



# Why Choose VMware?

WHITE PAPER

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## Introduction

As virtualization is now a critical component of an overall IT strategy, it is important to choose the right vendor. VMware is the leading business virtualization infrastructure provider, offering the most trusted and reliable platform for building private clouds and federating to public clouds.

Only VMware delivers on the core requirements for a business virtualization infrastructure solution because only VMware:

1. Is built on a robust, reliable foundation
2. Delivers a complete virtualization platform, from desktop through the datacenter out to public clouds.
3. Provides the most comprehensive virtualization and cloud management
4. Integrates with your overall IT infrastructure
5. Is proven by more than 170,000 customers.

Best of all, VMware delivers while providing low total cost of ownership (TCO).

## Section 1: Start with a Robust and Reliable Foundation

### Every Hypervisor is not Created Equally

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*“ 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

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The first step in successfully building a virtual infrastructure, that will serve as the foundation for a private cloud, is to choose a robust and production-proven hypervisor. Not all hypervisors are equal. VMware ESX/ESXi is—and will continue to be—the industry’s most robust and production-proven hypervisor and is a better choice than other hypervisors for building a private cloud.

### Comparing VMware ESX to Microsoft Hyper-V and Citrix XenServer

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 fourth generation, VMware ESX has been production-proven in tens of thousands of customer deployments all over the world. Other hypervisors are less mature, unproven in a wide cross-section of production datacenters and lack 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, future VMware releases will take ESX to the next level of enterprise-class hypervisors—further extending our lead and ensuring that our customers obtain unparalleled levels of performance and reliability.

HYPERVISOR ATTRIBUTES	VMWARE ESX 4.1	WINDOWS SERVER 2008 R2 WITH HYPER-V	CITRIX XENSERVICES 5.6
Small Disk Footprint	✓ 70 MB disk footprint (VMware ESXi™)	✗ Over 3GB with mandatory Server Core installation; approximately 10GB with full Windows Server Installation	✗ 1.8GB
OS Independence	✓ No reliance on general-purpose operating system (VMware ESXi)	✗ Relies on Windows 2008 in parent partition	✗ Relies on Linux in Dom0 management partition
Hardened Drivers	✓ Optimized with hardware vendors	✗ Generic Windows drivers	✗ Generic Linux Drivers
Advanced Memory Management	✓ Ability to reclaim unused memory, de-duplicate memory pages, compress memory pages	✗ No ability to reclaim unused physical memory, de-duplicate pages, or compress pages	✗ Recently added basic overcommit, but does not adjust memory allocation based on VM usage; no deduplication or compression of pages
Advanced Storage Management	✓ VMware vStorage VMFS, Storage vMotion	✗ Lacks an integrated clustered file system, no live storage migration	✗ Lacks an integrated cluster file system, no live storage migration, storage features support very few arrays
High I/O Scalability	✓ Direct driver model	✗ I/O bottleneck in parent OS	✗ I/O bottleneck in Dom0 management OS
Host Resource Management	✓ Network traffic shaping, per-VM resource shares, set quality of service priorities for storage and network I/O	✗ Lacks similar capabilities	✗ Lacks similar capabilities

<b>HYPERVISOR ATTRIBUTES</b>	<b>VMWARE ESX 4.1</b>	<b>WINDOWS SERVER 2008 R2 WITH HYPER-V</b>	<b>CITRIX XENSERVICES 5.6</b>
Performance Enhancements	✓ AMD RVI, Intel EPT, large memory pages, universal 8-way vSMP, VMI paravirtualization, VMDirectPath I/O, PV guest SCSI driver	✗ Large memory pages, 4-way vSMP on Windows Server 2008 and Windows 7 virtual machines only	✗ No large memory pages, no paravirt guest SCSI device, no direct I/O device support
Virtual Security Technology	✓ VMware VMsafe™ security API	✗ Nothing comparable	✗ Nothing comparable
Flexible Resource Allocation	✓ Hot add VM vCPUs and memory, VMFS Volume Grow, hot extend virtual disks, hot add virtual disks	✗ Only hot add virtual disks	✗ Nothing comparable

Table 1. A Comparison of Hypervisors

**Windows Server 2008 R2 with Hyper-V and Xen: Too Much Code**

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 the ongoing focus at VMware to advance virtualization reliability, the company 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. 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. Xen and Windows Server 2008 R2 with Hyper-V both 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 R2 install. However, the disk footprint of Server Core in its virtualization role is still approximately 3.6GB. 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 and KVM offerings, such as those from Citrix, Oracle, Red Hat, and Novell 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 Datacenter**

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? 364,000 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 EMC showed a single ESX host is capable of driving over 364,000 IOPS, requiring the SSD equivalent of thousands of rotating disks.

To put this result into perspective, you would need to run 700,000 Microsoft Exchange mailboxes (LoadGen heavy user profile) on a single server to generate this I/O. In the same test, a single ESX virtual machine achieved over 120,000 IOPS. With that kind of performance power available, even your most demanding workloads can be virtualized.

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 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. Xen and Windows Server 2008 R2 with Hyper-V both use generic drivers that are not optimized for when many virtual machines are running concurrently.

VMware investigated the indirect driver model, now used by Xen and Windows 2008 with 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, VMware ESX supports the broadest breadth of memory overcommit technologies with minimal performance impact by combining several exclusive technologies.

Content-based transparent memory page sharing (TPS) 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. Think of it as deduplication for memory. Depending on the similarity of operating systems and workloads running on a VMware ESX host, transparent page sharing alone can typically save from 5 to 30 percent of the server's total memory by consolidating identical memory pages (as high as 45 percent memory savings in a VDI environment). VMware's balloon driver can also reclaim idle memory so other virtual machines can make use of it. Last, a new memory management technology was added in VMware vSphere 4.1 called "memory compression." Compressed memory is a new level of the memory hierarchy, between RAM and disk. Slower than memory, but much faster than disk, this feature improves the performance of virtual machines when memory is under contention, because less virtual memory is swapped to disk as a result.

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

After dismissing the value of these VMware memory management techniques for quite some time, both Citrix and Microsoft have turned around and released or announced memory capabilities of their own. But in both cases, they still fall far short of the full breadth of what VMware delivers. For instance, Citrix's dynamic memory in XenServer 5.6 cannot dynamically adjust the size of its balloon driver based on real-time virtual machine usage. This limitation can create major performance issues for active virtual machines while leaving lots of unused RAM in idle virtual machines.

### 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 vSphere simplifies the use and management of shared storage with the VMware vStorage Virtual Machine File System (VMFS). With VMFS, a resource pool of multiple VMware ESX and ESXi servers can concurrently access the same datastores to boot and run virtual machines, effectively virtualizing your storage resources. The ease of storage management using VMFS has allowed customers to get more value out of their SAN investments.

VMFS gives VMware vSphere 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 of VMFS formatted volumes for those virtual machines.

Our competition lacks a true distributed system features. In Microsoft Hyper-V R1, this gap lead to a serious restriction where only one virtual machine could reside on a LUN if a customer wanted virtual machine independent restarts (like VMware HA) or migrations. With Hyper-V R2, Microsoft addresses this one-VM-per-LUN limitation by introducing a brand new technology called Cluster Shared Volumes (CSV), a layer built on top of NTFS that only works with Hyper-V. But CSV is not truly a clustered file system, and CSV is a fairly complex architecture that requires a Hyper-V host to act as a coordination node for every shared LUN. If the coordination were to go down, another Hyper-V host would take its place, but that change in roles suffers from a few seconds of downtime, negatively impacting any virtual machines running on that shared LUN. Also, there is currently very little support for CSV from backup vendors. Only one third-party backup product currently supports CSV.

The support for rich storage features across hundreds of storage arrays provided by VMFS contrasts with the approach taken by Citrix. Citrix XenServer lacks a cluster file system and it only exposes rich storage feature such as cloning and snapshots if used with a very limited set of arrays for which specific integrations have been provided. The Citrix StorageLink approach exposes a smaller set of storage features, but only with a select few arrays that support the StorageLink interface. To address this gap, XenServer 5.6 recently added host-based snapshots, but during testing, it was discovered to not work well with XenServer dynamic memory, creating a major limitation for the IT admin.

### 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 major security vendors, fully integrated with VMware vSphere 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 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 Taneja Group report 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."

Noteworthy 2009 industry awards given to VMware vSphere include:

- The Wall Street Journal—2009 Technology Innovation Award  
Honored technological breakthroughs in such areas as medicine, software, the Internet, wireless and consumer electronics. VMware vSphere was recognized in the "Software" category in 2009.
- ChannelWeb—Best Products of 2009  
This award recognized new products that have a significant effect on how enterprises, small and medium size businesses, and solution providers address IT infrastructure and management. VMware vSphere 4 was named best product in the "Virtualization" category.
- InfoWorld—2009 Technology of the Year Award  
This award recognized the 10 technologies that made the greatest impact during 2009. The winners were selected from a wide range of products tested and reviewed in the InfoWorld Test Center throughout the year. VMware vSphere 4 was recognized as the year's "Best Server Virtualization Product."
- NetWorld—Product of the Year 2009  
NetWorld awarded VMware vSphere 4 the title of best product in the "Virtualization" category. Winners are chosen by NetWorld readers as the most valuable, innovative, and reliable products.
- PC Pro—Business Software of the Year 2009  
VMware vSphere 4 won the PC Pro "Business Software of the Year" award as the piece of software that judges believe made the biggest difference to business computing in 2009. The PC Pro Editorial Awards are voted on by a combination of the magazine's editorial team and its roster of respected "Real World Computing" editors.
- SearchServerVirtualization.com—Product of the Year 2009  
Presented to top vendors based on product innovation, performance, ease of integration and value, among other parameters. VMware vSphere 4 was named "Virtualization Platform of the Year."

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

- eWeek (6.7.09): VMware vSphere 4 Raises the Virtualization Bar  
"These new capabilities place vSphere 4 well ahead of Microsoft's Hyper-V platform and open-source projects based on the Xen hypervisor, and earn the new VMware platform an eWEEK Labs Analyst's Choice award."

- InfoWorld (5.21.09) VMware vSphere 4: The once and future virtualization king  
“... I can say that my brief experience with vSphere has been positive, and the features offered are taking things to the next level. They also would seem to highlight just how far behind VMware’s competitors really are.”
- SearchServerVirtualization (5.21.09) Virtualization Users Remain True-Blue VMware Adherents  
“VMware still reigns supreme for veteran virtualization users, who say Hyper-V is far from being a strong option in heterogeneous data centers and question XenServer’s long-term viability.”
- CIO.com (3.26.09) VMware Bucks Microsoft’s Cheaper is Better Mantra  
“Physical hosts running VMware software can pack in 1.5 VMs for every 1 VM on a Microsoft Hyper-V server, according to the [Taneja Group] report. Comparing costs based on the number of VMs a host can support, Taneja Group concluded VMware is actually cheaper by between five percent and 29 percent than Hyper-V.”
- SearchServerVirtualization (2.26.09) VMware outshines Hyper-V, et al. in hypervisor comparison  
“VMware VI 3.5 Update 3 satisfied all Burton Group’s criteria 100% and outshone the competition...”

## Section 2: Build a Complete Virtual Platform for Your Applications

### From the Desktop through the Datacenter out to Public Clouds

While a reliable, industry-proven hypervisor is the critical foundation for any virtual infrastructure, it does not constitute a complete solution by itself. Companies need an overall platform that delivers the right infrastructure and application services for running their business. This platform must have built-in aggregation, migration, allocation, power management, and availability services. Only VMware vSphere delivers all of these built-in services for your applications. Other offerings are incomplete and fall short of delivering the entire solution.

### Live Server and Storage Migration: Transparent Agility

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*“ 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... 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 IT, ViaHealth / Rochester General Hospital

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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 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 a comparable capability 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.

VMware vSphere goes a step further by maintaining a virtual machine's network configurations and security zone setting, even when the virtual machine migrates from one host to another. The competition has nothing comparable.

Figures 1 and 2 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.

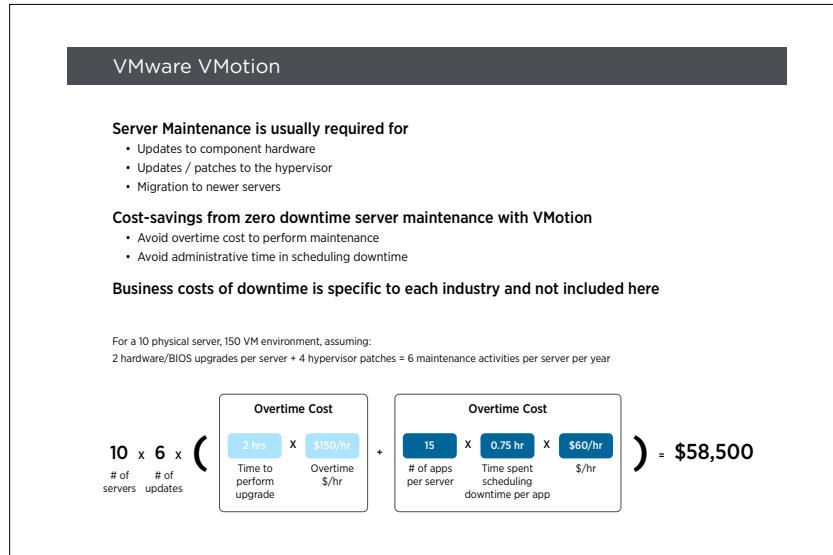


Figure 1. Saving Money with VMware VMotion

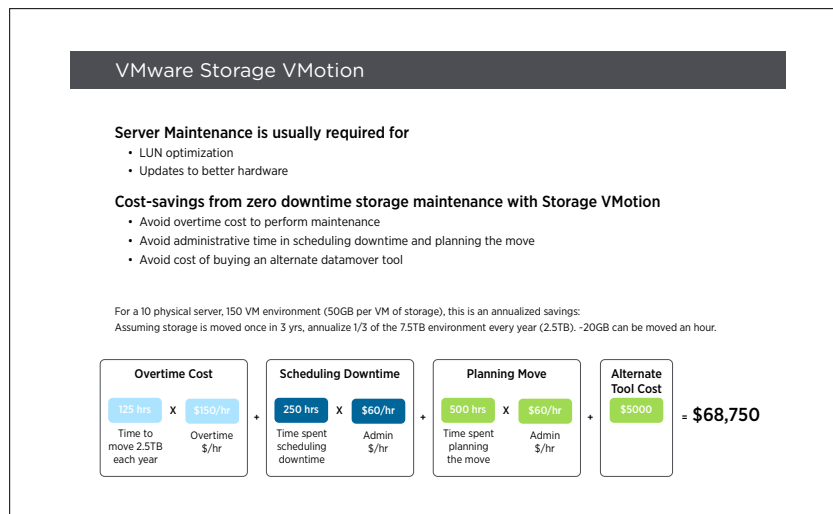


Figure 2. Saving Money with VMware Storage VMotion

Windows Server 2008 R2 with Hyper-V and Xen-based products have server-to-server live migration but still lack storage array-to-array live migration. While server-to-server live migration is an important building block to build a private cloud, a hypervisor plus live migration is not a complete solution in and of itself. Read the other paragraphs in this section to see the other VMware application and infrastructure services for building a private cloud platform.

FEATURES	VMWARE VSPHERE 4.1 WITH VCENTER	WINDOWS SERVER 2008 R2 WITH HYPER-V AND SCVMM R2	CITRIX XENSERVER 5.6 WITH ESSENTIALS ENTERPRISE EDITION
Live Virtual Machine Migration for Zero Application Downtime	✓	✓	✓
Concurrently Live Migrate Multiple VMs	✓	✗ Only one live migration at a time per host	✗ Only one live migration at a time per host
Live migration while maintaining virtual switch and network security zone settings	✓	✗	✗
Maintenance Mode with Dynamic Workload Placement	✓	✓	✗
Live Storage Migration	✓	✗	✗
Live Storage Migration from one storage protocol to another (from iSCSI to NFS to Fibre Channel and vice versa)	✓	✗	✗
Conversion from thin to thick provisioned disks during live storage migration	✓	✗	✗

Table 2. A Comparison of Live Migration Services

**Aggregation: Transform Isolated Resources into Shared Pools**

VMware vSphere aggregates compute resources from farms of physical servers, storage, and network into logical resource pools that maximize efficiency and utilization – this pooling is a critical foundation for building a private cloud. 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 pooling. 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 vNetwork Distributed Switch simplifies and enhances the provisioning, administration and monitoring of virtual machine networking. It provides a centralized point of control for cluster level networking and moves beyond per host network configuration in virtual environments. Neither Microsoft nor Citrix’s current offerings have anything like the vNetwork Distributed Switch. Citrix has announced plans for an open source based distributed switch for its commercial XenServer product but no release date has been given, whereas this capability is available today from VMware and third parties have extended its capabilities, like the Cisco Nexus 1000V.

- VMware vShield Zones monitor and enforce network traffic within your virtual datacenter to meet corporate security policies and ensure regulatory compliance. It enables you to run your applications efficiently within a shared computing resource pool, while still maintaining trust and network segmentation of users and sensitive data. Neither Microsoft nor Citrix’s current offerings have anything like vShield Zones. Any one deploying Microsoft or Citrix’s product would have to create separate clusters of virtualization hosts, with each cluster mapped to a specific network security zone. Virtual machines could not move between clusters without violating the network security zone requirements for the virtual machine.
- 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.

FEATURES	VMWARE VSPHERE 4.1 WITH VCENTER	WINDOWS SERVER 2008 R2 WITH HYPER-V AND SCVMM R2	CITRIX XENSERVER 5.6 AND CITRIX ESSENTIALS ENTERPRISE EDITION
Hierarchical Resource Pools	✓	✗	✗
Isolation Between Resource Pools	✓	✗	✗
Maintain Virtual Network Switch Settings When VMs Live Migrate to Another Host	✓	✗	✗
Manage One Virtual Switch for the Entire Cluster	✓	✗	✗
Maintain Network Security Settings When VMs Live Migrate to Another Host	✓	✗	✗
Enforce Network Security Settings at VM-level, Instead of at Host-level	✓	✗	✗

Table 3. A Comparison of Resource Aggregation Capabilities in Virtualization Platforms

**Allocation: Elastic Pools of Resources**

To build a true private cloud, automated workload balancing within shared pools of resources is required because it delivers optimized resource usage. This capability 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:

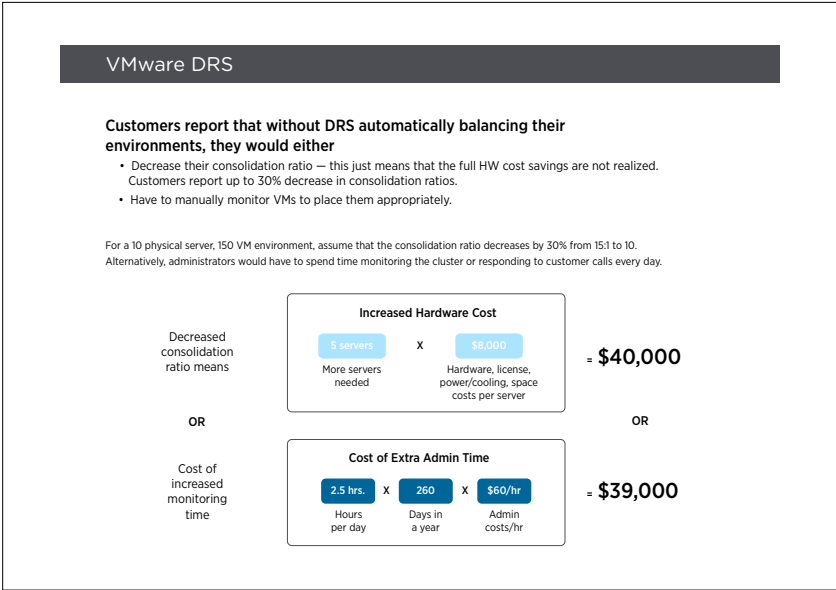
- Dynamically allocate IT resources to the highest priority applications. Create rules and policies to prioritize how resources are allocated to virtual machines.
- Give IT autonomy to business organizations. Provide dedicated IT infrastructure to business units while still achieving higher hardware 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

Microsoft PRO Tips (requires System Center Operations Manager) and Citrix’s dynamic workload balancing (requires purchase of Essentials for XenServer) do not come even close to matching the maturity and robustness of VMware DRS. The logic that drives PRO Tips is split between two lightly-integrated servers, each with its own infrastructure and user interfaces. This design implementation creates a significant headache when IT administrators attempt to configure, tune, and troubleshoot PRO Tips behavior because the functionality is not provided by a single, unified manager. Also, PRO Tips relies upon independent third-party management packs to provide the “intelligence”, but there’s no clear way for multiple packs to coordinate actions with each other, potentially resulting in conflicting recommendations. Similarly, the heuristics in Citrix’s workload balancing is also unproven and does not work well with its recently released dynamic memory capability.

Therefore, IT administrators trying to use Microsoft or Citrix’s offering end up having to do a lot of manual monitoring to ensure those systems are performing load balancing as they should, which ultimately pulls IT administrators away from other higher value work and results in lower IT administrator productivity.

Figure 3 illustrates an example of how VMware DRS can save \$40,000 per year in an IT environment with 150 virtual machines.



**Figure 3.** Saving Money with VMware DRS

In conjunction with VMware DRS, VMware vNetwork Distributed Switch and vShield Zones are also critical for enabling elastic pools of resources. vNetwork Distributed Switch provides a centralized point of control for cluster level networking and moves beyond per host network configuration in virtual environments. vShield Zones enables you to run your applications efficiently within a shared computing resource pool, while still maintaining trust and network segmentation of users and sensitive data. Neither Microsoft nor Citrix have anything comparable.

A new, related workload balancing capability in vSphere 4.1 is Storage I/O Control and Network I/O Control. These capabilities allow IT administrators to set up quality of service priorities for storage and network resources so as to ensure individual virtual machines are guaranteed a minimum amount of storage and networking bandwidth.

FEATURES	VMWARE VSPHERE 4.1 WITH VCENTER	WINDOWS SERVER 2008 R2 WITH HYPER-V AND SCVMM R2	CITRIX XENSERVER 5.6 WITH ESSENTIALS ENTERPRISE EDITION
Continuously Monitors Utilization Across Resource Pools	✓	✗	✗
Utilizes Live Migration for Zero Downtime, Automated Load Balancing	✓	PRO Tips heuristics are not proven, requires System Center Operations Manager	Citrix WLB heuristics are not proven, does not work well with dynamic memory
Hierarchical Resource Pools	✓	✗	✗
Isolation Between Resource Pools	✓	✗	✗
Affinity Rules	✓	✗	✗
Maintenance Mode for Servers	✓	✓	✓
Recommends Host for Initial Virtual Machine Placement	✓	✓	✓
Maintain Virtual Network Switch Settings When VMs Live Migrate to Another Host	✓	✗	✗
Manage One Virtual Switch for the Entire Cluster	✓	✗	✗
Maintain Network Security Settings When VMs Live Migrate to Another Host	✓	✗	✗
Enforce Network Security Settings at VM-level, Instead of at Host-level	✓	✗	✗
Ability to set per-VM shares and priorities on shared storage I/O bandwidth	✓	✗	✗
Ability to set per-VM shares and priorities on shared network I/O bandwidth	✓	✗	✗

Table 4. A Comparison of Dynamic Resource Allocation Capabilities in Virtualization Platforms

### Power Management: Cluster-level Power Savings

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, DPM monitors a DRS cluster and verifies whether service level agreements (SLAs) could be met at a lower power consumption rate. When an application workload increases, DPM re-activates the suspended hosts (via Wake-on-LAN, IPMI, or iLO). Without this type of cluster-level power management, power management at the cluster-level is not possible. Microsoft does not deliver functionality with this level of flexibility. Microsoft Hyper-V R2 has a core parking feature that only focuses on power savings for individual processor cores. Citrix recently introduced a capability called Automated Power Management, but upon testing, it did not effectively leverage Citrix's new dynamic memory. A technology like DPM really needs to work well with memory overcommitment to achieve maximum power savings because during periods of low utilization, high levels of overcommit are possible, letting you get by with the fewest servers running.

### Availability: Flexible, Uniform High Availability

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*“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

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A shared IT services platform for a private cloud 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. VMware does this best with its wide-ranging capabilities to protect applications from:

- Total site failure: VMware vCenter Site Recovery Manager
- Planned downtime : vMotion, Storage vMotion
- Unplanned downtime: HA (host and VM failure monitoring), virtual machine level fault tolerance, NIC teaming

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. 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. ESX's memory overcommit also enables the flexibility required for HA without having to buy a lot of additional physical RAM per host to accommodate the restarted virtual machines.

Figure 4 illustrates an example of how VMware HA can save \$60,000 per year in an IT environment with 150 virtual machines.

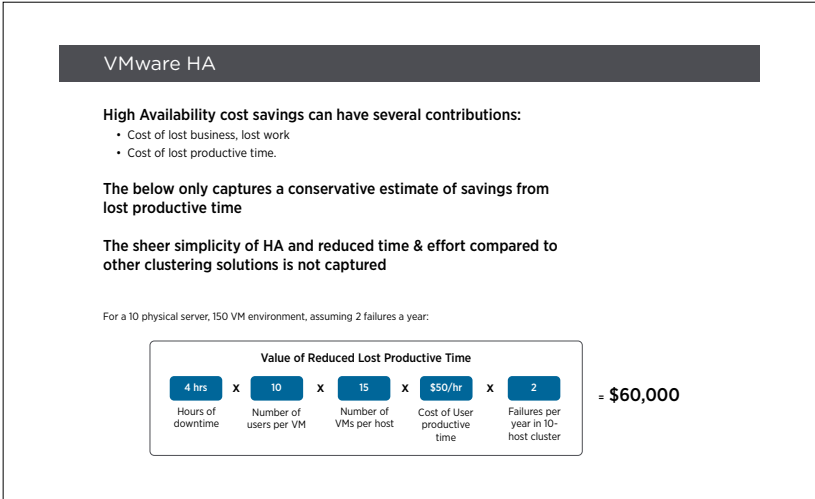


Figure 4. Saving Money with VMware HA

VMware Fault Tolerance (FT) provides zero downtime and zero data loss availability for all virtual machines against x86 hardware failures. Enabling fault tolerance for a specific virtual machine enables that workload to run on two different ESX hosts simultaneously and allows the virtual machine to run seamlessly in the event of hardware failure on either host. Neither Microsoft nor Citrix has this capability built into its virtualization platform – they both ask customers to purchase a separate third-party product to get this type of virtual machine level fault tolerance. The problem is, beyond the additional cost, that the third-party solution is still not available for Hyper-V, and for XenServer, the third-party solution only supports Windows Server 2003 and Windows Server 2008 virtual machines.

Figure 5 illustrates an example of how VMware FT can save \$69,000 per year in an IT environment with 150 virtual machines.

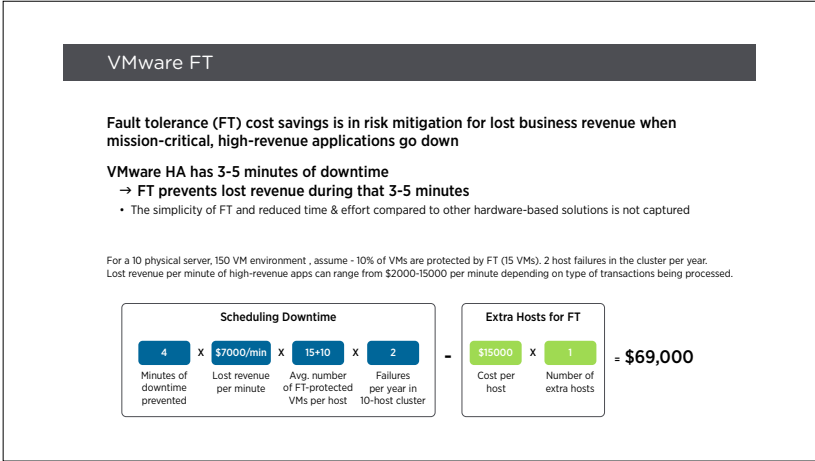


Figure 5. Saving Money with VMware FT

### Section 3: Most Comprehensive Virtualization Management

#### From Provisioning to Data Disaster Recovery

No other virtualization platform vendor provides the breadth of VMware’s management solutions for virtualization. Only VMware provides a comprehensive offering for management of the virtual infrastructure from the desktop to the datacenter to the public cloud. Best of all, our management solutions integrate with your existing systems management tools so you can use what you already have and get an integrated experience for physical and virtual machine management.

#### Centrally Manage Thousands of Virtual Machines

VMware vCenter Server 4.1 can centrally manage hundreds of VMware ESX hosts (up to 1000 per datacenter) and thousands of virtual machines (up to 5000 per datacenter), 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. VMware vCenter Server also has a Linked Mode that provides visibility across multiple vCenter Server instances, with roles, permissions and licenses replicated across the infrastructure so you can simultaneously log in, view and search the inventories of up to 10 vCenter Servers.

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

FEATURES	VMWARE VSPHERE 4.1 WITH VCENTER SERVER	WINDOWS SERVER 2008 R2 WITH HYPER-V AND SCVMM R2	CITRIX XENSERVER 5.6 WITH ESSENTIALS ENTERPRISE EDITION
“Hot” Virtual Machine Cloning	✓	✗	✗
Provisioning from Virtual Machine Templates	✓	✓	✓
Automated Guest Customization	✓	Windows only	✗
Virtual Appliance Marketplace	✓	✗	✗

FEATURES	VMWARE VSPHERE 4.1 WITH VCENTER SERVER	WINDOWS SERVER 2008 R2 WITH HYPER-V AND SCVMM R2	CITRIX XENSERVER 5.6 WITH ESSENTIALS ENTERPRISE EDITION
Centralized Host Configuration	✓	✗	✓
Choice of Management Database	✓	✗	✗
Web Management Client	✓	✗	✗
Advanced CPU Resource Controls	✓	✓	✗
Network Bandwidth Resource Controls	✓	✗	✓
Customizable Alarms	✓	with SCOM	✓
Scheduled Tasks	✓	✗	✗
Comprehensive task and event tracking, including hosts, virtual machines, storage and networking	✓	✗	✗
Customizable Reports	✓	with SCOM	✓
Resource Topology Maps	✓	✗	✗
Single client for connecting to centralized management platform & stand-alone host	✓	✗	✗
Higher level management abstraction with host profiles and vApps	✓	✗	✗

Table 5. A Comparison of Integrated Virtual Infrastructure Management Features

**Managing the Private Cloud with VMware vCenter**

VMware provides a set of management and automation solutions that work together with VMware vSphere to:

- Standardize and automate key tasks, processes and policies in the datacenter.
- Manage service levels by reducing risk and streamlining problem management.
- Optimize the infrastructure to get the most out of capital IT investments.

VMware vSphere and vCenter provide solutions for creating standardized and repeatable processes, managing capacity and performance, controlling configuration changes, protecting business-critical applications against outages and self-service provisioning for development and testing environments. Users of other virtualization platform vendors must rely on third-party products to get the same breadth of virtualization management functionality.

- Standardize and Automate IT:** Use templates, profiles and simple scripts to standardize operations with VMware vCenter Server and the [vSphere PowerCLI](#). Create repeatable processes from hundreds of pre-configured workflow steps in [vCenter Orchestrator](#).

- **Manage Service Levels:** Ensure business owners that performance SLAs will be met as you manage and ensure the performance of multi-tier applications with [VMware vCenter AppSpeed](#). Stay ahead of potential problems with accurate, relevant insights into the changes that affect your virtual infrastructure with [vCenter Change Insight](#) (coming in 2010).
- **Optimize the Infrastructure:** Plan ahead with intelligent forecasting and minimize waste by reclaiming unused resources with [VMware vCenter CapacityIQ](#), and get an accurate view of costs for virtualized workloads with [VMware vCenter Chargeback](#). Optimize how virtual machines use the infrastructure with VMware vSphere Thin Provisioning, Distributed Virtual Switch, Dynamic Resource Scheduler, and other key capabilities in VMware vSphere.
- **Self-service for the Dev/Test Cloud:** Deliver on-demand access to a library of system configurations and simplify management of software testing and development with [VMware vCenter Lab Manager](#).

All the above solutions work in conjunction with [VMware vCenter Server](#) to help you monitor all virtual machine activity in the virtual datacenter. No other virtualization platform vendor delivers this breadth of virtualization management capabilities.

### Automate Data Disaster Recovery

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*“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.

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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. Or have multiple sites fail over to the same recovery site (many to one). 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.

FEATURES	VMWARE SITE RECOVERY MANAGER	WINDOWS SERVER 2008 R2 WITH HYPER-V AND SCVMM R2	CITRIX XENSERVER 5.6 WITH ESSENTIALS ENTERPRISE
Integrate Virtualization Software with Storage Replication	✓	✗	StorageLink has a small HCL
Graphically Create Recovery Plans	✓	✗	✗
One-Button Nondisruptive DR Testing Anytime	✓	✗	✗
One-Button DR Failover Automation	✓	✗	✗
Detailed DR Test and Recovery History for Compliance	✓	✗	✗

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

**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, dedicated set-up, 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 offer an out-of-the-box solution that supports patching of offline or

suspended virtual machines. In May 2009, Microsoft released a separate, unsupported tool for patching offline virtual machines. But it still has considerable limitations (i.e. it can be used only on virtual machines in the SCVMM library and does not support suspended virtual machines).

Figure 6 provides an example of how VMware vCenter Update Manager can save almost \$150,000 per year in an IT environment with 150 virtual machines.

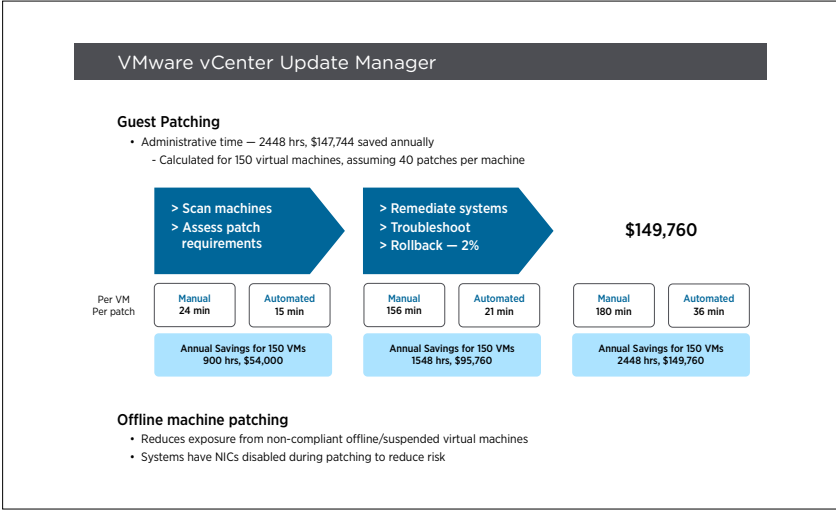


Figure 6. Saving Money with VMware vCenter Update Manager

FEATURES	VMWARE VSPHERE WITH VMWARE VCENTER SERVER	WINDOWS SERVER 2008 R2 WITH HYPER-V AND SCVMM R2	CITRIX XENSERVR 5.6 WITH ESSENTIALS ENTERPRISE
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 Scanning	✓	✗	✗
Zero-Downtime Host Patching	✓	✓	✓
Maintenance Mode Support	✓	✓	✓
Automatic Patch Downloads	✓	✓	✗
Create Multiple Baselines	✓	✗	✗

FEATURES	VMWARE VSPHERE WITH VMWARE VCENTER SERVER	WINDOWS SERVER 2008 R2 WITH HYPER-V AND SCVMM R2	CITRIX XENSERVER 5.6 WITH ESSENTIALS ENTERPRISE
Automated Snapshots Prior to Patching	✓	✗	✗
Integration with Dynamic Workload Placements	✓	✗	✗

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

**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.

**Section 4: Integrate with Your Infrastructure**

**VMware Solutions Support Your Overall x86 Infrastructure**

VMware ESX is the most broadly deployed and trusted virtualization platform in the world. By working proactively with more than 1,300 technology and consulting 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 a broad set of hardware. If your virtualization solution only supports a subset of your applications, operating systems, or 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, Windows 2008 Server with Hyper-V favors Windows (especially Windows Server 2008), Xen favors Linux, and Oracle favors Oracle.

Only VMware solutions can support your overall x86 infrastructure, allowing you to simplify your datacenter by standardizing on one virtualization solution for your x86 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, Citrix XenServer has a hardware compatibility list (HCL) and it is much smaller than VMware’s. Microsoft achieves

broad hardware support because they use the same Windows Server 2008 drivers for Hyper-V deployments. But those Windows drivers have traditionally been the major root cause when it comes to Windows instabilities so there is a clear trade-off with reliability.

	<b>VMWARE ESX 4.0</b>	<b>CITRIX XENSERVER 5.5</b>
Supported Servers	>1550 certified	244 certified
Supported Storage Controllers	>650 certified	112 certified
Supported Storage	>850 certified	113 certified
Supported Network I/O Cards	>350 certified	105 certified
<b>Data collected as of April 29, 2010</b>		

**Table 8.** A Comparison of Hardware Support Among Virtualization Platforms

### VMware Supports the Largest Number of Guest Operating Systems

VMware ESX supports 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 4.1 supports eight-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, Windows Server 2008 R2 with Hyper-V supports four-way virtual SMP on Windows Server 2008 and Windows 7 guests only. Most other guests on Windows Server 2008 R2 with Hyper-V are limited to one or two virtual CPUs.

See the VMware Guest Operating System Installation Guide on [www.vmware.com](http://www.vmware.com) for full details on support for guest operating systems.

<b>GUEST OPERATING SYSTEM SUPPORT</b>	<b>VMWARE ESX 4.1</b>	<b>MICROSOFT WINDOWS 2008 SERVER R2 WITH HYPER-V</b>	<b>CITRIX XENSERVER 5.5</b>
TOTAL	65	17	25
Windows NT 4.0	✓	✗	✗
Windows 2000	✓	✓	✓
Windows Server 2003 64-Bit	✓	✓	✓
Windows Server 2003	✓	✓	✓

<b>GUEST OPERATING SYSTEM SUPPORT</b>	<b>VMWARE ESX 4.1</b>	<b>MICROSOFT WINDOWS 2008 SERVER R2 WITH HYPER-V</b>	<b>CITRIX XENSERVER 5.5</b>
Windows Server 2008 64-Bit	✓	✓	✓
Windows Server 2008	✓	✓	✓
Windows 7 64-Bit	✓	✓	✓
Windows 7	✓	✓	✓
Windows XP 64-Bit	✓	✓	✗
Windows XP	✓	✓	✓
Windows Vista 64-Bit	✓	✓	✗
Windows Vista	✓	✓	✓
Windows 98	✓	✗	✗
Windows 95	✓	✗	✗
Windows 3.1	✓	✗	✗
MS-DOS 6.22	✓	✗	✗
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 64-Bit	✓	✗	✗
Red Hat Enterprise Linux 3	✓	✗	✓
Red Hat Enterprise Linux 2.1	✓	✗	✗
SUSE Linux Enterprise Server 11 64-bit	✓	✓	✓
SUSE Linux Enterprise Server 11	✓	✓	✓

GUEST OPERATING SYSTEM SUPPORT	VMWARE ESX 4.1	MICROSOFT WINDOWS 2008 SERVER R2 WITH HYPER-V	CITRIX XENSERVER 5.5
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	✓	✗	✗
Ubuntu 9 Linux 64-Bit	✓	✗	✗
Ubuntu 9 Linux	✓	✗	✗
Ubuntu 8 Linux 64-Bit	✓	✗	✗
Ubuntu 8 Linux	✓	✗	✗
Ubuntu 7 Linux 64-Bit	✓	✗	✗
Ubuntu 7 Linux	✓	✗	✗
Novell NetWare 6	✓	✗	✗
Novell NetWare 5	✓	✗	✗
OS/2 Warp 4	✓	✗	✗
Sun Solaris 10 x86 64-Bit	✓	✗	✗
Sun Solaris 10 x86	✓	✗	✗
Sun Solaris 9 x86	✓	✗	✗
Sun Solaris 8 x86	✓	✗	✗
SCO OpenServer 5	✓	✗	✗
SCO Unixware 7	✓	✗	✗
Open Enterprise Server 2	✓	✗	✗

GUEST OPERATING SYSTEM SUPPORT	VMWARE ESX 4.1	MICROSOFT WINDOWS 2008 SERVER R2 WITH HYPER-V	CITRIX XENSERVER 5.5
CentOS 5 64-Bit	✓	✗	✓
CentOS 5	✓	✗	✓
CentOS 4 64-Bit	✓	✗	✗
CentOS 4	✓	✗	✓
Oracle Enterprise Linux 5 64-Bit	✓	✗	✓
Oracle Enterprise Linux 5	✓	✗	✓
Oracle Enterprise Linux 4 64-Bit	✓	✗	✗
Oracle Enterprise Linux 4	✓	✗	✗
Debian 5 64-bit	✓	✗	✗
Debian 5	✓	✗	✓
Debian 4 64-Bit	✓	✗	✗
Debian 4	✓	✗	✓
FreeBSD 7 64-bit	✓	✗	✗
FreeBSD 7	✓	✗	✗
FreeBSD 6 64-bit	✓	✗	✗
FreeBSD 6	✓	✗	✗
Asianux 3 64-bit	✓	✗	✗
Asianux 3	✓	✗	✗
Serenity Systems eComStation 1.2R	✓	✗	✗
TOTAL	65	17	25
Data collected as of May 7, 2010			

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

### Gain Access to Broad Application Support

More and more ISVs test their software on VMware even before they release it. 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

VMware supports deep integration of the VMware vSphere 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 vSphere extensions.

VMware vSphere 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 vSphere, including VMware vMotion, VMware DRS and VMware HA. This has led to broad industry support for management integration with VMware vSphere. Each API and SDK is intended for different developer communities and target platforms.

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

VMware offers 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 vSphere users. Our Technology Alliance Partners have been essential to the rapid adoption of VMware vSphere 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.

## Section 5: 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 170,000 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 94 percent of customers use VMware solutions in production environments. The success that VMware customers have achieved is proof that our solutions are mature and deliver real value, not “vaporware” 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.

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

- 50 out of top 50 Banks: Commercial & Savings
- 10 out of the top 10 Aerospace and Defense Companies
- 5 out of the 5 Global Airlines
- 9 of the top 10 Chemical Companies
- 5 of the top 5 Diversified Financial Companies
- 5 of the top 5 Energy Companies
- 4 of the top 4 Entertainment Companies
- 10 out of the 10 Pharmaceutical Companies
- 4 of the top 4 Securities Companies

### Johnson Controls, Inc.

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*“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.

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### AstraZeneca

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*“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

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### Cardinal Health

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*“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

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### Small and Medium-Sized Businesses Run VMware

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

### HelioVolt Corporation

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*“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

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### Boise Inc.

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*“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.

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### ViaHealth / Rochester General Hospital

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*“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

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## University of Plymouth

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*“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

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## Section 6: 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 complete platform for your applications with VMware vSphere.
- Provides the most comprehensive virtualization and cloud management with VMware vCenter family of products.
- Integrates with a customer’s overall x86 infrastructure with broad software and hardware ecosystem support.
- Has a proven success record with over 170,000 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, which does not tell an accurate story.

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 cost 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.

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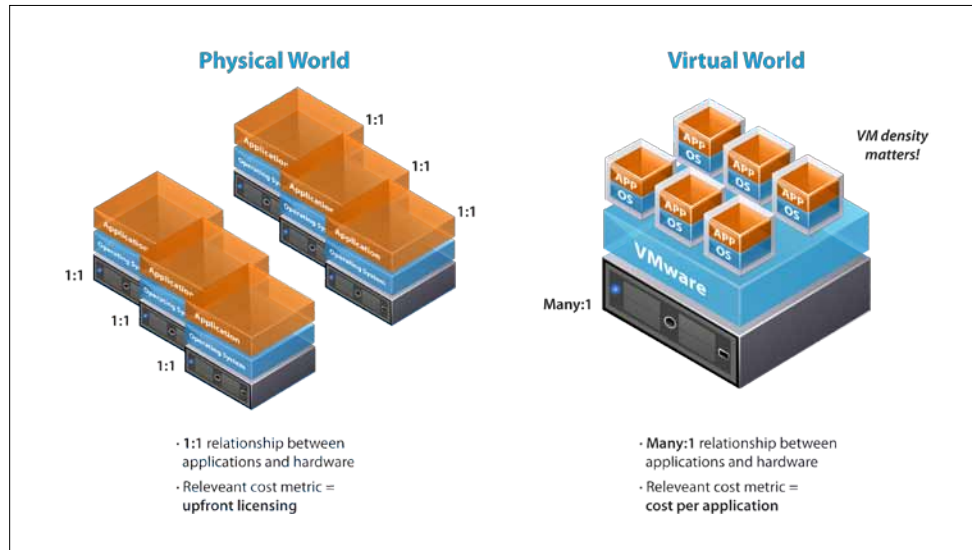
*“We have six ESX server hosts right now running nearly 150 virtual machines”*

— Brian Mislavsky, Information Systems Engineer, George Washington University

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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.



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

- **Memory Oversubscription**

More efficient use of physical RAM by reclaiming unused physical memory and consolidating identical memory pages among virtual machines on a host.

- **Direct Driver Model**

VMware ESX can achieve very high I/O throughput and can handle the I/O requirements for more virtual machines simultaneously requesting hardware resources.

- **DRS with Resource Pools**

Dynamically load balance virtual machines across a cluster so applications get required resources when they need them—a “safety net” that lets administrators run individual servers at higher utilization levels while meeting service level agreements.

- **High Performance “Gang” Scheduler**

Can account for CPU and I/O needs of virtual machines by dynamically allocating more resources and larger processor timeslices to virtual machines.

- **Support for Large Memory Pages and Nested Page Tables**

Optimize memory access and can provide substantial performance benefits for mission critical, memory-intensive applications, can reduce CPU resource consumption by up to 15 percent.

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

As you'll see in the example below, the VMware solution can virtualize 100 applications at a much lower cost-per-application.

	<b>VMWARE VSPHERE ENTERPRISE PLUS EDITION</b>	<b>VMWARE VSPHERE ADVANCED EDITION</b>	<b>VMWARE VSPHERE STANDARD EDITION</b>	<b>WINDOWS SERVER 2008 R2 (HYPER-V) + SYSTEM CENTER</b>	<b>CITRIX XENSERVER 5.6 + ESSENTIALS ENTERPRISE</b>
Number of applications virtualized	100	100	100	100	100
Number of VMs per host	18	18	18	12	12
Number of hosts	6	6	6	9	9
Infrastructure Costs	\$162,237	\$162,237	\$162,237	\$222,308	\$209,271
Software Costs	\$128,518	\$106,532	\$83,820	\$108,350	\$121,993
Total Costs	\$299,755	\$268,769	\$246,057	\$330,658	\$331,264
Cost-per-application	\$2,907	\$2,687	\$2,460	\$3,307	\$3,313

**Table 10.** A Maximize Virtual Machine Density per Physical Server

Note: The efficacy of the new memory management capabilities delivered in Citrix XenServer 5.6, compared to the overall set of scalability technologies in VMware vSphere, is still to be determined. Citrix dynamic memory only represents a small part of the overall set of scalability-enhancing technologies that VMware vSphere delivers.

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.

Don't be misled by other virtualization vendors claiming they are "free" and less expensive than VMware. They base these claims by only looking at one factor: license price comparison. Such comparisons are over-simplified and misleading. Run your own comparisons with your own numbers using the VMware Cost-Per-Application Calculator ([www.vmware.com/go/costperapp](http://www.vmware.com/go/costperapp)).

**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 vSphere 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.

- **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.
- **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.
- **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.
- **VMware Fault Tolerance** provides zero downtime and zero data loss availability for any virtual machine against x86 hardware failures. Enabling fault tolerance for a high-value, high transaction virtual machine enables that workload to run on two different ESX hosts simultaneously and allows the virtual machine to run seamlessly in the event of hardware failure on either host. In an environment with 150 virtual machines, this capability can save an estimated \$69,000 in lost business revenue when protecting high-value, high transaction applications.
- **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.

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

Additionally, the VMware vCenter family of products automates management tasks that have traditionally been very time-consuming and error-prone.

