# InfiniBand: Enhancing Virtualization ROI With New Data Center Efficiencies

Sujal Das

Director, Product Management

VMWORLD 2006

# Agenda

- Introduction to Mellanox Technologies and Products
- Meeting Data Center Server and Storage Connectivity Needs

- InfiniBand in VMware Community Source Development
  - Experiences
  - Enhancements and Optimizations
  - Performance Testing and Results

- End User Benefits
- Release Plan
- Future Enhancements

- Summary

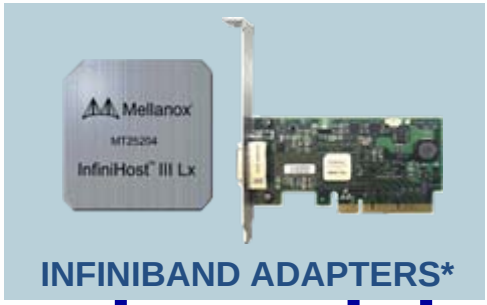
# Mellanox Technologies

- A global leader in semiconductor-based server and storage connectivity solutions
- Leading provider of high performance InfiniBand solutions
  - 10Gb/s and 20Gb/s Node-to-Node
  - 30Gb/s and 60Gb/s Switch-to-Switch
  - 2.25us latency
  - 3.5W per HCA (host channel adapter) port

- RDMA and hardware based connection reliability
- Efficient and scalable I/O virtualization
- Price-performance advantages
- Converges clustering, communications, management and storage onto a single link with Quality of Service

# InfiniBand Interconnect Building Blocks

Mellanox TECHNOLOGIES




INFINIBAND ADAPTERS*


INFINIBAND SWITCH SILICON**

OEMs

SERVERS

STORAGE

COMMUNICATIONS INFRASTRUCTURE EQUIPMENT

EMBEDDED SYSTEMS

END USERS

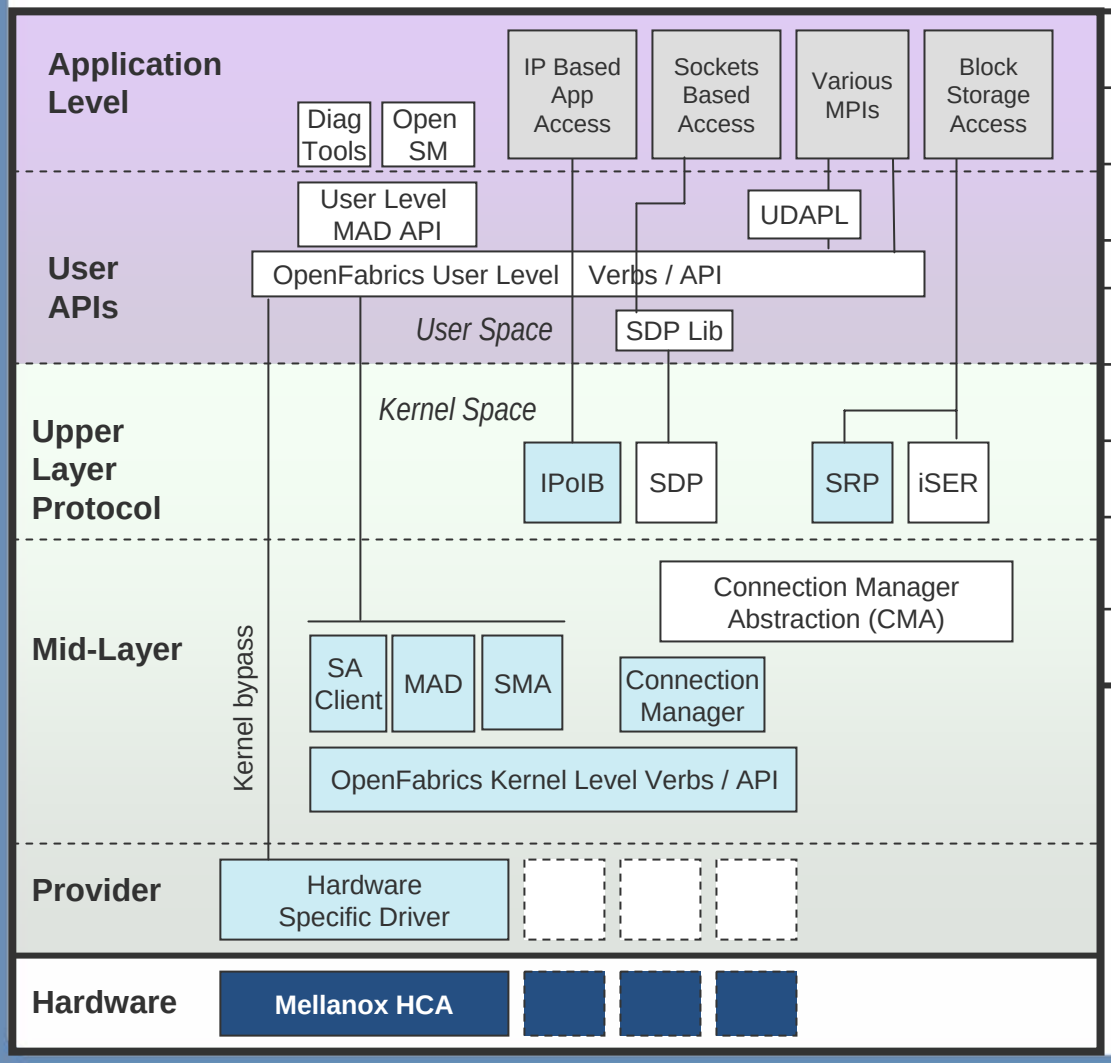
Enterprise Data Centers

High Performance Computing

Embedded Systems

*Single-port and dual-port
** 8-port and 24-port

# InfiniBand Software & OpenFabrics Alliance




| | |
|---|---|
| SA | Subnet Administrator |
| MAD | Management Datagram |
| SMA | Subnet Manager Agent |
| IPoIB | IP over InfiniBand |
| SDP | Sockets Direct Protocol |
| SRP | SCSI RDMA Protocol (Initiator) |
| iSER | iSCSI RDMA Protocol (Initiator) |
| UDAPL | User Direct Access Programming Lib |
| HCA | Host Channel Adapter |

Components used with VMware VI 3

Components are in kernel 2.6.11+

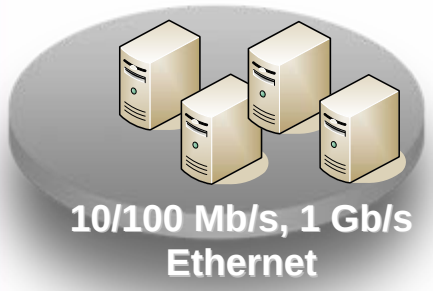
SLES 10 and RHEL 4 Distributions

Microsoft WHQL program

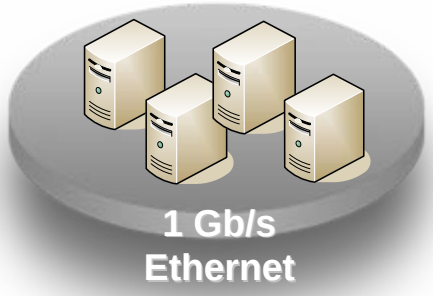
# Global Market Penetration


**Strong Tier-1 OEM relationships - the key channel to end-users**

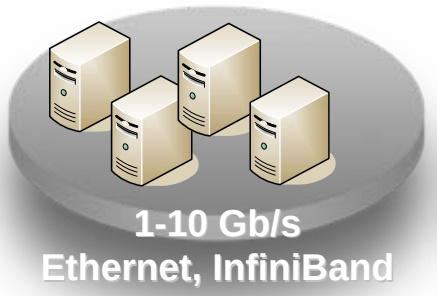
# Connectivity Needs in Server Farms



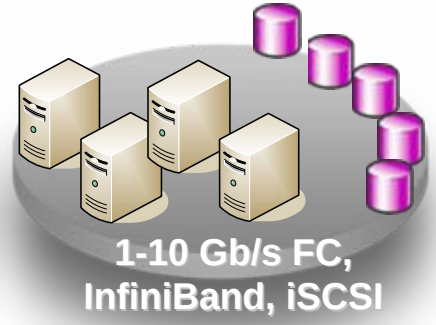

**Front End Servers: Web and other services**




**Application Servers: Business Logic**

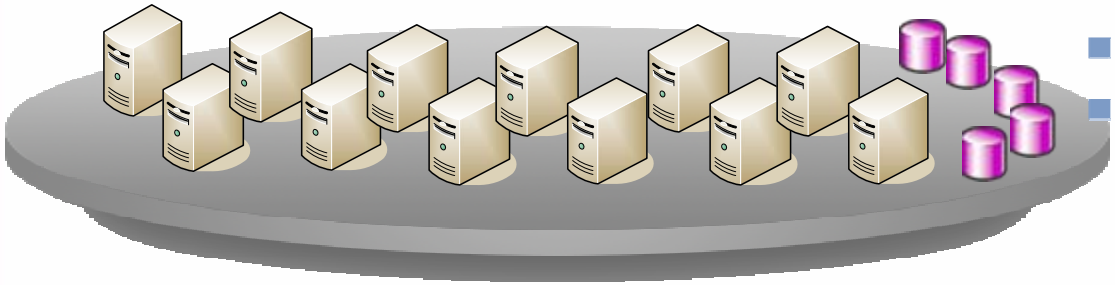



**Back End Servers: Database systems**




**Storage Servers and Systems**

- Server islands → different connectivity needs



- Need for higher resource utilization
- Shared pool of resources
- Maximum flexibility, minimum cost

**Uniform connectivity that serves most demanding apps**

# Why 10Gb/s+ Connectivity?

**Multi Core CPUs** → More applications per server and I/O

**SAN Adoption** → More traffic per I/O with server I/O consolidation

**Shared Resources** → I/O capacity per server dictated by the most demanding apps

→ **10Gb/s+ connectivity for all data center servers**

**Multi-core CPUs mandating 10Gb/s+ connectivity**

# Emerging IT Objectives

**IT as a Business Utility**

- Applications just work
- Low maintenance cost
- Do more with less
- Price-performance-power

**IT as a Competitive Advantage**

- Reliable service
- High availability
- Agility and Scalability
- Quicker business results

**Server and storage I/O takes on a new role**

# Delivering Service Oriented I/O

**End-to-End Quality Of Service**

- Congestion control @ source
- Resource allocation

**I/O Consolidation**

- Multiple traffic types over one adapter
- Up to 40% power savings

Converged I/O

- Clustering
- Communications
- Storage
- Management

**Optimal Path Management**

- Packet drop prevention
- Infrastructure scaling @ wire speed

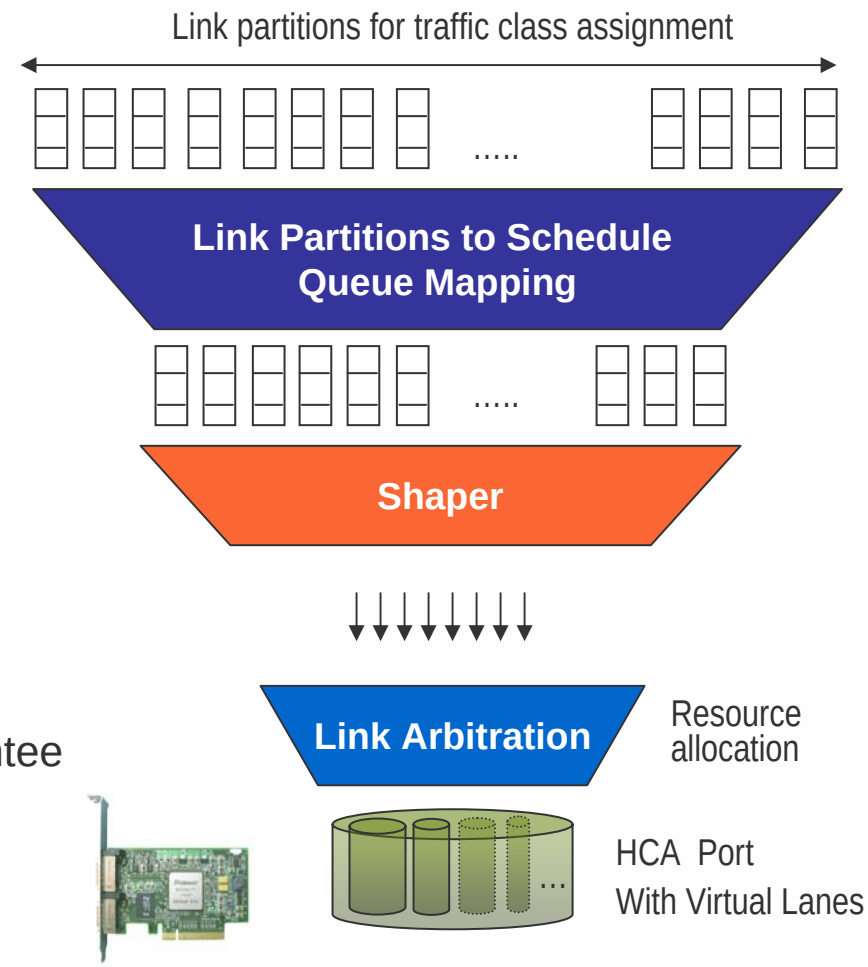
**Dedicated Virtual Machine Services**

- Virtual machine partitioning
- Near native performance


**Guaranteed services under adverse conditions**

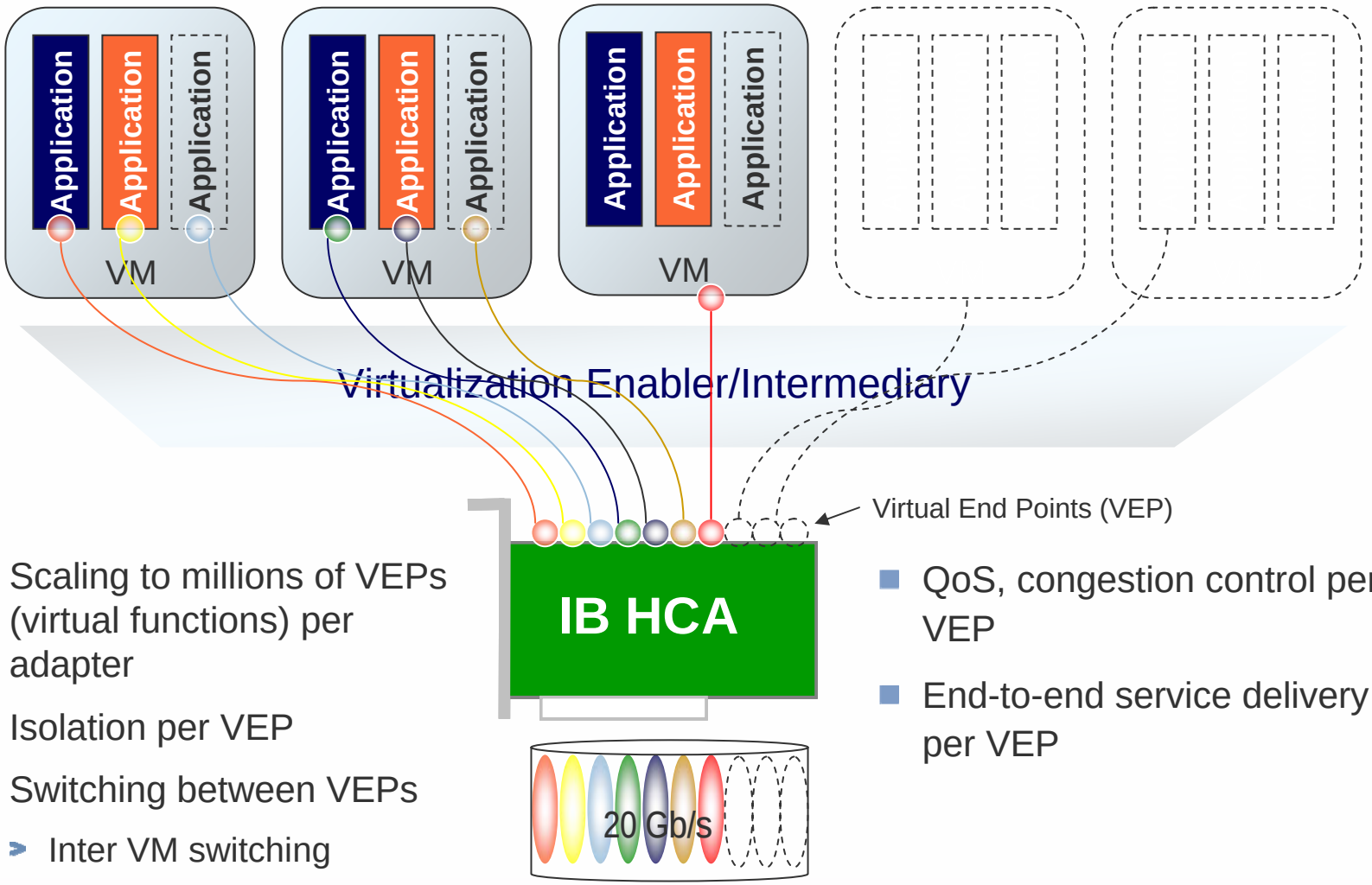
# End-to-end Services

- Quality of service
  - More than just 802.1p
  - Multiple link partitions
  - Per traffic class
  - Shaping
  - Resource allocation
- Congestion control
  - L2 based
  - Rate control at source
  - Class based link level flow control
  - Protection against bursts to guarantee no packet drops




**Enables E2E traffic differentiation, maintains latency and performance**

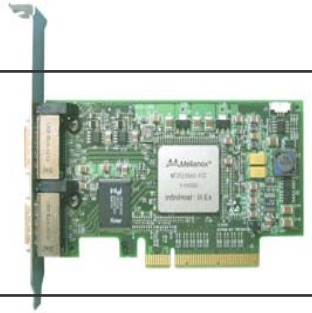
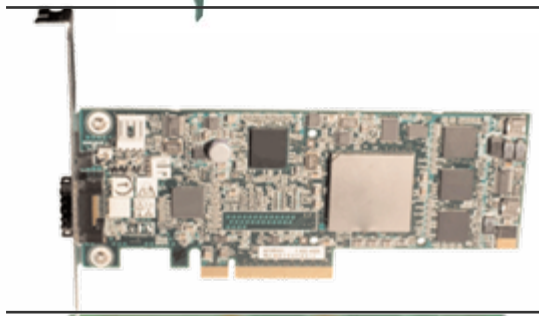
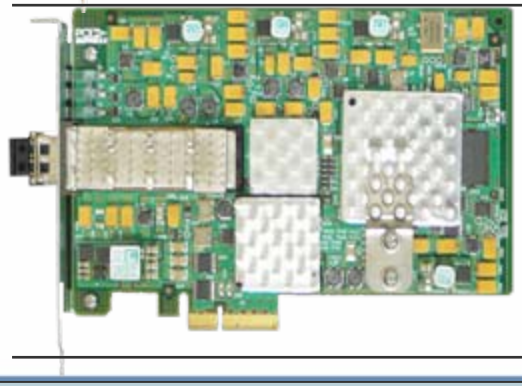
# Scalable E2E Services for VMs




- Scaling to millions of VEPs (virtual functions) per adapter
- Isolation per VEP
- Switching between VEPs
  - Inter VM switching

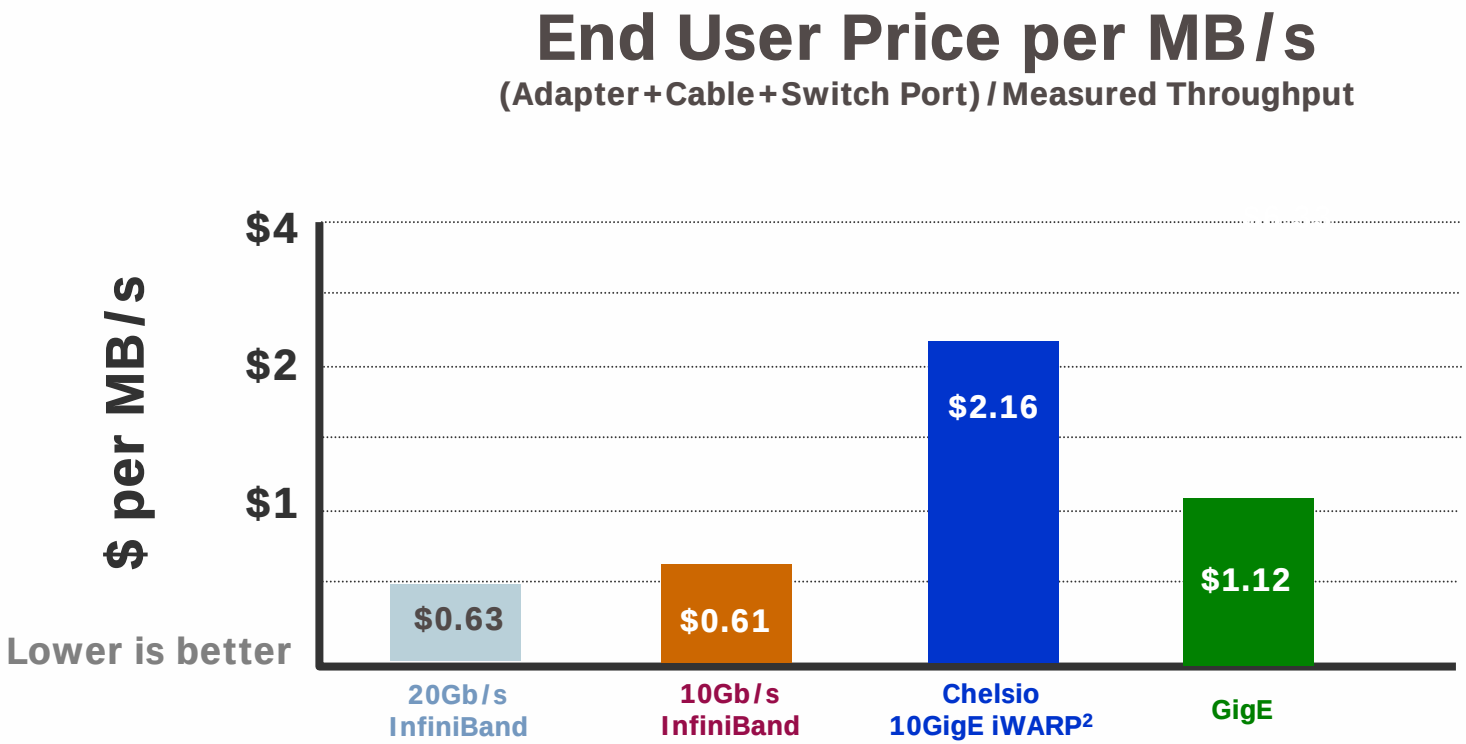
- QoS, congestion control per VEP
- End-to-end service delivery per VEP

# 3rd Generation Advantage

| | Bandwidth per port | Power/ port | RDMA | Stateless Offload | Full Offload |
|---|---|---|---|---|---|
|  Mellanox TECHNOLOGIES | 10 or 20Gb/s | ~4-6W | Yes | Yes | Yes |
|  **Vendor A** | 10Gb/s | ~20W | No | Yes | Yes |
|  **Vendor B** | 10Gb/s | 12W | No | Yes | No |

**Power Efficient with leading Performance and Capabilities**

# Price-Performance Benefits




Source for GigE and 10GigE iWARP: Published press release adapter and switch pricing, from Chelsio, Dell, Force10

**Industry leading price-performance**

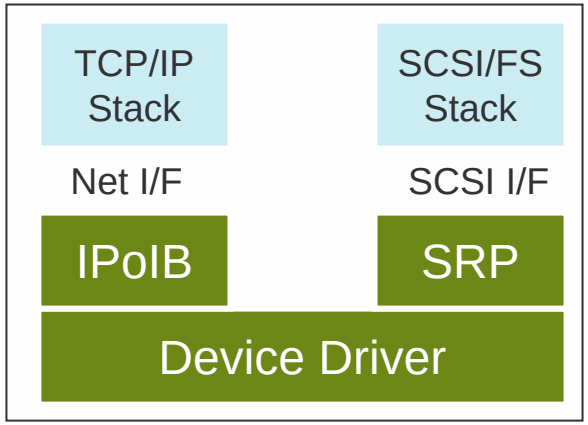
# VMware Community Source Involvement

- One of the first to join Community Source
- Active involvement since
- Motivations
  - Work with virtualization vendor with most market share
  - Spirit of partnership and excellent support
  - Eventual Virtual Infrastructure-based product deployments
- Benefits over Xen
  - Real-world customer success stories
  - Proven multi-OS VM support
  - Go-to-market partnership possibilities

**Pioneering role in the Community Source program**

# The InfiniBand Drivers

- Linux based drivers used as basis
- Device driver, IPoIB and SRP (SCSI RDMA Protocol)
- Storage and Networking functionality
- Subnet Management functionality
- Sourced from OpenFabrics Alliance (www.openfabrics.org)
- Uses latest 2.6.xx kernel API



# The Challenges

- ESX Linux API is based on a 2.4 Linux Kernel
  - Not all the 2.4 APIs are implemented
  - Some 2.4 APIs are slightly different in ESX
  - Different memory management
  - New build environment
- Proprietary management for networking and storage

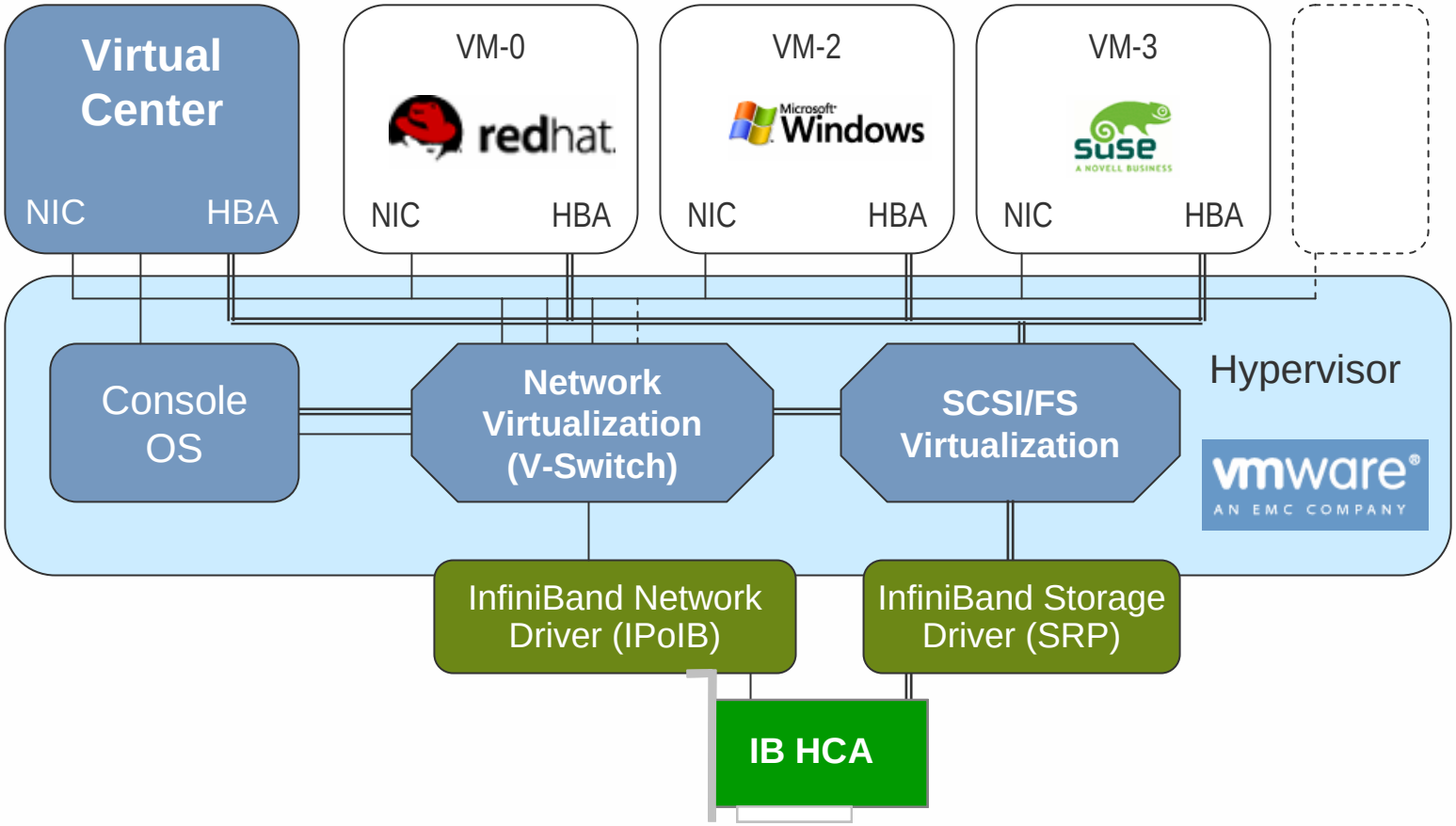
# Enhancements or Optimizations

- ESX kernel changes
  - Common spinlock implementation for network and storage drivers
  - Enhancement to VMkernel loader to export Linux-like symbol mechanism
  - New API for network driver to access internal VSwitch data
  - SCSI command with multiple scatter list of 512-byte aligned buffer

- InfiniBand driver changes
  - Abstraction layer to map Linux 2.6 APIs to Linux 2.4 APIs
  - Module heap mechanism to support shared memory between InfiniBand modules
  - Use of new API by network driver for seamless VMotion support
  - Limit one SCSI host and net device per PCI function

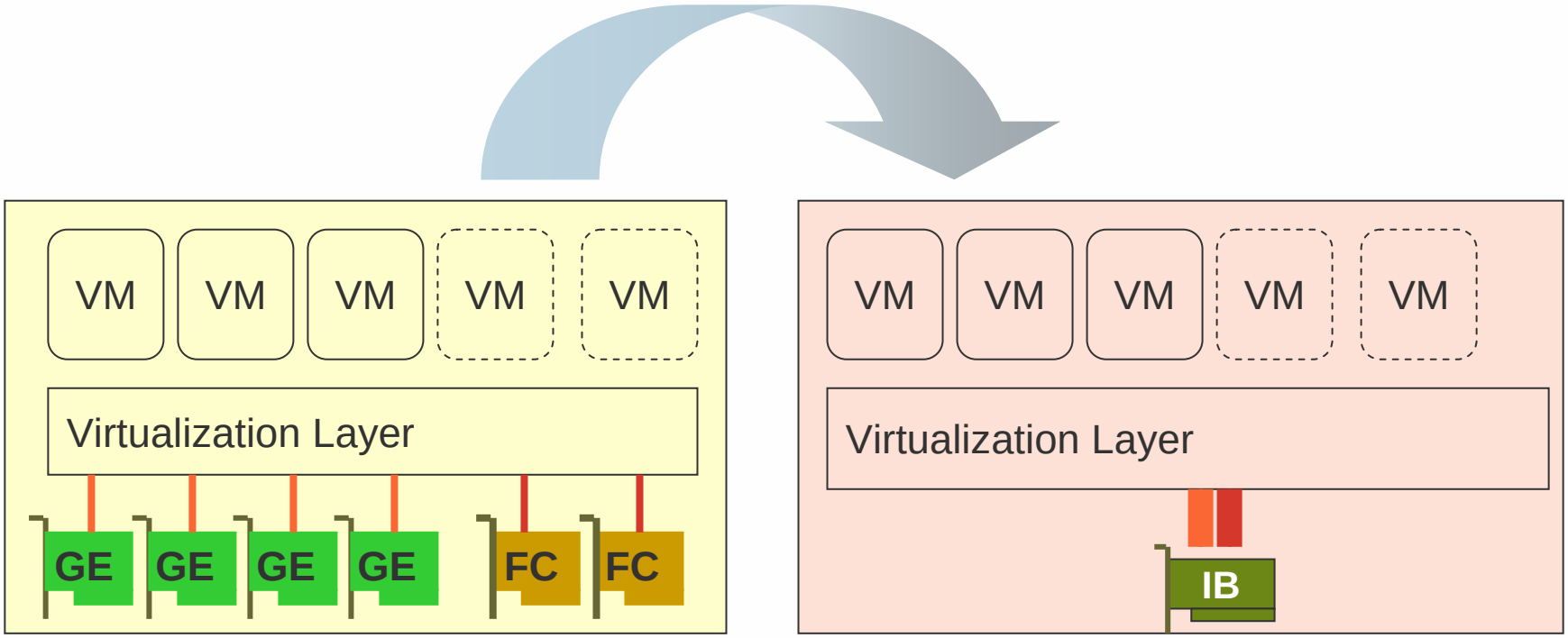
**Effective collaboration to create compelling solution**

# InfiniBand with Virtual Infrastructure 3




**Transparent to VMs and Virtual Center**

# VM Transparent Server I/O Scaling & Consolidation




Typical Deployment Configuration

With Mellanox InfiniBand Adapter

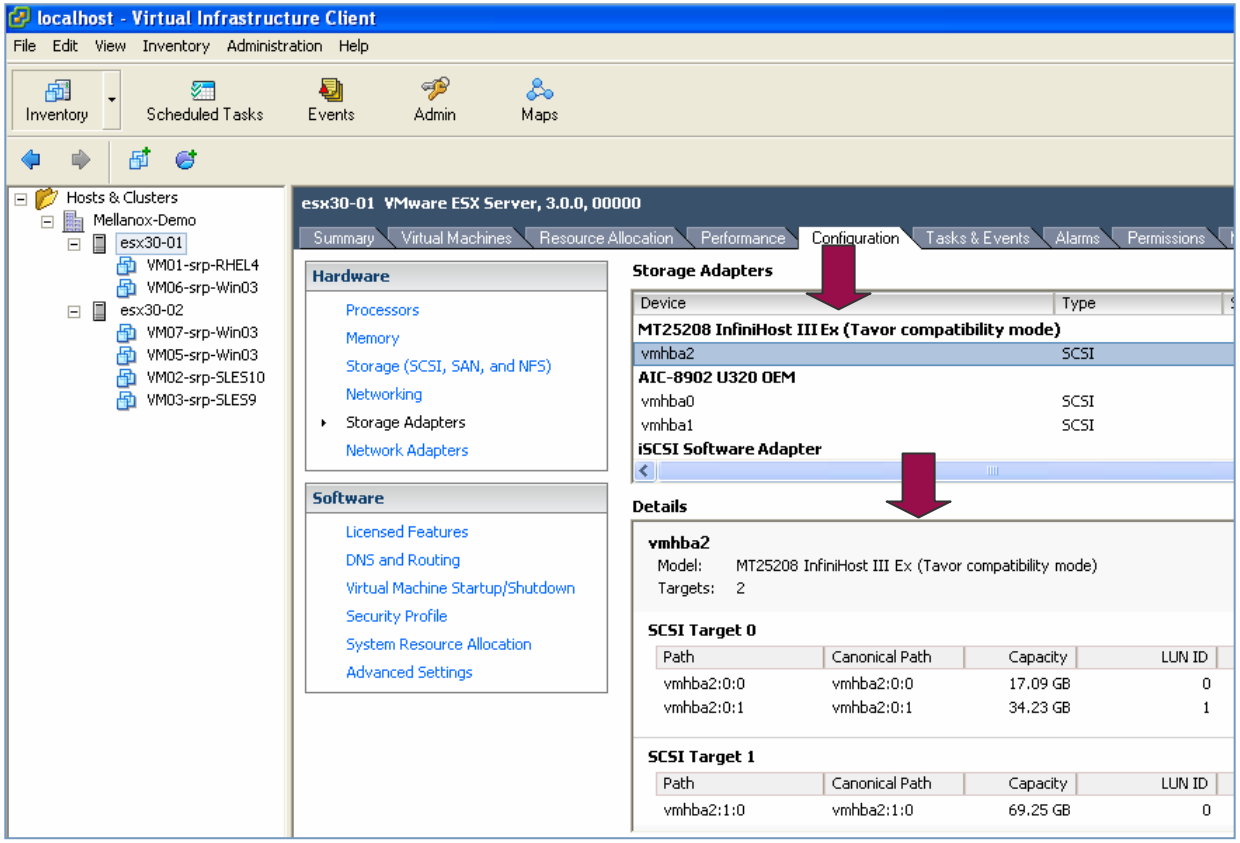
**3X networking, 10X SAN performance**

Per adapter performance. Based on comparisons with GigE and 2 Gb/s Fibre Channel

# Using Virtual Center Seamlessly with InfiniBand

Storage configuration

vmhba2



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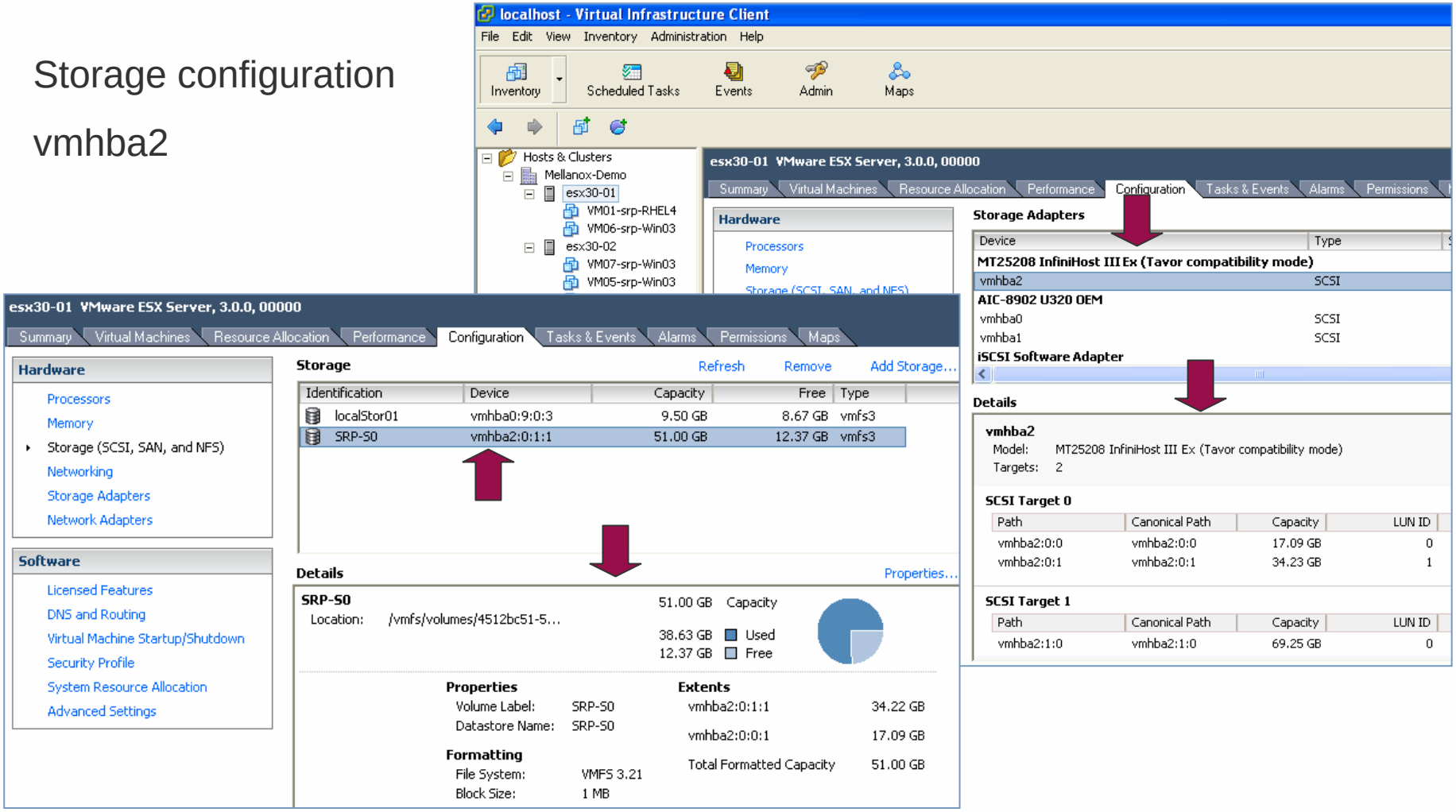

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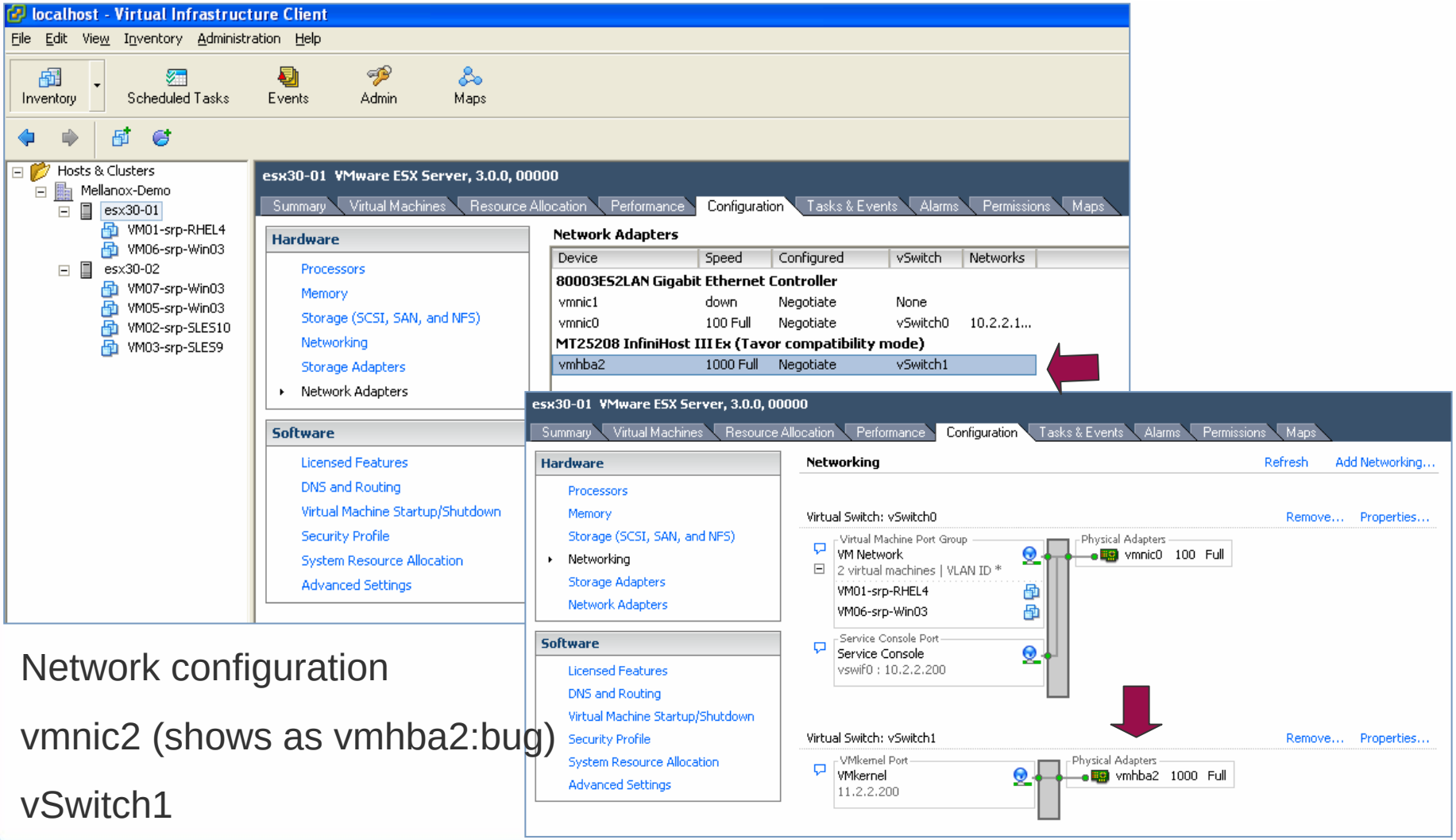


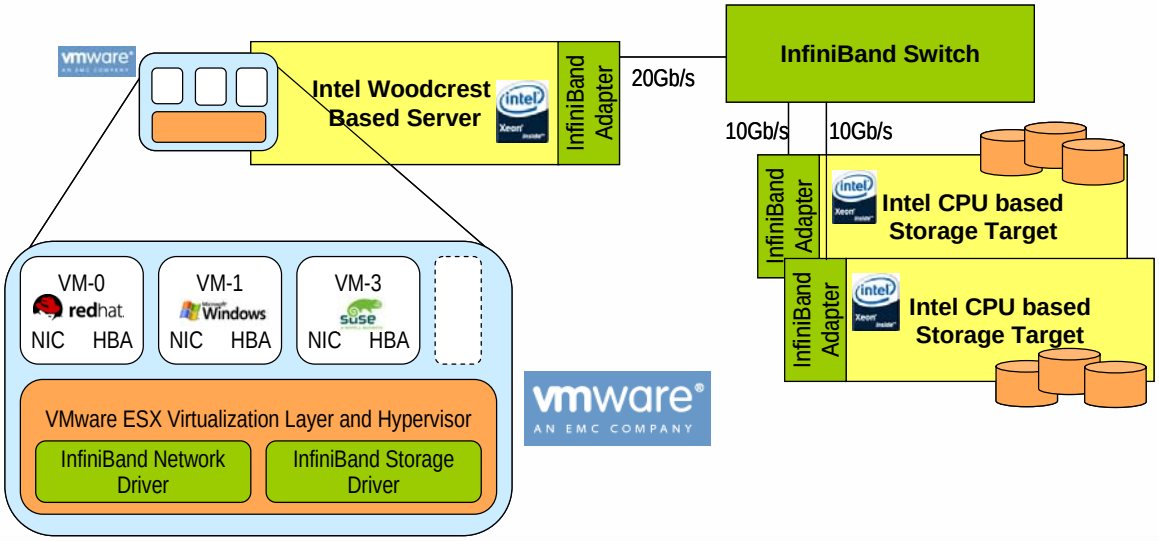

Network configuration

vmnic2 (shows as vmhba2:bug)

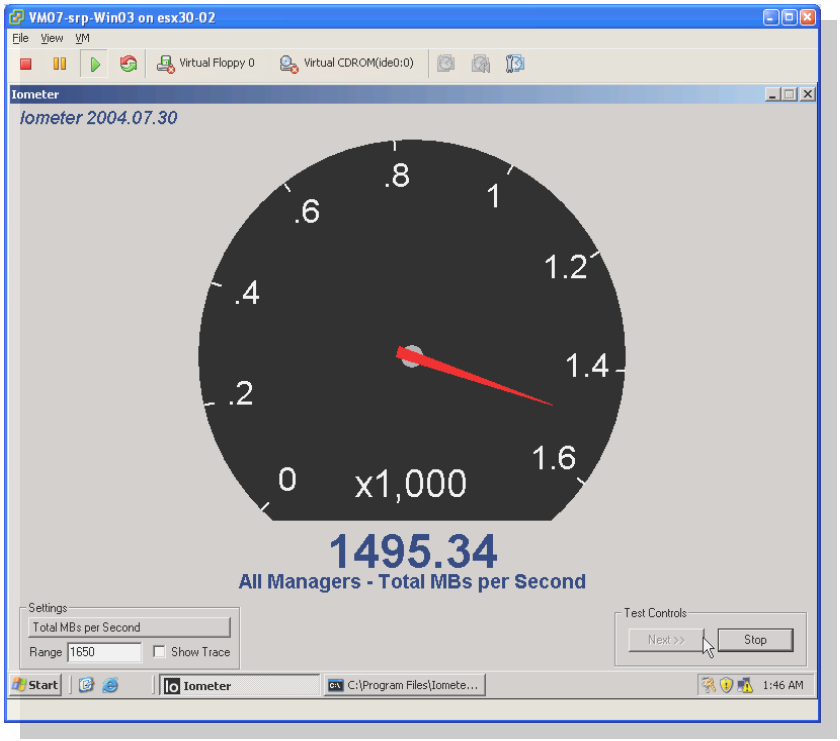
vSwitch1

# Performance Testing Configuration

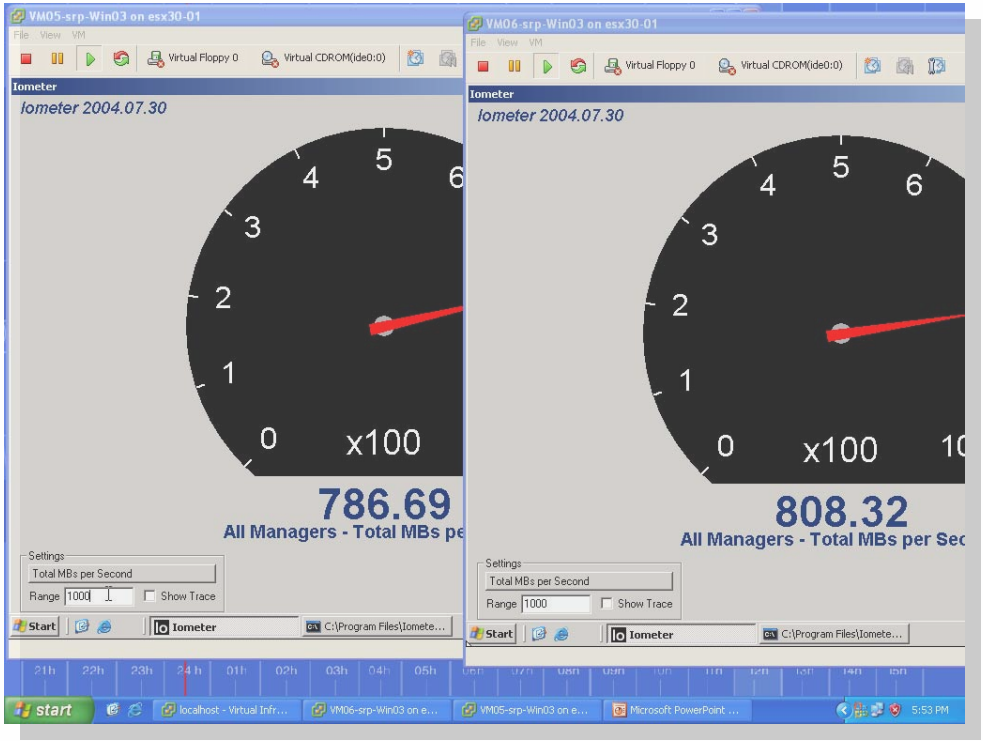
- ESX Server:
  - 2 Intel Dual Core Woodcrest CPUs
  - 4GB Memory
  - InfiniBand 20Gb/s HCA
- Switch:
  - Flextronics 20 Gb/s 24 port Switch
- Native InfiniBand Storage (SAN)
  - 2 Mellanox MTD1000 Targets (Reference Design)
  - www.mellanox.com



# Performance Testing Results Sample - Storage

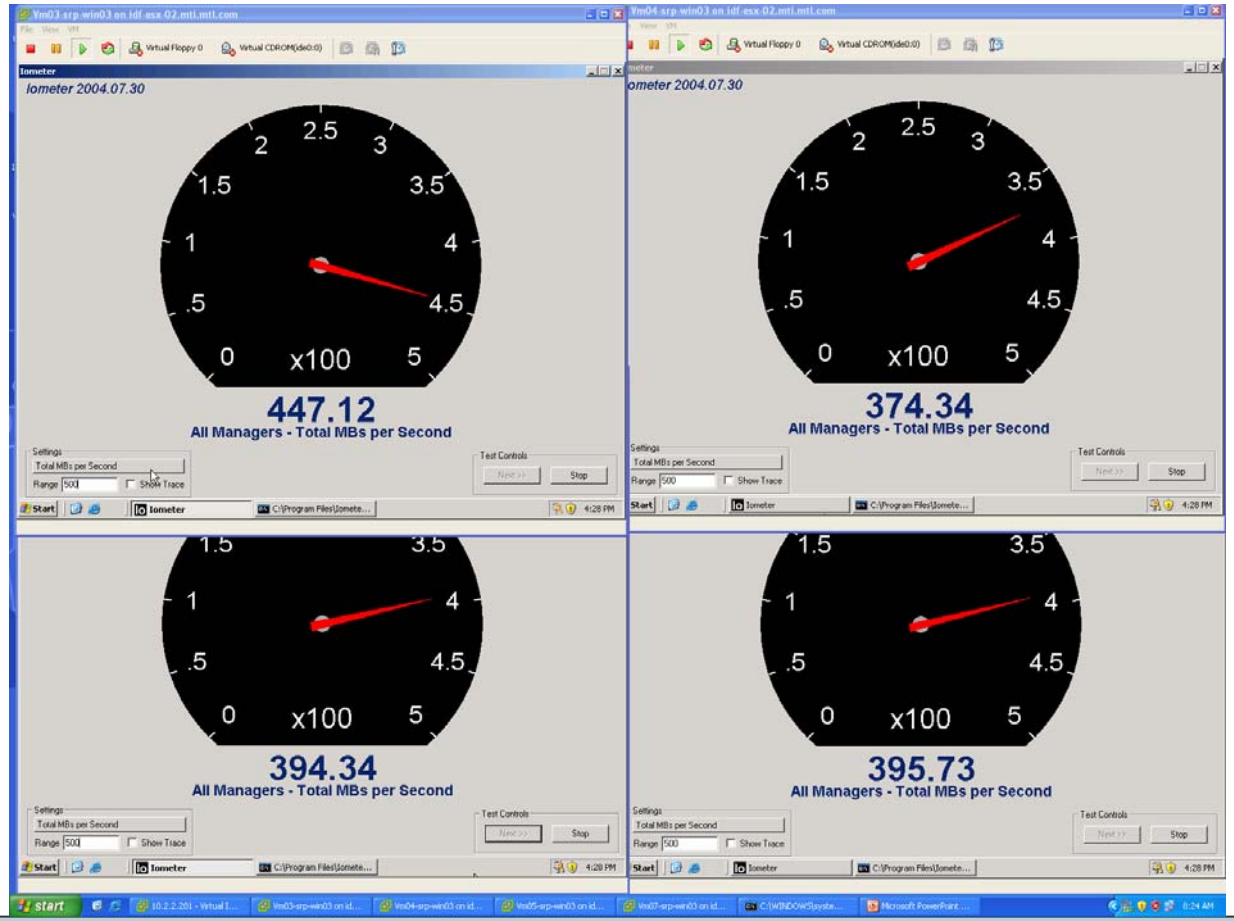



128KB Read benchmark from one VM




128KB Read benchmarks from two VMs

# More Compelling Results




128KB Read benchmarks from four VMs

**Same as four dedicated 4Gb/s FC HBAs**

# Tested Hardware

- Mellanox 10 and 20 Gb/s InfiniBand Adapters
- Cisco and Voltaire InfiniBand Switches
- Cisco Fibre Channel Gateways with EMC back-end storage
- LSI Native InfiniBand Storage Target

# Compelling End User Benefits

**Lower Initial Purchase Cost**

- Up to 40% savings

**Lower Per-port Maintenance Cost**

- Up to 67% savings

**Lower I/O Power Consumption**

- Up to 44% savings

**Seamless**

- Transparent interfaces to VM apps and Virtual Center Management

Based on $150/port maintenance cost (source: VMware, IDC), end user per port cost (adapter port + cable + switch port) comparisons between 20Gb/s IB HCA ($600/port), GigE NIC ($150/port) and 2Gb/s FC HBA ($725/port) (Source: IDC)

Typical VMware virtual server configuration (source: VMware), 2W power per GigE port, 5W power per FC port, 4-6W power per 20Gb/s IB port (source: Mellanox)

**Best of both worlds – seamless + cost/power savings**

# Compelling End User Benefits (contd.)

**VI 3 Component Acceleration**

- Backup, Recovery, Cloning, Virtual Appliance deployment

**VM Application Acceleration**

- Database, file system and other storage intensive applications

* Benchmark data not available yet

**Best of both worlds – seamless + I/O scaling**

# Experimental Release Plans

- VMware Virtual Infrastructure (incl. ESX) Experimental Release
- Mellanox InfiniBand drivers installation package
- Targeted for late Q1 2007
- For further details, contact:
  - Junaid Qurashi, Product Management, VMware, jqurashi@vmware.com
  - Sujal Das, Product Management, Mellanox, sujal@mellanox.com

# Future Work

- Evaluate experimental release feedback
- GA product plans
- Feature enhancements
  - Based on customer feedback
  - VMotion acceleration over RDMA
  - Networking performance improvements

# Call to Action: Evaluate Experimental Release

- InfiniBand: for high performance, reliable server & storage connectivity
- Tier 1 OEM channels and global presence

- Multi-core & virtualization driving 10Gb/s connectivity in the data center
- I/O convergence & IT objectives driving stringent I/O requirements
- InfiniBand delivers “Service Oriented I/O” with service guarantees

- Pioneering role in community source program
- VI 3 with InfiniBand – seamless IT experience with I/O scale-out
- Compelling cost, power and performance benefits

| Lower Initial Purchase Cost | Lower Per-port Maintenance Cost | Lower I/O Power Consumption |
|---|---|---|
| Up to 40% savings | Up to 67% savings | Up to 44% savings |

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