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Virtual Platform Management

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Introduction to Realtimepublishers

by Don Jones, Series Editor

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Chapter 1: The Business Value of Virtualization

Every once in a while, a new IT technology is introduced that promises to have far-reaching impacts on how organizations manage technology. Although there are almost always huge benefits, issues such as deployment, administration, and general management of the technology are also important concerns. Just a few short years ago, the term *virtualization* was generally reserved for a few members of the IT department that were interested in specific applications. Server virtualization solutions have been around for many years, but they were often relegated to running on desktop computers or on a few select servers within an environment.

As a result of a variety of both business and technical reasons, things have changed quickly. Today, server virtualization has moved to the forefront of solution options for organizations that are looking into optimizing their investments in data center assets. Solutions are available from a variety of vendors and can provide dramatic cost savings and related benefits. Although virtualization provides numerous technical and business benefits, IT organizations must consider issues related to the management of this technology.

This guide will walk through many of the details related to best practices for managing virtualization. The focus will be on understanding how and why virtualization should be considered and, once an IT department decides to deploy virtual machines (VMs), how best to manage them. This chapter will lay the foundation for discussing why virtualization is such an important technology. Specifically, it will cover an overview of how virtualization technology works, along with details related to the types of problems that virtualization can help solve. The goal is to serve as an introduction for the in-depth technical topics explored in later chapters.

A Brief History of IT Approaches

Before you can understand how and why virtualization technology is so important to the future of IT departments, it is helpful to take a brief look at the history of IT solutions. In the earliest days of business computing, primary computer resources were largely centralized. The mainframe computer was a standard and provided CPU, memory, and storage resources from a central location. End users would employ what amounted to large "extension cords" to provide input and output to the central system.

This arrangement made management relatively simple for IT staff; rather than administer dozens or hundreds of computers, only a primary central system had to be taken care of. As an aside, it can certainly be argued that these systems implemented a form of virtualization because individual "dumb terminals" could be provided with isolated environments that were carved up from the mainframes' total resource pool. Of course, there were limitations from an end-user standpoint, and staring at a text-based green screen left much to be desired.

The advent of the affordable desktop computer allowed end users increased flexibility in installing and configuring applications. Desktop software could increase productivity. Over time, IT departments began to support client-server computing environments. In this configuration, both end-user computers and centralized servers shared the burden of processing and data storage. Client computers often focused on user interaction and information presentation while servers stored data and provided some businesses-related functions. Although there were obvious functionality and usability benefits, administration and management became significantly more complex due to the flexibility of configuration and a larger number of computers to manage.

Modern enterprise applications often have many dependencies. Multi-tier applications regularly include components that must be run as many different services. For example, a Web server might be required to provide interaction with the user. Business logic might be run within a specialized application-server tier, and data storage might be handled by a database. In some ways, this increased complexity provides much-needed benefits. Performance and scalability are often improved by distributing the workload over many server components. A more recent push towards service-oriented architecture (SOA) helps to lessen the dependencies between applications. Figure 1.1 provides a summary of this evolution over time.

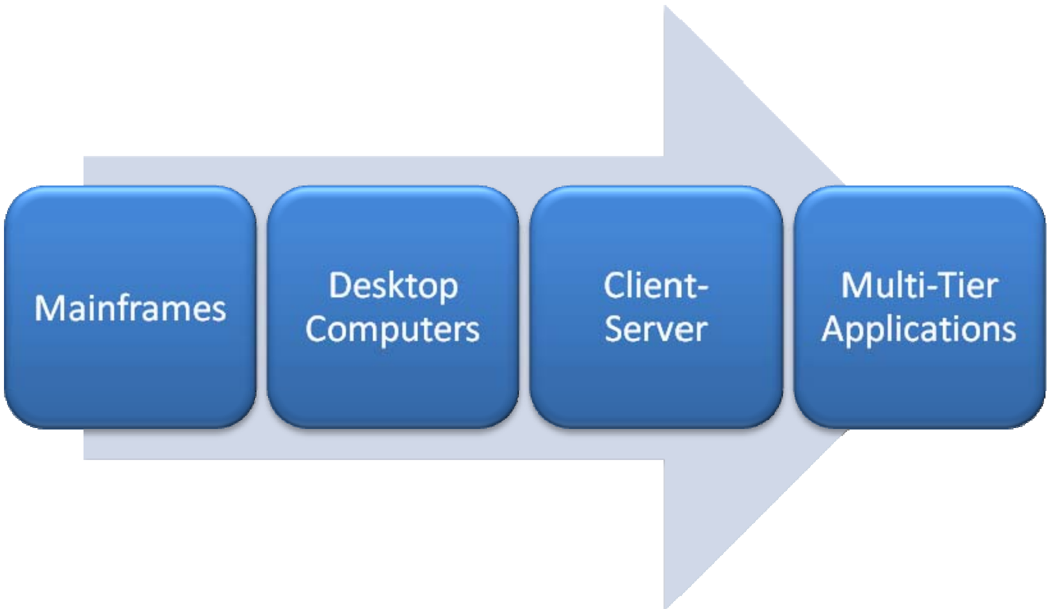

Figure 1.1: The evolution of IT architectures over time.

The bottom line, however, is that modern IT environments are complicated and have many "moving parts" that must be managed by IT staff. Add to that the need to quickly adapt to business changes while dealing with decreased budgets and reduced human resources, and the list of challenges is long. This evolution and its associated challenges help set the stage for the topic of this chapter—server virtualization.

An Overview of Virtualization

Although the term virtualization is often heard in modern IT environments, it's important to have a solid understanding of the technology that is being described. Taken in a general sense, virtualization can apply to many different components of an IT infrastructure. For example, network-level virtualization might refer to the abstraction of physical routers and switches into logical network fabrics. Similarly, the purpose of storage virtualization is to hide the underlying physical implementation of hard disks and other devices and to present to users a single, large storage pool.

Although this guide will look at several technical implementation details of virtualization in later chapters, let's start with a basic example. A major goal of server virtualization is to allow multiple operating systems (OSs) and applications to run on a given piece of hardware concurrently. Each of these OSs runs within an isolated space known as a VM and runs independently of the others. Figure 1.2 provides a conceptual overview of one way in which server virtualization may be implemented.

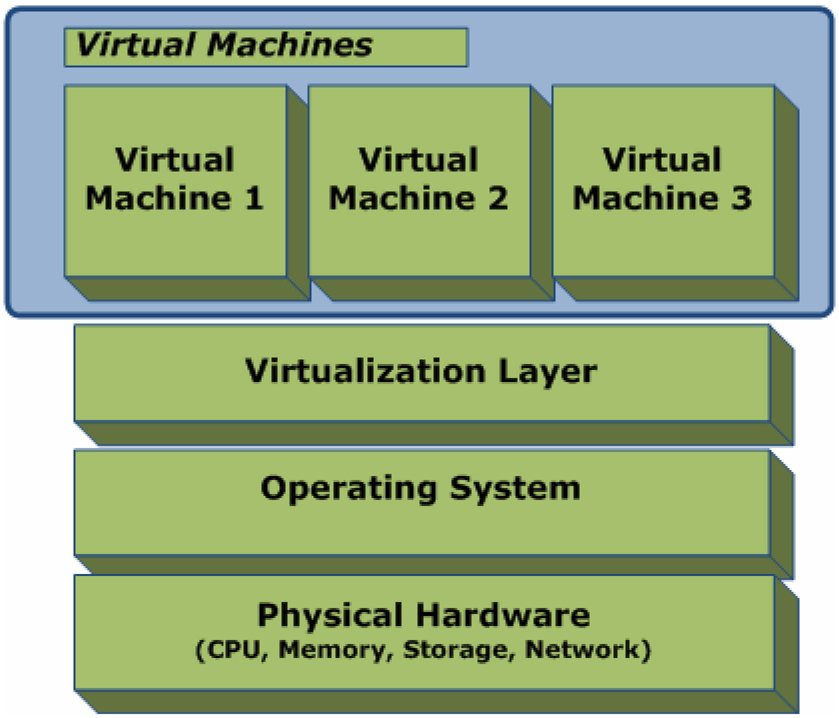

Figure 1.2: A technical overview of server virtualization.

Starting from the bottom of the diagram, the base portion of this configuration is the physical hardware that makes up the server. This includes the CPUs, memory, hard disks, and network components that are part of the computer. It also includes any other physical devices that might be attached.

Running atop the physical hardware is a base OS. The purpose of the OS is to coordinate all interactions between applications and the underlying hardware through the use of device drivers and other features. So far, this is the standard configuration that you would expect for any server within the data center. In a non-virtualized configuration, systems administrators would then install and configure applications within the OS and directly make them available for use.

Figure 1.2 shows a configuration that includes a virtualization layer that runs within the computer's OS. The virtualization layer runs as an application or a service and provides for the creation of isolated VM environments. Each of these VMs provides a virtual computer in which a separate OS can be installed and configured. The OS and applications that are installed within the VM are generally unaware that they're running in a virtual environment. They can use CPU, memory, disk, and network resources just as they would on a physical computer.

This setup brings us to the job of the virtualization software. Whenever resources are requested by a VM, it is the job of the virtualization layer to access the underlying physical hardware. The goal is to coordinate a resource request (such as reading a file from the disk) with the other concurrent requests. This prevents any of the VMs from directly accessing the hardware and allows the virtualization layer to coordinate requests for CPU time, physical memory, disk reads and writes, network I/O, and other operations.

Virtualization Terminology

If you're new to the concept of virtualization, it might be helpful to review a few terms that will be used throughout this guide:

- Virtualization host—A host computer is the physical machine on which a virtualization platform is installed. Depending on the virtualization approach chosen, there may be special requirements for the configuration of this machine. In IT data center environments, the most common option for a production virtualization host is a rack-mounted server. In general, however, just about any modern computer (including desktops and workstations) can be used to support VMs. The actual number of VMs that can be hosted will vary based on the specifications of the hardware.
- Host OS—The primary OS that is run on the virtualization hardware is known as the host OS. This OS has direct access to the underlying hardware and generally contains device drivers to support all the devices that are attached to the system. Users and systems administrators can install applications and services directly on the host OS as needed. However, for performance reasons, they may decide to dedicate a machine to virtualization services by limiting the number of other processes that might compete for resources.
- Virtualization software—The virtualization software is responsible for the creation of VM environments and for translating and coordinating resource requests to the underlying host OS. There are numerous ways in which the virtualization software can be implemented, each with its own terminology. For example, software-based Hypervisors run directly on the host computer's hardware and use a very small resource footprint for the host OS itself. Other virtualization layers might be implemented as an application or a service that is run within the host OS. The details related to these approaches will be covered later in this guide. For now, all the information covered will apply regardless of how the virtualization layer is implemented.

- VM—A VM is an independent, isolated environment that is created by a virtualization solution. It is designed to appear to software and applications as a physical machine. Like a physical computer, this environment has a standard boot process and can have access to resources such as virtual hard disks and virtual network adapters. Applications that are run within a VM are able to access resources such as files or other computers on the network. Access to the underlying physical hardware on the host computer is coordinated by the virtualization software.
- Guest OS—In most configurations, systems administrators will install a new OS within each VM. These OSs are known as guest OSs because they run atop the host OS. The specific OS versions that can be installed vary based on the virtualization solution, but often the goal is to provide support for as many different types of OSs as possible.

A Virtualization Example

Overall, it's important to keep in mind the distinction between host and guest terminology. As both environments can run OSs and applications, the distinction is often blurred. In fact, that is one of the goals of virtualization. To illustrate a specific virtualization implementation, Figure 1.3 provides an example based on the Microsoft Virtual Server 2005 R2.

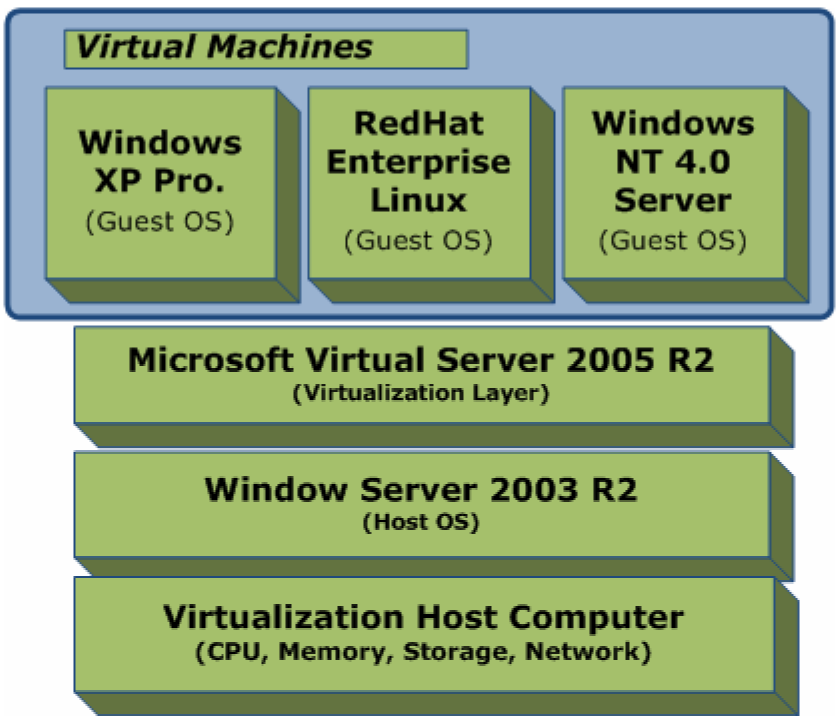

Figure 1.3: An example of a virtualization environment based on Microsoft Virtual Server 2005.

In this figure, the host OS is Windows Server 2003 R2. Systems administrators can install this OS just as they would on any other server computer. Typical steps would involve configuring the base hardware, launching the installation process, installing device drivers, installing security updates, and configuring applications and services.

After the host OS is installed and configured, the virtualization layer can be installed. In this case, Microsoft Virtual Server 2005 R2 is installed and configured as a service. The standard installation includes the virtualization service itself, an administration Web site, and various helper services. Using the administrative tools, systems administrators can create and configure new VMs.

Each VM initially appears as a brand new computer with a blank hard disk. Therefore, the next logical step is to install guest OSs within each VM. In this example, Windows XP, Windows NT 4.0 Server, and Red Hat Linux are each installed into a separate VM. All three guest OSs can run concurrently on the same hardware and they can access resources that are physically attached to the host hardware. Again, this is only one implementation method using a specific solution. But if you're new to the concept of virtualization, you can keep this basic architecture in mind.

Business and IT Challenges

In recent years, many businesses have discovered the true strategic value of IT. To execute successfully, the entire organization is dependent on its IT infrastructure. It's no secret that IT departments are often faced with many constraints. They are often pushed to provide more services while staying within constrained budgets. And, the costs of technical resources such as hardware, software, and network devices tend to go up over time. So far, we have covered an overview of the technology related to the implementation of server virtualization. Now it's time to look at the business and technical challenges this solution is intended to solve.

Reducing Data Center Costs

Modern businesses rely on their IT investments to support all areas of the business. From end users that are communicating over the Internet to users of enterprise applications, the assets maintained by IT staff are critical to meeting business goals. A major issue for many companies is controlling the costs related to implementing and maintaining this infrastructure.

For many organizations, a large share of the overall IT budget is dedicated to maintaining the data center. All the hardware, software, and networking devices that the business relies upon must be properly maintained and remain available for use. One significant source of costs is that of maintaining the physical equipment itself. The more servers and network devices an IT department needs to support, the greater the chance of failure. More machines also means more monitoring, and if any device becomes unavailable, IT staff generally has to scramble to return it to service as quickly as possible. Many of these costs and risks can be decreased by reducing the number of "moving parts" in the data center. Data center costs can be broken down into several primary components (see Figure 1.4).

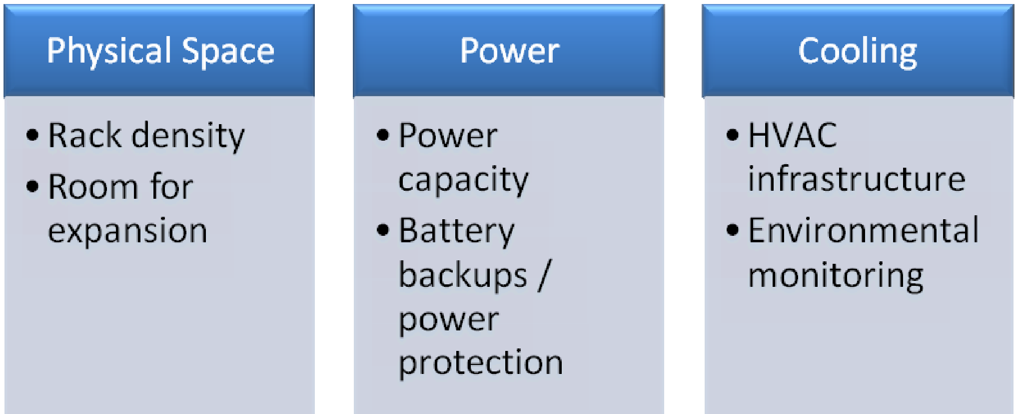

Figure 1.4: Factors leading to major data center costs.

Physical Space

All the many devices that must be supported within the data center take up physical space. Each rack consumes floor space, and because the size of the data center is usually limited, just providing enough room for expansion can be a challenge. To meet this challenge, in some cases, IT departments have chosen to retire older equipment earlier than planned. Newer servers and networking devices can provide far greater capabilities in smaller spaces. Another approach is to physically expand the data center space or to distribute resources among multiple data centers.

These options can present some tremendous costs to IT departments. For example, even if additional data center space is available, moving resources takes time and effort. Setting up the management infrastructure to support multiple data center locations can also be costly.

Power

Data centers rely upon their power infrastructures to keep servers and networking devices up and running. In recent years, the raw cost of the electricity consumed by these devices has become a major cost by itself. Modern CPUs and servers use significantly more power than their older counterparts and many businesses have found that their per-rack power consumption is far greater than they had initially planned for. Greater power demands often require additional capacity to be brought into the data center. This might in turn require physical redesigning of the data center, leading to increased costs.

As if the provisioning of power wasn't enough, there are several secondary costs to keep in mind. Most data centers must provide redundant power connections to make sure that critical devices remain available should a circuit fail. To have full redundancy, these requirements can easily double the amount of power that must be available. And, to protect against site-wide outages, battery backup arrays and fuel-based generators must be implemented. All these components must be regularly tested and maintained. Clearly, providing adequate power can impact the bottom line for IT organizations.

Cooling

An unnecessary by-product of the use of electricity is the heat generated by data center components. Ranging from CPUs to hard disks to network devices, all these pieces of hardware generate heat. To ensure reliability, data center administrators must ensure that adequate cooling is available. With the increase in power consumption (and the associated heat generation) per rack, managing “hot spots” in the data center can quickly become a full-time task. To ensure that critical systems don’t overheat, administrators must invest in environmental monitoring solutions (and the staff to manage them). In addition, scaling cooling infrastructure (assuming that it’s even possible for a given data center) can be costly.

Implementing Agile IT Environments

For modern IT organizations, keeping up with the pace of changes that are required in order to support business initiatives can be challenging. It often seems that as soon as a new solution is implemented, it’s time to make modifications to the infrastructure. Changes can come from within the IT department—for example, when a server must be upgraded to new hardware for maintenance reasons—or from business units.

Regardless of the reasons for change, IT departments that can react quickly provide a significant advantage to the organizations that they support. Through the use of virtualization, IT departments can create a fluid environment in which virtual computers can be dynamically started, stopped, moved, or copied throughout the environment. This can often be done without any physical effort and in a matter of minutes. A specific example of increasing agility is in reducing deployment times for new servers.

Reducing Deployment Times

Even well-managed IT departments often have problems trying to keep pace with the changing needs of the business units they support. One important task is the provisioning of new servers and other devices to support business initiatives. The process of deploying a new server often requires many steps, each of which requires time and effort (see Figure 1.5).

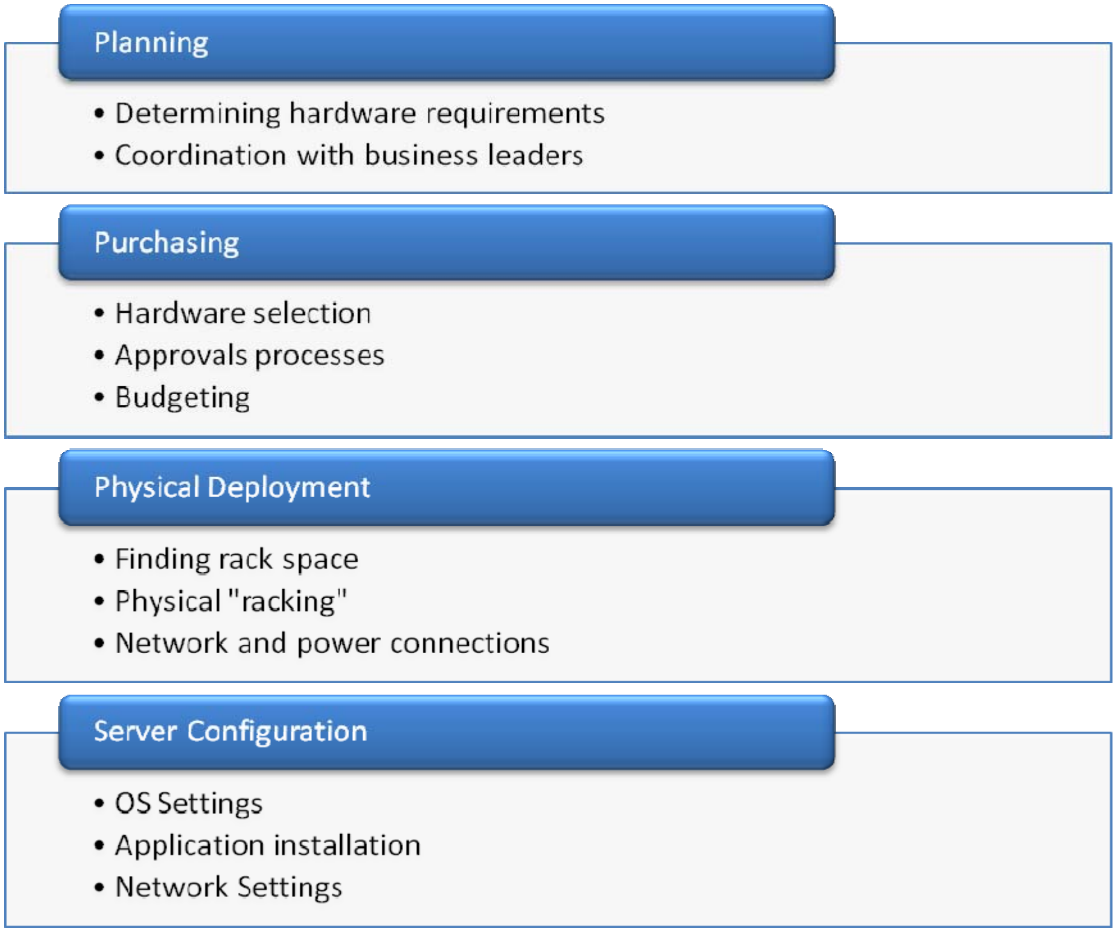

Figure 1.5: Steps involved in deploying a new server.

The process generally begins with determining the requirements for the new server and then purchasing it. Depending on an IT organization's internal processes and relationships with preferred vendors, this generally takes at least several days. Once the equipment arrives, it must be physically placed in a data center environment. That involves manual labor as well as support from network and power infrastructure. Finally, the server's OS and applications must be configured. The entire process can take days or weeks, depending on the availability of hardware, personnel resources, and the specific requirements for the server's configuration.

In some cases, this amount of time and effort is unavoidable—a new physical server might be required to support an enterprise application, and the hardware specifications must be exact. However, it's much more common for users such as software developers to require a lower-capacity computer for testing or other related purposes. In fact, modern server hardware often provides so much performance that few single applications can take complete advantage of the machine's potential.

For those cases, the deployment of VMs can greatly simplify the process. Many IT organizations have found that they can deploy a new VM in a matter of minutes. When given a choice, they've found that end users often prefer to have a VM ready for use by the end of the day rather than waiting for the deployment of a new physical machine. By more quickly providing the necessary computing resources, IT staff can avoid being the bottleneck in meeting business goals.

Technical Challenges

Shifting focus from the business-related aspects of working in an IT environment, let's take a look at some of the technical challenges. Non-technical staff might wonder why it is so difficult to deploy, move, or reconfigure applications. After all, with all the talk of modularized systems and disconnected applications, why is it so difficult to create a fluid, changeable environment? Let's look at the major challenges that make reacting to changes a difficult process.

Managing Servers

For many IT departments, the process of installing an OS and configuring applications is necessary every time a new server is purchased. Often, tasks such as upgrading server hardware to improve performance involve a certain amount of risk because the OS and services must be reinstalled and reconfigured manually on the new hardware. In an ideal world, the entire configuration of the system could be moved or copied to a new computer without requiring any reconfiguration.

The main problem is the tight coupling that occurs between applications, OSs, and physical hardware. Most modern OSs have been designed to monopolize the hardware on which they run. That is, they are not designed so that they can share resources with other OSs that are running at the same time. Configured settings and device drivers are often closely tied to the underlying hardware. Frequently, a seemingly simple change (such as upgrading a network interface card—NIC) can require new drivers to be installed.

Because of this tight coupling, server workloads cannot easily be moved between heterogeneous hardware platforms without requiring reinstallation or, at least, significant reconfiguration. Figure 1.6 shows an example. In this case, an OS that is installed on the first server has been configured to run on that hardware. If a systems administrator were to attempt to copy the OS, applications, and data directly to another computer (through the use of disk imaging software or by physically moving the hard disks), it is likely that there would be numerous problems that would prevent the second server from booting.

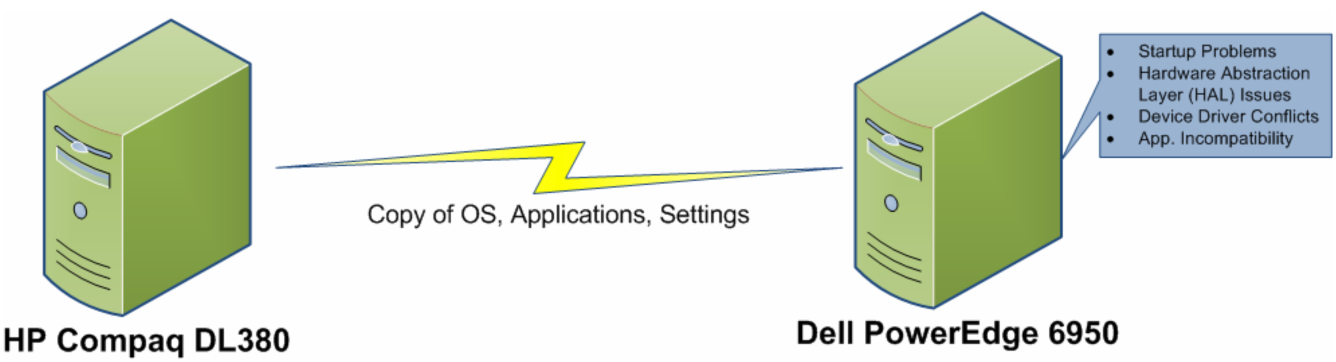

Figure 1.6: The relationship between OSs and hardware.

Managing Complex Applications

In the old days of applications, a single executable component was often responsible for handling processing and completing a business task. The application itself often worked in a silo and had limited dependencies on other applications or services. Although this approach wasn't perfect, it did make management fairly simple. For example, if the application had to be moved to another server, it could be reinstalled and the configuration could be easily copied.

Modern IT environments are far more complex. Enterprise applications have many "moving parts," and systems and network administrators must understand how to handle this complexity. Often, there are many interdependencies between applications and services. For example, an Enterprise Resource Planning (ERP) solution might require a Web server, an application server, a database server, and monitoring components. These servers, in turn, would depend on network infrastructure, including routers, switches, and firewalls.

The result is that applications tend to be tightly coupled to the platforms on which they're running. Moving, for example, an entire Customer Relationship Management (CRM) solution from one set of servers to another can be a significant challenge. In addition to the many steps that are required, there is a significant amount of inherent risk in making the changes. Overlooking some configuration settings might prevent the system from running optimally. Add in issues with potential downtime, data integrity concerns, and planning, and it's not a small task. The ability to move or copy services is particularly important for supporting disaster recovery scenarios and for managing hardware upgrade life cycles.

Benefits of Virtualization

Building on this foundation of the major types of business and technical challenges that affect IT departments, let's take a detailed look at how server virtualization can help address many of these issues. This section will focus on how the use of VMs can improve IT operations and decrease costs.

Hardware Independence

The primary benefit of virtualization technology is the ability to create layers of abstraction between applications, OSs, and hardware. As mentioned earlier, one of the major sources of IT management complexity is that OSs and software are tied to the hardware on which they're running. If an OS or application must be moved (for example, to place it on a new server for performance reasons), many interdependencies must be taken into account.

Virtualization solves this problem. The guest OS and any applications that are installed within a VM are tied only to the VM's hardware configuration, so the VM can easily be moved to any computer that is running the same virtualization layer. Figure 1.7 provides an illustration of how this would work.

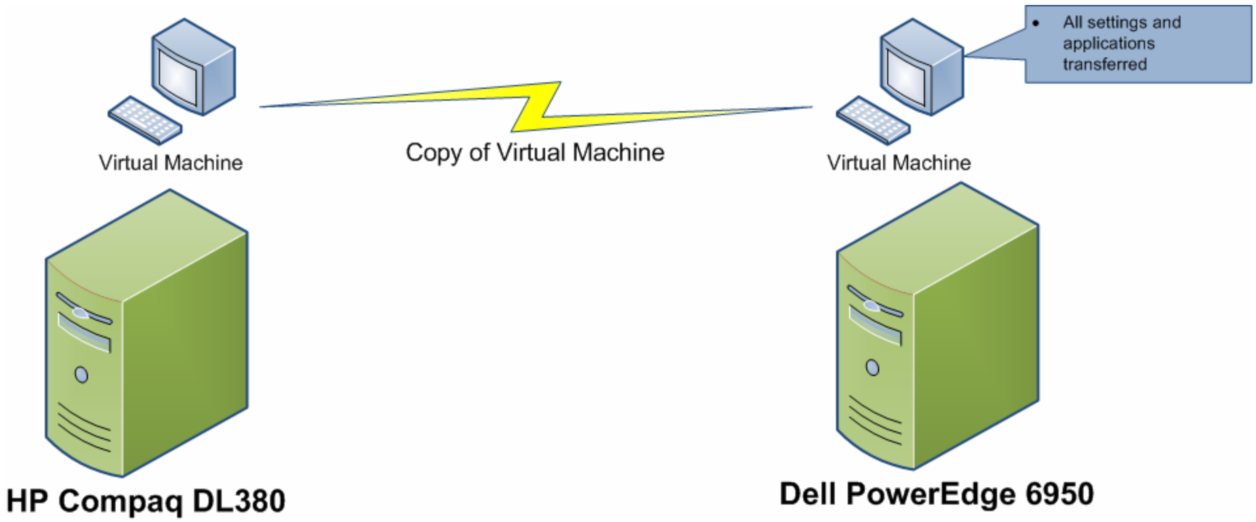

Figure 1.7: Moving a VM between heterogeneous hardware platforms.

There are many ways in which this functionality can be used. For example, software developers might perform the initial configuration of a VM in a test environment. Once it is ready for production, they can either copy or move the entire VM (which includes the guest OS and all other settings) to a production-class server for access by end users. In cases in which a particular VM has outgrown its host computer, the VM can be quickly and easily moved to newer and faster hardware without worrying about compatibility. This can help make the process of hardware upgrades simpler and safer. In addition, it can allow systems administrators to quickly reallocate VMs to machines based on their actual resource and performance requirements.

Increasing Hardware Utilization

Many systems administrators devote a significant amount of their time to managing the most-used resources in their environments (for example, there might be a database cluster that just never seems to be fast enough, no matter how much hardware is thrown at it). Although these systems are certainly important, a simple fact in many IT environments is that the majority of systems within a data center are vastly underutilized.

Modern computer hardware often provides so much computing capacity that few single applications can take advantage of their full potential. Some industry estimates show that overall resources in a typical data center are, at best, 15 percent utilized. The additional "slack" is based on a variety of reasons. In some cases, old servers that are rarely (if ever) used are still present on the network. No one is really sure who is responsible for the machine, so it just sits there, consuming resources. In other cases, IT organizations might have over-estimated the amount of resource usage of a particular application (or the application may no longer be in active use). IT departments are also forced to plan resources for periods of peak usage, even though these periods might be very infrequent.

Regardless of the reason for under-utilization, each of these servers takes up physical space, requires electricity, and generates heat—the resulting data center costs can be significant. An effective solution to this problem is to combine workloads. If three servers are each 20 percent utilized, the applications that run on them could be combined onto a single server (see Figure 1.8). This process, often called *server consolidation*, can be a tricky task as a result of the potential application compatibilities and differences in OSs and hardware. However, if the workloads can be placed within VMs, they can be quickly and easily moved to physical servers based on their current computing resource needs.

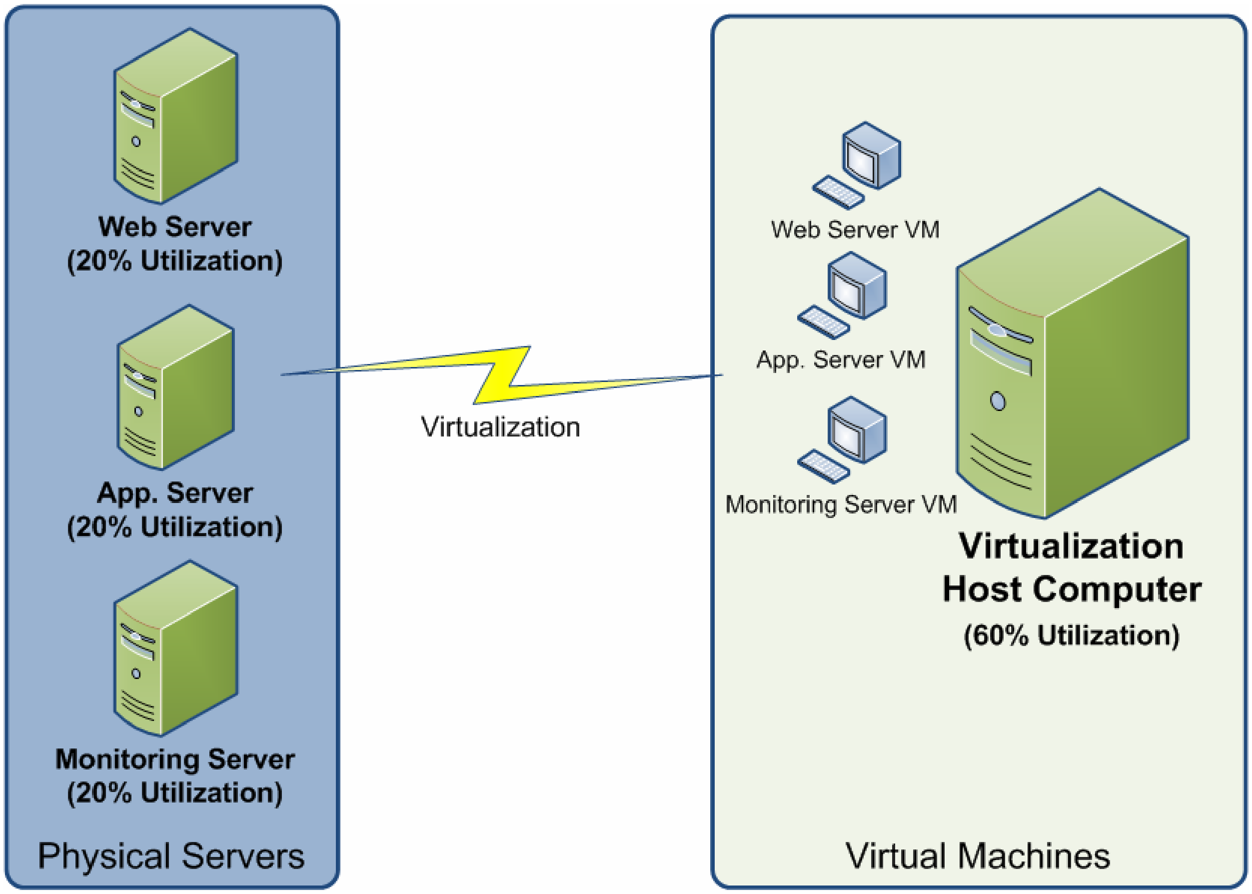

Figure 1.8: Increasing hardware utilization through the use of VMs.

Taking this example further, IT organizations can envision an environment in which most of the servers are running virtualization software and VMs can be reallocated based on performance requirements. The result is a dramatic increase in Return on Investment (ROI) due to better utilization of an organization's existing computing assets.

Adapting to Changes

"Old-school" IT departments often had the luxury of creating a networking and server infrastructure based on technical requirements, then having the business adapt to making the most of it. Times have changed, and IT departments often play a critical strategic role in ensuring the viability and competitiveness of the entire organization.

The ability to quickly respond to changing business and technical requirements is a crucial strength for modern IT organizations. As VMs can be easily moved between servers, IT departments can adapt to changing requirements without the costly operation of physically relocating hardware. Additionally, resources such as CPU time and physical memory can be easily allocated to VMs based on their need—often without even requiring the VM to go offline. Current virtualization layers allow systems administrator to dynamically define the relative "priority" of each VM and/or to reserve resources to ensure that a VM will always perform optimally. These benefits can translate into an IT department that is more in sync with the organization that it supports.

Support for Legacy Applications

Older applications that have special requirements (often politely referred to as "legacy" applications) are a constant thorn in the side of systems administrators. For example, an old accounting system might require the use of Windows NT 4.0 or even MS-DOS, even though the IT department no longer officially supports these platforms. Or a seldom-used engineering tool might require the use of serial port devices that aren't supported on newer hardware.

Regardless of the reason, IT departments are often stuck within maintaining older hardware because they have no way of porting these applications to modern systems. The costs are often tremendous—supporting outdated hardware can be a challenge because parts are more likely to fail. In addition, replacement parts might not be readily available and it can be difficult to find expertise (or willingness) to support these older servers.

Virtualization can help support legacy applications by allowing older OSs and applications to run within a VM. As long as the VM's hardware configuration is supported by the OS and application, it should run properly. Virtualization vendors have focused on implementing VM environments that are compatible with as many different types of guest OSs as possible. The VMs themselves can then be hosted on modern hardware. Often, many such VMs can be hosted on the same computer, thereby simplifying administration while maintaining compatibility.

Simplified Administration

Server sprawl is a constant problem in many IT data centers. The problem is that as new servers are deployed or repurposed, the number and types of computers that must be supported increases dramatically. This leads to additional effort required for systems administration and maintenance. For example, every new sever that is deployed will generally require multiple network connections and multiple power feeds. Whenever a component within the computer fails, IT staff must be ready to fix it as quickly as possible.

Additional costs are frequently the result of server sprawl. Managing more servers usually requires more systems administrators (or more time from already-overworked staff). In addition, data center costs related to power, cooling, and physical space can be major drains on IT budgets.

Through the use of server virtualization, many of these costs can be reduced. It’s usually much easier to manage multiple VMs that are running on a single physical server than to manage multiple physical servers. As there is less hardware to be monitored and configured, the room for error is reduced. And through the use of remote management tools, the number of trips to the data center can be significantly reduced.

Platform Standardization

Consistency is an important aspect of a well-managed IT environment. Fewer differences in server configurations equates to simplified administration. Unfortunately, in many IT environments, the deployment process for new servers and applications is handled on an ad-hoc basis. Different systems administrators might perform tasks in their own ways, and differences in hardware platforms and application requirements might lead to OS inconsistencies. Even when automated tools are used to manage complexity, the situation is far from ideal.

Virtualization offers a potential solution by providing a standardized virtual hardware configuration. All the software and services that are installed within the VM are configured to support the VM environment, regardless of the underling physical hardware. IT departments can help ensure consistency by creating a base library of VM images. These images should adhere to IT best practices, such as having a locked-down OS configuration, installation of the latest security updates, and support for accessing network resources. When it becomes necessary to provision a new VM, rather than starting the process from scratch, systems administrations and end users can simply copy these base images (see Figure 1.9).

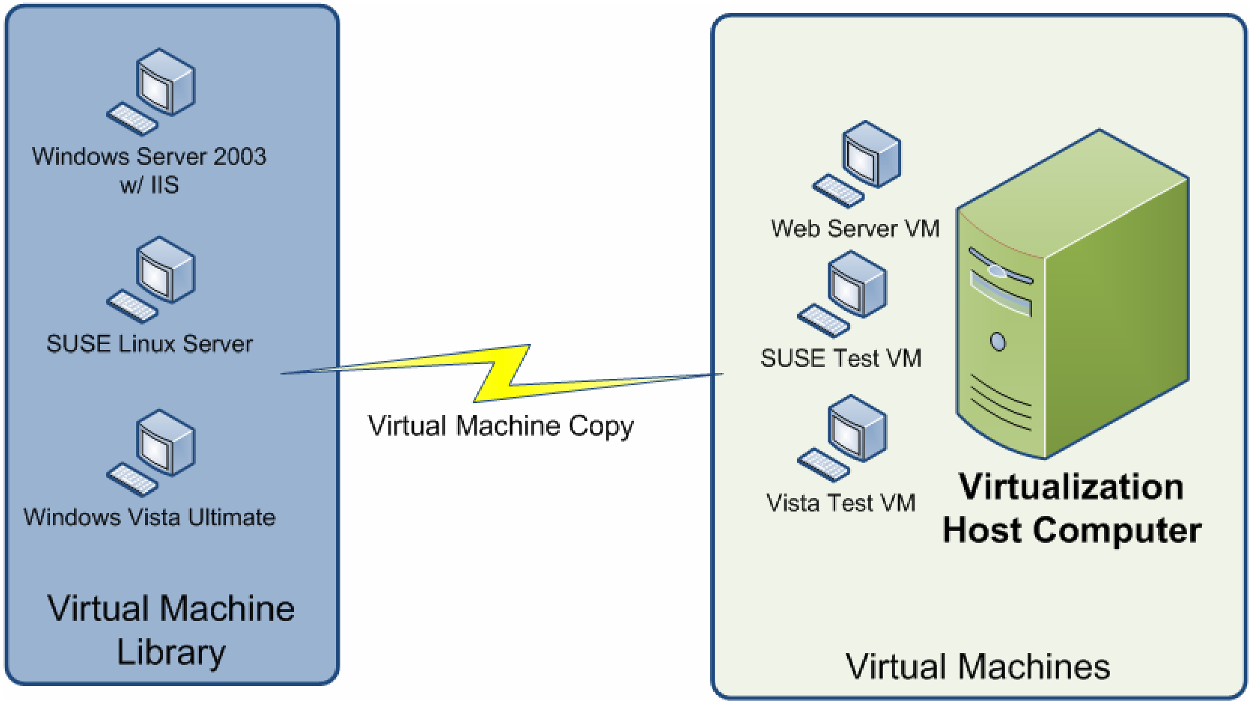

Figure 1.9: Creating a library of base VM images.

This situation provides benefits to IT staff (who can ensure that newly deployed VMs adhere to their standards and best practices) as well as to virtualization users (who can have a new VM ready for use within a matter of minutes).

Improved Security

Modern OSs provide a tremendous amount of flexibility and functionality in the form of services and optional applications. With this power, however, comes risk—if some of the features are not properly configured or if the OS is not updated with the latest security fixes, a new computer could become a significant security liability. Although there are certainly ways in which these oversights can be managed, an ideal solution is for the entire computer to run in a restricted environment.

Virtualization solutions provide the ability to run an entire VM under a limited security context. Although the specific implementation details and options will vary based on the platform, the general concept is to limit the types of operations that can be performed from within a VM. A good first line of defense can come from limiting network connectivity. Virtual networks can be configured to allow only certain VMs to talk to each other. Figure 1.10 provides an example setup.

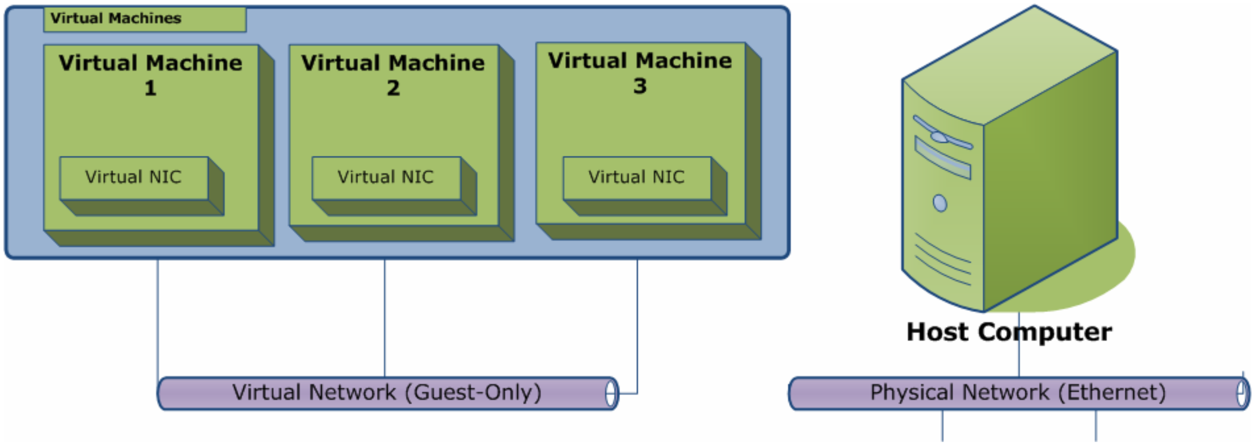

Figure 1.10: Configuring virtual networks to increase security.

This feature can significantly reduce security problems by limiting the number and types of computers that can be affected by a new VM. For example, a few users in the Engineering department might require several new VMs to adequately test a new multi-tier application that they're developing. By placing these new VMs on an isolated virtual network, IT systems administrators can ensure that these VMs cannot access the host computer or other physical machines or VMs in the environment.

Systems administrators can also configure VMs to run under limited security contexts. For example, in Microsoft Virtual Server 2005 R2, a VM can be configured to run under the security permissions of a designated user account. In this configuration, even if the VM is compromised, access to the host computer will be limited.

Supporting Business Continuity

Business continuity planning and disaster recovery are important concerns for IT environments of any size. The goal is to minimize or eliminate a disruption in service, even after major disasters occur. Organizations have been put under increasing pressure to ensure that services remain available after natural disasters such as earthquakes, fires, and floods. A common method by which this goal is achieved is through the creation of one or more disaster recovery sites. Apart from the cost of implementing and maintaining a disaster recovery site, there are many technical issues that make maintenance a challenge.

First and foremost, costs can quickly multiply when organizations are forced to purchase duplicate hardware to place at disaster recovery sites. In some cases, it might be acceptable for disaster recovery sites to contain a limited set of computing resources (as some applications might not be considered mission critical). The primary challenge, however, is to keep the disaster recovery site synchronized with changes in the primary site. If, for example, an OS update is applied or a security setting is changed on the primary site, that change must also be propagated to all the disaster recovery sites. Also, it might be difficult or costly to maintain identical hardware at each disaster recovery site. This difficulty adds risk to a failover process because systems administrators must take into account configuration differences. It's easy to see how this scenario can be difficult to maintain manually.

Through the use of virtualization, IT organizations can greatly simplify the process of maintaining disaster recovery sites. VMs are not tied to the underlying host hardware, so the need for identical failover equipment is eliminated. Smaller servers, or fewer large ones, can be placed in disaster recovery sites. In the event of a disaster, VMs can be copied to the disaster recovery site with minimal reconfiguration (assuming that backup network resources are available). Changes to details such as network settings can be managed through scripting or other virtualization automation features.

Limitations of Virtualization

There are many benefits related to using virtualization technology in an IT environment. It's important to keep in mind, however, that virtualization is not the ideal solution for every type of workload. To make better decisions related to which applications are best suited to running in a virtual environment, let's take a look at some important considerations.

Performance Requirements

Perhaps the most common questions posed by technical staff about virtualization concern performance. The fact of the matter is that any virtualization solution will create some amount of overhead. In some cases, the overhead might be barely perceptible. This is particularly true when the workloads that are included within a VM are using a small portion of the host computer's overall capacity.

In other cases, however, high-end applications such as busy relational database servers might place a large load on CPU, memory, disk, and network subsystems. For such applications, it might make sense to install and configure the application to run directly on physical hardware. Doing so can help ensure that maximum performance is obtained for the application and can prevent contention for system resources from other applications or services. Overall, however, it's highly likely that just about every IT environment can benefit from implementing virtualization in some portion of their data center workloads.

Special Hardware Requirements

The virtual hardware configuration of a VM is usually designed to provide access to the most commonly used components of a computer—virtual hard disks and virtual network adapters are always supported. Some applications and workloads might have specific hardware requirements that might not be supported in a virtual environment.

For example, some virtualization platforms do not support emulation of USB devices. And some may provide limited or no support for Fibre Channel Host Bus Adapter (HBA) cards that might be required to access an organization's Storage Area Network (SAN). More commonly, some types of applications might require access to 3-D graphics acceleration features that are probably not supported by the virtual hardware platform (even if they are supported by the host hardware). IT staff should keep in mind the limitations of the VM configuration and compare them with any special hardware requirements before choosing to move an application to a virtualized environment. Table 1.1 provides an example of how this data can be collected and analyzed.

Hardware Category	Hardware/Software Type	Required Configuration	Virtualization Support?
OS	OS	Windows Server 2003 R2	Yes
	Service pack level	RTM	Yes
Software	Database	Microsoft SQL Server 2005 SP1	Verify with vendor
Hardware	CPU	Single P4 2.0GHz or faster	Yes (depends on host hardware)
	Memory	2.0GB	Yes (supports up to 3.6GB per VM)
	Total disk space	OS: 12.0GB Application:25.0GB	Yes
	Network adapters	Three Gigabit Ethernet adapters	Yes; Requires multiple virtual networks

Table 1.1: Comparing virtualization hardware requirements.

In addition to considering special hardware requirements for guest OSs and applications, systems administrator must make sure that the host computer is also supported. Some server virtualization solutions have specific hardware requirements for the host computer. Components such as disk controllers and network adapters must be on the approved hardware list to be supported by the virtualization vendor.

Licensing

Software licensing can be difficult to manage, but it is a necessary aspect of running an IT environment. With respect to virtualization, IT staff should verify specific license policies with their vendors. Some software companies have chosen to provide free or reduced-cost licensing for copies of their applications that are run within a VM. Others, however, consider a VM to be the same as a physical machine for licensing purposes.

In general, IT departments should assume that they must obtain separate licenses for each OS (whether physical or virtual) that they plan to install, unless they have been provided with alternative pricing. In some cases, organizations might choose to keep a certain application running on physical hardware to maximize their software investments. It is becoming increasingly common, however, for software vendors to be more lenient with VMs.

Physical + Virtual: The Best of Both Worlds

Based on the many benefits of virtualization technology, it's likely that most IT departments will deploy VMs for at least some of their workloads. However, due to tradeoffs and limitations, the practice of running applications directly on physical hardware is unlikely to disappear (at least in the short term).

Most data centers will support a combination of physical and virtual computing resources to find the optimal balance of performance and hardware utilization. By adding server virtualization to an IT department's technology bag of tricks, systems administrators can greatly improve the levels of service they provide to their users and other areas of the business. There is a drawback, however—managing environments that support both virtual and physical servers can be more challenging than managing physical servers alone. In later chapters, this guide will focus on recommendations for managing just such an infrastructure.

Summary

This chapter began with an introduction to the world of virtualization technology. Though the discussion remained as an overview, it looked at how a single physical computer can host multiple VMs. The focus then shifted to the many challenges that are faced by IT departments. Issues can be either business related or technical in nature. Based on this information, we looked at the many potential benefits of using virtualization, including hardware independence, portability, security, and support for disaster recovery. Of course, no technical solution is perfect, so we examined limitations of virtualization solutions.

All this information should help answer the basic questions

- What is virtualization?
- How can virtualization help my IT environment?

Future chapters will dive down into much more technical detail, focusing on how server virtualization can help to solve many common IT problems.

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