

Why Choose VMware?



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Introduction

When choosing a virtualization platform, it is important to ensure that you 1) realize all the promised benefits of virtualization, and 2) maximize your return on investment. A large number of providers now claim to offer virtualization solutions, but in actuality, only offer a hypervisor. How do you cut through the noise and determine who can actually deliver a complete shared services delivery platform versus just a hypervisor? Are all virtualization offerings basically the same? Should you just choose based on upfront software license costs?

As virtualization will quickly become an essential component of your overall IT strategy, answers to these questions are critical to ensure that you get a virtualization solution that can fully support you now and in the future, as your IT requirements evolve.

So, given that context, what is most important when picking between vendors?

From working with analysts, customers, and partners, it is apparent that companies need a solution that meets ALL of the following requirements:

1. Is built on a robust, proven foundation.
2. Delivers a platform for shared IT services.
3. Provides a complete solution for virtualization management.
4. Supports your entire IT infrastructure.
5. Is proven across tens of thousands of customer deployments.

As you will see, it quickly becomes clear that only VMware delivers on all of these important requirements. And best of all, VMware delivers while providing low total cost of ownership (TCO).

Start with a Robust and Reliable Foundation

All Hypervisors are Not Created Equal

"VMware is the clear and obvious leader in virtualization products. We tried both the Microsoft and Oracle virtualization products and found them lacking in features and performance compared to the VMware product."

— David Greer, Director of Information Services, HelioVolt Corporation

The hypervisor is the core foundation for a virtualized datacenter. Contrary to what many vendors who are new to virtualization would like the market to believe, the hypervisor is not a commodity. There are fundamental differences between hypervisors that will impact your experience with virtualization. Your choice of hypervisor will determine whether you are able to introduce virtualization into your IT environment successfully and fully realize the benefits of a virtual infrastructure. Select the most robust, production-proven hypervisor, otherwise you introduce unnecessary risk and overhead into your environment.

Learn how VMware ESX™ is—and will continue to be—the industry's most robust and production-proven hypervisor and why it is a better choice than other hypervisors.

Comparing ESXi and Microsoft Hyper-V

VMware ESX—the industry’s first “bare-metal” hypervisor for x86 systems—is the most reliable and robust virtualization platform. Launched in 2001 and now in its third generation, VMware ESX has been production-proven in tens of thousands of customer deployments all over the world. Other hypervisors are still “version 1.0” products, unproven in production datacenters and lacking core capabilities needed to deliver the reliability, scalability and performance that customers require.

So while others try to catch up to VMware in the areas highlighted below, upcoming VMware releases will take ESX to the next level of enterprise-class hypervisors—extending our lead further and ensuring that our customers obtain unparalleled levels of performance and reliability.

Table 1. A Comparison of Hypervisors

Hypervisor Attributes	VMware ESX	Microsoft Hyper-V 1.0
Small Disk Footprint	✓ 32MB disk footprint (VMware ESXi)	✗ 2.6GB with mandatory Server Core installation
OS Independence	✓ No Console OS (VMware ESXi)	✗ Relies on Windows 2008
Hardened Drivers	✓ Optimized with hardware vendors	✗ Generic Windows drivers
Advanced Memory management	✓ Ability to reclaim unused memory, de-duplicate memory pages	✗ No ability to reclaim unused physical memory
Advanced Storage Management	✓ VMware vStorage VMFS	✗ Lacks an integrated clustered file system
High I/O Scalability	✓ Direct driver model	✗ I/O bottleneck in parent OS
Host Resource Management	✓ Network traffic shaping, Storage I/O priorities, per-VM resource shares	✗ Lacks similar capabilities
Performance Enhancements	✓ AMD RVI, large memory pages, universal 4-way vSMP, VMI paravirtualization	✗ No AMD-RVI, no large memory pages, 4-way vSMP on Windows 2008 VMs only
Virtual Security Technology	✓ VMware VMsafe™ security API	✗ Nothing comparable

Hyper-V, Xen and KVM: Too Much Code

When it comes to virtualization, smaller is better. A smaller virtualization footprint reduces the attack surface for external threats and can drastically lower the number of patches required—both result in a more reliable product and a more stable datacenter.

As part of VMware's ongoing focus to advance virtualization reliability, VMware created VMware ESXi, the industry's smallest hypervisor and first complete x86/x64 virtualization architecture with no dependence on a general-purpose operating system. No other virtualization platform can match the compact size of VMware ESXi with its small disk footprint of 32MB. It removes all the patches that would normally need to be applied to and the security risks associated with a general-purpose server operating system. Microsoft Hyper-V, Xen and KVM all have architectures that depend on a general-purpose server operating system, linking the reliability of their hypervisors to that of the respective general-purpose server operating system.

Microsoft attempted to follow VMware's lead to reduce the attack surface of its virtualization platform by offering Windows Server Core (a subset of Windows Server 2008) as an alternative parent partition to a full Windows Server 2008 install. However, the disk footprint of Server Core in its virtualization role is still approximately 2.6GB. Until Microsoft changes its virtualization architecture to remove its dependency on Windows, it will remain large and vulnerable to Windows patches, updates, and security breaches. All of the proprietary Xen-based offerings, such as those from Citrix, Oracle, Red Hat, Novell and Virtual Iron face similar issues by relying upon general-purpose Linux operating systems as a core part of their virtualization architectures.

Achieve Better Scalability and Performance in your Data Center

The hypervisor plays a key part in delivering scalable virtualization performance. Detailed performance demonstrations and comparisons clearly demonstrate that VMware ESX achieves high-performance throughput in a heavily virtualized environment, even as the number of total supported users and virtual machines per physical host increases.

How Fast Can VMware ESX Go? 100,000 IOPS and More!

I/O is one of the most critical performance bottlenecks in virtual environments, but even the most I/O-intensive applications run fast on VMware ESX. The result is that end users have no idea that their applications are being served from a virtual environment—any latency or overhead is usually imperceptible to the end-user. A recent test conducted by VMware with the EMC Midrange Partner Solution Engineering Team, showed that a single ESX host is capable of driving over 100,000 IOPS, maxing out the throughput of 500 disk drives in a SAN. To put this into perspective, you would need to run 200,000 Microsoft Exchange mailboxes (LoadGen heavy user profile) to generate an I/O rate of 100,000 IOPS. With that kind of performance power available, even your most demanding workloads can be virtualized.

Other vendors have tried to show-off their I/O performance, but their test results have been criticized due to suspect test configurations not based on real world virtualization scenarios. They also unrealistically limit tests to only one or two virtual machines to avoid their scaling weaknesses.

So then the question arises, why does ESX scale and perform so much better than other vendors' offerings. There are a number of reasons, as articulated in a recent VMware article, "A Look at Some VMware Infrastructure Architectural Advantages." Two main reasons are the 1) VMware ESX direct driver model, and 2) its more effective management of memory.

Advantages of the Direct Driver Architecture

The VMware ESX direct driver model utilizes certified and hardened I/O drivers in the VMware ESX hypervisor. These drivers must pass rigorous testing and optimization steps performed jointly by VMware and the hardware vendors before they are certified for use with VMware ESX. With the drivers in the hypervisor, VMware ESX can provide them with the special treatment, in the form of CPU scheduling and memory resources, that they need to process I/O loads from multiple virtual machines. Conversely, the Xen and Microsoft architectures rely on routing all virtual machine I/O to generic drivers installed in the Linux or Windows OS in the hypervisor's management partition. These generic drivers can be overtaxed by the activity of multiple virtual machines. Hyper-V and Xen both use generic drivers that are not optimized for multiple virtual machine workloads.

VMware investigated the indirect driver model, now used by Xen and Hyper-V, in early versions of VMware ESX and quickly found that the direct driver model provides much better scalability and performance as the number of virtual machines on a host increases.

Better Memory Management for Scalability

In most virtualization scenarios, system memory is the limiting factor controlling the number of virtual machines that can be consolidated onto a single server. By more intelligently managing virtual machine memory use, VMware ESX can support more virtual machines on the same hardware than any other x86 hypervisor. Of all x86 bare-metal hypervisors, only VMware ESX supports memory overcommit, which allows the memory allocated to the virtual machines to exceed the physical memory installed on the host. VMware ESX supports memory overcommit with minimal performance impact by combining several exclusive technologies.

Content-based transparent memory page sharing conserves memory across virtual machines with similar guest operating systems by seeking out memory pages that are identical across the multiple virtual machines and consolidating them so they are stored only once, and shared. Depending on the similarity of operating systems and workloads running on a VMware ESX host, transparent page sharing alone can typically save anywhere from 5 to 30 percent of the server's total memory by consolidating identical memory pages.

If all virtual machines on a host spike at the same time and require all of their memory allocation, VMware DRS can automatically load balance by performing live migrations of virtual machines to other hosts in a VMware Distributed Resource Scheduler (DRS) cluster using VMware vMotion™ technology.

Why File Systems Matter

Virtual machines are fully encapsulated in virtual disk files that are either stored locally on the VMware ESX host or centrally managed using shared SAN, NAS or iSCSI storage. A benefit of shared storage is that it allows virtual machines to be migrated easily across pools of hosts—and VMware Infrastructure 3 simplifies use and management of shared storage with the VMware vStorage Virtual Machine File System (VMFS). With VMFS, a resource pool of multiple VMware ESX servers can concurrently access the same files to boot and run virtual machines, effectively virtualizing the virtual machine storage. The ease of storage management using VMware vStorage VMFS has been a huge financial boon to VMware's storage partners as it has clearly shown to customers the value proposition of shared storage when virtualizing their datacenters.

While conventional file systems (like Microsoft's NTFS) allow only one server to have read-write access to the file system at a given time, VMFS is a high-performance cluster file system that allows multiple VMware ESX hosts read-write access to the same virtual machine storage, concurrently.

VMFS gives VMware Infrastructure 3 a distributed systems orientation that distinguishes it from our competition. VMware DRS and VMware High Availability (HA) features rely on the ability to aggregate the processing, storage and network capacity of multiple hosts into a single pool or cluster upon which virtual machines are provisioned. The VMFS file system enables this capability. VMFS allows multiple hosts to share access to the virtual disk files of a virtual machine for live migrations with VMware vMotion and rapid restart while managing distributed access to prevent possible corruption. For times when customers need direct access to capabilities that are specific to their storage array, they can use a raw device mapping (RDM) instead VMFS for those virtual machines.

Our competition is just now rolling out first-generation hypervisors with a single-node orientation. Those products lack the distributed system features such as resource pooling, and they rely on conventional clustering for virtual machine mobility and failover. Their clustering technologies are difficult to configure and they require dedicating a LUN to each virtual machine for independent operations, meaning either 1) maintaining one virtual machine per LUN—a management nightmare or 2) if multiple virtual machines are stored on a single LUN, all those virtual machines must failover concurrently—neither case is ideal. Our competition advocates purchasing a third-party cluster file system to address this issue, but that introduces more complexity, validation, and cost into your environment.

An Ecosystem of Virtualization Security Solutions

With VMware VMsafe, you gain access to a rich ecosystem of third-party security solutions for virtualized environments. VMware is the first and only virtualization vendor to introduce this open security framework that is fully integrated with its virtualization platform.

- Choose from best-of-breed security solutions from all major security vendors, fully integrated with VMware Infrastructure capabilities such as VMware vMotion, VMware Storage vMotion, VMware DRS and VMware HA.
- Get fine-grained visibility over virtual machine resources and monitor every aspect of the execution of the system.
- Stop previously undetectable viruses, rootkits and malware before they can infect a virtualized system.
- Protect your assets better in a virtual environment than you could on physical counterparts with security capabilities not available on physical environments.

As for our competition, they currently do not offer anything comparable.

Industry Recognition for VMware

The reliability of VMware products and the company's overall leadership is being recognized by press and analysts alike.

Among the hundreds of awards given to VMware products over the past several years, one stood out regarding reliability. Redmond Magazine recently awarded VMware ESX the top spot in the "most reliable" category of its 2008 Editors' Choice Awards for all IT products.

- Redmond Magazine: Most Reliable Category of 2008 Editors' Choice Awards
"The least stable part of ESX is usually the administrator. The code is virtually bomb-proof."

Also, a recent Taneja Group report also espoused the reliability of VMware ESX:

- Taneja Group: Architectural Requirements for a Datacenter-Ready Virtualization Platform
"Of all the OS and hardware based virtualization platforms that are currently competing for end user attention and investment, the VMware hypervisor architecture comes the closest to meeting the standards for data center readiness. VMware ESX Server 3i aspires to deliver the reliability, security and performance of native hardware, which makes it a compelling choice for enterprise use."

Independent press and bloggers are also reporting on VMware's leadership and advantages:

- eWeek Channel Insider: VARs Choose VMware for Server Virtualization
"Solution providers say VMware wins by a landslide when it comes to server virtualization..."
- CRN: Partners: Microsoft Still Trailing In Virtualization
"I don't believe Microsoft will have a true competitor to ESX Server for at least another year, and it will certainly still be missing features which ESX Server has."
- TechTarget blog: VMware Superiority Doesn't End With its Hypervisor
"...it appears to me that VMware has a pretty good strategy, focus and direction for staying ahead of the competition."
- Network World: Microsoft a Distant Third in Mock Debate on Virtualization
Debate outcome: "VMware's going to win the virtualization battle, and Microsoft won't even be its nearest competitor."

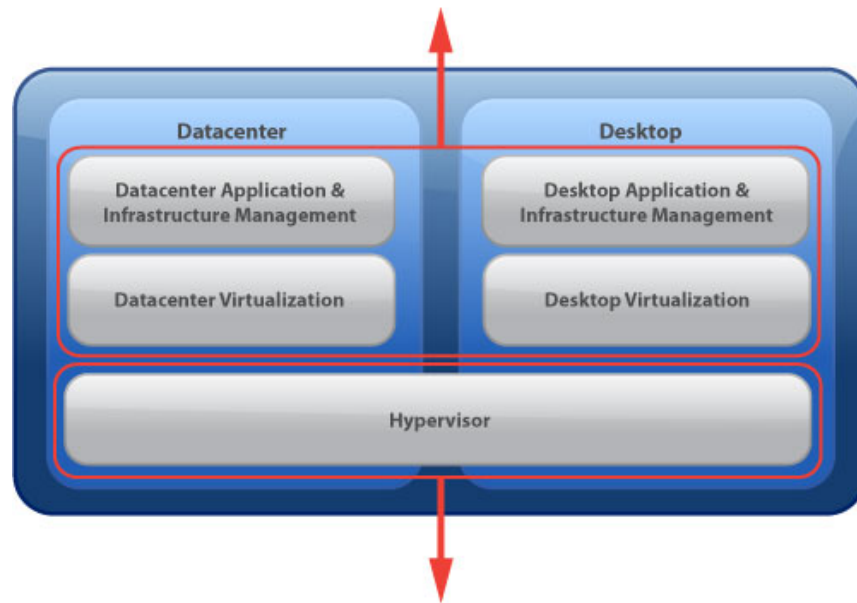
Shared IT Services Platform for Your Applications

Application Platform for Your Business Needs

While a reliable, industry-proven hypervisor is the critical foundation for any virtualization deployment, it does not constitute a complete virtualization solution by itself. Companies need an overall "shared IT services platform" for running their applications. This platform must have built-in aggregation, migration, allocation, power management and availability services. Only VMware Infrastructure 3 delivers all of these built-in services for a shared IT services platform. Other offerings are incomplete and fall short of delivering the entire platform.

As Figure 1 illustrates, VMware Infrastructure 3 delivers aggregation, migration, allocation, power management, and availability services that are critical for running business applications in a virtual datacenter.

Choose a vendor who delivers a **platform for shared devices delivery.**



Important foundation, but not enough.

Figure 1. VMware Infrastructure as a Platform for Shared IT Services

Live Server and Storage Migration: Transparent Agility

"I wouldn't put my mission-critical systems on a virtualization solution like Microsoft Hyper-V, which is dependent on an operating system. We all know the track record of operating systems with patches and vulnerabilities. And other virtualization products lack the complete toolset that you get from VMware, including capabilities like live migration. The tools that VMware offers allow us to be more productive, as well as offer higher SLAs to our application owners. We couldn't do without it."

— Tom Gibaud, Manager of Information Technology, ViaHealth / Rochester General Hospital

Virtualization without live migration limits how dynamic and agile your IT can really be because it is a core enabler for a shared IT services platform. It eliminates all application downtime and visible disruptions to the end-user when virtual machines are moved from one server to another or from one storage array to another.

VMware invented live virtual machine migration with VMware vMotion in 2003 and datacenters have never been the same since. In 2006, VMware further extended our leadership by releasing Storage vMotion, which enables live migration of virtual machine files from one storage array to another with no visible interruptions. With the high attach rate of shared storage to virtualized servers, transparent migration of virtual machine files from one array to another is critical. No other virtualization platform vendor delivers anything comparable to VMware Storage vMotion today.

With VMware vMotion and VMware Storage vMotion, IT administrators can perform crucial tasks such as planned maintenance and automated load balancing during normal business hours. There is no further need for costly overtime pay (evenings, weekends) or hours spent scheduling maintenance windows with application owners. Workers stay productive without any disruption to their day-to-day work, and IT administrators get their nights and weekends back.

Figures 2 and 3 illustrate two examples of how VMware vMotion and VMware Storage vMotion can save \$58,500 and \$68,750 (per year) respectively, in an IT environment with 150 virtual machines.

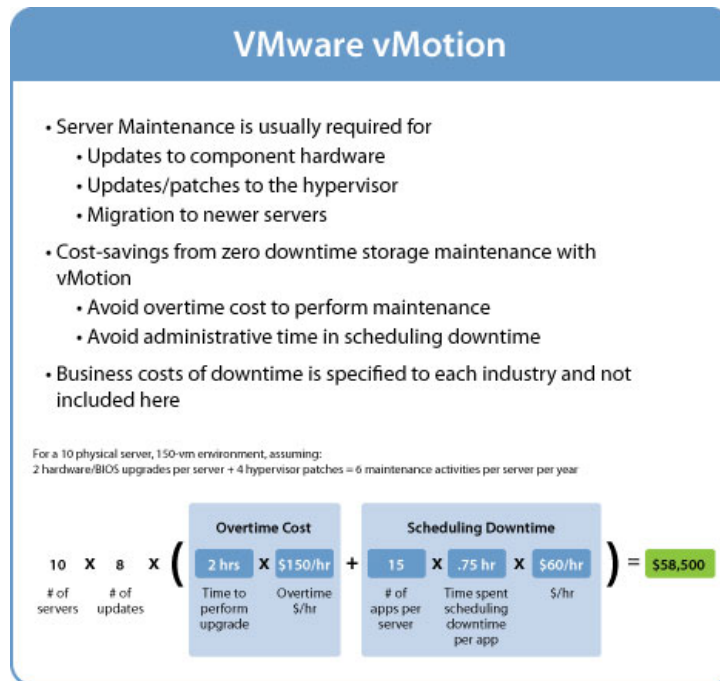


Figure 2. Saving Money with VMware vMotion

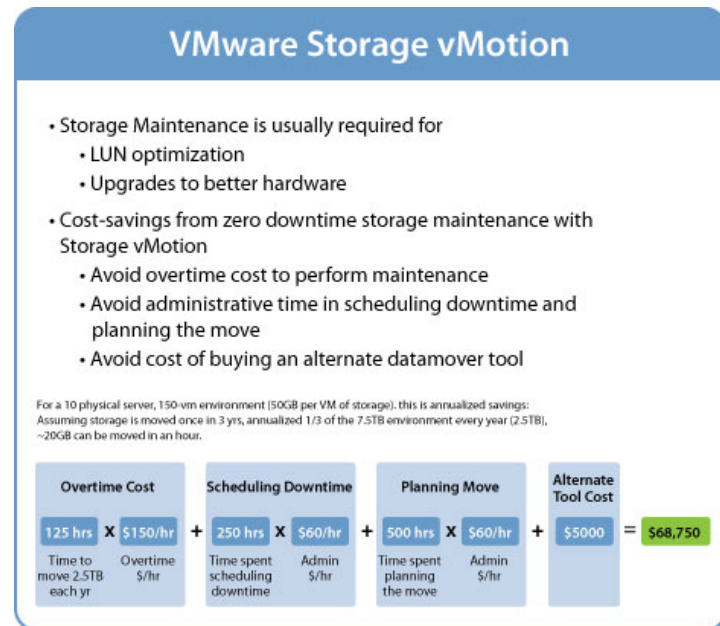


Figure 3. Saving Money with VMware Storage vMotion

Microsoft Hyper-V lacks both server-to-server and array-to-array live migration capabilities and therefore cannot eliminate application downtime. To enable hardware maintenance, virtual machine migrations with Microsoft’s platform must be scheduled after business hours or during weekends (overtime) to minimize impact to the end-users.

Without live migration, a basic, common task such as planned maintenance of servers and shared storage creates unacceptable end-user disruptions. See an example of this disruption as caused by Microsoft’s Quick Migration—a Microsoft virtual machine migration offering that involves downtime.

Table 2. A Comparison of Platforms for Shared IT Services

Features	VMware Infrastructure 3.5	Microsoft Hyper-V with SCVMM	Citrix XenServer 5.0 with XenCenter
Live Virtual Machine Migration for Zero Application Downtime	✓	⊘	✓
Zero Application Downtime 'Maintenance Mode' for Patching Servers	✓	⊘	✓
Maintenance Mode with Dynamic Workload Placement	✓	⊘	⊘
Maintenance Mode with Flexible Automation Rules	✓	⊘	⊘
Live Storage Migration	✓	⊘	⊘

Aggregation: Transform Isolated Resources into Shared Pools

VMware Infrastructure aggregates compute resources from farms of physical servers, storage, and network into logical resource pools that maximize efficiency and utilization. Without this ability to aggregate into logical pools, companies end up with silos of resources even after they have virtualized and performed server consolidation.

Only VMware provides a resource pool model that self-manages and self-optimizes the physical resources while enabling IT to carve out, allocate and delegate responsibility for logical resources to different constituents according to their resource needs.

- VMware Resource Pools (part of VMware vCenter Server) create shared logical pools of CPU and memory resources within a VMware DRS cluster that guarantee a level of resources for specific groups of users. They can be flexibly added, removed or reorganized as business needs or organizations change. There is isolation between resource pools so that changes within one resource pool do not impact other unrelated pools. No other offering provides this type of logical resource pools. Citrix has a capability it calls “resource pools,” but it only does batch configuration changes to a set of virtual machines—there is no capability to allocate shared resources.
- VMware vStorage VMFS leverages shared storage to allow multiple instances of VMware ESX to read and write to the same storage, concurrently. It allows you to greatly simplify virtual machine provisioning and administration by efficiently storing the entire virtual machine state in a central location. Most other offerings do not include a clustered file system in their virtualization offering—customers would need to purchase it from a third party.
- VMware DRS ensures that resource utilization is maximized while business units retain control and autonomy of their infrastructure.

Allocation: Elastic Pool of Resources

Automated workload balancing within shared pools of resources delivers optimized resource usage. This ensures that companies get full utilization from their resources and that the right resources are available when needed.

VMware DRS continuously monitors utilization across resource pools and intelligently aligns resources with business needs, enabling you to:

- Dynamically allocate IT resources to the highest priority applications. Create rules and policies to prioritize how resources are allocated to virtual machines.
- Give IT autonomy to business organizations. Provide dedicated IT infrastructure to business units while still achieving higher hardware utilization through resource pooling.
- Empower business units to build and manage virtual machines within their resource pool while giving central IT control over hardware resources.

" With [VMware] DRS, we are able to free up the VI team so they can work on other projects. "

— Fazil Habibulla, Vice President and Systems Engineer at Natixis Capital Markets

Live migration is required for this IT service because it must be transparent to end-users. VMware DRS is totally transparent to end users because it uses VMware vMotion to move virtual machines within the cluster. Any other offering that attempts automated workload balancing without live migration will disrupt end-users, making the capability unusable.

Microsoft and Citrix do not have capabilities that are comparable to VMware DRS. Therefore, IT administrators have two options to balance their workload across the virtual environment, both of

which increase complexity and cost. First, IT administrators could run their servers at lower utilization rates (i.e., more spare headroom) to accommodate spikes in usage. But this option means purchasing more hardware and licenses. Alternatively, IT administrators could manually monitor each server and manually load balance virtual machines. This option pulls IT administrators away from other higher value work, resulting in lower IT admin productivity and higher operational costs.

Figure 4 illustrates an example of how VMware DRS can save \$40,000 per year in an IT environment with 150 virtual machines.

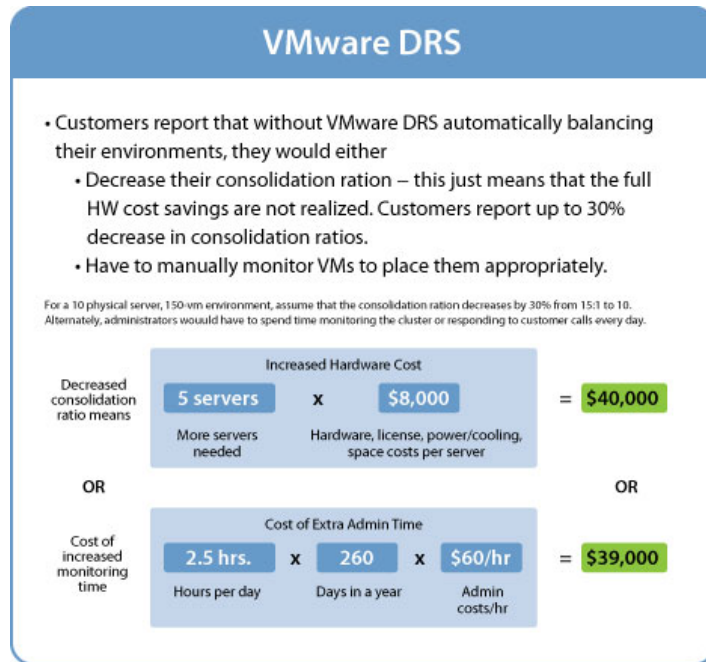


Figure 4. Saving Money with VMware DRS

Table 3. A Comparison of Dynamic Resource Allocation Capabilities in Virtualization Platforms

Features	VMware Infrastructure 3.5	Microsoft Hyper-V with SCVMM	Citrix XenServer 5.0 with XenCenter
Continuously Monitors Utilization Across Resource Pools	✓	⊘	⊘
Utilizes Live Migration for Zero Downtime, Automated Load Balancing	✓	⊘	⊘
Hierarchical Resource Pools	✓	⊘	⊘
Isolation Between Resource Pools	✓	⊘	⊘
Affinity Rules	✓	⊘	⊘
Maintenance Mode for Servers	✓	⊘	✓
Recommends Host for Initial Virtual Machine Placement	✓	✓	✓

Power Management: Intelligently Save Power

VMware Distributed Power Management (DPM) continuously monitors resource requirements across a VMware DRS cluster, consolidates workloads, and powers down unused servers to reduce overall power consumption. This capability extends cost savings via power consumption beyond what users can obtain from simple server consolidation.

Based on user-defined policies, VMware DPM monitors a VMware DRS cluster and verifies whether service level agreements (SLAs) could be met at a lower power consumption rate. When an application workload increases, VMware DPM re-activates the suspended hosts. Neither Microsoft nor Citrix can deliver anything close to this level of flexibility.

Availability: Flexible, Uniform High Availability

"The university has virtualized 50,000 Exchange 2007 mailboxes on VMware Infrastructure. We not only have a more manageable and flexible Exchange environment, but we have replaced Microsoft clustering with built-in capabilities such as VMware HA and VMware vMotion. We couldn't be happier with the uptime and performance of our Exchange implementation on VMware."

— Adrian Jane, Infrastructure and Operations Manager, University of Plymouth

A shared IT services platform needs to improve application availability by providing capabilities to protect against planned infrastructure downtime and provide resilience to unplanned downtime across all aspects of the hardware – server, component, storage, network and software. As illustrated in Figure 5, VMware does this best with its wide range of capabilities to protect applications from:

- Planned infrastructure downtime (VMware vMotion, Storage vMotion).
- General application protection from unplanned infrastructure downtime (NIC teaming, multipathing, VMware HA, VMware Consolidated Backup, VMware vCenter Site Recovery Manager).
- Unplanned application downtime (via virtual machine failure monitoring in VMware HA).

	Minimize planned outages	Prevent unplanned outages
Component	NIC Teaming, Multipathing	NIC Teaming, Multipathing
Server	VMware DRS with Maintenance Mode vMotion	VMware HA
Storage	Storage vMotion	VCB
Data	N/A	VCB
Site	Site Recovery Manager	Site Recovery Manager

All independent of physical hardware, operating system, and application

Figure 5. VMware Technologies for Business Continuity

The inherent reliability of VMware ESX is also a big factor here, ensuring that no new risks are introduced into the environment because of the hypervisor.

VMware HA provides cost-effective high availability for any application running in a virtual machine without the cost or complexity of traditional clustering offerings like Microsoft Clustering Services (MSCS). Regardless of the guest operating system or underlying hardware configuration, VMware HA provides protection across your entire virtualized IT environment. It eliminates the need for dedicated stand-by hardware.

Other virtualization vendors cannot deliver this pervasive, failover protection as an integrated capability of their virtualization platform. VMware HA is a simple, scalable and cost-effective solution for high availability in virtual environments.

- VMware HA is a more scalable solution than clustering options, making it suitable for an organization's entire infrastructure. VMware HA can now support up to 32 nodes in a cluster (vs. the 16 of Windows Server 2008 Cluster Server 64-bit), improving availability for critical applications by scaling across a larger number of VMware ESX hosts.
- VMware HA is a more flexible solution and avoids the storage management complexity inherent in Microsoft's clustering solution. Because VMware HA is built on VMFS clustered file system capabilities, users can safely run HA on virtual machines that are mapped on the same shared storage LUN. Each virtual machine can be restarted independently without affecting the other virtual machines on that same LUN. Microsoft MSCS restarts all the virtual machines on a LUN, even if not all of them are located on a failed host, forcing users that want to have high availability to provision one LUN for each virtual machine they deploy. This limitation has a negative impact on storage administration and consumption, making management substantially more complex and reducing administrators' productivity as the number of virtual machines grows.

- Unlike Citrix, which requires users to purchase additional, expensive third-party software (Marathon), VMware HA is fully integrated with vCenter Server and is included in Virtual Infrastructure, Standard Edition.

Figure 6 illustrates an example of how VMware HA can save \$60,000 per year in an IT environment with 150 virtual machines.

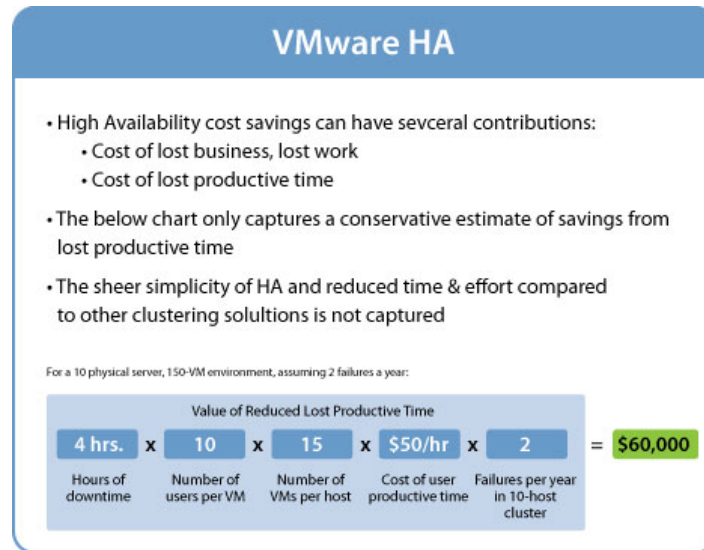


Figure 6. Saving Money with VMware HA

Complete Virtualization Management

From Provisioning to Data Disaster Recovery

No other virtualization platform vendor provides the breadth of management solutions for virtualization that VMware can offer. Only VMware provides a comprehensive solution for management of the virtual infrastructure over the entire life cycle of the virtual machine. Best of all, our management solutions integrate with your existing systems management tools so you can use what you already have and get a “single pane of glass” for physical and virtual machine management.

Centrally Manage Thousands of Virtual Machines

VMware vCenter Server can centrally manage hundreds of VMware ESX hosts and thousands of virtual machines, delivering operational automation, resource optimization and high availability to IT environments. Using a single Windows management client for all tasks, administrators can provision, configure, start, stop, delete, relocate and remotely access virtual machines with keyboard and mouse control. The VMware vCenter Server client is also available in a Web browser implementation for access from any networked device. The browser version of the client makes providing a user with access to a virtual machine as easy as sending a bookmark URL.

Others offer either incomplete solutions or require a customer to deploy, configure, manage multiple applications—often from third parties—and often just to obtain a subset of the functionality available in VMware vCenter Server.

VMware vCenter Server delivers the highest levels of simplicity, efficiency, security and reliability to manage small and large virtualized IT environments including:

- Centralized management
- Performance monitoring
- Operational automation
- Clustering and pooling of physical server resources
- Rapid provisioning
- Secure access control
- Full SDK support for integrations

Table 4. A Comparison of Integrated Virtual Infrastructure Management Features

Features	VMware Infrastructure 3.5 with vCenter Server	Microsoft Hyper-V with SCVMM	Citrix XenServer 5.0 with XenCenter
Integrated P2V Tool	✓	✓	No live P2V
Integrated V2V Tool	✓	Can import VMDK	⊘
Virtual Machine Clones	✓	✓	⊘
Provisioning from Virtual Machine Templates	✓	✓	✓
Automated Guest Customization	✓	Windows only	⊘
Virtual Appliance Marketplace	✓	⊘	⊘
Centralized Server Configuration	✓	✓	✓
Centralized License Management	✓	⊘	⊘
SQL Management Database	✓	✓	⊘
Web Management Client	✓	⊘	⊘
Advanced CPU Resource Controls	✓	✓	⊘
Network Bandwidth Resource	✓	⊘	✓

Controls			
Customizable Alarms	✓	Requires SCOM	✓
Customizable Tasks	✓	Requires SCOM	⊘
Event Logging	✓	✓	✓
Performance Monitoring	✓	Requires SCOM	Basic
Resource Topology Maps	✓	⊘	⊘

Quickly Add New Server Resources for Better Provisioning

VMware ESX and VMware DRS make it quick and simple to add new server resources to a virtualized datacenter. VMware ESXi comes embedded on new servers so you can purchase an virtualization-ready server and have it up and running in minutes. Pull the new server out of the box, plug in network and power cables, power it on, and walk through a few simple set-up screens. VMware vCenter Server will automatically detect the new server and add it to the existing VMware DRS cluster. VMware DRS begins to migrate live virtual machines to the new server according to SLAs defined by IT or business owners.

Without the ability to easily add server resources, IT administrators would spend lots of time manually configuring each new server, causing significant delays in getting business units the computing resources they need.

Manage the Entire Software Life Cycle with VMware IT Services Solutions

VMware provides a set of management and automation products that work together with VMware Infrastructure 3 to manage IT service delivery across the entire software life cycle. The products include developing, staging, deploying, updating and retiring IT services. Users of other virtualization platform vendors must rely on third-party products.

- Implement a consistent and automated process for requesting, approving, deploying, updating and retiring virtual machines with VMware vCenter Lifecycle Manager.
- Streamline the rollout of new and updated IT services from pre-production to production with VMware vCenter Stage Manager.
- Support development and QA teams with fast and simple self-service provisioning, including a library of multitier environments, while retaining control over infrastructure and policies with VMware vCenter Lab Manager

All three solutions integrate with VMware vCenter Server so you can monitor all virtual machine activity in the virtual datacenter. No other virtualization platform vendor delivers this breadth of integrated virtualization management capabilities.

- Microsoft's offering for development and QA teams, a self-service portal included with System Center Virtual Machine Manager (SCVMM), provides only a fraction of VMware vCenter Lab Manager capabilities, and is poorly integrated with the rest of Microsoft Systems Center. To access, users must navigate from SCVMM to an entirely different web-based user interface. Even then, the Microsoft SCVMM portal supports only basic virtual machine creation and management, not the VMware vCenter Lab Manager features such as multi-machine configurations, virtual machine templates, user and group resource controls, graphic monitoring tools, and network fencing—all essential to support active software development and test environments.

- Microsoft's SCVMM library feature is very rudimentary compared with the features of the VMware vCenter Lab Manager configuration library and the media library.
- Neither Microsoft nor the Xen vendors (Citrix, Virtual Iron, Red Hat, Novell) offer any solutions comparable to VMware vCenter Lifecycle Manager or VMware vCenter Stage Manager. Third-party products would be required to supplement what's lacking in Microsoft and Xen core offerings.

Table 5. A Comparison of Application and Infrastructure Management Tools

Features	VMware Infrastructure 3.5 with IT Services Delivery suite	Microsoft Hyper-V with SCVMM	Citrix XenServer 5.0 with XenCenter
Lab Management Automation Tool	✓ Lab Manager	Only basic self-provisioning with SCVMM Self-Service Portal	Third-party
Virtual Machine Life Cycle Automation Tool	✓ Lifecycle Manager	⊘	Third-party
Automated Release Management Tool	✓ Stage Manager	⊘	⊘

Automate Data Disaster Recovery

"We use VMware software all over our company, and it has saved each individual area time, money and resources. It has helped us consolidate our Windows Servers and strengthen our disaster-avoidance and disaster-recovery plans. We run our production system and key Microsoft applications like Exchange and SQL on virtual machines."

— Bill Frost, Senior IS Engineer, Boise Inc.

Help meet your recovery time objectives (RTO) and compliance requirements by using VMware vCenter Site Recovery Manager to manage failover from production datacenters to backup sites. Manage failover between two active sites by having each act as a recovery site for the other. Even planned datacenter failovers in scenarios such as datacenter migrations are made easier with Site Recovery Manager.

Simplify and automate key elements of setting up, testing and executing recovery plans with Site Recovery Manager.

- Setup recovery infrastructure - Site Recovery Manager guides users through the process of connecting to the remote site and to the storage replication software in use. It also makes it easy to map production resources, including computing and network resources, to the corresponding resources at a recovery site.
- Create recover plans - Site Recovery Manager provides an intuitive interface to help users create recovery plans for different failover scenarios and different parts of their infrastructure. Users can specify virtual machines to be suspended or shut down to free resources for recovery. They can also specify the order in which virtual machines are powered on, set user-defined scripts to execute automatically, and determine where to pause the recovery process if necessary.
- Test recovery plans - Site Recovery Manager automates the creation of a non-disruptive and isolated testing environment on the recovery site by leveraging the snapshot capabilities of storage arrays and connecting virtual machines to the user's isolated testing network. It automates the execution of the

recovery plan to be used in an actual failover and cleans up the testing environment once testing is complete. Test results are saved for viewing and export at any time.

- Automate failover - Once an administrator initiates a recovery plan from VMware vCenter Server, Site Recovery Manager automates execution of the steps in the recovery plan to ensure that recovery is executed exactly as designed. Administrators have full visibility into execution.

No other virtualization platform vendors deliver on all four key elements.

Table 6. A Comparison of Disaster Recovery Capabilities for Virtualized IT Environments

Features	VMware Infrastructure 3.5 with Site Recovery Manager	Microsoft Hyper-V with SCVMM	Citrix XenServer 5.0 with XenCenter
Integrate Virtualization Software with Storage Replication	✓	⊘	Only has integration with NetApp, EqualLogic replication
Graphically Create Recovery Plans	✓	⊘	⊘
One-Button Nondisruptive DR Testing Anytime	✓	⊘	⊘
One-Button DR Failover Automation	✓	⊘	⊘
Detailed DR Test and Recovery History for Compliance	✓	⊘	⊘

Automate Patching of Virtual Machines and Hosts

Patching is one of the most significant pain points for every IT department and is an element that must be addressed in virtual datacenters. Without a solution such as VMware vCenter Update Manager, virtual machine proliferation could soon make it very difficult to maintain compliant environments.

VMware vCenter Update Manager lets you:

- Improve datacenter security against vulnerabilities by automatically retrieving patches for Windows, Linux and guest applications.
- Reduce the risks associated with patching virtual machines by allowing fast rollbacks to a pre-patch stage.
- Eliminate application downtime related to VMware ESX host patching.
- Increase IT administrator productivity with unique automation capabilities.
- Increase flexibility by allowing delayed reboot of virtual machines.

Update Manager is a fully integrated module of VMware vCenter Server and does not require a complex installation or additional infrastructure. Microsoft's System Center Virtualization Machine Manager (SCVMM) does not have integrated patching capabilities for virtual environments and requires Microsoft System Center Configuration Manager (SCCM), which requires dedicated infrastructure, is another component to install and involves a separate user interface (UI). Citrix XenServer only provides a patch tracking system that reports on the latest patch applied to a virtual machine. Users must manually keep track of patch availability, manually download patches and install them.

Automated Patching of Offline Virtual Machines

Only VMware supports automated patching of offline virtual machines directly out-of-the-box. Neither Microsoft SCCM nor Citrix XenCenter supports patching of offline or suspended virtual machines. On March 18th 2008, Microsoft released a 76-page technical note that describes a work-around methodology to perform automated patching of offline virtual machines using SCCM. Aside from considerable limitations (i.e. it can be used only on virtual machines in the SCVMM library and does not support suspended virtual machines), the technical paper clearly shows the complexity that users will have to face with Microsoft's solution. The proposed work-around makes extensive use of custom scripts and would require months of testing.

Non-Disruptive Hypervisor Updates

Only VMware allows non-disruptive hypervisor patching. VMware vCenter Update Manager is fully integrated with VMware DRS, allowing non-disruptive, zero-downtime patching of VMware ESX, even in cases that require a reboot. Microsoft Hyper-V cannot provide zero-downtime patching because of its lack of live migration capabilities. It is also at a much greater risk for downtime, because of its dependency on the large general-purpose server operating system, Windows Server 2008.

Figure 7 provides an example of how VMware vCenter Update Manager can save almost \$150,000 per year in an IT environment with 150 virtual machines.

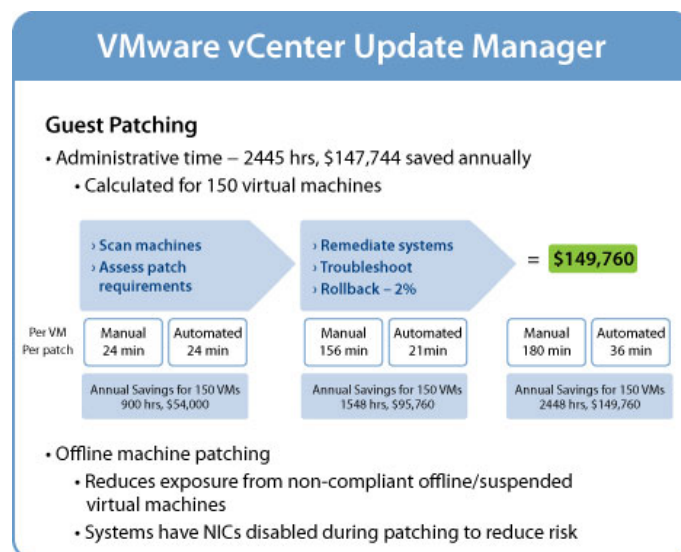


Figure 7. Saving Money with VMware vCenter Update Manager

Table 7. A Comparison of Patch and Update Management Features for Virtualized IT Environments

Features	VMware Infrastructure 3.5	Microsoft Hyper-V with SCVMM and SCOM	Citrix XenServer 5.0
Integrated Patch Management Wizard	✓	⊘	⊘
Installed as a Plug-In to the Management Interface	✓	⊘	⊘
Secure Offline Patching of Virtual Machines	✓	Loosely integrated add-on to SCCM	⊘
Linux Virtual Machine Support	✓	⊘	⊘
Zero-Downtime Host Patching	✓	⊘	✓
Maintenance Mode Support	✓	⊘	✓
Automatic Patch Downloads	✓	✓	⊘
Create Multiple Baselines	✓	⊘	⊘
Automated Snapshots Prior to Patching	✓	⊘	⊘
Integration with Dynamic Workload Placements	✓	⊘	⊘

Use Your Existing Systems Management Tool

You can maximize your investment by using your existing systems management tool to manage your VMware virtual machines alongside your physical non-virtualized servers. It's the "single pane-of-glass" that IT administrators desire for monitoring while still providing dedicated tools for in-depth management of particular sub-systems.

All major systems management vendors have deep integration into VMware vCenter Server by using our SDKs and APIs. The list of partners include management vendors such as BMC, CA, HP, IBM, Microsoft, NetIQ, Quest Software, Symantec and many others. This approach preserves your existing operational processes. While other vendors want you to replace your existing tool with a "universal" management offering that claims to do everything (from Windows to Linux to Unix, from physical machines to virtual machines), VMware works in tandem with established systems management vendors to make sure companies get the best of both worlds—physical and virtual.

Integrate with Your Infrastructure

VMware Solutions Support Your Entire IT Infrastructure

VMware ESX is the most broadly deployed and trusted virtualization platform in the world. By working proactively with nearly 700 technology partners, we have created a level of ecosystem support that gives customers peace of mind knowing that VMware solutions integrate well with their existing technology investments.

When selecting among various virtualization offerings, you should select one that supports all your workloads, is supported by more applications and operating systems, and works on the hardware you currently have. If your virtualization solution only supports a subset of your applications/operating systems/hardware, then two things happen. One, you are unable to fully realize the benefits of treating your datacenter as a seamless pool of resources rather than as separate, contained, physical servers. Two, you end up complicating your datacenter with multiple silos of virtualization, each only supporting its preferred applications—for example, Hyper-V favors Windows (especially Windows Server 2008), Xen supporting Linux, and Oracle supporting Oracle.

Only VMware solutions can support your entire IT infrastructure, allowing you to simplify your datacenter by standardizing on one virtualization solution for all your workloads and existing infrastructure. The comparison is simple: do you want one solution that meets all your requirements (VMware), or do you want multiple offerings from multiple vendors that each supports only a subset of your requirements?

Benefit from Broad Hardware Support

VMware works closely with system OEMs and peripheral manufacturers to certify VMware ESX with their hardware—usually delivering certification on or shortly after those products are first released.

While other virtualization platform vendors may claim they don't need a hardware compatibility list because they use generic general purpose operating system drivers, this claim is not accurate. For instance, both Citrix XenServer and Virtual Iron have hardware compatibility lists (HCL)—both of which are far smaller than VMware's HCL. Microsoft claims that they have a very big HCL because they can use the same Windows Server 2008 drivers for Hyper-V deployments. However, Windows drivers have traditionally been the major root cause when it comes to Windows instabilities.

Table 8. A Comparison of Hardware Support Among Virtualization Platforms

	VMware Infrastructure 3	Citrix XenServer 5.0	Virtual Iron v4.4
Supported Servers	>450 certified	104 certified	54 certified
Supported HBAs	>450 certified	66 certified	26 certified
Supported Network I/O Cards	>160 certified	51 certified	11 certified

VMware Supports the Largest Number of Guest Operating Systems

VMware ESX supports far more guest operating systems than any other bare-metal virtualization platform. The superior performance of VMware ESX with unmodified (fully virtualized) guests, made possible by our exclusive binary translation technology, means that VMware ESX can run off-the-shelf operating systems with near-native performance. Other hypervisors suffer serious performance degradation with unmodified guests. VMware ESX also supports transparent paravirtualization for guest operating systems, which allows a single binary version of the operating system to run either on native hardware or on a hypervisor in paravirtualized mode. This means that support for paravirtualization interfaces is compiled into the kernel, and is present even when the kernel is running on native hardware. Working with members of the Linux community, including IBM, Red Hat, and XenSource, VMware co-defined paravirt-ops, an open-interface standard for paravirtualizing Linux guests.

We support all guest operating systems in a consistent, unbiased manner. For example, VMware ESX supports four-way virtual symmetric multiprocessing (SMP) for each guest (unless the guest's SMP support on a physical machine is for fewer CPUs, such as XP and Vista, which are two-way only). In contrast, Microsoft Hyper-V only supports four-way virtual SMP on Windows Server 2008 guests. Most other guests on Hyper-V will be limited to one virtual CPU.

See the [VMware Guest Operating System Installation Guide](#) (PDF, 3.7MB) for full details on support for guest operating systems.

Table 9. A Comparison of Guest Operating System Support Among Virtualization Platforms

Guest Operating System Support	VMware ESX 3.5	Microsoft Hyper-V 1.0	Citrix XenServer 5.0
TOTAL	30	11	20
Windows NT 4.0	✓	⊘	⊘
Windows 2000 Server	✓	✓	✓
Windows Server 2003 64-Bit	✓	✓	✓
Windows Server 2003	✓	✓	✓
Windows Server 2008 64-Bit	✓	✓	✓
Windows Server 2008	✓	✓	✓
Windows XP 64-Bit	✓	✓	⊘
Windows XP	✓	✓	✓
Windows Vista 64-Bit	✓	✓	⊘
Windows Vista	✓	✓	✓

Red Hat Enterprise Linux 5 64-Bit	✓	⊘	✓
Red Hat Enterprise Linux 5	✓	⊘	✓
Red Hat Enterprise Linux 4 64-Bit	✓	⊘	⊘
Red Hat Enterprise Linux 4	✓	⊘	✓
Red Hat Enterprise Linux 3	✓	⊘	✓
Red Hat Enterprise Linux 2.1	✓	⊘	⊘
SUSE Linux Enterprise Server 10 64-Bit	✓	✓	⊘
SUSE Linux Enterprise Server 10	✓	✓	✓
SUSE Linux Enterprise Server 9 64-Bit	✓	⊘	⊘
SUSE Linux Enterprise Server 9	✓	⊘	✓
SUSE Linux Enterprise Server 8 64-Bit	✓	⊘	⊘
SUSE Linux Enterprise Server 8	✓	⊘	⊘
Ubuntu 8.04 LTS 64-Bit	✓	⊘	⊘
Ubuntu 8.04 LTS	✓	⊘	⊘
Ubuntu Linux 7.1 64-Bit	✓	⊘	⊘
Ubuntu Linux 7	✓	⊘	⊘
Novell NetWare 6	✓	⊘	⊘
Novell NetWare 5.1	✓	⊘	⊘

Sun Solaris 10 x86 64-Bit	✓	⊘	⊘
Sun Solaris 10 x86	✓	⊘	⊘
CentOS 5 64-Bit	⊘	⊘	✓
CentOS 5	⊘	⊘	✓
CentOS 4	⊘	⊘	✓
Oracle Enterprise Linux 5 64-Bit	⊘	⊘	✓
Oracle Enterprise Linux 5	⊘	⊘	✓
Debian 3	⊘	⊘	✓
Debian 4	⊘	⊘	✓
TOTAL	30	11	20

Gain Access to Broad Application Support

More and more ISVs test their software on VMware even before they release it. In fact, SAP AG announced full support for its solutions in 64-bit Windows- and Linux-based production environments running on VMware ESX, the first and so far only virtualization platform to earn this distinction.

Most major global software vendors support customers running their application in and with VMware environments, including:

- Adobe
- Avaya
- BMC Software
- Borland Software Corp.
- Cisco Systems
- Cognos
- Computer Associates
- Dell
- EMC
- HP
- i2
- IBM
- Juniper Networks, Inc.
- LANDesk
- Legato
- McAfee
- Microsoft

- MySQL
- Novell SUSE
- Oracle
- Red Hat
- Research in Motion
- SAP
- Sun Microsystems
- Sybase
- Symantec
- TIBCO

VMware Partner Support Programs

We support deep integration of the VMware Infrastructure platform with third-party management tools and solutions through APIs and SDK products aimed at different developer communities and target platforms. Our technology partners have access to VMware engineering resources and product source code to support deeply integrated VMware Infrastructure extensions.

VMware Infrastructure APIs and SDKs expose every control, performance and monitoring feature offered by VMware vCenter Server, so third parties can build in support for every aspect of VMware Infrastructure, including VMware vMotion, VMware DRS and VMware HA. This has led to broad industry support for management integration with VMware Infrastructure. Each API and SDK is intended for different developer communities and target platforms.

- VMware Infrastructure SDK
- VMware CIM APIs
- VI Perl Toolkit
- VI Windows Toolkit (PowerShell)
- Virtual Disk Development Kit
- VMware Guest SDK
- VMware VMCI SDK

We offer in-depth VMware SDK and API technical resources to developers.

More than 550 member organizations in our Technology Alliance Partner Program offer a wide range of products, solutions, training, consulting and services to VMware Infrastructure users. Our Technology Alliance Partners have been essential to the rapid adoption of VMware Infrastructure worldwide.

The VMware Technology Alliance Program supports VMware ecosystem partners with resources ranging from source code access with our Community Source Program, to sales and marketing assistance.

Depend on a Customer-Proven Solution

VMware—The Proven, Trusted Choice

VMware is the proven choice for virtualization from the desktop to the datacenter. More than 120,000 customers of all sizes, including all of the Fortune 100, trust VMware as their virtualization infrastructure platform. VMware customers report rapid return on investment (ROI)—typically within 6 to 9 months. More than 85 percent of VMware Infrastructure customers use it in production environments. Our successful customers “prove” that we’re providing a proven solution, not some vision or a version 1.0 product that will take several generations to mature.

The Most Successful Companies in the World Run VMware

Across all industries, VMware has been adopted by the world’s leading companies, from the desktop to the datacenters, around the world.

87 percent of the Fortune Global 500 are VMware customers, including:

- 25 out of top 25 Banks: Commercial & Savings
- 9 out of the top 10 Aerospace and Defense Companies
- 7 out of the 7 Global Airlines
- 5 of the top 5 Chemical Companies
- 4 of the top 4 Diversified Financial Companies
- 4 of the top 5 Energy Companies
- 5 of the top 5 Entertainment Companies
- 12 out of the 12 Pharmaceutical Companies
- 5 of the top 5 Securities Companies

Johnson Controls, Inc.

"Our whole objective is to drive up our system utilization, and the beauty of VMware virtual infrastructure is that it allows us to do this—without performance degradation."

—Philip Cramer, Windows Team Supervisor, Johnson Controls, Inc., Johnson Controls, Inc.

AstraZeneca

"VMware Infrastructure is proving to have a lot of benefits for us. For example, we are already using VMotion to achieve high availability and 24/7 uptime. Because we can use templates for the virtual machines, documentation is easier and server certification can be done in less time. We are confident that the production virtual machines will give us at least the same performance as the old physical machines did—perhaps better."

—Askin Karatepe, Server and Database Administrator, AstraZeneca

Cardinal Health

"When you're consolidating into brand-new facilities with no IT expertise onsite, you need an extremely high availability solution. The only way to make it happen with our set of requirements, without having hundreds of IT technicians onsite to re-image these things continually, is with VMware technology."

—Justin Hooper, Director of Windows System Engineering and Implementation, Cardinal Health

Small and Medium-Sized Businesses Run VMware

Small and medium-sized businesses run on VMware. In many cases, they have evaluated other offerings in the marketplace, but ultimately chose VMware.

HelioVolt Corporation

"VMware is the clear and obvious leader in virtualization products. We tried both the Microsoft and Oracle virtualization products and found them lacking in features and performance compared to the VMware product."

—David Greer, Director of Information Services, HelioVolt Corporation

Boise Inc.

"We use VMware software all over our company, and it has saved each individual area time, money and resources. It has helped us consolidate our Windows Servers and strengthen our disaster-avoidance and disaster-recovery plans. We run our production system and key Microsoft applications like Exchange and SQL on virtual machines. They run smoothly while using less CPU, less disk space, and a lot less memory than when they're run on physical machines. Having seen other virtualization technologies, we know that no competitive product comes even close to the value that VMware delivers to our organization every day."

—Bill Frost, Senior IS Engineer, Boise Inc.

ViaHealth / Rochester General Hospital

"I wouldn't put my mission-critical systems on a virtualization solution like Microsoft Hyper-V, which is dependent on an operating system. We all know the track record of operating systems with patches and vulnerabilities. And other virtualization products lack the complete toolset that you get from VMware, including capabilities like live migration. The tools that VMware offers allow us to be more productive, as well as offer higher SLAs to our application owners. We couldn't do without it."

—Tom Gibaud, Manager of Information Technology, ViaHealth / Rochester General Hospital

University of Plymouth

"The university has virtualized 50,000 Exchange 2007 mailboxes on VMware Infrastructure. We not only have a more manageable and flexible Exchange environment, but we have replaced Microsoft clustering with VMware's built-in high availability solutions such as HA and VMotion. We couldn't be happier with the uptime and performance of our Exchange implementation on VMware. VMware technology works for small companies all the way up to massive financial institutions. And clearly, it has worked for us."

—Adrian Jane, Infrastructure and Operations Manager, University of Plymouth

Determine True Total Cost of Ownership

Debunking the Myth

VMware meets all essential customer requirements when companies virtualize their datacenters.

- Built on the robust, proven foundation of VMware ESX.
- Delivers a platform for shared IT services with VMware Infrastructure.
- Provides a complete solution for virtualization management with VMware vCenter family of application and infrastructure management products.
- Integrates with a customer's entire IT infrastructure with broad software and hardware ecosystem support.
- Has a proven success record with over 120,000 VMware customers and counting.

But what about cost? Other vendors would like you to believe that VMware is too expensive. In fact, they commonly claim that VMware is three to five times more expensive than their own offerings. They base their claims on comparisons of upfront licensing costs.

Instead, comparisons should be based on total cost of ownership (TCO). Looking beyond just the upfront license costs, any company doing a TCO analysis for virtualization must include the following in its calculations:

- Virtual Machine Density per Physical Server—How many virtual machines can run per host and therefore how many servers and software licenses do you need to buy?
- Operational Costs Savings—How does each solution improve your IT staff efficiency and reduce operational costs given how IT administration and maintenance costs dominate IT budgets today?

Maximize Virtual Machine Density per Physical Server

Before virtualization, IT organizations would run one application per physical server, so cost-per-server was a quick way to compare costs—it was a one-to-one relationship.

But once you virtualize, many applications (each in its own virtual machine) run on each physical server—it is now a many-to-one relationship. Consequently, cost-per-server comparisons no longer make sense. A much more accurate metric is cost-per-application because you want to know how much it costs to run the entire set of applications required to maintain business operations. To illustrate with an analogy, it is like asking: "Which is more cost-effective, a 4-door sedan or a 50-passenger bus?" The sedan may cost less upfront, but if your requirement is to transport a football team, then the 50-passenger bus is clearly more cost-effective! The cost-per-passenger is much lower because the bus has a higher passenger-per-vehicle density. Density matters in a many-to-one relationship.

Virtual machine density per host (number of concurrent virtual machines that can run on a physical server) directly affects cost-per-application. No other virtualization platform achieves the high virtual machine density of VMware ESX and can still maintain consistent, high application performance across all running virtual machines.

VMware has invested in technologies to achieve very high virtual machine density on VMware ESX.

- Our advanced memory management features such as memory overcommit (with memory ballooning) and transparent page sharing, utilizes physical memory far more efficiently than any other virtualization platform on the market. In fact, no other virtualization platform has memory overcommit and transparent page sharing today, which severely limits the number of concurrent VMs other

platforms can run on a physical server—customers end up having to buy more physical servers and/or memory. VMware ESX can commonly run twice the number of virtual machines on a physical server as our competitors. No other virtualization platform has these capabilities, meaning, fewer VMs per host, diminished performance, and larger hardware requirements.

- Scalable performance: VMware's engineers have fine-tuned VMware ESX to achieve consistent, high performance when running many concurrent virtual machines on a physical server. The VMware direct driver model and virtualization-specific scheduler are key enablers of our more scalable performance. Others will focus on single virtual machine performance running on a single physical server, but that does not tell the whole story. Single virtual machine performance does not reflect what happens in the real-world with virtualization.

Being able to run your applications on fewer physical servers directly affects your bottom line by dramatically reducing hardware, software, power, cooling and datacenter space costs.

Customers tell us that VMware DRS lets them run even more virtual machines per host (compared to running without VMware DRS). They are willing to run at higher average server utilization levels with VMware DRS because they view VMware DRS as a "safety net". Should a spike occur on any given server, VMware DRS will balance workloads within the cluster so that no virtual machine is starved of resources. Without DRS, customers estimate they would run at least 25-30 percent lower utilization levels to provide extra headroom. This translates directly into 25-30 percent more server hardware and software costs.

Table 10. A Comparison of Cost Per Virtual Machine Among Virtualization Platforms

	VMware ESXi	VMware VI3 Foundation	VMware VI3 Enterprise	Microsoft Hyper-V	Citrix XenServer Enterprise	Other "free" Xen based
Hardware: 2P Server with 16GB RAM	\$7,000	\$7,000	\$7,000	\$7,000	\$7,000	\$7,000
Guest OS: 2P Windows Server 2008 Datacenter Edition Without Hyper-V	\$5,942	\$5,942	\$5,942	\$5,998	\$5,942	\$5,942
Virtualization License: 2 Sockets	\$0	\$995	\$5,750	\$0	\$2,600	\$0
Subtotal	\$12,942	\$13,937	\$18,692	\$12,998	\$15,542	\$12,942
Total VMs (2GB each)	16	16	16	8	8	8
Price per VM	\$809	\$871	\$1,168	\$1,621	\$1,943	\$1,618

* Assumes 2:1 memory overcommit on VMware VI3 hosts

Some have argued that they can add more memory to the Hyper-V or Xen host to achieve the same number of running virtual machines on VMware ESX. Even in this case, VMware still comes out less expensive or comparable, as illustrated in Figure 8.

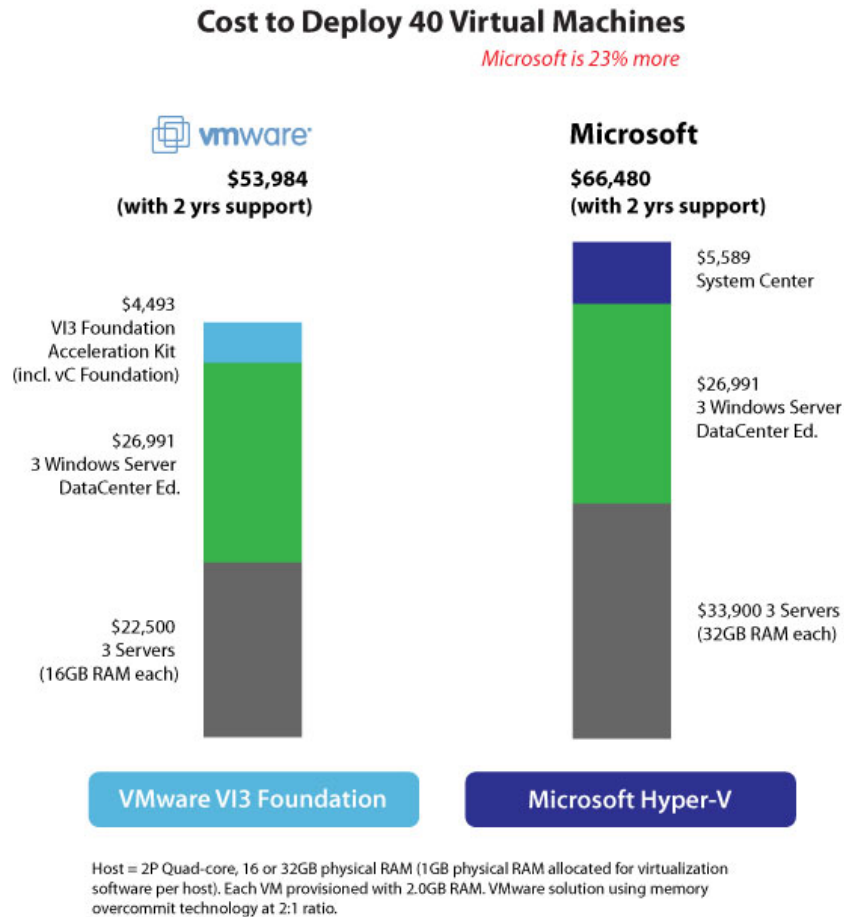


Figure 8. VMware Offers a Lower Total Cost of Ownership than Microsoft

Save on Operational Costs

IT management and operational costs can be several times greater than hardware and software acquisition costs over the lifetime of a server and must be factored into any total cost of ownership analysis.

You can directly reduce your operational costs by using the dynamic IT services built into VMware Infrastructure 3 that most other competitors do not offer. For example:

- VMware vMotion enables planned server maintenance with no downtime impact on end-users. IT administrators no longer need to come in on weekends or evenings (overtime pay) and spend hours contacting application owners to schedule a maintenance window. In a VMware environment with 150 virtual machines, a company can save an estimated \$52,800 in IT administrative costs each year by using VMware vMotion instead of scheduling downtime during evenings and weekends (See Figure 2).
- VMware Storage vMotion enables storage array maintenance and upgrades with no downtime impact to end-users. In a VMware environment with 150 virtual machines and 7.5TB of shared storage, a company can save an estimated \$52,250 in IT administrative costs each year when performing storage array maintenance and upgrades (See Figure 3).

- VMware DRS saves IT from having to manually monitor virtual machines and manually move them to ensure proper resource reallocation. In a VMware environment with 150 virtual machines, a company can save an estimated \$46,800 in IT administrative costs each year using VMware DRS instead of manually monitoring workload and responding to customer calls when there are issues (See Figure 4).
- VMware HA automatically restarts virtual machines when hosts or individual virtual machines unexpectedly fail (unplanned downtime). This capability dramatically reduces the costs of lost end-user productivity due to the downtime. In a VMware environment with 150 virtual machines, a company can save an estimated \$60,000 in lost productivity (See Figure 6).
- VMware vCenter Update Manager automates scanning, tracking, applying, and remediating patches for the virtualization layer and guest operating systems. In a VMware environment with 150 virtual machines, a company can save an estimated \$149,000 in operational costs compared to applying patches manually. This figure does not even include the cost savings of using VMware vMotion with VMware vCenter Update Manager to patch the virtualization layer without taking applications down (See Figure 7).

These savings would be lost by going with another solution that does not offer these dynamic IT capabilities.

Additionally, VMware also recently expanded its VMware vCenter family of products to include VMware vCenter Lab Manager, VMware vCenter Site Recovery Manager, VMware vCenter Stage Manager, and VMware vCenter Lifecycle Manager—solutions that automate time-consuming and error-prone management tasks



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