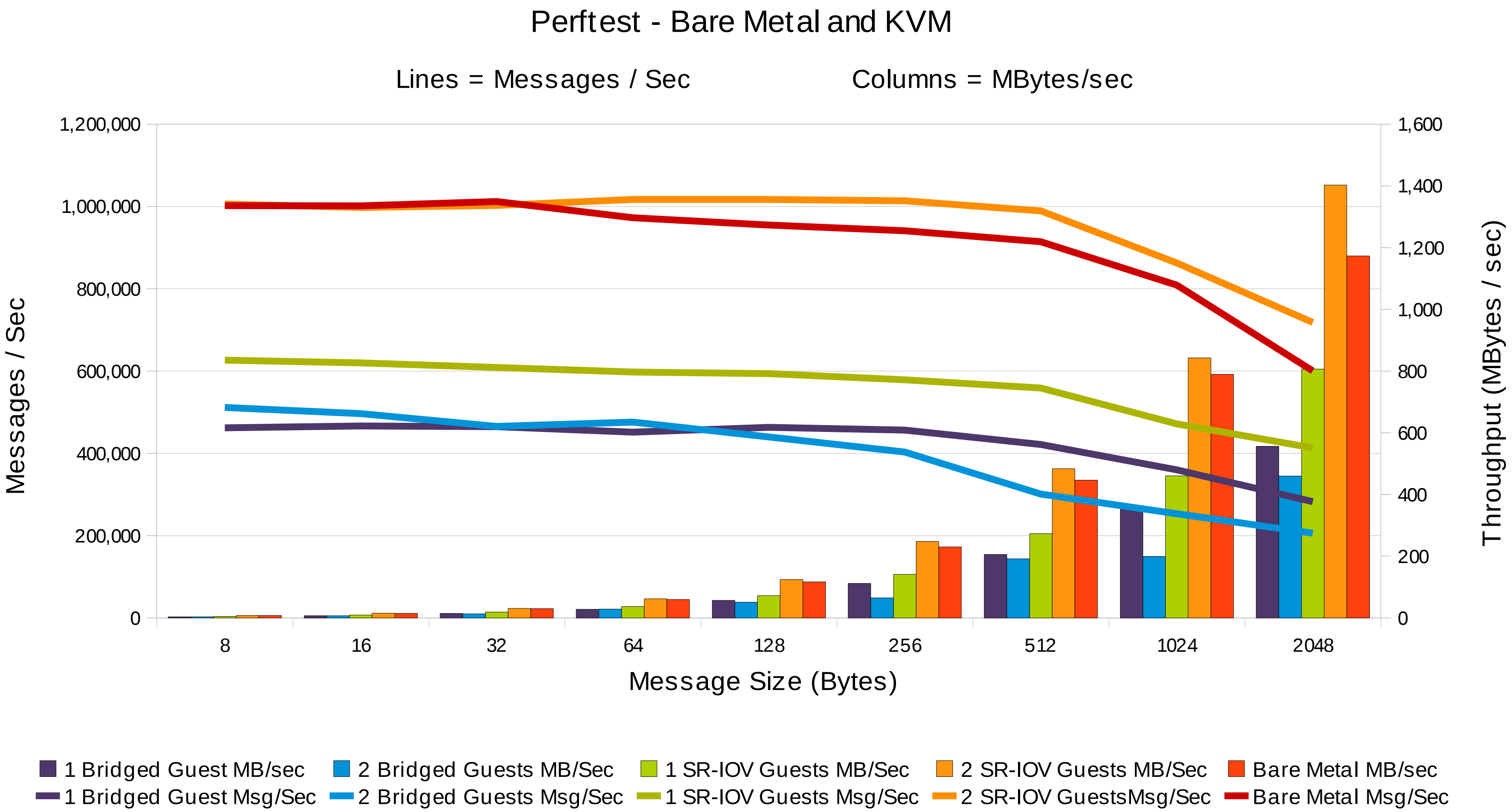
Infiniband 4X QDR IB Dual-port Mezzanine HCAs(1 port connected)

Infiniband Switch BLc 4X QDR IB Switch

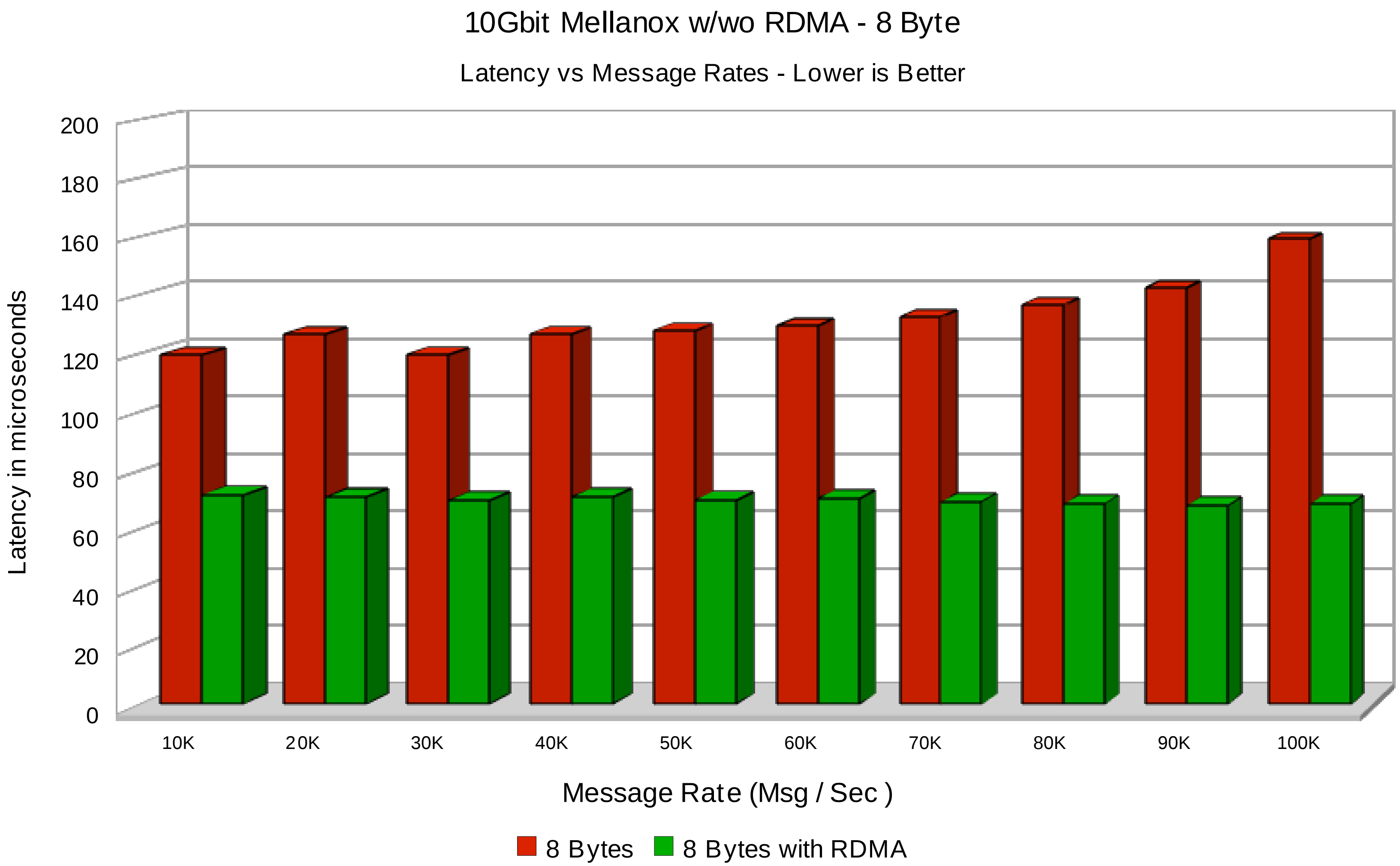
MRG 1.3 / AMQP Scale up, KVM ~5%



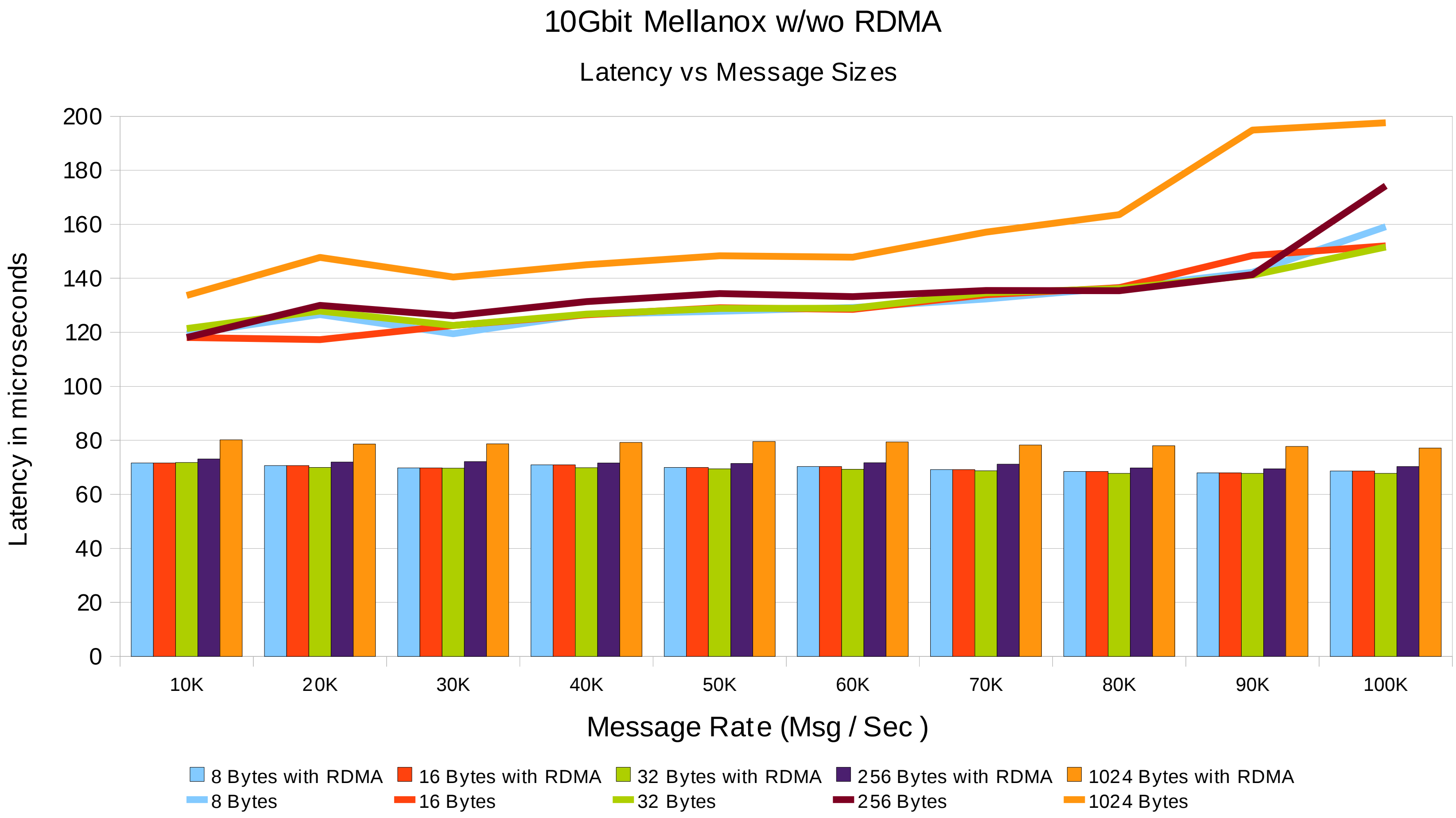
MRG 1.3 / AMQP Scale up, KVM ~5%



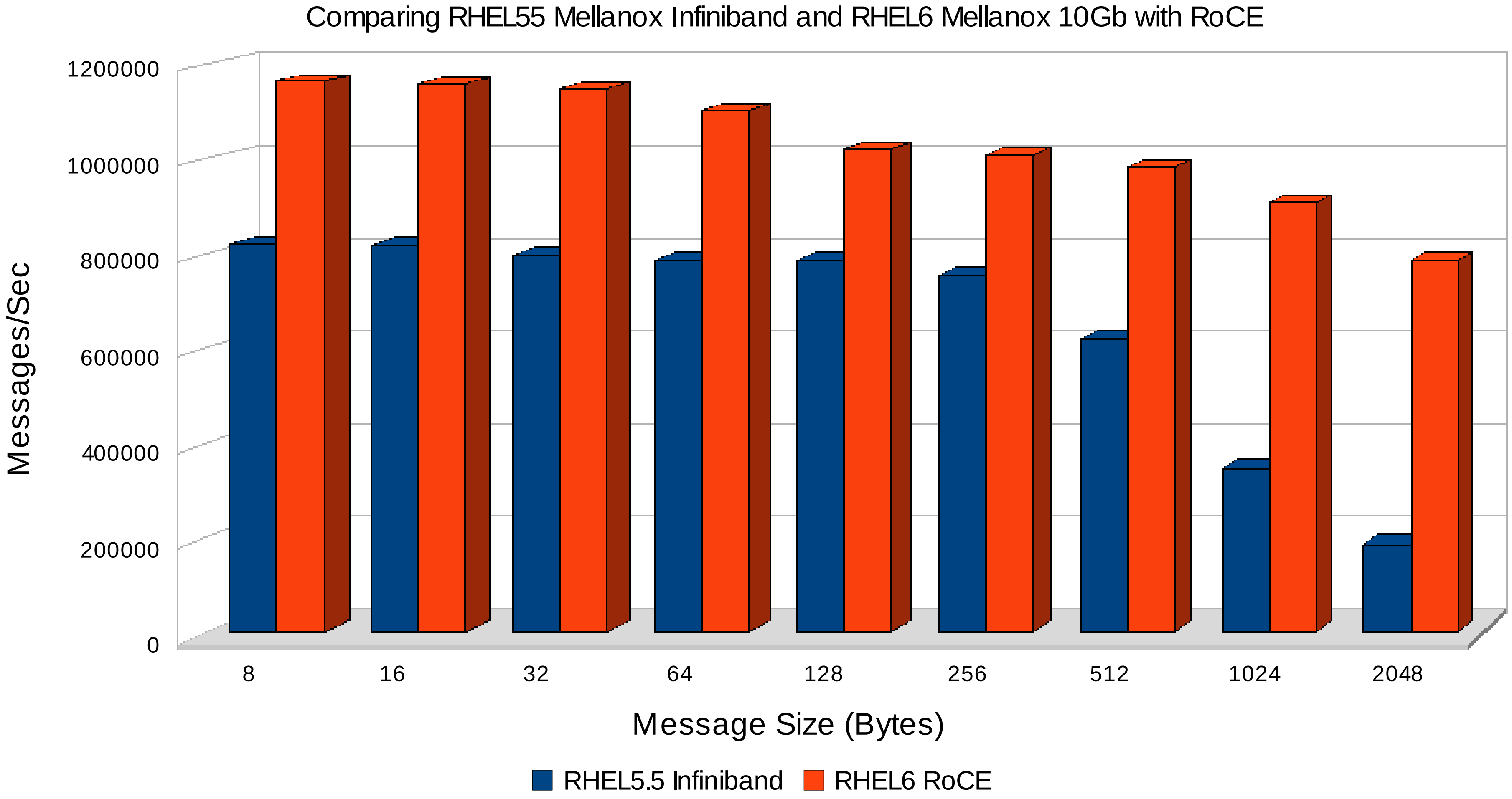
MRG 1.3 RHEL6 A quick peak at RoCE (RoE)



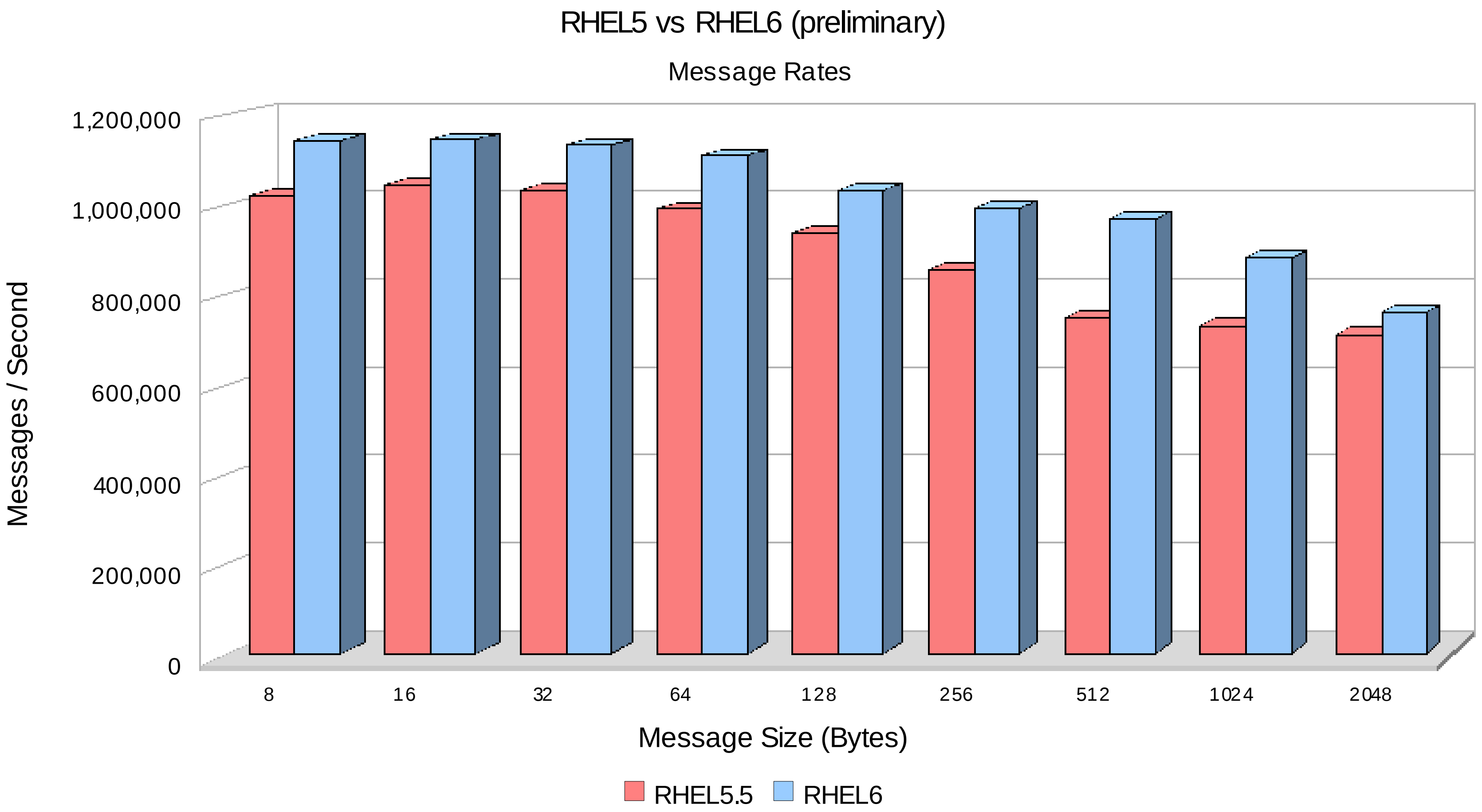
MRG 1.3 RHEL6 A quick peak at RoCE (cont)



RHEL5.5 Infiniband vs. RHEL6 10Gbit – Messages / Sec



RHEL5.5 to RHEL6



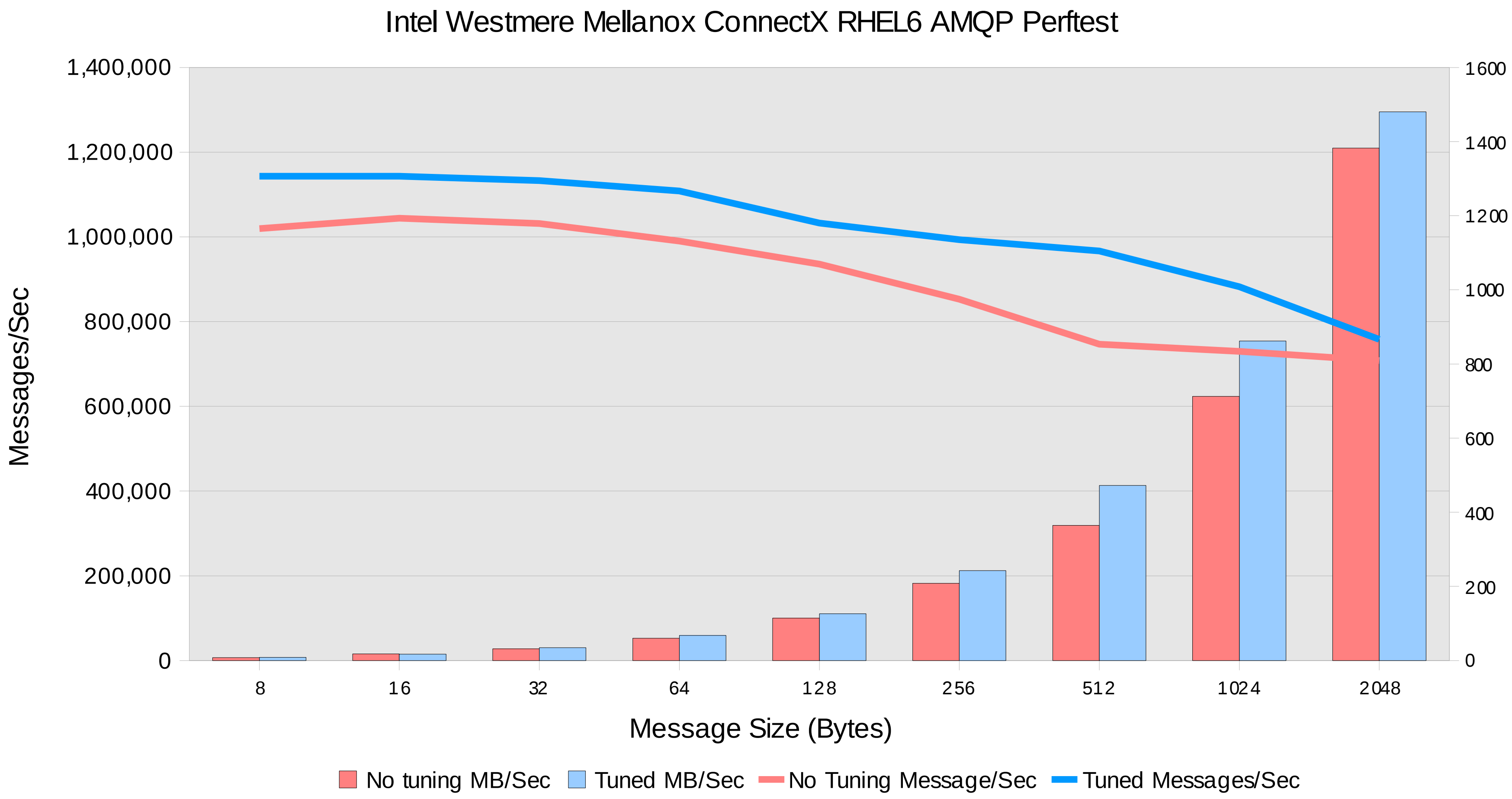
10 Gbit Ethernet (Mellanox)

Tuning

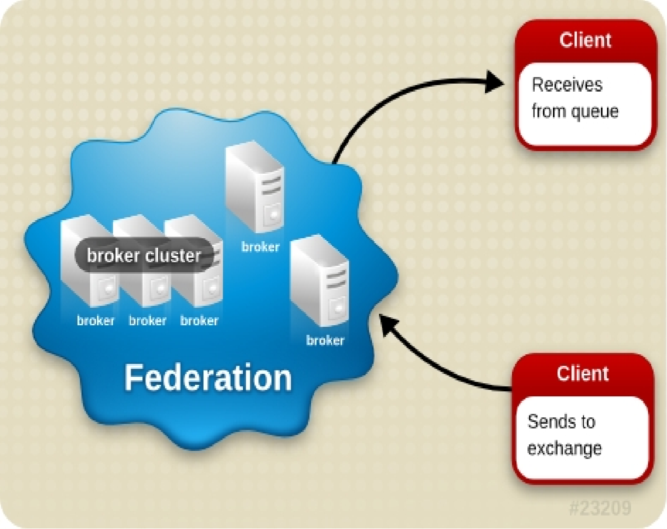
Tuning can provide excellent improvements

- Steps are different for throughput vs latency, goal is the same.
  - Try to maximize CPU cache hits and localize memory
  - Use NUMA if possible
    - *numactl -c1 -m1 /root/qpid/cpp/src/qpidd --auth no -m no --pid-dir /var/run/qpidd --data-dir /var/lib/qpidd --load-module /root/qpid/cpp/src/.libs/rdma.so -P rdma*
  - Move IRQ handlers as needed
  - Understand the NIC parameters, tune as necessary

The impact of tuning



Clustering and Federation



Active/Active Clustering provides

Cluster acts as virtual single broker

scalability and enhanced load-balancing

Producers and consumers can be connected to any broker in the cluster based on RHEL5 OpenAIS technology

Federation and Disaster Recovery provides

Geographical distribution of brokers configured via *links* and *routes*

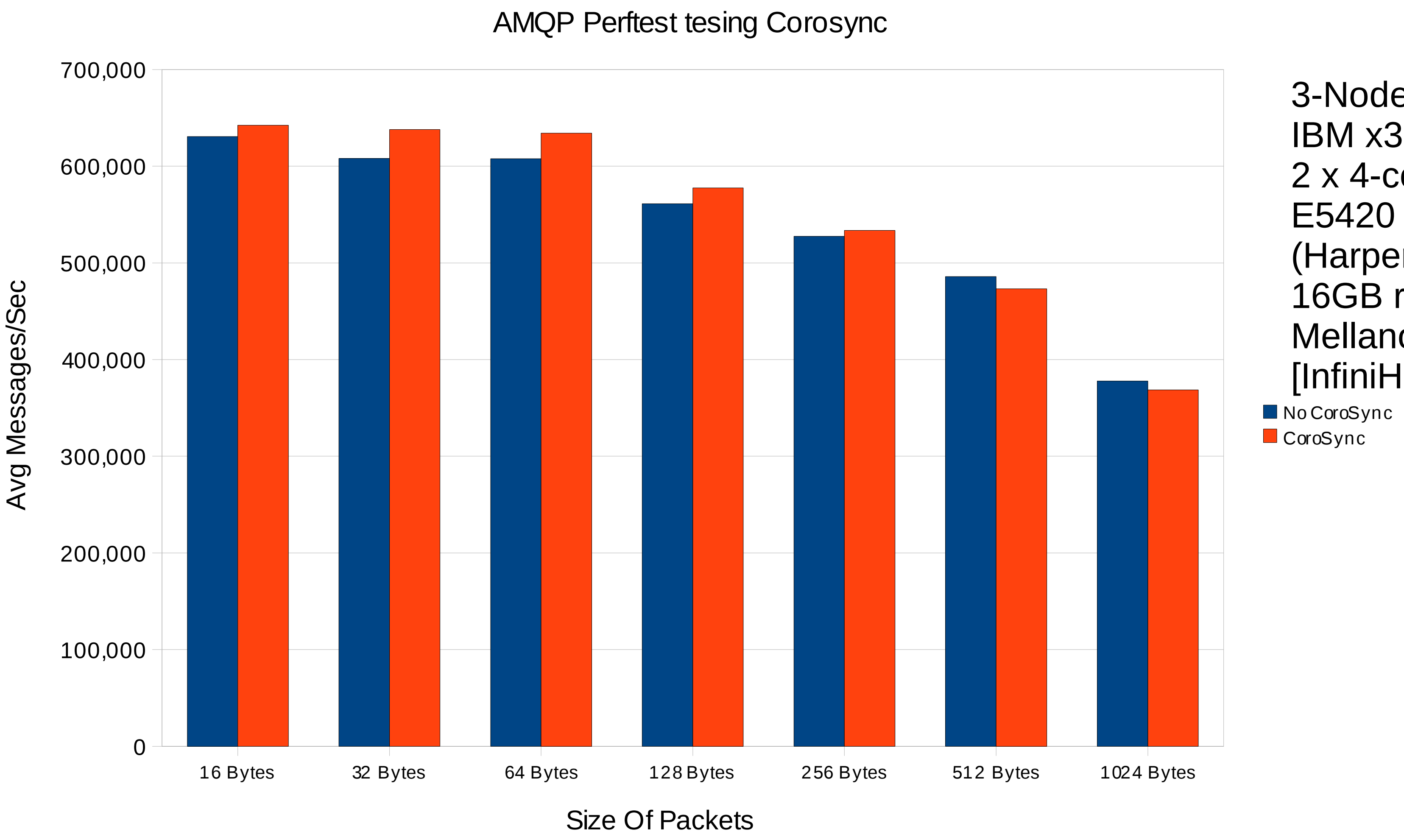
DR is setup via queue state replication

link: connection between two brokers that allows messages to be passed between them - can be RDMA, SSL, TCP etc.

route: path that messages take from one broker to another; can run along one or more links to the final destination. Routes can be dynamic or static

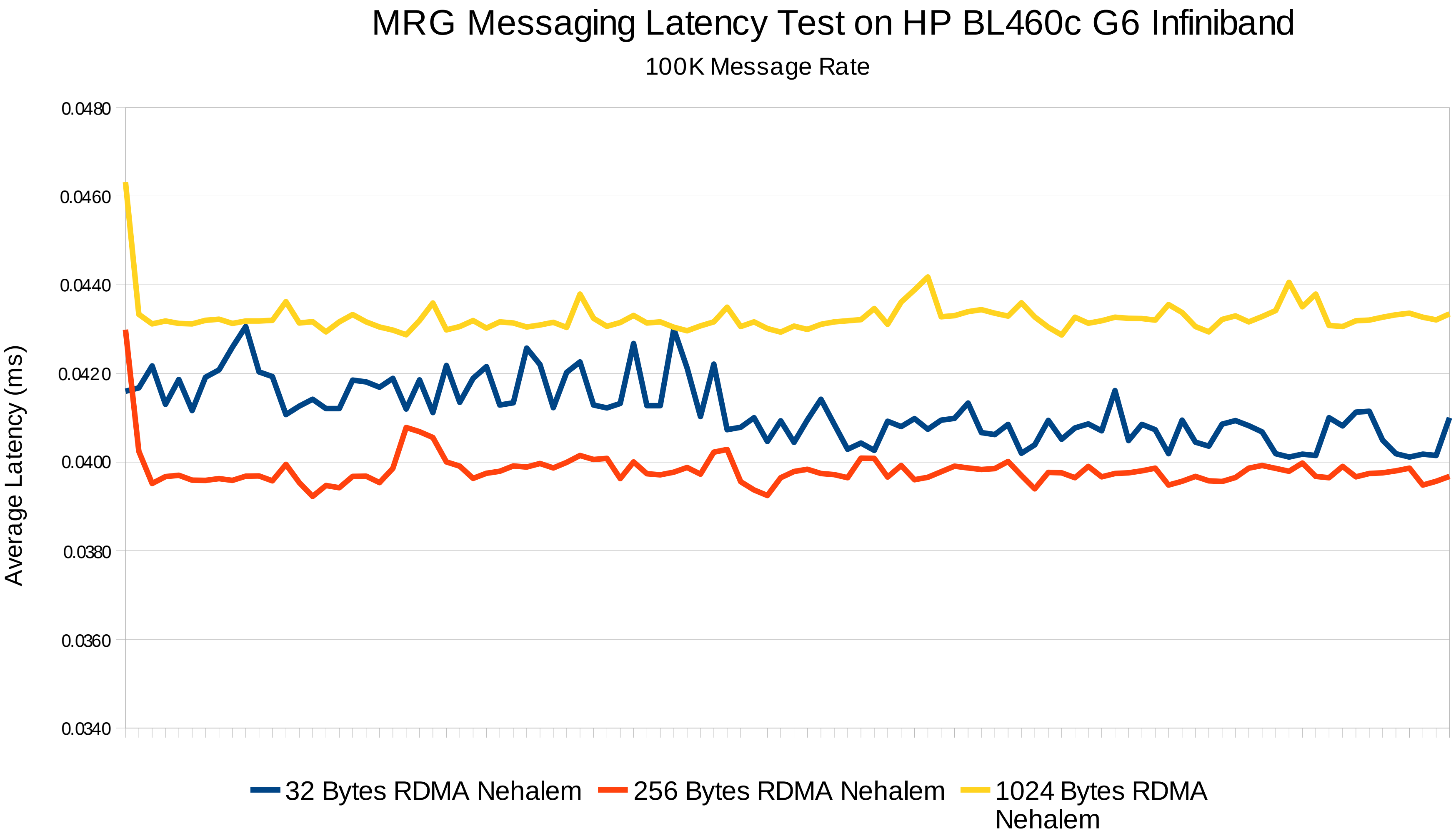
MRG 1.2 Messaging Clustered Throughput with RDMA

On prebuild of corosync for RHEL 6, Final RHEL6 / MRG 1.3 data not yet avail

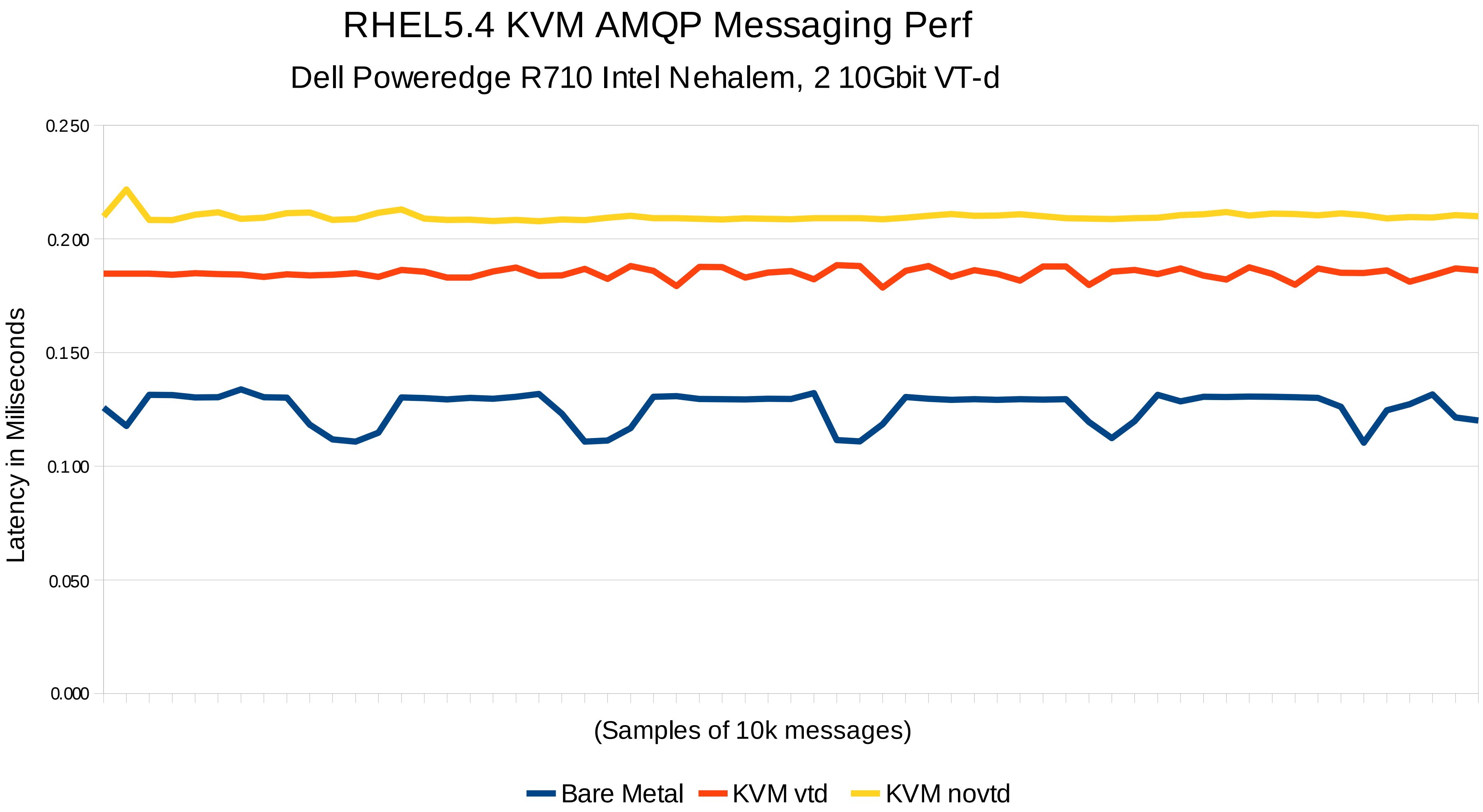


3-Node cluster
IBM x3550
2 x 4-core Xeon
E5420 2.5MHz
(Harpertown)
16GB ram 266 MHz
Mellanox MT25204
[InfiniHost III Lx HCA]

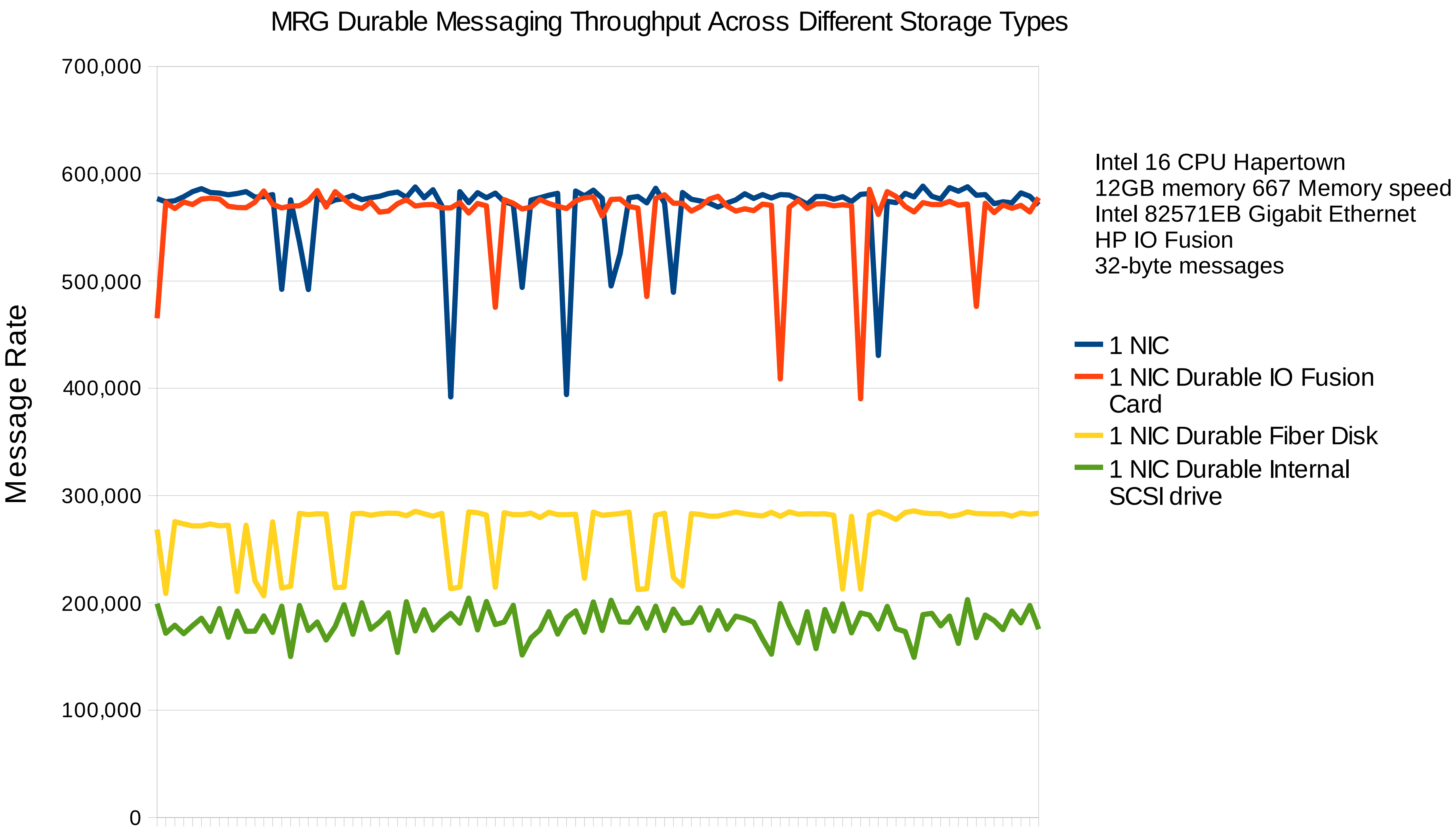
MRG 1.2 Messaging Infiniband RDMA Latency: Under 40 Microseconds Reliably Acknowledged



MRG 1.2 Messaging on KVM Virtualized Performance: <200 Microsecond Latency, Reliably Acknowledged

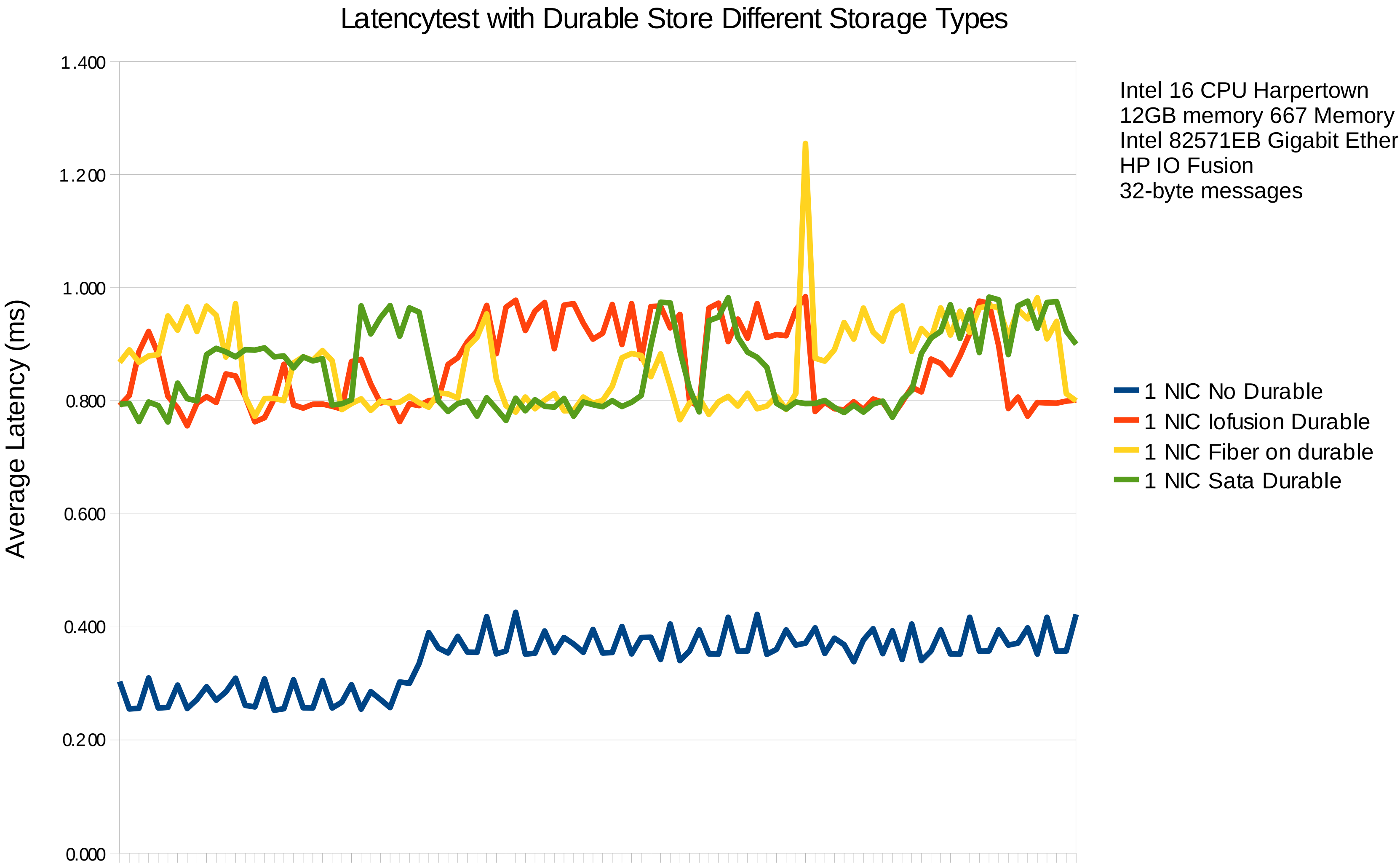


MRG 1.2 Messaging Durable Messaging Throughput



Intel 16 CPU Hapertown
12GB memory 667 Memory speed
Intel 82571EB Gigabit Ethernet
HP IO Fusion
32-byte messages

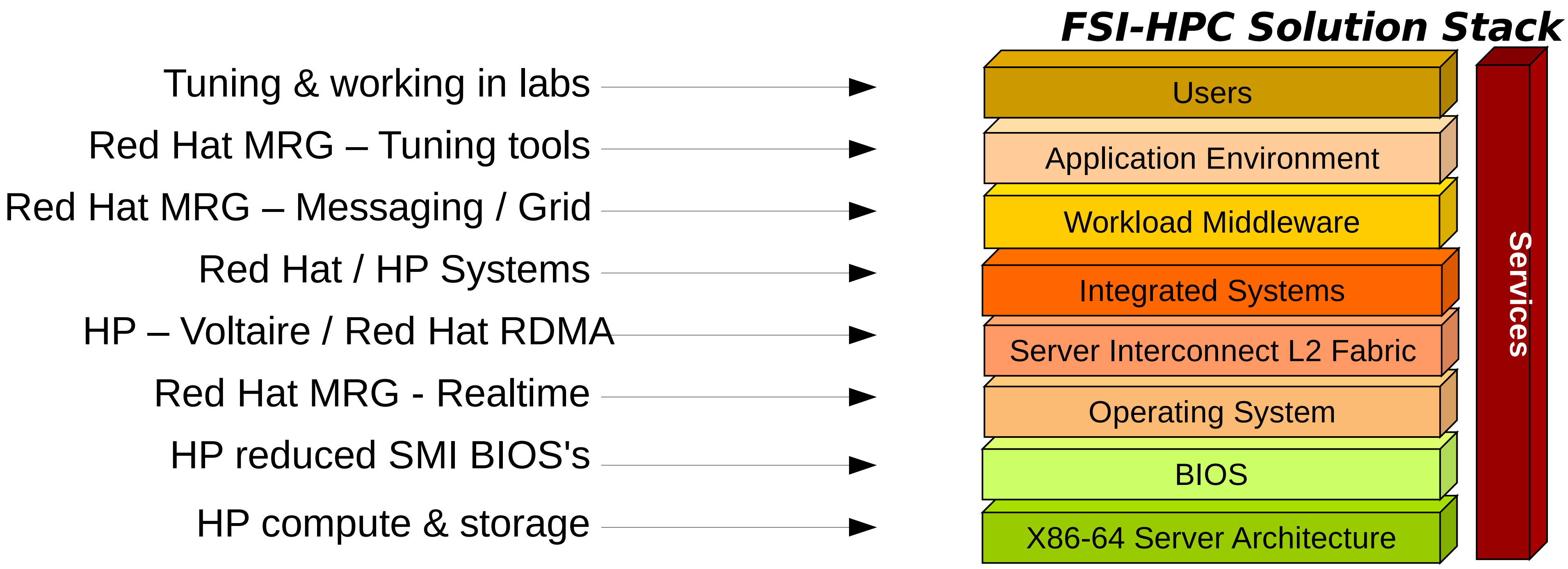
MRG 1.2 Messaging Durable Messaging Latency



Intel 16 CPU Harpertown
12GB memory 667 Memory speed
Intel 82571EB Gigabit Ethernet
HP IO Fusion
32-byte messages

All Layers of the stack matter

If you are concerned about performance, source of latency, or issues can come from all layers...



Tuning & working in labs

Red Hat MRG – Tuning tools

Red Hat MRG – Messaging / Grid

Red Hat / HP Systems

HP – Voltaire / Red Hat RDMA

Red Hat MRG - Realtime

HP reduced SMI BIOS's

HP compute & storage

Determinism, and performance needs to work at each layer, HP & Red Hat for example are partnered across the stack

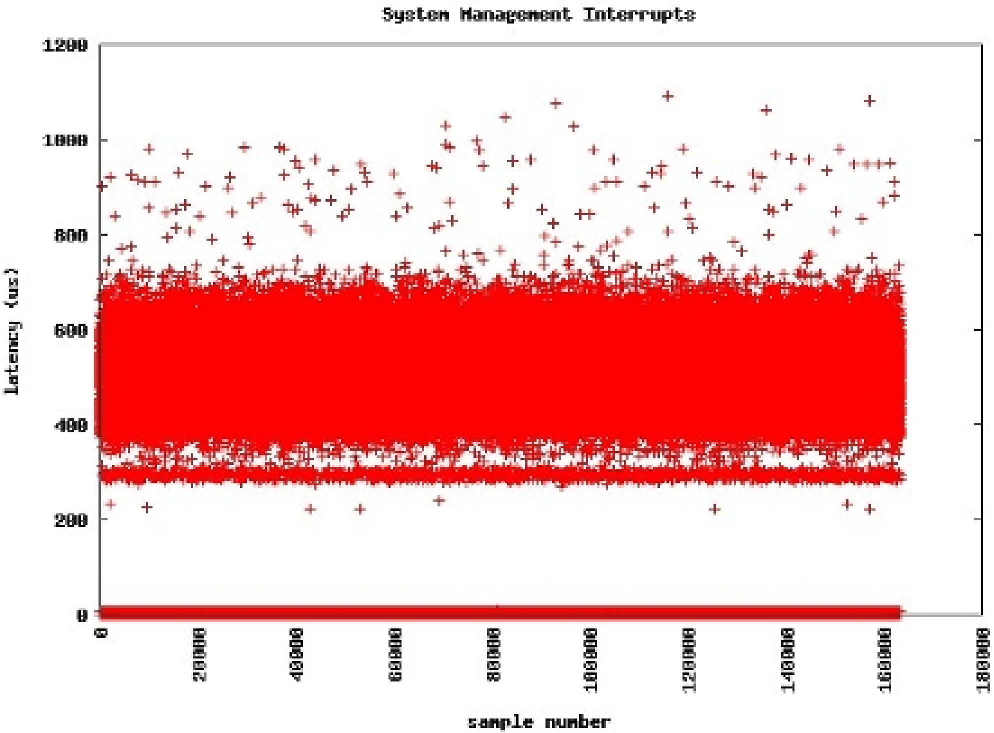
Dealing with SMIs

HP BIOS Option for Low Latency Apps (G5,G6,G7)

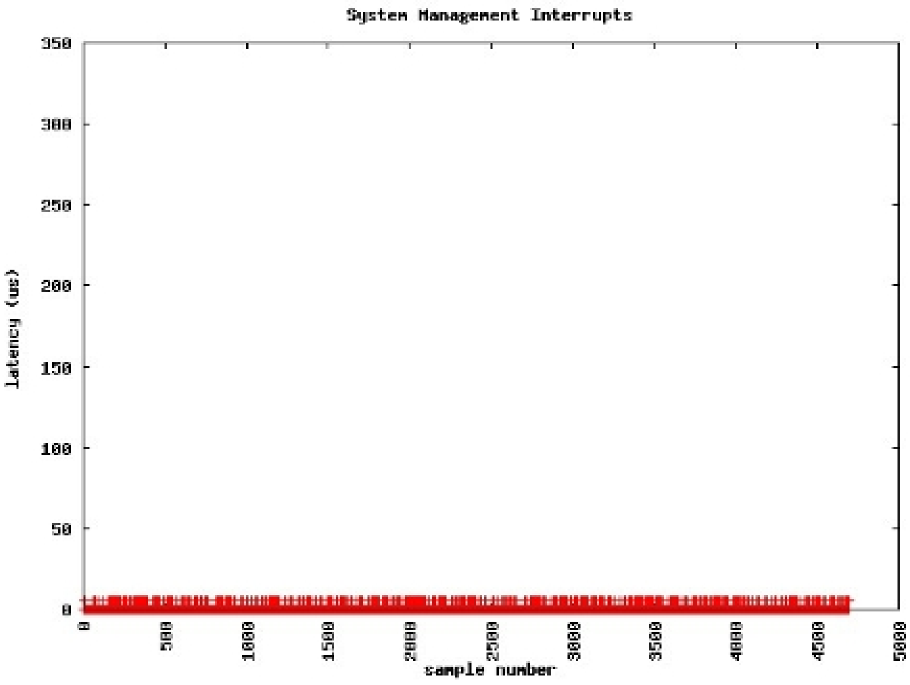
Disable frequent SMIs used for Dynamic Power Savings Mode, CPU Utilization monitoring, P-state monitoring and ECC monitoring

Benefits both RHEL & MRG operating environments.

Latency spikes with standard BIOS settings



Latency when SMIs disabled in BIOS



Real Time

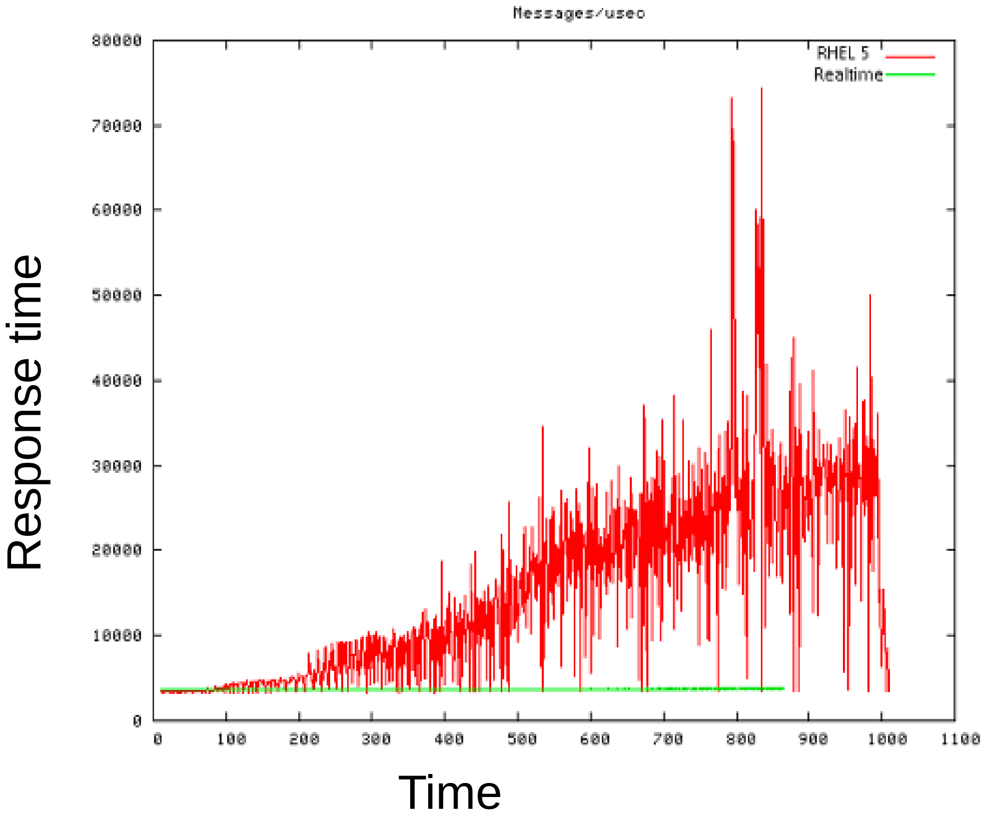
MRG – Realtime RHEL on HP systems

Enables applications and transactions to run predictably, with guaranteed response times

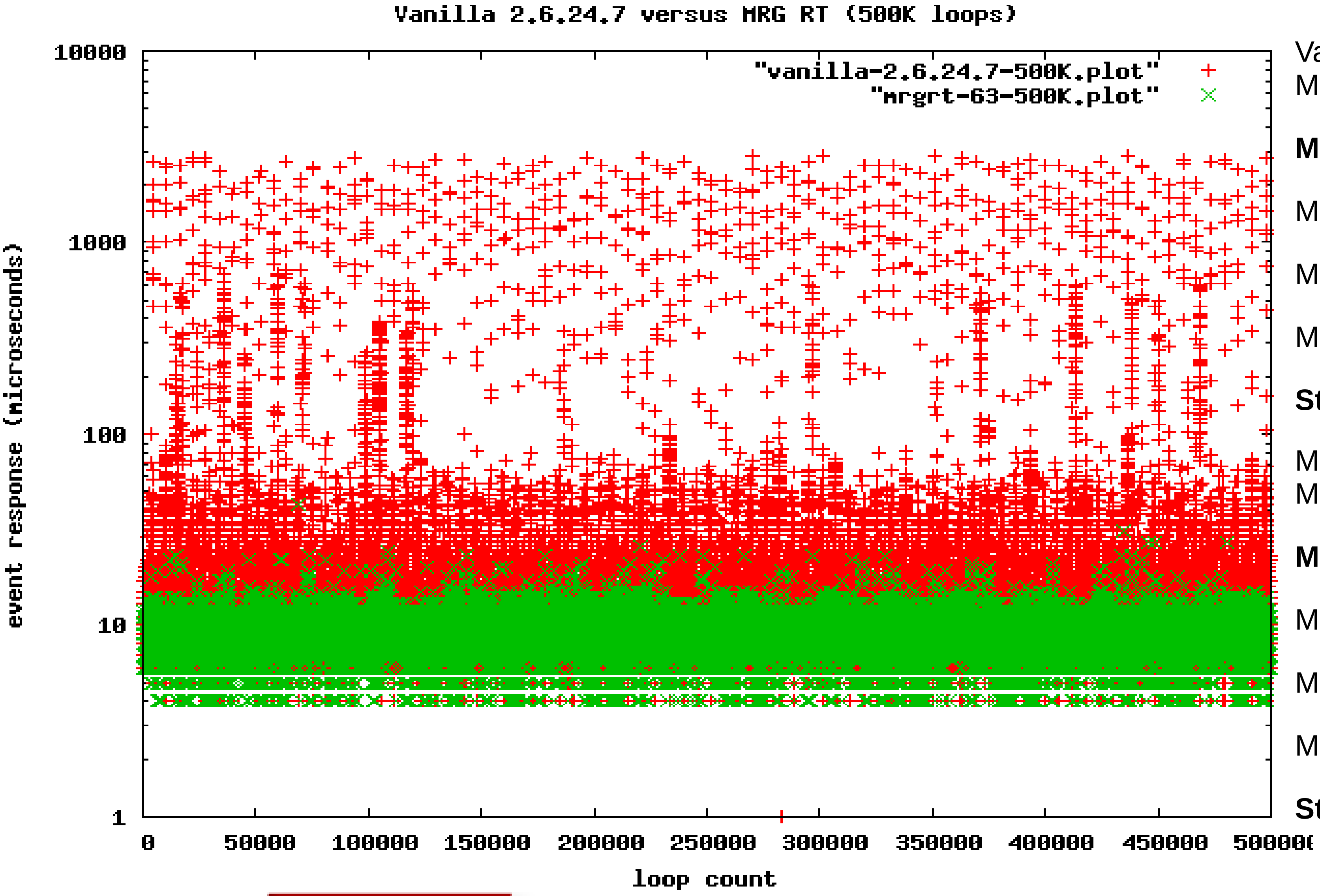
Upgrades RHEL 5 to realtime OS

- Provides replacement kernel for RHEL5;x86/x86_64
- Preserves RHEL Application Compatibility

For certified hardware, see ***www.redhat.com/mrg/hardware***



MRG 1.2 Realtime Scheduling Latency



Vanilla
Min: 1

Max: 2857

Mean: 11.47

Mode: 9.00

Median: 9.00

Std. Deviation: 54.94

MRG RT
Min: 4

Max: 43

Mean: 8.34

Mode: 8.00

Median: 8.00

Std. Deviation: 1.49

MRG 1.3, what is new with regard to 'R'

2.6.33 kernel

Realtime will move to a 2.6.33-based kernel

Perf tool

Realtime will include the new Performance Counter subsystem in the kernel and also the new associated perf performance tool

Improved performance

Realtime performance will continue to improve

Certification

Additional hardware enablement/hardware

New Realtime self-service hardware certification program

Grid

MRG Grid

Provides leading High Performance & High Throughput Computing

- Brings advantages of scale-out and flexible deployment to any application or workload
- Delivers better asset utilization, allowing applications to take advantage of all available computing resources

Enables building cloud infrastructure and aggregating multiple clouds

- Integrated support for virtualization as well as public clouds
- Seamlessly aggregates multiple cloud resources into one compute pool

Provides seamless and flexible computing across:

- Local grids
- Remote grids
- Private and hybrid clouds
- Public clouds (Amazon EC2)
- Cycle-harvesting from desktop PCs

Based on Condor and Includes:

Enterprise Supportability

From Red Hat

Web-Based Management Console

Unified management across all of MRG for job, system, license management, and workload management/monitoring

Low Latency Scheduling

Enable job submission to Condor via AMQP Messaging clients

Enable sub-second, low-latency scheduling for sub-second jobs

Virtualization Support via libvirt Integration

Support scheduling of virtual machines on Linux using libvirt API's

Cloud Integration with Amazon Ec2

Enable automatic cloud provisioning, job submission, results storage, teardown via Condor scheduler

Extensible, it can be a dependency for other jobs or executed based on rules (e.g. add capacity in in the cloud if local grid out of capacity)

Concurrency Limits

Set limits on how much of a certain resource (e.g. software licenses, db connections) can be used at once

Dynamic Slots

Mark slots as partitionable and sub-divide them dynamically so that more than one job can occupy a slot at once

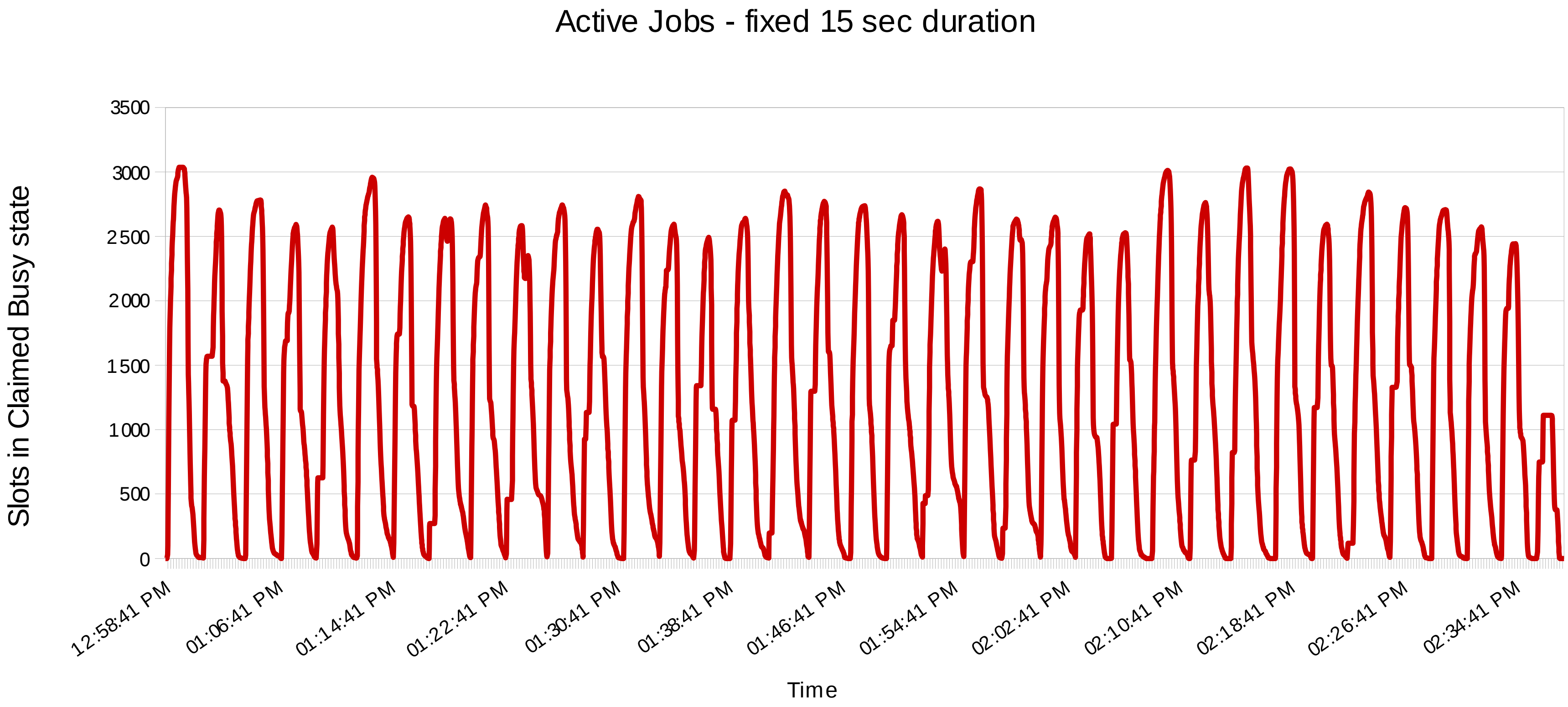
MRG 1.3, what is new with regard to 'G'

- New User Tools
  - Job submission interface
  - User centric UI with submissions
- New Admin Tools
  - Configuration management
  - Trigger/event service (diagnostic)
  - Multiple pool/grid representation (e.g. EC2 nodes)
  - Facility for administrators to adjust User/Group priorities and do so in a hierarchical manner for hierarchical fair share
- Engine
  - Windows Execute Node Support
  - Enhanced workflow (DAGMan) management
  - **Enhanced scalability**

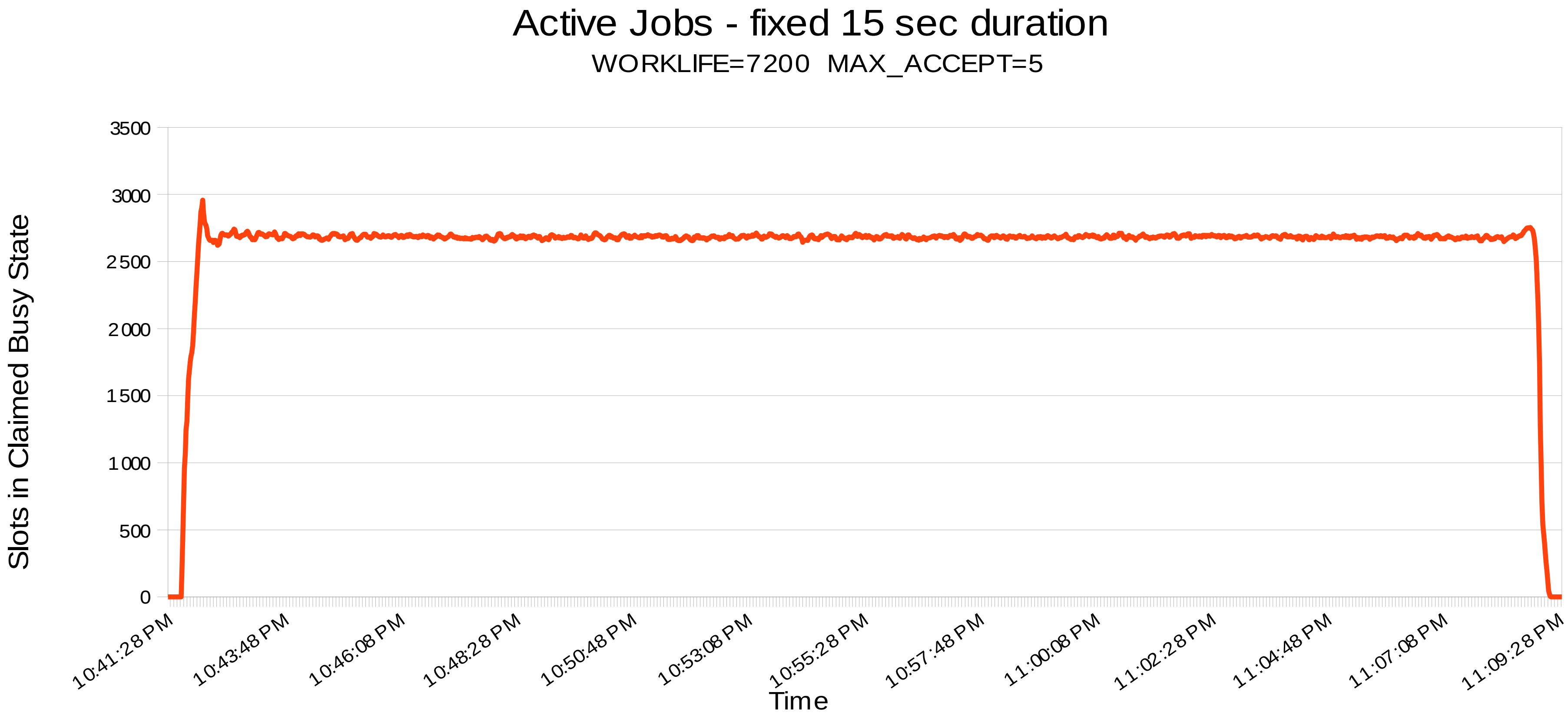
Grid scalability data

- Enterprise workload focus
  - Previous optimized for long duration jobs at scale
  - Enhancements for short running jobs at scale
- Performance testing showed room for improvement
  - Our testing showed some cyclic behavior
    - Mostly visible on short duration jobs
  - Multiple improvements lead to good utilization
    - Can now achieve ~98% utilization with 4 minute jobs
    - Can now achieve ~88% utilization with 15 second jobs

Grid scalability - Before



Grid scalability - After



Tools

MRG Realtime Tools

TUNA: System Tuning Tool

Dynamically control tuning parameters like process affinity, parent & threads, scheduling policy, device IRQ priorities, etc.

FTrace: Latency Tracer

Runtime trace capture of longest latency codepaths – both kernel and application. Peak detector

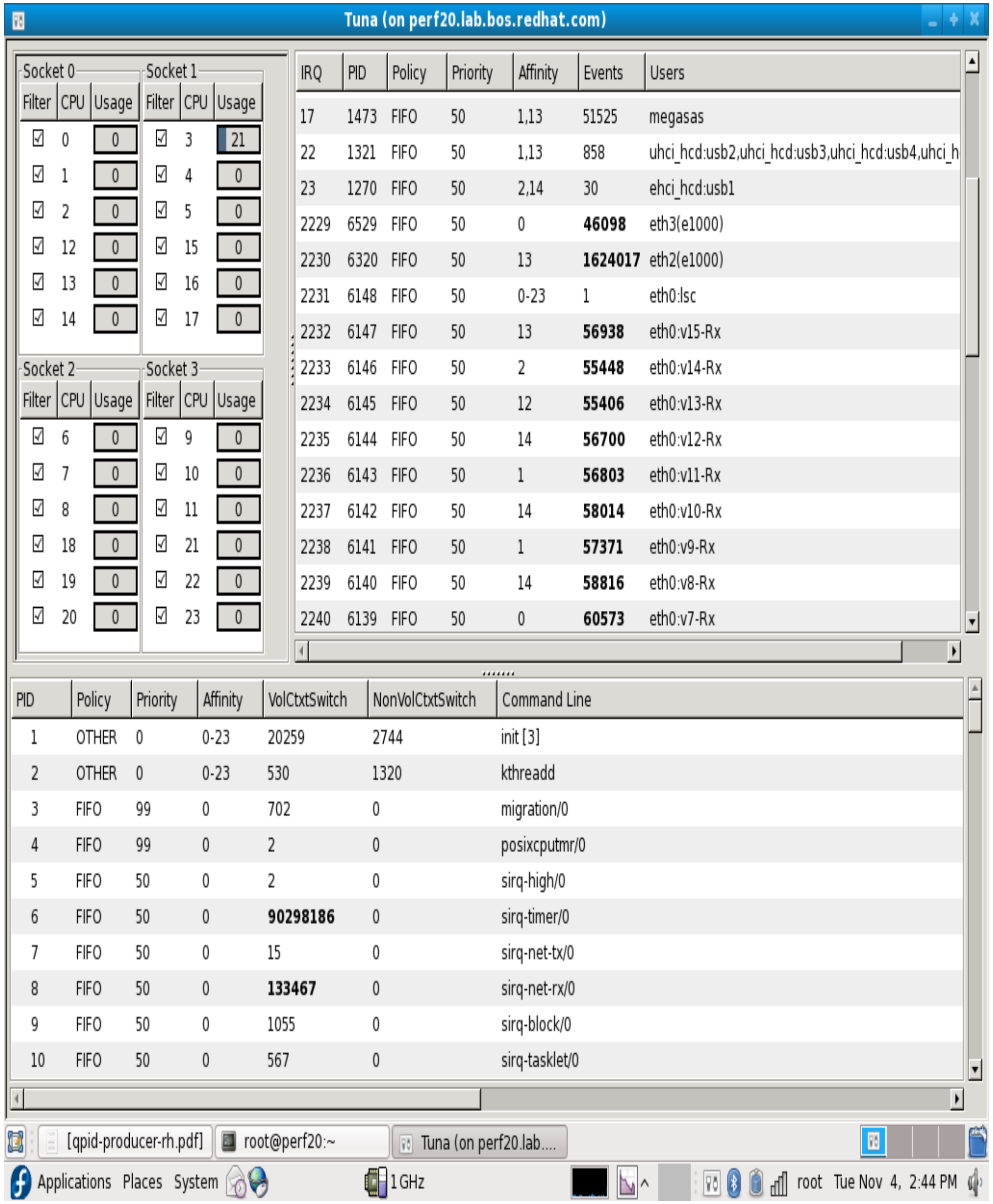
Selectable triggers for threshold tracing

Detailed kernel profiles based on latency triggers

RTEval: Hardware Latency Detector

- Tool that finds hardware latencies in your system so that you can achieve low latency across your entire platform
- Complements MRG Realtime hardware certification program

Existing standard RHEL5 based performance monitoring tools remain relevant



Tuna (on perf20.lab.bos.redhat.com)

Socket 0

Filter	CPU	Usage
☑	0	0
☑	1	0
☑	2	0
☑	12	0
☑	13	0
☑	14	0

Socket 1

Filter	CPU	Usage
☑	3	21
☑	4	0
☑	5	0
☑	15	0
☑	16	0
☑	17	0

Socket 2

Filter	CPU	Usage
☑	6	0
☑	7	0
☑	8	0
☑	18	0
☑	19	0
☑	20	0

Socket 3

Filter	CPU	Usage
☑	9	0
☑	10	0
☑	11	0
☑	21	0
☑	22	0
☑	23	0

IRQ	PID	Policy	Priority	Affinity	Events	Users
17	1473	FIFO	50	1,13	51525	megasas
22	1321	FIFO	50	1,13	858	uhci_hcd:usb2,uhci_hcd:usb3,uhci_hcd:usb4,uhci_h
23	1270	FIFO	50	2,14	30	ehci_hcd:usb1
2229	6529	FIFO	50	0	**46098**	eth3(e1000)
2230	6320	FIFO	50	13	**1624017**	eth2(e1000)
2231	6148	FIFO	50	0-23	1	eth0:lsc
2232	6147	FIFO	50	13	**56938**	eth0:v15-Rx
2233	6146	FIFO	50	2	**55448**	eth0:v14-Rx
2234	6145	FIFO	50	12	**55406**	eth0:v13-Rx
2235	6144	FIFO	50	14	**56700**	eth0:v12-Rx
2236	6143	FIFO	50	1	**56803**	eth0:v11-Rx
2237	6142	FIFO	50	14	**58014**	eth0:v10-Rx
2238	6141	FIFO	50	1	**57371**	eth0:v9-Rx
2239	6140	FIFO	50	14	**58816**	eth0:v8-Rx
2240	6139	FIFO	50	0	**60573**	eth0:v7-Rx

PID	Policy	Priority	Affinity	VolCtxtSwitch	NonVolCtxtSwitch	Command Line
1	OTHER	0	0-23	20259	2744	init [3]
2	OTHER	0	0-23	530	1320	kthreadd
3	FIFO	99	0	702	0	migration/0
4	FIFO	99	0	2	0	posixcputmr/0
5	FIFO	50	0	2	0	sirq-high/0
6	FIFO	50	0	**90298186**	0	sirq-timer/0
7	FIFO	50	0	15	0	sirq-net-tx/0
8	FIFO	50	0	**133467**	0	sirq-net-rx/0
9	FIFO	50	0	1055	0	sirq-block/0
10	FIFO	50	0	567	0	sirq-tasklet/0

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Take Home Exam

An example to try

Broker

```
numactl -c1 -m1 /root/qpid/cpp/src/qpidd --auth no -m no --pid-dir /var/run/qpidd --data-dir /var/lib/qpidd -P rdma
```

Driver

```
cat run_latencytest_rdma.sh

#!/bin/bash

for rate in `seq 1 10`; do  echo "rate at ${rate}0000"; /usr/bin/latencytest -b $1 --size $2 --rate ${rate}0000 -P rdma & sleep 60; kill %1; echo ;  sleep 1; done 2>&1 > $3


./run_latencytest_rdma.sh 172.168.10.18 32 perf18_rhel6_mellanox_10gb_rdma.log &
```

Questions ?

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