# **Module 3**

1. **Implementing Hyper-V and Rapid Server Deployment**

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| **At a Glance** |

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# **Overview**

In this module, your students become familiar with virtualization as it is implemented using Microsoft’s Hyper-V feature. First, students learn how to install Hyper-V on a Windows Server 2019 host. Students learn that Hyper-V Manager and PowerShell can both be used to create and configure virtual machines, as well as start and manage the state of virtual machines. Next, Generation 1 and Generation 2 virtual machines are discussed so that students are aware of the two types of machines, and recognize their similarities and, more importantly, their differences. Additionally, students are introduced to the settings for a virtual machine. Both where the settings are stored and how virtual hardware components are prepared are explained. The important topic of virtual networks and Hyper-V virtual switches is discussed to ensure students are aware of their importance and function. Similarly, it is important that students have a grasp of the commonly configured virtual machine features: checkpoints, live update, and replication. These topics are covered to ensure your students have a complete understanding of virtual machines. Finally, the quick and extensive deployment of virtual machines is a real-world topic of which students must be aware. Specifically, rapid server deployment is often used to install operating systems on several servers and virtual machines within large organizations. Students learn that virtual machine templates and WDS are two methods that can be used to perform Windows Server 2019 rapid server deployment. The topics in this module together form a foundation for future modules, and provide students with a solid base of knowledge in the world of Windows Server 2019 virtualization.

# **Module Objectives**

* Install Hyper-V on a Windows Server 2019 host
* Explain the purpose and configuration of Hyper-V virtual switches
* Create virtual machines within Hyper-V Manager
* Modify virtual machine settings
* Use virtual machine checkpoints
* Outline the process used to configure and perform live migration
* Identify the purpose and usage of virtual machine replication
* Explain the methods used to perform rapid server deployment with Windows Server 2019
* Use virtual machine templates to create new virtual machines
* Install and configure WDS
* Use WDS to install Windows Server 2019

# **Teaching Tips**

**Implementing Hyper-V**

1. Define virtualization as a process that allows an administrator to use server hardware more efficiently by running multiple guest operating systems (virtual machines) simultaneously.
2. Discuss the advantages virtualization provides.
3. Mention that to enable virtualization, a computer must run a hypervisor that emulates a unique set of virtual hardware components for each virtual machine.
4. Point out that Hyper-V is a Type-1 hypervisor that is available within the Standard and Datacenter editions of Windows Server 2019, as well as within Microsoft Hyper-V Server 2019.
5. **Installing Hyper-V**
6. Review some of the pre-installation requirements to meet before installing Hyper-V.

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| ***Teaching***  ***Tip*** | Refer students to Table 1-2 for a refresher in the minimum hardware requirements for Windows Server 2019. |

1. Refer to Figure 3-1 through Figure 3-5 and walk through the steps of installing Hyper-V on Windows Server 2019 by using the Add Roles and Features Wizard.
2. Note that Figure 3-1 illustrates the selection of the Hyper-V role when adding a role within Server Manager.
3. Note that Figure 3-2 illustrates the selection of one or more network interfaces that provide access to the physical network in an organization. Explain that when an administrator selects a network interface at this screen, an external virtual switch will be created within Hyper-V to allow virtual machines access to the physical network using the network interface.
4. Note that Figure 3-3 illustrates how to enable the live migration of virtual machines. Explain that live migration allows an administrator to copy a running Hyper-V virtual machine from one server (the source server) across a network to another server in the same Active Directory domain (the target server).
5. Emphasize that if live migration is enabled, an administrator must choose how the two servers authenticate to each other during the live migration process. Compare the Credential Security Support Provider (CredSSP) authentication and Kerberos authentication.

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| ***Teaching***  ***Tip*** | Remind students that live migration can be skipped at this point and installed later. |

1. Refer to Figure 3-4 to illustrate the prompts for the location of the files that comprise each virtual machine.

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| ***Teaching***  ***Tip*** | Remind students that the operating system installed within a Hyper-V virtual machine is stored within one or more virtual hard disk files. The hardware and feature settings for a particular virtual machine are stored in separate virtual machine configuration files. |

1. Explain that after the Add Roles and Features Wizard installs the Hyper-V role, there are prompts to reboot the computer to complete the installation. Mention that on most systems, a computer will reboot twice; the first reboot adds Hyper-V in a Type 1 configuration, and the second reboot allows Hyper-V to start the host operating system that is used to manage virtual machines.
2. Explain that following the installation of Hyper-V, an administrator can use PowerShell or the graphical Hyper-V Manager tool to manage Hyper-V and Hyper-V virtual machines.
3. Refer to Figure 3-5 to illustrate the Hyper-V Manager tool Navigation pane displaying a newly installed server name.
4. **Understanding Virtual Networks**
5. Explain the purpose of a wireless access point (WAP) and a switch when creating a physical network.
6. Note that a hypervisor provides physical network access to virtual machines.
7. Mention that a hypervisor allows an administrator to create additional virtual networks that can be used by virtual machines, and the host operating systems that manage them.
8. Describe a virtual switch as a virtual network within Hyper-V and discuss how they are used.
9. Describe the three types of Hyper-V virtual switches used with virtual machines.

* External virtual switch
* Internal virtual switch
* Private virtual switch

1. Refer to Figure 3-6 to illustrate how a single host operating system or virtual machine can have multiple virtual network interfaces that each connect to a different virtual switch.
2. Point out that in some environments, the host operating system and all virtual machines are connected only to an external virtual switch, so that they can respond to requests from computers on the physical network.
3. Explain how internal and private virtual switches can be used to create an isolated network for specific types of communication (e.g., cluster configuration information), or to provide enhanced security.
4. Discuss what is meant by N-tier data security.
5. Mention that an administrator can create and modify virtual switches by selecting Virtual Switch Manager within the Actions pane of Hyper-V Manager.
6. Refer to Figure 3-7 to illustrate that the *New virtual network switch* option is highlighted by default when an administrator opens the Virtual Switch Manager.
7. Refer to Figure 3-8 to illustrate how to create a new virtual switch by selecting the type of virtual switch, clicking Create Virtual Switch in the Create virtual switch pane, and supplying a virtual switch name.
8. Refer to Figure 3-8 again, and explain what an administrator must do if he or she selects External network to create an external virtual switch.
9. Explain what is meant by the term single-root I/O virtualization (SR-IOV).
10. Explain that after an administrator creates external and internal virtual switches, the administrator will see the associated virtual network interface on their host operating system within Server Manager, as well as within the Network Connections area of Control Panel.
11. Refer to Figure 3-9 to illustrate the Network Connections area of Control Panel. Note that that the physical network interface (Ethernet) is also shown within the Network Connections area of Control Panel.

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| ***Teaching***  ***Tip*** | Point out that the physical network interface should not be configured to use IP, because IP functionality must only be provided by virtual network interfaces when Hyper-V is installed. |

1. Refer to Figure 3-10 and explain that when an administrator accesses the properties of the physical network interface he or she will notice that both IPv4 and IPv6 are not enabled, but that the Hyper-V Extensible Virtual Switch protocol is enabled.
2. **Creating Virtual Machines**
3. Introduce this topic by explaining that virtual machines are created within Hyper-V Manager after an administrator has installed Hyper-V and configured the appropriate virtual switches.
4. Refer to Figure 3-11 and explain that to create a new virtual machine within Hyper-V Manager, an administrator can select New from the Actions pane and then select Virtual Machine to start the New Virtual Machine Wizard.
5. Emphasize the important differences between selecting Finish and Next in the New Virtual Machine Wizard. Note that clicking Finish creates a Generation 2 virtual machine. Clicking Next takes the administrator to another window where there are prompts to supply the appropriate configuration settings.
6. Refer to Figure 3-12 to illustrate the effect of clicking Next in this window. Explain that this action results in prompting the administrator for configuration settings starting with the virtual machine name and path for the virtual machine configuration files.
7. Refer to Figure 3-13 to illustrate the window that displays after clicking Next in Figure 3-12. Explain that the administrator is now prompted to choose the generation of the virtual machine. Discuss the many differences between a Generation 1 and a Generation 2 machine.
8. Refer to Figure 3-14 to illustrate the window that appears after selecting the virtual machine generation and clicking Next in Figure 3-13. Explain that the administrator is prompted to select the amount of memory that the virtual machine will use. Explain the amounts of memory and the types of memory that can be allocated.
9. Refer to Figure 3-15 to illustrate the window that appears after clicking Next in Figure 3-14. Explain that an administrator is prompted to select the virtual switch to which the first network adapter will connect.
10. Refer to Figure 3-16 to illustrate the prompt for virtual hard disk configuration that appears after an administrator clicks Next in Figure 3-15.
11. Refer to Figure 3-17 to illustrate the window that appears after an administrator configures a virtual hard disk and clicks Next in Figure 3-16. Explain that an administrator is now prompted for the options needed to install a guest operating system within the virtual machine. Describe the various installation options.
12. Explain that after an administrator configures their installation options, they can click Finish to create their virtual machine. Mention that alternatively, an administrator can click Next to see a summary of their choices, and then click Finish to create their virtual machine.
13. **Configuring Virtual Machines**
14. Refer to Figure 3-18 to illustrate the Virtual Machines pane of Hyper-V Manager and the Actions pane, which lists actions an administrator can take on a virtual machine.
15. Describe how an administrator can click Start within the Actions pane to boot the virtual machine.
16. Describe how an administrator can click Settings within the Actions pane in order to modify the settings for their virtual machine.
17. Refer to Figure 3-19 to illustrate the Hardware and Management sections of a Generation 2 virtual machine. Explain that by default, the Hardware section for a virtual machine lists the hardware that was configured during the creation of the virtual machine. Note that an administrator can add hardware.
18. Refer to Figure 3-20 to illustrate how to change the boot order for hardware devices within the UEFI BIOS by selecting Firmware within the Hardware section.
19. Refer to Figure 3-21 to illustrate how to configure UEFI security by selecting Security within the Hardware section.
20. Refer to Figure 3-22 to illustrate how to modify the memory configuration by selecting Memory under the Hardware section.
21. Refer to Figure 3-23 to illustrate how an administrator can optionally specify advanced processor capabilities by expanding the Processor node under the Hardware section. Discuss the many options that can be modified.
22. Remind your students that Generation 2 virtual machines emulate Serial Attached SCSI (SAS) storage devices. Refer to Figure 3-24 to illustrate how an administrator can add additional virtual hard disk drives, virtual DVD-ROM drives, or a virtual hard disk that is shared by multiple virtual machines if he or she selects a SCSI Controller under the Hardware section. Note that an administrator can also remove the SCSI Controller from the system, which also removes any attached storage devices.
23. Refer to Figure 3-25 to illustrate how a Hard Drive under a SCSI Controller can be highlighted and the associated virtual hard disk file path will be displayed. Discuss the options that can be clicked to modify the virtual hard drive settings within a virtual machine.
24. Refer to Figure 3-25 and discuss what is meant by configuration of a pass-through disk. Explain how to remove a disk altogether. Discuss the terms Quality of Service (QoS) and Input/Output Operations Per Second (IOPS) for a virtual hard disk file.
25. Refer to Figure 3-26 to illustrate how an administrator can select Image file and click Browse to select an ISO image file that will be associated with the virtual DVD drive, or select None to disassociate an existing ISO image, when he or she highlights a DVD Drive under a SCSI Controller.
26. Refer to Figure 3-27 to illustrate how an administrator can associate the network interface with a virtual switch, and optionally enable and set a VLAN identification number when he or she selects a Network Adapter under the Hardware section.
27. Refer to Figure 3-27 again and explain how an administrator can select Hardware Acceleration or Advanced Features to configure optional network interface components. Describe some of the possible interface components.
28. Mention that non-hardware-related configuration efforts for a Generation 2 virtual machine are performed within the Management section of virtual machine settings. Describe some of the configuration settings.
29. Refer to Figure 3-28 to illustrate the Hardware and Management section that displays when an administrator accesses the settings for a Generation 1 virtual machine.
30. Discuss the similarities and differences between the Hardware sections for Generations 1 and 2 virtual machines.
31. **Working with Virtual Machines**
32. Explain why the preferred way to boot a newly created virtual machine is to first click Connect in the Actions pane to obtain the Virtual Machine Connection window and then click Start within this window to boot the virtual machine.
33. Refer to Figure 3-29 to illustrate the Virtual Machine Connection window.
34. Pont out that an administrator can use the associated buttons on the toolbar of the Virtual Machine Connection window, or within the Actions pane of Hyper-V Manager, to perform key actions within a virtual machine that are normally performed on a physical computer.
35. Refer to Figure 3-30 to illustrate the Actions pane of Hyper-V Manager.
36. Describe the actions that might need to be performed.
37. Explain how an administrator can view information for a running virtual machine within Hyper-V Manager.
38. **Managing Hyper-V Features**
39. Introduce the most commonly configured Hyper-V features.

* Checkpoints
* Live Migration
* Replication

1. Define a checkpoint as a Hyper-V feature that allows an administrator to revert the state of a virtual machine to a previous point in time. Note that a checkpoint is often called a snapshot.
2. Explain why and when checkpoints are created.
3. Discuss how checkpoint files are named and where they are stored.
4. Refer to Figure 3-31 to illustrate the naming and storage of checkpoint files.
5. Define and describe the two different mechanisms for creating checkpoints: standard checkpoints and production checkpoints.
6. Define and describe the backup service used to create production checkpoints: Volume Shadow Copy Service (VSS) for the Windows guest operating system and File System Freeze (fsfreeze) service for Linux guest operating systems.
7. Point out that Hyper-V uses production checkpoints by default. Refer to Figure 3-32 to illustrate how an administrator can modify this setting within virtual machine properties by selecting the Checkpoints node under the Management section.
8. Explain how to create a checkpoint.
9. Refer to Figure 3-33 to illustrate how a checkpoint is displayed after it is created within the Checkpoints pane within Hyper-V Manager. Explain how to apply (or delete) the checkpoint.
10. Explain how live migration allows an administrator to move a virtual machine to another server running Hyper-V within the same Active Directory domain.
11. Refer to Figure 3-34 to illustrate how the Move Wizard prompts an administrator regarding whether to move the virtual machine or virtual machine storage.
12. Explain that if an administrator selects Move the virtual machine, the virtual machine configuration files and virtual machine hard disk files will be moved to the destination server. Mention that if an administrator chooses Move the virtual machine’s storage, only the virtual hard disk files are moved to the destination server.
13. Refer to Figure 3-35 and explain how to enable live migration if it was not enabled during the installation of Hyper-V.
14. Explain how replication can be used to create a copy of a virtual machine on a destination Hyper-V host within the same Active Directory domain that is continually updated as changes are made.
15. Explain why an administrator would want to use replication.
16. Refer to Figure 3-36 to illustrate how to enable replication.
17. Explain that after replication is enabled on the target Hyper-V host, an administrator can replicate a virtual machine by selecting it within Hyper-V Manager and clicking Enable Replication within the Actions pane.
18. **Quick Quiz 1**
19. Which type of migration allows an administrator to copy a running Hyper-V virtual machine from one server (the source server) across a network to another server in the same Active Directory domain (the target server)?
20. live migration
21. replication
22. virtual migration
23. checkpointing
24. Answer: a. live migration
25. Which type of Hyper-V virtual switch represents a virtual network to which only virtual machines can connect?
    1. external
    2. internal
    3. production
    4. private
26. Answer: d. private
27. Which network interface component allows all traffic on the virtual switch to be sent to the virtual network interface for monitoring purposes?
    1. router guard
    2. device naming
    3. port mirroring
    4. NIC Teaming
28. Answer: c. port mirroring
29. Which term refers to a persistent connection to a process through a file on the filesystem?
    1. MAC address spoofing
    2. named pipe
    3. port mirroring
    4. device mirroring
30. Answer: b. named pipe
31. **Rapid Server Deployment**
32. Open this topic by discussing why rapid server techniques are used by large organizations to minimize the time it takes to install a new server.
33. Mention the two methods used to implement rapid server deployment (RSD).

* Copy a virtual machine template
* Perform a network installation using Windows Deployment Services (WDS)

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| ***Teaching***  ***Tip*** | For more information on rapid server deployment, see the following Web site: <https://redmondmag.com/articles/2015/07/01/rds-rapid-deployment.aspx> |

**Using Virtual Machine Templates**

1. Explain that a Windows Server 2019 virtual machine template is a virtual machine containing a Windows Server 2019 installation that is saved (exported) to a folder on the file system for future use.
2. Explain that a virtual machine template can be copied (imported) multiple times within Hyper-V Manager to create new virtual machines that contain a Windows Server 2019 installation.
3. Review the minimum hardware settings and naming convention that should be considered when creating a virtual machine template.
4. Explain that following the installation of a Windows 2019 server, an administrator can optionally install server roles and features, as well as third-party software that the administrator wishes to be available on new virtual machines that are created from the virtual machine template.
5. Explain that any unique information from the Windows Server 2019 operating system that was installed into the virtual machine must be removed by running the System Preparation Tool.
6. Refer to Figure 3-37 to illustrate how to select the Generalize box from the System Preparation Tool window. Emphasize that this will remove all unique information from the system (the Generalize option) and shut down the guest operating system when finished.
7. Discuss how the Out-of-Box Experience (OOBE) wizard will generate a new computer name and unique identifiers within the Windows Registry as well as prompt the administrator to specify regional options, accept the Windows license agreement, and specify a new Administrator password.
8. Explain that after the System Preparation Tool shuts down the guest operating system, an administrator can select the virtual machine within Hyper-V Manager and select Export from the Actions menu to create a virtual machine template that can be later imported to create new virtual machines.
9. Refer to Figure 3-38 to illustrate what happens when an administrator clicks Export. Specifically mention that an administrator must choose a folder in which to store the virtual machine template.
10. Introduce the topic of importing a virtual machine template by mentioning that after an administrator has created a virtual machine template, the administrator can use it to simplify the creation of new virtual machines.
11. Explain how to open the Import Virtual Machine wizard by clicking Import Virtual Machine within the Actions pane of Hyper-V Manager so that an administrator can create a new virtual machine based on the virtual machine template.
12. Refer to Figure 3-39 to illustrate the prompt where the administrator specifies the folder containing the virtual machine template to import.
13. Refer to Figure 3-40 to illustrate the prompt used to select the virtual machine template within the folder that the administrator wishes to import.
14. Refer to Figure 3-41 to illustrate how an administrator chooses to create a copy of the virtual machine template.
15. Refer to Figure 3-42 to illustrate how an administrator enters the target folder paths for the virtual machine configuration files.
16. Refer to Figure 3-43 to illustrate how an administrator enters the target folder paths for the virtual machine hard disk files.
17. Explain that upon finishing the new virtual machine install using the template, there are cleanup items to perform such as renaming the new virtual machine, modifying the settings of the virtual machine to suit the needs of an organization, and starting the guest operating system.
18. Explain that when the guest operating system is started for the first time, an administrator is prompted to complete the Out-of-Box Experience (OOBE) wizard to provide information unique to the virtual machine.
19. Refer to Figure 3-44 to illustrate the start of the OOBE wizard prompts.

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| ***Teaching***  ***Tip*** | When an administrator creates a virtual machine within a commercial cloud environment, such as Microsoft Azure or Amazon Web Services (AWS), templates for most operating systems are made available by the cloud provider for the administrator to import. |

**Using Windows Deployment Services**

1. Introduce the installation media for Windows client and server operating systems that are being used starting with Windows Vista and Windows Server 2008. Note that it is primarily composed of two large Windows Imaging Format (WIM) image files.

* boot.wim (called a boot image) contains a bootable Windows installation program
* install.wim (called an install image) contains the operating system files that are copied to the hard disk or SSD during the installation process.

1. Explain how these WIM files can be used in conjunction with Windows Deployment Services (WDS) to deploy Windows operating systems to computers that are configured to boot from the network using a PXE-capable network interface.
2. Explain how the multicast feature of IP can be used to boot several computers from the network simultaneously and install an operating system from a WDS server. Emphasize that this feature allows an administrator to use WDS to perform rapid server deployment of Windows Server 2019 on multiple physical servers or virtual machines that boot from the network using PXE.
3. Mention that to implement rapid server deployment using WDS, an administrator must complete two primary steps. Note that following these steps, the administrator can boot physical servers and virtual machines from the network using PXE to perform the installation process.

* Install WDS
* Configure the WDS to respond to client computers using the appropriate boot and install images

1. Refer to Figure 3-45 and explain that to begin the installation of WDS, an administrator first opens the Server Manager. Then note that the administrator selects the Windows Deployment Services role as the role to add to install WDS on Windows Server 2019.
2. Explain that this starts the Add Roles and Features Wizard, and eventually the administrator is prompted to select the two role services that are required for full WDS functionality.
3. Refer to Figure 3-46 to illustrate the selection of the two role services that are required for full WDS functionality.

* The Deployment Server provides the core functionality of WDS.
* The Transport Server responds to PXE requests from the network and uses IP multicast to send the contents of WIM images to each computer.

1. Refer to Figure 3-47 to illustrate how the configuration of WDS is performed using the Windows Deployment Services tool. Review the steps to start this tool.
2. Refer to Figure 3-48 to illustrate the prompts provided for choosing whether to integrate WDS with an Active Directory domain. Explain that integrating WDS with Active Directory allows WDS to automatically join Windows systems to the Active Directory domain during the installation process as well as allows any domain user to perform a WDS installation.
3. Refer to Figure 3-49 to illustrate how to choose the folder that will be used to store WDS configuration and WIM images. Emphasize that for performance reasons, an administrator should change the default folder shown in Figure 3-49 to a folder that is on a separate hard disk or SSD, so that WDS disk operations do not compete with Windows Server 2019 disk operations.
4. Refer to Figure 3-50 to illustrate and explain how to configure the DHCP options.
5. Refer to Figure 3-51 to illustrate and explain how the server should respond to PXE requests from computers on the network. Note that there are several options. Explain that normally, the *Respond to all computers (known and unknown)* option is selected. Discuss the effect of selecting the other options.
6. Explain that after an administrator clicks Next, a summary of his or her choices displays and the administrator can click Finish to complete the initial WDS configuration.
7. Refer back to Figure 3-47 and explain that to add a boot image, an administrator can right-click the Boot Images folder. Refer to Figure 3-52 to illustrate the beginning of the Add Image Wizard.
8. Refer to Figure 3-53 to illustrate how an administrator can optionally change the default boot image name, and then click Next and Finish, copying the image to the WDS server.
9. Refer back to Figure 3-47 and explain that to add an install image for Windows Server 2019 to a WDS server, an administrator can right-click the Install Images folder, and select Add Install Image to start the Add Image Wizard.
10. Refer to Figure 3-54 and explain that a WDS server may have several different install image files for different operating systems. Not that because of this, an administrator must select an existing image group or create a new one to store any install images.
11. Refer to Figure 3-55 to illustrate how an administrator can optionally deselect the editions that he or she does not wish to deploy using WDS. Explain that after an administrator clicks Next and Finish, the install.wim is copied to the WDS server.

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| ***Teaching***  ***Tip*** | An administrator only needs one boot image on a WDS server, even if that server has multiple install images for different operating systems. The boot.wim from a Windows Server 2019 installation media can be used to install Windows Server 2019 and earlier server operating systems, as well as Windows 10 and earlier client operating systems. |

1. Explain that once an administrator has configured WDS with the appropriate boot and install images, the administrator can start a WDS installation.
2. Refer back to Figure 3-47 and explain that an administrator starts the procedure by right-clicking the server within the Windows Deployment Services console. Mention that the administrator then selects All Tasks, and clicks Start to allow the WDS service to respond to PXE requests.
3. Emphasize the importance of ensuring that the network interface is listed at the top of the boot order for computers or virtual machines that an administrator wishes to install and proceeds to start those systems.
4. Point out that if WDS and DHCP are configured properly, an administrator should receive an IP address within a few moments, as well as a prompt indicating the key to press in order to start a WDS installation.
5. Describe the two types of possible prompts that might appear depending on whether a legacy computer (F12 key) or modern computer (ENTER key) is being used.
6. Refer to Figure 3-56 to illustrate how a WDS installation from a PXE network boot starts on a legacy computer.
7. Mention that after the key is pressed for either computer type, the boot image is downloaded from the WDS server to start the installation process.
8. Review the final steps an administrator must complete.
9. Explain that following these selections, the Windows installer will download the contents of the associated install image to the computer and complete the installation process.

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| ***Teaching***  ***Tip*** | An administrator can automate the selections for the Windows installer by creating an unattended answer file for use with WDS and specifying this file in the properties of their server within the Windows Deployment Services tool. To create an unattended answer file, an administrator must use the Windows System Image Manager tool that is provided as part of the Windows Assessment and Deployment Kit (ADK). Search for “answer files” on <https://docs.microsoft.com> for more information. |

1. **Quick Quiz 2**
2. Which term refers to a virtual machine containing a Windows Server 2019 installation that is saved (exported) to a folder on the file system for future use?
   1. replica
   2. virtual machine template
   3. boot image
   4. named pipe
3. Answer: b. virtual machine template
4. The installation media for Windows client and server operating systems is primarily composed of two large \_\_\_\_\_\_\_\_\_\_ image files.
   1. NTFS
   2. ReFS
   3. WIM
   4. ISO
5. Answer: c. WIM
6. Which key is usually entered at the initial prompt on a legacy system to start a WDS installation?
   1. F2
   2. F6
   3. F8
   4. F12
7. Answer: d. F12
9. An administrator can automate the selections for the Windows installer by creating an \_\_\_\_\_\_\_\_\_ answer file for use with WDS and specifying this file in the properties of their server within the Windows Deployment Services tool.
   1. open
   2. extended
   3. unattended
   4. automated
10. Answer: c. unattended

# **Class Discussion Topics**

1. Discuss the differences between physical switches and virtual switches.
2. Compare a production checkpoint to a standard checkpoint. What are the benefits of one over the other, and what are the situations where each would be used?
3. Discuss the two rapid server deployment methods available: virtual machine templates and WDS. What are the major characteristics of each method? What are their similarities and differences? When is one method chosen over the other?

# **Additional Projects**

1. Ask your students to research the importance of live migration and generate a short presentation on the topic (6-10 slides) that they can volunteer to present to the class.
2. Ask your students to read the article about new features in Hyper-V at <https://docs.microsoft.com/en-us/windows-server/virtualization/hyper-v/what-s-new-in-hyper-v-on-windows>. Have students write a report summarizing the article by selecting at least three new or updated features and justifying their classification as important.
3. Virtual machine checkpoints are similar to another storage technology called differencing disks. Have students research both technologies and write a report comparing the two features.

# **Additional Resources**

1. Virtualization

<https://docs.microsoft.com/en-us/windows-server/virtualization/virtualization>

1. Hyper-V Architecture
2. <https://docs.microsoft.com/en-us/virtualization/hyper-v-on-windows/reference/hyper-v-architecture>
3. Intro to Hyper-V dynamic memory

<https://www.veeam.com/blog/hyper-v-dynamic-memory-managing-vm-ram.html>

1. Get started with Hyper-V on Windows Server
2. <https://docs.microsoft.com/en-us/windows-server/virtualization/hyper-v/get-started/get-started-with-hyper-v-on-windows>
3. Windows Deployment Services Reference
4. <https://docs.microsoft.com/en-us/windows/win32/wds/windows-deployment-services-reference>

**Key Terms**

* **boot image** A Windows Imaging Format (WIM) image file that contains a bootable Windows installation program.
* **capture image** A file that that contains a modified installation program.
* **Credential Security Support Provider (CredSSP)** An authentication process that requires an administrator to start a live migration process while logged into the source server as a user with administrative privileges in the domain.
* **Deployment Server** A server that provides the core functionality of WDS.
* **device naming** A network interface component that allows the name of the underlying physical network adapter to be shown within the virtual network adapter.
* **DHCP guard** A network interface component that prevents DHCP servers that are not authorized within Active Directory from assigning IP configuration to a network interface.
* **differencing disk** A storage technology that stores changes made to an operating system after creation. A differencing disk is a .vhdx file that references another .vhdx file containing an installed operating system. When you create a new virtual machine, you can attach an existing differencing disk to your virtual machine for storage. When you boot this new virtual machine, the differencing disk will boot the operating system stored in the .vhdx file it references. Any changes you make within the operating system will only be stored in the differencing disk and not the .vhdx file it references.
* **dynamic memory** A feature of Hyper-V that allows a hypervisor to handle RAM consumption by host VMs in a flexible way.
* **external virtual switch** A type of Hyper-V virtual switch that represents an underlying physical switch, and serves to connect virtual machines to an underlying physical network via a physical network interface on the server running Hyper-V.
* **File System Freeze (fsfreeze)** The backup service used to create production checkpoints for Linux guest operating systems.
* **Hyper-V Extensible Virtual Switch** A protocol that is automatically enabled on a physical network interface when you create an external virtual switch. It allows Hyper-V the ability to share the physical network interface with multiple virtual machines simultaneously.
* **Input/Output Operations Per Second (IOPS)** The measure of how many input/output operations a storage device can complete within one second. It is a standard performance benchmark for hard drives, solid state drives, flash drives, and network attached storage (NAS) devices.
* **install image** A Windows Imaging Format (WIM) image file that contains the operating system files that are copied to the hard disk or SSD during the installation process.
* **internal virtual switch** A type of Hyper-V virtual switch that represents a virtual network to which virtual machines and the host operating system can connect.
* **IPsec task offloading** A network interface component that performs IPsec calculations within the physical network interface hardware instead of using the virtual processor (enabled by default).
* **Kerberos** The default authentication protocol within Active Directory. Kerberos allows an administrator to start a live migration from any computer running Hyper-V Manager within an Active Directory domain. However, it requires that both computer accounts within Active Directory be configured for constrained delegation.
* **live migration** A Hyper-V configuration feature that allows an administrator to move a running virtual machine to another server running Hyper-V within the same Active Directory domain. Live Migration can only be enabled if the Hyper-V host operating system is joined to an Active Directory domain.
* **MAC address spoofing** A network interface component that allows a virtual machine to change its MAC address on outgoing packets.
* **multicast** A feature of IP that allows group communication where data transmission is addressed to a group of destination computers simultaneously.
* **N-tier** A type of data security design that requires users to pass through a number of systems (N) that implement security measures before gaining access to sensitive data.
* **named pipe** A persistent connection to a process via a file on the filesystem.
* **NIC Teaming** A network interface component that allows multiple network interfaces to function together for load balancing and fault tolerance.
* **non-uniform memory access (NUMA)** An advanced processor capability that allows an administrator to define memory settings on multi-physical-processor systems that support non-uniform memory access (NUMA) for faster memory sharing between processors.
* **Out-of-Box Experience (OOBE)** A wizard that will generate a new computer name and unique identifiers within the Windows Registry as well as prompt you to specify regional options, accept the Windows license agreement, and specify a new Administrator password.
* **pass-through disk** The term used to identify a physical disk that is not a member of a pool, but is used as a storage source in a virtual disk. Pass-through disks are previously used physical disks with an existing file system and disk format (such as Windows, UNIX, AIX, Linux, Solaris, and HP). SANsymphony software can migrate these disks into the configuration without modifying the structure of the existing data. Pass-through disks can be used to create single, dual, or mirrored virtual disks.
* **port mirroring** A network interface component that allows all traffic on the virtual switch to be sent to the virtual network interface for monitoring purposes.
* **Preboot Execution Environment (PXE)** An industry standard client/server interface that allows networked computers that are not yet loaded with an operating system to be configured and booted remotely by an administrator.
* **private virtual switch** A type of Hyper-V virtual switch that represents a virtual network to which only virtual machines can connect.
* **production checkpoint** A Windows Server 2019 mechanism for creating checkpoints that uses the backup service provided by the guest operating system to perform checkpoint functionality but does not save the state of running programs. Production checkpoints are less resource-intensive than standard checkpoints.
* **protected network** A network interface component that automatically moves the virtual machine to another Hyper-V system if the virtual machine is part of a cluster (enabled by default).
* **Quality of Service (QoS)** An option that allows an administrator to specify minimum and maximum limits to the number of Input/Output Operations Per Second (IOPS) for a virtual hard disk file.
* **rapid server deployment** A series of techniques that minimize the time it takes to install a new server.
* **router guard** A network interface component that prevents unauthorized routers from communicating with the network interface.
* **Shielding** A feature that allows BitLocker to be used to encrypt virtual hard disks so that they cannot be used on another virtual machine, using encryption keys that are stored in the TPM.
* **single-root I/O virtualization (SR-IOV)** A network interface component that separates network traffic for each virtual machine within the network interface hardware. SR-IOV allows the network interface to work closely with Hyper-V to separate network requests from different virtual machines in order to optimize performance. This setting should only be enabled if the underlying network interface hardware supports the feature.
* **smart paging file** A paging file that Hyper-V uses to store memory information if physical memory becomes exhausted.
* **standard checkpoint** A Windows Server 2019 mechanism for creating checkpoints that uses Hyper-V to provide checkpoint functionality and also saves the state of running programs within the Snapshots directory.
* **switch** A physical device that connects to the network interfaces within each computer on the network using an Ethernet cable.
* **System Preparation Tool** A tool used to remove all unique information from the Windows Server 2019 operating system installed within the virtual machine, including the computer name, unique system identifiers within the Windows Registry, regional settings, license information, Administrator password, and so on.
* **Transport Server** A WDS server that responds to PXE requests from the network and uses IP multicast to send the contents of WIM images to each computer.
* **unattended answer file** A file for use with WDS that can automate the selections during the Windows installer process.
* **virtual LAN (VLAN)** The partitioning of a physical switch so that each partition acts as an independent physical switch.
* **virtual machine bus (VMBus)** A mechanism within the Hyper-V architecture that enables logical communication in partitions. The VMBus works as the internal communications channel to redirect requests to virtual devices, allowing files to be dragged and dropped between the virtual machine and the host.
* **virtual machine queue** A network interface component that optimizes the transfer of network traffic to a virtual machine (enabled by default).
* **virtual machine template** A virtual machine running in Windows Server 2019 that contains a Windows Server 2019 installation that is saved (exported) to a folder on the file system for future use. This virtual machine template can then be copied (imported) multiple times within Hyper-V Manager to create new virtual machines that contain a Windows Server 2019 installation.
* **virtual switch** A virtual network within Hyper-V that provides the same capabilities as a physical switch.
* **Volume Shadow Copy Service (VSS)** The backup service used to create production checkpoints for Windows guest operating systems.
* **Windows Assessment and Deployment Kit (ADK)** A collection of tools and technologies produced by Microsoft designed to help deploy Microsoft Windows operating system images to target computers or to a virtual hard disk image in VHD format. Windows Assessment and Deployment Kit was formerly known as Windows Automated Installation Kit.
* **Windows Deployment Services (WDS)** A tool used to rapidly deploy Windows Server 2019 to physical servers that are connected to the network.
* **Windows Deployment Services tool** The tool used for the configuration of WDS.
* **Windows Imaging Format (WIM)** A file-based disk image format. It was developed by Microsoft to help deploy Windows Vista and subsequent versions of the Windows operating system family, as well as Windows Fundamentals for Legacy PCs.
* **Windows System Image Manager** A tool that is provided as part of the Windows Assessment and Deployment Kit (ADK). It is needed to create an unattended answer file.
* **wireless access point (WAP)** A device in a wireless network that that sends radio waves to the wireless network interface in each computer on the network.