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Covers ESX & ESXi 3.5 and vCenter Server 2.5, Update 3

VMware® VI3

IMPLEMENTATION AND ADMINISTRATION

ERIC SIEBERT

vmware vEXPERT

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Foreword

Virtualization is fundamentally changing the data center and how we approach computing. A friend recently showed me a demo of his latest project, a 3D simulation of a data center. In the demo, your avatar would walk around the rows of racks in a virtual representation of your physical facility. With a click of the mouse, a server in a rack would open like a drawer and a little status screen would emerge and hover in the air in front of your virtual data center administrator. "That's a really fun demo," I told my friend, "but it would have actually been useful even five years ago. Now? Not so much."

My friend, who had been in the software industry for 30 years, had missed the wildfire impact that virtualization has had on the IT industry. The hardware is still there, racked up and plugged in, but the physical server is no longer the unit of work or the unit of management in the data center. We no longer look at one physical machine at a time; we manage entire data centers in a single pane of glass. And just as I don't care exactly which disk sector my bits are stored on, in most cases these days I don't care which physical server my applications are running at the moment—or even my desktop. (I'm happy to report my friend has seen the light and is now building a virtual representation of his virtual infrastructure.)

The wave of x86 virtualization technology from VMware and others has enabled this transformation, but the benefits of the technology are what have supercharged the velocity of the change. My employer, VMware, reports its 130,000 customers can reduce hardware and operating costs by as much as 50%, reduce energy costs by 80%, reduce the time it takes to provision new servers by up to 70%, and save more than $3,000 per year for every server workload virtualized. Usually the savvy IT professional takes marketing numbers from a vendor with a grain of salt, but just talk to your fellow IT professionals for confirmation. Every day on blogs and social networks, I see messages pass by like "I Love VMware," "Snapshots saved my bacon once again," and "Entering maintenance mode, watching production servers VMotion while eating lunch at my desk."

One of the paradoxes of virtual infrastructure is that most things are the same as physical infrastructure, while at the same time being completely different. You're running

the same applications in the same topologies. You can treat the applications basically the same as you had been doing previously—after all, from inside the virtual machine, the workloads think they're still back in a physical box. But at the same time, virtualization touches and transforms every part of the enterprise software stack: networking, storage, security, disaster recovery, management, provisioning, and other business processes, and even how you handle the financials. As a result, the syllabus for a virtualization training class often looks like a complete university curriculum in information technology because it has to touch on all these areas. Virtualization experts are the mixed martial artists of IT—experts in kicks, punches, throws, and wrestling moves.

Because of this breadth of impact, virtualization can be daunting. VMware has had a robust set of user forums for years, where the storage expert and the networking expert can come together and help each other with their virtual infrastructure projects—and both become virtualization experts in the process. By now, the VMware Communities is the best enterprise software online community I've ever seen, and by far the best place to ask a quick or not-so-quick question about your virtual infrastructure. There you'll often see esiebert 7625, the author of this book, answering questions and adding to the conversation.

Eric Siebert is a natural encyclopedist and cataloguer. You can now find more information about VMware online than most of us can comfortably digest—documentation, white papers, presentations, blogs, wikis, magazines, and community sites abound. On the Communities, Eric has a knack for not only answering your question, but also always seeming to have a set of links to resources that explain the answer and give you a mini-course in why the answer is the way it is. That's why on the VMware Communities, you'll see a little brain icon with "Guru" beside Eric's handle.

Eric is a prime example of the Roman philosopher Seneca's maxim *docendo discimus*—by teaching we are learning. Eric is a working, hands-on VMware administrator and 25-year IT veteran, but with his work helping literally thousands on the VMware Communities and through his website, freelance writing, and blogging, Eric truly has become an expert educator. Eric was recently one of the first recipients of the VMware vExpert award for his contributions giving back to other virtualization users.

This book, written by an expert educator and hands-on practitioner, takes you through the full lifecycle of a virtual infrastructure implementation, clearly lays out both the concepts and the steps required for someone new to virtualization, and can serve as a quick, clear review of best practices for the more experienced virtualization administrator.

I wish you luck in your journey in virtualization. The first time you come into work in the morning and realize that one of your servers restarted during the night because of VMware's High Availability feature, but neither your monitoring systems nor your end users noticed anything amiss, I encourage you to march into your boss's office and ask for a promotion and a raise. You will have earned it.

John Troyer
VMware Communities
Palo Alto, CA

Introduction

Virtualization is not a new technology, but it has gained popularity in recent years and is used to some degree in almost all datacenters. For most companies, it's not a question of *when* they are going to virtualize their infrastructure but *how much* they are going to virtualize. Virtualization has many benefits over traditional physical servers, and the technology is constantly evolving and improving to further make the decision of whether to virtualize an easy one. In addition to the many vendors offering virtualization hypervisors, such as VMware, Microsoft, and Citrix, the physical hardware technology vendors, such as AMD and Intel, are changing their products to optimize them to work with virtual hosts. In addition, a large amount of vendors have written virtualization-specific applications or modified their applications and hardware to work in virtual environments because they recognize that virtualization is here to stay. Virtualization is so popular now that almost all software vendors support it. So, you don't have to worry about issues with a vendor supporting their application running in a virtual environment. In addition, most vendors have changed their licensing policies so that they are friendly to running on virtual machines.

If you are looking at this book, you must be interested in learning more about virtualization and how to implement it. This book was written to cover all the various phases of implementing a virtualization project using VMware Virtual Infrastructure 3, from the initial planning stages all the way through designing, building, configuring, maintaining, troubleshooting, and more. VMware has made it fairly easy to install and use their virtualization products, but there's a lot you need to know to properly set up your environment and to understand how everything works, including the differences between

physical and virtual servers. This book walks you through the various stages and provides information and tips to guide you through them so that you make informed decisions, use best practices, and avoid common mistakes.

This book was written using ESX version 3.5 Update 3 and vCenter Server version 2.5 Update 3. VMware is continuously updating their products to further improve them and provide more features and functionality, and as of the writing of this book, VMware is close to releasing their next-generation product (VI4), tentatively named vSphere. This new version should be an exciting release as VMware continues to build on their Virtual Datacenter OS vision and to head toward their vCloud initiative. Look for a follow-up to this book that will help you understand the new version and how to implement and administrate it and upgrade to it from the VI3 release.

A friend of mine likes to say that virtualization is a journey, not a project. The journey begins with learning about virtualization, but does not end after you implement it. Virtualization is an enabling technology that will change the way you do things in your datacenter and provide you with greater flexibility and more options for administering your servers. My own virtualization journey began many years ago as part of a server consolidation project and continues today; I am still learning and adapting to all the new technologies and features that come with each new release. So head on over to the first chapter and let your own journey into virtualization begin!

Chapter 1

Assessing Your Current Environment

Before starting on your virtualization journey, it is important to thoroughly understand your current IT infrastructure. By introducing virtualization into your environment, you are making a big change that will have a ripple effect on all parts of your environment. Standard procedures such as monitoring, backups, patching, and administration will all be affected by this. In addition, all components of your infrastructure will most likely be affected in some way by this big change. As a result, you need to assess all parts of your infrastructure, not just the servers you plan to virtualize, to uncover any potential problems or hurdles that may impact your project. The old woodworking rule "measure twice, cut once" also applies with computers. You can save yourself from making costly mistakes by making sure you get accurate measurements before you begin.

An Important Note

In December 2008, VMware announced that they were changing the product names of some of the components in VI3. This was done to better align the product naming with their Virtual Datacenter OS vision. The main change involved introducing vCenter as the new name for their many automation and management products. This affected VirtualCenter, which was renamed as vCenter Server, and so subsequently this book has been updated to use this new name. However, although the name of the product has changed, the application and documentation for VI3 has not, and you will still see the old name used in both. This name change applies only to VirtualCenter Server 2.5, and the terms vCenter Server and VirtualCenter refer

to the exact same product. Older 2.0.x versions of VirtualCenter continue to use that name and are not considered part of the change. It is expected that the new name will be fully used in the application and documentation when VMware introduces their next major release of ESX and vCenter Server (VI4 or vSphere) sometime in 2009. In addition, some of the other products have had the name vCenter added to the beginning of their names, such as vCenter Converter and vCenter Update Manager, and that has also been reflected in this book.

Documenting Your Current Server Environment

Most virtualization projects will involve migrating your current physical servers to virtual machines (VMs). Therefore, it is important that you thoroughly understand your current environment before attempting to migrate it to virtual servers. By doing this, you can ensure that you purchase properly sized server hardware and the right number of VMware licenses. It's a good idea to do a thorough inventory of all your current physical servers so that you know exactly what you have before you start virtualizing. Also identify what you intend to do with the old physical hardware after it has been virtualized. Often, you may end up reusing newer physical hardware as ESX hosts. It's best to decide what you will do with your old servers as part of your planning so that you will know exactly what hardware you will be discarding, reusing, and leaving alone.

Watch Out!
Don't virtualize known problems; make sure your current server environment is healthy before attempting to virtualize it. For example, if you have existing performance or application problems in a physical environment, attempt to resolve those before moving them to a virtual environment.

Measuring Your Current Performance Usage

Measuring your current performance is necessary so that you can get a good idea of how your current environment is performing. By doing this, you can ensure that you properly size your virtual hardware and can avoid any bottlenecks on your ESX hosts. Doing this before you start your project is important so that you do not run into any surprises that can cause problems during your deployment phase.

What to Measure

You should focus on four general performance categories: CPU, memory, disk, and network. You should gather these metrics for a minimum of one week, and preferably over a one-month period of time. Gathering these metrics for a longer period of time gives you a better understanding of any performance trends that you may be experiencing that might not happen on a regular basis. It is also important to gather metrics during critical business cycles (for example, weekly payroll processing or a monthly reporting process) where performance may spike. The combined results of these metrics will help determine your overall consolidation ratio (number of VMs per ESX host) and how many ESX servers you will need for the number of physical servers that you want to virtualize. Consolidation ratios can vary from as little as 2:1 to as high as 50:1 based on the total amount of resources that your VMs will require and the size of your ESX host servers.

Let's go over the categories, some important metrics, and some guidelines on each one.

Measuring CPU Usage

Typically, most Windows servers have very low overall CPU usage (< 10%), which is why virtualization is a great solution to maximize your hardware resources and reduce the number of physical servers in your environment. Average processor utilization is the best metric to use to measure how busy a server actually is. It will give you an overall indication of how much processor the physical server is using, which you can use to help plan your ESX host size. Most servers will peak near 100% at various times, but the peaks are not as important as the overall average utilization. High processor queue lengths can indicate a bottleneck on a physical server, which may disappear in a virtual environment because of the way the ESX hypervisor handles the scheduling and processing of CPU requests. Table 1.1 lists the CPU metrics that you will want to watch to determine the amount of CPU usage on your servers.

Table 1.1

Important CPU Metrics

Statistic	Description	Why This Is Important
Processor queue length (average and maximum)	Processor queue length is the number of threads in the processor queue. There is a single queue for processor time even on computers with multiple processors or cores. Therefore, if a computer has multiple processors, you need to divide this value by the number of processors servicing the workload.	A sustained processor queue length of ten or more threads typically indicates a processor bottleneck.

continues...

Table 1.1 continued

Statistic	Description	Why This Is Important
% processor time (average and maximum)	% processor time is the percentage of elapsed time that the processor spends to execute a non-idle thread. It is calculated by measuring the duration the idle thread is active in the sample interval and subtracting that time from the interval duration. (Each processor has an idle thread that consumes cycles when no other threads are ready to run.) This counter is the primary indicator of processor activity, and displays the average percentage of busy time observed during the sample interval. It is calculated by monitoring the time that the service is inactive and subtracting that value from 100%.	This value indicates how much CPU that your server is actually using, which can be used to plan the amount of CPU needed on a virtual host.

Measuring Memory Usage

The actual amount of physical memory that a server uses will determine how much memory your ESX hosts will need to be able to support all the VMs on it. It is possible to overcommit an ESX host (assigning VMs more memory than the host physically has), but it is not recommended in most cases because it will degrade the performance of your VMs once your host's physical memory has been used up. Table 1.2 lists the memory metrics that you will want to watch to determine the amount of memory usage on your servers.

Table 1.2

Important Memory Metrics

Statistic	Description	Why This Is Important
Available free memory (average and least)	Available MBytes is the amount of physical memory, in megabytes, immediately available for allocation to a process or for system use. It is equal to the sum of memory assigned to the standby (cached), free, and zero page lists.	This value indicates how much physical memory is not being used by your server. If you have excessive free memory then consider reducing the amount of RAM assigned to the server when moving it to a virtual host.

Statistic	Description	Why This Is Important
Pages/sec (average and maximum)	Pages/sec is the rate at which pages are read from or written to disk to resolve hard page faults. This counter is a primary indicator of the kinds of faults that cause systemwide delays.	This value counts the number of times per second that the computer must access virtual memory rather than physical memory. This number normally increases as available memory decreases. Too many pages/sec can cause excessive disk activity and create a disk bottleneck. This often indicates that a system does not have enough physical memory.

Measuring Disk Usage

The important things to know about a disk are how much you are using (disk space) and how much reading and writing to the disk that each server does (transfer rate). Disk is the slowest of the resources because it relies on a mechanical device and is usually the first bottleneck to performance in most systems. Therefore, it is important to understand how much disk activity your servers will be doing so that you can select a proper storage solution for your virtual hosts. It's also important to factor in the number of spindles (hard disks) in your redundant array of inexpensive disk (RAID) groups on your physical servers. A RAID group with more spindles will have better disk performance than one with fewer spindles. If you were to virtualize a physical server with a ten-spindle RAID group, you may not get the same performance if your ESX host is configured with only a five-spindle RAID group. Table 1.3 lists the disk metrics that you will want to watch to determine the amount of disk usage on your servers.

Table 1.3

Important Disk Metrics

Statistic	Description	Why This Is Important
% disk time	% disk time is the percentage of elapsed time that the selected disk drive was busy servicing read or write requests.	Similar to % processor time, this can be useful in characterizing the workload and gives a general indication of how busy the disk is.

continues...

Table 1.3 continued

Average disk queue length	Average disk queue length is the average number of both read and write requests that were queued for the selected disk during the sample interval.	This tells you how many I/O operations are waiting for the hard disk to become available. This number should be as low as possible; a high number (> 5) can indicate an I/O bottleneck depending on the number of spindles (hard disks) in your RAID group. It's best to divide your average queue length by the number of spindles in your RAID group to get a more accurate number.
Disk bytes/sec	Disk bytes/sec is the rate bytes are transferred to or from the disk during write or read operations.	This provides information about the throughput of the disk system and how busy it is.
Physical disk transfers/sec	Disk transfers/sec is the rate of read and write operations on the disk.	This is the total number of read and write requests processed per second (commonly known as I/O operations per second or IOPS). Like disk bytes/sec, this also measures the throughput of the system. The difference is that this counter does not consider the size of the request, just the fact that it is a request.

Measuring Network Usage

Network is a resource that typically is plentiful in virtual hosts because you can easily put many multiport high-speed network interface cards (NICs) in your ESX servers. You should still identify any servers that generate a large amount of network traffic so that you can add extra NICs if needed, and it will also help you when you build and configure your virtual switches (vSwitches). Also, network traffic between VMs that are on the same vSwitch does not go over the physical network (it travels along the host bus), which could reduce the amount of network traffic generated by your servers after they are virtual. Table 1.4 lists the network metrics that you will want to watch to determine the amount of network usage on your servers.

Table 1.4

Important Network Metrics

Statistic	Description	Why This Is Important
Bytes total/sec	Bytes total/sec is the rate at which bytes are sent and received over each network adapter, including framing characters. Network interface\\bytes received/sec is a sum of network interface\\bytes received/sec and network interface\\bytes sent/sec.	This counter shows the amount of traffic through your network interface in byte per second.

How to Measure It

You can determine your current performance usage in a number of ways:

- Use existing enterprise monitoring systems.
- Use operating system built-in performance monitoring tools (PerfMon).
- Use third-party analysis tools such as PlateSpin PowerRecon or Tek-Tools Profiler for VMware.
- Contact a VMware business partner and have them install the Capacity Planner tool in your environment.

VMware's Capacity Planner

Capacity Planner is a powerful tool that automatically collects all the relevant performance metrics on each Windows server in your environment and prepares a report that you can use to determine your hardware requirements for your virtual environment. It can identify trends in your environment and make recommendations for grouping physical servers on virtual hosts. It uses the built-in Microsoft performance counters and does not require that an agent be installed on each server that will be analyzed (it uses the WMI and the Remote Registry service). The Enterprise dashboard screen from Capacity Planner, along with all the other available options, is shown in Figure 1.1.

Currently, Capacity Planner is provided by VMware to its business partners only and is not available to the general public. Most business partners will install and configure it in your environment for you for free as long as you plan on buying software/hardware and professional services from them for your virtualization project. Using Capacity Planner is the best method for collecting data from your servers and reporting on it, because it was developed specifically for infrastructure assessment and data analysis and will provide consolidation estimates, recommendations, and capacity assessments.

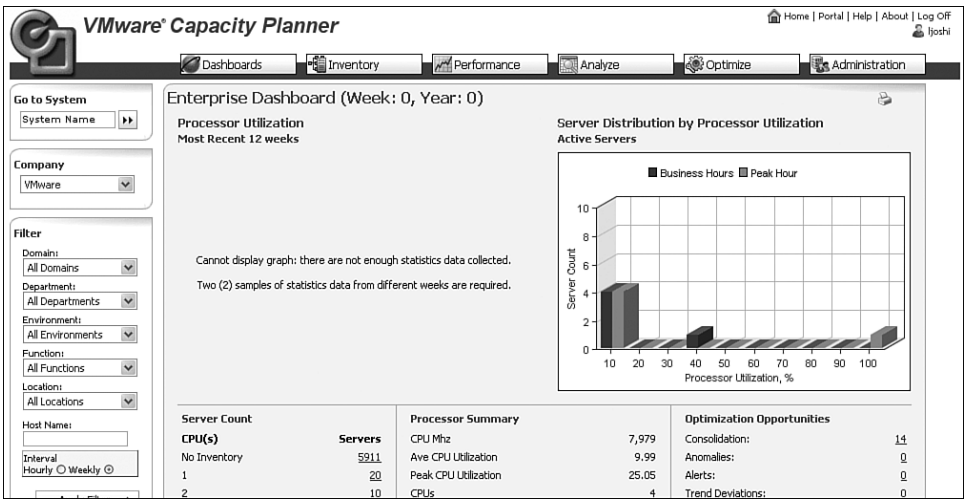

Figure 1.1 Sample screen from VMware's Capacity Planner tool

Beginning with vCenter Server version 2.5, a "lite" version of Capacity Planner was integrated into vCenter Server as a feature called Guided Consolidation. This utility uses a built-in wizard to discover physical systems and analyze them to prepare them to be converted into VMs. Once these systems have been analyzed, they can be converted into VMs by the built-in VMware Converter feature of vCenter Server 2.5. The data gathered by this utility is basic and does not use some of the more advanced metrics that the full version of Capacity Planner uses. It can analyze up to 100 systems simultaneously and reports only on average CPU and memory utilization. Because of its limitations, it is recommended that you use a more robust performance monitor for your initial implementation. We discuss this feature in detail in a later chapter.

Using Built-In Operating System Tools to Gather Server Performance Statistics

For your Windows servers, you can use the Windows built-in performance monitor utility (PerfMon) to measure your server's statistics. The downside to this method is that you will have to set up, collect, and review the statistics for each server individually, which can be time-consuming if you have many servers. Alternatively, you can set up a dedicated workstation or server to centrally monitor and collect statistics from each server.

Most Linux servers have only built-in real-time statistic reporting tools. You may look at some free tools that provide historical performance reporting for Linux servers, like Sysstat (http://pagesperso-orange.fr/sebastien.godard/).

If you do choose to use PerfMon to gather your statistics, the following steps will help you set up and configure it. Before you begin, if you are going to use a central workstation to collect statistics, make sure the Performance Logs and Alerts service on the workstation is

configured to start with a domain account that has access to every server that you want to monitor:

1. Load the PerfMon utility on a workstation or server (Administrative Tools > Performance).
2. In the left pane, select Counter Logs (located under Performance Logs and Alerts).
3. Select Action from the top menu (or right-click Counter Logs) and choose New Log Settings.
4. Enter a descriptive name for your log settings.
5. Click the Add Counters button.
6. Choose the Select Counters from Computer option, and type in the name of one of the servers you are going to monitor below it. Be sure and include the \\ before the Windows server name.
7. After you enter your server name, it will connect to it and display a list of available counters below it, as shown in Figure 1.2.

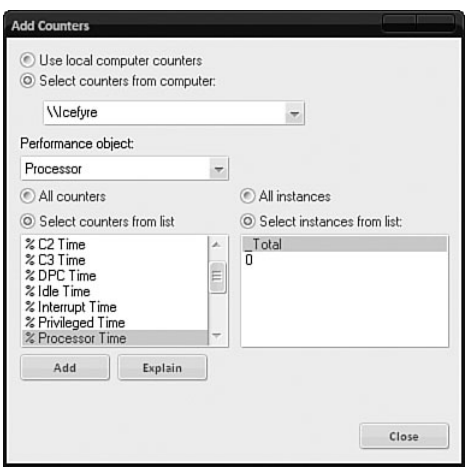

Figure 1.2 PerfMon Add Counters window

8. Select the performance object that you want to display counters for (for example, processor, memory, network interface), and then select the individual counter (for instance, Pages/sec), select All Instances if it is applicable (except for Network Interfaces, you do not want to select the Loopback interface) and not grayed out, and then click the Add button.
9. Repeat this for every performance counter that you want to monitor on the server. The recommended counters you will want to add are listed here:

Memory: Available MBytes

Memory: Pages/sec

Processor: % processor time

System: Processor queue length

Network Interface: Bytes total/sec

Physical Disk: % Disk Time

Physical Disk: Avg. disk queue length

Physical Disk: Disk bytes/sec

Physical Disk: Disk transfers/sec

10. After you have added all counters for a particular server, you can type in a new server name to continue adding counters for other servers.
11. Click the Close button after you have added all counters.
12. Select the data sample interval, as shown in Figure 1.3; the default is 15 seconds, which is an aggressive interval and will result in more peak instances because of the shorter sampling period. You may want to consider changing this to a high interval between one and five minutes so that you do not overwhelm the workstation and cause it to miss data from some of the servers.
13. Click OK to save your custom log settings.

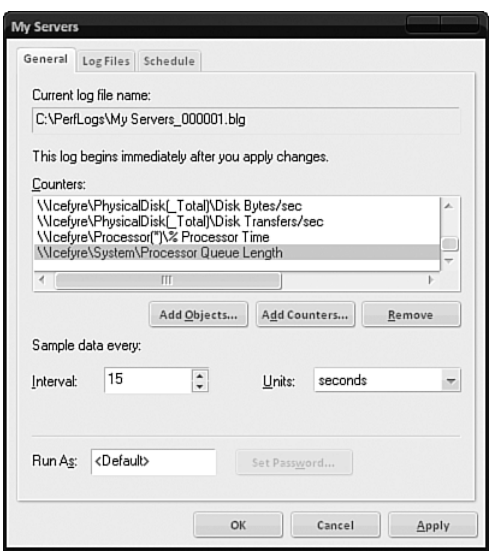

Figure 1.3 PerfMon Log Settings window

14. Collection will automatically begin (as indicated when the icon turns green). The results will be written to a log file (for example, C:\PerfLogs\MyServers000001.blg). You can stop it at any time by selecting your log settings and selecting Action, Stop (or by right-clicking it and selecting Stop). When you stop a collection, the log file it has written to is no longer used; a new log file is created once you start it again.
15. If you have stopped your collection, you can review it by selecting System Monitor in the left pane, and then clicking the Disk icon (View Log Data). Then, on the Source tab, select your log file that was created; optionally, you can change the time range. On the Data tab, add your performance counters for each server. On the General tab, select your view type (Graph, Histogram, or Report) and click OK. Your counter will be displayed, and you can see the minimum, maximum, and average results for each one, as shown in Figure 1.4.

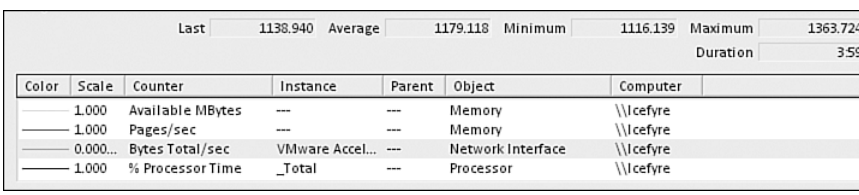

Figure 1.4 PerfMon resulting historical data for each counter

16. It's a good idea to test this for a short period (for example, one hour) and review the results to make sure it is working before you leave it running for a longer period of time.

Using Enterprise Monitoring Systems

If you are using an existing monitoring system, try to report on only the appropriate statistics that will be relevant to determining your needs to size your virtual hosts. Too many statistics can make it more difficult to determine how busy a host is in each of the categories. Also, remember that when you convert your physical servers to VMs your enterprise monitoring system may not report accurate statistics because of the differences inherent with virtual environments.

What to Do with the Data You Collect

After you have gathered your performance statistics, you should group your servers into three categories:

- High overall resource utilization
- Medium overall resource utilization
- Low overall resource utilization

Then identify the servers that have the highest resource utilizations in specific areas: CPU, memory, disk, and network. You should then review the servers in the high overall resource utilization category to make sure that virtualizing them makes sense. Also, do the same for the top few servers in each of the specific resource areas. When you've determined which servers you want to virtualize, you can move on to sizing your hardware to match your expected workload.

It is helpful to put together a spreadsheet that contains the following information about your physical servers to help you add up the amount of CPU, memory, and disk needed for your ESX hosts:

- Server name
- Model
- Operating system
- Function
- Number of CPUs
- Speed of CPUs
- Total disk space
- Total disk space used
- Physical memory

Next, add your performance measurements to it:

- Average CPU usage (% processor time)
- Maximum CPU usage (% processor time)
- Average processor queue length
- Maximum processor queue length
- Average available free memory
- Minimum available free memory
- Average memory pages/sec
- Maximum memory pages/sec
- Average % disk time
- Maximum % disk time
- Average disk queue length

- Maximum disk queue length
- Average disk bytes/sec
- Maximum disk bytes/sec
- Average disk transfers/sec
- Maximum disk transfers/sec

Finally, add a ranking for each resource using a scale of one (least) to five (most) based on the averages for the measurements of each category. This ranking will help give you an idea of where each server ranks in usage for each of the resource areas. A server that has high ranking in more than two of the following categories may not be a good virtualization candidate:

- CPU resource usage
- Memory resource usage
- Disk resource usage
- Network resource usage

When you are done, you will have a spreadsheet that contains an inventory of all your physical servers and the resource usage statistics that you can use to help size your ESX hosts properly. In the next chapter, we discuss sizing hardware for your ESX hosts.

Which Servers Are Not Good Virtualization Candidates?

Almost all servers and workloads can be virtualized, but in some cases you may not want to virtualize certain servers because of high-resource utilization, licensing issues, and application support issues. Let's cover some reasons you might not want to virtualize certain servers and some reasons that you may consider virtualizing these types of servers:

- High-resource utilization servers

  Why you might not want to virtualize. A server that has very high resource requirements may not always be as good a fit as a virtual server. Typically, these types of servers have very high CPU and memory usage and high disk and network I/O, and on a virtual host where multiple servers are competing for resources they might not perform as well.

  Why you should consider virtualizing. When virtualizing these types of servers, you may be able to have only one or two VMs on a host server. You might wonder why anyone would want to put just a single VM on an ESX host. The reason for this is to take advantage of some of the powerful features that virtualization offers such as snapshots, VMotion, and high availability (HA) that are more difficult and costly to implement in a physical environment. Also, virtualizing these servers can make for easier disaster recovery implementation and simplified hardware upgrades.

- Vendor licensing models

  Why you might not want to virtualize. Some applications, such as Oracle, do not have virtualization-friendly licensing and require you to license their software based on the number of physical CPUs in the host server and not the number of virtual CPUs assigned to the VM that is running the application. So, a VM with two virtual CPUs on a four-CPU host server would require you to purchase a license for four CPUs regardless of the fact that the VM that is running the application has only two virtual CPUs.

  Why you should consider virtualizing. Thankfully, most vendors today license their software based on the number of CPUs assigned to the server regardless of whether they are physical or virtual. Other vendors are changing their licensing models to meet the growing demand for using virtual servers. Check with your vendor to see if they have changed their licensing model or have any plans to do so in the future.

- Application support

  Why you might not want to virtualize. Some vendors will not provide support for their application if it is running on a virtual server. We discuss this in more detail later on.

  Why you should consider virtualizing. Very few vendors do not support running their applications on virtual servers. Consider alternative support options. (For example, HP provides support for both VMware and Microsoft products.)

- Specific licensing requirements:

  Why you might not want to virtualize. Certain applications use stricter licensing methods to prevent piracy and illegal use of their software. Examples of this are hardware dongles (parallel/serial port/USB device keys) that plug into the server and must be present at all times and specific MAC address or hard drive serial number licensing. If a VM moves from one host to another as a result of a failure or due to resource constraints on a host, then the hardware dongle will no longer be present and the application will no longer work.

  Why you should consider virtualizing. There are ways to accommodate these types of licensing schemes on virtual servers. Digi makes a device called AnywhereUSB that works with ESX servers and provides IP-based connections to USB devices.

- Hardware that cannot be virtualized

  Why you might not want to virtualize. Some servers might have nonstandard hardware like fax and modem boards that are not supported in ESX which supports only a limited, very specific set of hardware.

  Why you should consider virtualizing. Solutions are available for faxing and using modems via network connections over IP.

Should I Consider a 100% Virtualized Environment?

Although you will find that having a 100% virtualized environment is certainly achievable, there are a few reasons why you might want to maintain a few physical servers:

- **Support issues.** Some application vendors may require you to reproduce the problem on a physical server if they suspect the virtual host might be causing the problem. For this reason, it is a good idea to keep a physical server around for certain infrastructure components like Active Directory. If you have eight domain controllers in your environment, you might consider virtualizing six of them and leaving two of them as physical servers. Same with database servers; if you leave one or two Oracle or SQL database servers as physical servers, it gives you the flexibility to move a database hosted on a VM to a physical server if the vendor requests it.
- **Infrastructure issues.** If your environment suffers a major failure (for example, a storage area network [SAN] goes down or you experience a major network failure), you may lose most of your VMs. For this reason, you may want to copy at least one DNS/DHCP physical server (because many functions rely on DNS to work properly).
- **All the eggs in one basket.** You will most likely be using shared storage with your ESX hosts to take advantage of all the features that require it. However, if something happens to that storage, it will affect all your hosts and VMs that utilize it. To offset this risk, consider running a few of your key infrastructure VMs (for example, domain controllers, authentication servers, database servers, and DNS servers) on local disk rather than shared storage. That way the VM will not be affected if something happens to your shared storage device.

Application Compatibility

The assessment of your environment should also include software applications in addition to hardware. You should do a complete inventory of applications running on your servers that you plan to virtualize so that you can ensure there will be no support or licensing issues when running them on virtual servers. You do not want to find out after you are done with your project that the application vendor will not provide support to you because the project is running on a virtual server. In addition, there might be special licensing considerations or configuration changes that need to be made to an application that has been virtualized:

- **Support issues.** One of the first steps that you should complete when considering virtualization is to determine whether the applications you use are supported by the vendor in a virtualization environment. Almost all applications will run properly on virtual

servers, but you will find that vendors typically have varying levels of support for virtual servers. The levels you will see will include the following:

Complete support for it. The vendor has certified their application to run on virtual servers and will support it without question. You will find most major applications will fall into this category, with a few notable exceptions, such as Microsoft.

Best effort support. The vendor will make an effort to support their application on a virtual server but may ask you to reproduce the problem on a physical server if they determine that the virtual environment is at fault. Microsoft falls into this category; if you have premier-level support with them, they will make more of an effort to help you.

No support. The vendor will provide no support for their application in a virtual environment. Typically, this is either because of known issues when running the application on a virtual server or that the vendor has not yet tested their product on virtual servers. If this is the case, you need to decide whether you want to risk virtualizing the application. If you do, plan for the times that you do need to contact support for help with problems (such as having a physical server available for reproducing the problem).

- **Licensing issues.** Some vendors have non-virtualization-friendly licensing models when you run their products on virtual servers; Oracle is a good example of this. Typically, they will still license based on the physical number of processors in the host server regardless of how many processors the VM has assigned to it. So for a VM running on a four-CPU host that has only a single virtual CPU, you may be required to license for four CPUs. Other vendors will change their models slightly for virtual servers. For example, IBM has a new processor value unit formula that makes licensing on virtual servers much more difficult to calculate compared to physical servers. Other vendors will license differently based on clusters of servers with pooled resources. If this is the case, you may need to create a smaller cluster just for the specific application to keep costs down. It's also common in virtual environments for a VM to not always be on the same host server because of features such as Distributed Resource Scheduler (DRS), HA, and VMotion. This can also cause headaches when licensing applications that are tied to specific hosts and hardware resources. It's best to contact all your software application vendors and find out their virtualization support policy in the early stages of your project. You might find that it may cost more to run their applications on virtual servers, but often the advantages that virtualization provides outweigh the increased costs.

Did You Know?
Put together a spreadsheet of all your applications and check with each vendor to find out their virtualization support policy. Also check to see how they license their products in a virtual environment. Often, you can find this information on their website or in their knowledge base. Include columns for support level, licensing model, and the URLs to their policies. After you complete your spreadsheet, meet with the application owners to discuss the results and make sure they understand the vendor's policy toward virtualization.

Getting Everyone On Board with Virtualization

Virtualization introduces many unique and new concepts into your environment, and as a result many groups within IT often put up resistance to it. This is typically a result of the fear and mistrust of a nonstandard technology like VMware and is most often caused by the lack of understanding of how VMware works. Therefore, plan to educate everyone who will be involved in your virtualization project early on so that they have a good understanding about what VMware is and its capabilities and features. Once they learn more about it and discover the great benefits of virtualization, they will be better prepared and more willing to help you implement it. This section provides examples of the types of resistance you will experience from each group and how you can best deal with each of them. You will often find that most people who are initially negative toward VMware eventually become supporters after they learn more about it and experience it for themselves.

Did You Know?
Before you attempt to explain virtualization concepts to other groups, make sure you understand the product thoroughly yourself. First download an evaluation copy, install and configure it, and make sure to read through the documentation. Also contact VMware or a business partner and have them assist you by presenting their product to your company.

The following subsections provide some tips for dealing with specific groups within IT to help them better understand virtualization concepts.

Dealing with Network Administrators

Traditionally, most network groups manage the physical network connection of a server from the switch all the way to the NIC. Virtualization changes that with vSwitches, which

effectively extend the physical network from the NIC in an ESX host to a vSwitch that is managed by the ESX server and a virtual NIC that connects a VM to the vSwitch. This vSwitch is usually managed by ESX administrators and not network administrators, which can cause some concern among network administers because they can no longer control and manage part of the network that connects a virtual server to a physical network.

802.1Q VLAN tagging is a network technology commonly used when virtualizing servers. It enables you to use multiple VLANs on a single vSwitch and is a must-have in large environments. Without it, you would have to create a separate vSwitch for each VLAN and dedicate at least one NIC to it. This technology is not used that often with physical servers, and some network people might not have much experience with it. It's fairly simple to set up and configure, and we cover more on this in a later chapter.

Another networking area that is often a concern with virtualization is connecting VMs to your public demilitarized zone (DMZ) while keeping your ESX service console on your private internal network. The concern with this is that the ESX server is straddling the DMZ, because it has connections to both the private and public networks, and a potential attacker could compromise a VM in the DMZ and gain access to your internal network. The design of ESX does not allow for this to occur, and the only scenario in which this could potentially happen is if someone mistakenly configured a VM with two virtual NICs (vNICs), one being on an internal network vSwitch and the other on an external network vSwitch, which you would never want to do (unless the VM is acting as a firewall or proxy server).

Here's what you should tell your network administrators:

- Explain the concept of vSwitches and vNICs and how they interact with physical switches and physical NICs.
- Show them how to set up and configure a vSwitch and how to install a vNIC in a VM and connect it to a vSwitch.
- Explain to them how ESX uses trunked network ports and how 802.1Q VLAN tagging works in a virtual networking environment.
- Explain virtual network security principles and how vSwitches are isolated from each other so that traffic cannot leak between them.
- Demonstrate NIC teaming and failover in a virtual switch.

By the Way

Putting together a pilot project is a great way to learn and experience virtualization and demonstrate its capabilities and potential. Consider a small-scale project using the 60-day evaluation licenses with one to two ESX or ESXi hosts on some existing hardware. You might also try using the free VMware Server, which can run on a wide variety of hardware and operating systems as a good introduction to virtualization.

Dealing with Developers

Many developers will be concerned that their applications may not run properly on virtual servers. Another concern may be that software vendors will not support their products running in virtual environments. Early on in your project, gather support statements from software vendors that show their level of support for virtualization. Demonstrate the snapshot and cloning features of VMware that will be a great benefit to them. Also explain what virtual hardware is and how VMs see the same hardware regardless of the underlying physical hardware (except for the CPU). By having consistent hardware on all servers, you can eliminate any potential problems that may be caused by using different hardware on different servers running the same applications.

Here's what you should tell your developers:

- Show them statements of support for VMware from software vendors.
- Show them a VM's hardware configuration.
- Explain how VM hardware can easily be modified (more RAM, more disk space, and so on).
- Tell them about VMware's capability to rapidly provision new servers and to have dedicated, isolated development sandboxes.
- Show them information about the Lab Manager and Stage Manager automation products that VMware offers as additional components to VI3.
- Demonstrate creating snapshots and reverting back and cloning existing VMs and creating new ones from templates.

Dealing with Security Administrators

This is the group that tends to put up the most resistance to VMware because of the fear that if a VM is compromised it will allow access to the host server and the other VMs on that host. This is commonly known as "escaping the cave," and is more an issue with hosted products such as VMware Workstation and Server and less an issue with ESX, which is a more secure platform.

By the Way

The term *escaping the cave* comes from the analogy that a VM is trapped inside a cave on the host server. Every time it tries to escape from the cave, it gets pushed back in, and no matter what it does, it cannot escape from the cave to get outside. To date, there has never been an instance of a VM escaping the cave on an ESX server.

ESX has a securely designed architecture, and the risk level of this happening is greatly reduced compared to hosted virtual products such as Server and Workstation. This doesn't mean it can't happen, but as long as you keep your host patched and properly secured, the chances of it happening are almost nonexistent. Historically, ESX has a good record when it comes to security and vulnerabilities, and in May 2008, ESX version 3.0.2 and VirtualCenter 2.0.2[1] received the Common Criteria certification at EAL4+ under the Communications Security Establishment Canada (CSEC) Common Criteria Evaluation and Certification Scheme (CCS). EAL4+ is the highest assurance level that is recognized globally by all signatories under the Common Criteria Recognition Agreement (CCRA).

Another concern when it comes to security is with storage logical unit numbers (LUNs). The concern is that a VM that has its virtual disk on a SAN LUN that is shared with other VMs may allow for an attacker to access other data on that LUN or on the SAN fabric itself. Again, the secure design of ESX specifically prevents this from being possible. A VM cannot directly access the Fibre Channel cards in a host system and therefore cannot see anything beyond the virtual disk assigned to it.

Here's what you should tell your security administrators:

- Show them the industry security certifications that ESX has achieved.
- Explain how the design of ESX does not allow for VMs to directly access host hardware without going through the hypervisor.
- Show them CIS ESX Host and Virtual Machine Benchmarks and Guidelines.
- Allow them access to a VM so that they can verify its security for themselves.
- Show them the vCenter Server roles and very granular permissions that control access to the ESX hosts and VMs.
- Explain the ESX Service Console is not just a Linux operating system but a modified and more secure version based on Red Hat Linux. In addition, explain how ESXi no longer has a Service Console and is less vulnerable than ESX.
- Explain that the guest operating system on a VM is subject to the same security risks as a physical system and if compromised does not allow access to the ESX host.

Dealing with Management

IT management groups are usually the ones that get your funding approved and are typically the ones that sponsor your project. It's important that they understand the technology and its benefits so that they can support you, ensure you get the appropriate funding, and promote your project within the rest of your company.

Here's what you should tell your management:

- Demonstrate some of the cool features that virtualization provides, such as snapshots, VMotion, NIC teaming, and HA.

- Explain the cost-savings benefits and ROI that virtualization can provide (greatly reduced power and cooling costs, for instance).
- Show them the many customer success stories that VMware provides on its website.
- Explain how virtualization can greatly simplify disaster recovery.
- Provide a high-level executive overview of the technology, its features, and how it works.

Dealing with Storage Administrators

Many storage administrators have their own ideas about designing and configuring storage and do not like deviating from them. The most frequent area of contention when deploying ESX is the size of the SAN LUNs. Some old-school storage administrators like creating smaller LUNs (for example, 20GB) and do not like creating the larger LUN sizes that work best with ESX. In addition, assigning storage to ESX servers is a bit different from traditional methods because the same LUNs must all be presented to every ESX server with the same LUN IDs because ESX servers must all see the same storage for features such as VMotion to work.

Here's what you should tell your storage administrators:

- Explain how the VMFS file system is a cluster file system that leverages shared storage to allow multiple instances of ESX Server concurrent read and write access to the same storage resources.
- Explain what a virtual disk file (vmdk) is and how they are used on VMFS volumes.
- Explain how VMFS volumes work best with larger LUNs, and how using extents to enlarge VMFS volumes across multiple LUNs is not a best practice.
- Show them the SAN Configuration guide and the SAN Design and Deployment guide that VMware provides.
- Explain the reduced SAN administration workload that results because there is no need to configure storage for each server (VM) individually; it's only necessary to configure it for each ESX host.
- Explain how ESX servers use multipathing to connect to the SAN fabric.

Dealing with Operating System Administrators

This group will typically be concerned with performance, compatibility, security, and manageability of their servers running in a virtual environment. The biggest concerns are typically resource contention and not knowing how their servers will perform on a virtual host.

Here's what you should tell your operating system administrators:

- Show them how templates work and will allow them to quickly and easily deploy new servers.
- Explain how resource pools work and how resource shares, limits, and reservations can help control the amount of host resources that a VM can access.
- Explain how the VI client and vCenter Server are used to administer ESX hosts and VMs and how roles and permissions are used to assign specific privileges to access both host servers and VMs.
- Explain the key differences between virtual and physical hardware and how the ESX scheduler handles CPU requests.

Did You Know?
Seeing is believing. Download and set up an evaluation version, and then demonstrate some of the advanced features, such as HA and VMotion. Also, unplug a NIC cable on a multi-NIC vSwitch to demonstrate NIC teaming. To get a visual indication of these features working, ping a VM from a separate workstation while you demonstrate. Seeing these features in action is a sure way to impress any naysayers.

Summary

Assessing your current environment is important if you are planning on migrating your current physical servers to VMs on your ESX hosts. You might be tempted to do some guessing in your haste to get started, but a proper assessment ensures that you do not run into surprises later on and that you plan on adequate hardware to support your needs. So take the time and see where you are today, before you progress to where you want to be tomorrow. In the next chapter, we cover all the many things that you will want to plan for when architecting your new VI3 environment.

Endnotes

1. The use of the term VirtualCenter here refers to the old name, which still applies to VirtualCenter version 2.0.x and is also still present inside the application in vCenter Server 2.5 (because the software has not yet been updated to reflect the new name).

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