

WHITE PAPER

File / Print / DNS Servers

Getting Started with Virtual Infrastructure



fo \equiv dus

Contents

- Introduction.....3**
 - Leveraging Virtual Infrastructure.....4
- Designing the Virtual Infrastructure.....5**
 - Design Overview.....5
 - Design Considerations5
 - Design Decisions9
- Virtual Infrastructure Implementation..... 12**
 - Planning 12
 - Implementation 12
- Summary 14**
 - Additional Resources..... 14
 - About the Author 14

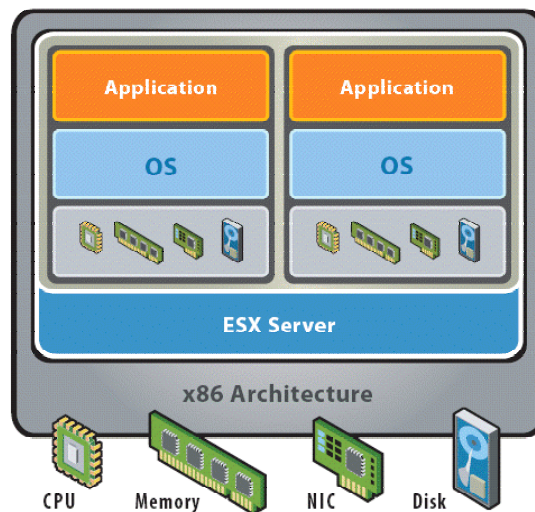
File, Print and DNS Servers – Getting Started with Virtual Infrastructure

Introduction

VMware Infrastructure 3 is the industry's first full Infrastructure virtualization suite that empowers enterprises and small businesses alike to transform, manage and optimize their IT systems infrastructure through virtualization. VMware Infrastructure 3 delivers comprehensive virtualization, management, resource optimization, application availability and operational automation capabilities in an integrated offering. VMware Infrastructure 3 includes the following products:

- ESX Server
- VMFS
- Virtual SMP
- VirtualCenter
- VMotion
- DRS (Distributed Resource Scheduler)
- HA (High Availability)
- Consolidated Backup

VMware Infrastructure virtualizes and aggregates industry standard servers and their attached network and storage into unified resource pools. Complete environments including operating systems and applications are encapsulated in virtual machines that are independent from the hardware. A virtual machine is like a server, but instead of electronics, it is a set of software files. Each virtual machine represents a complete system – with processors, memory, networking, storage and BIOS. A virtual machine runs operating systems and applications without any modifications just like a physical server.



Leveraging Virtual Infrastructure

A mainstay in just about any corporate network, regardless of OS choice, are three core components— file servers, print servers and DNS servers.

A file server can have many roles in an organization. It might be a central file store for user data files, or it could be a file server supporting a specific application or need. It may even be used to support user roaming profile data. Whatever the use, it is certainly a critical, integral component in any network.

A print server's responsibility is to act as a central print management entity through which all users send their print data. By using a print server, there is a simplified, single point of management for print queues, priorities and controlling the availability of a specific printer or set of printers on the network.

A DNS server could easily be considered the most critical server in any network. Many components of corporate network infrastructure rely heavily on proper DNS functionality. Active Directory relies upon it, as do applications that rely on FQDN references or SSL encryption. It is critical that DNS be working properly or users may not be able to log onto the network. If a user is unable to logon, they will not be able to use any of the applications or resources available on the network.

Considering how integral and essential these components are to the proper functioning of any network, the need for an almost "bullet-proof" implementation is vital. A typical physical server in any corporate environment will usually have a certain level of redundancy built in. Redundant power supplies, redundant fan kits and multiple NIC cards teamed together are commonly found in most servers.

Many times, RAM and processor specifications in a given server far exceed the actual needs of the services running on the server; observing Windows® *Performance Monitor* on many servers will reveal that the machine is idle most of the time, with most of the hardware investment not being realized fully. Not only is the hardware typically underutilized, but the level of redundancy included only applies to this one server and must be addressed over and over again for each server added to the environment. Compounding the issue is the fact that not only must the hardware be redundant, but so must the service hosted on that hardware. This usually means adding a second server to the environment to host another instance of DNS, File and Print services, etc. Now there are two redundant, yet underutilized servers on the network.

Hardware efficiency and redundancy are key issues, but so are backup/restoration scenarios and disaster recovery. Most servers in an environment are typically backed up individually. As more servers are added to an environment, backup windows become more challenging to maintain. Disaster recovery and business continuity present a completely separate set of challenges. How do you guarantee a server will be available? Which servers are deemed critical to business operations and how do you ensure their availability? What if disaster strikes and the physical hardware is no longer available? Perhaps a replicated datacenter is critical to business operations.

The solution to address these key concerns is to build a redundant *infrastructure* that meets the common needs of all of these components as a whole, not individually. By creating a redundant infrastructure, new services can be easily rolled out without needing to revisit the challenge of availability with each new implementation. Virtual Infrastructure is the solution to this challenge.

Designing the Virtual Infrastructure

Design Overview

File, print and DNS servers have similar resource requirements. None of them are typically processor-heavy, many don't require significant amounts of memory, and most of the time performance expectations are predictable.

At the most basic level, a virtual infrastructure design will include a single VMware ESX Server with enough local SCSI storage, memory, processing power and network bandwidth to support the virtual machines that will run in the environment. However, in this basic form, there is no allowance for infrastructure redundancy; if that single ESX Server were to fail, all running virtual machines would be unavailable until the problem was corrected and the ESX Server was back online.

In most cases, virtual infrastructure needs to provide a level of redundancy based on the business requirements of the virtual machines that will be deployed. Providing a redundant environment can be as simple as having multiple VMware ESX Server installations available to support the virtual machines. Adding shared storage such as a SAN to the environment and maintaining a redundant networking infrastructure are also key factors in a redundant virtual infrastructure.

Generally speaking, business needs driving virtual infrastructure call for a redundant environment capable of not only supporting the virtualization needs of today, but it must also have the flexibility to grow and evolve as the organization moves forward.

Design Considerations

File and print servers have significantly higher hardware requirements than DNS servers. File and print servers roles' are very similar in the functions they perform. Both send and receive data to and from client workstations via TCP connections. TCP session data requires memory on the server to track the session. As more sessions are opened on the servers, memory requirements increase. File and print servers may have a high demand to move large amounts of data across the network to client and devices. This in turn also increases disk I/O. To the contrary, DNS servers are relatively low-resource intensive servers. Their responsibilities are typically limited to maintaining a name translation table in memory and service lightweight name requests from clients.

The three server roles discussed within the scope of this document are listed below, with the typical workload requirements for each of four hardware categories.

| | CPU | Memory | Networking | Disk I/O |
|--------------|-----|----------|------------|----------|
| File Server | Low | Moderate | High | High |
| Print Server | Low | Moderate | High | High |
| DNS Server | Low | Low | Low | Low |

Table 1 – Typical workloads by server role

Processor and Memory

As shown above, all three server roles typically have low CPU requirements. A key benefit in virtual infrastructure is ESX Server's intelligent process scheduling mechanism to schedule a running virtual machine's processes on the physical processors in the server. ESX Server hosts typically have multiple processors, permitting a virtual machine's process to be run on any physical processor at any given moment. This mechanism empowers ESX Server to make the most efficient use of all available processors in the host.

Memory requirements for the various roles range from low to moderate. File servers and print servers share a common thread in the role that they play in a network. Both are responsible for moving data from a client device to a storage medium over a TCP/IP network. As the number of client connections to a file and/or print server increases, memory requirements rise as the operating system must maintain TCP session data for each connection.

Many times, physical machines are built with more RAM than necessary simply because memory is considered inexpensive and the hassle of adding RAM later is inconvenient. Typically, most servers require less than 512MB RAM. ESX Server's memory management capabilities efficiently manage through mechanisms such as transparent page sharing, which "shares" common memory pages across virtual machines.

Networking

File and print servers tend to be among the most demanding in terms of their networking requirements. Virtual networking is approached in much the same way as physical networking. In a VMware Infrastructure, *virtual switches* connect virtual machines to the physical network. The physical network adapters in an ESX Server host server are bonded to the virtual switch and create an "uplink" between the virtual switch and the physical network to which the ESX Server's NIC cards are attached. Multiple physical NIC adapters can be bonded to a single virtual switch to create a load-balanced and redundant networking environment for the virtual machines.

Other networking considerations include VMotion traffic (discussed later), Service Console traffic, data backup traffic, etc. All of these need to be considered when designing the environment.

Storage Options

A virtual machine consists of nothing more than a set of files. Each virtual machine is comprised of a .VMX configuration file, an NVRAM file, which is a file-based BIOS image for the virtual machine, a set of log files, and one or more .VMDK virtual disk files. The virtual disk file is similar in concept to the relationship of an .ISO image to a CD-ROM disc, in that it is a flat-file representation of a hard disk, which is mounted by the virtual machine. Virtual disk files are generally equal to the size of the virtual disk capacity; an 8GB virtual disk will produce an 8GB .VMDK file.

VMware Infrastructure 3 provides many options for choosing a storage medium for these files. At the most basic level, local storage, or disk space locally installed in the ESX Server host server itself, can be used to store the virtual machines' .VMDK virtual disk files. This option is inexpensive, but inhibits the easy migration of virtual machines to other ESX Server installations.

Implementing shared storage in the infrastructure removes the dependency of any one particular ESX Server. Virtual machines are stored entirely on the shared storage and ESX Server simply become a set of resources on which a virtual machine can run. No ESX Server "owns" a particular virtual machine and any ESX Server can boot any virtual machine provided it can access the LUN on which the virtual machine is stored. VMware Infrastructure 3 offers three types of shared storage options – fiber channel SAN, iSCSI SAN and NAS. Shared storage also has the advantage of enabling use of advanced virtualization capabilities like VMotion, VMware HA and VMware DRS.

Over the past several years, fiber channel SAN solutions have become widely deployed in corporate infrastructure. A fiber channel SAN is a high-speed fiber-connected network of servers, storage arrays and interconnecting switches, creating a “storage network”. The SAN presents LUNs, or storage partitions, to the servers in such a way so that they appear to be locally attached to the server. The downside to fiber channel SANs has always been their complexity and high cost.

iSCSI is a new SAN storage technology that uses the same SCSI/SATA storage disks as fiber-channel SANs, but leverages inexpensive Gigabit Ethernet interconnects to connect the ESX Server to the storage arrays. The benefit is a high-speed shared storage array that is inexpensive to build and maintain. Beginning with version 3.0, VMware ESX Server supports iSCSI SANs for use with VMFS volumes. Although now iSCSI is a bit slower than fiber channel SANs, the cost difference between the two may make it a worthwhile investment. Before committing to an iSCSI solution, be sure to check the VMware supported hardware list at the following URL:

http://www.vmware.com/vmtn/resources/esx_resources.html

Advantages of SAN Integration

A SAN can present a set of shared storage devices, in the form of a LUN, to multiple ESX Server installations simultaneously in the infrastructure. Each server has access to the LUN as if it were directly attached to that server. SANs also provide the ability to back up and restore data quickly and efficiently, and to create effective disaster recovery plans and ensure high availability.

VMware ESX Server supports using SAN storage for virtual machines. Leveraging a SAN, you can take advantage of advanced VMware Infrastructure features such as VMotion, VMware HA and VMware DRS. VMotion allows you to move running virtual machines from one ESX Server host to another, on the fly, with no interruption in service. VMware HA (high availability) provides easy to use, cost-effective high availability for all applications running in virtual machines. If a virtual machine is affected by server failure, VMware HA can power on the virtual machine on another available ESX Server host. DRS dynamically allocates and balances computing capacity across collections of hardware resources aggregated into logical resource pools. VMware DRS continuously monitors utilization across resource pools and intelligently allocates available resources among virtual machines based on performance thresholds set by an administrator.

Many medium to large organizations may already have a SAN deployed in the environment. Check with the storage group in your organization to see if any current deployment will fit into the virtual infrastructure architecture. Otherwise, begin looking into SAN options for your organization’s VI deployment.

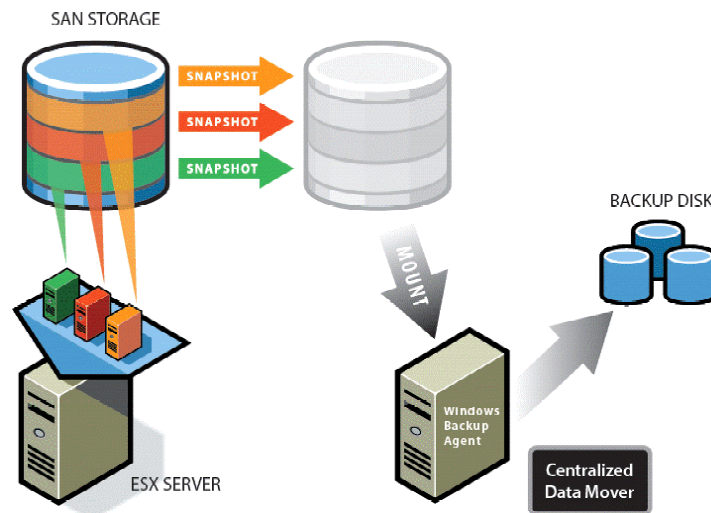
Leveraging VirtualCenter

VirtualCenter is a critical component of VMware Infrastructure. Although ESX Server does not require a VirtualCenter server to host and run virtual machines, an enterprise-class virtual infrastructure is incomplete without it. Enterprise features such as VMotion, VMware HA, VMware DRS, centralized management, virtual machine templates, VMware clustering and resource pools are not available without VirtualCenter.

An environment consisting of a single ESX Server does not gain much benefit from VirtualCenter, but once a second ESX Server is added to the infrastructure, VirtualCenter becomes paramount in maintaining an efficient, well-managed environment.

Virtual Machine Backup

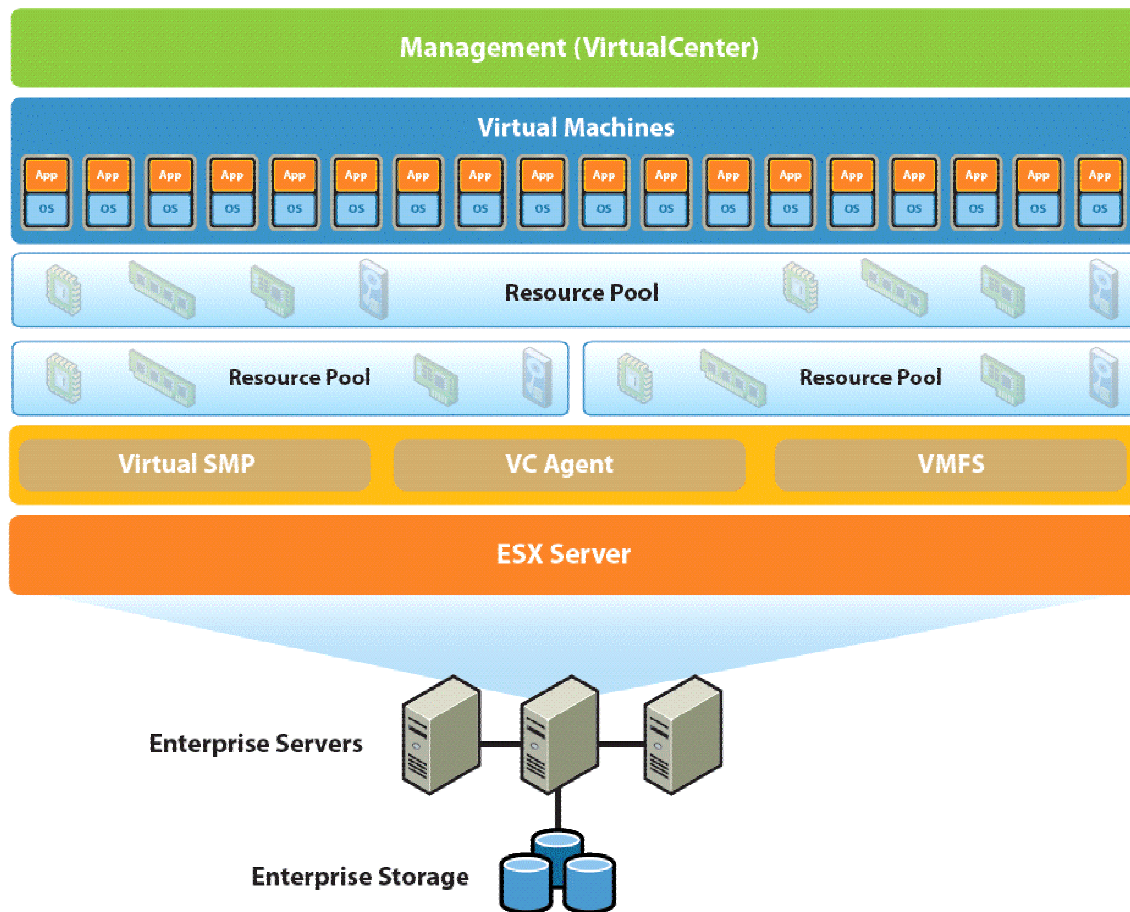
A new product for VMware Infrastructure 3 is VMware Consolidated Backup. VMware Consolidated Backup provides an easy to use, centralized backup facility for virtual machines. It enables virtual machine contents to be backed up from a centralized Microsoft® Windows 2003 proxy server rather than directly from the ESX Server. Utilizing a proxy server reduces the load on ESX Server allowing it to run more virtual machines. Consolidated Backup uses industry standard backup agents, such as those from your enterprise backup solution, to move virtual machine data to tape devices. Manageability is improved because Consolidated Backup requires only a single agent on the proxy server rather than on every virtual machine. Consolidated Backup enables the use Fiber Channel tape devices for virtual machine backups, eliminating backup traffic on the LAN.



Consolidated Backup is a set of drivers and scripts that enable LAN-free backup of virtual machines from a centralized Microsoft® Windows 2003 proxy server using an industry-standard backup agent. Consolidated Backup includes pre-backup and post-backup scripts for integration with most major backup providers. The administrator creates a backup job for each virtual machine and that job is dispatched on a Consolidated Backup proxy. For virtual machines running Microsoft® Windows operating system, the pre-backup script quiesces NTFS inside the virtual machine, takes a virtual machine snapshot, and mounts the snapshot to the proxy server directly from the SAN. The backup client then backs up the contents of the virtual machine – either as a set of files and directories or as a virtual disk image. Finally, the post-backup script tears down the mount and takes the virtual disk out of snapshot mode. VMware Consolidated Backup is included as part of VMware Infrastructure Enterprise edition and is an optional component of Standard edition.

Design Decisions

Although a single-ESX Server installation can support all three physical server roles discussed in this document, a recommended best practice for a production virtual infrastructure design is to start with two or more VMware ESX Server installations attached to a SAN for shared storage. Use multiple network interface cards in ESX Server to provide networking redundancy and load balancing. Implement VirtualCenter to manage the environment and enable VMotion to allow virtual machines to be moved between ESX Server hosts while powered on and servicing users and applications.



The build process begins with ESX Server. Most organizations will have a standardized server hardware vendor. Most major vendors offer similar hardware platforms for x86-based servers. Whichever manufacturer is selected, ESX Server should meet a minimum set of hardware attributes, discussed below.

Processors

Dual Intel-Xeon or AMD-Opteron processors will be included in the design. Dual-core processors are supported by VMware ESX Server and are licensed by physical processor, not the number of cores. Therefore, a server with two Intel Xeon dual-core processors will only require a two-processor ESX Server license, but will have four cores (or four logical processors). Dual-core servers are able to support more virtual machines per host when compared to single-core servers.

Memory

At the minimum, 4 GB of RAM should be installed in each server. The amount of RAM in a host server is directly related to the number of virtual machines that host can support concurrently. If dual-core processors will be included in the host servers, 8GB minimum is recommended.

Networking

Most corporate environments likely already have a redundant physical networking infrastructure in place. As stated previously, ESX Server has the ability to bond multiple Ethernet adapters into a single logical interface for connecting virtual switches to the physical network. This has the added benefit of providing redundancy while load-balancing network connectivity from virtual machines. A minimum of three Gigabit Ethernet adapters should be present in each ESX Server. Two of the network adapters will be bonded to a single virtual switch and will provide physical network connectivity to the virtual machines and the service console. The third network interface will be dedicated to VMotion traffic on a separate virtual switch. Additional network interfaces can be added to create isolated segments for an alternate subnet, a DMZ, a backup network or out-of-band management, if desired.

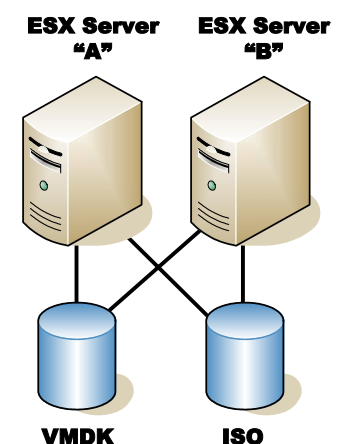
Storage

Each ESX Server should have an embedded or add-in SCSI RAID adapter coupled to a series of internal SCSI disk drives to hold the ESX Server software installation. RAID-1, or disk mirroring, will provide adequate redundancy for the installation, but RAID-5 will provide faster read access to the array and is recommended. An additional "hot-spare" drive should also be included to provide immediate failover in the event of a hard drive failure.

Additionally, each ESX Server should have at least one host-bus adapter (HBA) for connection to the SAN storage array; preferably two for redundancy. Whether fiber-channel SCSI or iSCSI, a host-bus adapter offloads the processing requirements for SAN storage operations from the server's processors to a processor on the HBA, thereby freeing the server processors to service virtualization needs. In the case of an iSCSI SAN, using an HBA is optional as ESX Server 3.0 has a software-based iSCSI initiator built into the VMkernel. However, when connecting ESX Server to fiber-channel SANs, using an HBA is mandatory.

The number and size of LUNs that should be available on the SAN for the virtual infrastructure will vary based on the needs of the environment. At a minimum, two LUNs should be made available – one for storing the .VMDK virtual machine disk files and one for storing virtual machine templates, ISO images, supporting files, etc.

To determine the amount of storage necessary for the environment, whether it will be local storage in an ESX Server or shared storage on a SAN, calculate the total disk space for each virtual machine that will run on the environment, including operating systems, applications and data, and then add 20% as a cushion. Include space for virtual machine templates, and ancillary storage for .ISO files, virtual machine backups, 3rd party software, swap files and log files.



Additional Redundancy

Dual power supplies, redundant fan kits and remote access interfaces (HP iLO, Dell DRAC, etc.) will assist in minimizing the potential points of failure in ESX Server. Remote "lights-out" access via a remote access interface allows for connection to the physical power on/off operations of the server when remotely connected.

VirtualCenter Integration

Although VirtualCenter may be installed in a virtual machine, the recommended best practice for production use is to run VirtualCenter from a separate physical machine in the enterprise, therefore, an additional physical server will be necessary. If the VirtualCenter server is desired for testing, training, or other non-production purposes, a virtual machine can be used for the management environment.

Virtual Infrastructure Implementation

Planning

Careful planning and coordination are paramount to the successful implementation of any new technology or infrastructure in an environment. The first step is to create an effective project plan, document each phase of the implementation process and notify key personnel of their involvement in the appropriate stage(s). The deployment will likely require the coordination of many groups in the organization such as the storage group for SAN integration, the networking group, server architects, etc. The plan should include the following:

1. Define the business objectives for the implementation
2. Define the scope of the implementation, noting the various groups that will be involved such as the storage, networking, purchasing, etc.
3. Order the ESX Server and/or VirtualCenter Server hardware
4. Determine if ample SAN storage is available or must be purchased
5. Contact the Networking group to determine if adjustments must be made to support the virtual infrastructure
6. Decide whether virtual servers will be new builds or physical to virtual (P2V) conversions
7. Determine where the VMware License Server will be installed
8. Define the testing scenarios and pilot group(s) for the new virtual machines prior to rolling into production.
9. Calculate how much physical disk space will be required to host the virtual disk files
10. Review the current server backup architecture and determine the best course of action for backing up virtual machines and/or data
11. Obtain VMware software licensing and media

VMware maintains a supported hardware list that details the vendors and models of server hardware and SAN equipment that VMware has certified for VMware Infrastructure. Most major server hardware vendors such as Dell, IBM and HP all have server models on the supported hardware list. The hardware and SAN compatibility guides can be downloaded from VMware's web site.

Implementation

The detailed steps for the implementation of VMware Infrastructure will vary greatly based on an organization's needs and internal business procedures. To that end, the step-by-step procedures of the build process are considered beyond the scope of this document; however the basic, high-level steps are outlined below.

The following is a preliminary list of prerequisites for beginning any virtual infrastructure build:

- Installation media for VMware ESX Server and VirtualCenter
- VMware Infrastructure license file
- A network attached workstation to run the Virtual Infrastructure Client
- Static IP addresses for the ESX Server and VirtualCenter Management Server (not required, but strongly recommended)
- Provisioned and zoned physical disk with physical connectivity to ESX Server hosts

- ☑ Host names for the ESX Server and VirtualCenter servers
- ☑ A database server and available database instance (using MSDE for all but a very small VI implementation will not suffice)
- ☑ VMware P2V Assistant (assuming physical to virtual conversion will be used for migration)
- ☑ A dedicated, SAN attached Windows server (for Consolidated Backup functionality)

Once the project plan has been written and approved, and all prerequisites have been met, the build process can begin. Below is a typical, high-level process for assembling and implementing the infrastructure.

1. Install and configure the VMware ESX Servers, including SAN attached storage, virtual networking, etc.
2. Install and configure VirtualCenter and enable VMotion
3. Create new virtual machines for the File server(s), print server(s) and DNS server(s). If included as part of the plan, migrate (P2V) the physical servers to the new virtual machines.
4. Test the virtual infrastructure, including basic internal testing and the pilot group rollout
5. Roll out to production

Although these steps appear to simplify the process, the actual procedures will include much more detail. There are many ways to implement virtual infrastructure. The best recommendation that can be made is to educate yourself on best practices in deploying VMware products.

The following list of VMware documents will help in planning the deployment and the actual implementation of the VMware products. All of the following documents are available from the VMware web site.

- Introduction to VMware Infrastructure - Using VMware VirtualCenter and ESX Server
- Installation and Upgrade Guide
- Server Configuration Guide
- Resource Management Guide – ESX Server 3 and VirtualCenter 2
- SAN Configuration Guide – ESX Server 3 and VirtualCenter 2
- Virtual Machine Backup Guide

Summary

There are many possibilities in the design options available for virtual infrastructure, far too numerous to explore within the scope of this document. Instead, the ideas discussed here follow VMware and industry best practices and are intended to provide guidance in implementing VMware Infrastructure in your environment, rather than a step-by-step recipe for VI implementation.

The process of assembling the virtual environment is based on the information gathered thus far, and the decisions made are based on that information. This paper is entitled "*Getting Started With Virtual Infrastructure*", and as the title states, this may simply be the beginning of virtual infrastructure in your environment. Whether the design that fits your environment is a single server implementation, or a complex design that includes multiple ESX Server installations, VirtualCenter, SAN integration and high-availability scenarios, understand that VI is completely scalable as the needs of the organization and the environment grow. Adding additional ESX Server installations and/or shared storage to the existing environment is straightforward and requires little or no interruption to production users and services.

Additional Resources

The following is a list of additional resources available for the design and implementation of VMware Infrastructure.

VMware Web Site

<http://www.vmware.com>

VMware Technology Network Web Site

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

VMware Discussion Forums:

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

VMware Training and Certification

<http://mylearn1.vmware.com/mgrreg/>

VMware Documentation

<http://www.vmware.com/support/pubs/>

About the Author

Michael Burke is a Virtual Infrastructure Engineer for Foedus, a leading Virtual Infrastructure Services company in the Northeast. With over five years experience working with VMware products, he has written several technical articles and was a technical editor for the book "VMware ESX Server: Advanced Technical Design Guide"



VMware, Inc. 3145 Porter Drive Palo Alto CA 94304 USA Tel 650-475-5000 Fax 650-475-5001 www.vmware.com
© 2006 VMware, Inc. All rights reserved. Protected by one or more of U.S. Patent Nos. 6,397,242, 6,496,847, 6,704,925, 6,711,672, 6,725,289, 6,735,601, 6,785,886, 6,789,156 and 6,795,966; patents pending. VMware, the VMware "boxes" logo and design, Virtual SMP and VMotion are registered trademarks or trademarks of VMware, Inc. in the United States and/or other jurisdictions. Microsoft, Windows and Windows NT are registered trademarks of Microsoft Corporation. Linux is a registered trademark of Linus Torvalds. All other marks and names mentioned herein may be trademarks of their respective companies.



fo Ξ dus