

# What is virtualization?

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This chapter is not intended to expose you to the tedium of a step-by-step exploration of virtualization. We assume anyone picking up this book already understands the value of this emerging technology. Instead, we provide a quick overview of virtualized servers and end-user devices. We also provide information useful for making a business case for shifting IT budget dollars in that direction. Finally, we provide you with a list of things to consider during virtualization strategy discussions.

The chapter is short, to the point, and only introduces a short delay before we jump into the reason you bought this book—implementation of Microsoft virtualization technology.

## EVOLUTION OF VIRTUALIZATION

In the 1970s, mainframes ruled the datacenter. Partitioning ensured both optimum use and efficient sharing of resources. This was a great way to get the most for the many, many dollars organizations spent to acquire, implement, and manage these behemoths.

All processing was performed on a single computer with data retrieved from and stored to storage located in the datacenter. Access to the datacenter was tightly controlled. In many cases, users received reports

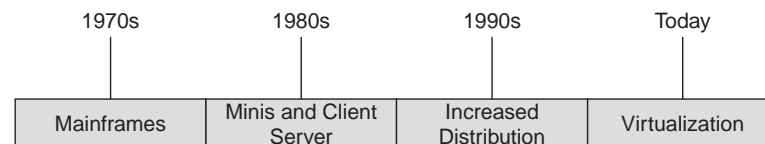
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from the computer operators through a window or slot. They accessed electronic information with dumb terminals with no local processing capabilities. The terminals were simple devices which collected keystrokes and presented data in green-screen text.

Distributed processing began in the 1980s, with personal computers finding their way to the desktop. These were fat clients which participated in client/server configurations and connected to the mainframe's smaller cousin, the minicomputer. Although many companies still performed the bulk of their business processing in a centralized environment, both applications and data began to drift out to endpoint devices.

During the 1990s, another shift in business processing architecture took place with the advent of layered system technology. This included building applications with presentation and data access logic layers. Data resided in database servers in the datacenter. Still, fat client endpoint devices continued to run applications, and more data than ever before found its way to local hard drives. This was also a time when malware writers began perfecting their art. Attacks that eventually spread across entire enterprises often started on an unprotected—or weakly protected—personal computer.

In the twenty-first century, IT managers began to realize that traditional methods of managing desktop and laptop systems were no longer effective in dealing with changes in business requirements, user demands regarding technology implementations, and black hat hackers transitioning from fun and games to an organized crime business model. Demands for the rapid turnaround of application installation or upgrade requests, the need to quickly apply security patches to operating systems and applications, and many other management headaches are driving a new approach to endpoint and server processing and management—virtualization. Figure 1.1 shows a timeline for the development of virtualization technology.



■ FIGURE 1.1 Evolution of virtualization timeline.

## VIRTUALIZATION DEFINED

As with all emerging technologies, there are several definitions or perceptions of what constitutes virtualization. To remove ambiguity, it is important to understand what virtualization means within the context of this book. Let us start with the definition provided by Amit Singh, author of kernelthread.com, in “An Introduction to Virtualization”:

*Virtualization is a framework or methodology of dividing the resources of a computer into multiple execution environments, by applying one or more concepts or technologies such as hardware and software partitioning, time-sharing, partial or complete machine simulation, emulation, quality of service, and many others [1].*

This is an accurate definition, but it fails to consider business drivers. It should be more specific about expected outcomes. Integrating outcomes, we arrived at the following:

*Virtualization is the configuration of servers or clients which results in the division of resources into multiple, isolated execution environments, by applying one or more concepts or technologies to reduce costs and enhance flexibility associated with the acquisition, implementation, management, expansion, and recovery of critical business systems.*

Our definition takes virtualization beyond the realm of “cool technology” and places it where you can make a case for allocating IT budget. Virtualization, if properly planned and positioned, can quickly demonstrate return on investment (ROI) while improving your ability to agilely react to new solution requests from business managers.

## HOW VIRTUALIZATION WORKS

How our definition is implemented depends on a vendor’s view of the world. As you might expect—since this is a book on how to implement Microsoft’s virtualization solutions—we move virtualization from concept to reality using Microsoft’s virtualization toolbox. In this chapter, we provide a high-level overview. In Chapter 2, we examine Microsoft’s complete virtualization strategy.

The Microsoft virtualization toolbox contains solutions for both server (Hyper-V) and client (App-V and Virtual PC/MED-V) platforms. Each solution is implemented in a way that closely aligns with the virtualization business and technology drivers reviewed later in this chapter. We focus

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### Warning

Virtual PC and MED-V are not supported in Windows 7.

### Warning

Not all processors are compatible with Microsoft Hyper-V. Processors must support hardware-assisted virtualization (i.e., Intel VT or AMD-V technology).

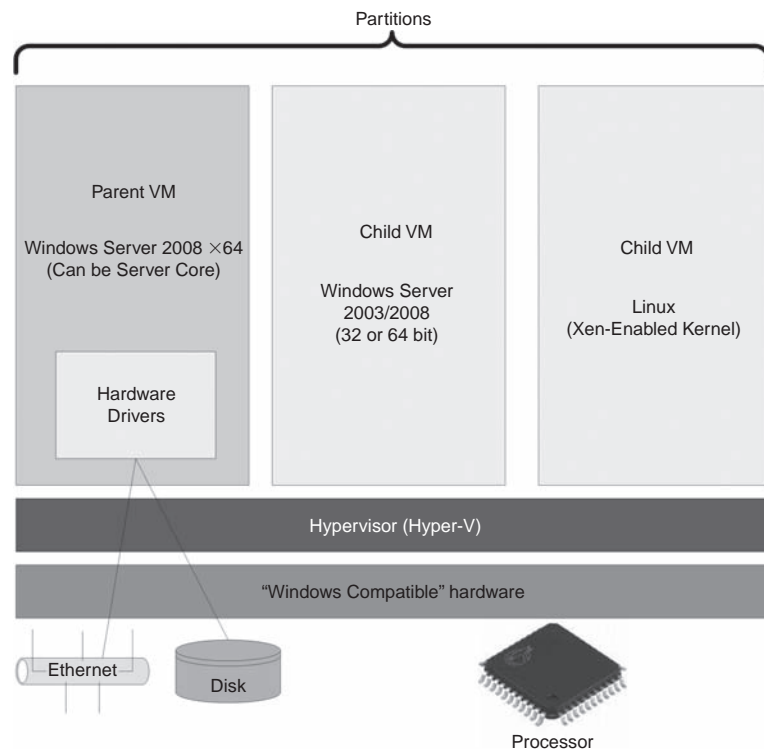
on App-V in this chapter, because it appears to be Microsoft's preferred method of virtual application delivery. Chapter 15 is dedicated to Virtual PC and MED-V.

### Server virtualization

Figure 1.2 is a simple depiction of how to get the most from your server hardware with Hyper-V. Building a Hyper-V virtual environment begins with a hardware platform designed for Windows compatibility. It must be capable of 64-bit operation and be virtual technology enabled. Installed on top of the hardware layer, and abstracting it from future virtual machines (VMs), is the hypervisor.

The hypervisor “decouples” hardware from the production operating systems running in the VMs. Configured and managed via the parent VM, it oversees hardware resources by

- Supporting the creation and deletion of VMs
- Managing memory access and security rules



■ FIGURE 1.2 Hyper-V concepts.

- Enforcing CPU usage policy
- Scheduling and managing processor usage
- Managing attached/installed device ownership

VMs in a Hyper-V world live in partitions. The first partition created contains the parent VM, which must run Windows Server 2008 x64 or Windows Server Core. Once the parent partition is in production, you can create child partitions which contain your business server environments.

#### Note

All partitions share the following characteristics:

- Each partition is configured with one or more *virtual* processors
- Each partition participates in hardware resource sharing
- Each partition hosts software known as a *guest*

## Client virtualization

Microsoft's approach to client virtualization focuses on efficient, controlled, and safe distribution of applications from a central point. Based on technology acquired during Microsoft's purchase of SoftGrid, App-V technology has evolved into a powerful solution for organizations of any size.

Before going into how App-V works, we think it is important to understand how Microsoft's approach to application virtualization compares to other solutions. Figure 1.3 shows three primary methods used today.

Instead of permanently installing applications on users' endpoint devices, they are installed in virtualized server environments, on blade servers (with each blade corresponding to a single desktop device), or by using thin clients which access terminal services. These are fundamentally examples of server-based computing, which still leaves a significant amount of computing resources unused on enterprise desktops.

Microsoft also supports desktop virtualization. See Chapters 2 and 15 for the "what and how."

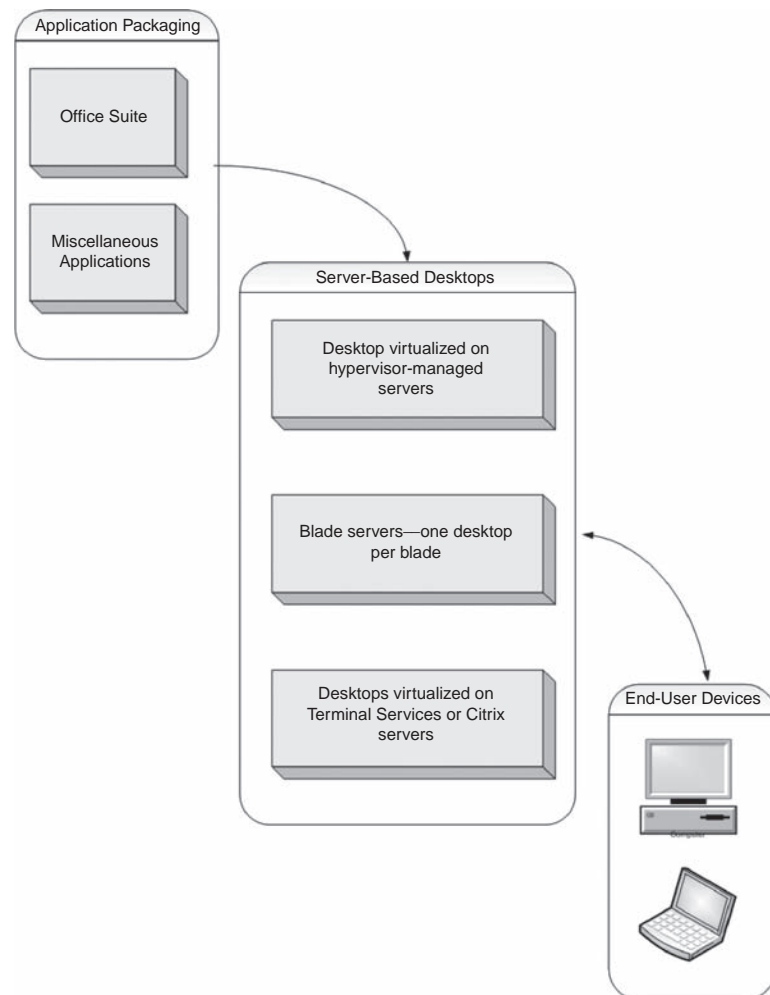
Figure 1.4 depicts a basic Microsoft App-V-enabled desktop. Each application runs in an isolated environment. Although the applications share OS services and hardware resources, components unique to each application (e.g., registry entries, dynamic link libraries, COM objects, etc.) are private—running within the application "sandbox." App-V does not virtualize the OS, just the applications.

The second piece of an App-V solution for endpoint availability and security management is centralized distribution and management of applications. There are two ways to do this. First, entire applications can be downloaded to virtualized runtime environments. Second, only those components necessary for initial load and execution of the virtualized

#### Note

In Windows Server 2008 R2, Microsoft has renamed Terminal Services. It is now called Remote Desktop Services (RDS). The terms terminal services and RDS are used interchangeably throughout this book.

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■ **FIGURE 1.3** General approaches to client virtualization.

applications are downloaded. App-V supports both methods and downloads additional application components as needed.

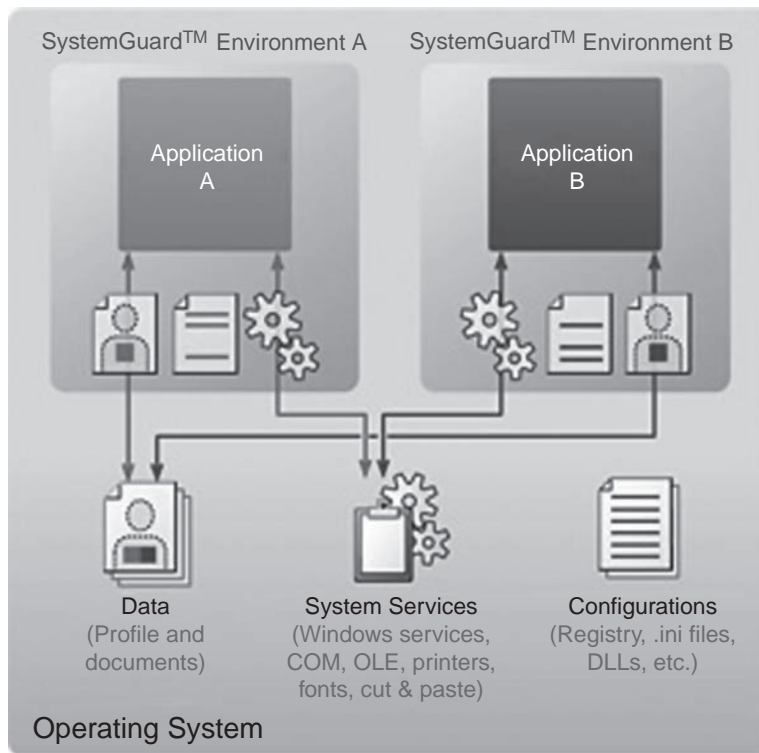
Hyper-V, App-V, Virtual PC/MED-V, and RDS are the basic building blocks of Microsoft virtualization. In subsequent chapters, we drill deep into how they work and explore optional implementation strategies.

### Tip

Do not virtualize because it is cool or just because you can. You are more likely to get management support—and budget—if you can clearly state why and how virtualization will benefit the business.

## BUILDING A BUSINESS CASE FOR VIRTUALIZATION

Transitioning from a traditional computing environment to one based on strategic use of virtualization is not free. New servers are usually required to support multiple VMs or to implement, manage, or monitor App-V



■ FIGURE 1.4 Basic App-V architecture.

rollouts. And let us not forget training for IT staff. So why should management shift dollars from other projects to fund virtualization?

Virtualization provides a long list of benefits to the business, including:

- *Consolidation of workload to fewer machines.* Server consolidation is usually one of the first benefits listed when IT begins to discuss virtualization. Although a definite benefit, you will probably only virtualize a subset of your datacenter—for reasons which will become obvious—resulting in limited ROI.
- *Optimized hardware use.* Most servers are underutilized. Placing multiple VMs on expensive server hardware drives processor, memory, disk, and other resources closer to recommended utilization thresholds. For example, instead of an application server using only 5-10% of its processing capability, multiple application servers on the same platform can drive average processors upto 40% or 50%. This is much better use of invested hardware dollars.

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- *Running legacy applications on new hardware.* Any organization which has been around a few years has old applications it can not live without. Rather, it has applications its users must have or civilization as we know it will collapse. As the software stands fast, and hardware and operating systems evolve, you might find it difficult or impossible to run legacy applications on replacement platforms. Server and client virtualization provide opportunities to continue to run older environments on hardware with which they are incompatible. This is possible due to the abstraction of operating environments from the underlying hardware components.
- *Isolated operating environments.* Have you ever needed to run two versions of an application at the same time on the same device? If so, isolated environments are a great way to facilitate this. Further, each operating environment can have its own registry entries, code libraries, etc. So application incompatibilities are rare. Finally, failures or corruption in one environment will not affect other applications or data. Isolated environment capabilities in App-V can sometimes be a bigger selling point than server consolidation.
- *Running multiple operating systems simultaneously.* You do not have to make the leap to Linux to have the need to run multiple server operating systems. Most organizations do not upgrade all servers to the latest version of Windows Server at the same time. So there are often various versions in the datacenter, running critical applications. Hyper-V partitioning allows you to consolidate servers running operating systems at various version or patch levels, without the risk of incompatibilities. If you are gradually introducing other operating systems into the datacenter, they can all happily coexist with current operating systems—in “sibling” partitions on the same hardware platform.
- *Ease of software migration.* Application streaming, coupled with isolated operating environments, makes end-user application deployment much easier. Using Hyper-V, new application rollouts or upgrades to existing applications are easy and centrally managed.
- *Quick buildup and tear-down of test environments.* Testing is a big part of any internal development process, but rapid test environment builds are difficult to achieve. With virtualization, engineers create virtual image files which are quickly deployed when relevant system testing is required. Image files are also a great way to refresh a test environment when changes do not quite work as expected.

We believe this list represents the major reasons why an organization would want to move to virtualization, except for one. The final reason, improved business continuity, is so important we decided to give it special attention.



## Virtualization and business continuity

Business continuity is an important consideration in system design, including both system failures and datacenter destruction scenarios—and everything in between. Traditional system recovery documentation provides instructions for rebuilding a system using the hardware which is no longer accessible or operational. The problem is that there are usually no guarantees your disaster recovery or hardware vendors will be able to duplicate the original hardware.

Using different hardware can result in extended rebuild times as you struggle to understand why your applications do not function. Even if you can get the same hardware, you need to rebuild the environment from the ground up.

Finally, interruptions in business processes occasionally happen when systems are brought down for maintenance. You understand the necessity, but your users seldom do.

Virtualization provides advantages over traditional recovery methods, including:

- *Breaking hardware dependency.* Since the hypervisor provides an abstraction layer between the operating environment and the underlying hardware, you do not need to duplicate failed hardware to restore critical processes.
- *Increased server portability.* If you create virtual images of your critical system servers, it does not matter what hardware you use to recover from a failure—as long as the recovery server supports your hypervisor and, if necessary, the load of multiple child partitions. Enhanced portability extends to recovering critical systems at your recovery test site, using whatever hypervisor-compatible hardware is available.
- *Elimination of sever downtime (almost).* You may never reach the point at which maintenance downtime is eliminated, but virtualization can get you very, very close. Because of increased server portability, you can shift critical virtual servers to other devices while you perform maintenance on the production hardware. You can also patch or upgrade one partition without affecting other partitions. One way to accomplish this is via clustering, failing over from one VM to another in the same cluster. From the client perspective, there is no interruption in service—even during business hours.
- *Quick recovery of end-user devices.* When a datacenter goes, the offices in the same building often go as well. Further, satellite facilities

can suffer catastrophic events requiring a complete infrastructure rebuild. The ability to deliver desktop operating environments via a centrally managed virtualization solution can significantly reduce recovery time.

It might seem that virtualization is an IT panacea. It is true that it can solve many problems, but it also introduces new challenges.

## THE OTHER SIDE OF VIRTUALIZATION

Any new technology brings with it changes to the process. Virtualization is no exception. Although there are challenges, they are usually outweighed by the benefits—assuming you understand and address them up front. The following is a list of common issues which must be considered when developing a virtualization strategy.

- *License management.* It is somewhat easy to track operating system and application licenses in a traditional datacenter or across user desktops. However, licensing in a virtualized world is different and often confusing. Make sure you understand how your vendors license virtual instances of their products and ensure your engineers adhere to licensing policy. It is very easy to bring up VMs without thinking about license availability.
- *New skill sets.* Configuring, monitoring, and managing virtualized environments require skills not typically found in in-house resources. This is a challenge easily met with training and new hiring requirements.
- *Support from application vendors.* The big question? Will your application vendor support its software within your selected virtual environment? Does the application even run virtualized? Does the vendor know or care?
- *Additional complexity.* It should not be a surprise that virtualization adds another layer of complexity to your infrastructure.
- *Security.* Security on VMs is not very different from standard server security. However, the underlying layers (i.e., the hypervisor and related services) require special consideration, including adjustments to antivirus solutions. Apart from technology differences, the ease with which engineers can build VMs can result in explosive growth of unplanned, unmonitored, and insecure servers. Make sure your change management process is adjusted, policies updated, and staff trained on what is and is not acceptable behavior.

- *Image proliferation.* This might not be a bad thing unless the images you keep on the virtual shelf are rife with weak configurations or other challenges you might not want spreading like a disease across your datacenter.
- *Ineffectiveness of existing management and monitoring tools.* As we hinted in the security bullet, your tried and true monitoring and management tools might not include the intricacies of virtualization management.
- *Inability of the LAN/WAN infrastructure to support consolidated servers.* What happens to your switch when you replace several single traditional servers with one or more beefy hardware platforms running multiple VMs? If you can not answer this or other similar questions, you are not quite ready to make the leap to virtualization.

And these are just the thought-provoking issues we could come with. You may have your own set, which reflect the unique way you do business.

## FINALLY, DROP THE HAMMER

I am sure you have heard the adage, “If the only tool you have is a hammer, every problem looks like a nail.” This is a very wise statement, and fits very well what some organizations try to do with server virtualization. After you address the list of potential “gotchas,” you still have one very important question to answer as you evaluate each server. Does it make sense to virtualize this environment?

For example, a server with average process utilization of 50% or more is probably not a good candidate for virtualization. However, two or more servers, each with less than 10% processor capacity used, are excellent candidates. In addition to processor capacity, pay attention to NIC (network interface card), disk, and memory utilization. A VM running a specific application will use the same resources as a stand-alone server. Do not consolidate servers when performance hits far outweigh budget savings. Figure 1.5 shows a sample worksheet for evaluating virtualization candidates.

### Tip

The total processing power required in a virtualized hardware platform is roughly equal to the sum of the processing resources used by the target applications on the nonvirtualized servers.

Server	Component	Current	Supported by Hyper-V
Domain Controller	CPU	20% use of single 2 GHz processor	Depends on host hardware
	Memory	2 GB	Yes
	Disk space	20 GB	Yes
	NIC	5% use of single gigabit Ethernet	Yes
	OS	Windows Server 2008	Yes

■ **FIGURE 1.5** Virtualization worksheet.

As a general rule, you should leave database servers until last. It is usually a bad idea to virtualize database environments unless they contain little-used tables. Your biggest gains when developing your strategy will likely result from considering the following:

- Application servers
- File servers
- Print servers
- Domain controllers
- Web servers
- Testing servers
- Development servers
- Business recovery environments

Virtualization planning documents are available from Microsoft, for both servers and end-user devices, at <http://tinyurl.com/Microsoft-IPD>. We refer to these resources throughout the design and setup chapters.

## SUMMARY

Virtualization was an inevitable result of the increasing capability of datacenter technology and the continuing pressure to reduce technology costs; hardware use is optimized, recovery times are reduced, and IS is able to react quickly to changing business-user demands. However, virtualization is not an answer for every system in your datacenter.

Not every application behaves well—and not every vendor for that matter—in a virtualized environment. A careful analysis of current hardware utilization, application constraints, and vendor support is a critical first step, even before you put together your business case for virtualization. It is difficult to understand business value when you do not understand how many of your applications are candidates for aggregation. Once you have this information, you can begin working to get virtualization technology into your IS budget.

Finally, virtualization is not a panacea. It introduces new challenges which you must consider in order to adapt security and operational monitoring and controls.

## REFERENCE

- [1] Singh A. An introduction to virtualization, [kernelthread.com](http://kernelthread.com); 2004 [cited January 2010]. Available from [www.kernelthread.com/publications/virtualization/](http://www.kernelthread.com/publications/virtualization/).