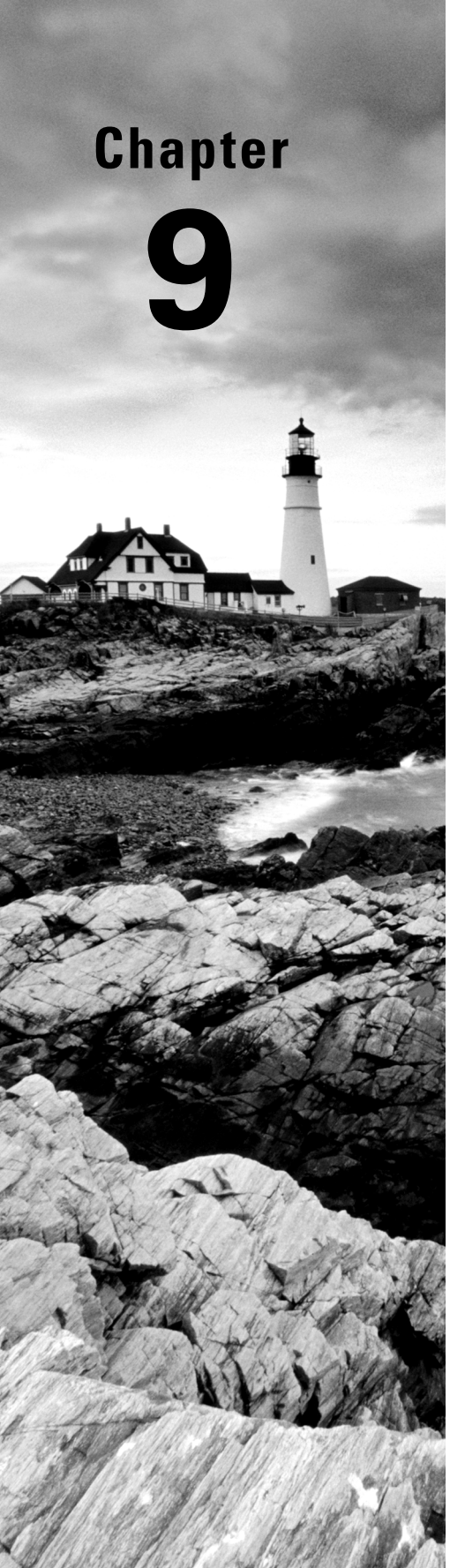


Chapter 9

Use Virtualization in Windows Server 2012

THE FOLLOWING 70-410 EXAM OBJECTIVES ARE COVERED IN THIS CHAPTER:

✓ **Create and configure virtual machine settings**

- Configure dynamic memory
- Configure smart paging
- Configure Resource Metering
- Configure guest integration services
- Create and configure Generation 1 and 2 virtual machines
- Configure and use extended session mode
- Configure remoteFX

✓ **Create and configure virtual machine storage**

- Create VHDs and VHDX
- Configure differencing drives
- Modify VHDs
- Configure pass-through disks
- Manage checkpoints
- Implement a virtual Fibre Channel adapter
- Configure storage Quality of Service

✓ **Create and configure virtual networks**

- Configure Hyper-V virtual switches
- Optimize network performance
- Configure MAC addresses
- Configure network isolation
- Configure synthetic and legacy virtual network adapters
- Configure NIC teaming in virtual machines

Hyper-V is a server role in Windows Server 2012 R2 that allows you to virtualize your environment and therefore run multiple virtual operating system instances simultaneously on a physical server. This not only helps you to improve server utilization but also helps you to create a more cost-effective and dynamic system.

In this chapter, you will learn the basic concepts and features of Hyper-V that a Windows Server 2012 R2 technical specialist must know. You will also get a solid understanding of what is important in virtualization and in what areas of your work life you can use it.

Hyper-V Overview

In the following sections, I'll introduce you to Hyper-V. To begin, you'll take a look at virtualization and what types of virtualization exist. I will then discuss Hyper-V features and the Hyper-V architecture before finishing up with the Hyper-V requirements for software and hardware.

What Is Virtualization?

Virtualization is a method for abstracting physical resources from the way that they interact with other resources. For example, if you abstract the physical hardware from the operating system, you get the benefit of being able to move the operating system between different physical systems.

This is called *server virtualization*. But there are also other forms of virtualization available, such as presentation virtualization, desktop virtualization, and application virtualization. I will now briefly explain the differences between these forms of virtualization:

Server Virtualization This basically enables multiple servers to run on the same physical server. Hyper-V is a server virtualization tool that allows you to move physical machines to virtual machines and manage them on a few physical servers. Thus, you will be able to consolidate physical servers.

Presentation Virtualization When you use *presentation virtualization*, your applications run on a different computer, and only the screen information is transferred to your computer. An example of presentation virtualization is Microsoft Remote Desktop Services in Windows Server 2012 R2.

Desktop Virtualization *Desktop virtualization* provides you with a virtual machine on your desktop, comparable to server virtualization. You run your complete operating system and applications in a virtual machine so that your local physical machine just needs to run a very basic operating system. An example of this form of virtualization is Microsoft Virtual PC.

Application Virtualization *Application virtualization* helps prevent conflicts between applications on the same PC. Thus, it helps you to isolate the application running environment from the operating system installation requirements by creating application-specific copies of all shared resources. It also helps reduce application-to-application incompatibility and testing needs. An example of an application virtualization tool is Microsoft Application Virtualization (App-V).

Hyper-V Features

As a lead-in to the virtualization topic and Hyper-V, I will start with a list of key features, followed by a list of supported guest operating systems. This should provide you with a quick, high-level view of this feature before you dig deeper into the technology.

Key Features of Hyper-V

The following are the key features of Hyper-V:

New Architecture The hypervisor-based architecture, which has a 64-bit micro-kernel, provides a new array of device support as well as performance and security improvements.

Operating System Support Both 32-bit and 64-bit operating systems can run simultaneously in Hyper-V. Also, different platforms like Windows, Linux, and others are supported.

Support for Symmetric Multiprocessors Support for up to 64 processors in a virtual machine environment provides you with the ability to run applications as well as multiple virtual machines faster.

Network Load Balancing Hyper-V provides support for *Windows Network Load Balancing (NLB)* to balance the network load across virtual machines on different servers.

New Hardware Architecture Hyper-V's new architecture provides improved utilization of resources such as networking and disks.

Quick Migration Hyper-V's *quick migration* feature provides you with the functionality to run virtual machines in a clustered environment with switchover capabilities when there is a failure. Thus, you can reduce downtime and achieve higher availability of your virtual machines.

Virtual Machine Snapshot You can take snapshots of running virtual machines, which provides you with the capability to recover to any previous virtual machine snapshot state quickly and easily.

Resource Metering Hyper-V *resource metering* allows an organization to track usage within the businesses departments. It allows an organization to create a usage-based billing solution that adjusts to the provider's business model and strategy.

Scripting Using the Windows Management Instrumentation (WMI) interfaces and APIs, you can easily build custom scripts to automate processes in your virtual machines.

RemoteFX Windows Server 2012 R2 Hyper-V RemoteFX allows for an enhanced user experience for RemoteFX desktops by providing a 3D virtual adapter, intelligent codecs, and the ability to redirect USB devices in virtual machines.

Fibre Channel The virtual Fibre Channel feature allows you to connect to the Fibre Channel storage unit from within the virtual machine. *Virtual Fibre Channel* allows an administrator to use their existing Fibre Channel to support virtualized workloads. Hyper-V users have the ability to use Fibre Channel storage area networks (SANs) to virtualize the workloads that require direct access to SAN logical unit numbers (LUNs).

Enhanced Session Mode *Enhanced Session Mode* enhances the interactive session of the Virtual Machine Connection for Hyper-V administrators who want to connect to their virtual machines. It gives administrators the same functionality as a remote desktop connection when the administrator is interacting with a virtual machine.

In previous versions of Hyper-V, the virtual machine connection gave you limited functionality while you connected to the virtual machine screen, keyboard, and mouse. An administrator could use an RDP connection to get full redirection abilities, but that would require a network connection to the virtual machine host.

Enhanced Session Mode gives administrators the following benefits for local resource redirection:

- Display configuration
- Audio
- Printers
- Clipboard
- Smart cards
- Drives
- USB devices
- Supported Plug and Play devices

Shared Virtual Hard Disk Windows Server 2012 R2 Hyper-V has a new feature called Shared Virtual Hard Disk. *Shared Virtual Hard Disk* allows an administrator to cluster virtual machines by using shared virtual hard disk (VHDX) files.

Shared virtual hard disks allow an administrator to build a high availability infrastructure, which is important if you are setting up either a private cloud deployment or a cloud-hosted environment for managing large workloads. Shared virtual hard disks allow two or more virtual machines to access the same virtual hard disk (VHDX) file.

Automatic Virtual Machine Activation (AVMA) *Automatic Virtual Machine Activation (AVMA)* is a new feature that allows administrators to install virtual machines on a properly activated Windows Server 2012 R2 system without the need to manage individual

product keys for each virtual machine. When using AVMA, virtual machines get bound to the licensed Hyper-V server as soon as the virtual machine starts.

Network Isolation One nice feature of using Microsoft Hyper-V network virtualization is the ability of Hyper-V to keep virtual networks isolated from the physical network infrastructure of the hosted system. Because administrators can set up Hyper-V software–defined virtualization policies, you are no longer limited by the IP address assignment or VLAN isolation requirements of the physical network. Hyper-V allows for built-in network isolation to keep the virtual network separated from the virtual network.

Dynamic Memory *Dynamic Memory* is a feature of Hyper-V that allows it to balance memory automatically among running virtual machines. Dynamic Memory allows Hyper-V to adjust the amount of memory available to the virtual machines in response to the needs of the virtual machines. It is currently available for Hyper-V in Windows Server 2012 R2.

Supported Guest Operating Systems

The following guest operating systems have been successfully tested on Hyper-V and are hypervisor-aware. Table 9.1 shows all of the guest server operating systems and the maximum number of virtual processors. Table 9.2 shows all of the guest client operating systems and the maximum number of virtual processors.

TABLE 9.1 Hyper-V guest server operating systems

Guest Operating System (Server)	Maximum Number of Virtual Processors
Windows Server 2012 and Server 2012 R2	64
Windows Server 2008 R2 with Service Pack 1 (SP1)	64
Windows Server 2008 R2	64
Windows Server 2008 with Service Pack 2 (SP2)	8
Windows Home Server 2011	4
Windows Small Business Server 2011	Essentials edition: 2 Standard edition: 4
Windows Server 2003 R2 with Service Pack 2 (SP2)	2
Windows Server 2003 with Service Pack 2 (SP2)	2

TABLE 9.1 Hyper-V guest server operating systems *(continued)*

Guest Operating System (Server)	Maximum Number of Virtual Processors
Red Hat Enterprise Linux 5.7 and 5.8	64
Red Hat Enterprise Linux 6.0–6.3	64
SUSE Linux Enterprise Server 11 SP2	64
Open SUSE 12.1	64
Ubuntu 12.04	64

TABLE 9.2 Hyper-V guest client operating systems

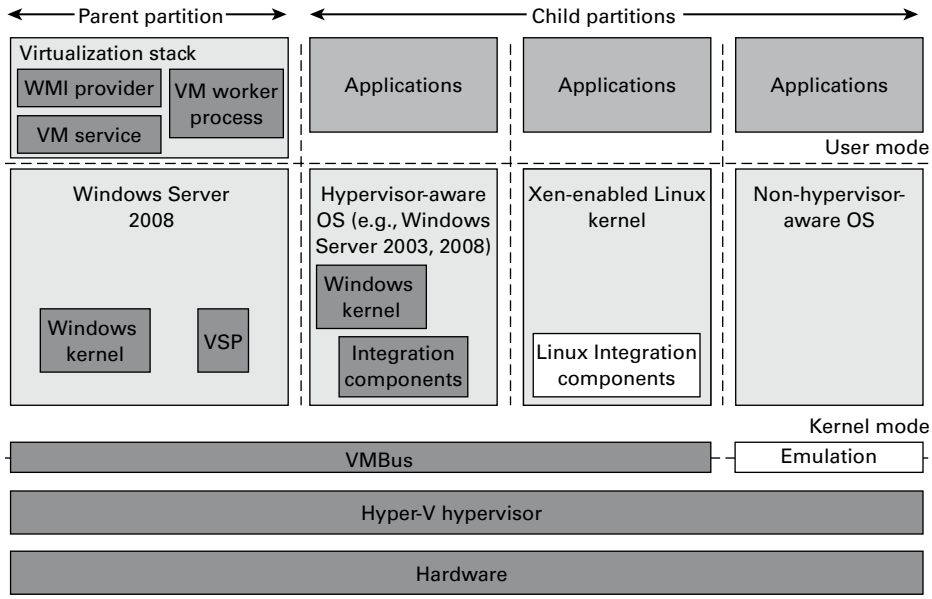
Guest Operating System (Client)	Maximum Number of Virtual Processors
Windows 8	32
Windows 7 with Service Pack 1 (SP1)	4
Windows 7	4
Windows Vista with Service Pack 2 (SP2)	2
Windows XP with Service Pack 3 (SP3)	2
Windows XP x64 Edition with Service Pack 2 (SP2)	2
CentOS 5.7 and 5.8	64
CentOS 6.0–6.3	64
Red Hat Enterprise Linux 5.7 and 5.8	64
Red Hat Enterprise Linux 6.0–6.3	64
SUSE Linux Enterprise Server 11 SP2	64
Open SUSE 12.1	64
Ubuntu 12.04	64

The list of supported guest operating systems may always be extended. Please check the official Microsoft Hyper-V site to obtain a current list of supported operating systems: `www.microsoft.com/virtualization`.

Hyper-V Architecture

This section will provide you with an overview of the Hyper-V architecture (see Figure 9.1). I'll explain the differences between a hypervisor-aware and a non-hypervisor-aware child partition.

FIGURE 9.1 Hyper-V architecture



As you can see, Hyper-V is based on the new microkernel architecture. Hyper-V provides a virtualization layer called a *hypervisor* that runs directly on the system hardware. You can see that the hypervisor is similar to what the kernel is to Windows. It is a software layer responsible for the interaction with the core hardware and works in conjunction with an optimized instance of Windows Server 2012 R2 that allows running multiple operating systems on a physical server simultaneously. The Hyper-V architecture consists of the hypervisor and parent and child partitions.

The Windows Server 2012 R2 operating system runs in the parent partition, and it delivers the WMI provider for scripting as well as the VM service.

Virtual machines each run in their own child partitions. Child partitions do not have direct access to hardware resources; instead, they have a virtual view of the resources, which are called *virtual devices*.

If you're running a hypervisor-aware operating system like Windows Server 2003, Windows Server 2008, Windows Server 2008 R2, Windows Server 2012, or Windows Server 2012 R2 in your virtual machine, any request to the virtual devices is redirected via the high-speed bus to the devices in the parent partition, which will manage the requests.

By default, only Windows Server 2008 R2, Server 2012, and Server 2012 R2 are hypervisor-aware operating systems. Once you install Hyper-V Integration Components on an operating system other than Windows Server 2008 R2 and newer, it will be hypervisor-aware. Microsoft provides a hypervisor adapter to make Linux hypervisor aware.

Non-hypervisor-aware operating systems (for example, Windows NT 4.0) use an emulator to communicate with the Windows hypervisor, which is slower than molasses in the winter.

Hyper-V Requirements

The following sections will describe the hardware and software requirements for installing the Hyper-V server role. It is important to understand these requirements for obtaining your software license as well as for planning for server hardware. When you understand the requirements, you can design and configure a Hyper-V solution that will meet the needs of your applications.

Hardware Requirements

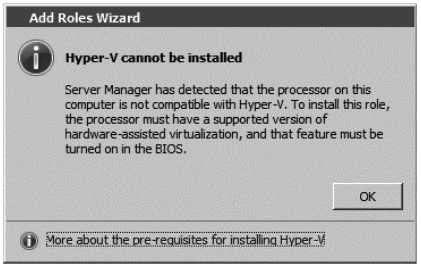
In addition to the basic hardware requirements for Windows Server 2012 R2, there are requirements for running the Hyper-V server role on your Windows server. They are listed in Table 9.3.

TABLE 9.3 Hardware requirements for Hyper-V

Requirement Area	Definition
CPU	x64-compatible processor with Intel VT or AMD-V technology enabled. Hardware Data Execution Prevention (DEP), specifically Intel XD bit (execute disable bit) or AMD NX bit (no execute bit), must be available and enabled. Minimum: 1.4GHz. Recommended: 2GHz or faster.
Memory	Minimum: 1GB RAM. Recommended: 2GB RAM or greater. (Additional RAM is required for each running guest operating system.) Maximum: 1TB.
Hard disk	Minimum: 8GB. Recommended: 20GB or greater. (Additional disk space needed for each guest operating system.)

The Add Roles Wizard in Server Manager additionally verifies the hardware requirements. A good starting point is to check your hardware against the Microsoft hardware list to make sure that Windows Server 2012 R2 supports your hardware. If you try to install the Hyper-V server role on a computer that does not meet the CPU requirements, you'll get a warning window that looks like Figure 9.2.

FIGURE 9.2 Warning window that Hyper-V cannot be installed



Software Requirements

To use virtualization in Windows Server 2012 R2, you need to consider the basic software requirements for Hyper-V. Hyper-V runs only on the following editions of the Windows Server 2012 R2 operating system:

- Windows Server 2012 R2 Standard edition
- Windows Server 2012 R2 Datacenter edition
- Microsoft Hyper-V Server 2012 R2 edition

Hyper-V Installation and Configuration

The following sections explain how to install the Hyper-V role using Server Manager in Windows Server 2012 R2 Full installation mode or the command line mode in Windows Server 2012 R2 Server Core. We will then take a look at Hyper-V as part of Server Manager before discussing how to use the Hyper-V Manager. Finally, we will look at the Hyper-V server settings and then cover two important areas for Hyper-V: virtual networks and virtual hard disks.

Install the Hyper-V Role

Now it's time to see how to install the Hyper-V server role on the two installation options of Windows Server 2012 R2, namely, a Full installation and a Server Core installation.

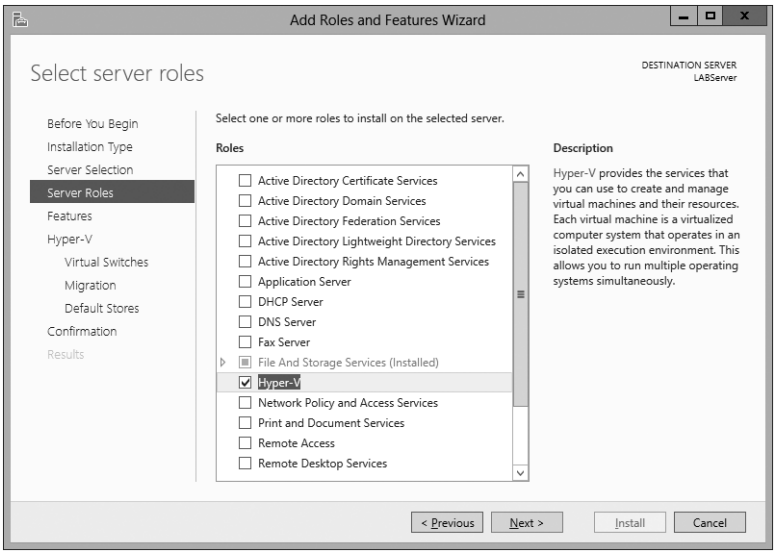
Installing Hyper-V in Full Installation Mode

You can install the Hyper-V server role on any Windows Server 2012 R2 installation for which the Full option was chosen. In addition, the server must meet both the hardware and software requirements. The installation process is simple, as Exercise 9.1 demonstrates.

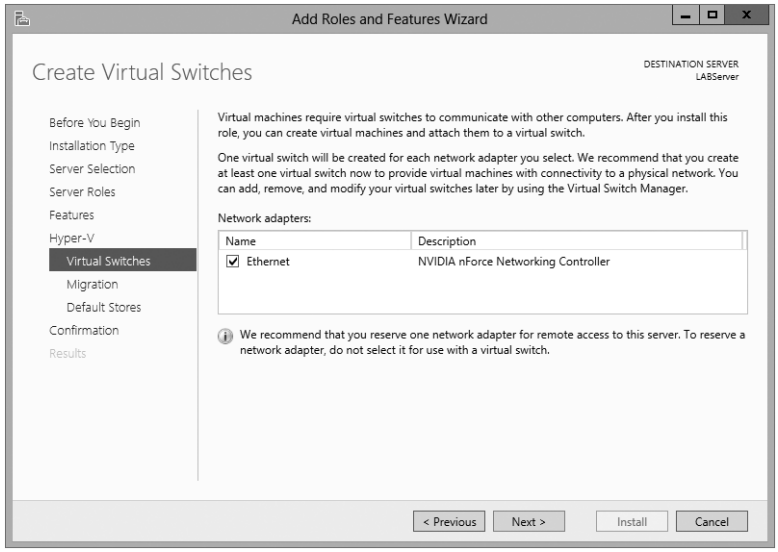
EXERCISE 9.1

Installing Hyper-V in Full Installation Mode

1. Open Server Manager.
2. In Server Manager, choose option 2, Add Roles And Features.
3. At the Select Installation Type page, choose the role-based or feature-based installation. Click Next.
4. On the Select Destination Server screen, choose Select A Server From The Server Pool and choose the server to which you want to add this role. Click Next.
5. On the Select Server Roles screen, click the check box next to Hyper-V. When the Add Features dialog box appears, click the Add Features button. Then click Next.



6. At the Select Features screen, click Next.
7. At the Hyper-V introduction screen, click Next.
8. At the Create Virtual Switches screen, choose your adapter and click Next.



9. At the Virtual Machine Migration screen, click Next. You want to use migration only if you have multiple Hyper-V servers. Since we will have only one for this exercise, just skip this screen.
10. At the Default Stores screen, accept the defaults and click Next.
11. At the Confirmation screen, click the Install button.
12. After the installation is complete, click the Close button.
13. Restart your server.

Installing Hyper-V in Server Core

The Server Core installation option is introduced in Windows Server 2012 R2. It creates an operating system installation without a GUI shell. You can either manage the server remotely from another system or use the Server Core's command-line interface.

This installation option provides the following benefits:

- Reduces attack surface (because fewer applications are running on the server)
- Reduces maintenance and management (because only the required options are installed)
- Requires less disk space and produces less processor utilization
- Provides a minimal parent partition
- Reduces system resources required by the operating system as well as the attack surface

By using Hyper-V on a Server Core installation, you can fundamentally improve availability because the attack surface is reduced and the downtime required for installing patches is optimized. It will thus be more secure and reliable with less management.

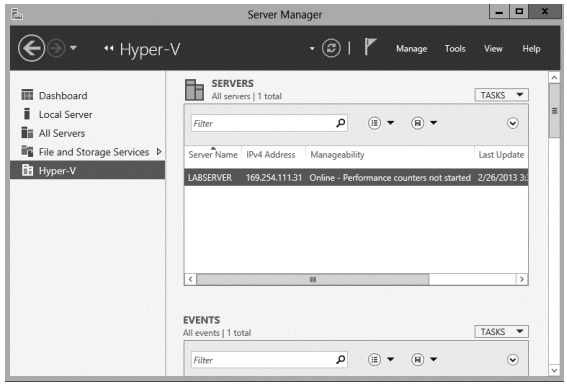
To install Hyper-V for a Windows Server 2012 R2 installation, you must execute the following command in the command-line interface:

```
Dism /online /enable-feature /featurename:Microsoft-Hyper-V
```

Hyper-V in Server Manager

As with all of the other Windows Server 2012 R2 roles, the Hyper-V role neatly integrates into Server Manager. Server Manager filters the information just for the specific role and thus displays only the required information. As you can see in Figure 9.3, the Hyper-V Summary page shows related event log entries, the state of the system services for Hyper-V, and useful resources and support.

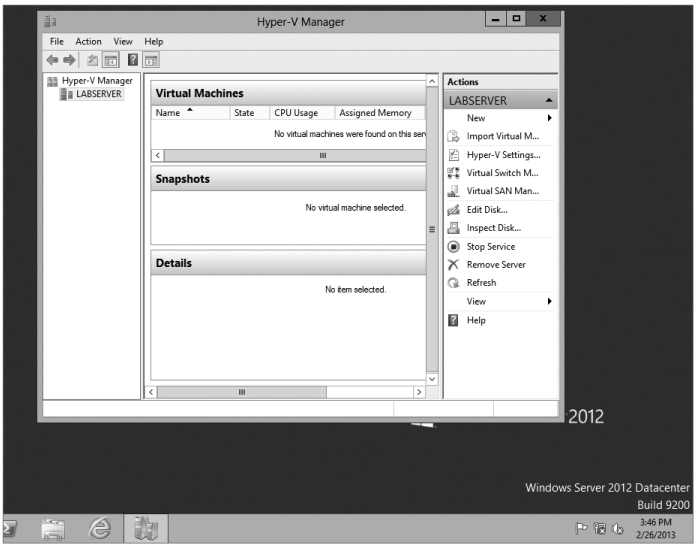
FIGURE 9.3 Hyper-V in Server Manager



Using Hyper-V Manager

Hyper-V Manager is the central management console to configure your server and create and manage your virtual machines, virtual networks, and virtual hard disks. Unlike Virtual Server 2005, where you managed all virtual machines through a web interface, Hyper-V Manager is managed through a Microsoft Management Console (MMC) snap-in. You can access it either in Server Manager or by using Administrative Tools ➢ Hyper-V Manager. Figure 9.4 shows how Hyper-V Manager looks once you start it.

FIGURE 9.4 Hyper-V Manager



Hyper-V Manager is available for the following operating systems:

- Windows Server 2012 R2
- Windows Server 2008 R2
- Windows Server 2008
- Windows 8
- Windows 7
- Windows Vista with Service Pack 1 (SP1)

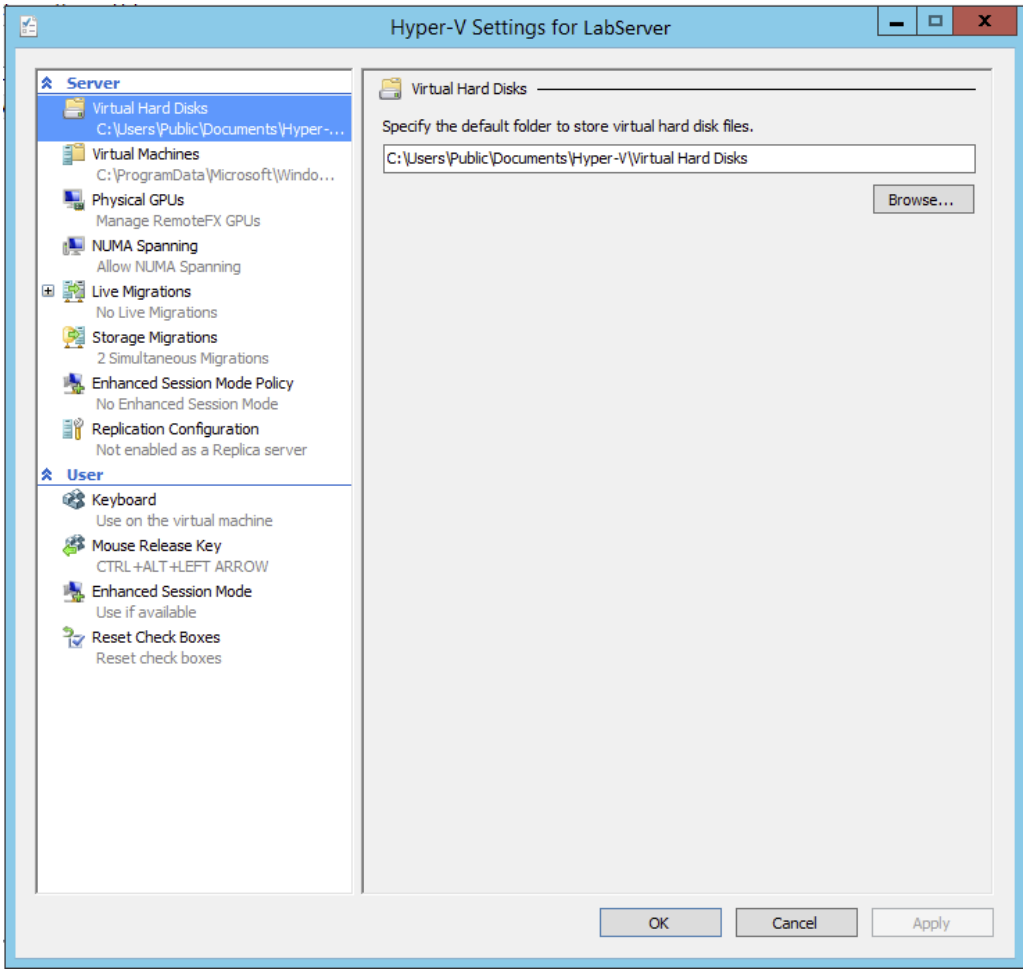
Hyper-V Manager is installed on a Windows Server 2012 R2 machine only when you install Hyper-V on it. On Windows Server 2008/2008 R2, Server 2003, Windows Vista, Windows 7, or Windows 8, you will need to install the Hyper-V Manager MMC.

You can use Hyper-V Manager to connect to any Full or Server Core installation remotely. Besides Hyper-V Manager, you can use the WMI interface for scripting Hyper-V.

Configure Hyper-V Settings

In this section, you will get an overview of the available Hyper-V settings for the server. You configure all server-side default configuration settings like default locations of your configuration files or the release key. You can open the Hyper-V Settings page (see Figure 9.5) in Hyper-V Manager by clicking Hyper-V Settings in the Actions pane.

FIGURE 9.5 Hyper-V Settings



The Hyper-V Settings page includes the following settings:

Virtual Hard Disks Specifies the default location of your virtual hard disk files (`.vhd` and `.vdhx`).

Virtual Machines Specifies the default location of your virtual machine configuration files. It includes the Virtual Machine XML configuration files (part of the `Virtual Machines` folder) as well as related snapshots (part of the `Snapshot` folder).

Physical GPUs This feature allows for graphical processing unit (GPU) accelerated video within a virtual machine. The GPU will allow you to support 3D GPU accelerated graphics.

NUMA Spanning An administrator can configure Hyper-V to allow virtual machines to span nonuniform memory architecture (NUMA) nodes. When the physical computer has NUMA nodes, this setting provides virtual machines with additional computing resources. Spanning NUMA nodes can help you run more virtual machines at the same time. However, using NUMA can decrease overall performance.

Live Migrations *Live migration* allows a Hyper-V administrator to relocate running virtual machines easily from one node of the failover cluster to another node in the same cluster. Live Migration is explained in more detail later in this chapter.

Storage Migrations *Storage Migration* allows an administrator to move their virtual machine storage from one location to another. This setting allows you to specify how many storage migrations can be performed at the same time on this system.

Replication Configuration This setting allows you to configure this computer as a Replica Server to another Hyper-V server. Hyper-V Replica allows administrators to replicate their Hyper-V virtual machines from one Hyper-V host at a primary site to another Hyper-V host at the Replica site.

Each node of the failover cluster that is involved in Replica must have the Hyper-V server role installed. One of the servers in the Hyper-V replication needs to be set up as a Replica Broker to allow the replication to work properly.

Keyboard Defines how to use Windows key combinations. Options are Physical Computer, Virtual Machine, and Virtual Machine Only When Running Full Screen.

Mouse Release Key Specifies the key combination to release the mouse in your virtual machine. Options are Ctrl+Alt+left arrow, Ctrl+Alt+right arrow, Ctrl+Alt+space, and Ctrl+Alt+Shift.

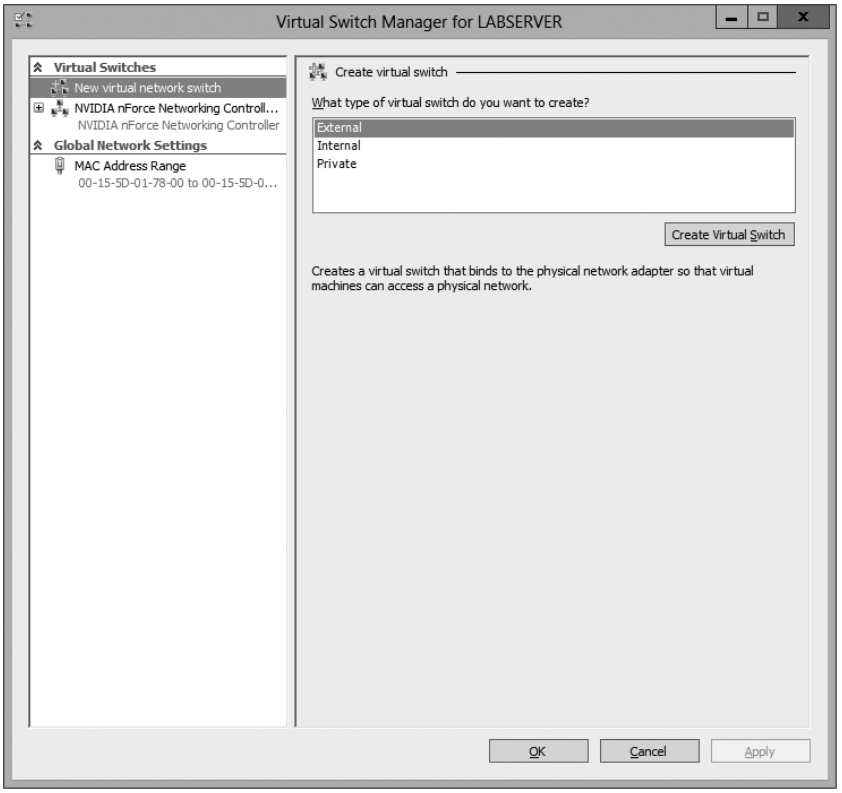
Reset Check Boxes Resets any check boxes that hide pages and messages when checked. This will bring any window up again on which you checked the Do Not Show This Window Again check box.

Manage Virtual Switches

A *virtual network* provides the virtual links between nodes in either a virtual or physical network. Virtual networking in Hyper-V is provided in a secure and dynamic way because you can granularly define virtual network switches for their required usage. For example, you can define a private or internal virtual network if you don't want to allow your virtual machines to send packages to the physical network.

To allow your virtual machines to communicate with each other, you need virtual networks. Just like normal networks, virtual networks exist only on the host computer and allow you to configure how virtual machines communicate with each other, with the host, and with the network or the Internet. You manage virtual networks in Hyper-V using Virtual Switch Manager, as shown in Figure 9.6.

FIGURE 9.6 Virtual Network Manager



Using *Virtual Switch Manager*, you can create, manage, and delete virtual switches. You can define the network type as external, internal only, or private.

External Any virtual machine connected to this virtual switch can access the physical network. You would use this option if you want to allow your virtual machines to access, for example, other servers on the network or the Internet. This option is used in production environments where your clients connect directly to the virtual machines.

Internal This option allows virtual machines to communicate with each other as well as the host system but not with the physical network. When you create an internal network, it also creates a local area connection in Network Connections that allows the host machine to communicate with the virtual machines. You can use this if you want to separate your host's network from your virtual networks.

Private When you use this option, virtual machines can communicate with each other but not with the host system or the physical network; thus, no network packets are hitting the wire. You can use this to define internal virtual networks for test environments or labs, for example.

On the external and internal-only virtual networks, you also can enable virtual LAN (VLAN) identification. You can use VLANs to partition your network into multiple subnets using a VLAN ID. When you enable virtual LAN identification, the NIC that is

connected to the switch will never see packets tagged with VLAN IDs. Instead, all packets traveling from the NIC to the switch will be tagged with the access mode VLAN ID as they leave the switch port. All packets traveling from the switch port to the NIC will have their VLAN tags removed. You can use this if you are already logically segmenting your physical machines and also use it for your virtual ones.

Exercise 9.2 explains how to create an internal-only virtual switch.

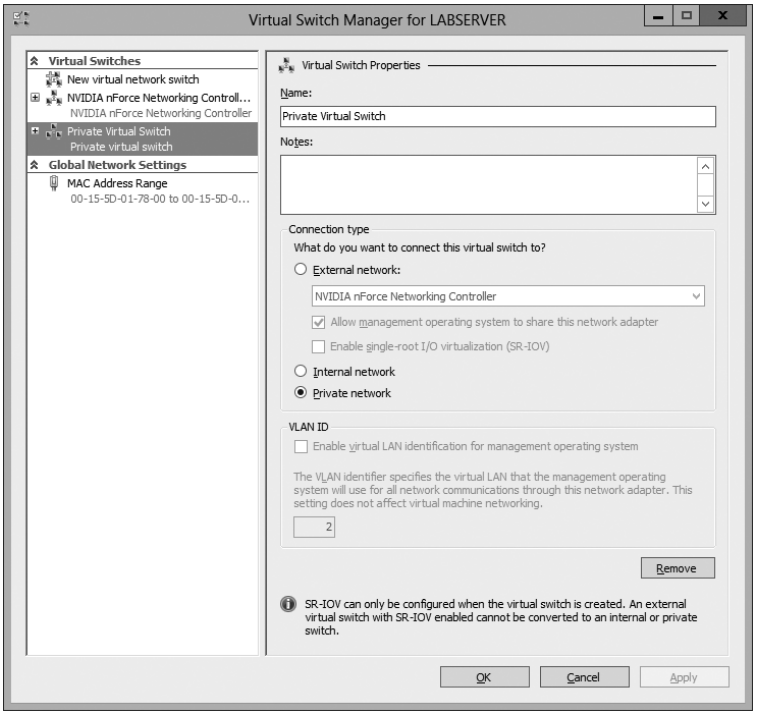
EXERCISE 9.2

Creating an Internal Virtual Network

1. Click the Windows Key ➢ Administrative Tools ➢ Hyper-V Manager.
2. In Hyper-V Manager, in the Actions pane, choose Virtual Switch Manager.
3. On the Virtual Switch page, select Private and click the Create Virtual Switch button.
4. On the New Virtual Switch page, enter **Private Virtual Network** in the Name field.
5. Click OK.

When you create the internal virtual switch, a network device is created in Network Connections, as shown in Figure 9.7.

FIGURE 9.7 Virtual network card



This is also the case when you create an external virtual network because it will replace the physical network card of the host machine to give the parent partition a virtual network card that is also used in the child partitions.

Unlike with Virtual Server 2005, Hyper-V binds the virtual network service to a physical network adapter only when an external virtual network is created. The benefit of this is that the performance is better if you do not use the external virtual network option. The downside, however, is that there will be a network disruption when you create or delete an external virtual network.

Communication between the virtual machine and the local host computer is not configured automatically. Once you install a virtual machine, you need to make sure that the TCP/IP settings are in agreement with the settings you define in the virtual network card. Start with a ping from your host machine to the virtual machines to verify that communication is working.

Managing Virtual Hard Disks

In addition to virtual networks, you need to manage virtual hard disks that you attach to your virtual machines. A virtual hard disk in Hyper-V, apart from a pass-through disk, is a VHD or VHDX file that basically simulates a hard drive on your virtual machine.

The following sections will first show you what types of virtual hard disks are available and then show you how to create them. You will also learn about what options are available to manage virtual hard disks.

Types of Hard Disks

Depending on how you want to use the disk, Hyper-V offers various types, as described in Table 9.4.

TABLE 9.4 Virtual hard disks in Hyper-V

Type of disk	Description	When to use it
Dynamically expanding	This disk starts with a small VHD file and expands it on demand once an installation takes place. It can grow to the maximum size you defined during creation. You can use this type of disk to clone a local hard drive during creation.	This option is effective when you don't know the exact space needed on the disk and when you want to preserve hard disk space on the host machine. Unfortunately, it is the slowest disk type.

Fixed size	The size of the VHD file is fixed to the size specified when the disk is created. This option is faster than a dynamically expanding disk. However, a fixed-size disk uses up the maximum defined space immediately. This type is ideal for cloning a local hard drive.	A fixed-size disk provides faster access than dynamically expanding or differencing disks, but it is slower than a physical disk.
Differencing	This type of disk is associated in a parent-child relationship with another disk. The differencing disk is the child, and the associated virtual disk is the parent. Differencing disks include only the differences to the parent disk. By using this type, you can save a lot of disk space in similar virtual machines. This option is suitable if you have multiple virtual machines with similar operating systems.	Differencing disks are most commonly found in test environments and should not be used in production environments.
Physical (or pass-through disk)	The virtual machine receives direct pass-through access to the physical disk for exclusive use. This type provides the highest performance of all disk types and thus should be used for production servers where performance is the top priority. The drive is not available for other guest systems.	This type is used in high-end datacenters to provide optimum performance for VMs. It's also used in failover cluster environments.

Creating Virtual Hard Disks

To help you gain practice in creating virtual hard disks, the following three exercises will teach you how to create a differencing hard disk, how to clone an existing disk by creating a new disk, and how to configure a physical or pass-through disk to your virtual machine. First, in Exercise 9.3, you will learn how to create a differencing virtual hard disk.

EXERCISE 9.3

Creating a Differencing Hard Disk

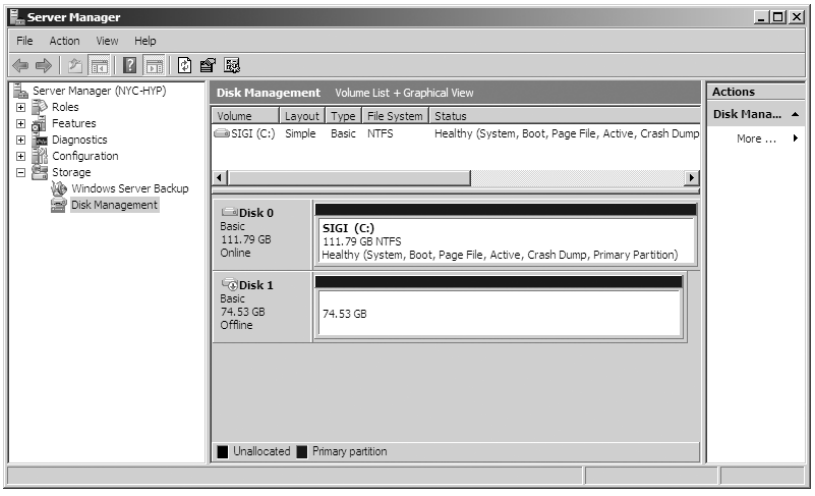
1. Open Hyper-V Manager.
2. In Hyper-V Manager, on the Actions pane, choose New ➢ Hard Disk.
3. In the New Virtual Hard Disk Wizard, click Next on the Before You Begin page.

EXERCISE 9.3 *(continued)*

4. At the Choose Disk Format screen, choose VHDX and click Next. The size of your VHDs depends on which format you choose. If you're going to have a VHD larger than 2,040GB, use VHDX. If your VHD is less than 2,040GB, then you should use VHD.
5. On the Choose Disk Type page, select Fixed Size and click Next.
6. On the Specify Name And Location page, enter the new name of the child disk (for example, **newvirtualharddisk.vhd**). You can also modify the default location of the new VHD file if you want. Click Next to continue.
7. Next, on the Configure Disk page, you need to specify the size of the VHD file. Choose a size based on your hard disk and then click Next to continue. I used 60GB as our test size.
8. On the Completing The New Virtual Hard Disk Wizard page, verify that all settings are correct and click Finish to create the hard disk.

The process to add a physical or pass-through disk to a virtual machine is quite different. For this, first you need to create the virtual machine, and then you open the virtual machine settings to configure the physical disk. If you want to add a physical disk to a virtual machine, the physical disk must be set as Offline in Disk Management, as shown in Figure 9.8.

FIGURE 9.8 In Disk Management, you can set disks as Offline.



To access Disk Management, click the Windows key, choose Administrative Tools ➢ Computer Management, expand Storage in the left pane, and click Disk Management.

You cannot share a physical disk among multiple virtual machines or with the host system.

Physical or pass-through disks might not be that important if your use of virtualization is based on test environments, but they become crucial when you need to plan for highly available virtual datacenters. This is especially true if you consider using failover clusters to provide the Quick Migration feature, which is when you should consider matching one logical unit number (LUN) from your enterprise storage system or storage area network (SAN) as one physical disk. This provides you with the optimum performance you need in such an environment.

Managing Virtual Hard Disks

Hyper-V also provides two tools to manage virtual hard disks: Inspect Disk and Edit Disk. These tools are available on the Actions pane in Hyper-V Manager.

Inspect Disk This provides you with information about the virtual hard disk. It shows you not only the type of the disk but also information such as the maximum size for dynamically expanding disks and the parent VHD for differencing disks.

Edit Disk This provides you with the Edit Virtual Hard Disk Wizard, which you can use to compact, convert, expand, merge, or reconnect hard disks. Figure 9.9 shows you the wizard's options when you select a dynamically expanding disk.

FIGURE 9.9 The Edit Virtual Hard Disk Wizard

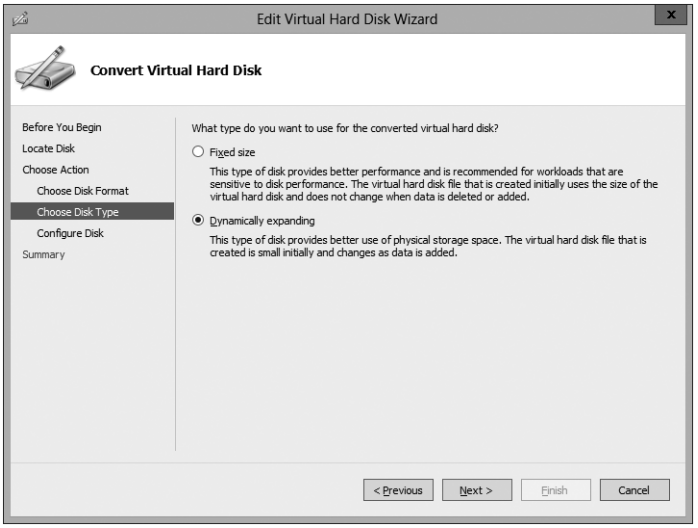


Table 9.5 provides you with an overview of what you can do with the wizard.

TABLE 9.5 Edit Disk overview

Action	Description
Compact	Reduces the size of a dynamically expanding or differencing disk by removing blank space from deleted files.
Convert	Converts a dynamically expanding disk to a fixed disk or vice versa.
Expand	Increases the storage capacity of a dynamically expanding disk or a fixed virtual hard disk.
Merge	Merges the changes from a differencing disk into either the parent disk or another disk (applies to differencing disks only!).
Reconnect	If a differencing disk no longer finds its referring parent disk, this option can reconnect the parent to the disk.

Generation 1 vs. Generation 2 VHDs

Previous versions of Hyper-V had some pretty major drawbacks. One big drawback was that Hyper-V could not boot a virtual machine from a virtual hard drive that was SCSI. Believe it or not, SCSI controllers were not even recognized by Hyper-V unless you installed the Integration Services component.

Another issue that the previous versions of Hyper-V had was the inability to copy files from the Hyper-V host to the virtual machines without the use of a network connection in the virtual machine. The older versions of Hyper-V, prior to Windows Server 2012 R2, are now considered generation 1 versions. Why is it so important to know which generations of Hyper-V you should use or need to use?

Hyper-V generations help determine what functionality and what virtual hardware you can use in your virtual machine. Windows Server 2012 R2 Hyper-V now supports two different virtual machine generations: generation 1 and generation 2.

As already explained, previous versions of Hyper-V are considered generation 1, and this provides the same virtual hardware to the virtual machine as in previous versions of Hyper-V.

Generation 2 is now included with Windows Server 2012 R2, and it provides new functionality on the virtual machines including secure boot (which is enabled by default), the ability to boot from a SCSI virtual hard disk or boot from a SCSI virtual DVD, the ability to use a standard network adapter to PXE boot, and Unified Extensible Firmware

Interface (UEFI) firmware support. Generation 2 now gives you the ability to support UEFI firmware instead of BIOS-based firmware.

So when you create VHDs in Windows Server 2012 R2, one of your choices will be the ability to create the VHDs as a generation 1 or generation 2 VHD. If you need the ability to have your VHDs run on older versions of Hyper-V, make them a generation 1 VHD. If they are going to run only on Windows Server 2012 R2, make your VHDs generation 2 and take advantage of all the new features and functionality.

Configuring Virtual Machines

The following sections cover the topics of creating and managing virtual machines as well as how to back up and restore virtual machines using features such as Import and Export and Snapshot. You'll also briefly look at Hyper-V's Live Migration feature.

Creating and Managing Virtual Machines

It is important to learn how to create a virtual machine, how to change its configuration, and how to delete it. You will take a look at the Virtual Machine Connection tool and install the Hyper-V Integration Components onto a virtual machine.

Virtual Machines

Virtual machines define the child partitions in which you run operating system instances. Each virtual machine is separate and can communicate with the others only by using a virtual network. You can assign hard drives, virtual networks, DVD drives, and other system components to it. A virtual machine is similar to an existing physical server, but it no longer runs on dedicated hardware—it shares the hardware of the host system with the other virtual machines that run on the host.

Exercise 9.4 shows you how to create a new virtual machine.

EXERCISE 9.4

Creating a New Virtual Machine

1. Open Hyper-V Manager.
2. In Hyper-V Manager, on the Actions pane, choose New ➢ Virtual Machine.
3. In the New Virtual Machine Wizard, click Next on the Before You Begin page.
4. On the Specify Name And Location page, give your virtual machine a name and change the default location of the virtual machine configuration files. Click Next to continue.

EXERCISE 9.4 *(continued)*

5. On the Assign Memory page, define how much of your host computer's memory you want to assign to this virtual machine. Remember that once your virtual machine uses up all of your physical memory, it will start swapping to disk, thus reducing the performance of all virtual machines. Click Next to continue.
6. On the Configure Networking page, select the virtual network that you previously configured using Virtual Network Manager. Click Next to continue.
7. On the next page, you configure your virtual hard disk. You can create a new virtual hard disk, select an existing disk, or choose to attach the hard disk later. Be aware that you can create only a dynamically expanding virtual disk on this page; you cannot create a differencing, physical, or fixed virtual hard disk there. However, if you created the virtual hard disk already, you can, of course, select it. Click Next to continue.
8. On the Installation Options page, you can select how you want to install your operating system. You have the option to install an operating system later, install the operating system from a boot CD/DVD-ROM where you can select a physical device or an image file (ISO file), install an operating system from a floppy disk image (VFD file, or a virtual boot floppy disk), or install an operating system from a network-based installation server. The last option will install a legacy network adapter to your virtual machine so that you can boot from the network adapter. Select Install An Operating System Later and then click Next.
9. On the Completing The New Virtual Machine Wizard summary page, verify that all settings are correct. You also have the option to start the virtual machine immediately after creation. Click Next to create the virtual machine.
10. Repeat this process and create a few more virtual machines.
11. If you want to install an operating system on one of the VMs, start the VM, load a Windows Server 2012 R2 installation disk into the DVD drive, and then, under the Media menu, choose DVD and Capture. Then just do a normal install.

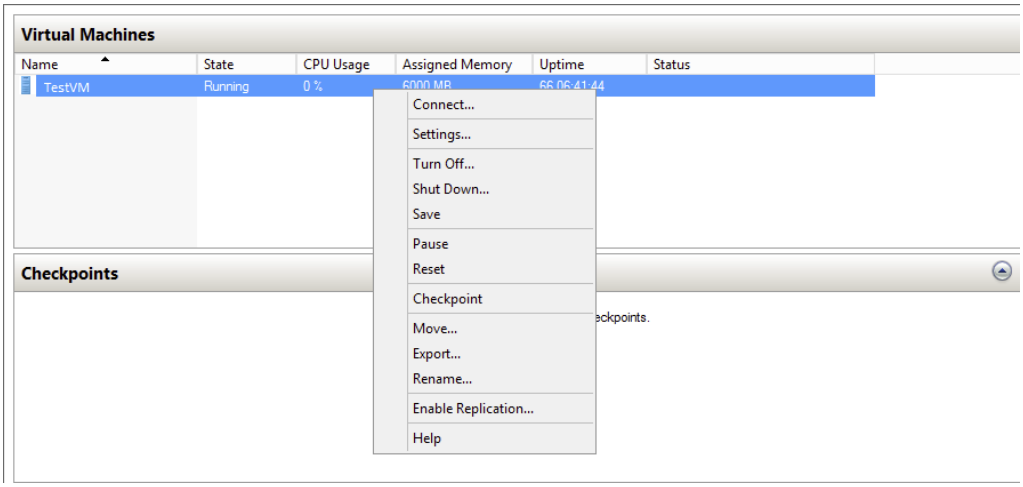
After completing Exercise 9.4, you will have a virtual machine available in Hyper-V Manager. Initially, the state of the virtual machine will be Off. Virtual machines can have the following states: Off, Starting, Running, Paused, and Saved. You can change the state of a virtual machine in the Virtual Machines pane by right-clicking the virtual machine's name, as shown in Figure 9.10, or by using the Virtual Machine Connection window.

Here is a list of some of the state options (when the VM is running) available for a virtual machine:

Start Turn on the virtual machine. This is similar to pressing the power button when the machine is turned off. This option is available when your virtual machine is Off or in Saved state.

Turn Off Turn off the virtual machine. This is similar to pressing the power-off button on the computer. This option is available when your virtual machine is in Running, Saved, or Paused state.

FIGURE 9.10 Options available when right-clicking a virtual machine



Shut Down This option shuts down your operating system. You need to have the Hyper-V Integration Components installed on the operating system; otherwise, Hyper-V will not be able to shut down the system.

Save The virtual machine is saved to disk in its current state. This option is available when your virtual machine is in Running or Paused state.

Pause Pause the current virtual machine, but do not save the state to disk. You can use this option to release processor utilization quickly from this virtual machine to the host system.

Reset Reset the virtual machine. This is like pressing the reset button on your computer. You will lose the current state and any unsaved data in the virtual machine. This option is available when your virtual machine is in Running or Paused state.

Resume When your virtual machine is paused, you can resume it and bring it online again.

Changing Configuration on an Existing Virtual Machine

To change the configuration settings on an existing virtual machine, you right-click your virtual machine's name in the Virtual Machines pane in Hyper-V Manager and choose Settings. You can change settings such as memory allocation and hard drive configuration. All items that you can configure are described in the following list:

Add Hardware Add devices to your virtual machine, namely, a SCSI controller, a network adapter, or a legacy network adapter. A legacy network adapter is required if you want to perform a network-based installation of an operating system.

BIOS This is the replacement of the virtual machine's BIOS. Because you can no longer enter the BIOS during startup, you need to configure it with this setting. You can turn Num Lock on or off and change the basic startup order of the devices.

Memory Change the amount of random access memory (RAM) allocated to the virtual machine.

Processor Change the number of logical processors this virtual machine can use and define resource control to balance resources among virtual machines by using a relative weight.

IDE Controller Add/change and remove devices from the IDE controller. You can have hard drives or DVD drives as devices. Every IDE controller can have up to two devices attached, and by default, you have two IDE controllers available.

Hard Drive Select a controller to attach to this device as well as to specify the media to use with your virtual hard disk. The available options are Virtual Hard Disk File (with additional buttons labeled New, Edit, Inspect, and Browse that are explained in the virtual hard disk section) and Physical Hard Disk. You can also remove the device here.

DVD Drive Select a controller to attach to this device and specify the media to use with your virtual CD/DVD drive. The available options are None, Image File (ISO Image), and Physical CD/DVD Drive Connected To The Host Computer. You also can remove the device here.

SCSI Controller Configure all hard drives that are connected to the SCSI controller. You can add up to 63 hard drives to each SCSI controller, and you can have multiple SCSI controllers available.

Network Adapter Specify the configuration of the network adapter or remove it. You can also configure the virtual network and MAC address for each adapter and enable virtual LAN identification.

COM1 and COM2 Configure the virtual COM port to communicate with the physical computer through a named pipe. You have COM1 and COM2 available.

Diskette Specify a virtual floppy disk file to use.

Name Edit the name of the virtual machine and provide some notes about it.

Integration Services Define what integration services are available to your virtual machine. Options are Operating System Shutdown, Time Synchronization, Data Exchange, Heartbeat, and Backup (Volume Snapshot).

Snapshot File Location Define the default file location of your snapshot files.

Smart Paging File Location This area allows you to set up a paging file for your virtual machine.

Windows Server 2012 R2 has a Hyper-V feature called *Smart Paging*. If you have a virtual machine that has a smaller amount of memory than what it needs for startup memory, when the virtual machine gets restarted, Hyper-V then needs additional memory to restart

the virtual machine. Smart Paging is used to bridge the memory gap between minimum memory and startup memory. This allows your virtual machines to restart properly.

Automatic Start Define what this virtual machine will do when the physical computer starts. Options are Nothing, Automatically Start If The Service Was Running, and Always Start This Virtual Machine. You also can define a start delay here.

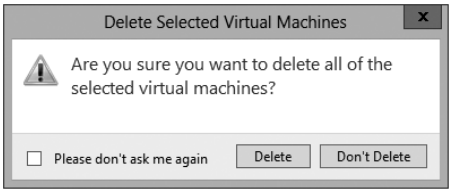
Automatic Stop Define what this virtual machine will do when the physical computer shuts down. Options are Save State, Turn Off, and Shut Down.

Please be aware that only some settings can be changed when the virtual machine's state is Running. It is best practice to shut down the virtual machine before you modify any setting.

Deleting Virtual Machines

You can also delete virtual machines using Hyper-V Manager. This deletes all of the configuration files, as shown in Figure 9.11.

FIGURE 9.11 Delete Virtual Machine warning window



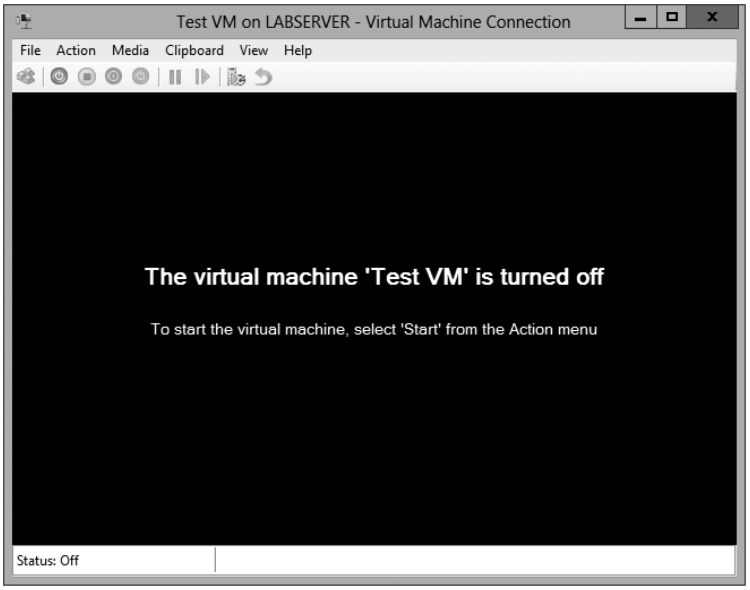
Make sure you manually delete any virtual disks that were part of the virtual machines to free up disk space. Virtual disks are *not* deleted when you delete a virtual machine.

Virtual Machine Connection

Similar to the Virtual Machine Remote Control (VMRC) client that was available with Virtual Server 2005 R2 and previous versions, Hyper-V comes with Virtual Machine Connection to connect to virtual machines that run on a local or remote server.

You can use it to log onto the virtual machine and use your computer's mouse and keyboard to interact with the virtual machine. You can open Virtual Machine Connection in Hyper-V Manager by double-clicking a virtual machine or by right-clicking a virtual machine and selecting Connect. If your virtual machine is turned off, you might see a window similar to the one in Figure 9.12.

FIGURE 9.12 Virtual Machine Connection window when the machine is turned off



Virtual Machine Connection not only provides you with functionality similar to that of Hyper-V Manager, such as being able to change the state of a virtual machine, but it also provides you with additional features that are especially useful when you want to work with a virtual machine.

File Access Settings or Exit Virtual Machine Connection Change the state of a virtual machine and create or revert a snapshot. Additionally, you have the options to send Ctrl+Alt+Delete to your virtual machine and Insert Integration Services Setup Disk.

Context-Sensitive Buttons Provide Quick Access to Key Features These buttons are available under the menu bar to provide you with fast access to the most important features, as you can see in Figure 9.13. It shows the connection of a running VM, but the VM has not had an operating system installed yet, so the figure shows the Windows Setup screen.

NIC Teaming

NIC Teaming, also known as load balancing and failover (LBFO), gives an administrator the ability to allow multiple network adapters on a system to be placed into a team. Independent hardware vendors (IHVs) have required NIC Teaming, but until Windows Server 2012, NIC Teaming was *not* part of the Windows Server operating system.

To be able to use NIC Teaming, the computer system must have at least one Ethernet adapter. If you want to provide fault protection, an administrator must have a minimum of two Ethernet adapters. One advantage of Windows Server 2012 R2 is that an administrator can set up 32 network adapters in a NIC team.

FIGURE 9.13 Virtual Machine Connection window showing a running Windows Server 2012 virtual machine

NIC Teaming is a common practice when setting up virtualization. This is one way that you can have load balancing with Hyper-V.

NIC Teaming gives an administrator the ability to allow a virtual machine to use virtual network adapters in Hyper-V. The advantage of using NIC Teaming in Hyper-V is that the administrator can use NIC Teaming to connect to more than one Hyper-V switch. This allows Hyper-V still to have connectivity even if the network adapter under the Hyper-V switch gets disconnected.

An administrator can configure NIC Teaming in either Server Manager or PowerShell.

Storage Quality of Service

Windows Server 2012 R2 Hyper-V includes a new feature called *Storage Quality of Service (QoS)*. Storage QoS allows a Hyper-V administrator to manage how virtual machines access storage throughput for virtual hard disks.

Storage QoS gives an administrator the ability to guarantee that the storage throughput of a single VHD cannot adversely affect the performance of another VHD on the same host. It does this by giving administrators the ability to specify the maximum and minimum I/O loads based on I/O operations per second (IOPS) for each virtual disk in your virtual machines.

To configure Storage QoS, you would set the maximum IOPS values (or limits) and set the minimum values (or reserves) on virtual hard disks for virtual machines.

If you are using shared virtual hard disks, Storage QoS will not be available.

Installing Hyper-V Integration Components

Hyper-V *Integration Components*, also called *Integration Services*, are required to make your guest operating system hypervisor-aware. Similar to the VM Additions that were part of Microsoft Virtual Server 2005, these components improve the performance of the guest operating system once they are installed. From an architectural perspective, virtual devices are redirected directly via the VMBus; thus, quicker access to resources and devices is provided.

If you do not install the Hyper-V Integration Components, the guest operating system uses emulation to communicate with the host's devices, which of course makes the guest operating system slower.

Exercise 9.5 shows you how to install Hyper-V Integration Components on one of your virtual machines running Windows Server 2012.

EXERCISE 9.5

Installing Hyper-V Integration Components

1. Open Hyper-V Manager.
2. In Hyper-V Manager, in the Virtual Machines pane, right-click the virtual machine on which you want to install Hyper-V Integration Components and click Start.
3. Right-click the virtual machine again and click Connect. Meanwhile, your virtual machine should already be booting.
4. If you need to log into the operating system of your virtual machine, you should do so.
5. Once the Windows Desktop appears, you need to select Insert Integration Services Setup Disk from the Actions menu of your Virtual Machine Connection window.
6. Once the Hyper-V Integration Components are installed, you are asked to perform a reboot.

After the reboot, Hyper-V Integration Components are installed on your operating system, and you will be able to use them.

Summary

Virtualization is quickly becoming a hot topic in information technology. The potential for consolidation is tremendous, and thus it will become more and more important.

After reading this chapter, you should have a good understanding of the Hyper-V architecture and what is required to install Hyper-V.

The section about installation and configuration covered various basic aspects of configuring the virtualization environment. You learned about the different types of virtual networks that are available, the options for installing the Hyper-V role, and the various types of virtual hard disks that you can use to optimize virtualization for your specific scenario.

You also learned how to configure virtual machines using the Hyper-V environment and how to create your own virtual datacenter on top of your Hyper-V machines. I showed you how to create and manage virtual machines, how to use Virtual Machine Connection to control a virtual machine remotely, and how to install Hyper-V Integration Components. You also learned how to export and import virtual machines as well as how to do snapshots of your virtual machine.

If you have never worked with virtualization software before, the information in this chapter may have been completely new to you. You should now be well prepared to try Hyper-V in your own environment.

Exam Essentials

Understand Hyper-V's architecture. When you have a good understanding of Hyper-V's architecture, especially when an operating system in a virtual machine is hypervisor aware versus non-hypervisor aware, you have a solid understanding of what is important from an architectural perspective.
You should know about the Hyper-V Integration Components and how they change the behavior of a virtual machine. Also know for which operating systems the integration components are available.

Know Hyper-V's requirements and how to install it. Know the hardware and software requirements as well as how to install Hyper-V. Hyper-V requires an x64-based processor and Data Execution Protection (DEP). Hardware-assisted virtualization must be enabled—don't forget this! Also remember that you can install Hyper-V two ways: using Server Manager or using the command line in Server Core.

Understand virtual networks and virtual hard disks. Virtual networks and hard disks are the two most tested topics. You definitely should know the types of virtual networks available (that is, external, internal only, and private virtual network) as well as all types of virtual hard disks (namely, dynamically expanding, fixed size, differential, and physical or

pass-through). You should be able to apply the correct one when needed. Don't forget the Edit Virtual Hard Disk Wizard, which is also a good source for questions in the exam.

Know how to create and manage virtual machines. You should be able to explain how to create a virtual machine, what options are available to install an operating system in a virtual machine, and how to install the Hyper-V Integration Components on a virtual machine. Don't forget about the virtual machine states and the virtual machine settings!

Understand how to back up and restore virtual machines. Have a good understanding of the concept of exporting and importing virtual machines, how snapshots work, and what lies behind a quick migration. Understand how you can export a virtual machine, what you should consider when moving it to a new host machine, and what happens after importing it to the import folder. The same applies to snapshots: You need to know what options you have available and what each option will do. Especially recognize the difference between applying and reverting a snapshot.

Review Questions

1. On which of the following x64 editions of Windows Server 2012 R2 does Hyper-V run? (Choose all that apply.)
   - **A.** Windows Server 2012 R2 Web Edition
   - **B.** Windows Server 2012 R2 Standard Edition
   - **C.** Windows Server 2012 R2 Itanium Edition
   - **D.** Windows Server 2012 R2 Datacenter Edition

2. You want to build a test environment based on virtual machines on a single Windows Server 2012 R2 machine, but you also want to make sure that the virtual machines communicate only with each other. What type of virtual network do you need to configure?
   - **A.** External
   - **B.** Internal only
   - **C.** Private virtual machine network
   - **D.** Public virtual machine network

3. Andy wants to change the memory of a virtual machine that is currently powered up. What does he need to do?
   - **A.** Shut down the virtual machine, use the virtual machine's settings to change the memory, and start it again.
   - **B.** Use the virtual machine's settings to change the memory.
   - **C.** Pause the virtual machine, use the virtual machine's settings to change the memory, and resume it.
   - **D.** Save the virtual machine, use the virtual machine's settings to change the memory, and resume it.

4. You want to make sure that the hard disk space for your virtual machines is occupied only when needed. What type of virtual hard disk would you recommend?
   - **A.** Dynamically expanding disk
   - **B.** Fixed-size disk
   - **C.** Differencing disk
   - **D.** Physical or pass-through disk

5. How do you add a physical disk to a virtual machine?
   - **A.** Use the Virtual Hard Disk Wizard.
   - **B.** Use the Edit Virtual Hard Disk Wizard.
   - **C.** Use the virtual machine's settings.
   - **D.** Use the New Virtual Machine Wizard.

6. Rich bought a new server with an Itanium IA-64 processor, 4GB RAM, and a SAN that provides 1TB hard disk space. After installing Windows Server 2012 R2 for Itanium-based systems, he wants to install Hyper-V on this server. Can Hyper-V be installed on this system?
   - **A.** Yes
   - **B.** No

7. What are the minimum CPU requirements for running Hyper-V on a machine? (Choose all that apply.)
   - **A.** An x64-based processor (Intel or AMD).
   - **B.** Hardware Data Execution Protection (DEP) must be enabled.
   - **C.** Hardware-assisted virtualization must be enabled.
   - **D.** The processor must at least have a dual core.

8. What is the command to install Hyper-V on a Windows Server 2008 machine that was installed in Server Core?
   - **A.** `start /w ocsetup Hyper-V`
   - **B.** `start /w ocsetup microsoft-hyper-v`
   - **C.** `start /w ocsetup Microsoft-Hyper-V`
   - **D.** `start /w ocsetup hyper-v`

9. On what operating systems can you install the Hyper-V Manager MMC? (Choose all that apply.)
   - **A.** Windows Server 2008 R2
   - **B.** Windows Server 2003
   - **C.** Windows XP SP3
   - **D.** Windows 7, Windows 8

10. What statement is correct for an external virtual network?
    - **A.** The virtual machines can communicate with each other and with the host machine.
    - **B.** The virtual machines can communicate with each other only.
    - **C.** The virtual machines can communicate with each other, with the host machine, and with an external network.
    - **D.** The virtual machines cannot communicate with each other.