Module 5

Installing and configuring Hyper-V and virtual machines

Module Overview

- Overview of Hyper-V
- Installing Hyper-V
- Configuring storage on Hyper-V host servers
- Configuring networking on Hyper-V host servers
- Configuring Hyper-V virtual machines
- Managing virtual machines

Lesson 1: Overview of Hyper-V

- What is Hyper-V?
- New Hyper-V host features in Windows Server 2016
- New Hyper-V virtual machine features in Windows Server 2016
- Windows Server Containers and Docker in Hyper-V

What is Hyper-V?

- Hyper-V is the hardware virtualization role in Windows Server 2016
- The hypervisor controls access to hardware
- Hardware drivers are installed in the host operating system
- Many guest operating systems are supported:
  - Windows Server 2008 SP2 or newer
  - Windows Vista SP2 or newer
  - Linux
  - FreeBSD

New Hyper-V host features in Windows Server 2016

New features for Hyper-V hosts include:

- Host resource protection
  - **Set-VMProcessor -EnableHostResourceProtection $True**
  - When the mechanism detects a virtual machine with excessive activity, the virtual machine is given fewer CPU resources and slows down.
- Hyper-V Manager improvements
  - Improves manageability of Hyper-V hosts by allowing for alternate credentials when connecting to a Hyper-V host.
- Nested virtualization
  - The Hyper-V server role **in a virtual machine** running Windows 2016 which can be useful for test and education environments.
- Rolling Hyper-V cluster upgrades
  - Allows you to upgrade a Windows Server 2012 R2 Hyper-V cluster to Windows Server 2016 by adding nodes to an existing cluster.
  - Virtual machines can be moved between nodes running Windows Server 2012 R2 and Windows Server 2016 during coexistence.

New Hyper-V host features in Windows Server 2016

New features for Hyper-V hosts include:

- Shielded virtual machines
  - There might be application administrators that have access **only** to some virtual machines, but the administrators for the Hyper-V hosts have access to the entire system.
  - A shielded virtual machine is BitLocker-encrypted to protect the data in case the virtual hard drive is accessed directly.
  - The keys for decrypting the virtual hard drive are controlled by a Host Guardian Service.
  - A shielded virtual machine must be a Generation 2 virtual machine that includes a virtual TPM.

New Hyper-V host features in Windows Server 2016

New features for Hyper-V hosts include:

- Start order priority
  - Improves Hyper-V host and virtual machine performance after restarts by identifying a specific startup order for virtual machines.
  - This reduces resource contention and allows you to start the most important virtual machines first.
- Storage QoS
  - Improves storage performance by allowing you to assign storage QoS policies on a Scale-Out File Server.
  - Virtual hard disks stored on the Scale-Out File Server can be limited, or can be guaranteed an amount of storage throughput.
- PowerShell Direct
  - You do not need to configure any network connectivity to the virtual machine from the host.
  - Enter-PSSession **-VMName** vm1

New Hyper-V virtual machine features in Windows Server 2016

New features for virtual machines include:

- Discrete device assignment
  - Allows virtual machines to directly access PCIe devices in the Hyper-V host. For some devices like a solid-state drive(SSD), this can provide increased performance.
- **Hot add** or remove for network adapters and memory
  - Network adapters and virtual memory can be added to a running virtual machine.
- Key storage drive
  - Allows Generation 1 virtual machines to store BitLocker Drive Encryption keys.
  - This is an alternative to the virtual TPM available in Generation 2 virtual machines.

New Hyper-V virtual machine features in Windows Server 2016

New features for virtual machines include:

- Integration services delivered through Windows Update
  - Integration services are a collection of services and drivers installed in guest operating systems to make them Hyper-V aware.
  - When integration services are installed, the guest operating system has device drivers that are specific to Hyper-V.
  - This allows the guest operating system to use the virtual hardware provided by Hyper-V.
  - Without integration services, the guest operating system can use only emulated hardware, which has limited performance.
  - To be able to use dynamic memory, virtual machines must support Hyper-V integration services through the deployment or inclusion of integration services components.

New Hyper-V virtual machine features in Windows Server 2016

New features for virtual machines include:

- Linux Secure Boot
  - Secure Boot verifies digital signatures on files during the boot process to prevent malware.
  - This feature was already available for Windows-based virtual machines
- Memory and processor capacity improvements
  - A single virtual machine now supports up to 12 TB of memory and 240 virtual processors.
- Virtual machine configuration file format
  - Increases efficiency of read and write operations to the virtual machine configuration file with a binary format instead of the previous XML format.
  - This also prevents administrators from making manual changes to the configuration file.

New Hyper-V virtual machine features in Windows Server 2016

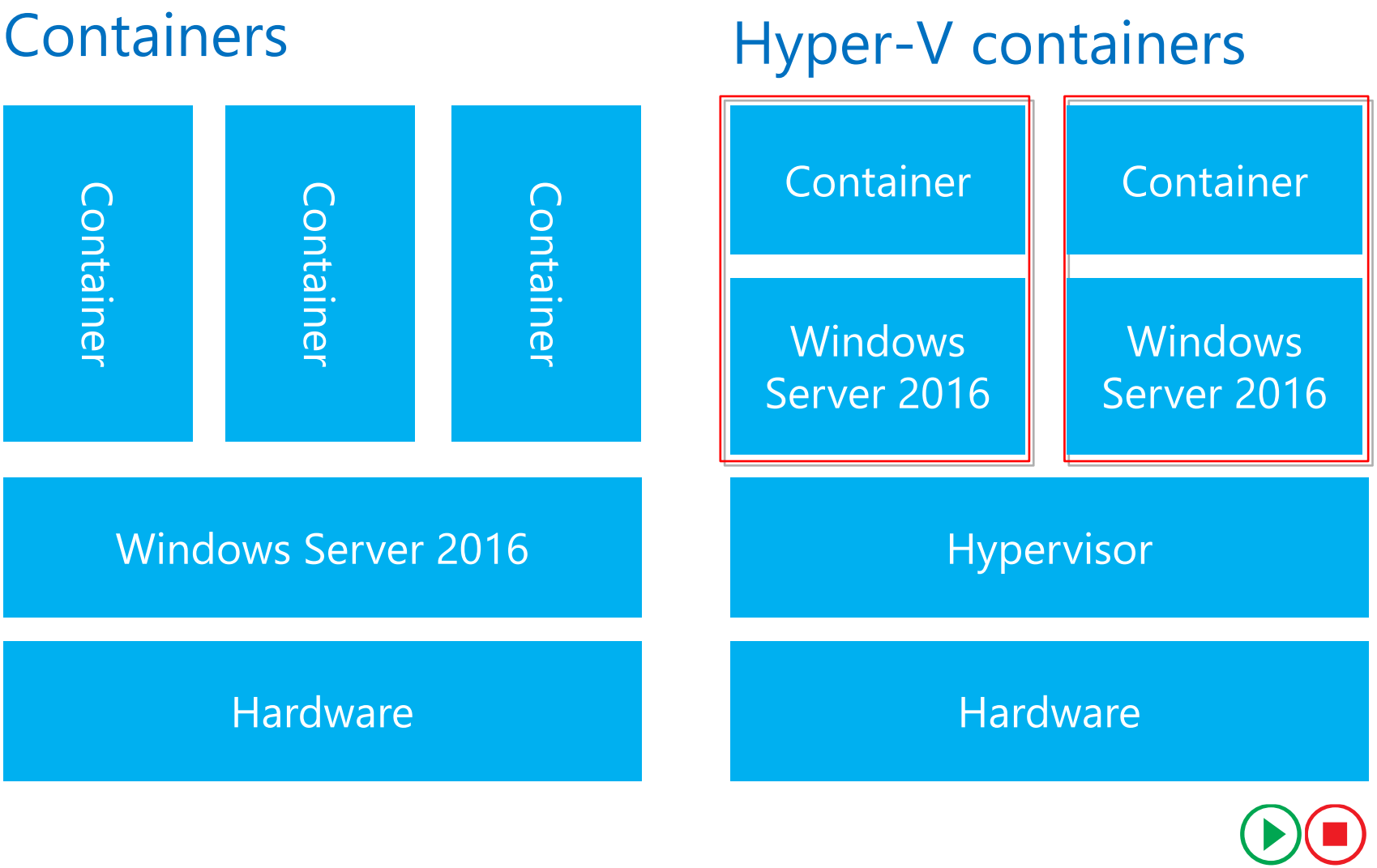
New features for virtual machines include:

- Virtual machine configuration version
  - Provides virtual machine compatibility with Windows Server 2012 R2. Any virtual machines migrated from Windows Server 2012 R2 (such as during a rolling cluster upgrade) are not automatically updated from configuration version 5 to 8 to retain backward compatibility.
  - After you update a virtual machine to version 8, it can only be hosted on Windows Server 2016.

Windows Server Containers and Docker in Hyper-V

- **Virtual machines** provide **hardware virtualization**
- **Containers** provide **operating system virtualization**:
  - Isolated namespace
  - Controlled access to hardware
- Benefits of containers:
  - Faster startup and restarts
  - High deployment density
- Docker is the management software for containers
- Hyper-V containers provide greater isolation

Windows Server Containers and Docker in Hyper-V



Lesson 2: Installing Hyper-V

- Prerequisites and requirements for installing Hyper-V
- Demonstration: Installing the Hyper-V role
- Nested virtualization

Prerequisites and requirements for installing Hyper-V

- Use **Systeminfo.exe** to verify that hardware requirements are met for Hyper-V

```
Hyper-V Requirements:      VM Monitor Mode Extensions: Yes
                           Virtualization Enabled In Firmware: Yes
                           Second Level Address Translation: Yes
                           Data Execution Prevention Available: Yes
```

- The host must have sufficient resources to meet the requirements of the virtual machines:
  - Processor
  - Memory
  - Storage
  - Network

Demonstration: Installing the Hyper-V role

- In this demonstration, you will see how to install the Hyper-V server role

Nested virtualization

- Enables a Hyper-V guest virtual machine to be a Hyper-V host as well
  - You can configure nested virtualization for a virtual machine by enabling virtualization extensions for the virtual machine processor.
  - **Set-VMProcessor -VMName DemoVM -ExposeVirtualizationExtensions $true**
- Useful for development and test servers
- Requirements:
  - At least 4 GB of static memory
  - MAC address spoofing enabled
    - To allow the nested guest virtual machines to communicate on the external network, you must enable MAC address spoofing.
    - You must configure MAC address spoofing on the virtual machine that you configured as a Hyper-V host.
  - Virtual machine configuration version 8.0

Nested virtualization

- The following features are disabled or will fail after you enable nested virtualization:
  - Virtualization Based Security
  - Device Guard
  - Dynamic Memory
  - Hot add Static Memory
  - Checkpoints
  - Live migration
  - Save or Restore state

Lesson 3: Configuring storage on Hyper-V host servers

- Storage options in Hyper-V
- Considerations for virtual hard disk formats and types
- Fibre Channel support in Hyper-V
- Where to store virtual hard disks?
- Storing virtual machines on SMB 3.0 shares
- Demonstration: Managing storage in Hyper-V

Storage options in Hyper-V

- Virtual hard disk formats:
  - .vhd
  - .vhdx
    - A .vhdx file can be as large as 64 TB.
    - A .vhdx allows larger block sizes for dynamically expanding and differencing disks, which provides better performance for these workloads.
  - .vhds
    - Windows Server 2016 introduces the .vhds format, which is specific to shared virtual hard disks. This format is a type of virtual hard disk that multiple virtual machines can access simultaneously for high availability with clustering.
- Virtual hard disk types:
  - Fixed-size
  - Dynamically expanding
  - Pass-through
  - Differencing

Considerations for virtual hard disk formats and types

- Create .vhdx virtual hard disks unless you need backward compatibility with Windows Server 2008 or Windows Server 2008 R2
- A dynamically expanding .vhdx-formatted virtual hard disk is suitable for production workloads
- The free space shown by dynamically expanding virtual hard disks is not equal to physical free space
- Multiple layers of differencing disks decreases performance
- If you modify a parent disk, the differencing disk is no longer valid
- You can relink a differencing disk to a parent disk

Fibre Channel support in Hyper-V

The virtual Fibre Channel adapter:

- Allows a virtual machine to connect to a Fibre Channel SAN directly
- Requires the **Hyper-V host** to have a Fibre Channel HBA
- Requires the Fibre Channel HBA driver to support virtual Fibre Channel

Where to store virtual hard disks?

- Storage performance is a critical factor in virtual machine performance
- Consider the following when planning storage for Hyper-V:
  - High-performance connectivity to storage
  - Redundant storage
    - The volume on which the virtual hard disk files are stored should be fault tolerant.
    - This is regardless of whether the virtual hard disk is stored on a local disk or on a remote SAN device.
  - High-performance storage
    - Many enterprises use hybrid SSD drives in RAID 1+0 arrays to achieve maximum performance and redundancy.
  - Adequate growth space

Storing virtual machines on SMB 3.0 shares

- SMB 3.0 is available in Windows Server 2012 and later
- Hyper-V can store the following on an SMB 3.0 file share:
  - Configuration files
  - Virtual hard disks
  - Checkpoint files
- Scale-Out File Server:
  - Provides highly available file shares
    - To provide high availability for file shares storing virtual machine files, you can use Scale-Out File Server.
    - Scale-Out File Server provides redundant servers for accessing a file share. This also provides faster performance than when you are accessing files through a single share, because all servers in the Scale-Out File Server are active at the same time.
  - Has storage QoS policies

Demonstration: Managing storage in Hyper-V

In this demonstration, you will see how to create a differencing disk based on an existing disk by using both Hyper-V Manager and Windows PowerShell

Lesson 4: Configuring networking on Hyper-V host servers

- Types of Hyper-V networks
- Demonstration: Configuring Hyper-V networks
- Best practices for configuring Hyper-V virtual networks
- New Hyper-V networking features in Windows Server 2016

Types of Hyper-V networks

- Use Virtual Switch Manager to create different types of virtual networks:
  - External
  - Internal
  - Private
- You can also:
  - Configure VLANs
  - Capture data travelling through a switch
  - Filter data travelling through a switch

Demonstration: Configuring Hyper-V networks

- In this demonstration, you will see how to create a public and a private network switch

New Hyper-V networking features in Windows Server 2016

- QoS for software-defined networking
- VMMQs
- RDMA for virtual switches
- Switch-embedded teaming:
  - Adapters must be identical
  - **New-VMSwitch -Name "ExternalTeam" -NetAdapterName "NIC1","NIC2"**
- NAT virtual switch:
  - NAT is often useful to control the use of IP addresses.
  - This is particularly true if there are many virtual machines that require access to the Internet.

Lesson 5: Configuring Hyper-V virtual machines

- What are virtual machine configuration versions?
- Virtual machine generation versions
- Demonstration: Creating a virtual machine
- The hot adding feature in Hyper-V
- Shielded virtual machines
- Virtual machine settings
- Best practices for configuring virtual machines

What are virtual machine configuration versions?

- Configuration versions allow compatibility for virtual machines between:
  - Windows Server 2012 R2 (version 5.0)
  - Windows Server 2016 (version 5.0 or 8.0)
  - Virtual machine configuration versions represent the Hyper-V compatibility settings for a virtual machine's configuration, saved states, and checkpoint files.
- Virtual machines **must be manually updated** from version 5.0 to version 8.0:
  - **Update-VMVersion "VMName"**

Virtual machine generation versions

Generation 2 virtual machines provide the following functionality:

- Secure boot
- Boot from a virtual hard disk that is connected to a virtual SCSI controller
- Boot from a virtual DVD that is connected to a virtual SCSI controller
- PXE boot by using a standard Hyper-V network adapter
- UEFI firmware support

Demonstration: Creating a virtual machine

- In this demonstration, you will see how to create a virtual machine by using Hyper-V Manager and Windows PowerShell

The hot adding feature in Hyper-V

- **Hot adding** requires Generation 2 virtual machines
- Memory:
  - Add memory to virtual machines with static memory while they are running
- Network adapter:
  - Add or remove network adapters on running virtual machines

Shielded virtual machines

- A shielded virtual machine is:
  - Protected from anyone with access to the Hyper-V host
  - A Generation 2 virtual machine with a virtual TPM
  - Protected by BitLocker
- The Host Guardian Service has two attestation modes:
  - Admin-trusted attestation
    - Computer accounts for trusted Hyper-V hosts are placed in an AD DS security group. This is simpler to configure but has a lower level of security.
  - TPM-trusted attestation
    - Trusted Hyper-V hosts are approved based on their TPM identity. This provides a higher level of security but is more complex to configure.
    - Hosts must have a TPM 2.0 and UEIF 2.3.1 with secure boot enabled

Virtual machine settings

- Integration services allow virtual machines to access Hyper-V services
- Smart paging allows disks to be used temporarily during virtual machine startup, when it is highly needed
- Resource metering monitors resource usage of virtual machines, for planning
- Discrete device assignment allows direct access to PCIe devices
- Linux and FreeBSD Generation 2 virtual machines can use secure boot

Best practices for configuring virtual machines

- Use Dynamic Memory unless an application does not support it
- Avoid using differencing disks
- Use multiple network adapters to separate physical networks for high availability
- Store each virtual machine’s files on a separate volume

Lesson 6: Managing virtual machines

- Managing virtual machine state
- Managing checkpoints
- Demonstration: Creating checkpoints
- Importing and exporting virtual machines
- PowerShell Direct
- Demonstration: Using PowerShell Direct

Managing virtual machine state

Virtual machine states define what resources are being used:

- Off
- Starting
- Running
- Paused
- Saved

Managing checkpoints

- Checkpoints allow administrators to make a snapshot of a virtual machine at a particular point in time
- Checkpoints do not replace backups
- Standard checkpoints create .avhd files (differencing disks), which merge back into the previous checkpoint when the checkpoint is deleted
- Production checkpoints are created by using VSS and require starting from an offline state

Demonstration: Creating checkpoints

- In this demonstration, you will see how to create a production checkpoint and a standard checkpoint in Hyper-V Manager

Importing and exporting virtual machines

- Import options:
  - Register the virtual machine in-place (use the existing unique ID)
  - Restore the virtual machine (use the existing unique ID)
  - Copy the virtual machine (create a new unique ID)
- Export options:
  - Export a checkpoint
  - Export a virtual machine including checkpoints
- Moving virtual machine storage:
  - Move all the virtual machine's data to a single location
  - Move the virtual machine's data to different locations
  - Move the virtual machine's virtual hard disks

PowerShell Direct

- PowerShell Direct:
  - **Does not require network connectivity**
  - Can only be used **from the host to the virtual machine**
- Requirements:
  - The **host and guest** must be running **Windows 2016/Windows 10 later**
  - **Windows PowerShell** must be running as administrator
  - **The virtual machine** must be running **locally on the host**.
  - You must be logged into the host computer **as a Hyper-V administrator**
  - You must use credentials to authenticate to the virtual machine
- Enter a session or invoke a command:
  - **Enter-PSSession -VMName** <*VM1*>
  - **Invoke-Command -VMName** <*VM1*> -Scriptblock {<*commands*>}

Demonstration: Using PowerShell Direct

- In this demonstration, you will see how to use PowerShell Direct