

WHITE PAPER

Building Virtual Infrastructure with VMware VirtualCenter



Virtual Infrastructure Software
for the Responsive Enterprise



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 sustainable competitive advantage need to:

- Drive cost out of their infrastructure 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 demonstrate how adopting virtual infrastructure – the combination of server, storage and networking virtualization technologies — as a fundamental IT strategy helps organizations achieve these goals.

VMware® VirtualCenter manages virtual infrastructure, which allows IT teams to continuously consolidate workloads for optimal savings on hardware and decreased operational costs. It allows system administrators to manage a higher number of servers. 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 and NetWare® operating systems.

Table of Contents

The Challenge for IT Today

- The legacy of the 1990's Information Technology explosion
- Cost, responsiveness and consistency remain core challenges

VMware Virtual Infrastructure

- Virtual infrastructure transforms the data center into a single pool of resources
- The VMware virtual hardware platform virtually standardizes server hardware
- Getting ready for Utility Computing

VMware Virtual Infrastructure Components

- VirtualCenter provides management for virtual infrastructure
- Continuous workload consolidation, instant provisioning and zero-downtime maintenance
- VMotion™ technology

Virtual Infrastructure Lowers Costs

- Managing large numbers of servers with fewer resources
- Just-in-time provisioning for increased operational productivity

Virtual Infrastructure Increases Responsiveness

- Instant provisioning of new servers without new hardware
- Debugging snapshots for diagnostics

Virtual Infrastructure Improves Consistency

- VMware virtual hardware rationalizes the datacenter
- Consistent management across Windows, Linux and NetWare
- Best-fit applications

The Virtual Infrastructure Wave

- Reduced operational, hardware, and support costs
- Deploy applications on or ahead of schedule, accelerating time-to-market
- Improved infrastructure quality across Windows, Linux and NetWare
- Increased staff leverage

Getting Started

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 and editions 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/one box" x86-based servers
- Pervasive over-provisioning caused by policies that size all servers for "worst-case" workload scenarios
- Long provisioning cycle times for new servers, storage and networking
- Long delays between change request submissions and operational changes
- Narrow scheduled downtime windows over-subscribed with maintenance activities
- Inconsistent, irreproducible 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 management systems for distributed Linux, Windows and NetWare servers.
- Incomplete information for equipment counts, status and ownership

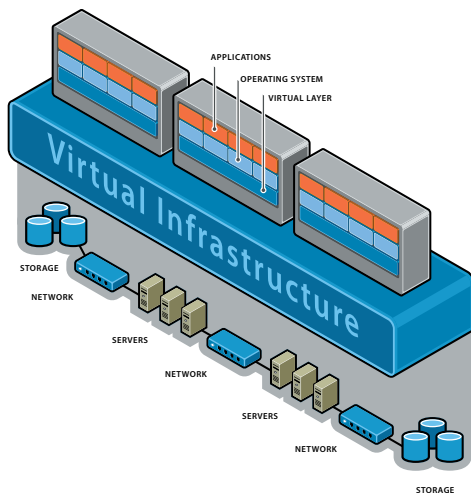
This list of challenges is daunting, but IT has started to regain the upper hand in the battle against costly, inflexible and disorderly infrastructure. As a first step, IT organizations have generally centralized their IT infrastructure into fewer locations for better visibility. As a second step, they 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 are already migrating 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 Virtual Infrastructure

Virtual infrastructure provides a layer of abstraction between the computing, storage and networking hardware, and the software that runs on it. Virtual infrastructure introduces a new category of infrastructure capabilities to the data center. With virtual infrastructure, IT organizations can provision new services and change the amount of resources dedicated to a software service simply by interacting with a management console. Hardware management is completely separated from software management, and hardware can be treated as a single pool of processing, storage and networking power – which can be allocated or reallocated to various software services on the fly.

VMware is a pioneer of virtual infrastructure. VMware's implementation of virtual infrastructure is based on virtual machine technology. This technology was originally developed for mainframes to allow multiple operating systems to share a single piece of hardware. VMware pioneered virtual machines on the x86 platform, and has spent almost six years enhancing their capabilities for general enterprise use. The VMware virtual hardware platform implemented by VMware's virtual machines makes virtual infrastructure possible. It provides a standardized hardware image – implemented entirely in software – on which operating systems and applications can run. Whether the underlying hardware is a SAN-attached 8-way system with gigabit Ethernet cards or a direct-attached blade server sharing a network switch, the exact same virtual hardware platform is presented to the operating system and its applications.



The VMware virtual hardware platform

The VMware Virtual Hardware Platform

By creating a uniform virtual hardware platform across the entire data center, virtual infrastructure allows software to be installed on or moved from one physical system to another without requiring reconfiguration of the operating system or applications. With VMware's ground-breaking VMotion™ technology, this move is transparent to the user and does not cause an interruption in user service.

Adopting virtual infrastructure results in:

- 60-80% utilization rates for x86-based servers - up from today's typical 5-15%
- Just-in-time provisioning of additional resources to applications
- Provisioning times for new applications measured in seconds, not days
- Response times for change requests measured in minutes
- Zero-downtime hardware maintenance without waiting for maintenance windows
- Unified server provisioning, monitoring and resource allocation across multiple generations of Windows, Linux and NetWare servers
- Guaranteed build consistency across systems
- Higher success rates for patch roll-outs
- Complete information for equipment counts, status and ownership

Getting Ready for Utility Computing

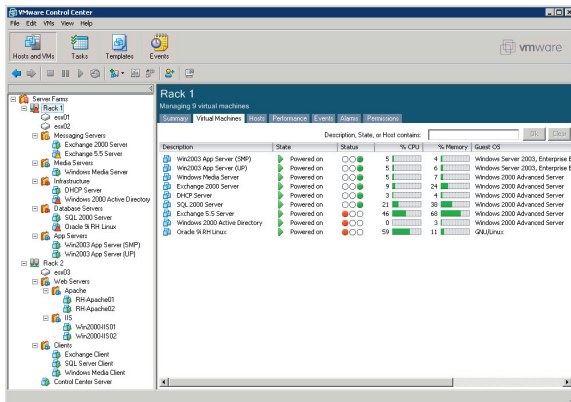
For organizations that want to evolve their infrastructure toward utility computing, the first step is the implementation of a virtual infrastructure. For these organizations, VMware offers a comprehensive open Web services API for its implementation of virtual infrastructure that easily plugs into other vendor's automation and policy management frameworks. As enterprises select vendors for higher-level capabilities such as service level management or chargeback, VMware virtual infrastructure can be easily integrated.

VMware Virtual Infrastructure Components

The primary building blocks required to build a virtual infrastructure solution include one or more Virtual Infrastructure Nodes (VINs) and VMware VirtualCenter. The available VIN options include the GSX Server™ VIN (which includes VMware GSX Server and VirtualCenter Agent) and the ESX Server™ VIN (which includes ESX Server, VirtualCenter Agent, VMotion and Virtual SMP™). IT managers can select either GSX Server or ESX Server VINs, or use a combination of both, based on their unique virtual infrastructure requirements.

In conjunction with one or more deployed VINs, VMware VirtualCenter management software delivers the business benefits of virtual infrastructure. With VirtualCenter, an administrator can manage thousands of Windows NT®, Windows 2000, Windows 2003, Linux and NetWare servers from a single point of control. The VirtualCenter interface provides a powerful view of all the virtual resources in a data center. From the VirtualCenter interface, administrators can perform:

- Continuous workload consolidation. Monitor and optimize the utilization of data center resources to minimize unused capacity while maintaining application service levels, by adjusting the resources dedicated to each software service.
- Instant provisioning. Reduce server-provisioning time from weeks to minutes, allowing administrators to respond immediately to requests for new IT services. Using server templates, administrators can ensure that new servers are fully consistent with current build and security policies.
- Zero-downtime maintenance. Safeguard business continuity 24/7, with no service interruptions for hardware maintenance, deployment, or migration. Where ESX Server VINs have been deployed, VMotion can be used to instantly move running operating systems and their applications from a system requiring maintenance to another virtual machine, then transfer them back when maintenance is complete.



The VirtualCenter user interface. In the left pane are the virtual hosts, containing virtual machines. The main window shows a dashboard of virtual machines across the data center.

Key VirtualCenter Features

Template Library: VirtualCenter allows administrators to manage a versioned library of server templates that can be used to provision new services. Administrators can also easily create new templates from running systems. For example, a server that has been tuned for optimal performance for Oracle databases, or contains a custom hardened security configuration, can instantly be transformed into a best practice image.

Provisioning and resource allocation: Administrators can use the VirtualCenter interface to provision new Windows NT, Windows 2000, Windows 2003, Linux or NetWare servers to the pool of hardware resources. They can then guarantee specific amounts of processor cycles, real memory access, disk I/O and network bandwidth to the server. When a server requires more or less resources, the allocations can be changed, or VMotion technology can be used to move it to another physical system without interrupting user service.

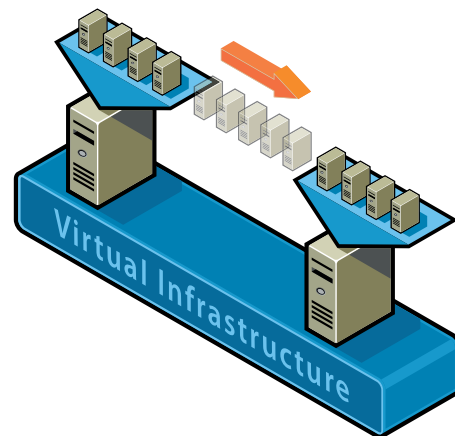
Monitoring and Alerting: Threshold and event alerts can be configured for a large number of events within the virtual infrastructure, including server failures and over/under utilization.

Virtual Infrastructure SDK: VirtualCenter provides a rich API integration capability so routine events can be automated or triggered by external systems.

VirtualCenter also incorporates a robust access control framework so levels of access can be granted to IT staff with different rights and privileges to manage the infrastructure.

VMware's Breakthrough VMotion Technology

VMotion transfers the entire system and memory state of a running virtual machine from one VMware ESX Server VIN to another. The system's disk, including all of its data, software and boot partitions, must be stored on a shared storage infrastructure such as a SAN. By reducing the problem to one of migrating system and memory state, VMware is able to leverage the basic suspend/resume capabilities of virtual machines, while providing an extra layer of availability that enables end-user services to continue uninterrupted with VMotion.



VMotion enables live servers to be moved from one virtual machine host to another. IT organizations can do zero-downtime maintenance and intelligent workload management without impacting user services.

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 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. Since the bitmap is small, this entire process takes less than two seconds on a Gigabit Ethernet network and appears as no more than momentary network latency to the applications, services, or users attempting to reach the virtual machine. Once the transfer is over and the virtual machine resumed, the bitmap is used by the target virtual machine to keep up-to-date on any memory changes needed from the source machine. The target virtual machine is effectively running with all the memory and system state of the source.

By keeping the transfer period from the source to destination under a few seconds, VMotion can take advantage of redundancies built into the network layer to ensure service continuity. The TCP/IP protocol guarantees that any lost packets will be automatically resent, and most distributed applications built in the last ten years are capable of handling a one to two second network loss.

The destination machine maintains the same network identity. VMotion technology 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.

VMotion depends on VirtualCenter and the ESX Server virtualization layer to ensure compatibility between the source and the destination. For VMotion to work, the only hardware requirement is the source and destination host machine have CPUs from the same processor family. For example, VMotion will work between an ESX Server running on a Pentium 4 1.5GHz and an ESX Server running on a Pentium 4 2.4GHz. It will not work between a Pentium III and Pentium 4.

Virtual Infrastructure Lowers Costs

Adopted by thousands of IT organizations worldwide, VMware server software has saved hundreds of millions of dollars in hardware and operational costs when used as a server consolidation platform. Now VirtualCenter and VINs further broaden the capabilities of VMware software to offer the benefits of true virtual infrastructure.

"VirtualCenter provides the next level of operation and management for Coleman's virtual infrastructure."

Shawn Kaiser
The Coleman Company, Inc.

Continuous workload consolidation

According to IBM studies, IT organizations have on average 30% peak utilization of their Intel servers, with an average prime shift usage of between 5-10% and a 24 hour average of 2-5%. The fundamental cause of server under-utilization is IT organizations have learned to deploy a single application for each operating system due to resource contention, vendor support, security and business unit demands for a separate operating system image. However, with virtual infrastructure, multiple operating systems with their applications can be collocated on a single physical server. Not only can the initial consolidation be performed, but with VirtualCenter's ability to monitor utilization levels across the entire hardware pool, IT organizations can continuously adjust the resources allocated to each server, and dynamically reallocate workloads across physical server boundaries using VMotion.

Before virtual infrastructure, workload management was complex, and typically required substantial up front planning to get right. With VMotion, however, administrators can take an incremental approach, since it is easy to make adjustments to workloads running under VirtualCenter. In other words, VMotion enables workload management to be a continuous improvement process.

"I don't have to overbuy hardware capacity to ensure peak demands will be met."

Global CTO
Financial services company

Lowering the cost of deploying new servers with instant provisioning

Using VirtualCenter, 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. VirtualCenter performs a SAN file copy to create an instance of the selected server template on the SAN 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 VirtualCenter to the hours or days that it typically takes using a manual server deployment process, and the cost savings of VirtualCenter add up very quickly.

Reducing 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 virtual infrastructure because it separates hardware management from software management. Before VirtualCenter, 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 the business unit needing to know, eliminating a whole class of IT administration costs.

Virtual Infrastructure Increases Responsiveness

VirtualCenter provides the capability for IT to dramatically increase its responsiveness to business unit demands by leveraging the flexibility of virtual infrastructure. Since virtual infrastructure cuts the bonds between hardware and software, it gives IT organizations the flexibility to manage software services purely in software and allows instant server provisioning and immediate adjustment of resources to business requirements.

Instant server provisioning

Whether a single new server is needed for a week, or 50 servers are required for an hour, VirtualCenter provides powerful instant provisioning capabilities that allow the real-time provisioning and de-provisioning of servers across Windows, Linux or NetWare operating systems. With VirtualCenter, 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 VirtualCenter.

"VirtualCenter allows me to easily manage workloads across multiple systems without requiring a major investment in staff or training."

Eric Kuzmack
Gannett Co., Inc

Immediate Resource Adjustments

With virtual infrastructure, IT can quickly reconfigure the amount of resources dedicated to each software service running in the data center. Consider a new software update that makes an application's performance degrade. Without virtual infrastructure, IT organizations either go through lengthy

testing cycles to eliminate this possibility, or they must immediately order more hardware to increase performance to acceptable levels. With virtual infrastructure, administrators can simply increase the resources allocated to that application, move it to a more powerful system using VMotion, or they can easily roll back the software update using the checkpointing features built into VMware ESX Server.

Staffing flexibility

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 lower. Hardware that needs to be maintained can be emptied of running virtual machines using VMotion, then repaired and put back in service. Maintenance can be done during prime usage hours – from 8-to-5 instead of scheduling downtime for the evenings or weekend. 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 worked on 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.

Virtual Infrastructure Improves Consistency

VMware's virtual 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 – not through policy – since it takes far less time for the administrator to use a gold master template than to create their own manual server. Together with the checkpointing and rollback capabilities of ESX Server, VirtualCenter dramatically increases the consistency of the computing infrastructure. Since virtual infrastructure is homogeneous, and server deployments are consistent, operational risk is dramatically lowered.

Unified Management platform across Windows, Linux and NetWare

Today IT maintains stovepipe management systems across Windows, Linux and NetWare servers. With VMware VirtualCenter, a base provisioning, monitoring and resource allocation framework now spans the entire x86-based infrastructure. Now administrators learn only one way of provisioning and monitoring systems, instead of one for every version of deployed operating system. This reduces training costs, and allows greater consistency of policy application across diverse operating systems.

Server builds with built-in consistency

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.

Higher 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 checkpointing 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.

These benefits give virtual infrastructure and VirtualCenter the ability to create continuous improvement and long-term success for initiatives such as: server consolidation, disaster recovery / business continuity and utility computing.

PROJECT	CHALLENGES	VIRTUALCENTER IMPACT
Server Consolidation	<ul style="list-style-type: none"> Cannot combine workloads Low utilization High administration costs Too many platforms and applications to test Space and cost-sensitivity 	<ul style="list-style-type: none"> High utilization Built-in monitoring and management Unified management across operating systems Consistent virtual hardware platform decreases testing Leverages lower-cost platforms
Disaster Recovery / Business Continuity	<ul style="list-style-type: none"> High hardware costs 1-to-1 mapping of production and DR servers Real estate and maintenance costs Testing – time and feasibility Scalability Reliability Poor management & processes 	<ul style="list-style-type: none"> Recover many production servers to a single DR server Decouple primary/secondary site infrastructure Simpler DR configuration from consistency across testing and production Prevent over-subscription of recovery site Easier tracking of changing requirements
Utility Computing	<ul style="list-style-type: none"> Mobility of computing resources Optimizing resource allocations Tracking of costs / assets Implementing on existing hardware 	<ul style="list-style-type: none"> Dynamic provisioning Independence of software applications and underlying hardware Integration with policy and automation tools Unified monitoring and reporting Extends value of existing multi-vendor investment

The Virtual Infrastructure Wave

Thousands of enterprises have already gained the benefits of server consolidation with VMware server software. Now VMware expands the capabilities of the platform by offering virtual infrastructure – a fundamental new strategy for next generation IT.

Virtual infrastructure represents a major advance in enterprise IT management. By leveraging the uniform hardware platform of virtual machine technology, as well as the server mobility capabilities of VMotion technology, virtual infrastructure offers dramatic increases in server utilization and IT flexibility. In addition, it offers new ways to optimize server maintenance, and provides far greater consistency and lower risk for IT services. By offering a complete virtual infrastructure SDK, VMware also preserves enterprises' existing investment in management infrastructures, and will be plug and play with future policy-based utility management frameworks from the major systems management vendors.

With the combination of VirtualCenter and VNs as the first products to make virtual infrastructure a reality, enterprise IT teams can immediately start reaping the benefits of continuous workload consolidation, instant server provisioning and zero-downtime maintenance.

Getting Started

The VMware Sales Team can help your IT organization determine how VMware software 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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