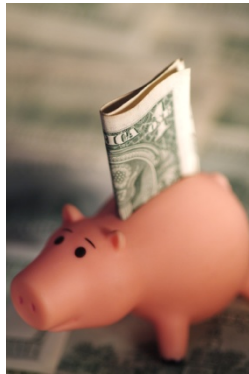# The <u>Eco</u>nomics of InfiniBand Virtual Device I/O

IBTA's Technical Forum '08: InfiniBand and the Enterprise Data Center

Jacob Hall
Wachovia Corporate & Investment Banking
VP, Chief Architect
Technology Products Group

We Must Design to Save

Design your technology in a way which *saves* cash, time, energy, and the environment automatically

Only the Economics Matter

…we must accelerate the adoption of better performing per watt technologies sooner. By increasing the rate of change, we will transfer $$ from energy and facilities to improved capability and competitive advantage.

Economics is <u>Eco</u> Friendly

<u>Eco</u>·nomics – *noun*

1. (used with a singular verb) the science that deals with the production, distribution, and consumption of goods and services, or <u>the material welfare of humankind</u>.

2. (used with a plural verb) financial considerations; economically significant aspects: What are the economics of such a project?

Futures

Processor Arrays

I/O is Decoupled
from the Chassis

Smarter Way To…

Take Inventory

Enables Recycling

Easier Reuse

Low Cost Chassis

Less Eco Impact

Better Cooling

Power Efficiency

Best Packaging
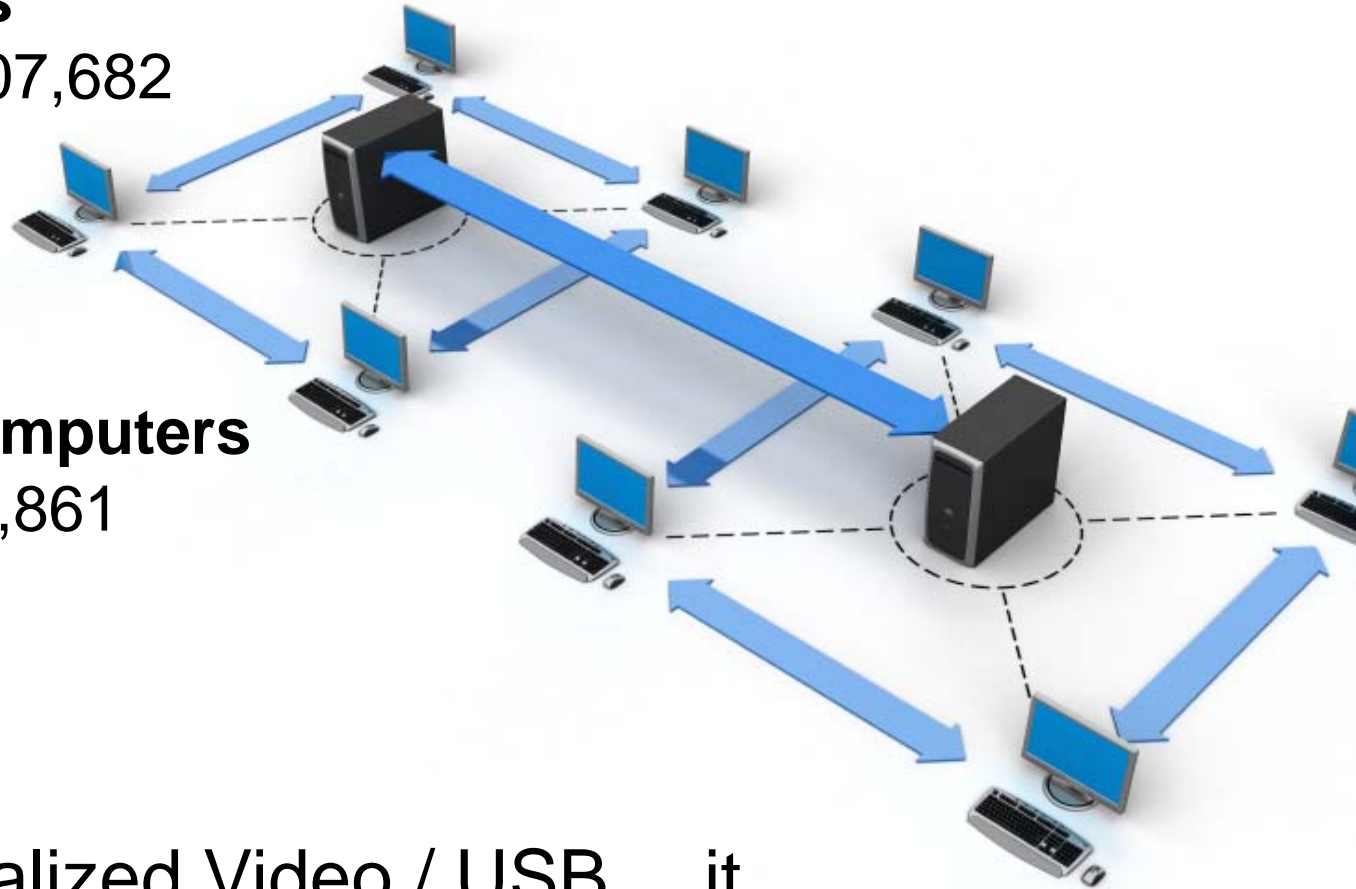
Desktop Computing Appliances

Top 10 US Banks
Processors = 1,507,682

Top 10 Super Computers
Processors = 467,861

Virtualized Video / USB …it
enables >10 Gbps sooner

The I/O Economy

Economic Report – A State of Disutility

48 Machine Configuration
2 Socket Quad Core / 2U

VM Environment

2U Compute Device
10 x Cables
6 x Ethernet Ports
2 x 4Gbps FC HBA
1 x 3Gbps SAS
2 x 70GB HD's
3+ Device Drivers
1 Firmware

x 48

Totals
Capital Cost: $549,578.00
Weight: 2916 lbs
I/O Weight: 516 lbs
Fuel for 3000 Miles: $1021.00
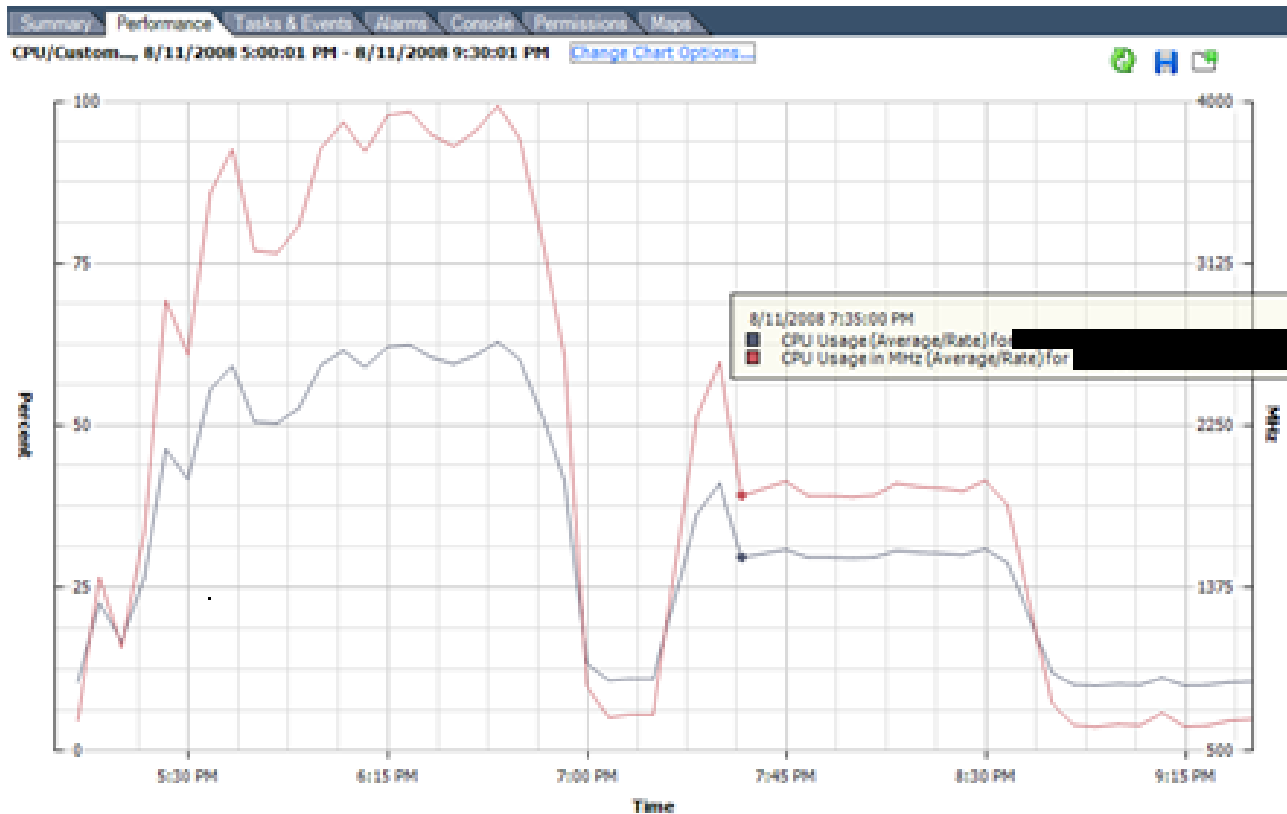Space: 106U
Watts: 16,128
Cables: 592
Bandwidth: 816 Gbps
People:

* Please review these facts. Quantified using readily available retail prices and data from the web.

Economic Trend - Latency Affects Everything

WACHOVIA

* Removing 240ms of 1Gbps Ethernet I/O Latency can Double Processor Efficiency

J2EE to Database Server using VM's.

½ CPU Energy Consumption
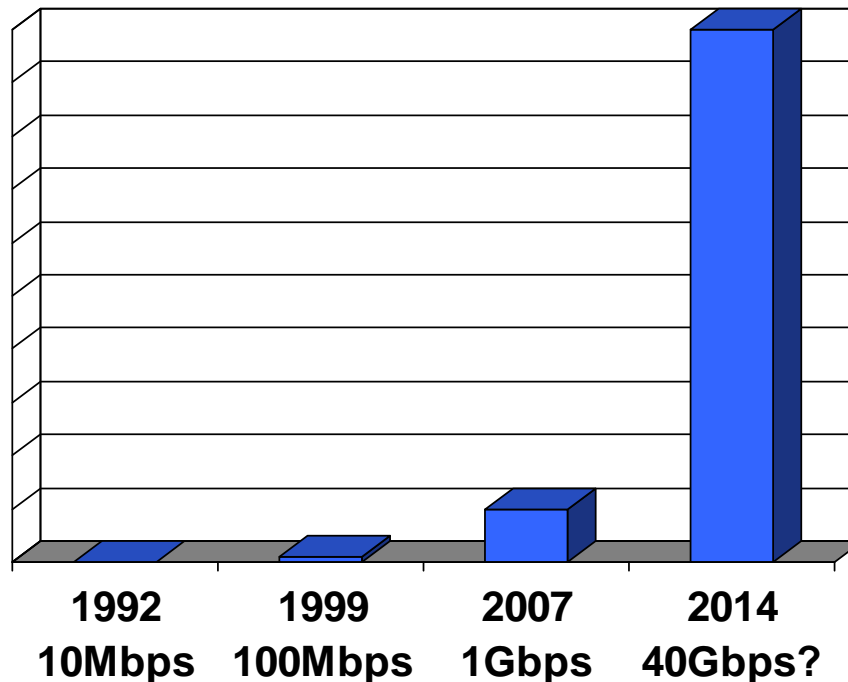

Greater Efficiency, Less Servers, Faster Response

Upgrading I/O Takes To Long

Historically, It Has Taken too Long (7-8 Years) to Completely Transition to the next Fastest I/O.

To Improve Efficiency, I/O Designs Need to Help Accelerate the <u>Adoption</u> of Better Performing per Watt Technologies.

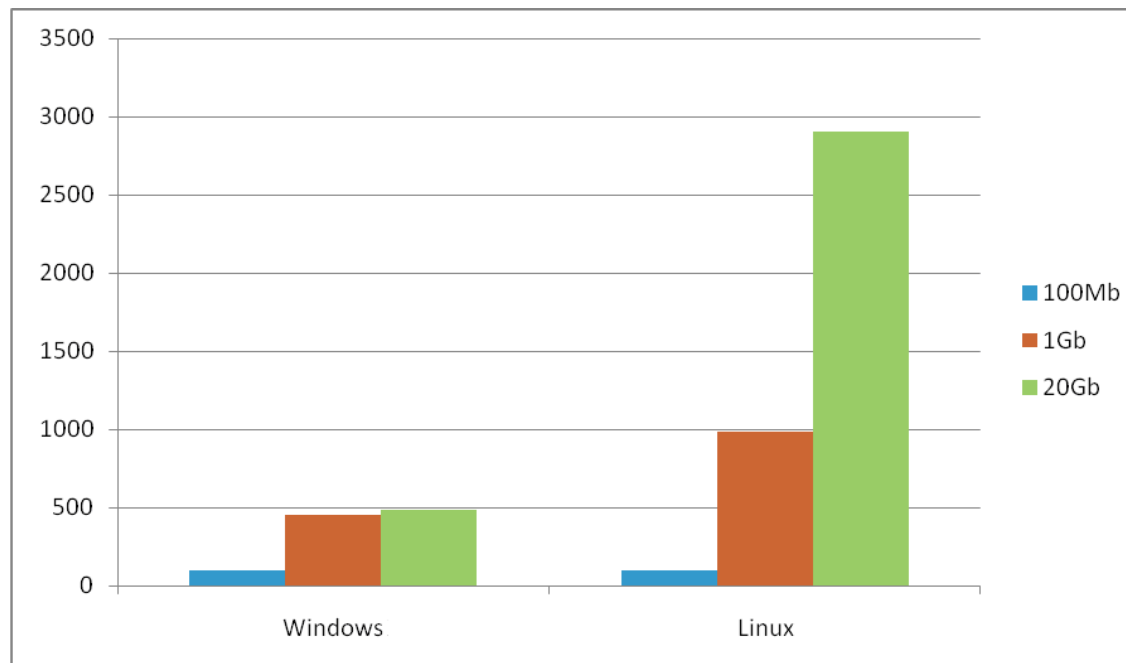| 1992 | 1999 | 2007 | 2014 |
| 10Mbps | 100Mbps | 1Gbps | 40Gbps? |

Economic Trend – Less Wires = Faster I/O

Two VM's on Separate Machines

PCI-Express 1.0

**Utilized Netperf Network Benchmark Tool**

* Using the same VM configuration, Windows did not show a significant performance gain. We will be retesting
  with updated drivers soon and we expect to see performance gains for a single VM machine to machine test.

Economic Trend – VM Provides I/O Efficiency

By using Unified I/O under Hypervisors; we can justify the expense of faster I/O sooner and save =>80 Watts of power per machine, which is enough to add more processors, ram, or other. The savings over time are significant.
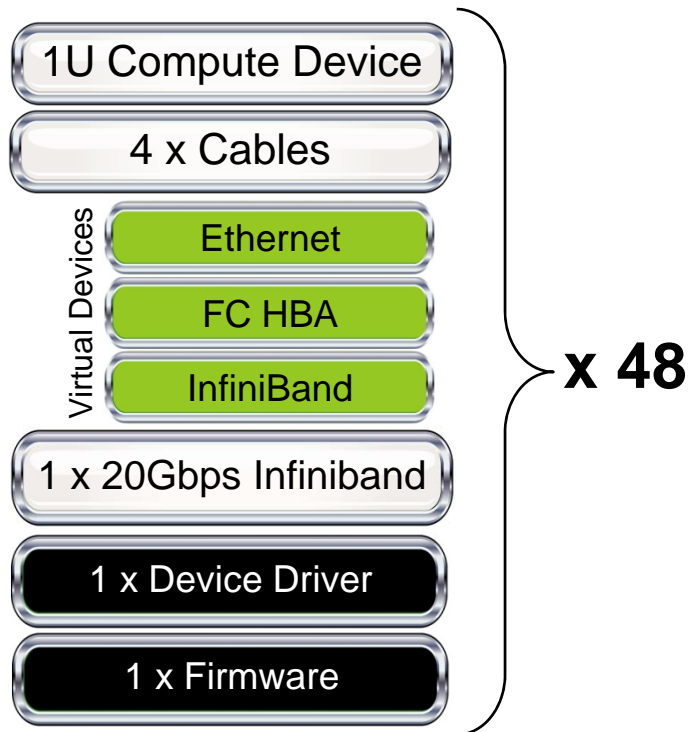

Aggregate Throughput
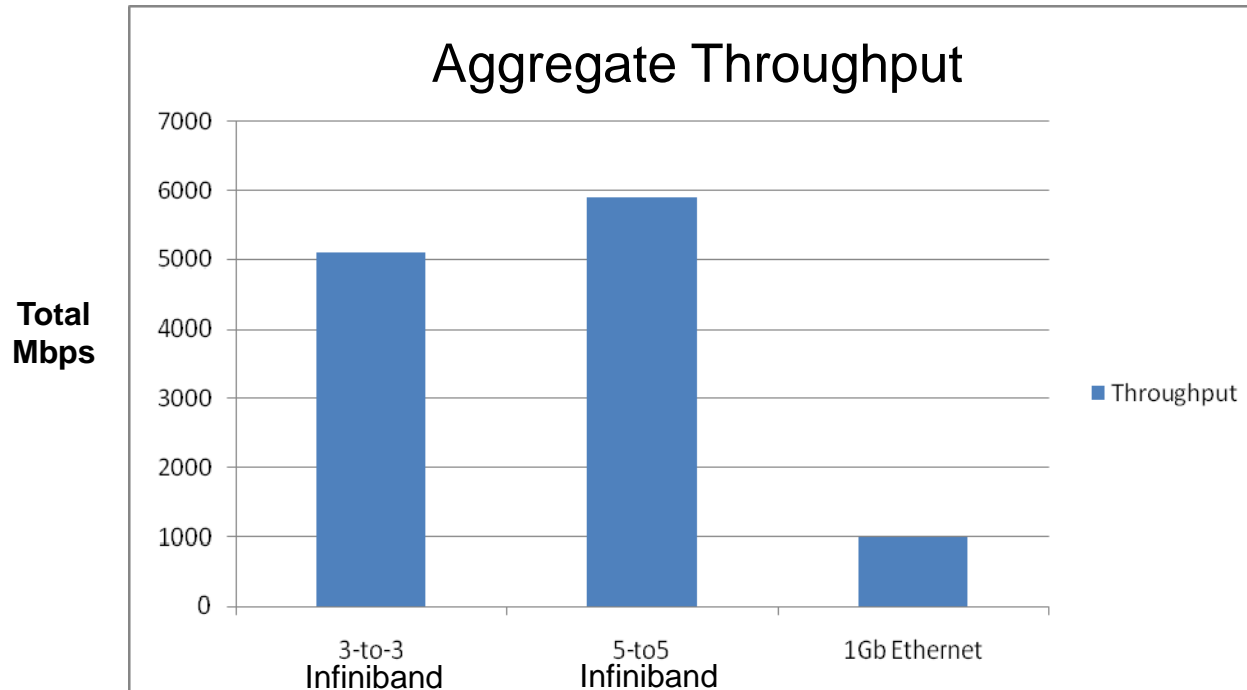
* Benchmark performed utilizing NetPerf and multiple VM's on separate physical machines

- One 20Gbps Infiniband port replaces six 1Gbps Ethernet connections (w/ bandwidth to spare for storage I/O)

Economic Outlook = Virtual Device I/O

48 Machine Configuration
2 Socket Quad Core

1U Compute Device
4 x Cables

Virtual Devices:
- Ethernet
- FC HBA
- InfiniBand

1 x 20Gbps Infiniband
1 x Device Driver
1 x Firmware

x 48

VM Environment

Totals
Capital Cost: $324,900.00
Weight: 1568 lbs
I/O Weight: 128 lbs
Fuel for 3000 Miles: $549.00
Space: 52U
Watts: 11,248
Cables: 200
Bandwidth: 1920 Gbps
People:

* Please review these facts. Quantified using readily available retail prices and data from the web.

Economic Outlook - Unified I/O Savings

	Non-Unified I/O	Unified I/O	**Unified I/O Savings**
Capital Cost	$549,578.00	$324,900.00	**$220,000.00**
Weight	2916 lbs	1568 lbs	**1300 lbs**
I/O Weight	516 lbs	128 lbs	**380 lbs**
Fuel to Move 3000 Miles	$1020.00	$548.80	**$470.00**
Space	106U	54U	**50U**
Watts	16,128	11,248	**4,880**
Cables	592	200	**390**
Bandwidth	816 Gbps	1920 Gbps	**1000 Gbps Faster**

 * These estimates were gathered using vendor websites. Results may vary depending on the vendor.

** 48 Port Ethernet and 24 Port Infiniband switches were utilized

*** Infiniband configurations assume no local disks.

Design for "Economic Value"

Let This Influence Your I/O Design

Value of Use = Water

Very useful, serves many purposes

Could not survive without it

Water is free, but it is bottled

Low cost of change

Value of Exchange = Diamonds

Nice to look at

Not as useful, specific design

Maintains a high cost of change

* We need a low cost of change

You May Ask: How Do I Differentiate?

Add Significant Value / Innovate

    Design for Zero Transition Cost

    Enable Recycling

    Integrate Today's Add-On Features

    Integrate New Hardware Concepts

Simplify

    Reduce Touch Points

    Reduce the Weight

Efficiency

    Improve Performance Per Watt

    Improve Utilization per Watt

    Reduce the Wait

Infiniband in Our Enterprise Progress Update

What Affects Enterprise Adoption?

"The real price of every thing, what every thing really costs to the man who wants to acquire it, is the toil and trouble of acquiring it. What every thing is really worth to the man who has acquired it, and who wants to dispose of it or exchange it for something else, is the toil and trouble which it can save to himself, and which it can impose upon other people." (Wealth of Nations Book 1, chapter V) 18
- Adam Smith

Status Update

Infiniband as NAS Appliance Interconnect

Evaluating Infiniband for Mainframe SysPlex Interconnect

Production Development Environment, hypervisor on Infiniband with Fabric Management

Enterprise Opportunity for Infiniband

Hypervisor + Infiniband Virtual Device I/O

Consolidated Virtual Device I/O Everywhere

VM Memory, Infiniband HCA Disk Controller (DRAM & Flash SSD) – Swap Files, Non-Critical Data, High Speed Caching

Infiniband Attached Storage Array for DASD Consolidation, OS Booting

Why Enterprises Will Embrace Infiniband

"Perfect competition describes a market in which no buyer or seller has market power. Such markets are usually allocatively and productively efficient.", Wikipedia

Ethernet is a monopoly, but is easily encapsulated as a virtual device

Infiniband supports 40Gpbs QDR; greater than 10 Meters

Infiniband 12x QDR Uplink @ 120 GB/s; 300 meters

Infiniband Supports large file sizes for Storage I/O

DCE / CEE will be a forklift upgrade anyway

Enterprises and Cloud / Utility Computing seeks "perfect competition"

Infiniband is a change agent and good for competition

It's Designed to Improve Operational Efficiency

Questions for the Enterprise

> **u·til·i·ty** –adjective, having or made for a number of useful or practical purposes rather than a single, specialized one: a utility knife.

Which I/O Silicon provides all features and capabilities allowing us to maximize our consolidation efforts?

Does the labor (or disutility) required to retrain resources for Infiniband Unified I/O, exceed the cost of labor to maintain three plus independent I/O technologies?

Was Ethernet designed to be a Unified I/O Utility?

If Ethernet was not designed for storage, should we move storage I/O to Ethernet?

Does it make sense for I/O to evolve like Virtual Machines and Multi-Core Computing? Is there value in not evolving?

Which technology supports RDMA and is the most energy efficient? Which provides the best processor efficiency?

Is there value in arguing over protocols ported to a protocol (Ethernet) which was not designed for storage?

Closing Statement

The industry argument shouldn't be focused on iSCSI versus FCoE over legacy Ethernet for I/O consolidation. The discussion should be focused on which Unified I/O Silicon and Protocol Stack provide the best and most complete capabilities for all of our I/O demands and a reduced cost of change. More importantly, it should also focus on the <u>Eco</u>nomics.

Thank You