Building the Virtualized Enterprise with VMware Infrastructure

vmware®

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Executive Summary

IT organizations are still grappling with the legacy of the IT explosion of the 1990s, which left many of them with high costs, slow response times, and an inconsistently managed infrastructure. Today, IT organizations that want to give their enterprise a sustainable competitive advantage need to:

- Reduce infrastructure costs through more efficient use of resources.

- Respond faster to business needs so projects get deployed more rapidly.

- Increase the consistency and predictability of operations.

This paper will clarify how adopting VMware infrastructure – the combination of server, storage and networking virtualization technologies — as a fundamental IT strategy helps organizations to achieve these goals.

VMware Infrastructure allows IT teams to continuously consolidate workloads to maximize server utilization and decrease operational costs. It allows system administrators to manage a higher number of servers, and it delivers more flexibility and responsiveness in provisioning new software services and maintaining existing ones. Most importantly, it standardizes and simplifies the management of diverse x86-based environments across Microsoft Windows®, Linux, Sun Solaris x86 and Novell NetWare® operating systems.

The IT Challenge Today

Today, IT infrastructure organizations are working diligently to solve the problems created by the explosion in the scope and complexity of IT platforms adopted in the 1990's. The migration of application architectures to thin-client multi-tier architectures, the introduction of multiple generations of Windows servers and the rapid growth of Linux have swept across IT organizations in successive waves over the last ten years. These waves caused explosive growth in server counts, network complexity and storage volumes throughout geographically distributed IT organizations. The policies and procedures adopted to gain back control of the infrastructure have often introduced their own challenges. Some of the resulting symptoms reported by IT organizations include:

- Large numbers of under utilized "one-application per box" x86-based servers

- Pervasive over-provisioning caused by policies that size all servers for "worst-case" workload scenarios

- Long delays between change request submissions and operational changes

- Long provisioning cycle times for new servers, storage and networking

- Narrow scheduled downtime windows are over-subscribed with maintenance activities

- Inconsistent, non-reproducible server builds due to a lack of build policies, or an inability to enforce them

- Rushed patch roll-outs that break application functionality or performance because the patch-testing systems do not match production systems

- Multiple infrastructure management systems for distributed Linux, Windows and NetWare servers

- Incomplete information for equipment counts, status and ownership

This list of challenges is daunting, but IT has started to regain the upper hand in the battle against costly, inflexible and disorderly infrastructure. As a first step, IT organizations have generally centralized their IT infrastructure into fewer locations for better visibility. As a second step, they are adopting a new generation of infrastructure technologies and methodologies. The common vision of IT organizations today is to provide their business units with lower cost, higher service-level infrastructure that enables them to respond faster to business unit demands.
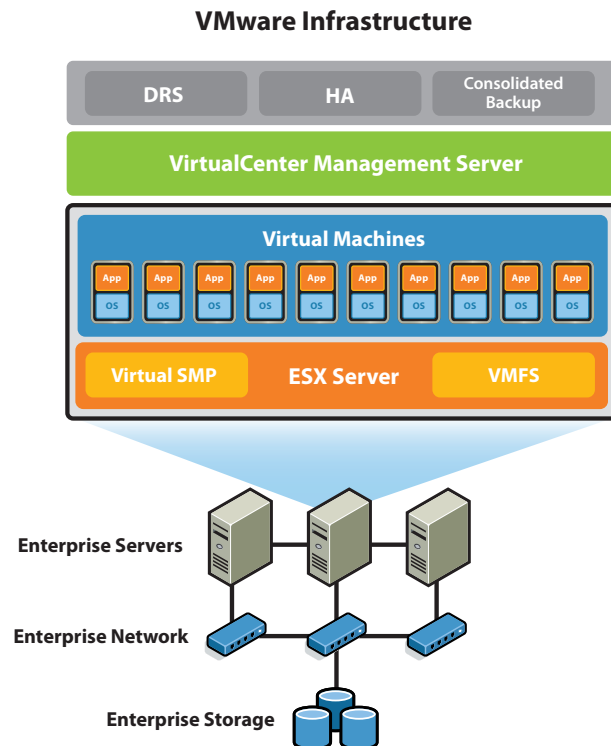
For example, most enterprises have already migrated to storage area networking for a flexible, lower cost, higher service level storage infrastructure. Currently, thousands of enterprises are adopting server virtualization technologies that provide the same benefits for the rest of the IT infrastructure. This synergistic combination of storage, networking and computing virtualization has created a new category of infrastructure software called virtual infrastructure. VMware provides the only production-ready server virtualization suite available today, VMware Infrastructure.

Introducing VMware Infrastructure

VMware Infrastructure is the most widely deployed software for optimizing and managing IT environments through virtualization – from the desktop to the data center. VMware first introduced virtualization technology to the x86 computing platform in 1999, and since then has saved its 20,000 customers billions of dollars in capital and operating costs. VMware Infrastructure abstracts the operating system from the hardware it's running on, providing standardized virtual hardware for operating systems and their applications that enables the virtual machines to run simultaneously and independently on one or more shared processors. With virtualization, customers can easily consolidate many disparate server workloads onto more reliable and higher performance hardware.
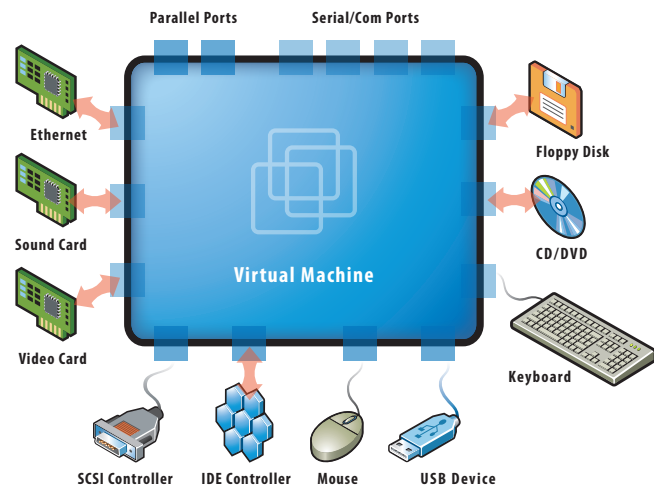
VMware Infrastructure

VMware Infrastructure transforms a mix of industry standard x86 servers and their existing processors, memory, disk and networking into a pool of logical computing resources. Operating systems and their applications are isolated into secure and portable virtual machines. System resources are then dynamically allocated to each virtual machine based on need and prioritization, providing mainframe-class capacity utilization and control of server resources. Virtual machines can run on any physical server in a resource pool and be shifted between those servers seamlessly with zero downtime. As a result, virtual

machines can be dynamically and automatically allocated to the most appropriate host in the resource pool to guarantee service levels to software applications. By aggregating hardware resources into resource pools, IT environments can be optimized to dynamically support changing business needs while ensuring flexibility and efficient utilization of hardware resources.

VMware Infrastructure provides a set of capabilities that make the entire IT environment more serviceable, available and efficient than physical hardware alone. Traditionally, companies have had to assemble a patchwork of various operating system or software application specific solutions for high availability, resource optimization and security. Because the virtualization layer is the first software installed on the bare metal, VMware Infrastructure can provide these capabilities consistently for all virtual machines. Standardizing the entire IT environment on the consistent virtualization-based distributed services is like creating an assembly line for IT that builds reliability, predictability and efficiency.

In order to better understand how VMware Infrastructure works, let's examine the definition and capabilities of virtual machines. A virtual machine is like a physical server, only instead of being a box of electronics, it is a set of software files. Each virtual machine represents a complete system – with processors, memory, networking, storage and BIOS – so that operating systems and software applications run in virtual machines, just like in a physical server, without any modification. The figure to the right shows the standard virtual components presented to every virtual machine, regardless of variations in the hardware present in the physical server.

Based on their inherent partitioning, isolation and encapsulation, virtual machines offer many advantages over physical servers. Virtual machines:

• Run on industry standard x86 physical servers

• Have full access to all physical server resources such as CPU, memory, disk, networking, and peripherals, allowing them to run any software application in a virtual machine

• Are completely isolated, providing secure processing, networking and data storage

• Can run concurrently with other virtual machines for optimal hardware utilization

• Are encapsulated in software files so that they can be provisioned, backed up or restored with the ease of a file copy

• Are portable, so full systems including virtual hardware, operating systems and fully configured applications can be easily moved from one physical server to another, even while running

• Can incorporate distributed resource management and high availability capabilities that provide better service levels to software applications than static physical infrastructure

• Can be built and distributed as plug-and-play virtual appliances that contain the entire stack of virtual hardware, operating system, and fully configured software applications for rapid deployment
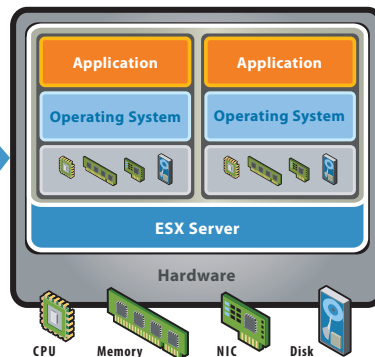

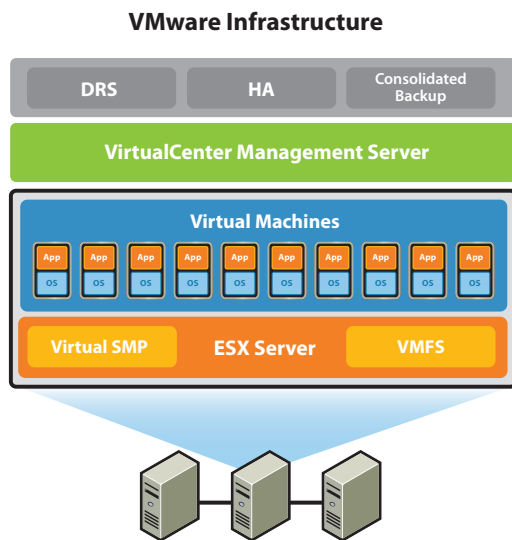Each virtual machine can use up to 16GB RAM and 4 CPUs with VMware Virtual SMP™
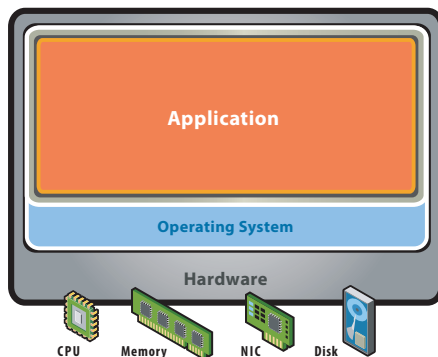
VMware Infrastructure Suite Components

VMware Infrastructure includes the following products:

• ESX Server 3 with VMware VMFS and Virtual SMP

• VirtualCenter 2 with VMotion, VMware DRS, and VMware HA

• Consolidated Backup

VMware Infrastructure

ESX Server provides very granular resource management, allowing it to share the resources of the physical server across the running virtual machines to maximize server utilization while ensuring virtual machine isolation. Virtualization acts as a resource multiplier, allowing a 4-way server with 32GB of memory to boot 32 virtual machines from a storage area network that collectively think they have 64 GB of memory, 32 virtual disks and 64 virtual network cards.

IT managers can take advantage of the fact that workloads are sometimes idle and that different applications are bound by different hardware resources (i.e., some applications are memory bound, some are CPU bound) and that peak usage occurs at different times for different workloads. Virtual machine resource allocations can be established with minimum, maximum, and proportional share amounts for CPU, memory, disk and network bandwidth, allowing applications to safely use greater physical resources periodically without requiring a constant allocation.

ESX Server delivers enterprise data center manageability when deployed with VirtualCenter. Virtual machines have built-in high availability, resource management and security features that provide better service levels to software applications than static physical environments can deliver.

VMware Infrastructure can run on certified hardware ranging from the largest x86 data center systems with multiple, dual-core processors and high-end fibre channel SAN storage arrays to entry-level white box servers using lower cost NAS and iSCSI storage.

VMware ESX Server is the building block of VMware Infrastructure

ESX Server installs directly on the hardware, or "bare metal", of each host server contributing resources to the virtual infrastructure. ESX Server provides a robust virtualization layer that enables each server to host multiple secure and portable virtual machines running side by side on the same physical server. The bare metal architecture gives ESX Server complete control over the server resources allocated to each virtual machine, and provides for near-native virtual machine performance with enterprise-class scalability.

A single ESX Server can host up to 128 running virtual machines, and given typical workloads, they often support about 10 running virtual machines per host processor. Each virtual machine can be configured to access up to 16GB of memory and up to 4 processors when using VMware Virtual Symmetric Multi-Processing (SMP). Sharing the physical server resources among a number of virtual machines dramatically increases hardware utilization and decreases capital cost.

VMware Virtual SMP provides Multi-processor virtual machines for demanding workloads

VMware Virtual SMP™ enhances virtual machine performance by enabling a single virtual machine to use multiple physical processors, or CPUs, in a host server simultaneously. Virtual SMP co-schedules non-idle virtual processors synchronously while allowing over-commitment of the processors. Idle virtual processors can be de-scheduled with the guest operating system running inside the virtual machine and then re-used for other tasks. Virtual SMP periodically moves processing tasks between the available processors to re-balance the workload. A unique VMware feature, Virtual SMP enables virtualization of the most processor-intensive enterprise applications such as databases, ERP and CRM.
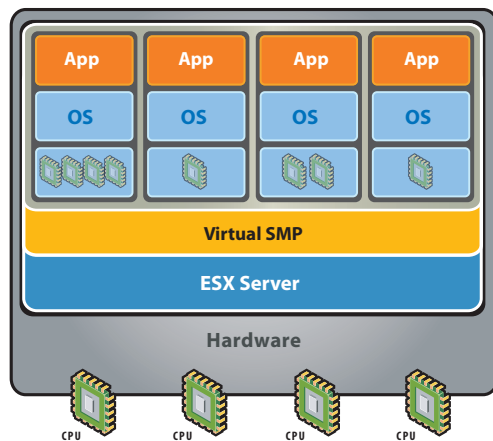
VMware VMFS enables innovative distributed services

Virtual machines are completely encapsulated in virtual disk files that can be either stored locally on the ESX Server or centrally using shared SAN, NAS or iSCSI storage. The latter configuration is more typical in enterprise environments where virtual machines are centrally accessible to other ESX Server installations using shared SAN, NAS or iSCSI storage and the Virtual Machine File System (VMFS). This configuration is much more powerful as it allows a resource pool of multiple installations of ESX Server to concurrently access the same files to boot and run virtual machines, effectively virtualizing the virtual machine storage.


Shared Storage
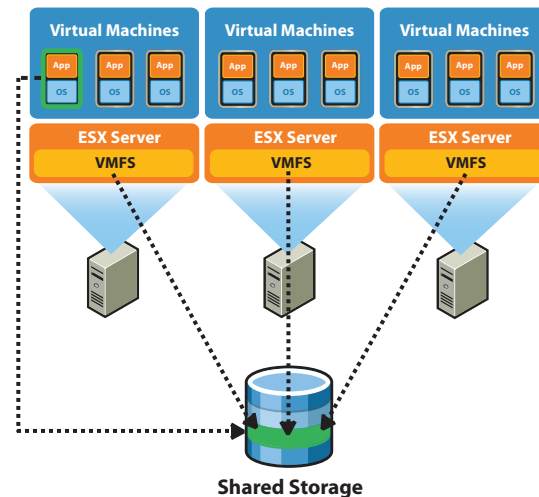
While conventional file systems allow only one server to have read-write access to the file system at a given time, VMware VMFS is a high-performance cluster file system that allows multiple installations of ESX Server read-write access to the same virtual machine storage concurrently. VMFS provides on-disk locking to ensure that multiple servers do not power a virtual machine at the same time. Should a server fail, the on-disk lock for each virtual machine is released so that virtual machines can be restarted on other physical servers.

The cluster file system enables innovative and unique virtualization-based distributed services. These services include live migration of running virtual machines from one physical server to another, automatic restart of failed virtual machines on a different physical server, and the clustering of virtual machines across different physical servers. As all virtual machines see their storage as local attached SCSI disks, no changes are needed to virtual machine storage configurations if they are migrated to another physical server.

VMware VirtualCenter manages all VMware Infrastructure

A VirtualCenter Management Server can centrally manage hundreds of ESX Server hosts and thousands of virtual machines, delivering operational automation, resource optimization and high availability to IT environments. VirtualCenter provides a single Windows management client for all tasks called the Virtual Infrastructure client. Virtual machines can be provisioned, configured, started, stopped, deleted, relocated and remotely accessed with keyboard and mouse control. The Virtual Infrastructure 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.
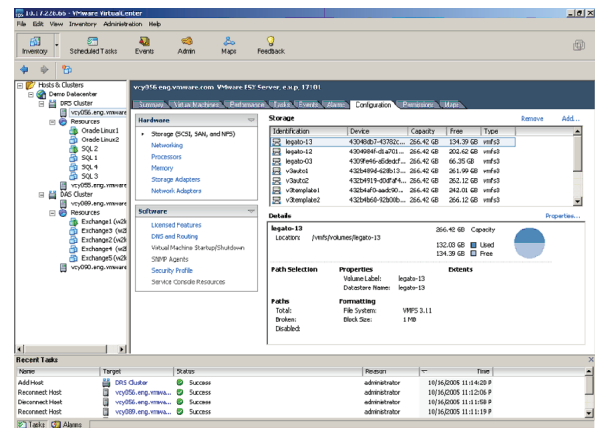
VirtualCenter provides a centralized view of many ESX Server hosts and virtual machines.
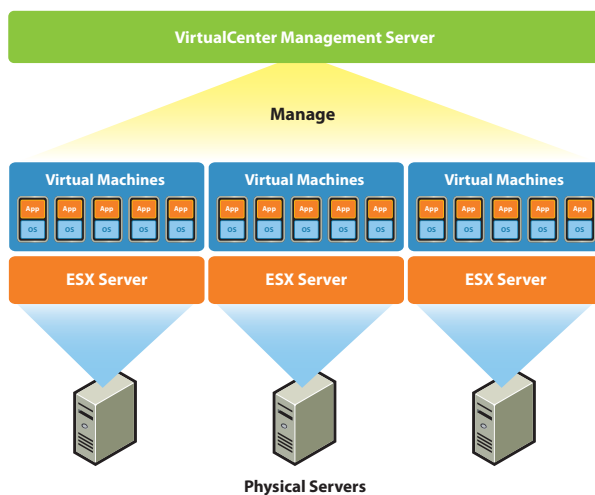
VirtualCenter delivers the highest levels of simplicity, efficiency, security and reliability required to manage a virtualized IT environment of any size, with key features including:

• Centralized management capabilities allow administrators to organize, monitor, and configure the entire environment through a single interface resulting in lower operating costs. VirtualCenter provides several organizational hierarchical views as well as a topology view to clarify host and virtual machine relationships.

• Performance monitoring capabilities, including utilization graphs of CPU, memory, disk I/O, and network I/O provide the detail needed to analyze host server and virtual machine performance.

- Operational automation through task scheduling and alerting improves responsiveness to business needs and prioritizes actions needing the most urgent attention.

- Rapid provisioning with a deployment wizard and virtual machine templates reduce the time and effort for creating and deploying virtual machines to a few mouse clicks.

- Secure access control, robust permissions mechanisms, and integration with Microsoft® Active Directory guarantee authorized access to the VMware Infrastructure and its virtual machines. Access to virtual machines can be securely restricted with customizable roles and permissions delegated to authorized administrators and end users, enabling full compliance with even the most detailed data center access control policies. Additionally, VirtualCenter includes full audit tracking to preserve a detailed record of every significant change made or operation performed in the data center to support new government regulations like Sarbanes-Oxley.

- Programmatic interfaces through the VMware Infrastructure SDK provide Web Services APIs to access the functionality and data provided through the graphical user interfaces, and enable integration with third party systems management products as well as custom extension of core functionality.

VMware VirtualCenter enables the organization of all ESX Server hosts and their virtual machines into clusters and resource pools to greatly simplify resource management. Clusters are a new concept in virtual infrastructure management that combines the power of multiple host servers with the simplicity of managing a single entity. Clusters reduce management complexity by aggregating standalone hosts into a single cluster with pooled resources and inherent high availability. Virtual machines can now be provisioned to a cluster rather than on single ESX Server host, making all the resources of the cluster available to the virtual machines. VirtualCenter can select the best host for virtual machines and move the virtual machines within the cluster if conditions change.
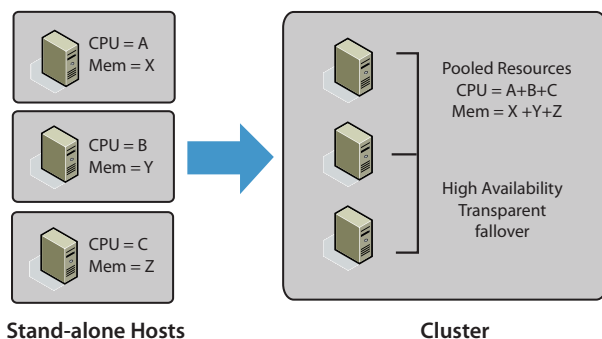
VMware clusters have inherent high availability because virtual machines now run on the cluster rather than on a standalone ESX Server host. If a VMware host fails, the virtual machines on it can be restarted on other hosts in the cluster. As hosts are added to or removed from clusters, the resources available to the virtual machines on the cluster are dynamically expanded or contracted.

Resource pools further simplify management and increase the flexibility of virtual infrastructure by providing a way to subdivide the resources of a stand-alone host or a cluster into smaller pools. A resource pool is a container for virtual machines that is configured with a set of CPU and memory resources that are shared by the virtual machines that run in the resource pool. A typical use of resource pools is to delegate control over a precisely specified set of resources to a group or individual without giving them access to the underlying physical environment.

Cluster
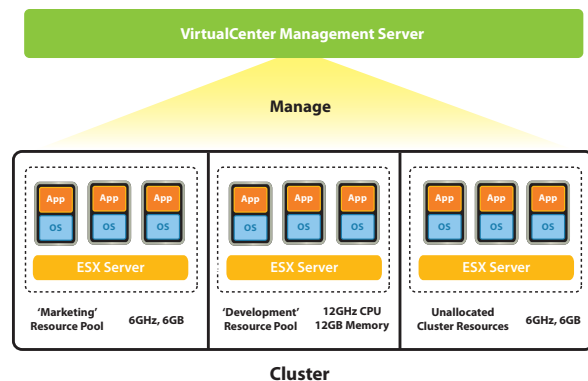
Resource pools are an ideal solution for giving users authority to create and manage their own virtual machines while constraining their resource usage. For example, a development team that needs to manage virtual machines could be provided with a resource pool like the one shown here that allocates a total of 12GHz of CPU capacity and 12GB of memory. The development team could then create and control its own virtual machines, but no matter how many virtual machines were started, its resource consumption could never exceed the size of the pool. Resource pools can be further nested, so the large 12GHz development resource pool could be further allocated into smaller resource pools for individual developers. In this way, resource pools simplify virtual infrastructure management by eliminating the need to provision virtual machines with individually preconfigured resource allocations. To maximize the utilization of shared virtual infrastructure, resource pools can be configured to allow them to "burst out" during periods of high activity to use any available floating capacity or even idle resources in adjacent pools on the cluster.

Stand-alone Hosts   **Cluster**

Resource pool allocations can also be changed dynamically which makes them a great container for enterprise applications that experience fluctuating workloads. For example, a multi-tier SAP installation could be configured as several networked virtual machines in a single resource pool. In anticipation of a period of increased SAP activity, the system administrator could simply allocate more CPU and memory to the SAP resource pool instead of having to individually adjust the resource allocations of each SAP virtual machine. The flexible hierarchical organization of resource pools allows users to match available IT resources to the business organization. Individual business units can receive dedicated infrastructure while still profiting from the efficiency of resource pooling.

VMware VMotion enables the live migration of virtual machines across hosts

A key enabling component of the dynamic, automated, and self-optimizing data center, VMware VMotion enables the live migration of running virtual machines from one physical server to another with zero downtime, continuous service availability, and complete transaction integrity. Live migration of virtual machines enables companies to perform hardware maintenance without scheduling downtime and disrupting business operations. VMotion also allows virtual machines to be continuously and automatically optimized within resource pools for maximum hardware utilization, flexibility, and availability.

Live migration of a virtual machine from one physical server to another with VMotion is enabled by three underlying technologies.

First, the entire state of a virtual machine is encapsulated by a set of files stored on shared storage such as a Fibre Channel or iSCSI Storage Area Network (SAN) or Network Attached Storage (NAS). VMware's clustered Virtual Machine File System (VMFS) allows multiple installations of ESX Server to access the same virtual machine files concurrently.

Second, the memory image and precise execution state of the virtual machine is rapidly transferred between ESX Server hosts over a high speed network. VMotion keeps the transfer period imperceptible to users by keeping track of on-going memory transactions in a bitmap. Once the entire memory and system state has been copied over to the target ESX Server, VMotion suspends the source virtual machine, copies the bitmap to the target ESX Server, and resumes the virtual machine on the target ESX Server. This entire process takes less than two seconds on a Gigabit Ethernet network.

Third, the networks being used by the virtual machine are also virtualized by the underlying ESX Server installations, ensuring that even after the migration, the virtual machine network identity and network connections are preserved. VMotion manages the virtual MAC address as part of the process. Once the destination machine is activated, VMotion pings the network router to ensure that it is aware of the new physical location of the virtual MAC address. Since the migration of a virtual machine with VMotion preserves the precise execution state, the network identity, and the active network connections, the result is zero downtime and no disruption to users.
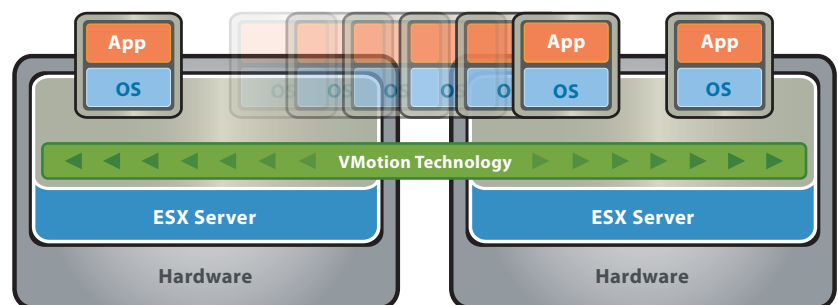
VMware DRS enables 80% utilization with guaranteed service levels

VMware Distributed Resource Scheduler (DRS) works with VMware Infrastructure to continuously automate the balancing of virtual machine workloads across a cluster in the virtual infrastructure. When a virtual machine is first started on the cluster, VMware DRS selects the ESX Server host it runs on by automatically identifying a machine with sufficient resources. If conditions on the selected host change (for example, if other virtual machine activity increases to the point that the virtual machine can't meet its guaranteed resource allocation), VMware DRS will recognize that condition and search for an alternate ESX Server host on the cluster that can honor the resource allocations needed by the virtual machine. VMware DRS will then use VMotion to migrate the virtual machine to the new host automatically and with zero downtime for its users and applications. The result is a continuous balancing of all server workloads across the virtual infrastructure.

VMware DRS works using the ESX Server Local Scheduler and the VirtualCenter Global Scheduler. The ESX Server Local Scheduler determines which processors within a host to use for virtual machine execution based on current workloads, and it will relocate virtual machines as often as every few milliseconds if a different host processor offers more capacity. In contrast, VirtualCenter's Global Scheduler continuously evaluates where best to locate a virtual machine across an entire cluster of ESX Server hosts. The Global Scheduler will determine which ESX Server will host a newly started virtual machine and it will use DRS to relocate a virtual machine if another ESX Server host offers a more suitable set of resources.

VMware DRS can be configured to operate in automatic or manual mode. In automatic mode, VMware DRS migrates the virtual machine to the most appropriate host in the cluster with no intervention required. In manual mode, VMware DRS provides a recommendation on optimal placement of the virtual machine, and leaves it to the system administrator to decide whether to make the change.

With VMware DRS, a new virtual machine can be placed on a cluster instead of a specific host server, and VMware DRS will make an intelligent decision about where to place it when it starts. VMware DRS also supports affinity and anti-affinity rules for certain use cases. For example, an anti-affinity rule can always keep clustered virtual machines on physically separate servers at all times for hardware redundancy. Alternately, an affinity rule can keep two virtual machines with internal networking requirements always on the same physical host.

VMware DRS preserves absolute levels of allocated resources when virtual machines are migrated. It is aware that a virtual machine allocated 10% of the CPU resources on an 8-way machine with 3GHz processors will need a larger percentage of host resources if migrated to a 2-way machine with slower processors.

VMware DRS will respond immediately when a new ESX Server host is added to a cluster, which is a simple drag-and-drop operation within VirtualCenter. The new host will expand the resource pool available to the cluster's virtual machines and
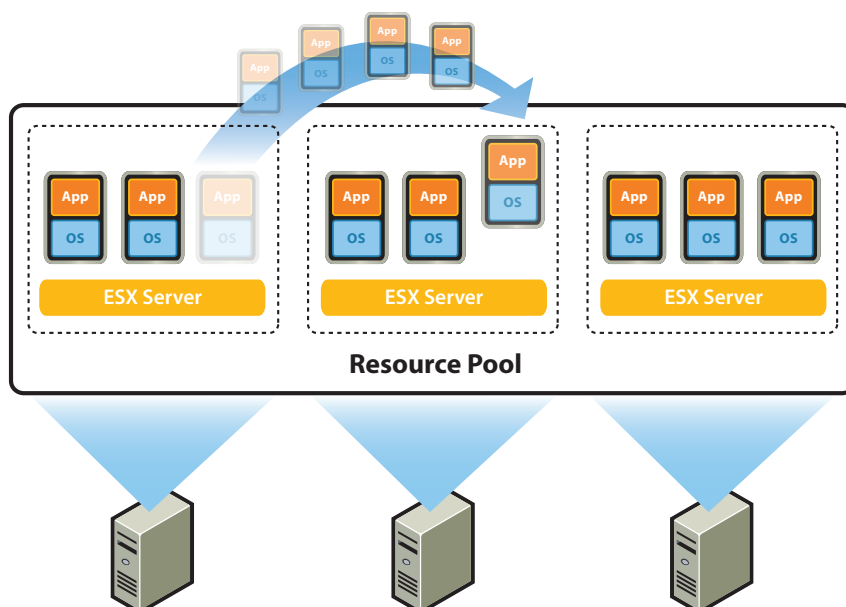
VMware DRS will rebalance workloads by shifting virtual machines to the new host as appropriate. VMware DRS will also respond to a host being removed from a cluster by migrating its virtual machines to remaining hosts in the cluster.

The end result with VMware DRS is a data center that can reliably run at over 80% utilization levels while safely maintaining guaranteed service levels for all applications. VMware DRS delivers much better ROI on x86 server investments with a minimum of capacity planning effort required.

VMware HA provides easy to use, cost effective high availability

VMware High Availability (HA) provides easy to use, cost effective high availability for applications running in virtual machines. The loss of an ESX Server host due to a hardware failure is no longer a catastrophic event, but simply means that the resource pool available to the cluster has been reduced. HA will manage the reassignment and restart of the failed host's virtual machines on the other ESX Server hosts in the cluster with the VirtualCenter Global Scheduler making the decisions on where to place the virtual machines to best meet resource guarantees.

High availability for applications is usually achieved with failover clustering products like Microsoft Cluster Services or Veritas Cluster Services, but that technology is expensive and difficult to configure and manage. Failover clustering requires expensive operating system upgrades or third-party software and the protected applications must be cluster-aware. Failover clustering can also be a resource hog as standby cluster nodes tie up dedicated hardware even if they are not in active use.

VMware HA delivers high availability without configuration. Simply select the VMware HA option for a cluster or host, and all its virtual machines will be protected with automatic restarting should a host fail. VMware HA differs from failover clustering in that there will be some downtime as a virtual machine is restarted, but for the majority of applications, that minimal interruption is acceptable and the expense and complexity of failover clustering is simply not necessary.

It's important to note that the VirtualCenter Management Server is not a single point of failure in a cluster protected by VMware HA. A VMware HA agent placed on each server maintains a "heartbeat" with the other servers in the resource pool and loss of a "heartbeat" initiates the process of restarting all affected virtual machines on other servers. Restart of virtual machines is made possible by the VMFS cluster file system that allows multiple installations of ESX Server to have read-write access to the same virtual machines files.

VMware HA ensures that sufficient resources are always available in the resource pool to allow restart of virtual machines on different physical servers in the event of a server failure.

Resource Pool

Physical Servers
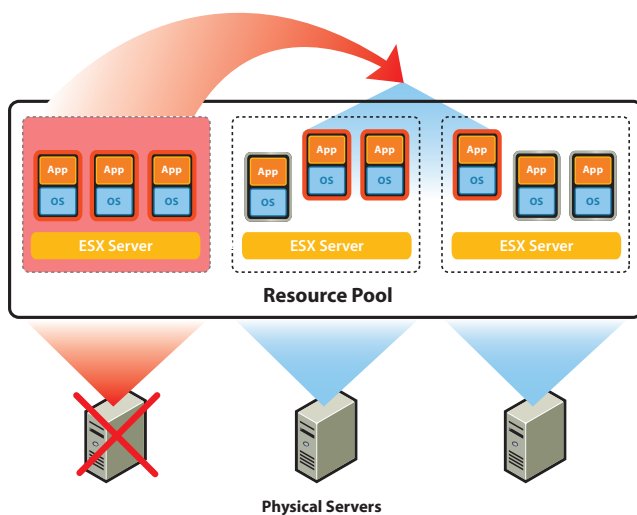
### VMware Consolidated Backup delivers LAN-free backup with zero downtime

VMware Consolidated Backup provides an easy to use, centralized facility for LAN-free backups that preserve file-level visibility.

VMware Consolidated Backup centralizes backup processing by taking snapshots of running virtual machines after quiescing the applications in the virtual machines to disk to ensure file system consistency. The virtual disk snapshots are then mounted by a Windows backup proxy server that can use a standard backup agent to process the backup to tape or disk devices. VMware Consolidated Backup is pre-integrated with popular backup utilities and provides pre-and post-processing scripts for easy out-of-the-box implementations.

VMware Consolidated Backup operates transparently with no need to interrupt virtual machine activity. The backup processing is moved off the ESX Server host so there's no impact on CPU and network resources needed by critical applications in virtual machines. Backups occur without system interruption and do not affect production servers.

Consolidated Backup reduces backup agent licenses required and improves manageability because it requires only a single backup agent on the proxy server rather than on every virtual machine. Utilizing a proxy server also reduces the load on ESX Server allowing it to run more virtual machines on the same physical server.

Full and incremental file-based backup is supported for virtual machines running Microsoft® Windows operating systems. Full image backup for disaster recovery scenarios is available for all virtual machines regardless of guest operating system.
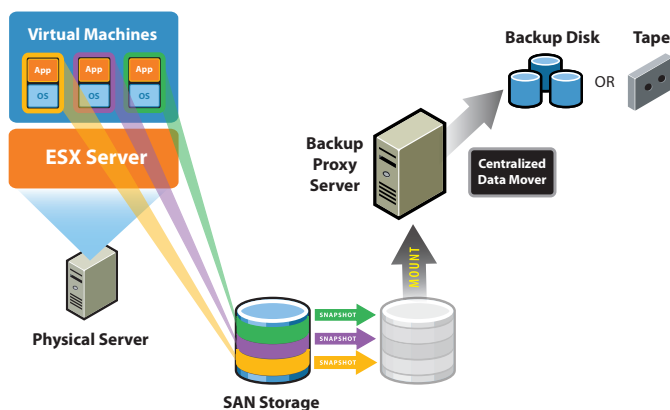
VMware Infrastructure 3 is available in Starter, Standard and Enterprise editions

VMware Infrastructure 3 is packaged in three editions designed to meet differing requirements from development to branch office to enterprise data center use. Additional add-on components can be added to the Starter and Standard editions to address specific needs.

VMware Infrastructure 3 Starter includes a VirtualCenter Agent and ESX Server and is designed for the small or remote work environment, be it small business, branch office or department. The Starter edition virtualizes standard IT infrastructure such as e-mail, file, print, proxy, and firewall servers, delivering simplicity, efficiency and tangible savings for small business IT operations.

VMware Infrastructure 3 Standard edition adds VMFS and Virtual SMP to increase scalability to handle any workload, allowing users to virtualize a broad range of applications including the most resource intensive enterprise software such as databases, ERP and CRM applications. VMware Infrastructure 3 Standard increases the efficiency and availability of mission critical applications.

VMware Infrastructure 3 Enterprise adds all of the distributed infrastructure services to include VMotion, HA, DRS and Consolidated Backup. VMware Infrastructure 3 Enterprise is the foundation for building the dynamic, automated and self-optimizing data center.

VMware Infrastructure Lowers Costs

Adopted by over 20,000 enterprise IT organizations worldwide, VMware virtualization software has saved billions of dollars in hardware and operational costs. The cost savings driven by VMware Infrastructure are only accelerating as processors grow more powerful, the suite is certified on additional low-cost hardware, and VMware Infrastructure continues to scale up to address the most demanding enterprise workloads.

Implement Server Consolidation and Containment while Maximizing Server Utilization

Contain server sprawl by running software applications in virtual machines on fewer, highly scalable, reliable enterprise-class servers. Customers of VMware Infrastructure are often able to consolidate 10 or more virtual machines per physical processor, thereby drastically increasing server utilization and containing server sprawl.

Consolidating underutilized servers lowers capital costs by reducing the need to buy additional hardware for new projects, and removing servers from the data center enables a proportional reduction in operational costs for power, cooling and floor space. As a virtual machine can now address up to 4 processors and 16GB of memory, up to 95% of current enterprise workloads can be virtualized and consolidated.

Enable Enterprise-wide Standardization

As virtualization abstracts the software from the hardware to create portable virtual machines, VMware Infrastructure makes it easier to standardize the data center enterprise-wide. VMware Infrastructure can run most popular operating systems on tower, rack and blade servers from all major hardware vendors, greatly extending the value of existing multi-vendor investments.

Streamline IT Operations and Increase Administrator Productivity

VMware Infrastructure simplifies labor and resource intensive IT operations such as server provisioning and maintenance across disparate hardware, operating system, and software application environments, allowing fewer IT staff to manage more workloads.

Additionally, the unified platform for monitoring and management provided by VirtualCenter dramatically increases system administrator productivity, enabling each system administrator to monitor and effectively manage a larger pool of infrastructure resources.

Reduce Business Unit to IT Coordination Costs

Perhaps one of the most intractable but least visible consumers of IT staff time is the cost of coordinating with business units. These costs go down dramatically when IT implements VMware Infrastructure as hardware management is separated from software management. Before VMware Infrastructure, for example, IT spent far too much time negotiating hardware downtime windows for business unit applications. Now, hardware downtime can happen at any time because running software can be shifted off hardware that requires maintenance without impacting the business unit, eliminating a whole class of IT administration costs.

Streamline Software Development & Testing

VMware Infrastructure streamlines software development and testing in many ways. Common time consuming tasks such as configuring servers, provisioning servers and archiving and restoring configurations are dramatically simplified to increase developer productivity. Additionally, development, test and staging environments require much less hardware when consolidated onto shared hardware using virtual machines. Finally, the use of virtual machines makes it much easier to increase testing coverage and improve software quality.

VMware Infrastructure Simplifies Management

VMware Infrastructure unifies the management of all x86-based operating systems onto a single virtual hardware platform that spans the data center. It brings the speed of provisioning, de-provisioning and rollback to real-time levels. It also enforces the discipline of deploying servers based on templates rather than policy, as it takes far less time for the administrator to use a gold master template than to manually create a server. Since virtual infrastructure is homogeneous, and server deployments are consistent, operational risk is dramatically lowered.

Securely Centralize Datacenter Management

VMware Infrastructure provides simplified monitoring, management, reporting and remote access across the datacenter from any location with the Virtual Infrastructure Client. There is no need to visit servers for system software and configuration needs. The browser version of the client makes providing a user with access to a virtual machine as easy as sending a bookmark URL.

Additionally, VMware Infrastructure provides a unified management platform across Windows, Linux and NetWare servers. Now administrators learn only one way of provisioning and monitoring systems, instead of one for every version of deployed operating systems. This reduces training costs, and allows greater consistency of policy application across diverse operating systems.

Ensure Consistent Server Builds

VirtualCenter provisions servers based on templates. By provisioning based on pre-configured combinations of operating systems and applications, IT managers can ensure that all servers running in the environment match the current best practice for security and configuration. As a result, each Exchange Server looks like every other Exchange Server. The servers built by one administrator look like the servers built by every other one. This means that troubleshooting becomes easier, and the likelihood of an accidental open port, or vulnerable service left active decrease to near-zero levels. Fundamentally, the infrastructure becomes rationalized and eccentric variability disappears.

Improve Success Rates for Patch Roll-outs

Since the infrastructure is rationalized, and consistent server builds are built-in to virtual infrastructure, IT managers can have the security of knowing that if a patch does not break one server type, it will not break any others. Moreover, exact duplicates of current production systems can be created in a test sandbox server for patch and upgrade testing. This is different from a restored backup or a disk image in that a virtual machine copy is an exact copy of the source system, including the virtual hardware layer. Additionally, with the snapshot and rollback capabilities included in virtual infrastructure, virtual machines with patches that fail in production can be instantly rolled back to the last known good state.

Deploy Virtual Appliances to Simplify Change Management

A virtual appliance is a fully pre-configured virtual machine including operating system and software application. Virtual appliances are revolutionizing the software distribution paradigm by combining the simple deployment of software with the benefits of a pre-configured device. For solution providers, building a virtual appliance is simpler and more cost effective than building a hardware appliance. Firewalls are an example of this paradigm shift. The first network firewalls were software programs. To setup a firewall, users had to purchase a computer, install a supported operating system, install the firewall, and configure everything. To eliminate some of the complexities involved in deploying firewalls, vendors built hardware-based firewalls. These firewall appliances were either standard or custom hardware that included a minimal operating system and the complete firewall program. A newer approach to this same problem is a firewall virtual appliance. In this case, the pre-configured firewall lives inside a virtual machine and can be deployed on existing hardware.

Simplify Legacy Software Migration

Virtual infrastructure allows legacy applications that require dated legacy operating systems to run unchanged for as long as needed on newer hardware using virtual machines. This has proven to be instrumental in helping companies extend the life and value of legacy software assets while avoid expensive porting costs. Hosting legacy systems in virtual machines greatly increases reliability and reduces maintenance expenses.

VMware Infrastructure Increases Agility

VMware Infrastructure provides the capability for IT to dramatically increase its responsiveness to business unit demands. Since virtual infrastructure cuts the bonds between hardware and software, it gives IT organizations the flexibility to rapidly provision new servers and adjust resources in response to changing business requirements.

Instantly Provision New Servers

Whether a single new server is needed for a week, or 50 servers are required for an hour, VMware Infrastructure provides powerful instant provisioning capabilities that allow the real-time provisioning and de-provisioning of servers across Windows, Linux, Solaris x86 or NetWare operating systems. IT organizations can implement just-in-time server provisioning schemes to allow business units to provision their own servers when needed. Imagine telling a business unit that their new server is up and running and waiting for their login, on the same call that they request a new server. Similarly, scaling out an application, or even performing routine maintenance requests that require server reboots can be performed an order-of-magnitude faster.

Using VMware Infrastructure, administrators can quickly select the "gold" template for a new server deployment from a library of standard server templates and deploy it to the hardware pool in seconds. VMware Infrastructure performs a file copy to create a new instance of the selected server template and then configures it for use. Server deployment becomes such a low cost operation that IT can create servers that would never have been cost-effective to deploy as complete physical servers: for example creating a temporary server for testing beta application software becomes trivial. Compare the seconds to provision a server with VMware Infrastructure to the hours or days that it typically takes using a manual server deployment process, and the cost savings of virtual infrastructure quickly add up.

Deliver Utility Computing to Business Units with Guaranteed Service Levels

Using resource pools, IT can respond instantly to shifting application and workload requirements to easily align computing resources with business priorities to satisfy guaranteed service levels. IT specifies the rules and priorities that govern virtual machine resource allocation, and the VMware Infrastructure continuously and automatically optimizes the virtual machine placement for maximum hardware utilization, flexibility and availability. This enables IT to provide dedicated infrastructure to business units while still profiting from higher hardware utilization gained through resource pooling. With VMware Infrastructure in place, fewer platforms can be deployed and used to flexibly to address changing requirements.

Enable All Applications to Benefit from High-End Hardware Performance and Reliability Gains

VMware Infrastructure's makes it cost effective to deploy high-end hardware in the datacenter such as rack servers with redundant components and 4-way blade servers. As the additional cost of high-end servers can be distributed across many more workloads than with low-end hardware, the initial investment in high-end hardware is quickly returned through the improved utilization and reduced operational costs of managing fewer servers. Additionally, each workload can take advantage of the high-end hardware's increased capabilities as needed to provide superior application performance and reliability for end users.

VMware Infrastructure Tightens Security

VMware Infrastructure delivers a consistent, secure and auditable data center environment that can be assembled from heterogeneous hardware. Operating systems running within virtual machines will still require security management and vulnerability patches, but their stability and security can be greatly improved and access management simplified with the fine-grained, role-based access controls enforced by VMware Infrastructure.

Centrally Secure and Audit the Data Center Infrastructure

Virtual machine configurations and remote access can be protected with very granular yet flexible access controls, so very few IT staff need direct access to the VMware Infrastructure server hardware., Administrators and end users can remotely perform all server provisioning and configuration actions with comprehensive audit logging to record significant operations. Managing access to virtual machines can also be a useful tool to control user access to applications that don't provide sufficient security on their own.

Isolate Faults and Security at the Hardware Level

Virtual machines are completely isolated from each other in operation, so an ill-behaved or compromised application cannot impact any other virtual machines in the environment other than through network traffic. Properly configured, virtual machines can better contain digital attacks though fault isolation, as one virtual machine can't bring down others. VMware Infrastructure virtual networking gives administrators the flexibility to either isolate virtual machines from the corporate network or to make them full peers with other physical machines on the network.

VMware Infrastructure Improves Availability

VMware Infrastructure can improve application availability by an order of magnitude with zero downtime required for hardware maintenance and server backups, enabling nearly 100% uptime for applications. Additionally, VMware Infrastructure makes it very simple to enable cost-effective high availability for all virtual machines with VMware HA.

Enable Zero-downtime Maintenance

Perhaps one of the most interesting implications of virtual infrastructure is the new flexibility IT management gains in scheduling staff tasks. By allowing hardware maintenance to be decoupled from software maintenance tasks, the amount of administration deferred to downtime windows is dramatically reduced. With VMware Infrastructure, IT can simply place an ESX Server host in maintenance mode and DRS will automatically migrate all virtual machines to other ESX Server installations in a resource pool, allowing physical server maintenance with zero downtime. Maintenance can be done during prime usage hours, from 8-to-5 instead of scheduling downtime for nights and weekends. Similarly, snapshot copies of running production systems can be taken at any time for debugging or patch testing. Problems with a new patch or a new application upgrade can be investigated offline without taking the server down for maintenance. This results in the ability to work on problems at the optimal pace and with the staff whose skills best fit the problem.

Enable Zero-downtime Backups

With Consolidated Backup, virtual machines can be backed up as virtual disks or with file level visibility without requiring any downtime or any performance hit on the virtual machine and the LAN. Consolidated Backup takes a virtual machine snapshot after quiescing the guest operating system file system to ensure file integrity. The virtual disk snapshots are then mounted by a Windows backup proxy server that can use a standard backup agent to process the backup to tape or disk devices.

Provide Advanced Business Continuity Protection with Simple & Rapid Disaster Recovery

Traditional high availability solutions are often relatively complex and expensive, and typically reserved for mission critical applications. VMware Infrastructure changes the economics of high availability and makes it accessible for the majority of software applications that have until now been left unprotected.

With VMware HA, companies can implement a unified disaster recovery platform that allows many production virtual machines to be recovered in the event of hardware failure without investing in costly one-to-one mapping of production and DR hardware. VMware HA provides cost-effective high availability for all applications running in virtual machines. Unlike other high availability solutions that are operating system or software application specific, VMware HA delivers a consistent, easy to manage high availability solution for the entire IT environment as a consistent "first line of defense".

Building the Virtualized Enterprise with VMware Infrastructure

The only production-ready virtualization suite, VMware Infrastructure is delivering proven results in a wide variety of environments and applications at more than 20,000 enterprise customer sites of all sizes. The suite is fully optimized, rigorously tested and certified for the widest range of hardware, operating systems and software applications allowing for enterprise-wide standardization independent of operating systems and hardware. VMware Infrastructure provides built-in management, resource optimization, application availability and operational automation capabilities that deliver transformative cost savings as well as increased operational efficiency, flexibility and IT service levels. VMware Infrastructure scales to support IT environments of any size and is not tied to any operating system, giving customers a bias-free choice of operating system and software applications.

In summary, VMware Infrastructure:

• Increases hardware utilization by up to 10 times

• Enables continuous uptime and non-disruptive maintenance of IT environments with live migration of entire running systems

• Accelerates the application development and deployment lifecycles

• Allows legacy systems to co-exist with new environments

• Eliminates the need for cumbersome software installation and configuration with Virtual Appliances

• Improves responsiveness to business needs with instant pro-visioning and dynamic optimization of application environments

• Streamlines labor and resource intensive IT operations across disparate hardware, operating system, and software application environments.

• Enables broad-based, cost-effective application availability and business continuity independent of hardware and operating systems

Getting Started

The VMware Sales Team can help your IT organization determine how VMware Infrastructure will provide these benefits in your particular test, development and production environments. Using ROI tools, case studies, and other tools, VMware will work with you to design and implement specific success criteria so you can evaluate our software effectively. Visit us on the Web at www.vmware.com, email us at sales@vmware.com, or call us at 877-4VMWARE to get started.

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