



Server Virtualization: Changing the Rules...

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Technology Briefing Objectives

- The introduction of **Server Virtualization** brings large benefits in the areas of cost savings, improved productivity, reliability and flexibility.
- It provides you with new options, and is making fundamental shifts in the way that organizations architect, design, deploy and manage server resources.
- This presentation focuses on the technologies that are available from VMware today, and how these technologies are "**Changing the Rules**"...

Areas to be Explored Include:

- What is a Virtual Machine?
- What are its Attributes and Benefits?
- Capacity Planning
- Server Provisioning and Deployment
- Disaster Recovery and High Availability
- Technologies that are Available Now
- Resources

General Information

- Presentations will be on event web site and event CD.
- Due to the amount of information in the presentation, questions will be addressed at the end of the presentation.
- Questions may also be asked of the people at the VMware booth at the Expo Hall.
- Other information resources will be presented at the end of the presentation.
- Questions may also be answered by other VMware sessions, as well as later in this session.

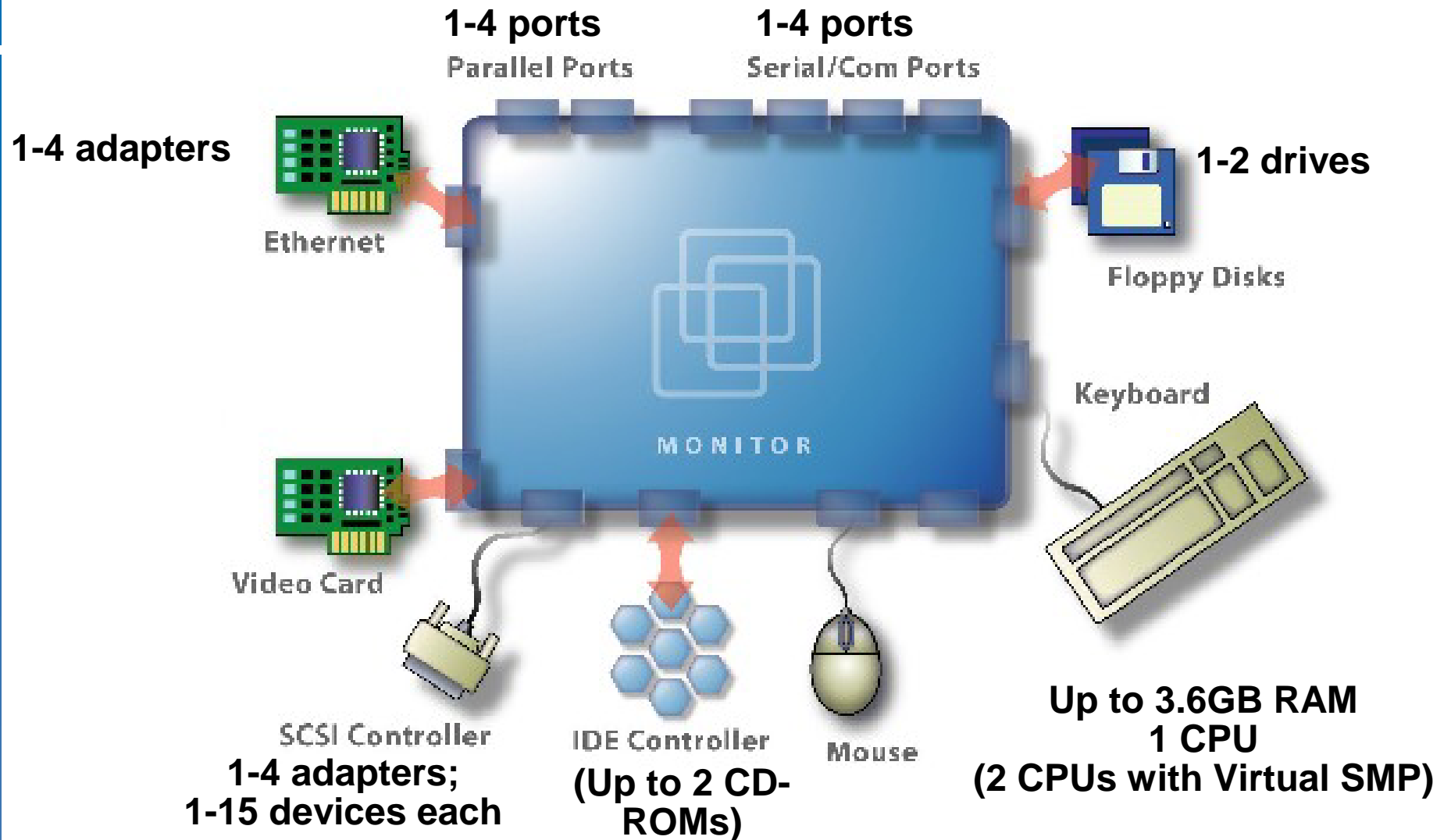
Other Recommended Sessions on Intel Server Virtualization

- 3326 - Improving Availability and Simplifying Disaster Recovery with Virtualization Technology - Renata Budko 5:30-6:45 PM Thursday
- 3329 - Improving Blade Economics with Virtualization Technology – John Kennedy 4-5:15 PM Today

What is a Virtual Machine?

- For the purposes of this presentation, consider a **Virtual Machine**, or **VM**, to be a software construct that appears as if it were a physical server.
- Multiple VM's can run on a **single physical server**.
- An OS doesn't know it is running in a VM, and sees generic hardware.
- A VM is isolated from other VM's. If one VM fails, the others are unaffected.

What's in a VM?



What does a Virtual Machine consist of?

A Virtual Machine consists of 3 files:

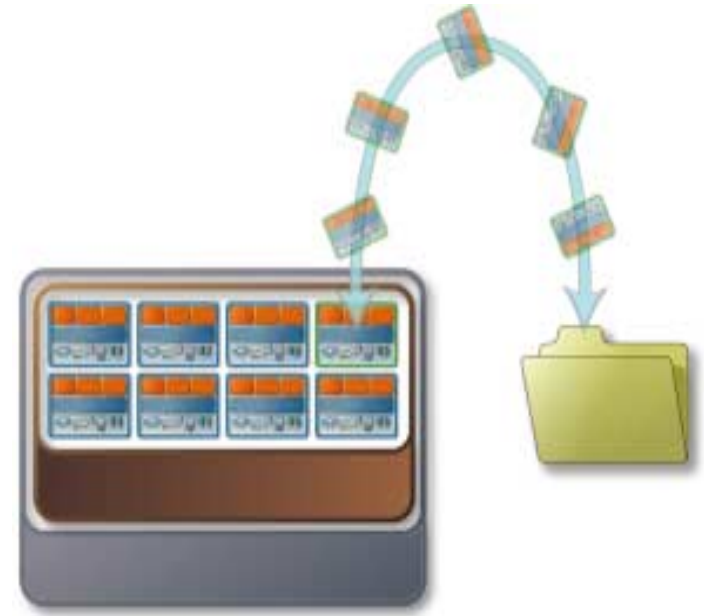
- A small configuration file, that defines the VM's hardware attributes.
- A small file that contains the “**Virtual BIOS**” settings called nvram.
- A **Virtual Disk** file, that contains all the files that are on the boot/system volume. This file is the size of the original disk or partition.

If you move these 3 files, you can move the offline VM from one physical server to another.

System Encapsulation

Entire state of the VM is encapsulated:

- Memory, disk images, I/O device state.
- VM state can be saved to a file
 - “Checkpointing”, aka “Suspend / Resume”.
 - VM state can be transferred through time and space.
 - Time: store in a file.
 - Space: transfer over a network.



Attributes of a Virtual Machine

- **Portability** - As the OS running within a VM does not know the real hardware that it is running on, it can be easily moved from one physical hardware platform to another.
- **Suspend Mode** - Machine state can be captured for root cause analysis.
- **Point in Time (PiT) Restoration** - Data can be saved to easily back out of changes.

Benefits of VM Portability-Simplification

- Easy server **backup and restore**. A VM can be restored on a different physical server, with no changes, as it does not see any differences to the underlying hardware.
- **Disaster Recovery** – Replacement servers do not need to be identical hardware, and VM's can be easily consolidated during recovery.
- Easy **migration and upgrade** to more powerful server.
- Easy **replacement or consolidation** of older servers.

Benefits of Suspend Mode

- Easy capturing application data while the system is having the problem for more effective root cause analysis.
- May facilitate certain types of system backups.
- The machine's memory state and other checkpoint information is placed in a disk-based **suspend file**.

Benefits of Point in Time (PiT) Restoration

A VM's Virtual Disk file can be placed in “**Undoable mode**”. This creates a “**Redo File**” that captures changes. You can choose to apply or discard changes that were made after the disk was placed in this mode. This can be used for:

- Patch management - Ability to test changes, and easily commit or reverse the changes.
- Software test and application development.
- Ability to restore a VM to a prior point in time.

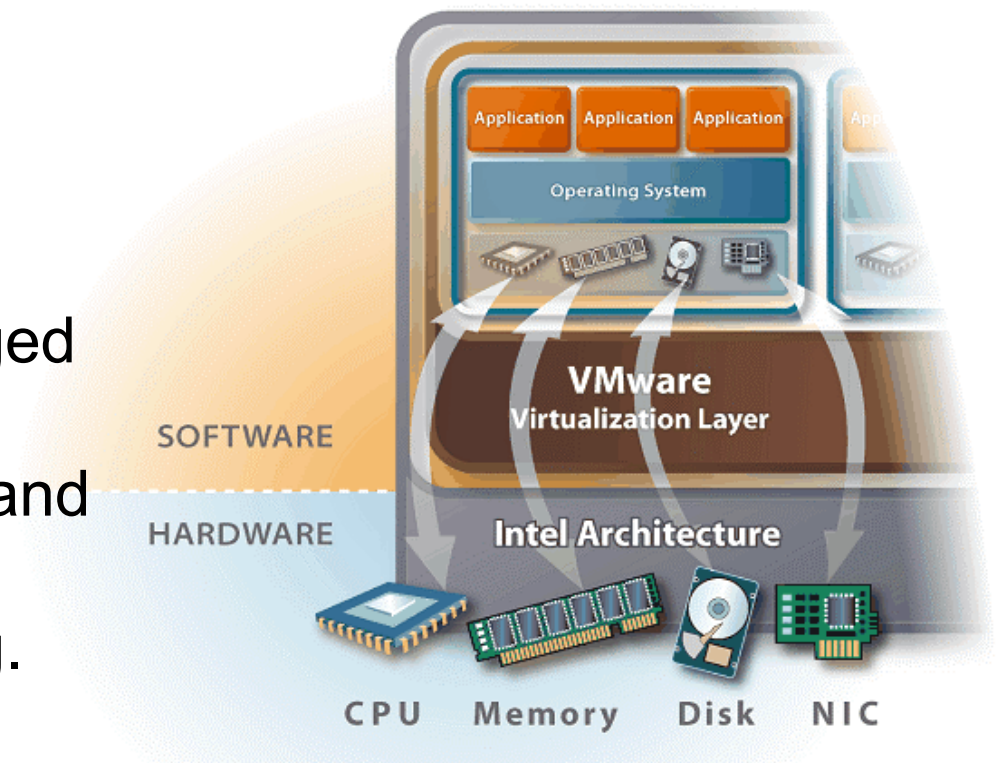
Why not put all Applications on a Single Operating System Instance?

- They may conflict with each other.
- You can't test all possible interactions.
- You can't even install many apps together.
- You need to dynamically control resources.
- Some apps misbehave – i.e., leak memory or crash.

In other words, most major applications assume they are on a dedicated instance.

What is ESX Server?

- A platform for VM's:
 - VMs can have minimum guaranteed resource allocations.
 - Allocations can be changed without rebooting.
 - SAN Path Management and protection built-in.
 - Supports Hyperthreading.
 - Supports Virtual SMP.
 - Can be deployed using HP's Rapid Deployment Pack.
 - More details later...



Attributes of VMware ESX Server

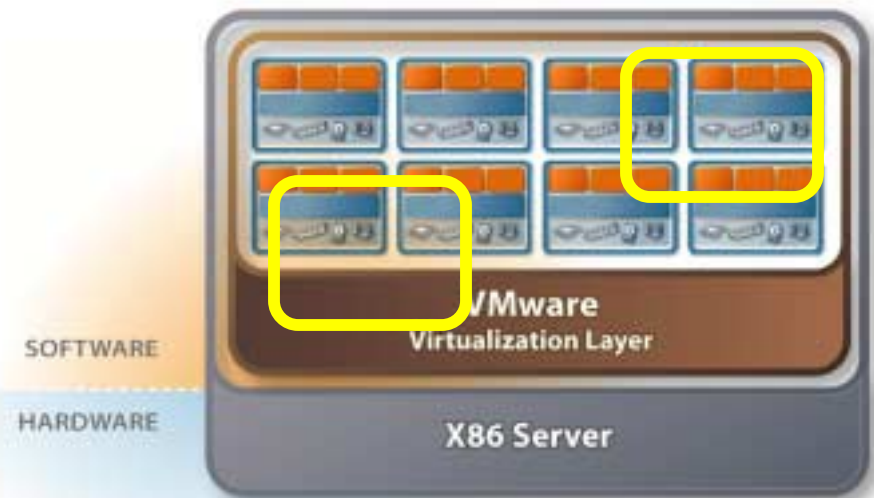
- **Dynamic Resource Allocation** - Resources are shared between all running VM's, and can be dynamically reallocated.
- **Isolation/Partitioning** – The state of one VM does not affect the state of another. If one VM fails, the others keep on functioning, unaffected.

Benefits of Dynamic Resource Allocation

- All of the VM's can have access to SAN and LAN resources, through the ESX Server's FC-HBA's and NIC's. This usage can be allocated and controlled.
- If a VM goes into a “resource runaway” condition, it will be limited by its maximum allocation, to minimize or prevent any negative effect on other VM's.
- Allows for adjustment of CPU, Memory and Disk resources to balance workload, and for changing of these allocations based on anticipated or measured workload changes.

Partitioning

- Run multiple Operating Systems, or multiple instances of the same OS on one ESX Server.
- Fully utilize server resources, as all VM's can be allowed to access common resources.
- Each VM fully protected and resource access share can be guaranteed.



Isolation

- CPU hardware / protection.
- Fault, performance, and security isolation.
- CPU, RAM, Disk, and network resource controls.
- Resource allocations can be changed “on the fly”.
- Guaranteed service levels.
- If one VM “crashes”, it has no negative effect on any other running VM’s.





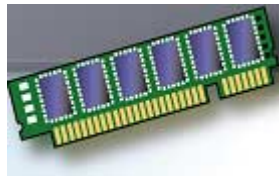
Capacity Planning & Workload Management Changing the Rules...

Four Basic “Food Groups” of a Server..

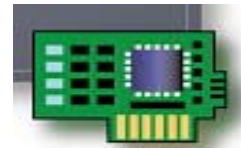
- **Storage**



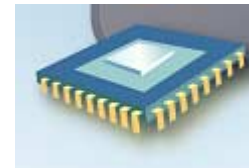
- **Memory**



- **Local Area Network**



- **Aggregate CPU Capacity**



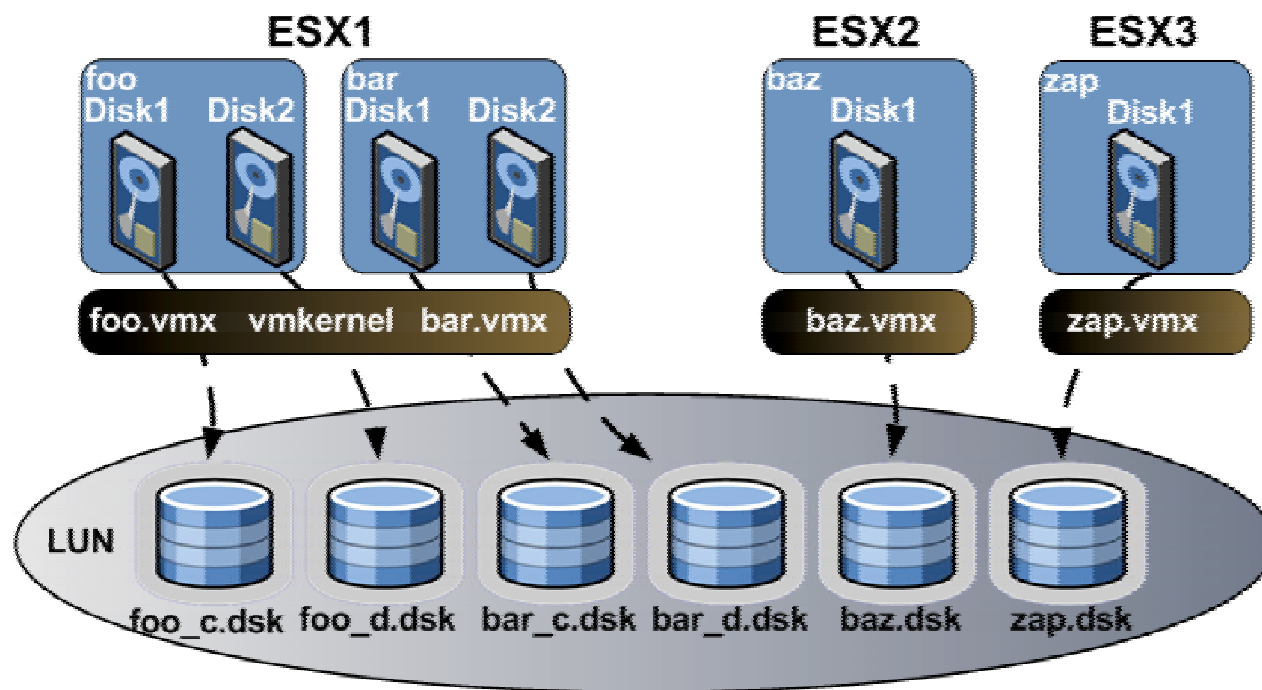
Disk Storage

- Every physical server on a SAN requires one or two Fibre Channel HBA's, depending on the fault tolerance requirements, as well as cables and switch ports.
- As a VM sees SCSI LUN's, and doesn't know whether the LUN is on local or SAN-based storage, a pair of HBA's on an ESX Server could allow all VM's to access SAN resources. This fact is often missed when calculating server consolidation cost savings.

SAN Cost Savings and Simplification

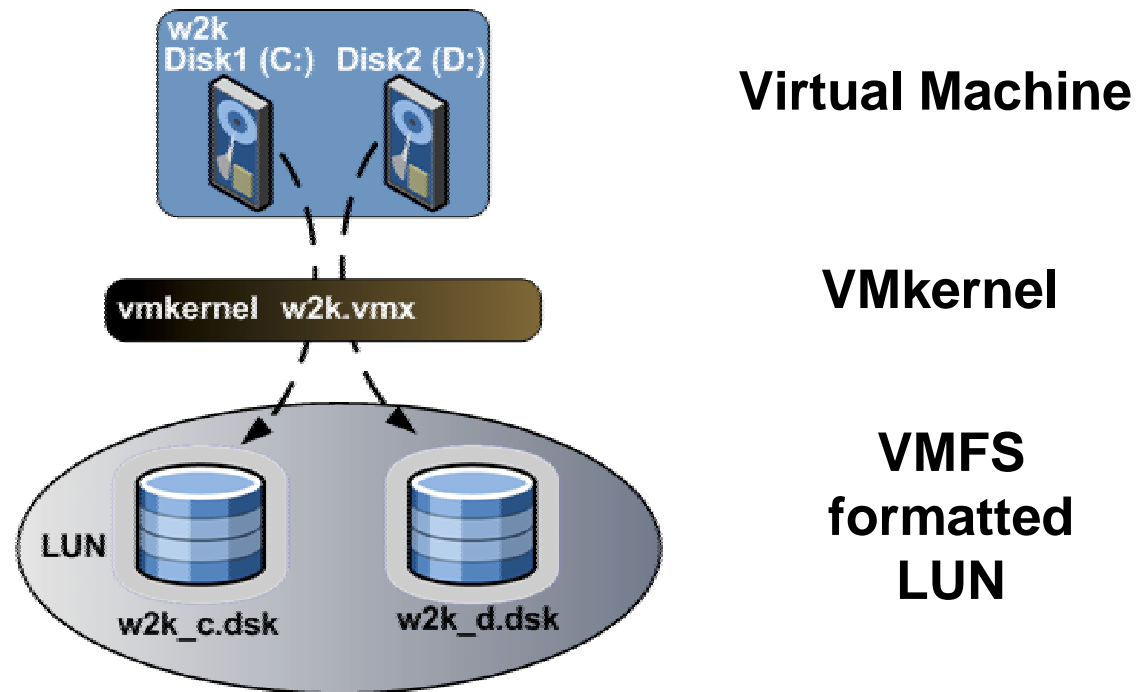
- 10 physical servers will require 20 Fibre Channel HBA's (for redundancy), 20 switch ports, cabling and path management software.
- One ESX Server will require 2 Fibre Channel HBA's (for redundancy), 2 switch ports, cabling and NO path management software, as it is built-in.
- There is also a cost savings associated with administering a simplified SAN configuration through its economic life.

ESX SAN Scaling



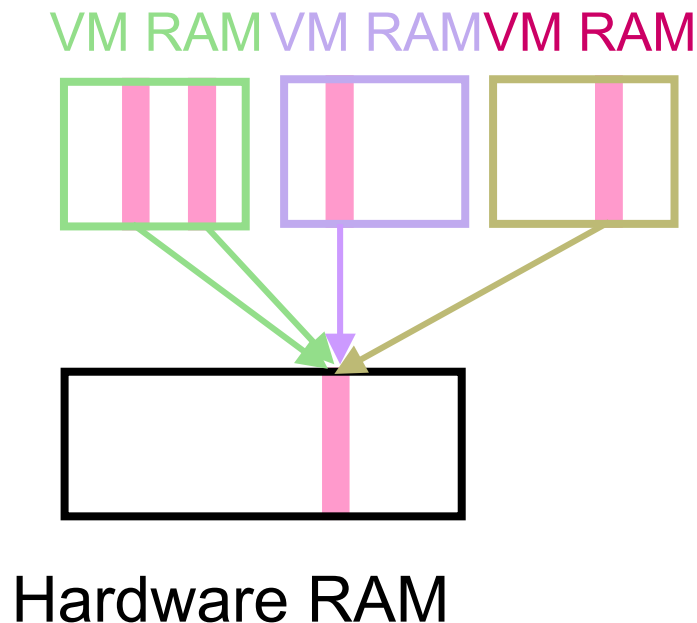
- Multiple ESX Servers may share a single LUN
- VMFS handles concurrent access
- vmkernel manages Fibre Channel Multipathing and Failover. No additional path management software is needed.

ESX Virtual Disk to File Mapping



- Each Virtual Disk in a VM maps to a file in a VMFS or a raw LUN.

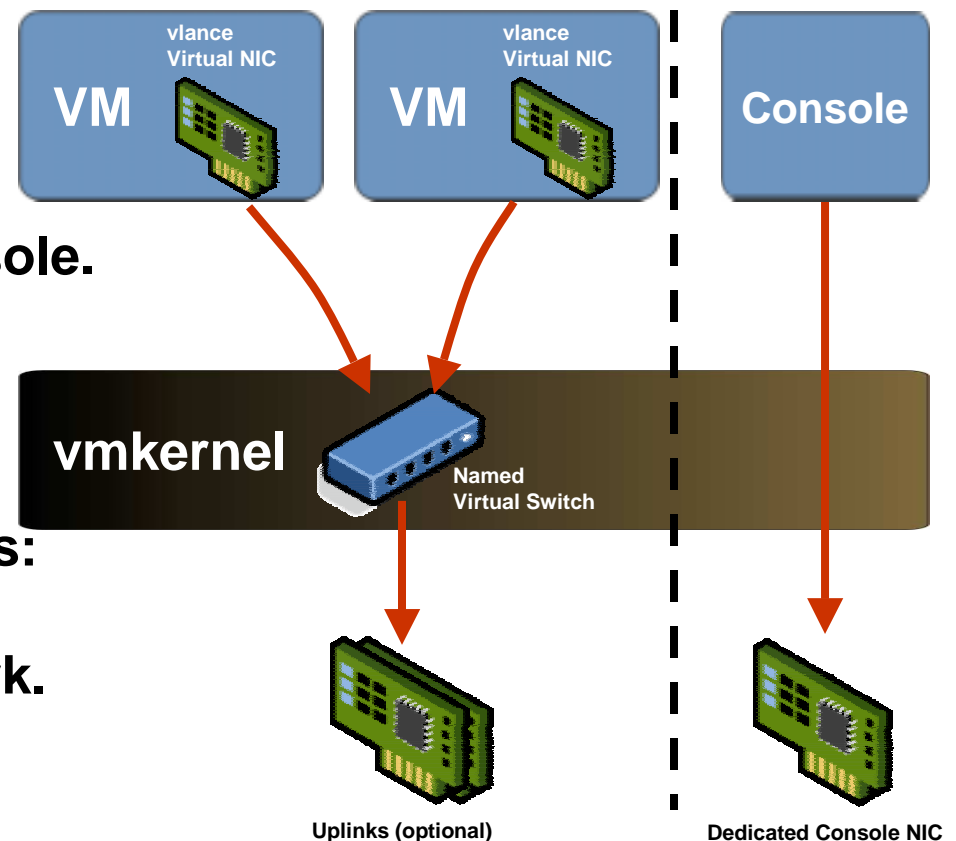
Transparent Page Sharing Technology



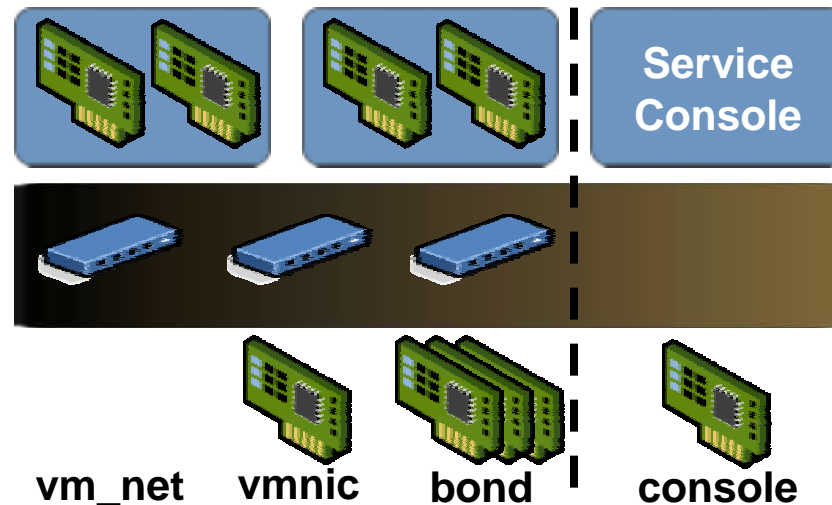
- Shares identical pages
- Periodic scans and fast match algorithm.
- Example: ~ 30% to 60% shared w/ idle Win2K VMs, due to code redundancies and “zero pages”.
- Single instance created when no longer redundant.
- No OS changes needed.

Network Virtualization

- VM's have Virtual NICs.
- Dedicate NICs to Service Console.
- Virtual NICs plug into Virtual Switches.
- Virtual Switches are named.
- May have zero or more uplinks:
 - Zero – “host only” network.
 - One – normal external network.
 - Two or more – “bonded” external links for fault tolerance and bandwidth aggregation- 802.3ad.
- Switches may have port groups.



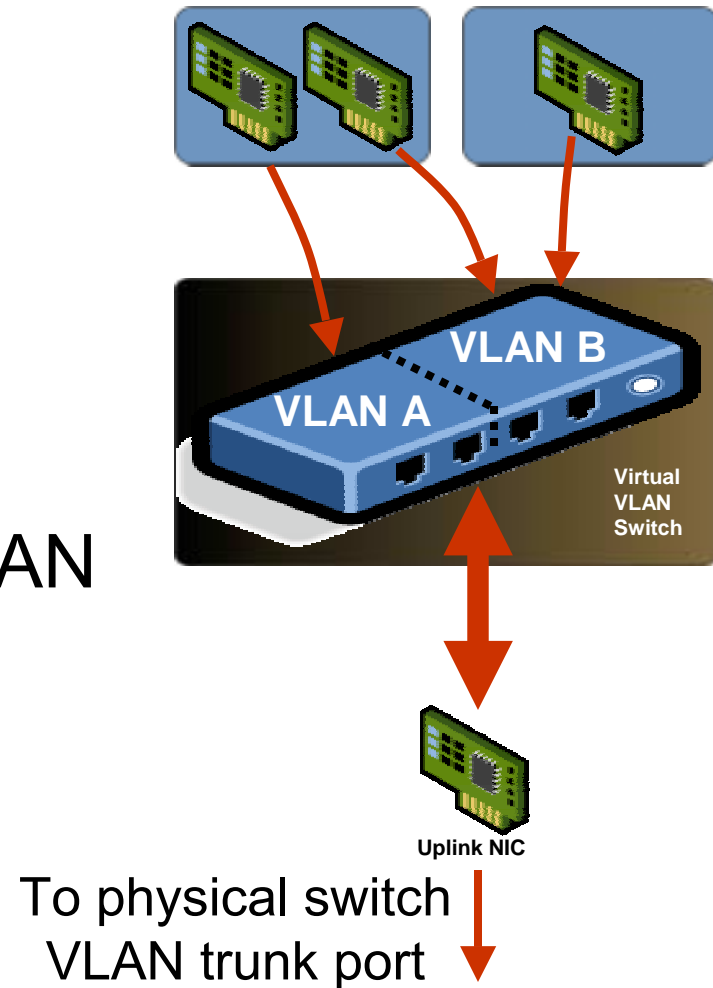
Network Access



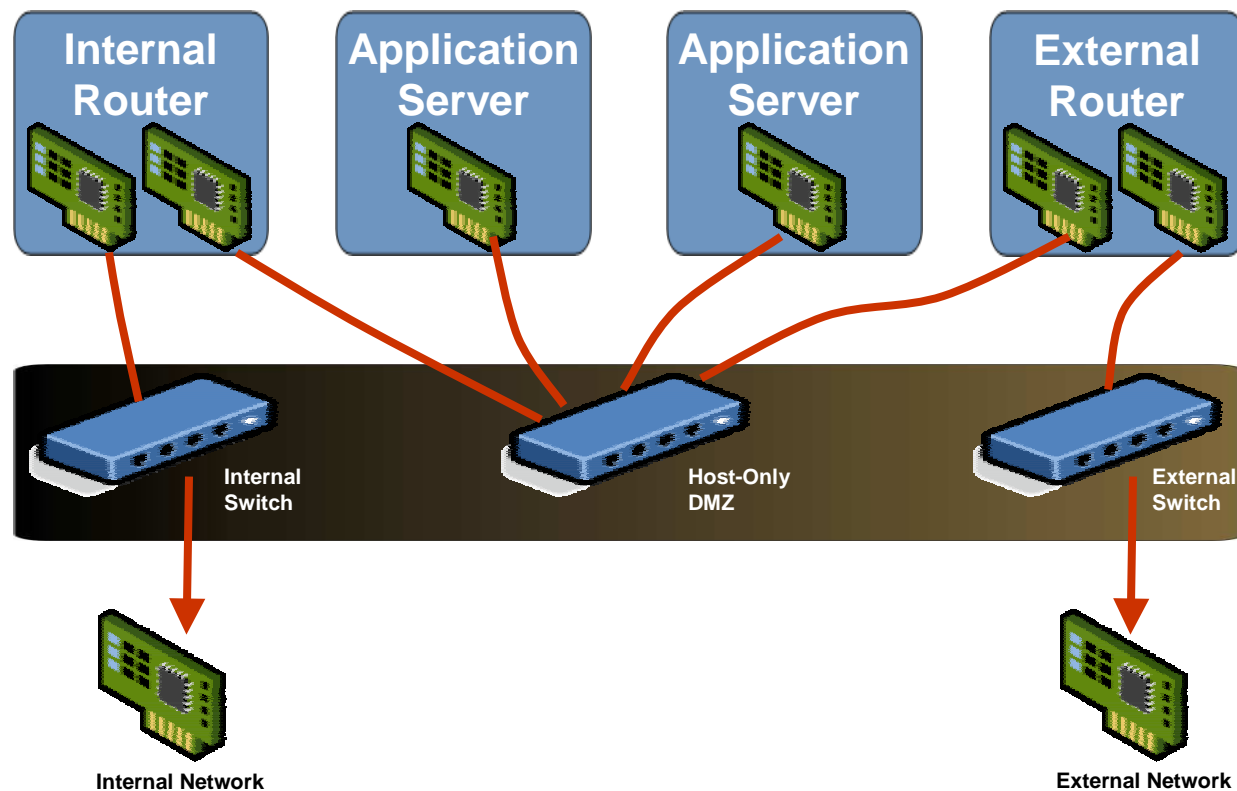
- Each Virtual NIC has own MAC address.
- Virtual NICs connect to Virtual Switches.
- Virtual Switches may have 0, 1, or more uplinks.
- Virtual Switches support PXE for deployment technologies such as Altiris and Symantec Ghost.
- Virtual Switch “Port Groups” may be VLANs (802.1q).

Port Groups

- Port Groups are optional Virtual Switch attributes.
- Each Port Group has a VLAN ID.
- Uplinks plug into physical switch trunk ports.



Firewall In A Box

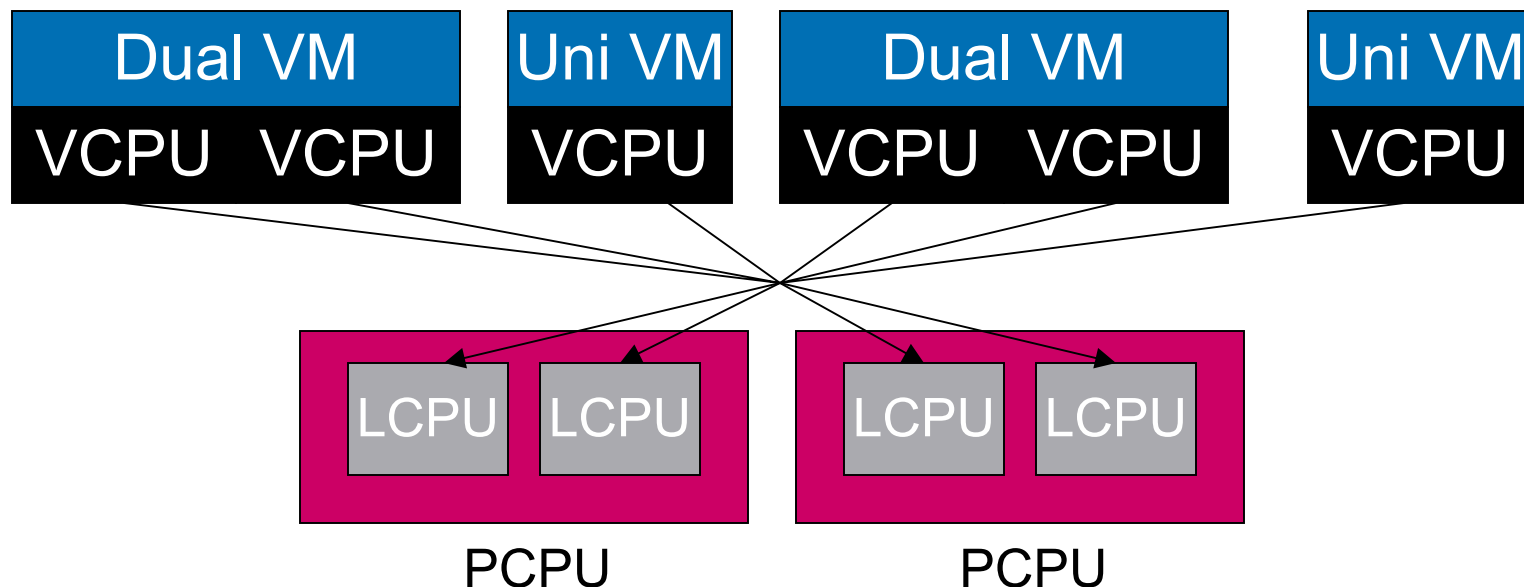


Could be done with 1 NIC + VLANs

What is CPU Hyperthreading?

Hyperthreading (HT) allows one CPU to execute two threads simultaneously.

- Each Physical CPU (PCPU or package) offers two Logical CPU's (LCPU's).
- VMkernel schedules Virtual CPU's (VCPU) onto Logical CPU's. Supported as of ESX Server 2.1.



Workload Management

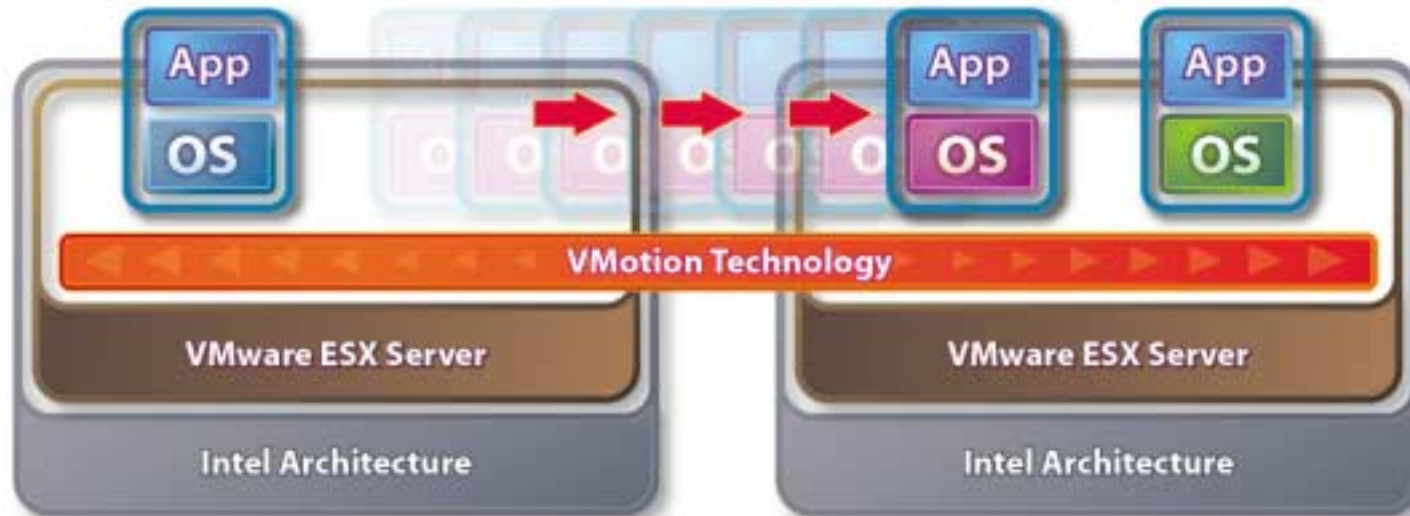
- Traditionally, you needed to guess what server resources an application required at peak periods, and provision a server based on these peak requirements, even if the peak requirements were a relatively small fraction of the server's total uptime.
- Because the portability of a VM, you can migrate a VM from one ESX Server to another, either offline, which is referred to as a “**Cold Migration**”, or “on the fly”, which is referred to as a “**Hot Migration**”.

Enhancements to Virtual Machine Portability - VMotion

- A technology called **VMotion** allows the transfer of a running Virtual VM from one ESX Server to another with imperceptible downtime.
- Workloads can be transferred to an ESX Server with more resources during peak periods.
- Workloads can be offloaded to other ESX servers during hardware maintenance for higher system availability.

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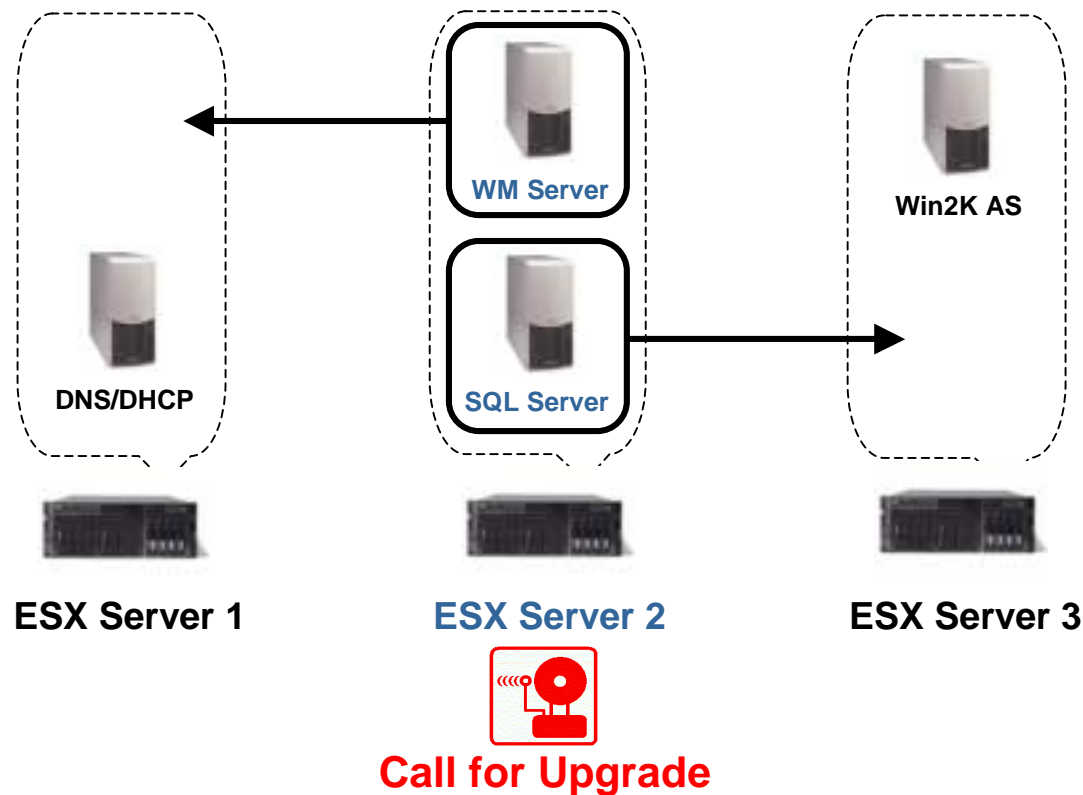
Instantly shift running systems across hosts with imperceptible downtime.



- 100% application availability
- 100% transaction integrity
- 100% data availability
- 100% transparency to end users

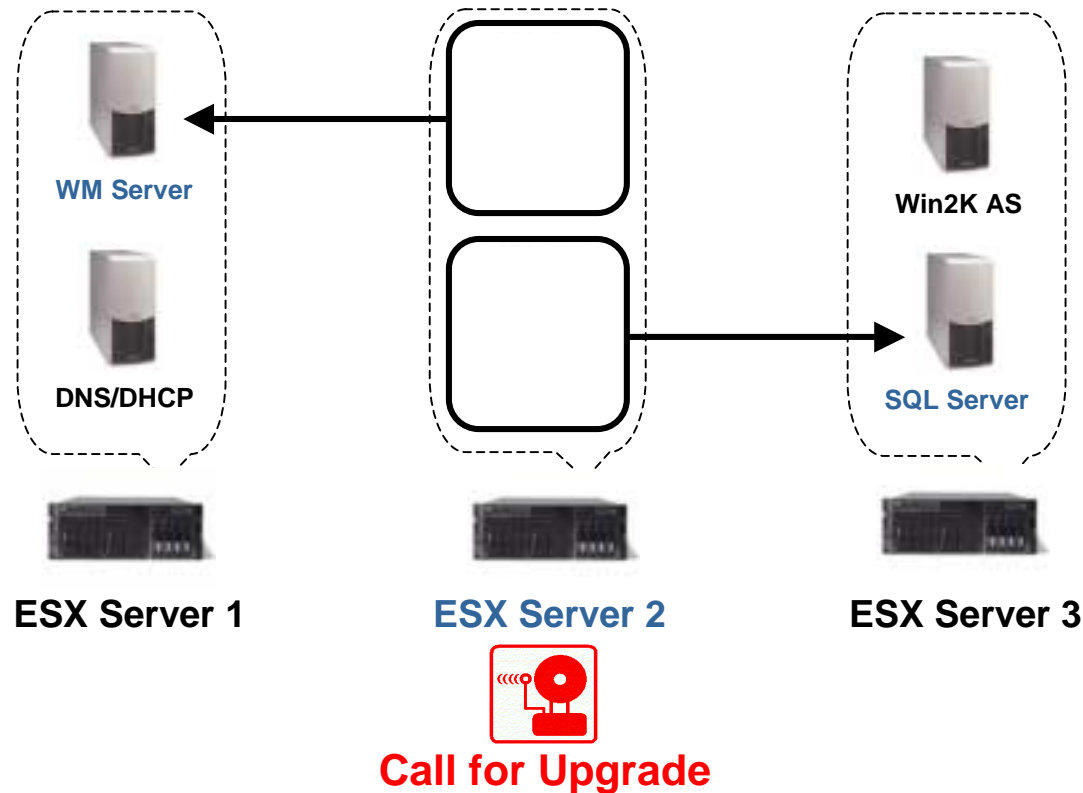
Zero Downtime Maintenance

Upgrade and service production hardware using VMotion with zero downtime and 100% customer transparency.



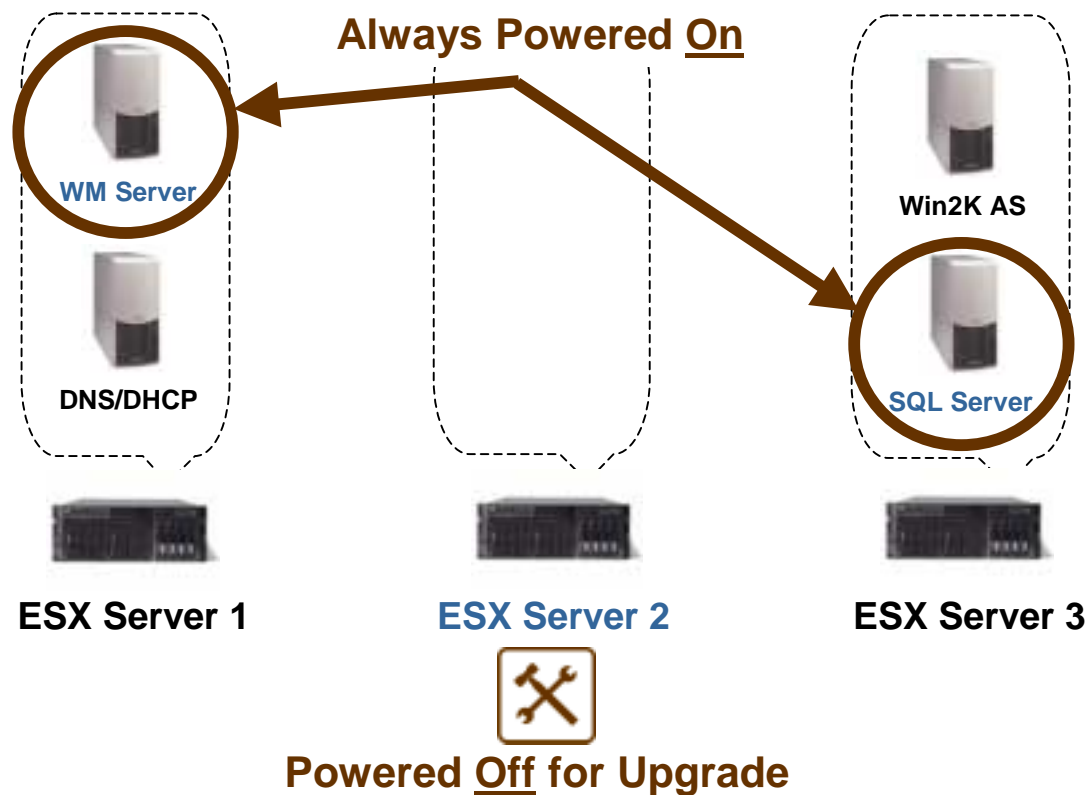
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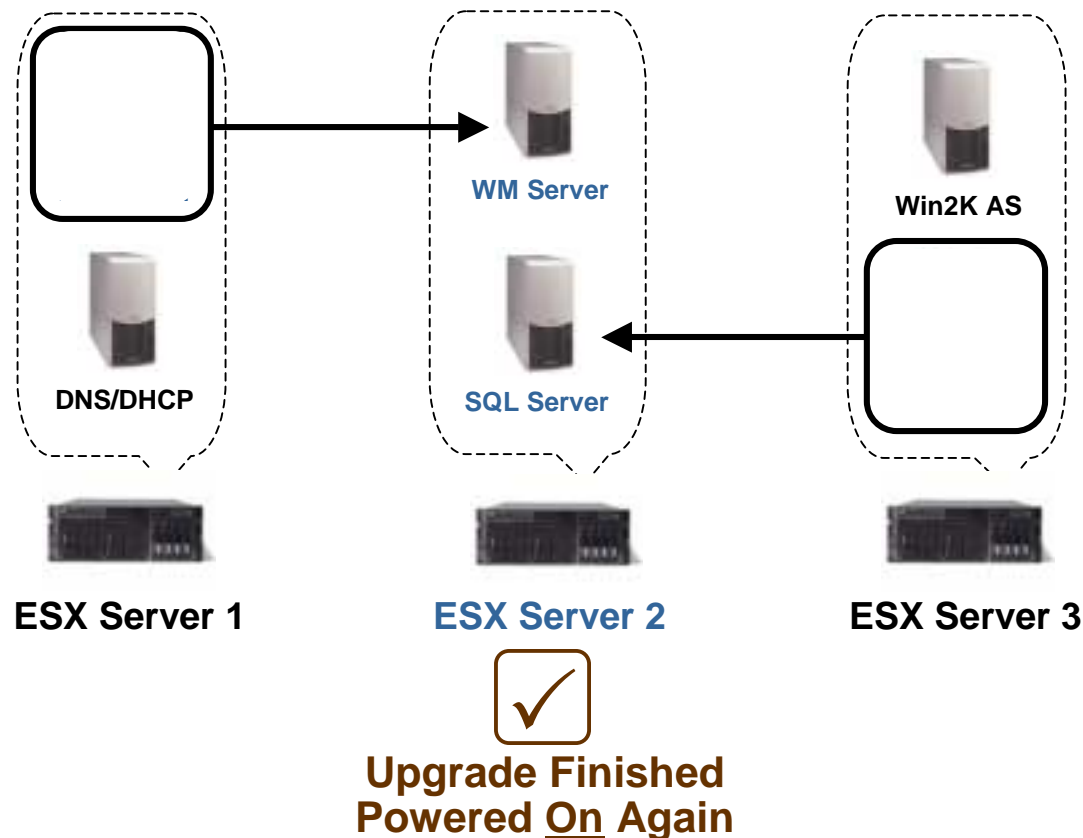
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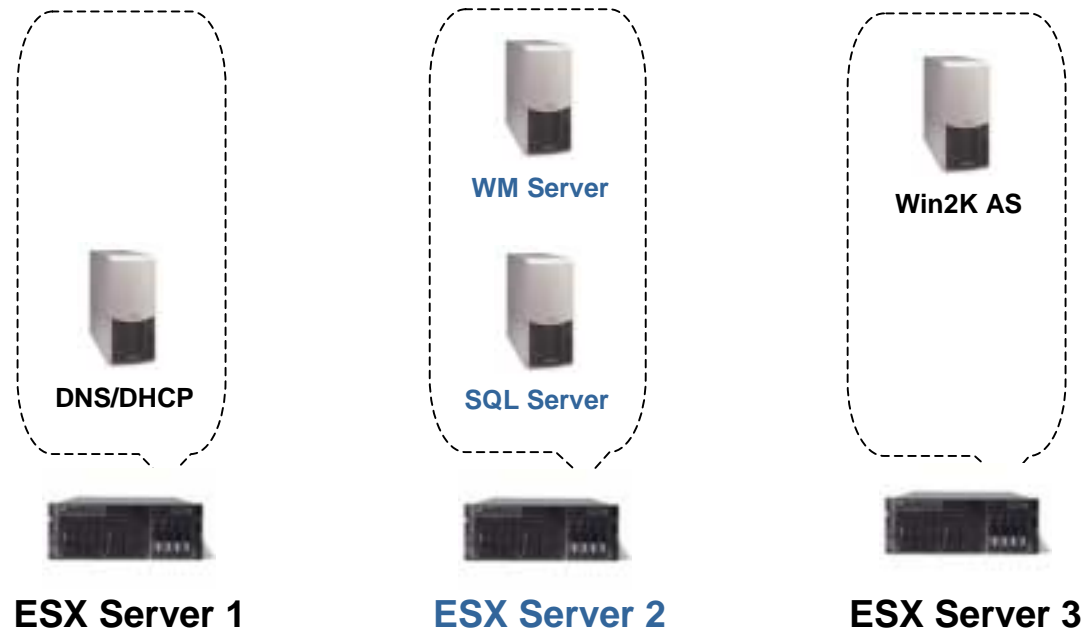
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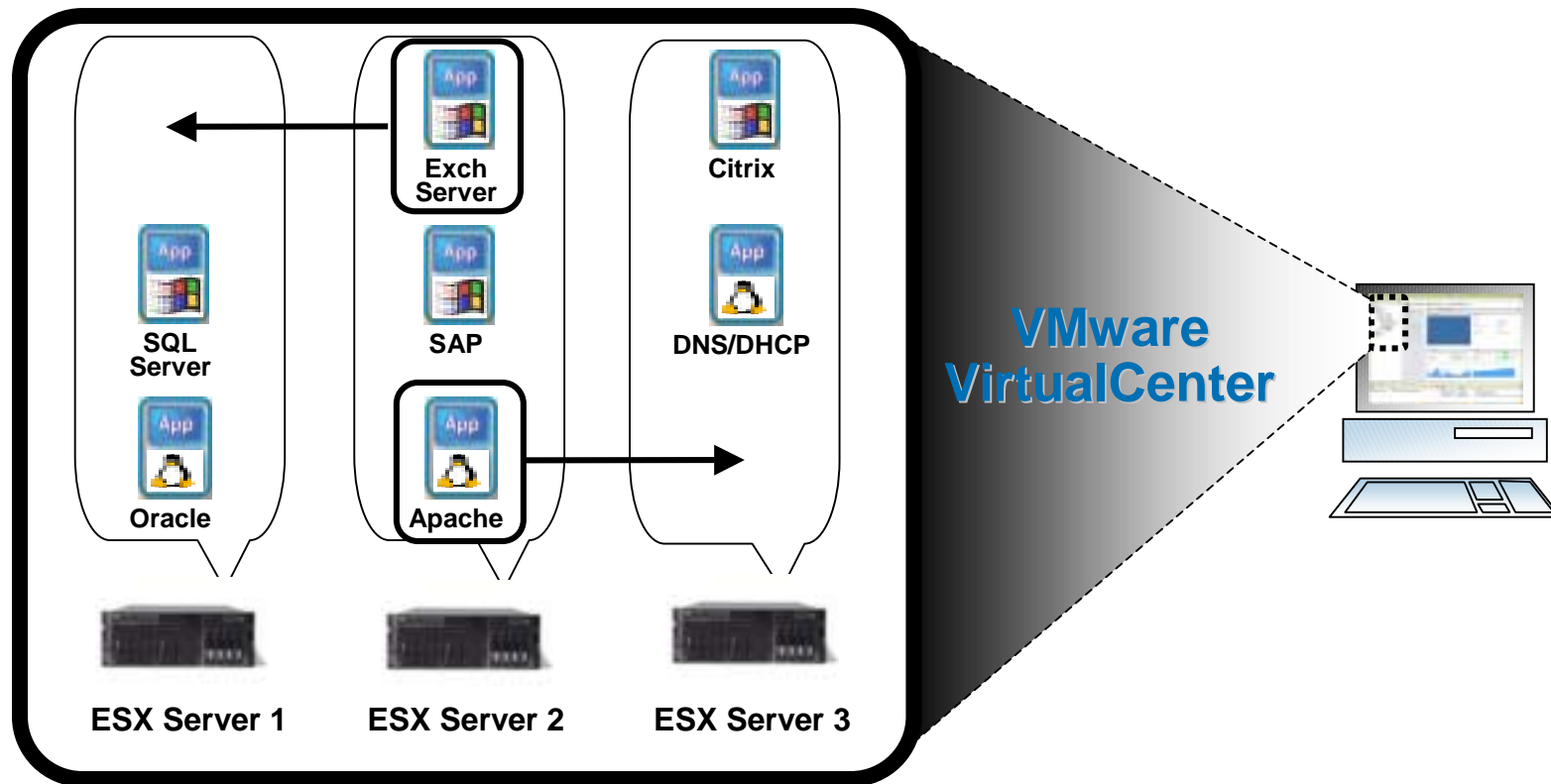


Workload Management

- A hot migration could take VMs off of one ESX server to give the remaining VMs greater access to resources.
- A hot migration could also transfer a VM to a lesser-used or unused ESX Server only during it's heavy traffic periods.
- Based on performance measurement data, ESX Servers can be “**load balanced**”, and this balance can easily be changed, either based on “trend data”, or dynamic changes.

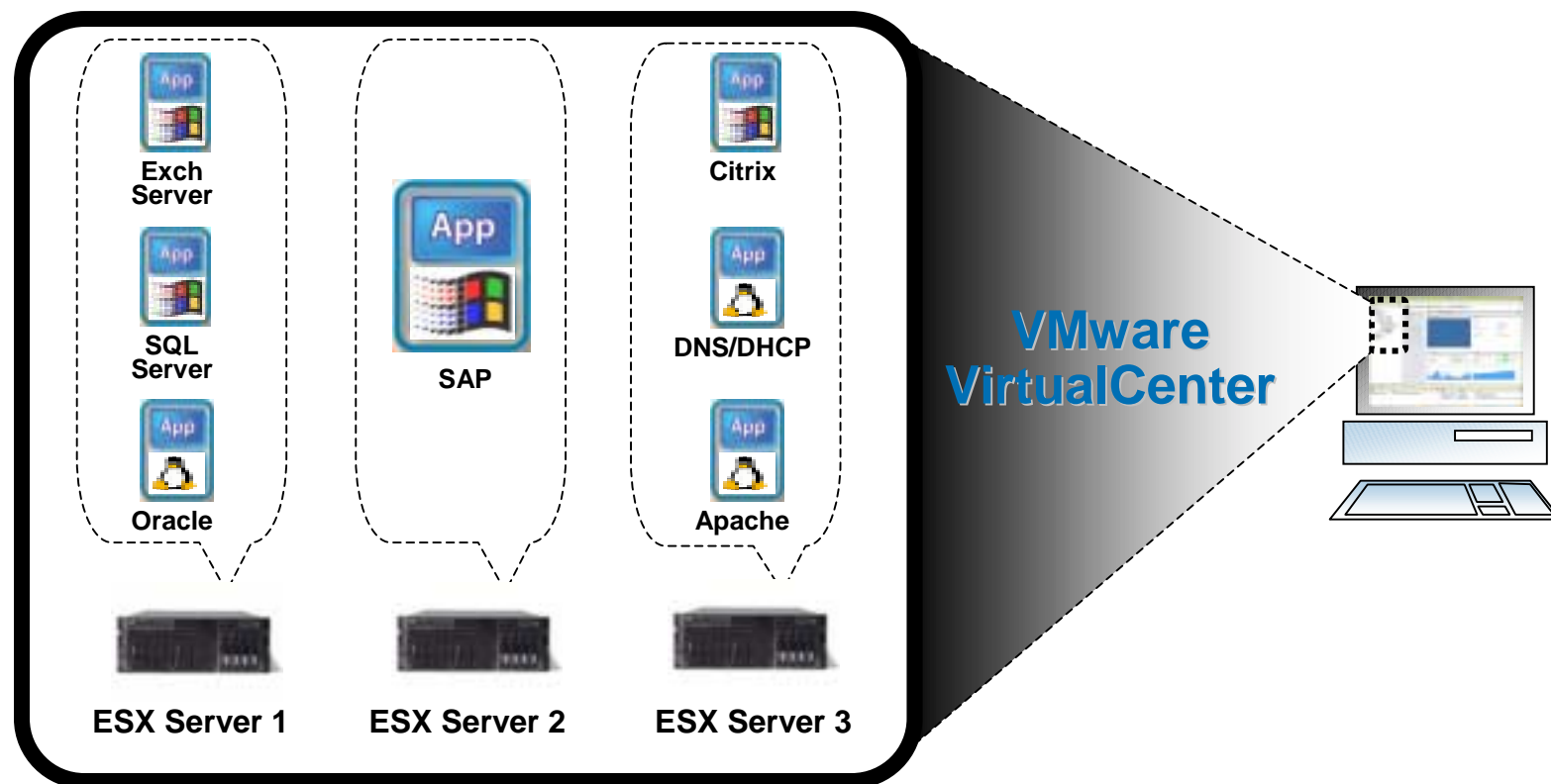
Workload Management with VMotion

Dynamically manage workloads in response to an unexpected increase in SAP utilization



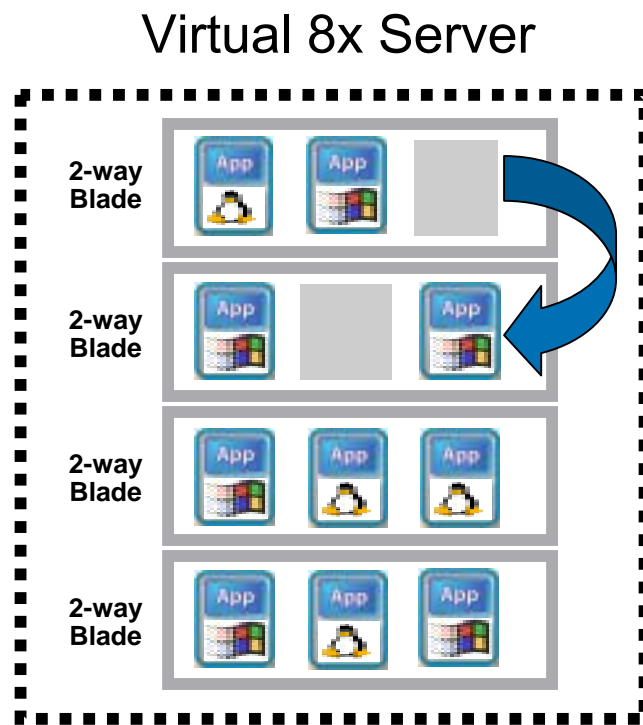
Workload Management with VMotion

Dynamically manage workloads in response to an unexpected increase in SAP utilization



Alternate Form Factors

Enable a Virtual Scale-Up solution from multiple server blades



- Achieve 60-80% average utilization.
- Share headroom across multiple server blades to handle spikes.
- Applications are now mobile across server blades.
- Transparently shift systems across blades to match complementary workloads.

Workload Management

- The allocation of CPU, Memory and Disk resources can also be changed dynamically, through guaranteed minimums, maximums, and a “**Proportional Share**” mechanism. Network traffic can be throttled through **Traffic Shaping**.
- This means that predictable service levels can be guaranteed, and resource allocations can be adjusted as needed, or even changed on a scheduled basis.

Capacity Planning –Other factors

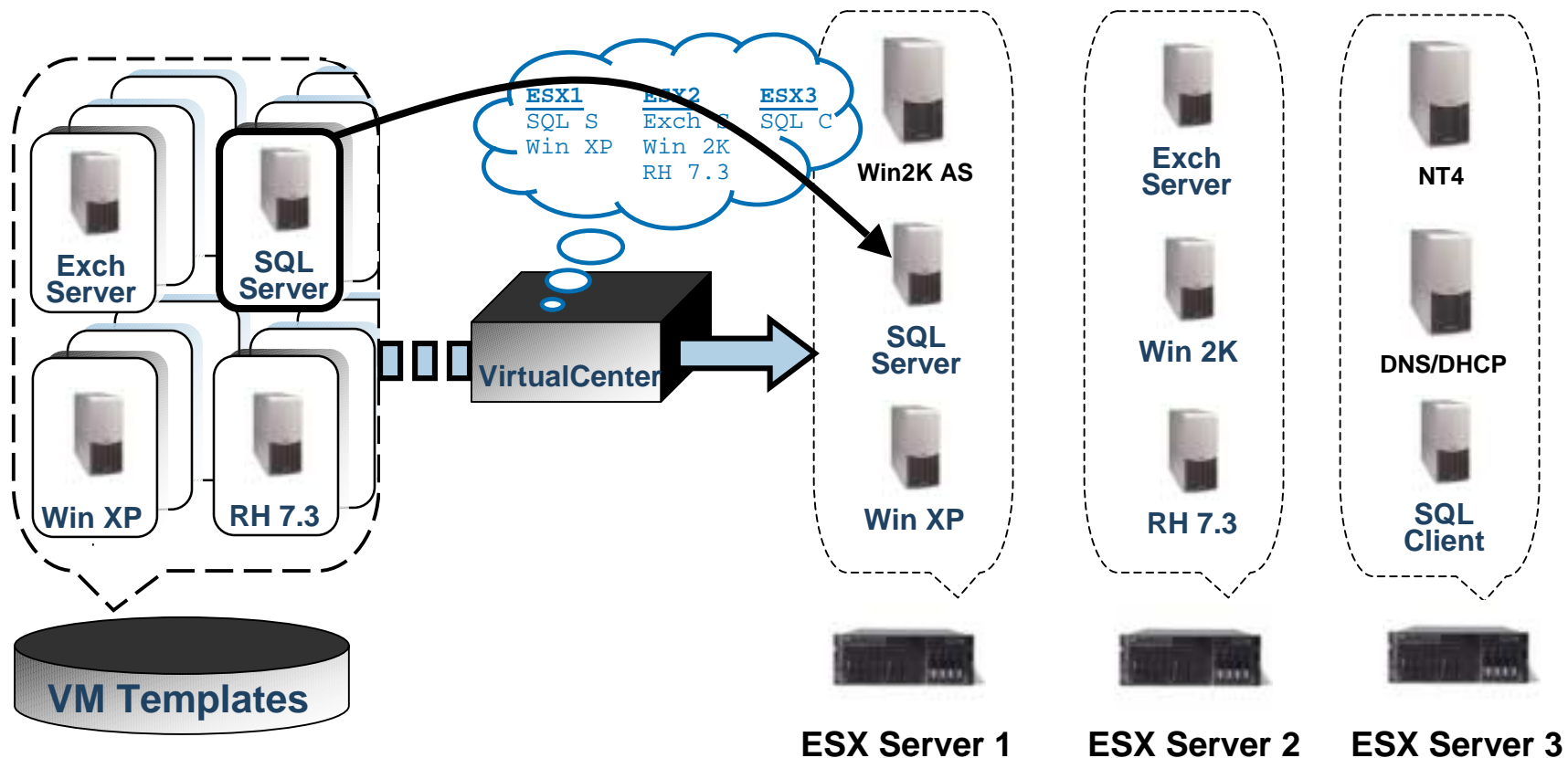
- Anticipated Workload Increases.
- Planning for Peak vs. Average loads.
- Time of day, day of week, day of month, day of year.
- Hardware Failover / Clustering.
- Inter-relationship between one VM's workload and another.
- Remember that VMotion, and dynamic resource allocation changes can help manage this.



Server Provisioning / Deployment
Disaster Recovery / High Availability
Changing the Rules...

VMware Automated Server Provisioning

Automate the deployment of new servers into a server farm using a single repository of VM templates



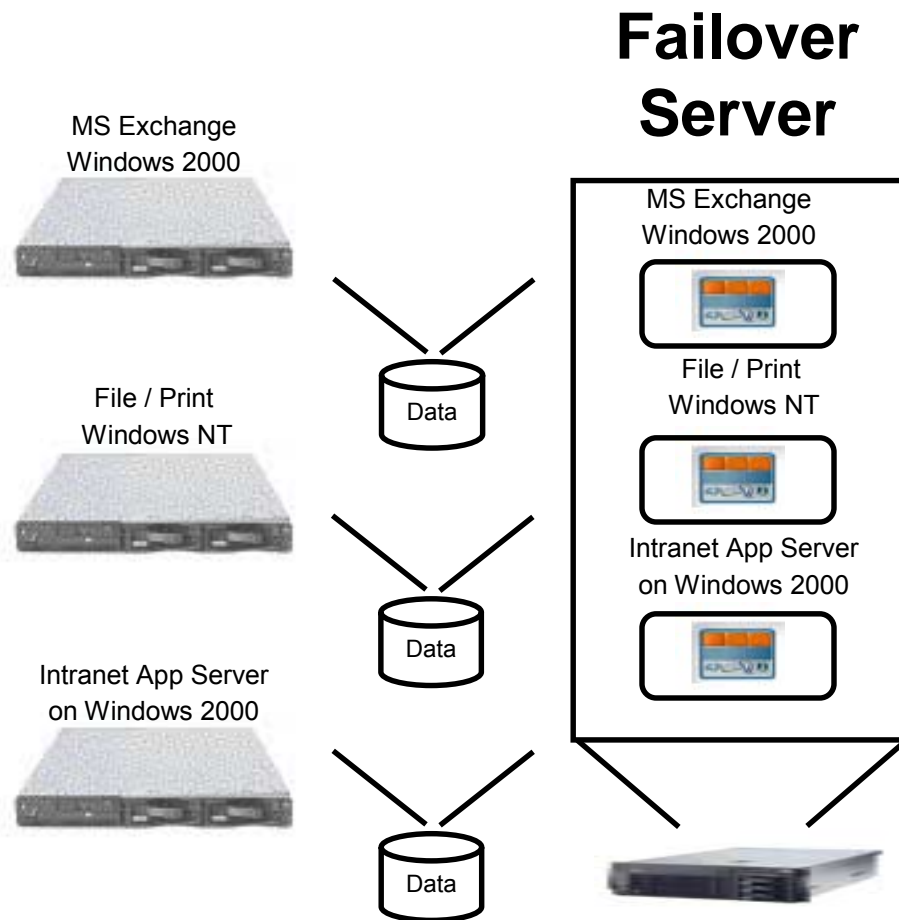
Disaster Recovery and High Availability

- VMs can be run on different hardware.
- Several VMs can be consolidated on a single physical server.
- Virtual Disks are stored on VMFS, allowing for multiple ESX Servers to access the same volume.
- VMFS can be replicated, and standby site can be brought up quickly.

Failover Clusters – 3 Configurations

- **Two nodes within the same ESX Server**
Protects against operator error, application and OS crashes.
- **Two nodes on two different ESX Servers**
Protects against operator error, application and OS crashes, hardware failures.
- **One active node on a physical server and its backup on an ESX Server** - Protects against operator error, application and OS crashes, hardware failures. Low-cost N+1 redundancy.

ESX Server based Failover Solution



Benefits:

- Low cost: organizations for whom 1-1 failover is unaffordable.
- Flexible: allows failover of heterogeneous-OS servers.
- Scalable: additional failover machines can be added as needed.

Physical to Virtual Server Consolidation

Mail System Example

Traditional Approach

Apache on
Linux



1U, 2-way Rackmount

Sendmail
Gateway
on Linux



1U, 2-way Rackmount

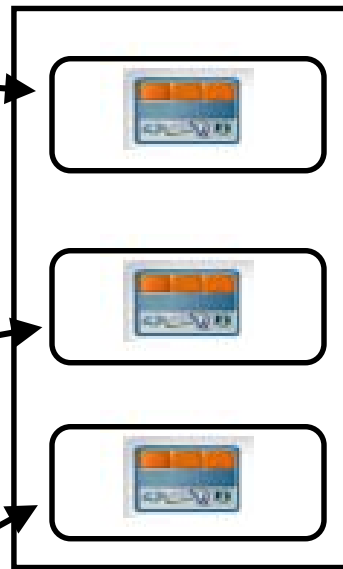
Exchange + IIS
on
Windows 2000



1U, 2-way Rackmount

Mail System Example

Consolidated Environment

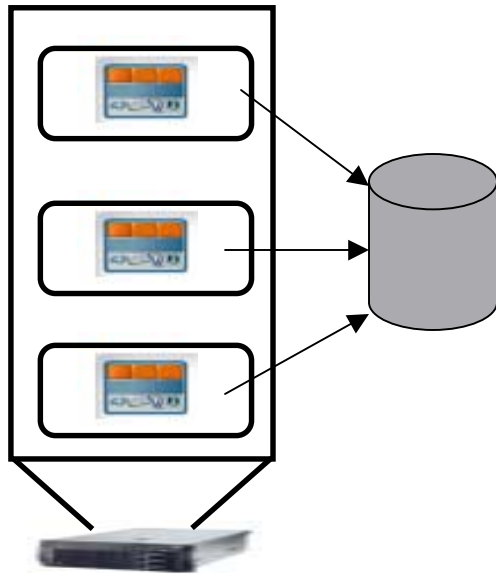


3U, 4-way
Rackmount

Customer Benefits

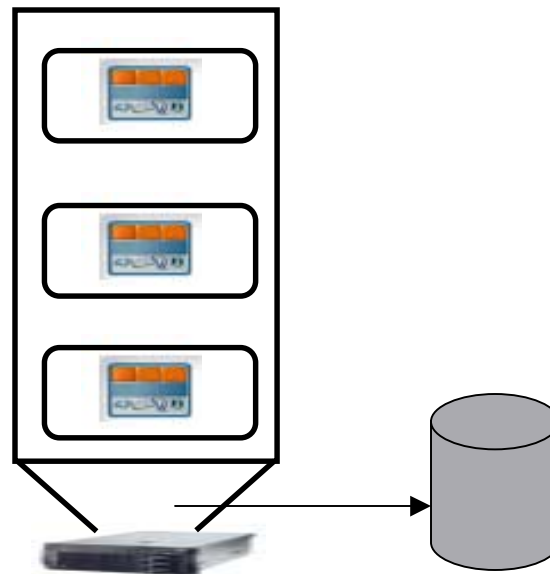
- **No need to standardize on one OS.**
- **Removes concerns about application interaction or dependencies.**
- **VMware resource governing guarantees that critical apps will get the resources they need.**
- **Reduced system setup and management costs.**
- **Manage “Legacy” OS and Apps with current physical hardware.**

Backup Options with VM's



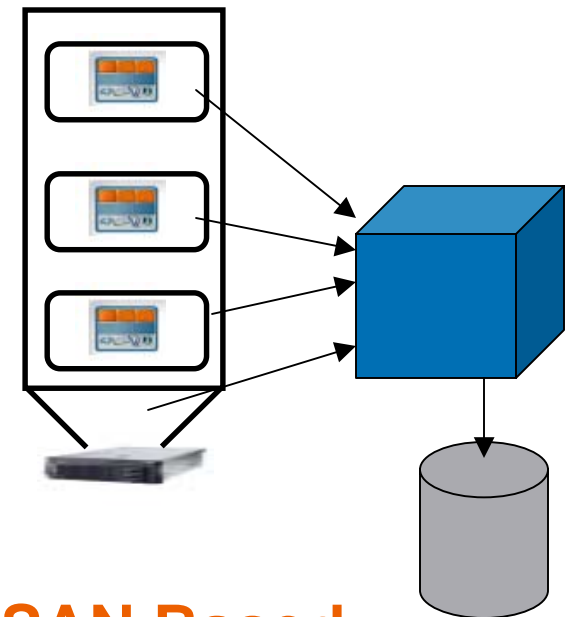
Backup Each VM

- Agent based inside each VM.
- Just like physical servers.



Whole Server Backup

- Use backup software with ESX Server Console OS.
- Reduce number of backup licenses.



SAN Based

- Use SAN snapshot.
- SAN handles checkpointing and tape archiving automatically.

Disaster Recovery Restoral Simplification

- In any of the backup scenarios, VMware makes recovery simpler.
- List of items required to bring to the DR site is smaller.
- ESX Server licenses and install.
- .DSK files (VM backups)
- Way to restore VM configurations.

VS

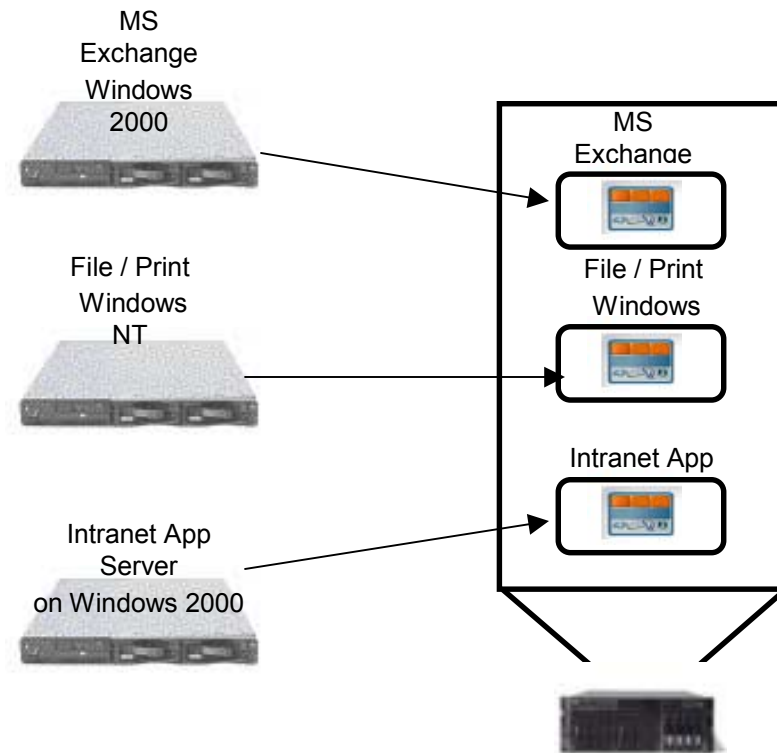
- Bringing full set of tapes and way to cold boot.
- Rebuild server on slot-for-slot identical hardware models.

Replication for Disaster Recovery

Replication technology such as HP Data Replication Manager

Continuous Replication for applications such as:

- **Exchange / Notes**
- **SQL Server / Oracle**
- **IIS**
- **Custom Application**



1-to-1 or Many-to-1 Continuous Replication

Some Tasks that Change...

Key Task	Traditional Approach	With Server Virtualization
Provision a new server	<ul style="list-style-type: none">• 3 - 10 days hardware procurement• 1 - 4 hours provisioning new server	<ul style="list-style-type: none">• 5 - 10 minutes provisioning new VM
Moving an application to a new server; Repurposing a server	<ul style="list-style-type: none">• 4 - 6 hours for migration• Service interrupted for duration of maintenance window• Requires days/weeks of change management preparation	<ul style="list-style-type: none">• 2 - 5 minutes using VMotion (no service interruption)• 10 - 30 minutes without VMotion
Hardware maintenance	<ul style="list-style-type: none">• Requires 1 - 3 hour maintenance window• Requires days/weeks of change management preparation	<ul style="list-style-type: none">• Zero downtime hardware upgrades with VMotion



Virtualization Technologies that
are available now...

Technologies that are Available Now...

- VMware Workstation
- GSX Server
- ESX Server
- VirtualCenter
- VMware P2V Assistant

VMware Virtualization Technologies...

Workstation

- Productivity Tool
- Performance 70-90% of Native

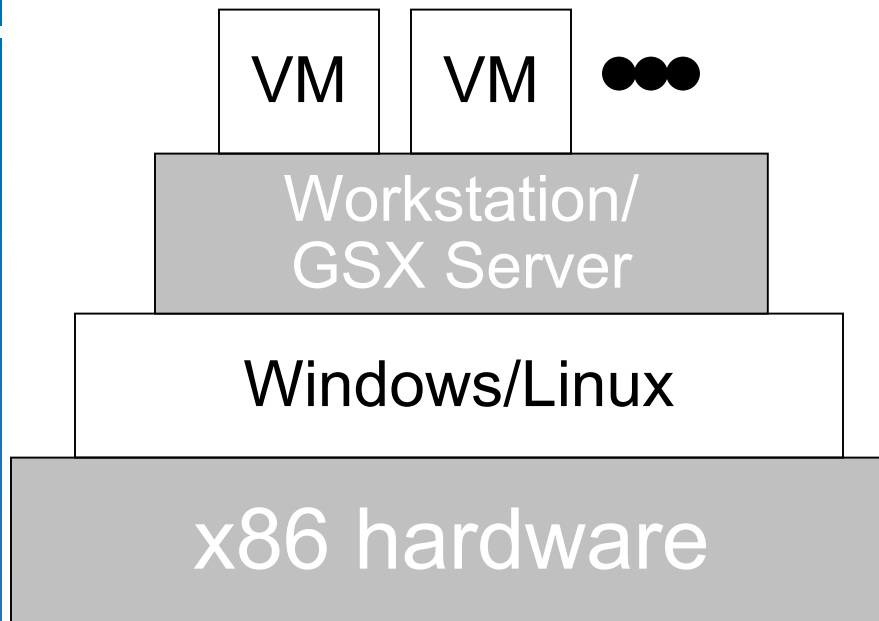
GSX Server

- For Departmental Services
- Remote Management
- Performance 70-90% of Native

ESX Server

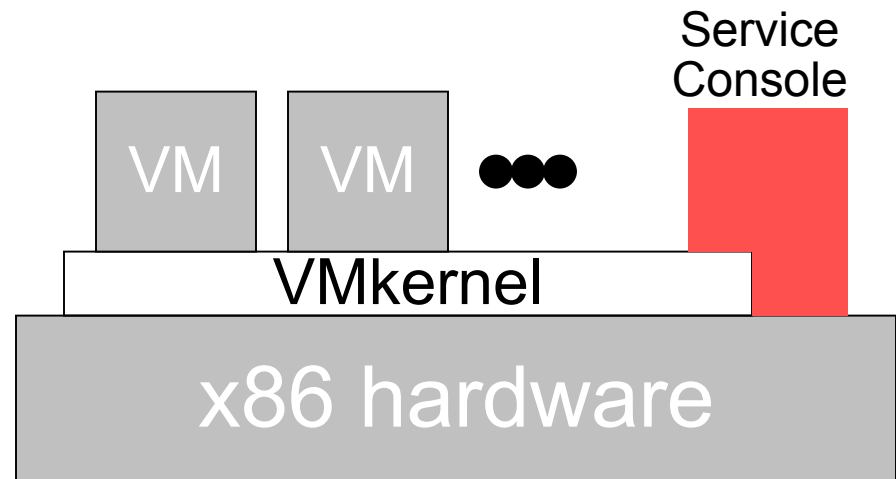
- For Data Center
- High Performance and Scalability
- Advanced Resource Management
- Remote Management
- Performance 83-98% of Native

Virtualization Architectures



Hosted (Workstation, GSX Server)

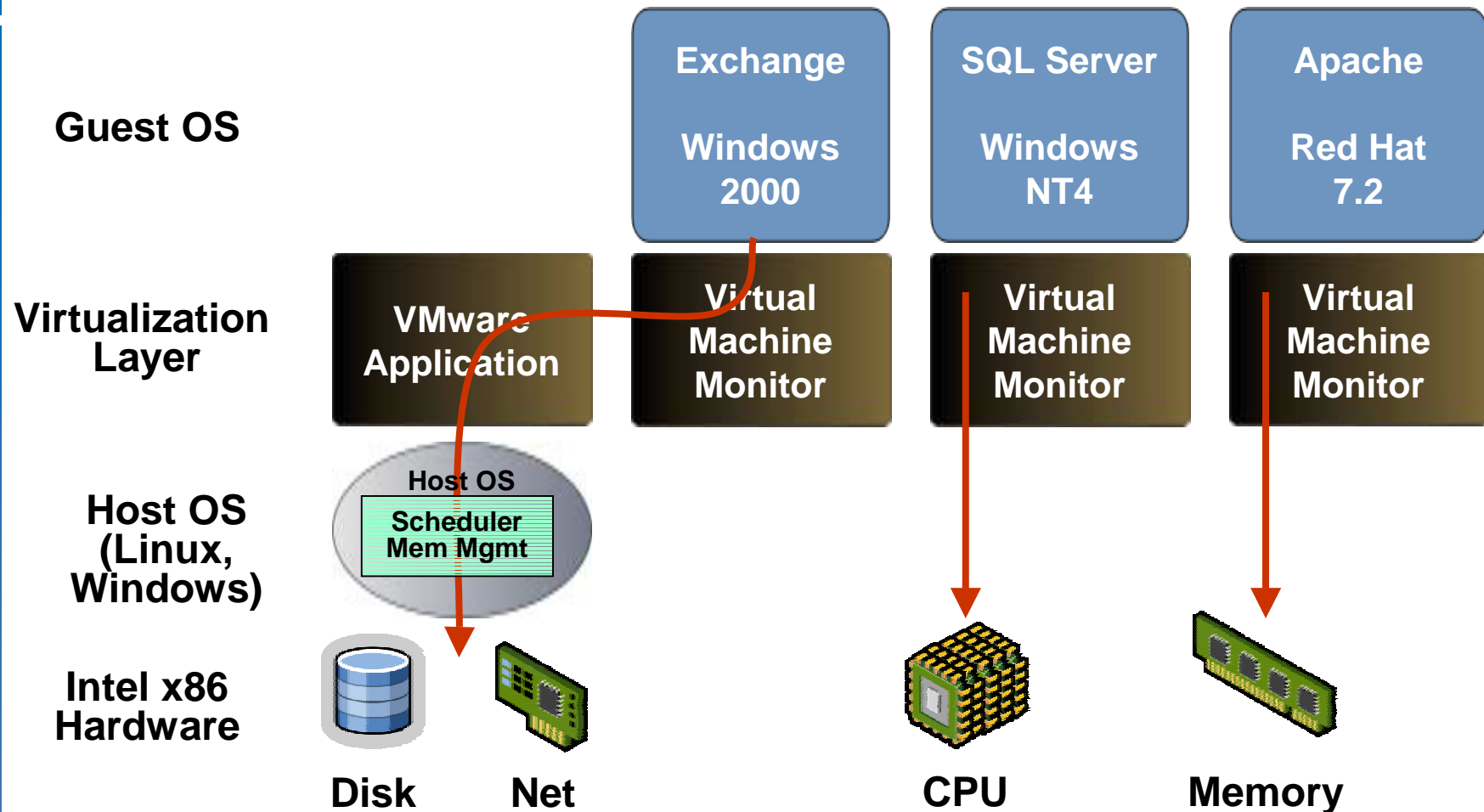
- Maximum device compatibility
- Installs like an application
- Lower price point



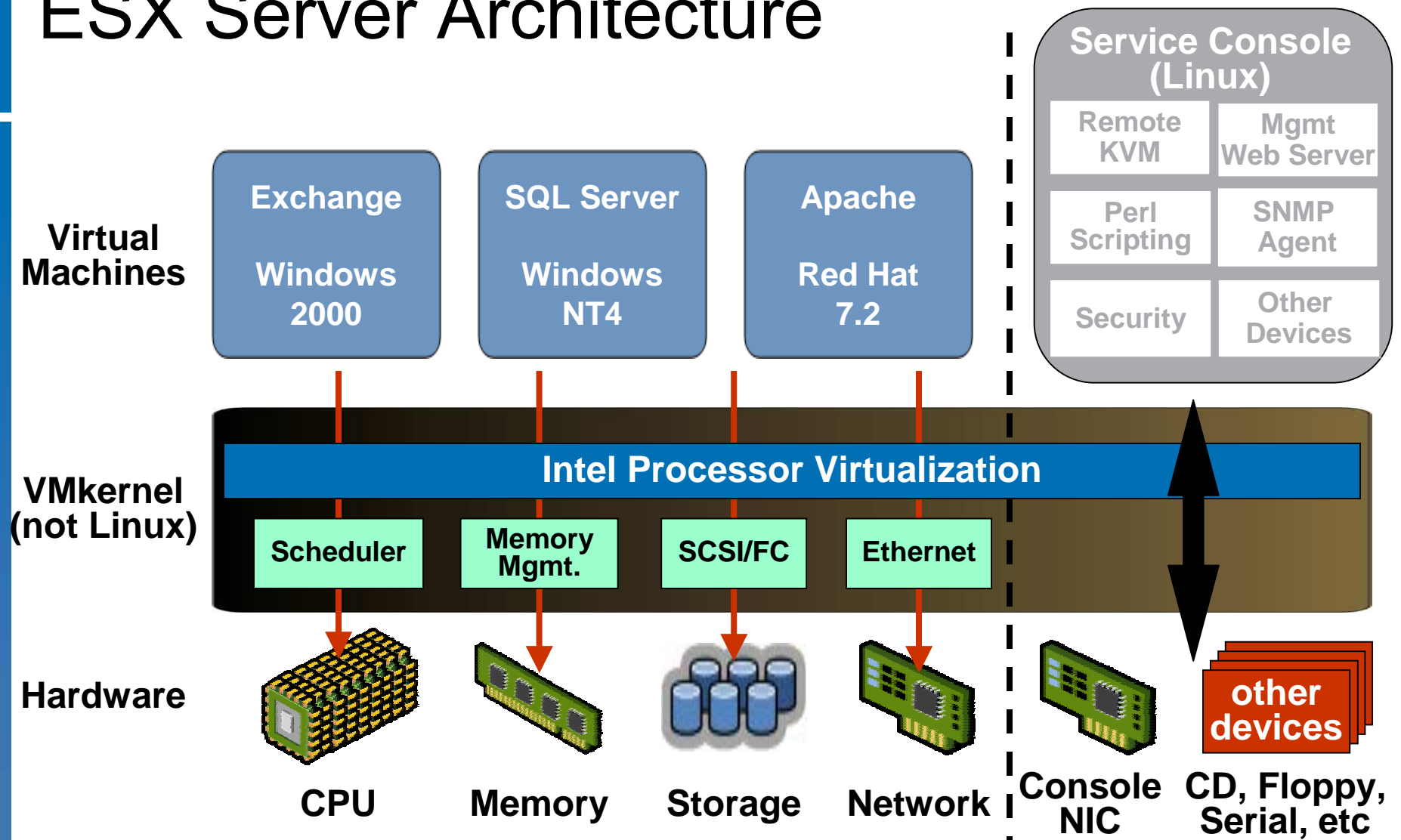
“Bare-Metal” (ESX Server)

- Maximum performance
- Lowest overhead
- Dynamic resource controls
- Virtual SMP

Workstation and GSX Server Architecture



ESX Server Architecture



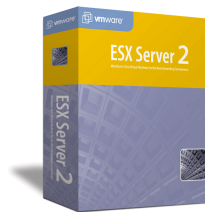
Comparing GSX and ESX Server...

VMware GSX Server



- Hosted on Windows or Linux
- Maximum hardware compatibility
- Up to 3.6GB RAM per Guest OS
- Up to 64 VMs per GSX Server
- Lower price point

VMware ESX Server



- Runs natively ("Bare-Metal")
- Maximum scalability and performance
- Up to 3.6GB RAM per Guest OS
- Up to 80 VMs per ESX Server
- Virtual SMP support
- Advanced memory management
- Dynamic resource allocation

VirtualCenter Overview

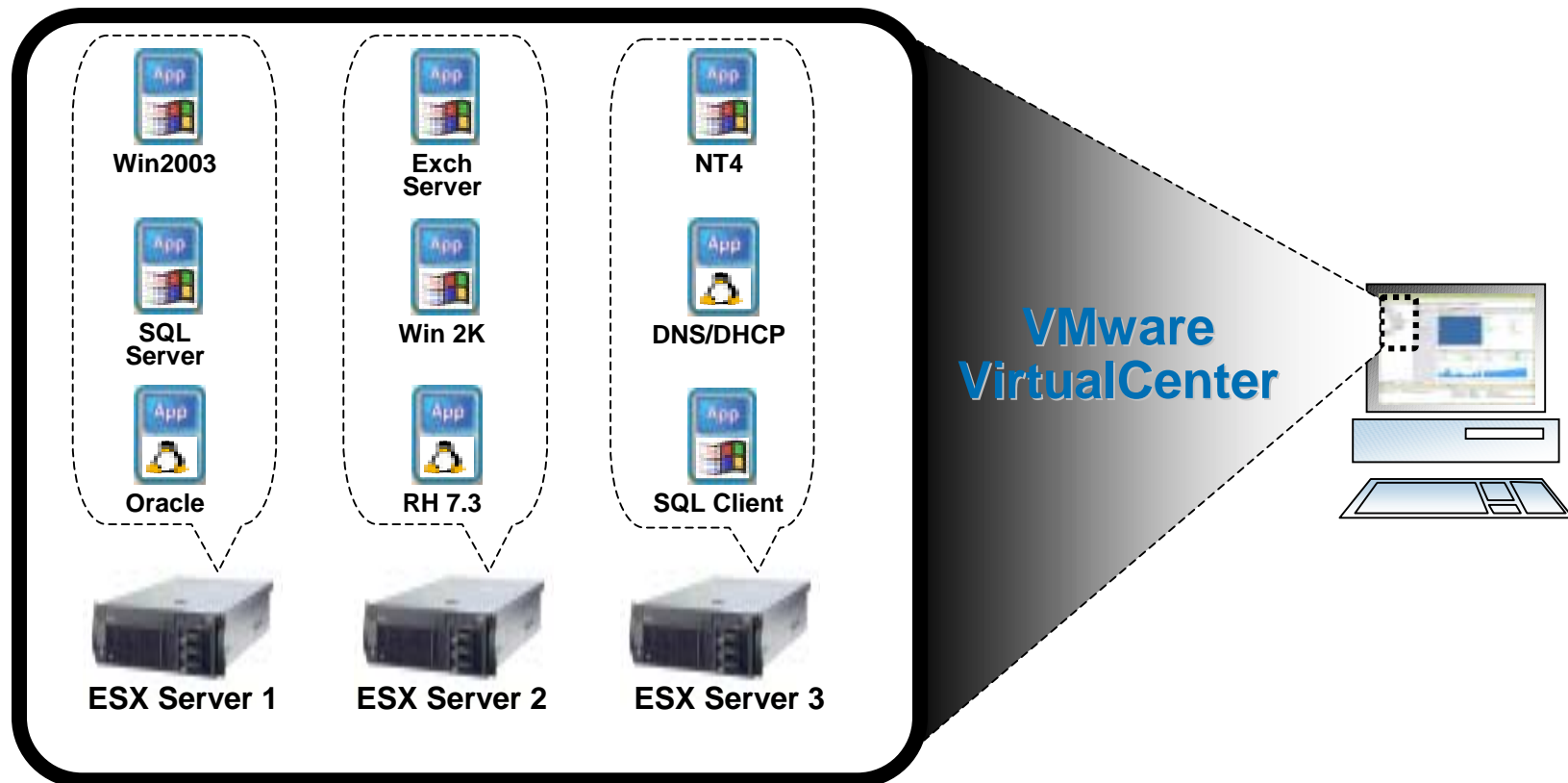
An enterprise solution for deploying and managing virtual machines across the data center.



- **Manage** Intel hardware as a single pool of computing resources.
- **Streamline** server provisioning and management.
- **Monitor** system availability and performance.
- **Move** workloads dynamically across distributed servers without service interruption.
- **Eliminate** scheduled downtime.

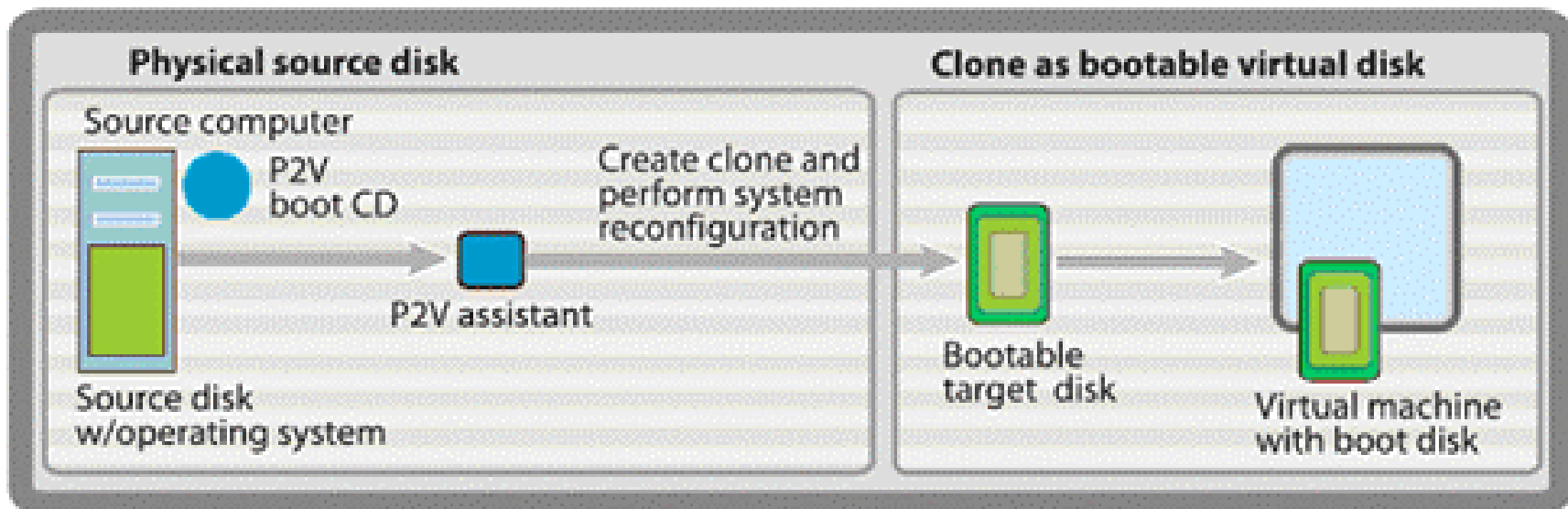
Centralized Management Console

Centrally manage a heterogeneous computing environment from a single graphical user interface.



VMware P2V Assistant

- Takes a snapshot of an existing physical system and transforms the physical server image into a VMware virtual machine. Simplifies conversion to a Server Virtualization environment



Resources...

- **Webinars – live and library of prior events**

<http://vmwareevents.webex.com>

- **Training**

<http://www.vmwaretraining.com>

- **Consulting Services**

<http://www.vmware.com/services/consulting.html>

- **Products**

<http://www.vmware.com/products>

Resources...

- **VMware from HP**

**[http://h18004.www1.hp.com/products/servers/
software/vmware/index.html](http://h18004.www1.hp.com/products/servers/software/vmware/index.html)**

- **Visit VMware booth in the expo hall**
- **Attend other VMware presentations and workshops at the event**
- **Visit the VMware web site**

<http://www.vmware.com>

- **Attend VMworld October 27-29 in San Diego**

<http://www.VMworld2004.com>



Resources...

- **ESX Server Support Information**
<http://www.vmware.com/support/esx21/>
 - Product Documentation and White Papers
 - Best Practices
 - Hardware Compatibility and Storage Information
 - Knowledgebase
- **Community forum at:**
<http://www.vmware.com/community>
- **Newsgroups at news.vmware.com**



Questions (can also be asked at VMware booth at Expo Hall...)

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Backup Slides... Detailed Information /
Frequently Asked Questions

Hosted vs. Bare-Metal Virtualization

Hosted

- Granularity of resource controls limited by design of underlying operating system.
- Security of any virtual machine is subject all all vulnerabilities of the underlying host operating system.
- Host operating systems are typically 10-40 million lines of complex error prone code.
- I/O of virtual machines must go through two protocol stacks that are not aware of each other.

“Bare-Metal”

- Enables fine-grained resource management of all major system resources.
- Micro-kernel virtualization layer is highly secure. There are no O/S services vulnerable to abuse.
- Virtualization layer of only 100K's of lines of code which enhances availability.
- Highly efficient direct I/O pass-through mimics mainframe architecture for both Network and Disk.

ISV Support of Software Running in a Virtual machine

- Kernel level Hardware drivers historically have been major source of instability to OS, including driver conflicts. VM has consistent hardware presented, regardless of true underlying hardware, there are far less variables, and greater stability.
- To most ISV's a VM is hardware, and looks just like a server. Most people don't ask if a given application will run on a particular model server.
- IBM, Veritas, BMC, CA, Novell, Oracle, and Citrix announcing their support for their Apps running in a virtual machine.

When to have an Application in a Separate Virtual Machine

- The more critical or sensitive the application, the greater the reason it should be isolated on a separate VM.
- You should not group VMs handling critical or sensitive data with applications that handle routine or unrestricted information.
- By isolating critical applications, restoration priority becomes more straightforward in the event of a disaster.

When to have an Application in a Separate Virtual Machine

- The more prone the application is to be security attacked, the greater the reason it should be isolated on a separate VM.
- The more complex the application, and/or the greater possibility of undesirable interactions with other applications, the greater the reason it should be isolated on a separate VM.

When to have an Application in a Separate Virtual Machine

- The more vulnerabilities that, historically, have been identified with an application, the greater the reason it should be isolated on a separate VM.
- Security applications, such as firewalls and Network-based IDS should be isolated on a separate VM.
- The greater the risk for data corruption, or the more inherently unstable the application, the greater the reason an application should be isolated on a separate VM.

When to have an Application in a Separate Virtual Machine

- Applications that have differing performance characteristics or resource utilization, should be isolated on a separate VM. This makes it easier to characterize and optimize resource requirements.

Leveraging Transparent Page Sharing

- Similarity of consolidated operating systems.
- Similarity of consolidated applications.
- Current RAM utilization.
- **Design tradeoffs** -The more of the same instances of the same application, the greater the potential for duplicate pages to be reclaimed by transparent page sharing. However, there is also a greater likelihood of the same limiting resource to become saturated. I.E. multiple VM's that have CPU intensive workloads.

How do you Access a VM?

- Remote Console software gives secure remote KVM access to the VM, as well as power and CD/DVD/Floppy drive access control.
- The CD/DVD drive access can be a physical drive, or an .iso file that can be mounted to be presented as if it were a CD/DVD. This can be on an ESX Server's local disk, SAN based disk, or network share. You can create a repository of OS and application installation disks, that can be easily accessed, shared and changed.

Server Provisioning and Deployment

- As a VM is portable, and tools exist to remove “Globally Unique” information, a library of VM based templates can be easily made that have patches, hot-fixes, organizational customization, and applications pre-installed.
- These templates can be easily deployed, dramatically reducing the time it takes to provision new servers, in some cases, shortening the time from weeks to minutes.
- These templates can also provide a foundation for restoration of backup tapes.

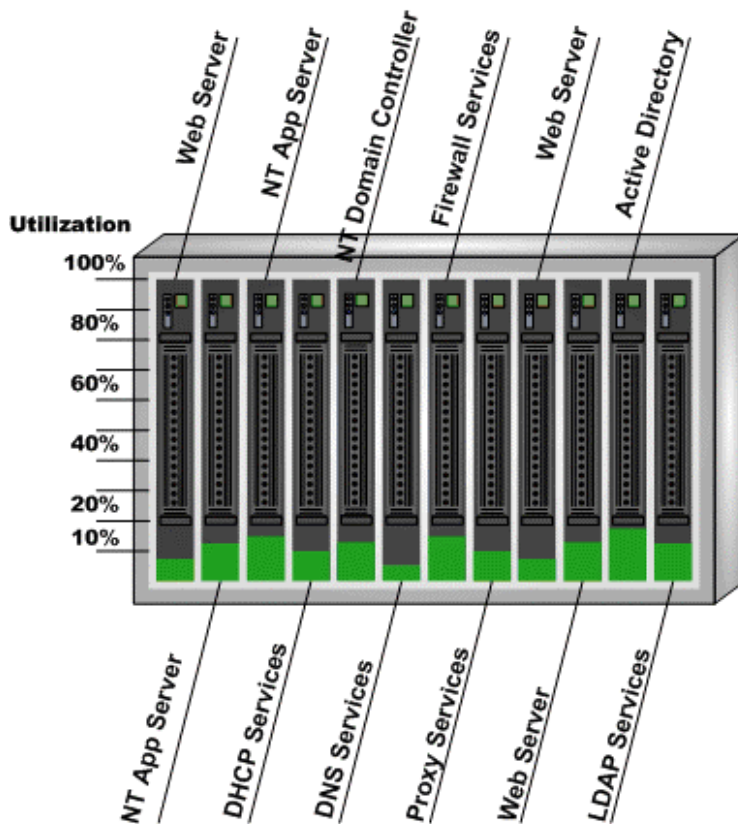
What's in a VM? (Windows example)



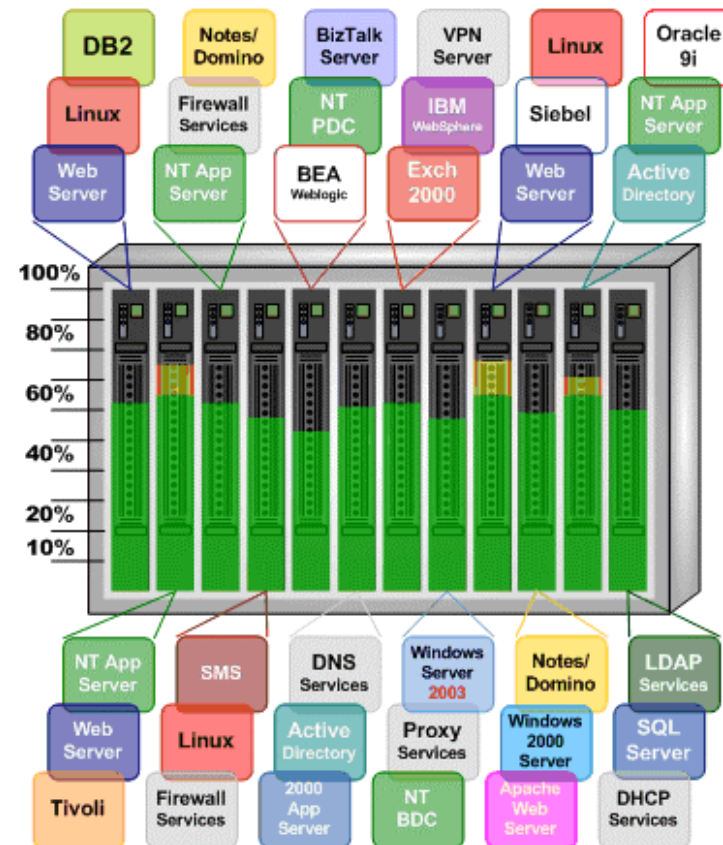
Increased System Utilization

Run Four Chassis Worth of Workloads on a Single Chassis

Blade Servers without VMware VirtualCenter



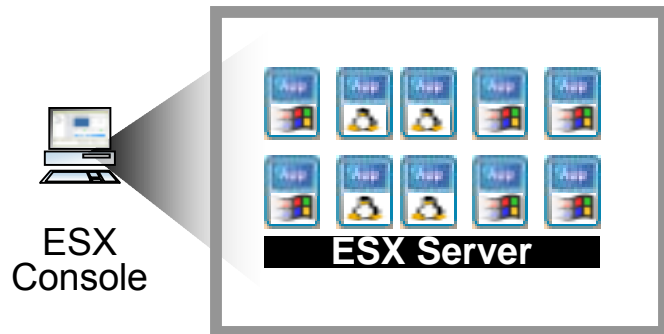
Blade Servers with VMware VirtualCenter



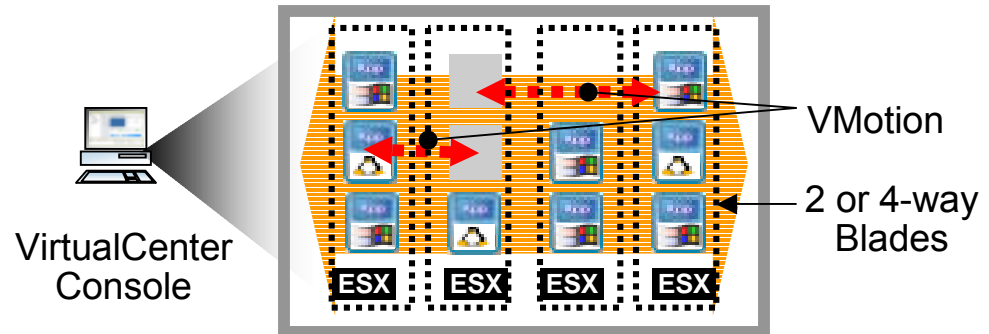
VMware on SMP and Blade Server Platforms

Same key benefits, differences in scale and flexibility

Large SMP

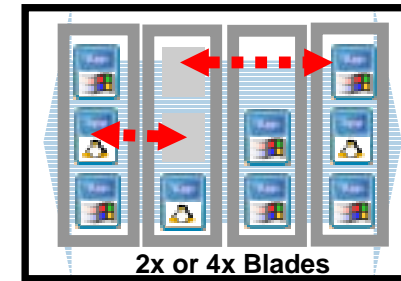
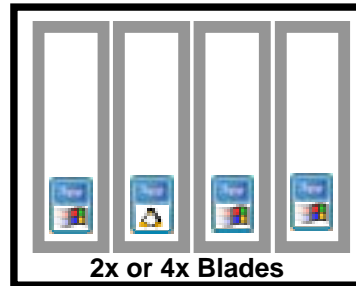


Blade Server



ESX Server on 4-16x SMP System	VirtualCenter w/VMotion on Blade Server
<p>Large single system image</p> <p>Automatic load-balancing of large number of VMs in same system</p> <ul style="list-style-type: none"> -Simplified resource sharing and management <p>Lower entry cost for smaller systems</p> <ul style="list-style-type: none"> -SCSI disk can be used 	<p>Greater resiliency and availability</p> <p>Multiple 2X/4X blade and ESX instances</p> <p>"Standby" blade within chassis for availability</p> <p>Modular scalability</p> <p>Increased scaling of memory and I/O capacity</p> <p>Blade form factor advantages</p> <p>Increased density, standardization, power efficiency</p> <p>Workload balancing with mixed blades</p> <p>e.g. temporarily migrate VM to higher performance blade to complete task more quickly</p>

VMware Multiplies Blade Server Benefits



BENEFIT	BLADES w/o VMware	BLADES & VIRTUALCENTER
SERVER DENSITY (# OF SERVERS IN 42U)	84 (2X)	168 - 508 (4-12X)
UTILIZATION	10-60%	50-80%
SERVICEABILITY (BLADE MAINTENANCE DOWNTIME)	1hr end-user downtime	ZERO end-user downtime
AVAILABILITY	N+N failover	N+1 failover
PROVISIONING TIME	<1 Hour	Minutes
CROSS-BLADE HOT MIGRATION	No	Yes

Hyperthreading and ESX Server

- Hyperthreading is used by default if present
 - Make sure HT is enabled in BIOS.
- VMkernel will schedule VMs intelligently
 - CPU-intensive Virtual CPU's will run in different Physical CPU's.
- VMs can be bound to Logical CPUs
 - On HT, CPUs 0 and 1 are really the two Logical CPUs in Physical CPU 0.
 - Caution! Don't bind, (by CPU affinity setting) busy VMs into the same Physical CPU.
- A VM can be isolated from Hyperthreading
 - Useful for CPU-intensive or cache-intensive workloads.

SAN Path Management Built-in ESX Server

The screenshot shows the VMware ESX Server 2.1.0 Storage Management interface in Microsoft Internet Explorer. The browser title is "esx112: Storage Management - Microsoft Internet Explorer". The address bar shows "VMware ESX Server 2.1.0 build-7653 | root@esx112.vmware.com". The navigation tabs are "Disks and LUNs", "Failover Paths", and "Adapter Bindings". The "Failover Paths" tab is active, showing a summary of the current state of paths from the system to SAN LUNs.

Storage Management: Failover Paths
Review the current state of paths from your system to SAN LUNs.

SAN LUN vmhba1:2:0 (4 Paths, Policy: mru)

Adapter : Target : LUN	SAN Target	Edit...
◆ vmhba1:2:0	50:06:01:68:10:20:AD:87	
◇ vmhba1:3:0	50:06:01:60:10:20:AD:87	
◇ vmhba2:2:0	50:06:01:68:10:20:AD:87	
◇ vmhba2:3:0	50:06:01:60:10:20:AD:87	

SAN LUN vmhba1:2:1 (4 Paths, Policy: mru)

Adapter : Target : LUN	SAN Target	Edit...
◆ vmhba1:2:1	50:06:01:68:10:20:AD:87	
◇ vmhba1:3:1	50:06:01:60:10:20:AD:87	
◇ vmhba2:2:1	50:06:01:68:10:20:AD:87	
◇ vmhba2:3:1	50:06:01:60:10:20:AD:87	



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