Solutions for Hands On Microsoft Windows Server 2019 3rd Edition by Eckert

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Solutions

Hands-on Windows Server 2019 (3e)
Chapter 1 Solutions

Review Questions

1. Servers that exist within a data center that is publicly accessible on the Internet are referred to as on-premises servers. True or False?

   Answer: False. On-premises servers are located within the premises of an organization, whereas cloud servers exist within a data center that is publicly accessible on the Internet.

2. Which of the following are hardware requirements for Hyper-V?

   a. 64GB of memory

   b. Two network interfaces

   c. Processor with Intel VT or AMD-V and SLAT

   d. A 32-bit or 64-bit processor

   Answer: c. Hyper-V requires a processor with Intel VT or AMD-V extensions as well as SLAT support. The amount of memory or number of network interfaces is irrelevant to Hyper-V, and Hyper-V must be installed on a 64-bit processor only.

3. Which Hyper-V feature allows you to install a virtual machine within another virtual machine?

   a. Nested virtualization

   b. SLAT

c. Checkpoints

d. Hyper-V containers

Answer: a. Nested virtualization allows you to nest one virtual machine within another virtual machine. SLAT is a processor feature required for Hyper-V, checkpoints are used to roll back virtual machines to a previous state, and Hyper-V containers are Windows Containers that access a unique copy of the underlying Windows kernel.

4. Containers are often used to host Web apps within cloud environments. True or False?

Answer: True. Due to their small size, containers are often used to host Web apps within a cloud environment.

5. What term is used to refer to a logical grouping of computers that participate in Active Directory single sign-on?

a. Group Policy

b. Domain

c. Domain controller

d. Azure Active Directory

Answer: b. An Active Directory domain is a logical grouping of computers that participate in single sign-on. Group Policy is used to manage domain computers, domain controllers authenticate users within a domain, and Azure Active Directory is a cloud service that can be used to provide domain functionality.

6. Which component of Microsoft Defender can be used to provide cloud-based threat analysis within Windows Server 2019?

    a. Shielded virtual machines

    b. IIS

    c. ATP

    d. Windows Defender Firewall

    Answer: c. Microsoft Defender ATP is an optional paid feature in Windows Server 2019 that uses cloud inspection to enhance malware detection. Shielded virtual machines provide encryption for virtual machine disk files, IIS is the Web server software within Windows Server, and Windows Defender Firewall provides firewall capabilities.

7. Windows Server 2019 supports up to 64 physical processors and 128 logical processors. True or False?

    Answer: False. Windows Server 2019 supports up to 64 physical processors and an unlimited number of logical processors.

8. Which filesystem feature of Windows Server 2019 allows you to create large volumes that span multiple physical storage devices?

    a. Storage Spaces

    b. ReFS

    c. Storage Migration Service

    d. Storage Replicas

Answer: a. Storage Spaces allows you to create volumes that span multiple physical storage devices. ReFS is merely a filesystem that can be used on a volume. The Storage Migration Service copies data between systems, and Storage Replicas can be used to synchronize data between different servers and storage devices.

9. Clustering may be used with multiple Windows Server 2019 systems to enhance speed and fault tolerance for network services. True or False?

   Answer: True. Clusters may be used to provide failover fault tolerance, as well as spread user requests across multiple servers for enhanced speed.

10. Which of the following management tools is not installed by default on Windows Server 2019?

    a. Server Manager

    b. MMC

    c. Windows PowerShell

    d. Windows Admin Center

    Answer: d. The Windows Admin Center is an optional download following Windows Server 2019 installation. All other tools are included by default.

11. Commands within Windows PowerShell are referred to as cmdlets. True or False?

    Answer: True. PowerShell uses the term cmdlet to refer to each command.

12. Which two small footprint installation options are available for Windows Server 2019? (Choose two answers.)

a. Nano Server

b. Microsoft Hyper-V Server

c. Server Core

d. Essentials

Answer: a, c. Nano Server and Server Core are small footprint installation options. Microsoft Hyper-V Server only provides Hyper-V, and Essentials Edition is only available with a full graphical desktop.

13. You can start the Windows Server Configuration Wizard within Server Core by running the `sconfig.cmd` command. True or False?

Answer: True. The sconfig.cmd command can be used to start the Windows Server Configuration Wizard in Server Core.

14. Which Windows Server edition supports Windows Containers and up to two Hyper-V Containers?

a. Essentials

b. Standard

c. Datacenter

d. Storage Server

Answer: b. While Standard and Datacenter both support Windows Containers and Hyper-V Containers, Standard is limited to a maximum of two Hyper-V Containers.

15. The minimum memory required for a graphical Windows Server 2019 installation is 512 MB. True or False?

    Answer: False. 2 GB are required at minimum for a graphical Windows Server 2019 installation.

16. Which of the following Windows Server 2019 editions are licensed per processor core? (Choose all that apply.)

    a. Essentials

    b. Standard

    c. Datacenter

    d. Hyper-V Server

    Answer: b, c. Standard and Datacenter editions are licensed per core. Essentials is licensed per server, and Hyper-V Server is free.

17. Which of the following is not a question that should be asked when planning a Windows Server 2019 installation?

    a. What are the storage needs of the server?

    b. Who will be supporting the server?

    c. How many users are expected to connect to the server?

    d. What services will the server run?

    Answer: b. Capacity planning involves planning the hardware and software needs of a server based on the services that the server will provide and the number of

users that will connect to it. The person supporting the server following installation is not considered within this process.

18. To install a Windows Server 2019 virtual machine, you typically attach an ISO image file that contains the installation media to a virtual DVD drive within the virtual machine settings. True or False?

    Answer: True. While a virtual machine can be configured to boot from a physical DVD, it is more common to attach an ISO image file to the virtual DVD within the virtualization management software.

19. Which of the following tasks are typically performed following a Windows Server 2019 installation? (Choose all that apply.)

    a. Verify the correct time and time zone information

    b. Activate the Windows Server 2019 operating system

    c. Configure the appropriate computer name and domain membership

    d. Set IP configuration on network interfaces

    Answer: a, b, c, d. All of these tasks are typically performed following a Windows Server 2019 installation.

20. Server Manager is typically used to perform most post-installation tasks on a graphical Windows Server 2019 system. True or False?

    Answer: True. Server Manager is a graphical tool that is installed by default on Window Server 2019 and that can be used to perform all post-installation tasks.

Discovery Exercises

Discovery Exercise 1

Although answers will vary, some common benefits of virtualization in this environment include:

- Reduced licensing for future servers (a single Datacenter license can provide many licensed virtual machines)
- Less server hardware needed (provided that SAN storage is present)—e.g., 1U servers hosting multiple virtual machines
- Less power and cooling requirements
- The ability to run a virtual machine on any Hyper-V server on a rack following a server failure
- The ability to migrate a virtual machine to the cloud
- The ability to host a virtual machine in the cloud

Some common benefits of hosting the company Web apps within containers include:

- No additional licensing requirements
- Scalability
- The ability to migrate the container to the cloud
- The ability to host the container within the cloud

Discovery Exercise 2

Although answers will vary, some key considerations include:

- The edition and licensing required
- The hardware needs of the third-party app and database software
- The number of users that will connect to the server simultaneously
- Future scalability for both software and hardware

Discovery Exercise 3

Although answers will vary, some key features that Windows Server 2019 introduces beyond prior versions of Windows Server include enhanced security (e.g., Microsoft Defender ATS), more Azure cloud integration, the ability to run Linux apps using the Windows Subsystem for Linux, more scalability (e.g., unlimited logical processors), additional storage features, enhanced software defined networking for large datacenter environments that employ virtual machines, as well as additional speed improvements.

Discovery Exercise 4

Although answers will vary, an on-premises Windows Server 2019 system can centralize the authentication management of the PCs using Active Directory, provide key network services such as central file server storage, provide fault tolerance for key network services (e.g., clustering), as well as provide the ability to run Linux containers using the Windows Subsystem for Linux (to allow developers to test their Linux Web apps locally before deploying to the cloud).

Discovery Exercise 5

Although answers will vary, Server Core systems can easily be managed remotely using PowerShell, Server Manager, and the Windows Admin Center. As a result, there is no additional management overhead for using Server Core within your environment. Moreover, the Server Core App Compatibility Feature on Demand (FOD) framework can be added to provide additional compatibility for enterprise apps that rely on additional graphical frameworks.

Discovery Exercise 6

Although answers will vary, the IPv4 address shown indicates that a DHCP server was not available on the network, and an APIPA address was automatically configured. Similarly, the IPv6 address indicates that ICMPv6 could not auto configure an IPv6 address. You should first determine if the server is connected to

network media and within a network that provides IP auto-configuration. If the environment does not support IP auto-configuration, then you should manually configure the IPv4 settings (and possibly the IPv6 settings if IPv6 is used).

Discovery Exercise 7

Answers will vary—not available.

Module 1

Getting Started with Windows Server 2019

At a Glance

Instructor's Manual Table of Contents

- Overview
- Objectives
- Teaching Tips
- Quick Quizzes
- Class Discussion Topics
- Additional Projects
- Additional Resources
- Key Terms

Lecture Notes

Overview

In this module, your students begin their journey by learning about the different ways Windows Server 2019 can be used within an on-premises or cloud environment. The important concept of hypervisors is introduced, with emphasis placed on Microsoft's Hyper-V product. This is because Microsoft's Hyper-V is often used to host a Windows Server 2019 virtual machine on-premises. Additionally, the nested virtualization feature of Hyper-V makes it attractive within cloud environments and IT lab environments. Another important topic, containers, is discussed next. Containers support the hosting of Web apps. In particular, students will learn how Hyper-V containers allow each container to access a separate copy of the underlying Windows Server kernel. With those concepts understood, the key features of Windows Server 2019 are reviewed next. This is followed by a discussion of the important tools used to configure and manage Windows Server 2019. It is imperative that your students understand how these tools work before moving on to the installation process. As part of that installation process, pre-planning concepts are explained. Your students will learn about the various Windows Server 2019 editions, capacity planning issues, and obtaining the installation media for Windows Server 2019. With these concerns understood, students are explicitly guided through the installation process. To culminate this module, students are introduced to the finalizing tasks that complete the installation process.

Module Objectives

- Summarize the different ways that Windows Server 2019 can be used within an on-premises or cloud environment
- Explain the purpose and function of Windows virtual machines and containers
- Outline the key features of Windows Server 2019
- Identify the differences between Windows Server 2019 editions
- Discuss the considerations necessary to plan for a Windows Server 2019 installation
- Describe the concepts and processes used to perform a Windows Server 2019 installation
- Outline common post-installation configuration tasks for Windows Server 2019
- Identify the different virtualization configurations that can be used to explore Windows Server 2019 within an IT lab environment

Teaching Tips

Using Windows Server 2019 within an Organization

1. Discuss the rise of computer networks and the Internet in the 1990s.

2. Distinguish between the concepts of a client and a server.

3. Explain how any operating system can function as a server.

4. Introduce the different types of servers including on-premises servers, cloud servers, and rackmount servers and blade servers.

5. Describe how rackmount servers are defined by the form factor concept of 1U or 2U and emphasize characteristics of rackmount servers.

Teaching Tip	Take the time to explain the characteristics and notation for a rackmount server in terms of the minimum height of 1.75 inches, the meaning of "U" in 1U and 2U, and the type of devices stored in a rack.

6. List and describe the many types of devices that can reside in a rack. Be sure to include and define storage area network (SAN) devices, which provide a large amount of hard disk or solid state disk (SSD) storage for the servers within the rack, as well as one or more uninterruptible power supply (UPS) devices.

7. Refer to Figure 1-1 to illustrate a sample server rack configuration that hosts three 1U servers (Web server, file server, and firewall server), two 2U servers (database server and email server), a 2U UPS, a 4U SAN, and a management station with a shared monitor/keyboard/mouse.

Teaching Tip	If you have students who would like a broader history lesson in computers beyond networking as a whole, refer them to the article titled "Timeline of Computer History" at this Website: https://www.computerhistory.org/timeline/networking-the-web/

Understanding Windows Server Virtualization

1. Define virtualization as the process of running more than one operating system at the same time on a single computer.

2. Explain that virtualization requires hypervisor software that allows the hardware to host multiple operating systems.

3. Note that there are two types of hypervisors: Type 2 and Type 1. Discuss characteristics of each type of hypervisor. Refer to Figure 1-2 to compare the two hypervisor types.

4. Provide examples of Type 2 and Type 1 hypervisors, emphasizing that Microsoft's Hyper-V is a Type 1 hypervisor.

Teaching Tip	More information on Type 1 and Type 2 hypervisors can be found on this Website: https://searchservervirtualization.techtarget.com/feature/Whats-the-difference-between-Type-1-and-Type-2-hypervisors

5. Describe the advantage hypervisor acceleration provides. Distinguish between hypervisor acceleration in AMD and INTEL processing machines.

6. Describe the advantage of utilizing Second Level Address Translation (SLAT) extensions with a hypervisor today.

7. Mention that all virtual machines store their configuration within a small configuration file specific to the hypervisor.

8. Explain that another virtual hard disk file is needed to hold the virtual machine operating system. Distinguish between thick provisioning and thin provisioning with respect to allocating this file. Emphasize that thin provisioning is often preferred for server virtualization as it conserves space on the underlying server storage hardware.

9. Point out that most on-premises and cloud operating systems today are virtual machines, and the virtual hard disk files that contain each virtual machine operating system are often hosted on a SAN within the organization or cloud data center. Mention that this configuration reduces the number of storage devices needed within the rackmount servers on the rack, which in turn reduces the space needed to host the server hardware.

10. Refer to Figure 1-3 to illustrate how most servers today that run a hypervisor and virtual machines are 1U, allowing the rack to accommodate more rackmount servers in the same space.

11. Discuss the concept of nested virtualization. Define nested virtualization as the ability to run other virtual machines within an existing virtual machine. Emphasize that nested virtualization is a feature of Microsoft's Hyper-V hypervisor.

12. Refer to Figure 1-4 to illustrate nested virtualization. Explain that for nested virtualization to work, both management operating systems illustrated in Figure 1-4 must run either Windows 10, Windows Server 2016, or Windows Server 2019.

13. Discuss the advantages of using nested virtualization. Be sure to mention that nested virtualization gives cloud data centers the ability to implement a more complex virtualization structure that suits their needs. Additionally, mention that nested virtualization gives software developers and IT administrators the ability to implement a complex virtualization structure on their Windows 10 PCs for learning and testing purposes.

14. Mention that nested virtualization must be enabled in the underlying Hyper-V using a Windows PowerShell command.

Teaching Tip	More information on nested virtualization can be found on this Website: https://docs.microsoft.com/en-us/virtualization/hyper-v-on-windows/user-guide/nested-virtualization#prerequisites

Understanding Windows Containers

1. Introduce this topic by reminding students that although virtualization makes more efficient use of server hardware, each virtual machine running on a hypervisor is a complete operating system that must be managed and secured like any other operating system running exclusively on server hardware.

2. Refer to Figure 1-5 to define and describe a container. Mention that containers do not have a complete operating system. Explain that a container is a subset of an operating system composed of one or more Web apps and the supporting operating system files needed by those Web apps only. Point out that containers must be run on an existing operating system that has container software installed.

3. Explain the concept of sandboxing by mentioning that an enclosed container's Web apps are executed in a way that isolates them from Web apps running within other containers and the underlying operating system.

4. Emphasize that to allow each Web app to be uniquely identified on the network, each container functions as a virtual operating system with a unique name and IP address.

5. Discuss why containers are well-suited for cloud environments, where resource efficiency and scalability are important for controlling data center costs.

6. Introduce the most common container software used to implement containers on operating systems today: Docker. Explain that the underlying component within Windows Server 2016 and later that allows an administrator to install and use Docker is called Windows Containers.

7. Mention that the core component of an operating system that executes all other components of the operating system is called the kernel.

8. Emphasize that containers do not contain a kernel, and thus must rely on the kernel in the underlying operating system to execute Web apps that they host.

9. Refer back to Figure 1-5 and explain that the three Web apps shown in the figure must be written for the Windows operating system and run within a Windows container if they are to use an underlying Windows operating system kernel for execution.

10. Emphasize the issues with the setup shown in Figure 1-5. First, the underlying operating system kernel is a single point of failure. Second, too many containers on a single underlying operating system may slow down the performance of the kernel or cause it

to crash. Third, one container could potentially access another container running on the same underlying kernel if a security loophole were exploited.

11. Use Figure 1-6 to discuss how these problems could be addressed by using Hyper-V alongside containers to provide a separate copy of the underlying kernel to each container. Note that these Hyper-V containers use the functionality of Hyper-V alongside Windows containers to provide additional performance and security features to Web apps that are run within containers on Windows Server.

Teaching Tip	For more information regarding Windows containers, please see the following Web site: https://docs.microsoft.com/en-us/virtualization/windowscontainers/about/

Windows Server 2019 Features

1. Inform your students that this section describes the following Windows Server 2019 features:

   - Active Directory
   - Security
   - Volume and filesystem features
   - Performance and reliability
   - Administration tools
   - Small footprint installation options
   - Hybrid cloud features
   - Linux application support

Active Directory

1. Introduce this topic by first explaining how a workgroup is a logical grouping of computers on a network. Mention that any Windows client or Windows Server operating system can be part of a workgroup. Point out that the default name for a workgroup is WORKGROUP.

2. Explain that workgroups implement peer-to-peer networking as each computer (or peer) on the network maintains its own shared resources, users, groups, and security.

3. Explain how authentication takes place in a workgroup.

4. Discuss the issues that can occur with a workgroup implementation.

5. Describe how a domain, a domain controller, and single sign-on are used to overcome the failures in the workgroup setup.

6. Introduce and define Active Directory as the software component that collectively provides the functionality for authentication using domains, domain controllers, and single sign-on.

7. Mention that Windows Server can easily be configured as an Active Directory domain controller to provide single sign-on for other computers that are joined to a domain.

8. Describe the other Active Directory services and components that can be used to centrally manage and secure the computers that are joined to the domain.

9. Define Group Policy as an Active Directory feature that can be used to configure operating system settings, security, and software for different computers and users in the domain.

10. Define Active Directory Certificate Services as a feature that can be used to automate the configuration of deployment of encryption certificates to domain computers and users.

11. Define Azure Active directory as a service hosted within Microsoft's Azure cloud to provide Active Directory services to an organization. Emphasize that Windows Server 2019 provides easier integration between Active Directory and Azure Active Directory.

Security

1. Point out that Windows Server 2019 is built to be even more secure than previous Windows Server systems.

2. Emphasize that Windows Server 2019 is implementing security by default.

3. Describe how Windows Server 2019 has more protection against malware. Mention that Microsoft Defender monitors the server for malware and automatically stops processes that are known to be dangerous. Explain how Microsoft Defender Advanced Threat Protection (ATP) performs deeper inspections of files and processes.

4. Review the feature called shielded virtual machines, which was introduced in Windows Server 2016. Mention that the concept of shielded virtual machines ensures that malicious users cannot access the virtual hard disk files used by Hyper-V virtual machines because Microsoft added BitLocker encryption support for these files.

5. Describe how Windows Server 2019 places more emphasis on security within the Internet Information Services (IIS) Web server software. Mention that there are additional modules enabling IIS to have a lower attack surface (vulnerable openings exposed to network attackers and malicious software), as well as allow modular security updates to quickly repair vulnerabilities that are found in the future.

6. State that Windows Server 2019 additionally includes basic security features, such as:
   - File and folder permissions
   - Security policies
   - Encryption of data

- Event auditing
- Various authentication methods
- Server management and monitoring tools

Volume and Filesystem Features

1. Introduce this topic by informing students that Windows Server 2016 and Windows Server 2019 support both the traditional New Technology File System (NTFS) available since Windows NT Server and the new Resilient File System (ReFS).

2. Introduce the many features of NTFS.

   - Built-in support for file and folder permissions, compression, Encrypting File System (EFS) encryption for individual files and folders, and user quotas that can be used to limit the space users are allowed to consume.
   - Support for data deduplication (data dedup for short), which saves space by allowing duplicate files on a volume to be stored once on the physical storage device. In Windows Server 2019, an administrator can now create NTFS large disk volumes of up to 8 PB (Windows Server 2016 only supports volumes of up to 256 TB).
   - NTFS is also a journaling file system, which means that it tracks changes to files and keeps a record of these changes in a separate log file.
   - Explain the advantage of the NTFS volume self-healing capability introduced with Windows Sever 2008. Mention that with NTFS volume self-healing, when software encounters a damaged disk area, NTFS can heal the area without having to take down the server.
   - NTFS also works very well in a virtualized environment because of the way that it works with file system cache.

3. Introduce the features of ReFS, emphasizing that it is still regarded as a filesystem in development.

   - Begin by defining a storage space as a feature first introduced in Windows Server 2016 that allows an administrator to build large, fault-tolerant volumes that span multiple physical storage devices.
   - Explain that the third-generation version of ReFS (ReFS v3) was made available in Windows Server 2019 and comes with additional performance and feature improvements, including support for data deduplication and dramatically improved performance with Storage Spaces.

4. Define Storage Replicas as a feature introduced in Windows Server 2016 that provides the ability to replicate data between two different servers seamlessly. Mention that that in Windows Server 2019, Storage Replicas now have better performance and are supported in more editions.

5. Mention that Microsoft released a new Storage Migration Service in Windows Server 2019 that simplifies the moving of data to newer systems, as well as to systems in the Azure cloud.

Performance and Reliability

1. Explain that several features make Windows Server 2019 reliable and powerful.
   - Privileged mode
   - Protected processes
   - Multitasking
   - Multithreading
   - Processor scalability
   - Server clustering

2. Describe the features privileged mode and protected processes provide.
   - Explain that the Windows kernel runs in privileged mode, which protects it from problems created by a malfunctioning program or process.
   - Point out that in addition to privileged mode, Microsoft uses protected processes in Windows Server 2012 and later to improve stability and performance.
   - Define the term *process* as a computer program or portion of a program that is currently running.
   - Define the term *protected process* as a process that cannot be influenced by a user or other processes on the system.

3. Describe the features multitasking and multithreading provide.
   - Emphasize that Windows Server 2019 and other recent Windows systems take full advantage of the multitasking and multithreading capabilities of modern computers.
   - Define the term *multitasking* as the ability to run two or more programs at the same time.
   - Point out that multithreading is the capability of programs written to run several program code blocks (called threads) at the same time.
   - Mention that the multitasking in Windows Server 2019 is called preemptive multitasking. Explain that this means each program runs in an area of memory separate from areas used by other programs.
   - Emphasize that the advantage of preemptive multitasking is that it reduces the risk of one program interfering with the smooth running of another program, thus increasing reliability.

4. Describe the features processor scalability provides.
   - Introduce this topic by pointing out that one of the reasons why Windows Server has become such a versatile and powerful operating system is that it can be easily scaled upward in processor capacity.
   - Define a physical processor as a processor that is plugged into a processor socket on the motherboard of the computer. Note that Windows Server 2019 can support up to 64 sockets for individual physical processors.
   - Discuss the concept of logical processors, noting that one physical processor can house several logical processors. Explain that each logical processor is called a core and it can run its own executable threads.
   - Discuss the concept of virtual processors. Explain that when a computer is functioning as a virtual server, each virtual machine can be set up to use logical

processors as virtual processors. Note that in this case, a virtual processor is a logical processor that functions for the use of a specific virtual machine.

5. Describe the features server clustering provides.
   - Refer to Figure 1-7 and define clustering as the ability to increase the access to server resources and provide fail-safe services by linking two or more discrete computer systems so they appear to function as one.
   - Explain that an administrator can configure a server cluster to provide both increased speed and fault tolerance. Point out that an administrator can configure a server cluster for fault tolerance only. Explain how this provides a process called failover because in this configuration, one server actively responds to client requests, while another one only responds to client requests if the other one fails.
   - Note that server clusters are often used for frequently accessed and mission-critical services, such as databases.
   - Describe the feature called Storage Spaces Direct.
   - Review the Windows Server 2019 clustering tools.
     - Create a cluster configuration and test to ensure it is set up to accomplish the tasks for which it is intended
     - Migrate configuration settings from one cluster to another
     - Troubleshoot cluster problems
     - Set up and optimize the storage used in a cluster
     - Secure a cluster and enable it to use new network capabilities

Teaching Tip	Clustering enables a large amount of disk storage to be made available to users, with failover for disk storage as well.

Administration Tools

1. Explain that administration tools are used to manage the servers and services on the network.

2. State that the major administration tools used with Windows Server 2019 include Server Manager, Windows PowerShell, and the Windows Admin Center.

3. Describe the advantages of using Server Manager.
   - Explain that the Server Manager tool was originally introduced in Windows Server 2008, with each subsequent version of Windows Server adding even more enhancements.
   - Use Figure 1-8 to illustrate how Server Manager allows an administrator to monitor and manage the configuration of the local server it is running on, as well as multiple servers on the network if an administrator chooses to add additional servers to the Server Manager interface.
   - State the tasks Server Manager is often used to complete.
     - View computer configuration information
     - Add, remove, and configure server roles, features, and system properties
     - Configure networking and security (including a firewall)

  - Configure Remote Desktop
  - Troubleshoot service and performance problems
  - Configure and manage storage
  - Configure and manage Active Directory objects
- Explain that most server configuration is still performed using Microsoft Management Console (MMC) snap-in tools that run outside of Server Manager and that they are specialized for a specific component or service (e.g., the Group Policy Management MMC snap-in tool).

Teaching Tip	Demonstrate how to use the Microsoft Management Console (MMC) snap-in tools.

4. Describe the advantages of using Windows PowerShell.
   - Explain why Microsoft created a new shell in 2006 called Windows PowerShell that provided these features to computers running Windows and Windows Server.
   - Mention that commands within Windows PowerShell are called cmdlets and have an action-object (or verb-noun) structure.
   - Refer to Figure 1-9 to illustrate how to obtain computer system information from the Windows Management Instrumentation (WMI).
   - Emphasize that Windows PowerShell is run as an Administrator account.
   - Review common tasks performed by administrators within Windows PowerShell.
     - Working with files and folders
     - Monitoring and managing disk storage
     - Configuring network settings and troubleshooting network connectivity
     - Installing and managing software applications and server roles
     - Viewing configuration information for auditing and inventory purposes
     - Managing services and processes
     - Restarting multiple computers within a domain environment
     - Managing Active Directory users and groups
   - Explain that Windows PowerShell is a powerful scripting language and an administrator can place cmdlets within text files alongside control structures that modify how the cmdlets are executed. Mention that these PowerShell scripts can then be executed to perform a series of tasks that can be re-executed periodically in the future as necessary.

Teaching Tip	Demonstrate how to write and run a short PowerShell script.

5. Describe the advantages of using Windows Admin Center.
   - Emphasize that Windows Admin Center is a new Web-based management tool in Windows Sever 2019.
   - Note that Windows Admin Center is not installed by default.
   - Discuss how to download and install the Windows Admin Center. Refer to Figure 1-10 to illustrate the Overview page.

- State some of the administrative tasks that an administrator can perform in the Windows Admin Center.
  - Performing system updates
  - Displaying resources and resource utilization
  - Managing encryption certificates
  - Managing hardware devices
  - Viewing system events
  - Managing files and server storage
  - Configuring firewall and network settings
  - Managing installed software, processes, and services
  - Configuring local user accounts (not Active Directory)
  - Editing the Windows registry
  - Scheduling tasks
  - Managing Hyper-V virtual machines
  - Managing clusters
  - Managing Azure cloud integration and services
  - Obtaining a Windows PowerShell console or Remote Desktop connection

Teaching Tip	Demonstrate how to download and install the Windows Admin Center from the official Microsoft Web site at: https://aka.ms/WindowsAdminCenter

Small Footprint Installation Options

1. Explain that a small footprint server installation involves installing Windows Server 2019 with a minimal set of services, features, and functionality.

2. Mention the security advantage resulting from small footprint installations in terms of having a smaller attack surface.

3. Discuss why small footprints are more suitable for cloud environments. Point out that they use far less storage, memory, and processor resources on a server, and can be installed within a virtual machine or used as a container.

4. Introduce the two small footprint installation options in Windows Server 2019: Server Core and Nano Server. Discuss the details and characteristics of each version.

5. Refer to Figure 1-11 to illustrate the use of the Windows Server Configuration Wizard within Server Core.

6. Explain why many Microsoft and third-party software packages cannot be installed on Server Core. Note that an administrator can download and install the Server Core App Compatibility Feature on Demand (FOD) framework to add many of the needed .Net components and allow more software to work on Server Core.

7. Mention that the FOD framework adds several graphical management tools back into Server Core. These include:

- Microsoft Management Console (MMC)
- Event Viewer
- Performance Monitor
- Resource Monitor
- Device Manager
- File Explorer
- Disk Management
- Failover Cluster Manager
- Hyper-V Manager

Hybrid Cloud Features

1. Explain what is meant by a hybrid cloud.

2. Mention that the Windows Server Azure Network Adapter allows an administrator to easily connect their on-premises Windows Server systems with other virtualized Windows Servers and services in the Azure cloud using a secure connection.

3. Point out that an administrator can use Azure Backup to back up important information to storage in the Azure cloud. Note that an administrator can use Azure Update Management to centrally manage the updates for on-premises computers and virtual machines running in Azure. Finally, state that Azure Site Recovery ensures that key services that an administrator needs to run on-premises are made automatically available in the Azure cloud if a failure is encountered for an on-premises server.

4. Emphasize that hybrid cloud features can be configured and monitored using the Windows Admin Center tool.

5. Explain how Kubernetes, which is a software product that can coordinate the execution and management of both on-premises containers as well as containers hosted within the Azure cloud, is utilized.

Linux Application Support

1. Explain how most Web apps that run in the cloud run within Linux containers.

2. Discuss how Microsoft's Windows Subsystem for Linux (WSL) makes it easier for Web app developers to create and test Linux apps on their Windows 10 PCs.

Windows Server 2019 Editions

1. Describe what is meant by an edition of Microsoft Windows Server 2019.

2. List the major Windows Server 2019 editions.
   - Windows Server 2019 Essentials Edition
   - Windows Server 2019 Standard Edition

- Windows Server 2019 Datacenter Edition

3. Name the two additional Windows Server 2019 editions, noting that each can be customized for a specific use.
   - Windows Storage Server 2019
   - Microsoft Hyper-V Server 2019

Windows Server 2019 Essentials Edition

1. Describe the characteristics of Windows Server 2019 Essentials Edition.

2. Refer to Table 1-1 to summarize Windows Server 2019 Essentials Edition and compare its features to those of the other editions.

Windows Server 2019 Standard Edition

1. Describe the characteristics of Windows Server 2019 Standard Edition.

2. Refer to Table 1-1 to summarize Windows Server 2019 Standard Edition and compare its features to those of the other editions.

Windows Server 2019 Datacenter Edition

1. Describe the characteristics of Windows Server 2019 Datacenter Edition.

2. Refer to Table 1-1 to summarize Windows Server 2019 Datacenter Edition and compare its features to those of the other editions.

Windows Storage Server 2019

1. Describe the characteristics of Windows Storage Server 2019 Edition.

Microsoft Hyper-V Server 2019

1. Describe the characteristics of Microsoft Hyper-V Server 2019.

Quick Quiz 1

1. Which of the following terms best describes the ability to increase the access to server resources and provide fail-safe services by linking two or more discrete computer systems so that they appear to function as though they are one?
   a. routing
   b. clustering
   c. failover
   d. back-up

   Answer: b. clustering

2. Which Windows Server 2019 footprint installation option is ideal for use within cloud environments that require the hosting of Web apps and supporting services only?
   a. Windows Core Server
   b. Windows Nano Server
   c. Server Manager
   d. Windows PowerShell

   Answer: b. Windows Nano Server

3. Which of the following describes the ability to run two or more programs at the same time?
   a. threading
   b. caching
   c. multitasking
   d. buffering

   Answer: c. multitasking

4. Which type of multitasking in Windows Server 2019 is used to run each program in an area of memory separate from areas used by other programs?
   a. preemptive
   b. non-preemptive
   c. core
   d. kernel

   Answer: a. preemptive

Preparing for a Windows Server 2019 Installation

1. Open this topic by emphasizing that an operating system installation will go better if detailed advanced planning is performed.

2. Review the steps to prepare for a server installation.
   - Explain how to determine hardware requirements. Refer to Table 1-2 to illustrate the minimum hardware requirements for Windows Server 2019.
   - Define and discuss the concept of capacity planning. As a starting point, review questions to consider when performing capacity planning for Windows Server 2019.
   - Explain how to consider processing speed in the install process, and point out that administrators need to pay particular attention to the number of processors.
   - Discuss how administrators can ensure that their server has enough memory for the applications that it will host, as well as free memory slots for future scalability.
   - Explain how to determine the amount and type of storage needed. Be sure to review fault tolerance using RAID, the use of additional hard disks, additional SSDs, and virtual machine hard disk files.

Teaching Tip	For more information on RAID, see the following Web site: http://www.raid-calculator.com/what-is-raid.aspx

Installing Windows Server 2019

1. Explain that a Windows Server 2019 installation can be broken down into three separate tasks:
   - Obtaining installation media
   - Starting the installation process
   - Completing the installation process

Obtaining Installation Media

1. Explain that the most common method used to install Windows Server is by booting a computer or virtual machine from installation media. Present some common media such as a bootable DVD or USB flash or an ISO image file.

2. Introduce some well-known disc burning software such as Burnaware or Rufus that can be used to copy a downloaded ISO image file to a DVD.

3. Emphasize the importance of downloading the correct ISO image file. Name the three separate ISO images available for Windows Server 2019.
   - Window Server 2019 Essentials
   - Windows Server 2019 Standard and Datacenter (which also includes the associated Server Core versions)
   - Microsoft Hyper-V Server 2019

Teaching Tip	Go to the Web site for Burnaware (https://www.burnaware.com) or Rufus (https://rufus.ie/) and demonstrate how to find, download, and install the disc burning software.

Starting the Installation Process

1. Introduce this topic by reminding students that they must have the installation media before starting this installation process.

2. Explain why an administrator might have to first modify the boot order within the computer BIOS. Review the multiple ways to change the order.

3. Refer to Figure 1-12 for an example of boot order within a BIOS.

Teaching Tip	Demonstrate how to enter the BIOS on an instructor lab machine. Demonstrate how the boot order is changed. Demonstrate rebooting the machine using different boot orders. Note how the order works, explain any failures that might occur, and explain how to correct any boot failures.

4. Mention that starting an installation of a virtual machine is similar to starting a physical server.

5. Refer to Figure 1-13 and Figure 1-14 and explain that when creating a new virtual machine within a virtualization configuration program, such as Hyper-V Manager, an administrator can attach an ISO image file that contains Windows Server 2019 installation media to the virtual DVD drive within the virtual machine, as well as configure the virtual machine BIOS with a boot order that is set to boot from a DVD before the virtual hard disk file.

6. Explain that when an administrator starts the virtual machine within their virtual machine software, it will boot the Windows Server 2019 installation media stored within the ISO image attached to the virtual DVD and start the installation process.

Completing the Installation Process

1. Introduce this section by noting that after an administrator starts a Windows Server 2019 installation, the remainder of the installation process is relatively straightforward.

2. Refer to Figure 1-15 to illustrate the first screen the installation program displays. Mention that the prompts available for an administrator are to enter the regional locale and keyboard format.

3. Refer to Figure 1-16 to illustrate the second screen in the installation process. Mention that an administrator is presented with the option to start an installation of Windows Server 2019 in the middle of the screen or to use the installation media to repair an already installed system that is unable to start (option located in the lower left corner).

4. Remind students that an installation is being performed in this example, so the Install now option should be selected.

5. Refer to Figure 1-17 to illustrate the prompts allowing the administrator to choose their desired Windows Server 2019 edition. Review the available editions and their characteristics if necessary.

6. Mention that after selecting the desired Windows Server 2019 edition, the administrator will be prompted to accept the Microsoft license terms for Windows Server 2019.

7. Refer to Figure 1-18 and explain that an administrator will be prompted to choose the type of installation desired. Note that the choices are Upgrade or Custom. Mention that on a new server, an administrator normally selects the Custom installation option to perform a new installation of Windows Server 2019.

8. Explain that after selecting the Custom installation option to perform a new installation of Windows Server 2019, an administrator must choose the storage location of the Windows Server operating system. Refer to Figure 1-19 to illustrate choices that are available when choosing the storage location of the Windows Sever operating system.

9. Refer to Figure 1-19 again. Note that an administrator can select an entire storage device, and the installation program will automatically create partitions on the device.

10. Refer to Figure 1-19 once more. Explain that alternatively an administrator can choose to create their own partitions by selecting the New button in Figure 1-19 and then format the partition with the filesystem of their choice (NTFS or ReFS). Explain that if an administrator's storage device has existing partitions, he or she can choose to delete them, re-format them, or extend their size.

11. Mention that the remainder of the installation process copies and configures Windows Server 2019, which could take several minutes. Point out that when the installation process completes, the system will restart and boot into Windows Server 2019. Emphasize that at this point, an administrator can safely remove any installation media from the computer or virtual machine to ensure that the boot process does not attempt to start another installation.

12. Refer to Figure 1-20 to illustrate that on the first boot following installation, an administrator will be prompted to specify a password for the local Administrator user account.

13. Refer to Figure 1-21 to illustrate the login screen.

Post-Installation Configuration

1. State the key configuration tasks that need to be performed following any Windows Server 2019 installation.
   - Setting the correct time and time zone
   - Configuring the Internet Protocol (IP) on the server's network interfaces
   - Configuring the firewall
   - Changing the default computer name and domain membership
   - Installing a modern Web browser
   - Activating the Windows Server operating system

Setting the Correct Time and Time Zone

1. Explain why it is important to set the correct time zone.

2. Mention that by default, Microsoft sets the time to the time listed in the BIOS clock, and the time zone to Pacific Time (the time zone for Microsoft's headquarters).

3. Explain that to change the time and time zone for a server within Server Manager, an administrator must navigate to Local Server and select the hyperlink next to Time zone in the Properties window. Refer to Figure 1-8 to illustrate this window.

4. Refer to Figure 1-11 and explain that to change the time and time zone within the Windows Server Configuration Wizard on Server Core, an administrator must select option 9.

Configuring the Network

1. Introduce this topic by noting that most functions computers perform today involve the sharing of information between computers on a network.

2. Describe how to connect a computer to a network. Explain the purpose of a network interface. Mention that a protocol breaks information down into packets that can be recognized by computers, routers, and other devices on a network.

3. Discuss the three protocols used by nearly all Windows computers.
   - Transmission Control Protocol/Internet Protocol (TCP/IP), which provides reliable communication of packets across networks and the Internet.
   - User Datagram Protocol/Internet Protocol (UDP/IP), which provides fast, yet unreliable communication of packets across networks and the Internet.
   - Internet Control Message Protocol (ICMP), which is used to send network-related information and error messages across networks and the Internet.

4. Explain that TCP/IP is actually a set, or suite, of protocols with two core components: TCP and IP. Mention that together, these two protocols ensure that information packets travel across a network as quickly as possible without getting lost or mislabeled.

5. Describe the characteristics of TCP. Mention that TCP ensures that any lost packets are retransmitted.

6. Explain the characteristics of IP. Mention that IP is responsible for labeling each packet with the destination address. Note that each computer that participates on an IP network must have a valid Internet Protocol (IP) address that identifies it to the IP protocol.

7. Point out that nearly all computers on the Internet use a version of the IP protocol called IP version 4 (IPv4). Point out that a small number of computers use a next-generation IP protocol called IP version 6 (IPv6).

8. Describe the purpose and characteristics of IPv4. Be sure to review the binary process called ANDing used to find the network ID. Refer to Figure 1-22 as an example.

9. Describe the purpose and characteristics of IPv6.

10. Describe how to configure IP on a network interface. Explain that an administrator can manually configure the necessary IP address, subnet mask, and default gateway on a network interface for their network. Discuss how a network can receive an IP configuration automatically from a Dynamic Host Configuration Protocol (DHCP) or Boot Protocol (BOOTP) server on the network.

11. Point out that to manually configure IP on a network interface within Server Manager, navigate to Local Server and select the hyperlink next to the associated network interface, such as the Ethernet network interface shown earlier in Figure 1-8. This will open the properties for the network interface as shown in Figure 1-23. Explain that an

administrator can then select either IPv4 or IPv6 shown in Figure 1-23 and click Properties to modify the associated IP configuration parameters.

12. Explain that if an administrator selects IPv4 and chooses Properties, he or she can enter an IP address, subnet mask, default gateway, preferred DNS server IP address, and alternate DNS server IP address (used if the preferred DNS server is unavailable), as shown in Figure 1-24. If the administrator is using Server Core, he or she can modify the same IP configuration for IPv4 and IPv6 by selecting option 8 within the Windows Server Configuration Wizard, shown earlier in Figure 1-11.

Configuring the Firewall

1. Explain why a firewall is necessary, noting that it prevents computers on the network from connecting to software and services that are running on a computer.

2. Point out that the firewall in Windows Server 2019 is enabled by default and blocks access to any software or services that have not been configured (only file sharing is configured by default and allowed within the firewall).

3. Explain the concept of a perimeter network, also known as a demilitarized zone (DMZ). Point out that it is a separate network surrounded by routers implementing advanced firewall capabilities for all traffic that is passing into the network from other computers within the organization and Internet. Mention that a perimeter network contains servers.

4. Emphasize that servers within a perimeter network do not need to have a firewall configured as they are protected by the network firewalls on the routers surrounding them. Mention that many server administrators disable the firewall on these servers to make future troubleshooting of user access easier.

5. Refer to Figure 1-8 and illustrate how to disable or modify the firewall's configuration within Server Manager. Explain that an administrator would navigate to Local Server and select the hyperlink next to Windows Defender Firewall in the Properties window.

Teaching Tip	For more information regarding a DMZ, please see the following Web site: https://searchsecurity.techtarget.com/definition/DMZ

Changing the Default Computer Name and Domain Membership

1. Explain that when Windows Server 2019 is installed, the installation process assigns a randomly generated computer name for the server.

2. Review some of the issues associated with a randomly generated computer name.

3. Review the rules that must be followed for a computer name. Define a NetBIOS name and explain how it is used with a computer name.

4. Refer to Figure 1-8 and explain how to change a computer name within Server Manager. Explain that an administrator navigates to Local Server and selects the hyperlink next to Computer name in the Properties window. Mention that at this point, the System Properties window is open and an administrator can click the Change button and supply a new computer name in the Computer name field as shown in Figure 1-25.

5. Refer to Figure 1-25 and explain how to change the computer name within the Windows Server Configuration Wizard on Server Core by selecting option 2.

6. Explain why an administrator will need to join a Windows Server 2019 to an Active Directory domain following installation.

7. Refer to Figure 1-8 and review the steps to join a server to a domain within Server Manager.

8. Refer to Figure 1-11 and review the steps to join a server to a domain within the Windows Server Configuration Wizard on Server Core by selecting option 1. Then explain that an administrator must supply the Active Directory domain name and log in as a valid domain user when prompted.

Installing a Modern Web Browser

1. Point out that the default Web browser that ships with Windows Server 2019 is Internet Explorer.

2. Explain that the default browser is included for legacy application support only, and that most modern Web tools, such as the Windows Admin Center, do not support it.

3. Provide a list of suggested modern browsers than can be used such as Edge Chromium or Google Chrome.

4. Define and describe the Internet Explorer Enhanced Security Configuration (IE ESC). Explain why an administrator must disable IE ESC before using Internet Explorer to download a modern Web browser.

5. Refer to Figure 1-8 to illustrate how to disable IE ESC within Server Manager.

Teaching Tip	Demonstrate how to locate, download, and install a modern browser such a Chrome. The Web site is at: https://www.google.com/chrome/

Activating the Windows Server Operating System

1. Discuss why it is necessary to activate a Windows operating system.

2. Explain that activation may be automatically performed based on the Generic Volume License Key (GVLK) if an organization has Key Management Services (KMS) installed

on a server within the network, or the Active directory-based Activation role installed on a domain controller within the domain to which the student's Windows Server 2019 computer is joined.

3. Mention that if an organization has purchased a retail product key or Multiple Activation Key (MAK) that can be used to activate a set number of computers, then an administrator can manually enter this key on their Windows Server 2019 computer to perform the activation if the system is connected to the Internet.

4. Refer to Figure 1-8 and explain how to manually activate a Windows Server 2019 system within Server Manager by navigating to Local Server and selecting the hyperlink next to Product ID in the Properties window. Next, enter the organization's license key and click Activate to complete the activation process.

Selecting a Windows Server 2019 Lab Environment

1. Explain that future Hands-On Projects within this book will require the use of Hyper-V to create multiple Windows Server 2019 virtual machines as necessary.

2. Refer to Figure 1-26 to illustrate how an administrator can install Windows Server 2019 directly on a computer and use Hyper-V to host these virtual machines. Explain why this may be impractical to implement.

3. Refer to Figure 1-27 to illustrate how an administrator can use Windows 10 Professional, Enterprise, and Education editions because they support Hyper-V and nested virtualization.

4. Mention which Hands-On Projects can be performed using each of the two scenarios.

Quick Quiz 2

1. Which term refers to the IP address of the network interface on a router to which packets are sent?
   a. forwarding router
   b. default gateway
   c. default router
   d. outbound IP

   Answer: b. default gateway

2. Which term refers to a protocol that takes IPv6 traffic and encapsulates it for transmission on an IPv4 network?
   a. Teredo
   b. APIPA
   c. TCP/IP
   d. DHCP

   Answer: a. Teredo

3. Which term refers to a separate network that is surrounded by routers that implement advanced firewall capabilities for all traffic that is passing into the network from other computers within the organization and Internet?
    a. DHCP
    b. APIPA
    c. DMZ
    d. UDP

   Answer: c. DMZ

4. Which server is used to resolve Internet names, such as www.google.ca, to IP addresses such that a user can connect to Internet resources by name?
    a. DHCP
    b. DNS
    c. APIPA
    d. WINS

   Answer: b. DNS

Class Discussion Topics

1. What are the main characteristics of a network operating system?

2. Compare DHCP with APIPA. What are the benefits of having both of these protocols available within a network?

3. Why are containers important as an alternative to virtual machines?

Additional Projects

1. Ask your students to research the importance of nested virtualization and generate a short presentation on the topic (6-10 slides) that they can volunteer to present to the class.

2. APIPA is an alternative to DHCP for small private networks. Ask your students to read more about APIPA and write a report explaining the basic characteristics and functions of APIPA.

3. Have your students research the value of utilizing a Windows Server 2019 Nano Server to create a cloud-based server. Why is this specific server type, which utilizes a small footprint, used for datacenters?

Additional Resources

1. What's new in Windows Server 2019
   https://docs.microsoft.com/en-us/windows-server/get-started-19/whats-new-19

2. Hyper-V on Windows Server
   https://docs.microsoft.com/en-us/windows-server/virtualization/hyper-v/hyper-v-on-windows-server

3. Windows Server release information
   https://docs.microsoft.com/en-us/windows-server/get-started/windows-server-release-info

4. Pricing and licensing for Windows Server 2019
   https://www.microsoft.com/en-us/cloud-platform/windows-server-pricing

5. How to Install Windows Server 2019 Step by Step
   https://computingforgeeks.com/install-windows-server-2019/

6. Windows Server documentation
   https://docs.microsoft.com/en-us/windows-server/

Key Terms

- **1U server** A rackmount server that is 1.75 inches high.
- **Active Directory** A central database of computers, users, shared printers, shared folders, other network resources, and resource groupings that is used to manage a network and enable users to quickly find a particular resource.
- **Active Directory Certificate Services** Used to automate the configuration of deployment of encryption certificates to domain computers and users.
- **Active Directory-Based Activation role** A role service that relies on AD DS to store activation objects.
- **Advanced Threat Protection (ATP)** A Microsoft Defender feature that forces any processes or files that are not known to be dangerous but look suspicious to be automatically sent to servers within Microsoft Azure, a cloud computing platform, for deeper inspection.
- **AMD-V** The name given to the hypervisor acceleration feature in AMD-based machines.
- **ANDing** A mathematical operation that compares two binary digits and gives a result of 1 or 0. If both binary digits being compared have a value of 1, the result is 1. If one digit is 0 and the other is 1, or if both digits are 0, the result is 0.
- **attack surface** The sum of the different points (the "attack vectors") where an unauthorized user (the "attacker") can try to enter data into or extract data from an environment. Keeping the attack surface as small as possible is a basic security measure.
- **authentication** The process of verifying the identity of a person or device.
- **Automatic Private IP Addressing (APIPA)** A feature in operating systems (such as Windows) that enables computers to automatically self-configure an IP address and subnet mask when their DHCP server isn't reachable.
- **Azure Active Directory** Purchased services hosted within Microsoft's Azure cloud to provide Active Directory services to your organization.

- **Azure Backup** Tool used to back up important information to storage in the Azure cloud.
- **Azure Site Recovery** Ensures that key services that you run on-premises are made automatically available in the Azure cloud if you encounter a failure of an on-premises server.
- **Azure Update Management** Centrally manages the updates for on-premises computers and virtual machines running in Azure.
- **Basic Input/Output System (BIOS)** The program a personal computer's microprocessor uses to get the computer system started after you turn it on. It also manages data flow between the computer's operating system and attached devices such as the hard disk, video adapter, keyboard, mouse, and printer.
- **blade server** A modular server often found in a rackmount server.
- **Boot Protocol (BOOTP)** The Bootstrap Protocol (BOOTP) is a computer networking protocol used in Internet Protocol networks to automatically assign an IP address to network devices from a configuration server.
- **broadcast** A message sent to all computers on a network (but usually blocked to other networks by a router).
- **Burnaware** Disc burning software that allows a user to download an ISO image file from their Microsoft partner portal and copy it to a DVD.
- **capacity planning** The process of determining current and future hardware requirements based on the needs of the users within the organization. Capacity planning should be performed prior to installing Windows Server 2019.
- **checkpoints** A Windows Server Hyper-V feature that creates a second virtual hard disk file that stores any changes to the operating system after the time the checkpoint was taken. This is useful before testing a risky software configuration; if the software configuration fails, the checkpoint can be used to roll back the operating system to the state in which it was before the software configuration was applied.
- **classless interdomain routing (CIDR) notation** An addressing notation used for IP addresses and their subnet masks.
- **client** A computer that accesses resources on another computer via a network or direct cable connection.
- **Client Access License (CAL)** A commercial software license that allows clients to use server software services.
- **cloud** The collection of servers publicly available on the Internet.
- **cloud server** Servers that exist within data centers outside the organization and are accessed via the Internet.
- **clustering** Linking two or more discrete computer systems so they appear to function as though they are one, thus increasing the ability to access server resources and provide fail-safe services.
- **cmdlet** A command-line tool available in Windows PowerShell. See Windows PowerShell.
- **computer name** A name for the server. It can be randomly generated when you install Windows Server 2019 during the installation process.
- **container** An alternative to virtual machines that may be used to host Web apps that are run on an underlying Windows Server operating system.
- **data deduplication** A feature that saves space by allowing duplicate files on a volume to be stored once on the physical storage device.

- **default gateway** The IP address of the router that has a connection to other networks. The default gateway address is used when the host computer you are trying to contact exists on another network.
- **demilitarized zone (DMZ)** A separate network that is surrounded by routers that implement advanced firewall capabilities for all traffic that is passing into the network from other computers within the organization and Internet. Also known as a perimeter network.
- **Desired State Configuration** A feature of Windows Server 2019 that is used to quickly configure multiple servers using a template file that lists required software and configuration items.
- **Docker** The most common container software used to implement containers on operating systems today.
- **domain** A logical grouping of computers that authenticate to a central database of users stored on special servers called domain controllers.
- **domain controller** A special sever that contains a central database of users that allow s them to authenticate to a domain.
- **Domain Name Space (DNS)** A server on the network that is used to resolve Internet names, such as www.google.ca, to IP addresses such that you can connect to Internet resources by name.
- **Dynamic Host Configuration Protocol (DHCP)** A network protocol that provides a way for a server to automatically assign an IP address to a workstation on its network.
- **edition** A name for the different versions of Windows Server 2019. Each edition is built on the same foundation but offers unique capabilities to suit the size and needs of an organization.
- **Encrypting File System (EFS)** A feature that provides encryption for individual files and folders.
- **failover** A process for configuring a server cluster for fault tolerance only. In this configuration, one server actively responds to client requests, while another one only responds to client requests if the other one fails.
- **Fully Qualified Domain Name (FQDN)** The proper term for Internet names.
- **Generation 1 virtual machine** A slower, legacy hardware for older operating systems emulated by Hyper-V.
- **Generation 2 virtual machine** Modern hardware for newer operating systems emulated by Hyper-V.
- **Generic Volume License Key (GVLK)** The key that is stored on the Windows Server 2019 installation media that you received from Microsoft.
- **Group Policy** Used to configure operating system settings, security, and software for different computers and users in the domain.
- **guest operating system** An operating system that must access the hardware through both the hypervisor and underlying host operating system.
- **host ID** The portion of an IPv4 address that represents a single computer on that network. No two computers on the same network can have the same host ID.
- **host operating system** An existing workstation operating system.
- **hybrid cloud** A type of integration between on-premises Windows Servers and Windows Servers and services run within the Azure cloud.
- **Hyper-V** Virtualization software used to host Windows Server 2019 virtual machines on-premises.
- **Hyper-V container** A functionality of Hyper-V alongside Windows containers to provide additional performance and security features to Web apps that are run within

containers on Windows Server. It allows each container to access a separate copy of the underlying Windows Server kernel.

- **Hyper-V Manager** Microsoft's Windows Server 2019 tool that allows an administrator to access Microsoft's virtualization platform.
- **hypervisor** Software used to implement virtualization by allowing the hardware to host multiple operating systems. A hypervisor handles simultaneous requests for underlying hardware efficiently.
- **Intel VT** The name given to the hypervisor acceleration feature in Intel-based machines.
- **Internet Control Message Protocol (ICMP)** A protocol that is used to send network-related information and error messages across networks and the Internet.
- **Internet Control Message Protocol version 6 (ICMPv6)** The implementation of the Internet Control Message Protocol (ICMP) for Internet Protocol version 6 (IPv6).
- **Internet Explorer Enhanced Security Configuration (IE ESC)** An option that is provided in Windows Server that establishes security settings that define how users browse Internet and intranet Web sites.
- **Internet Information Services (IIS)** A Microsoft Windows Server component that provides Internet, Web, FTP, mail, and other services to make the server into a full-featured web server.
- **Internet of Things (IoT)** The collective grouping of small Internet-connected devices.
- **Internet Protocol (IP) address** An address that identifies itself to the IP protocol.
- **Internet Service Provider (ISP)** An organization that provides services for accessing, using, or participating in the Internet.
- **IP version 4 (IPv4)** The most commonly used version of IP, which has been in use for many years. IPv4 has a limitation in that it was not designed to anticipate the vast numbers of networks and network users currently in existence.
- **IP version 6 (IPv6)** The newest version of IP that is designed for enhanced security and that can handle the addressing needs of growing networks.
- **ISO image file** A disk image of an optical disc. It is an archive file that contains everything that would be written to an optical disc, sector by sector, including the optical disc file system.
- **journaling** A filesystem that tracks changes to files and keeps a record of these changes in a separate log file.
- **kernel** An essential set of programs and computer code that allows a computer operating system to control processor, disk, memory, and other functions central to its basic operation.
- **Key Management Services (KMS)** An activation service that allows organizations to activate systems within their own network, eliminating the need for individual computers to connect to Microsoft for product activation.
- **keyboard-video-mouse (KVM) switch** A hardware device that allows a user to control multiple computers from one or more sets of keyboards, video monitors, and mice.
- **Kubernetes** An open-source container-orchestration system for automating application deployment, scaling, and management.
- **Local Area Network (LAN)** A network of computers in relatively close proximity, such as on the same floor or in the same building.
- **logical processor** A core within a multi-core processor that can run its own executable threads.
- **loopback IP address** Also called a physical or device address, the hexadecimal number permanently assigned to a network interface and used by the MAC sublayer (a

communications sublayer for controlling how computers share communications on the same network).

- **Media Access Control (MAC) address** A unique identifier assigned to a network interface controller (NIC) for use as a network address in communications within a network segment.
- **Microsoft Azure** A cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through Microsoft-managed data centers.
- **Microsoft Management Console (MMC)** A component of Windows 2000 and its successors that provides system administrators and advanced users an interface for configuring and monitoring the system.
- **Multiple Activation Key (MAK)** Activates systems on a one-time basis, using Microsoft's hosted activation services (that is, it requires connection with a Microsoft activation server). Once computers are activated, no further communication with Microsoft is required.
- **multitasking** The capability of a computer to run two or more programs at the same time.
- **Nano Server** One of two Windows Server 2019 small footprint installation options that is quite small and is ideal for use within cloud environments that require the hosting of Web apps and the supporting services.
- **nested virtualization** Running other virtual machines within an existing virtual machine.
- **NetBIOS name** A name or identifier used in older Windows systems to uniquely identify a computer.
- **network** A communications system that enables computer users to share computer equipment, software, data, voice, and video transmissions.
- **Network Address Translation (NAT)** Sometimes used by firewalls, proxy servers, and routers, NAT translates IP addresses on an internal or local network so that the actual IP addresses cannot be determined on the Internet, because the address seen on the Internet is a decoy address used from a pool of decoy addresses.
- **network ID** The portion of an IPv4 address that represents the network on which the computer is located.
- **New Technology File System (NTFS)** The traditional file system used in Windows operating systems.
- **Non-Volatile Memory Express (NVMe)** A host controller interface and storage protocol created to accelerate the transfer of data between enterprise and client systems and solid-state drives (SSDs) over a computer's high-speed Peripheral Component Interconnect Express (PCIe) bus.
- **octet** A set of four numbers in an IPv4 address separated by a periods.
- **on-premises server** Servers that are located within organizations.
- **packet** A unit of data transmitted on a network that contains control and address information as well as routing information.
- p**eer-to-peer networking** A network on which any computer can communicate with other networked computers on an equal or peer basis without going through an intermediary, such as a server or host.
- **perimeter network** A separate network that is surrounded by routers that implement advanced firewall capabilities for all traffic that is passing into the network from other computers within the organization and Internet. Also known as a demilitarized zone (DMZ) network.

- **physical processor** A processor chip plugged into a processor socket on a motherboard in a computer.
- **PowerShell script** Cmdlets written in PowerShell that can then be executed to perform a series of tasks that can be re-executed periodically in the future as necessary.
- **preemptive multitasking** Running two or more programs simultaneously so that each program runs in an area of memory separate from areas used by other programs.
- **privileged mode** A protected memory space allocated for the Windows Server kernel that cannot be directly accessed by software applications.
- **protected process** A process that cannot be influenced by a user or other processes on the system. Key processes on Windows Server 2019, including those that perform system maintenance or update a database, run as protected processes and cannot be interrupted prematurely.
- **protocol** A strictly defined set of rules for communication across a network that specifies how networked data is formatted for transmission, how it is transmitted, and how it is interpreted at the receiving end.
- **proxy server** A server application or appliance that acts as an intermediary for requests from clients seeking resources from servers that provide those resources.
- **rackmount server** Servers within an organization are housed within a rackmount case that is mounted alongside other servers on a vertical server storage rack.
- **Redundant Array of Independent Disks (RAID)** A data storage virtualization technology that combines multiple physical disk drive components into one or more logical units for the purposes of data redundancy, performance improvement, or both.
- **Resilient File System (ReFS)** The newer file system used in Windows Server 2019 operating systems.
- **router** A device that connects networks, is able to read IP addresses, and can route or forward packets of data to designated networks.
- **Rufus** Disc burning software that allows a user to download an ISO image file from their Microsoft partner to a bootable USB flash drive.
- **sandboxing** A type of execution where an administrator runs a container and the enclosed Web apps are executed in a way that isolates them from other Web apps running within other containers and the underlying operating system.
- **Second Level Address Translation (SLAT)** A processor-based hardware-assisted virtualization technology that makes it possible to avoid the overhead associated with software-managed shadow page tables.
- **server** A single computer that provides extensive multiuser access to network resources.
- **Server Core** One of two Windows Server 2019 small footprint installation options that retains much of the core Windows Server operating system but removes most of the graphical frameworks and processes. As a result, you typically configure Server Core using MS-DOS commands or PowerShell cmdlets, or configure remotely from a computer running Server Manager or the Windows Admin Center.
- **Server Core App Compatibility Feature on Demand (FOD)** A framework that can be downloaded and installed so that many additional graphical .Net components can be installed along with more software for Server Core.
- **Server Manager** A tool that was originally introduced in Windows Server 2008, with each subsequent version of Windows Server adding even more enhancements. While Server Manager allows you to monitor and manage the configuration of the local server it is running on, it can also be used to centrally manage multiple servers on the network if you choose to add additional servers to the Server Manager interface.

- **shell** A command-line environment, also called a command interpreter, that enables communication with an operating system. Commands that are run within a shell are typically specific to that shell (although different shells sometimes use the same or similar commands, particularly in UNIX and Linux).
- **shielded virtual machines** A feature that started in Windows 2016 that ensures malicious users cannot access the virtual hard disk files used by Hyper-V virtual machines by adding BitLocker encryption support for these files.
- **single sign-on** An authentication feature that allows a user to authenticate once to a domain controller to prove their identity to all domain members.
- **small footprint** A version of Windows Server 2019 installed with a minimal set of services, features, and functionality.
- **snapshots** Another name for checkpoints.
- **Software Defined Networking (SDN)** Feature of Windows Server 2019 Datacenter Edition that provides a method to centrally configure and manage physical and virtual network devices such as routers, switches, and gateways in your datacenter.
- **solid state disk (SSD)** A solid-state drive is a solid-state storage device that uses integrated circuit assemblies to store data persistently, typically using flash memory, and functioning as secondary storage in the hierarchy of computer storage.
- **storage area network (SAN)** Devices that provide a large amount of hard disk or solid state disk (SSD) storage for the servers within the rack.
- **Storage Migration Service** A feature in Windows Server 2019 that simplifies the moving of data to newer systems, as well as to systems in the Azure cloud.
- **storage pinning** Allows an administrator to force specific data to be stored on a particular device.
- **Storage Replicas** A feature first introduced in Windows Server 2016 that allows data to be replicated between two different servers seamlessly.
- **Storage Spaces** A feature first introduced in Windows Server 2016 that allows you to build large, fault-tolerant volumes that span multiple physical storage devices. The third-generation version of ReFS (ReFS v3) was made available in Windows Server 2019 and comes with additional performance and feature improvements, including support for data deduplication and dramatically improved performance with Storage Spaces.
- **Storage Spaces Direct** A feature that uses a server cluster to allow a large amount of disk storage across several different servers to be made available to users.
- **storage tiers** A key feature in Windows Server 2019 Standard Edition that automatically moves frequently-used data to faster storage devices, such as SSDs.
- **subnet mask** Used to distinguish between the network part and the host part of the IP address and to enable networks to be divided into subnets.
- **Teredo** A protocol that encapsulates IPv6 traffic into IPv4 packets.
- **thick provisioning** Allocating a fixed space for the virtual hard disk file when it is created.
- **thin provisioning** Dynamically allocating space as the virtual machine needs it.
- **thread** Program code blocks used in multithreading.
- **Transmission Control Protocol/Internet Protocol (TCP/IP)** A protocol that provides reliable communication of packets across networks and the Internet.
- **Trusted Platform Module (TPM)** Provides secure boot and encryption features for the Basic Input/Output System (BIOS).
- **Type 1 hypervisor** A hypervisor that interacts with the hardware directly, and contains a small operating system to manage the hypervisor configuration and virtual machines.

- **Type 2 hypervisor** A hypervisor that is designed to run on top of an existing workstation operating system (referred to as the host operating system).
- **unicast** A message that goes from one single computer to another single computer.
- **Unified Extensible Firmware Interface (UEFI)** Hardware required to support the Basic Input/Output System (BIOS).
- **uninterruptible power supply (UPS)** A device that provides backup battery power to servers and SANs within the rack in the event of a power loss.
- **User Datagram Protocol/Internet Protocol (UDP/IP)** A protocol that provides fast, yet unreliable communication of packets across networks and the Internet.
- **virtual machine** An instance of a discrete operating system running within virtual server software on one computer. Multiple virtual machines can run within the virtual server software on one computer.
- **virtual processor** A logical processor in a computer that is used by a virtual machine.
- **virtualization** The process of running more than one operating system at the same time on a single computer.
- **Windows Admin Center** A Windows Server 2019 Web-based management tool.
- **Windows Containers** A container is a subset of the Windows operating system composed of one or more Web apps and the supporting operating system files needed by those Web apps only.
- **Windows Management Instrumentation (WMI)** A set of specifications from Microsoft for consolidating the management of devices and applications in a network from Windows computing systems. WMI provides users with information about the status of local or remote computer systems.
- **Windows PowerShell** A powerful scripting language.
- **Windows Server Azure Network Adapter** Hardware that allows you to easily connect your on-premises Windows Server systems with other virtualized Windows Servers and services in the Azure cloud using a secure connection.
- **Windows Server Catalog** A list of compatible hardware devices for each version of Windows.
- **Windows Server Configuration Wizard (sconfig.cmd)** A tool that provides a quick way to configure server settings (network, firewall, computer name, domain, and so on) or perform server administration tasks (reboot, install updates, and so on) from the command line.
- **Windows Subsystem for Linux (WSL)** A Windows subsystem that provides a Linux kernel interface for Linux apps that allows them to execute directly on the Windows kernel within a Linux operating system environment (including a virtual Linux filesystem and directory structure).
- **workgroup** As used in Microsoft networks, a number of users who share drive and printer resources in an independent peer-to-peer relationship.