

Introducing Windows Server 2008

*Mitch Tulloch with the
Microsoft Windows Server
Team*

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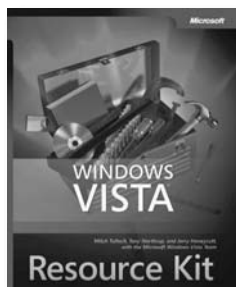
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Windows Server Virtualization

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Now that we've examined some possible usage scenarios for Microsoft Windows Server 2008, it's time to start digging deep into the features of the platform. But there are a *lot* of new features and enhancements in Windows Server 2008—why begin with virtualization?

Customer-facing answer? Need.

Technical answer for us IT pros? Architecture.

Why Enterprises Love Virtualization

Virtualization has been around in computing since the mainframe days of the late '60s. Those of us who are old enough to remember punch cards (carrying boxes of them around was a great way of getting exercise) might remember the IBM 360 mainframe system and the CP/CMS time-sharing operating system, which simulated the effect of each user having a full, standalone IBM mainframe at their fingertips. Each user's "virtual machine" was fully independent of those belonging to other users, so if you ran an application that crashed "your" machine, other users weren't affected.

PCs changed this paradigm in the '80s, and eventually gave users' *physical* machines that today are far more powerful than the mainframes of the '60s and '70s. But as desktop PCs began to proliferate, so did servers in the back rooms of most businesses. Soon you'd have two domain controllers, a mail server running Microsoft Exchange, a couple of file servers, a database server, a Web server for your intranet, and so on. Larger companies might have

dozens or even hundreds of servers, some running multiple roles such as AD, DNS, DHCP, or more.

Managing all these separate boxes can be a headache, and restoring them from backup after a disaster can involve costly downtime for your business. But even worse from a business standpoint is that many of them are underutilized. How does virtualization for x86/x64 platforms solve these issues?

Server Consolidation

In a production environment, having a server that averages only 5 percent CPU utilization doesn't make sense. A typical example would be a DHCP server in an enterprise environment that leases addresses to several thousand clients. One solution to such underutilization is to consolidate several roles on one box. For example, instead of just using the box as a DHCP server, you could also use it as a DNS server, file server, and print server. The problem is that as more roles are installed on a box, the uncertainty in their peak usage requirements increases, making it difficult to ensure that the machine doesn't become a bottleneck. In addition, the attack surface of the machine increases because more ports have to be open so that it can listen for client requests for all these services. Patching also becomes more complicated when updates for one of the running service need to be applied—if the update causes a secondary issue, several essential network services could go down instead of one.

Using virtualization, however, you can consolidate multiple server roles as separate virtual machines running on a single physical machine. This approach lets you reduce “server sprawl” and maximize the utilization of your current hardware, and each role can run in its own isolated virtual environment for greater security and easier management. And by consolidating multiple (possibly dozens of) virtual machines onto enterprise-class server hardware that has fault-tolerant RAID hardware and hot-swappable components, you can reduce downtime and make the most efficient use of your hardware. The process of migrating server roles from separate physical boxes onto virtual machines is known as *server consolidation*, and this is probably the number one driver behind the growing popularity of virtualization in enterprise environments. After all, budgets are limited nowadays!

Business Continuity

Being able to ensure business continuity in the event of a disaster is another big driver toward virtualization. Restoring a critical server role from tape backup when one of your boxes starts emitting smoke can be a long and painful process, especially when your CEO is standing over you wringing his hands waiting for you to finish. Having hot-spare servers waiting in the closet is, of course, a great solution, but it costs money, both in terms of the extra hardware and the licensing costs.

That's another reason why virtualization is so compelling. Because *guest* operating systems, which run inside virtual machines (VMs), are generally independent of the hardware on which the *host* operating system runs, you can easily restore a backed-up virtual server to a system that has different hardware than the original system that died. And using virtual machines, you can reduce both scheduled and unscheduled downtime by simplifying the restore process to ensure the availability of essential services for your network.

Testing and Development

IT pros like us are always in learn mode because of the steady flow (or flood) of new technologies arriving on our doorstep. I remember when I had to set up a test network to evaluate Exchange 5.5. I had eight boxes sitting on a bench just so I could try out the various features of the new messaging platform. These included an Exchange 5.0 server, an Exchange 4.0 server, and an MS Mail 3.0 server so that I could test migration from these platforms. Plus I had several different clients running on different boxes. The heat alone from these systems could have kept me warm during a Winnipeg winter.

Testing new platforms is a lot easier today because of virtualization. I can run a half dozen virtual machines easily on a single low-end server, and I can even set up a routed network without having to learn IOS by enabling IP routing on a virtual Microsoft Windows XP machine with two virtual NICs. Architects can benefit from virtualization by being able to create virtual test networks on a single server that mimic closely the complexity of large enterprise environments. Developers benefit too by being able to test their applications in isolated environments, where they can roll back their virtual machines when needed instead of having to install everything from scratch. The whole IT life cycle becomes easier to manage because virtualization reduces the time it takes to move new software from a development environment to test and then production.

Application Compatibility

Another popular use of virtualization today is to ensure application compatibility. Suppose you upgrade the version of Windows you have running on your desktop and find that a critical LOB application won't run properly on the new version. You can try several ways to resolve this problem. You can run the program in application compatibility mode, using the Application Compatibility Toolkit to shim the application so that it works on the new platform. Or you can contact the vendor for an updated version of the application. Another alternative, however, is virtualization: install Microsoft Virtual PC 2007 on each desktop computer where the user needs to use the problem application, install the old version of Windows as a guest OS, and then run the application from there.

Virtualization in the Datacenter

Virtualization also has a special place in the datacenter, as it lets you decouple workloads from hardware to make the best use of your resources. You can rapidly provision workloads as they

are needed so that your solutions can both scale up and scale out easily. Virtualization also simplifies automating complex solutions, though current virtualization products are limited in this regard. But that's where Windows Server 2008 comes in.

Virtualization Today

Virtualization today on Windows platforms basically takes one of two forms: Type 2 or Hybrid. A typical example of Type 2 virtualization is the Java virtual machine, while another example is the common language runtime (CLR) of the .NET Framework. In both examples, you start with the host operating system—that is, the operating system installed directly onto the physical hardware. On top of the host OS runs a Virtual Machine Monitor (VMM), whose role is to create and manage virtual machines, dole out resources to these machines, and keep these machines isolated from each other. In other words, the VMM is the virtualization layer in this scenario. Then on top of the VMM you have the guests that are running, which in this case are Java or .NET applications. Figure 3-1 shows this arrangement, and because the guests have to access the hardware by going through both the VMM and the host OS, performance is generally not at its best in this scenario.

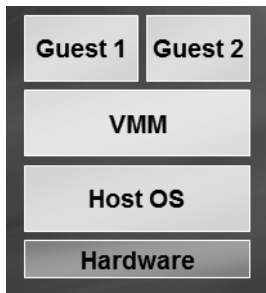


Figure 3-1 Architecture of Type 2 VMM

More familiar probably to most IT pros is the Hybrid form of virtualization shown in Figure 3-2. Here both the host OS and the VMM essentially run directly on the hardware (though with different levels of access to different hardware components), whereas the guest OSs run on top of the virtualization layer. Well, that's not exactly what's happening here. A more accurate depiction of things is that the VMM in this configuration still must go through the host OS to access hardware. However, the host OS and VMM are both running in kernel mode and so they are essentially playing tug o' war with the CPU. The host gets CPU cycles when it needs them in the host context and then passes cycles back to the VMM and the VMM services then provide cycles to the guest OSs. And so it goes, back and forth. The reason why the Hybrid model is faster is that the VMM is running in kernel mode as opposed to the Type 2 model where the VMM generally runs in User mode.

Anyway, the Hybrid VMM approach is used today in two popular virtualization solutions from Microsoft, namely Microsoft Virtual PC 2007 and Microsoft Virtual Server 2005 R2.

The performance of Hybrid VMM is better than that of Type 2 VMM, but it's still not as good as having separate physical machines.

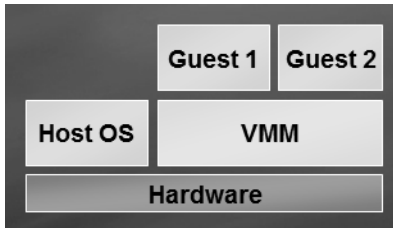


Figure 3-2 Architecture of Hybrid VMM



Note Another way of distinguishing between Type 2 and Hybrid VMMs is that Type 2 VMMs are *process virtual machines* because they isolate processes (services or applications) as separate guests on the physical system, while Hybrid VMMs are *system virtual machines* because they isolate entire operating systems, such as Windows or Linux, as separate guests.

A third type of virtualization technology available today is Type 1 VMM, or hypervisor technology. A *hypervisor* is a layer of software that sits just above the hardware and beneath one or more operating systems. Its primary purpose is to provide isolated execution environments, called *partitions*, within which virtual machines containing guest OSs can run. Each partition is provided with its own set of hardware resources—such as memory, CPU cycles, and devices—and the hypervisor is responsible for controlling and arbitrating access to the underlying hardware.

Figure 3-3 shows a simple form of Type 1 VMM in which the VMM (the hypervisor) is running directly on the bare metal (the underlying hardware) and several guest OSs are running on top of the VMM.

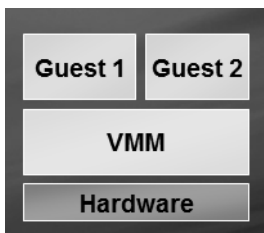


Figure 3-3 Architecture of Type 1 VMM

Going forward, hypervisor-based virtualization has the greatest performance potential, and in a moment we'll see how this will be implemented in Windows Server 2008. But first let's compare two variations of Type 1 VMM: monolithic and microkernelized.

Monolithic Hypervisor

In the monolithic model, the hypervisor has its own drivers for accessing the hardware beneath it. (See Figure 3-4.) Guest OSs run in VMs on top of the hypervisor, and when a guest needs to access hardware it does so through the hypervisor and its driver model. Typically, one of these guest OSs is the administrator or console OS within which you run the tools that provision, manage, and monitor all guest OSs running on the system.

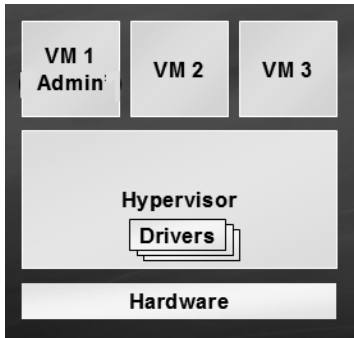


Figure 3-4 Monolithic hypervisor

The monolithic hypervisor model provides excellent performance, but it can have weaknesses in the areas of security and stability. This is because this model inherently has a greater attack surface and much greater potential for security concerns due to the fact that drivers (and even sometimes third-party code) runs in this very sensitive area. For example, if malware were downloaded onto the system, it could install a keystroke logger masquerading as a device driver in the hypervisor. If this happened, every guest OS running on the system would be compromised, which obviously isn't good. Even worse, once you've been "hyperjacked" there's no way the operating systems running above can tell because the hypervisor is invisible to the OSs above and can be lied to by the hypervisor!

The other problem is stability—if a driver were updated in the hypervisor and the new driver had a bug in it, the whole system would be affected, including all its virtual machines. Driver stability is thus a critical issue for this model, and introducing any third-party code has the potential to cause problems. And given the evolving nature of server hardware, the frequent need for new and updated drivers increases the chances of something bad happening. You can think of the monolithic model as a "fat hypervisor" model because of all the drivers the hypervisor needs to support.

Microkernelized Hypervisor

Now contrast the monolithic approach just mentioned with the microkernelized model. (See Figure 3-5.) Here you have a truly "thin" hypervisor that has no drivers running within it. Yes, that's right—the hypervisor has *no drivers at all*. Instead, drivers are run in each partition

so that each guest OS running within a virtual machine can access the hardware through the hypervisor. This arrangement makes each virtual machine a completely separate partition for greater security and reliability.

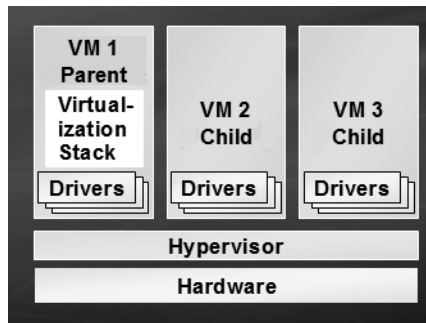


Figure 3-5 Microkernelized hypervisor

In the microkernelized model, which is used in Windows Server virtualization in Windows Server 2008, one VM is the parent partition while the others are child partitions. A partition is the basic unit of isolation supported by the hypervisor. A partition is made up of a physical address space together with one or more virtual processors, and you can assign specific hardware resources—such as CPU cycles, memory and devices—to the partition. The *parent partition* is the partition that creates and manages the *child partitions*, and it contains a virtualization stack that is used to control these child partitions. The parent partition is generally also the *root partition* because it is the partition that is created first and owns all resources not owned by the hypervisor. And being the default owner of all hardware resources means the root partition (that is, the parent) is also in charge of power management, plug and play, managing hardware failure events, and even loading and booting the hypervisor.

Within the parent partition is the virtualization stack, a collection of software components that work in conjunction with and sit on top of the hypervisor and that work together to support the virtual machines running on the system. The virtualization stack talks with the hypervisor and performs any virtualization functions not directly supplied by the hypervisor. Most of these functions are centered around the creation and management of child partitions and the resources (CPU, memory, and devices) they need.

The virtualization stack also exposes a management interface, which in Windows Server 2008 is a WMI provider whose APIs will be made publicly known. This means that not only will the tools for managing virtual machines running on Windows Server 2008 use these APIs, but third-party system management vendors will also be able to code new tools for managing, configuring, and monitoring VMs running on Windows Server 2008.

The advantage of the microkernelized approach used by Windows Server virtualization over the monolithic approach is that the drivers needed between the parent partition and the physical server don't require any changes to the driver model. In other words, existing drivers just work. Microsoft chose this route because requiring new drivers would have been a

showstopper. And as for the guest OSs, Microsoft will provide the necessary facilities so that these OSs just work either through emulation or through new synthetic devices.

On the other hand, one could argue that the microkernelized approach does suffer a slight performance hit compared with the monolithic model. However, security is paramount nowadays, so sacrificing a percentage point or two of performance for a reduced attack surface and greater stability is a no-brainer in most enterprises.



Tip What's the difference between a virtual machine and a partition? Think of a virtual machine as comprising a partition together with its state.

Understanding Virtualization in Windows Server 2008

Before I get you too excited, however, you need to know that what I'm going to describe now is not yet present in Windows Server 2008 Beta 3, the platform that this book covers. It's coming soon, however. Within 180 days of the release of Windows Server 2008, you should be able to download and install the bits for Windows Server virtualization that will make possible everything that I've talked about in the previous section and am going to describe now. In fact, if you're in a hotel after a long day at TechEd and you're reading this book for relaxation (that is, you're a typical geek), you can probably already download tools for your current prerelease build of Windows Server 2008 that might let you test some of these Windows Server virtualization technologies by creating and managing virtual machines on your latest Windows Server 2008 build.

I said *might* let you test these new technologies. Why? First, Windows Server virtualization is an x64 Editions technology only and can't be installed on x86 builds of Windows Server 2008. Second, it requires hardware processors with hardware-assisted virtualization support, which currently includes AMD-V and Intel VT processors only. These extensions are needed because the hypervisor runs out of context (effectively in ring 1), which means that the code and data for the hypervisor are not mapped into the address space of the guest. As a result, the hypervisor has to rely on the processor to support various intercepts, which are provided by these extensions. And finally, for security reasons it requires processor support for hardware-enabled Data Execution Prevention (DEP), which Intel describes as XD (eXecute Disable) and AMD describes as NX (No eXecute). So if you have suitable hardware and lots of memory, you should be able to start testing Windows Server virtualization as it becomes available in prerelease form for Windows Server 2008.

Let's dig deeper into the architecture of Windows Server virtualization running on Windows Server 2008. Remember, what we're looking at won't be available until after Windows Server 2008 RTMs—today in Beta 3, there is no hypervisor in Windows Server 2008, and the operating system basically runs on top of the metal the same way Windows Server 2003 does. So we're temporarily time-shifting into the future here, and assuming that when

we try and add the Windows Virtualization role to our current Windows Server 2008 build that it actually does something!

Figure 3-6 shows the big picture of what the architecture of Windows Server 2008 looks like with the virtualization bits installed.

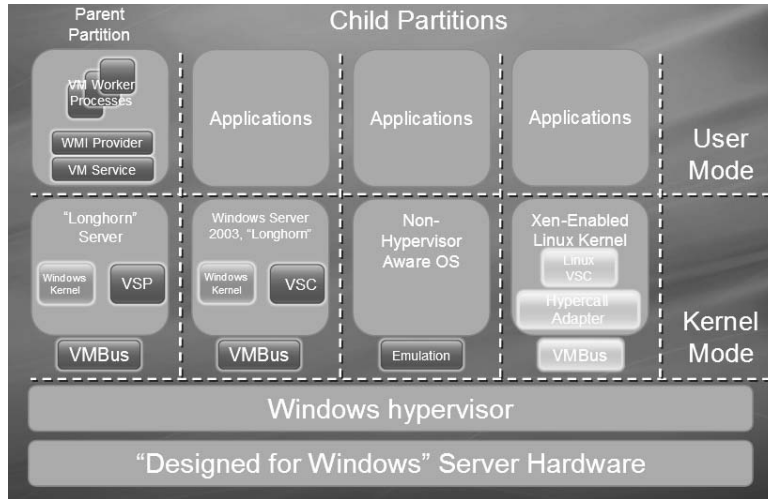


Figure 3-6 Detailed architecture of Windows Server virtualization

Partition 1: Parent

Let's unpack this diagram one piece at a time. First, note that we've got one parent partition (at the left) together with three child partitions, all running on top of the Windows hypervisor. In the parent partition, running in kernel mode, there must be a guest OS, which must be Windows Server 2008 but can be either a full installation of Windows Server 2008 or a Windows server core installation. Being able to run a Windows server core installation in the parent partition is significant because it means we can minimize the footprint and attack surface of our system when we use it as a platform for hosting virtual machines.

Running within the guest OS is the Virtualization Service Provider (VSP), a "server" component that runs within the parent partition (or any other partition that owns hardware). The VSP talks to the device drivers and acts as a kind of multiplexer, offering hardware services to whoever requests them (for example, in response to I/O requests). The VSP can pass on such requests either directly to a physical device through a driver running in kernel or user mode, or to a native service such as the file system to handle.

The VSP plays a key role in how device virtualization works. Previous Microsoft virtualization solutions such as Virtual PC and Virtual Server use emulation to enable guest OSs to access hardware. Virtual PC, for example, emulates a 1997-era motherboard, video card, network

card, and storage for its guest OSs. This is done for compatibility reasons to allow the greatest possible number of different guest OSs to run within VMs on Virtual PC. (Something like over 1,000 different operating systems and versions can run as guests on Virtual PC.) Device emulation is great for compatibility purposes, but generally speaking it's lousy for performance. VSPs avoid the emulation problem, however, as we'll see in a moment.

In the user-mode portion of the parent partition are the Virtual Machine Service (VM Service), which provides facilities to manage virtual machines and their worker processes; a Virtual Machine Worker Process, which is a process within the virtualization stack that represents and services a specific virtual machine running on the system (there is one VM Worker Process for each VM running on the system); and a WMI Provider that provides a set of interfaces for managing virtualization on the system. As mentioned previously, these WMI Providers will be publicly documented on MSDN, so you'll be able to automate virtualization tasks using scripts if you know how. Together, these various components make up the user-mode portion of the virtualization stack.

Finally, at the bottom of the kernel portion of the parent partition is the VMBus, which represents a system for sending requests and data between virtual machines running on the system.

Partition 2: Child with Enlightened Guest

The second partition from the left in Figure 3-6 shows an “enlightened” guest OS running within a child partition. An *enlightened guest* is an operating system that is aware that it is running on top of the hypervisor. As a result, the guest uses an optimized virtual machine interface. A guest that is fully enlightened has no need of an emulator; one that is partially enlightened might need emulation for some types of hardware devices. Windows Server 2008 is an example of a fully enlightened guest and is shown in partition 2 in the figure. (Windows Vista is another possible example of a fully enlightened guest.) The Windows Server 2003 guest OS shown in this partition, however, is only a partially enlightened, or “driver-enlightened,” guest OS.)

By contrast, a *legacy guest* is an operating system that was written to run on a specific type of physical machine and therefore has no knowledge or understanding that it is running within a virtualized environment. To run within a VM hosted by Windows Server virtualization, a legacy guest requires substantial infrastructure, including a system BIOS and a wide variety of emulated devices. This infrastructure is not provided by the hypervisor but by an external monitor that we'll discuss shortly.

Running in kernel mode within the enlightened guest OS is the Virtualization Service Client (VSC), a “client” component that runs within a child partition and consumes services. The key thing here is that there is one VSP/VSC pair for each device type. For example, say a

user-mode application running in partition 2 (the child partition second from the left) wants to write something to a hard drive, which is server hardware. The process works like this:

1. The application calls the appropriate file system driver running in kernel mode in the child partition.
2. The file system driver notifies the VSC that it needs access to hardware.
3. The VSC passes the request over the VMBus to the corresponding VSP in partition 1 (the parent partition) using shared memory and hypervisor IPC messages. (You can think of the VMBus as a protocol with a supporting library for transferring data between different partitions through a ring buffer. If that's too confusing, think of it as a pipe. Also, while the diagram makes it look as though traffic goes through all the child partitions, this is not really the case—the VMBus is actually a point-to-point inter-partition bus.)
4. The VSP then writes to the hard drive through the storage stack and the appropriate port driver.

Microsoft plans on providing VSP/VSC pairs for storage, networking, video, and input devices for Windows Server virtualization. Third-party IHVs will likely provide additional VSP/VSC pairs to support additional hardware.

Speaking of writing things to disk, let's pause a moment before we go on and explain how pass-through disk access works in Windows Server virtualization. Pass-through disk access represents an entire physical disk as a virtual disk within the guest. The data and commands are thus “passed through” to the physical disk via the partition's native storage stack without any intervening processing by the virtual storage stack. This process contrasts with a virtual disk, where the virtual storage stack relies on its parser component to make the underlying storage (which could be a .vhd or an .iso image) look like a physical disk to the guest. Pass-through disk access is totally independent of the underlying physical connection involved. For example, the disk might be direct-attached storage (IDE disk, USB flash disk, FireWire disk) or it might be on a storage area network (SAN).

Now let's resume our discussion concerning the architecture of Windows Server virtualization and describe the third and fourth partitions shown in Figure 3-6 above.

Partition 3: Child with Legacy Guest

In the third partition from the left is a legacy guest OS such as MS-DOS. Yes, there are still a few places (such as banks) that run DOS for certain purposes. Hopefully, they've thrown out all their 286 PCs though. The thing to understand here is that basically this child partition works like Virtual Server. In other words, it uses emulation to provide DOS with a simulated hardware environment that it can understand. As a result, there is no VSC component here running in kernel mode.

Partition 4: Child with Guest Running Linux

Finally, in the fourth partition on the right is Linux running as a guest OS in a child partition. Microsoft recognizes the importance of interoperability in today's enterprises. More specifically, Microsoft knows that their customers want to be able to run *any* OS on top of the hypervisor that Windows Server virtualization provides, and therefore it can't relegate Linux (or any other OS) to second-class status by forcing it to have to run on emulated hardware. That's why Microsoft has decided to partner with XenSource to build VSCs for Linux, which will enable Linux to run as an enlightened guest within a child partition on Windows Server 2008. I knew those FOSS guys would finally see the light one day...

Features of Windows Server Virtualization

Now that we understand something about how virtualization works (or will work) on Windows Server 2008, let's look at what it can actually do. Here's a quick summary:

- Creates and manage child partitions for both 32-bit (x86) and 64-bit (x64) operating systems.
- Creates VMs that can use SMP to access 2, 4, or even 8 cores.
- Creates VMs that use up to 1 TB of physical memory. Windows Server virtualization can do this because it's built on 64-bit from the ground up. That means 64-bit HV, 64-bit virtualization stack, and so on.
- Supports direct pass-through disk access for VMs to provide enhanced read/write performance. Storage is often a bottleneck for physical machines, and with virtual disks it can be even more of a bottleneck. Windows Server virtualization overcomes this issue.
- Supports hot-add access to any form of storage. This means you can create virtual storage workloads and manage them dynamically.
- Supports dynamic addition of virtual NICs and can take advantage of underlying virtual LAN (VLAN) security.
- Includes tools for migrating Virtual Server workloads to Windows Server virtualization. This means your current investment in Virtual Server won't go down the drain.
- Supports Windows Server 2008 Core as the parent OS for increased security. I said this earlier, but it bears repeating here because it's important.
- Supports NAT and network quarantine for VMs, role-based security, Group Policy, utilization counters, non-Microsoft guests, virtual machine snapshots using Volume Shadow Copy Service (VSS), resource control using Windows System Resource Manager (WSRM), clustering, and a whole bunch of other things.

To put this all in perspective, take a look at Table 3-1, which provides a comparison between Virtual Server 2005 R2 and Windows Server virtualization.

Table 3-1 Comparison of Virtual Server 2005 R2 and Windows Server Virtualization Features

Feature	Virtual Server 2005 R2	Windows Server Virtualization
32-bit VMs	Yes	Yes
64-bit VMs	No	Yes
SMP VMs	No	Up to 8 core virtual machines
Hot-add memory	No	Yes
Hot-add processors	No	Yes
Hot-add storage	No	Yes
Hot-add networking	No	Yes
Max memory per VM	3.6 GM	> 32 GB
Cluster support	Yes	Yes
Scripting support	Using COM	Using WMI
Max number of VMs	64	No limit—depends only on hardware
Management tool	Web UI	MMC snap-in
Live migration support	No	Yes
Works with System Center Virtual Machine Manager	Yes	Yes



Note Virtual Server 2005 R2 Service Pack 1 will support Intel VT and AMD-V technologies, as well as VSS.

Managing Virtual Machines in Windows Server 2008

At the time of this writing, the MMC snap-in for managing virtual machines that is provided with Windows Server virtualization is still evolving, but I wanted to give you a quick preview here. Figure 3-7 shows the Windows Virtualization Management console for a near-Beta 3 build of Windows Server 2008. The console tree on the left displays the name of the server, while the Details pane in the middle shows a number of virtual machines, most of them in an Off state and two in a Saved state. The Actions pane on the right lets you manage virtualization settings, import virtual machines, connect to a virtual machine, and perform other tasks.

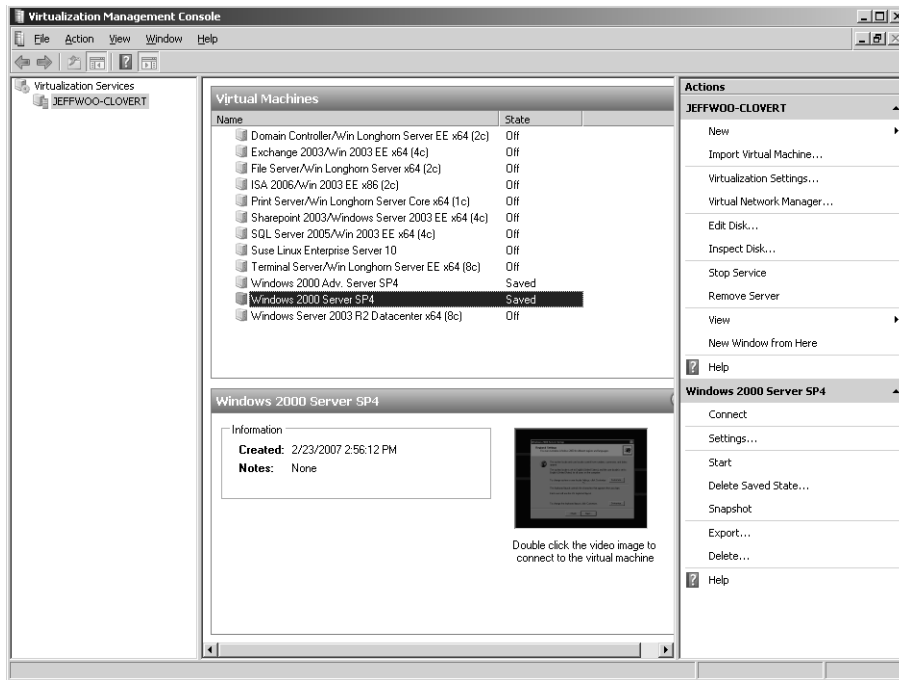


Figure 3-7 Windows Virtualization Management console

So that's a very brief preview of what's in store for virtualization in Windows Server 2008 in terms of managing virtual machines. Fortunately we also have some experts on the product team at Microsoft who provide us with some more information concerning this feature and especially the planning issues surrounding implementing Windows Server virtualization in your environment.

First, here's one of our experts talking about using Windows Server virtualization in conjunction with the Windows server core installation option of Windows Server 2008:

From the Experts: Windows Server Virtualization and a Windows Server Core Installation

The Windows server core installation option of Windows Server 2008 and Windows Server virtualization are two new features of Windows Server 2008 that go hand in hand. The Windows server core installation option is a new minimal GUI shell-less installation option for Windows Server 2008 Standard, Enterprise and Datacenter Editions that reduces the management and maintenance required by an administrator. The Windows server core installation option provides key advantages over a full installation of Windows Server 2008 and is the perfect complement to Windows Server virtualization. Here are a couple of reasons why.

- **Reduced attack surface** A Windows server core installation provides a greatly reduced attack surface because it is tailored to provide only what a role requires. By

providing a minimal parent partition, this reduces the need to patch the parent partition. In the past with one workload running per server, if you needed to reboot the server for a patch, it wasn't ideal, but generally one workload was affected. With Windows Server virtualization, you're not just running a single workload. You could be running dozens (even hundreds) of workloads in their own virtual machine. If the virtualization server requires a reboot for a patch (and you don't have a high availability solution in place), the result could be significant downtime.

- **Reduced resource consumption** With the parent partition requiring only a fraction of the memory resources for a Windows server core installation as opposed to a full installation of Windows Server 2008, you can use that memory to run more virtual machines.

In short, it is *highly recommended* that you use Windows Server virtualization in conjunction with a Windows server core installation.

—Jeffrey Woolsey
Lead Program Manager, Windows Virtualization

Next, let's hear another of our experts on the virtualization team at Microsoft share about how to identify what should be virtualized in your environment and what maybe shouldn't:

From the Experts: Virtualization Sizing

It is very important to understand how to roll out virtualization in your organization and what makes the most sense for your environment and business conditions. So often, some enthusiastic users and organizations start either attempting to virtualize everything or start with their most complex middleware environments. There are no right or wrong first candidates for virtualization but you need to ensure that you have fully thought about the impact of using virtualization in your environment and for the workloads in question.

As you think about what to virtualize and how to go about picking the right workloads, the order of deployment, and what hardware capabilities you need, find a model or a set of models that help you conceptualize the end solution. The System Center family of products provides you a set of tools that help simplify some of these issues, and other solutions from vendors like HP provide you tools to help size the deployment environment once you have figured out the candidates and the rollout process.

The next few paragraphs help identify some of the best practices in sizing your virtualization environment. Think of the following as a set of steps that will help you identify what workloads to virtualize and what the deployment schedule should look like.

1. **Assessment** As with any project, the first step is to fully know about where you are today and what capabilities you already have in your environment. The last thing you want to do is to sit and re-create the wheel and invest in things you already have in your environment. As you think about assessment, think about assessing all the components you have in your infrastructure, the types of workloads, and interdependencies of the various workloads. Also evaluate all the management assets you already have in your infrastructure and identify the functions that these are performing, such as monitoring, deployment, data protection, security, and so on. These are the easier items to assess, but the more critical one to assess will be the overall process discipline that exists in your organization and how you deal with change in today's world. While this is a hard factor to quantify, this is critical in evaluating what capacity you have to deploy virtualization. To help you make this assessment from a holistic perspective, there are tools available such as Microsoft's Infrastructure Optimization Model or Gartner's IT Maturity Model that you can choose to use. There is one thing a customer once told me that I will never forget—"If someone tells you they have a solution for your problems when you have not identified or told them what your problems are, most likely they are giving you something you already have in a different package—that is, if you are lucky."
2. **Solution Target** Once you have identified and assessed your current environment, find out where you can use virtualization today. All server virtualization solutions today provide these usage scenarios:
 - ❑ Production Server Consolidation, which encompasses all forms of consolidation of systems in existing or new environments.
 - ❑ Test and Development Environments, which addresses the use of virtualization for optimizing the test and dev cycles and not only enables you to leverage the cost saving from hardware needs but also enables easy creation and modification of the environments.
 - ❑ Business Continuance, where your primary motivator is to leverage the fact that virtualization transforms your IT infrastructure to files (in Microsoft's case a VHD file) to enable new and interesting continuance and disaster recovery solutions.

- ❑ Dynamic Datacenter, which is a new set of capabilities unleashed by virtualization to now enable you to not only create and manage your environment more efficiently, but provide a new level of capability to be able to dynamically modify the characteristics of the environments for workloads based on usage. The dynamic resource manipulation enables you to take the consolidation benefits and translate it to now making your IT a more agile environment.
- ❑ Branch Office, which while not being a core solution, is one usage scenario where virtualization helps change how IT systems are deployed, monitored, and managed and helps extend the capabilities of the branch environment to bring in legacy and new application environments under one common infrastructure umbrella.

As you are trying to decide which solution area or areas to target for your virtualization solution, do keep in mind the level of complexity of the solutions and the need for increasing levels of management tools and process discipline. Test and dev environments are the easiest to virtualize and usually can manage to take some downtime in case of hiccups—hence this is a natural start for everyone. Server Consolidation is another area that you can start using virtualization in today. The initial cost savings here are in the hardware consolidation benefits—but the true value of consolidation is seen only when you have figured out how to use a unified management infrastructure. Business continuance and branch scenarios need you to have a management infrastructure in place to help orchestrate these solutions and again to see the true value – you will need to have a certain level of processes outlined. Dynamic datacenter is a complex solution for most customers to fully deploy and this usually applies to a certain subset of the org’s infrastructure—select the workloads that need this type of solution more carefully as adding the SLAs to maintain such a solution should mean that the workload is really critical to the organization.

3. **Consolidation Candidates** Most users today are deploying virtualization to help consolidate workloads and bring in legacy systems into a unified management umbrella. In this light, it becomes important to identify which workloads are the most logical ones to consolidate today and what makes sense in the future. There are some workloads that sound attractive for virtualization, but might not be ideal at any stretch because of certain I/O characteristics or purely because they are so big and critical that they easily scale up to or beyond the capabilities of the hardware being thrown at them. Operations Manager or Virtual Machine Manager has a report that is generated called the virtualization candidates report that helps scan your entire IT org and tell you exactly what workloads are ideal for virtualization based on a number of thresholds such as CPU utilization, I/O intensity, network usage, size of the workload, and so on. Based on this report and knowing the

interdependencies identified during the assessment phase, you can make intelligent decisions on what workloads to virtualization and when.

4. **Infrastructure Planning** This is where the rubber meets the road so to speak. Once you have identified the candidates to virtualize, you need a place to host the virtualized workloads. Tools from companies such as HP (HP Virtualization Sizing Guide) help you identify the type of servers you will need in your environment to host the virtualization solution that you have identified in the previous step. There is one fundamental rule to consider as you are selecting the infrastructure for virtualization—the two biggest limiting factors for virtualization are memory and I/O throughput—so always ensure that you select a x64 platform for your hardware to ensure a large memory access, and always try to get the best disk subsystem either into the system for DAS or good SAN devices.
5. **Placement** This is not so much an area that is going to affect the sizing of your environment, but has the potential to impact your sizing decisions in the long run. Here we are referring to the act of taking one of the virtualization candidates and actually deploying it to one of the selected virtualization host systems. The knowledge of interdependencies of the various workloads affects some of how this placement occurs but from a high level, this is more about optimizing the placement for a few selected variables. Virtual Machine Manager has an intelligent placement tool that helps you optimize either to a load balancing algorithm or to a maximizing utilization algorithm. You can alternatively also tweak individual parameters to help optimize your environment based on your business weights of the different parameters.

As you size your virtualization environment, also keep in mind the overall manageability factor and how you can scale your management apps to help cover the new environment. Now that you have seen how to size your virtualization environments, keep two things in mind—virtualization is a great technology that can help in multiple levels and scenarios but is still not the panacea for all problems so do take the time to identify your true problems and also remember that you need to look at deploying and managing virtualized environments over a long period of time and hence the need to think about virtualization as a 3-year solution at least.

Virtualization is primarily a consolidation technology that abstracts resources and aids aggregation of workloads, so think carefully about how this affects your environment and what steps you need to have in place to avoid disasters and plan for them early.

—Rajiv Arunkundram

Senior Product Manager, Server Virtualization

Finally, an important planning item for any software deployment is licensing. Here's one of our experts explaining the current licensing plan for Windows virtualization:

From the Experts: Virtualization Licensing

One of the most talked about and often most confused areas for virtualization is licensing. Some of this is primarily caused due to the lack of one industry standard way of dealing with licensing and the other cause is that virtualization is a disruptive technology in how companies operate and hence not clear to customers on what the various policies mean in this new world.

Microsoft's licensing goals are to provide customers and partners cost-effective, flexible, and simplified licensing for our products that will be applicable across all server virtualization products, regardless of vendor. To this effect, several changes were put in place in late 2005 to help accelerate virtualization deployments across vendors:

- Windows server licensing was changed from installation-based licensing to instance-based licensing for server products.
- Microsoft changed licensing to allow customers to run up to 1 physical and 4 virtual instances with a single license of Windows Server 2003 Enterprise Edition on the licensed device; and 1 physical and unlimited virtual instances with Windows Server 2003 Datacenter Edition on the licensed device.
- With the release of SQL Server 2005 SP2, Microsoft announced expanded virtualization use rights to allow unlimited virtual instances on servers that are fully licensed for SQL Server 2005 Enterprise Edition.

With all these changes, you can now easily acquire and license Windows Server and other technologies in a much more efficient process. Virtualization also adds another level of complexity for licensing with the ability to easily move the images or instances around between machines. This is where licensing from the old era makes it tricky. The simple way to remember and ensure that you are fully licensed is to look at the host systems as the primary license holders with the instances being the deployment front. So if you want to move a workload to a system that has Windows Server Enterprise Edition running and already has 4 instances running, you will need an additional license; if it is lower than 4, you will not need an additional license to make the move happen.

Do note that the licensing policies for these apply across virtualization products in the same manner across all server virtualization platforms.

—Rajiv Arunkundram

Senior Product Manager, Server Virtualization

System Center Virtual Machine Manager 2007

The Virtualization Management Console snap-in that is included with Windows Server virtualization is limited in several ways, and it's mainly intended for managing virtual machines on a few servers at a time. Large enterprises want infrastructure solutions, however, and not just point tools. System Center Virtual Machine Manager fills this gap and will enable you to centralize management of a large enterprise's entire virtual machine infrastructure, rapidly provision new virtual machines as needed, and efficiently manage physical server utilization. Plus it's fully integrated with the Microsoft System Center family of products, so you can leverage your existing skill sets as you migrate your network infrastructure to Windows Server 2008.

System Center Virtual Machine Manager runs as a standalone server application, and it can be used to manage a virtualized datacenter that contains hundreds or even thousands of virtual machines in an Active Directory environment. System Center Virtual Machine Manager will be able to manage virtual machines running on both Microsoft Virtual Server 2005 R2 and Windows 2008 Server with Windows Server virtualization installed. You can even deploy System Center Virtual Machine Manager in a fiber-channel SAN environment for performing tasks such as the following:

- Deploying VMs from your SAN library to a host
- Transferring VMs from a host to your library
- Migrating VMs from one host to another host

The administrator console for System Center Virtual Machine Manager is built upon Windows PowerShell, and you can use it to add and manage host machines, create and manage virtual machines, monitor tasks, and even migrate physical machines to virtual ones (something called P2V).

System Center Virtual Machine Manager also includes a self-service Web portal that enables users to independently create and manage their own virtual machines. The way this works is that the administrator predetermines who can create virtual machines, which hosts these machines can run on, and which actions users can perform on their virtual machines.

At the time of this writing, System Center Virtual Machine Manager is in Beta 1 and supports managing only virtual machines hosted on Virtual Server 2005 R2.

SoftGrid Application Virtualization

Finally, another upcoming virtualization technology you should know about is SoftGrid Application Virtualization, which Microsoft took ownership of when it acquired Softricity in July 2006. SoftGrid provides a different kind of virtualization than we've been discussing here—instead of virtualizing an entire operating system, it virtualizes only an application. This functionality makes SoftGrid a more fine-grained virtualization technology than Windows

Server virtualization. Also, it's designed not for the server end but for deploying applications to desktops easily and updating them as necessary.

Essentially, what SoftGrid can do using its streaming delivery mechanism is to transform any Windows program into a dynamic service that then follows users wherever they might go. These services can then be integrated into Microsoft's management infrastructure so that they can be configured and managed using standard policy-based methods. At this point, SoftGrid isn't directly associated with Windows 2008 Server or Windows Server virtualization, but it's a new Microsoft technology you should be aware of as the virtualization landscape continues to evolve.

Conclusion

It would have been nice to have looked in greater depth at how Windows Server virtualization in Windows Server 2008 works. Unfortunately, at the time of this writing the bits aren't there yet. Still, you have to admit that this is one of the hottest features of Windows Server 2008, both from the perspective of the day-to-day needs of IT professionals and as a prime selling point for Windows Server 2008. I've tried to give you a taste of how this new technology will work and a glimpse of what it looks like, but I hope you're not satisfied with that—I'm not. I can't wait till all this comes together, and the plain truth of the matter is that in only a few years virtualization will be inexpensive and ubiquitous. So get ready for it now.

Bring back the mainframe!!

Additional Reading

If you want to find out more about the underlying processor enhancements from Intel and AMD that will support and be required by Windows Server virtualization, check out the following sources:

- See <http://www.intel.com/technology/virtualization/index.htm> for information concerning Intel VT technology
- See http://www.amd.com/us-en/Processors/ProductInformation/0,,30_118_8826_14287,00.html for information about AMD-V technology

For information on how Microsoft and XenSource are collaborating to support running Linux on Windows Server 2008, read the following article on Microsoft PressPass:

<http://www.microsoft.com/presspass/press/2006/jul06/07-17MSXenSourcePR.mspax>.

The starting point for finding out more about current (and future) Microsoft virtualization products is <http://www.microsoft.com/windowsserversystem/virtualserver/default.mspax> on Microsoft.com.

For more information about System Center Virtual Machine Manager and how you can join the beta program for this product, see <http://www.microsoft.com/windowsserversystem/virtualization/default.aspx> on the Microsoft Web site. From there, you can jump to pages describing Virtual Server 2005 R2, Virtual PC 2007, System Center Virtual Machine Manager, and most likely Windows Server virtualization on Windows Server 2008 in the near future as well.

If you're interested in finding out more about SoftGrid Application Virtualization, see <http://www.softtricity.com/index.asp>, although the Softtricity Web site will probably be folded soon into Microsoft.com.

Finally, be sure to turn to Chapter 14, "Additional Resources," if you want to find more resources about Windows Server virtualization in Windows Server 2008. In that chapter, you'll find links to webcasts, whitepapers, blogs, newsgroups, and other sources of information on this feature and other Microsoft virtualization technologies.