



**Driving Innovation
Through the Information
Infrastructure**

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I/O Virtualization

The Next Virtualization Frontier

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Demartek Company Overview

- Industry analysis with on-site test lab
- Lab includes servers, networking and storage infrastructure
 - Fibre Channel: 4 & 8 Gbps
 - Ethernet: 1 & 10 Gbps (with FCoE)
 - Servers: 8+ cores, very large RAM
 - Virtualization: ESX, Hyper-V, Xen
- We prefer to run real-world applications to test servers and storage solutions
 - Currently testing various SSD and FCoE technologies
 - We create our own data sets for application workloads
- Web: www.demartek.com



Agenda

- Why Do We Virtualize?
- I/O Virtualization – What Is It?
- Virtualizing the PCIe Bus
- Virtualizing the I/O Path (Single- and Multi-Root)
- Rack Area Networks
- Benefits of I/O Virtualization
- Hairpin Turns
- Discussion of Early Testing

Why Do We Virtualize?

- De-couple the logical from the physical
 - Hardware can be split into smaller logical units
 - Hardware can be represented as multiple units
 - Hardware can be combined into larger units
- Want to use computing resources more effectively, especially the under-utilized assets
- Improves deployment time
- Allows expensive resources to be shared, or shared more widely

I/O Virtualization – What Is It?

- Virtualizing the *I/O path* between a server and an external device
- Can apply to anything that uses an adapter in a server, such as:
 - Ethernet Network Interface Cards (NICs)
 - Disk Controllers (including RAID controllers)
 - Fibre Channel Host Bus Adapters (HBAs)
 - Graphics/Video cards or co-processors
 - SSDs mounted on internal cards

Virtualizing the PCIe Bus

- In June 2008, the PCI-SIG[®], the Special Interest Group responsible for PCI Express[®] (PCIe[®]) industry-standard I/O technology, announced the completion of the PCI-SIG I/O Virtualization (IOV) suite of specifications
- Works with system virtualization technologies
- Allows multiple operating systems to natively share PCI-Express devices

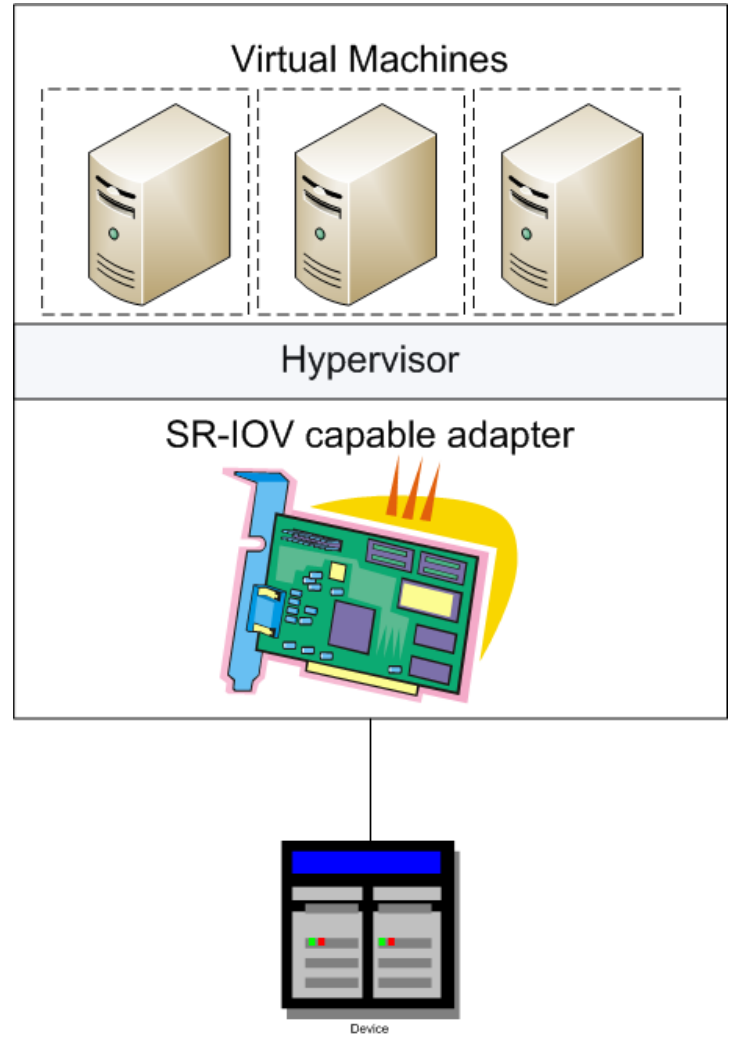


Processors and IOV

- Processor vendors:
 - Intel: Virtualization Technology for Directed I/O (VT-d)
 - AMD: Virtualization (AMD-V) Technology
- I/O Virtualization (IOV) includes:
 - I/O device assignment so that I/O devices can be assigned to virtual machines (VMs)
 - DMA remapping for VMs
 - Interrupt remapping for VMs

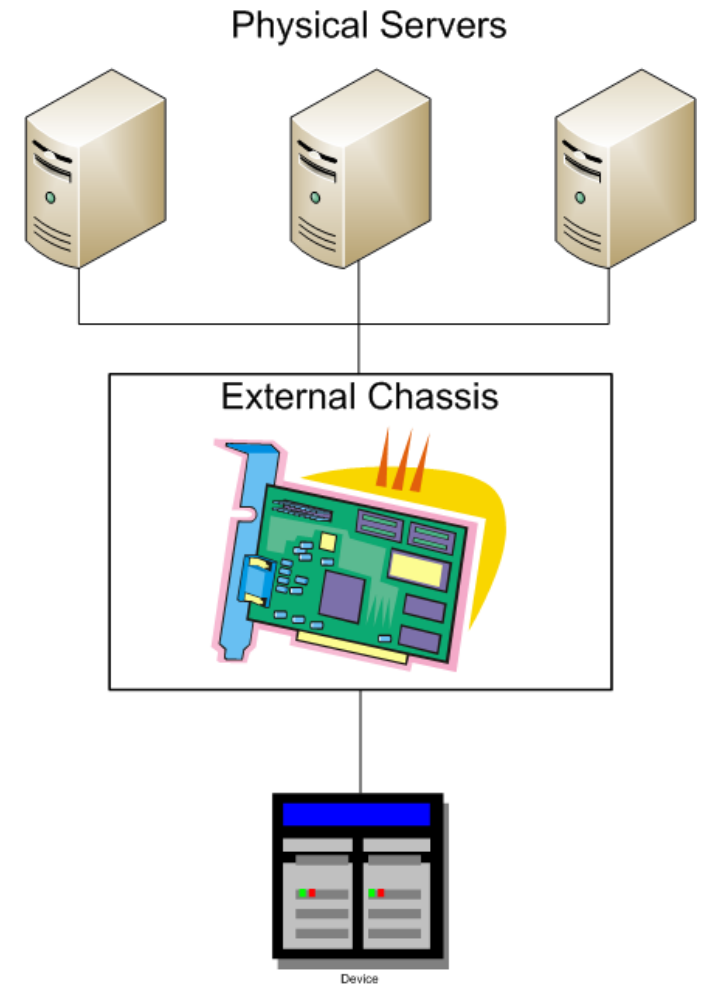
Virtualizing the I/O Path Single-Root

- Multiple VMs sharing one I/O adapter
- Bandwidth of the I/O adapter is shared among the VMs
- Virtual adapters created and managed by SR-IOV adapter (not hypervisor)
- Improved performance for VMs and their apps.



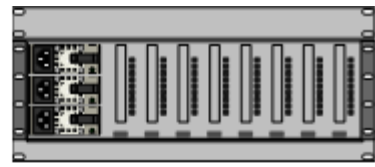
Virtualizing the I/O Path Multi-Root

- Multiple servers & VMs sharing one I/O adapter
- Bandwidth of the I/O adapter is shared among the servers
- The I/O adapter is placed into a separate chassis
- Bus extender cards are placed into the servers

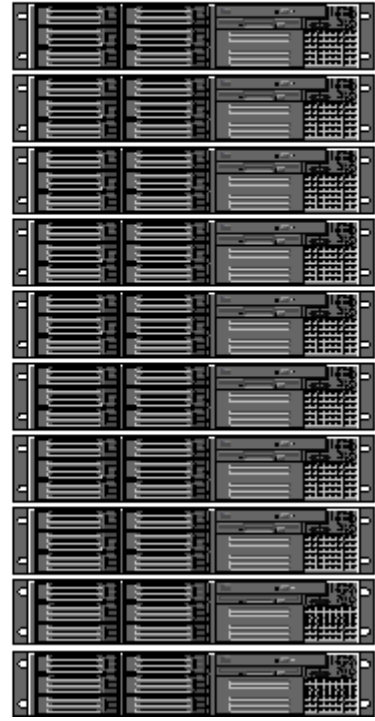


Rack Area Networking (RAN)

IOV
Switch



Servers



- IOV switch contains NICs, HBAs, etc
- IOV switch connects to LAN, SAN, DAS in other racks
- PCIe fabric and cables within the rack
- Servers have PCIe extender cards

Rack Area Networking (RAN)

- Uses IOV with multiple physical servers (and their guest VMs)
- Uses a top-of-rack IOV switch that supports various types of PCIe adapters
- Gives rack servers within a rack many of the same benefits as blade servers within a blade chassis
- Allows some rack servers to shrink to 2U, 1U or possibly ½U

External Implementations

- Natively extend the PCI-Express bus to an IOV external chassis or IOV switch
- Encapsulate PCI-Express within another transport such as Ethernet or Infiniband and extend the bus to an IOV external chassis or IOV switch



Benefits of I/O Virtualization

- Increases utilization of adapters
- Expensive adapters can be shared rather than dedicated to a single server/O.S.
- Decreases power consumption and cooling needs in some cases
- Reduced rack space servers can be deployed in some cases
- O.S. and hypervisor tasks can be offloaded to the adapter, increasing performance
- Some adapter upgrades are external to servers



Move VMs Without a SAN?

- Using IOV, VMs could be connected to their storage via standard disk controllers and DAS.
- Movement of VMs could be done to different physical servers without a traditional SAN

IOV Management

- IOV adapters and paths will no longer be exclusively assigned to individual servers
 - Similar to SAN storage devices that are not owned by an individual server
- O.S. and hypervisor vendors still have work to do to, but are making progress



Hairpin Turns

- In an IOV-capable environment, traffic can be sent out of one virtual adapter and received into another virtual adapter
- These two virtual adapters could reside on the same physical adapter, resulting in a “hairpin turn”
- The IOV adapters or IOV switches could act as LAN or SAN switches within the PCIe fabric (at lower cost)

Testing

- We have begun to test some of these technologies in our on-site lab
- Several smaller companies are building top-of-rack “IOV” switches
- Several larger companies are building IOV-capable adapters
- Look for “I/O Virtualization” or “IOV” on our news page:
www.demartek.com/Demartek_news.html

Demartek Free Resources

- Demartek article about I/O Virtualization in the February 2010 edition of Storage Magazine:
www.demartek.com/Demartek_SearchStorage_IOV_Article_2010-02.html
- Demartek has compiled a free comparison reference guide of the storage networking interfaces. This reference guide is updated periodically.
www.demartek.com/Demartek_Interface_Comparison.html
- Demartek publishes a free monthly newsletter highlighting recent reports, articles and commentary. Look for the newsletter sign-up at:
www.demartek.com/Newsletter



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