


MCSA Guide to
Installation, Storage,
and Compute with
Windows Server® 2016

MCSE/MCSA

Exam #70-740

Greg Tomsho

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Greg Tomsho

**MCSA Guide to Installation, Storage, and
Compute with Windows Server 2016,
Exam 70-740**

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Library of Congress Control Number: 2017945198

Student Edition ISBN: 978-1-3374-0066-4

Loose-leaf Edition ISBN: 978-1-3376-8595-5

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Introduction

MCSA Guide to Installation, Storage, and Compute with Windows Server® 2016, Exam 70-740, gives you an in-depth coverage of the 70-740 certification exam objectives and focuses on the skills you need to install and configure Windows Server 2016. With more than 80 hands-on activities and dozens of skill-reinforcing case projects, you'll be well prepared for the certification exam and learn valuable skills to perform on the job.

After you finish this book, you'll have an in-depth knowledge of Windows Server 2016, including installation, local and remote management, file and storage services, Hyper-V virtualization, and high availability. You'll also get hands-on experience working with Microsoft's newest server features including Storage Spaces Direct, PowerShell Direct, Nano Server, and Windows containers. This book is written from a teaching and learning point of view, not simply as an exam study guide. The chapters guide readers through the technologies they need to master to perform on the job, not just to pass an exam.

Intended Audience

MCSA Guide to Installation, Storage, and Compute with Windows Server® 2016, Exam 70-740 is intended for people who want to learn how to configure and manage a Windows Server 2016 computing environment and earn the Microsoft Certified Solutions Associate (MCSA) certification. This book covers in full the objectives of exam 70-740, one of three required for the MCSA: Windows Server 2016 certification. Exam 70-740 is also one of the four exams needed for the MCSE: Cloud Platform and Infrastructure certification. This book serves as an excellent tool for classroom teaching, but self-paced learners will also find that the clear explanations, challenging activities, and case projects serve them equally well. Although this book doesn't assume previous experience with Windows servers, it does assume a familiarity with current Windows operating systems, such as Windows 10. Networking knowledge equivalent to an introductory networking course or Network+ is highly recommended.

What This Book Includes

- A lab setup guide is included in the “Before You Begin” section of this introduction to help you configure a physical or virtual (recommended) lab environment for doing the hands-on activities.
- Step-by-step hands-on activities walk you through tasks ranging from a basic Windows Server 2016 installation to complex multi-server cluster configurations. All activities have been tested by a technical editor.
- Extensive review and end-of-chapter materials reinforce your learning.
- Critical thinking case projects require you to apply the concepts and technologies learned throughout the book.

- Abundant screen captures and diagrams visually reinforce the text and hands-on activities.
- A list of 70-740 exam objectives is cross-referenced with chapters and sections that cover each objective (inside cover and Appendix A).

Note

This text does not include Windows Server 2016 software. However, 180-day evaluation versions of Windows Server 2016 are available at no cost from <https://www.microsoft.com/en-us/evalcenter/evaluate-windows-server-2016>. More specific instruction can be found in “Using an Evaluation Version of Windows Server 2016” in the Before You Begin section of this Introduction.

About Microsoft Certification: MCSA

This book prepares you to take one of the three exams in the Microsoft Certified Solutions Associate (MCSA) Windows Server 2016 certification. The MCSA Windows Server 2016 certification is made up of three exams, which can be taken in any order:

- Exam 70-740: Installation, Storage and Compute with Windows Server 2016
- Exam 70-741: Networking with Windows Server 2016
- Exam 70-742: Identity with Windows Server 2016

Note

This text focuses on Exam 70-740. Companion texts focus on Exam 741 and Exam 742, respectively: *MCSA Guide to Networking with Windows Server 2016* (Cengage, 2018) and *MCSA Guide to Identity with Windows Server 2016* (Cengage, 2018).

Microsoft Certified Solutions Expert (MCSE): The Next Step

After achieving the MCSA Windows Server 2016 certification, you can move on to the MCSE certification. For the MCSE: Cloud Platform and Infrastructure certification, the MCSA Windows Server 2016 certification is a prerequisite. You then have the option of taking one of the ten exams to complete the MCSE. To see the list of exams you can take to complete the MCSE, see <https://www.microsoft.com/en-us/learning/mcse-cloud-platform-infrastructure.aspx>.

Chapter Descriptions

This book is organized to familiarize you with Windows Server 2016 features and technologies and then provide an in-depth coverage of Windows Server 2016 installation, management, storage, and virtualization. It wraps up by discussing Nano Server and Windows containers, two new features included in Windows Server 2016. The 70-740 exam objectives are covered throughout the book, and you can find a mapping of objectives and the chapters in which they’re covered on the inside front cover, with a more detailed mapping in Appendix A. The following list describes this book’s chapters:

- **Chapter 1**, “Introducing Windows Server 2016,” describes the role of a server operating system and provides an overview of Windows Server 2016 core technologies, such as the NTFS file system, Active Directory, disk management, Hyper-V, and PowerShell. You’ll also be introduced to server roles and new features in Windows Server 2016.

Note 

Chapter 1 of this book is available as a PDF for free download by students and instructors from the Cengage website. If you are starting with one of the other Windows Server 2016 MCSA books (70-741 or 70-742), you can use Chapter 1 of this book as an introductory chapter to Windows Server 2016 before beginning those books.

- **Chapter 2**, “Installing Windows Server 2016,” discusses the details of planning a Windows Server 2016 installation, including installing the first server on a new network, expanding an existing network, and upgrading to Windows Server 2016, including server role migration. The Server Core installation option is discussed next, followed by optimizing an installation by using Features on Demand.
- **Chapter 3**, “Configuring and Managing Windows Server 2016,” explains how to work with server roles and features and how to manage servers remotely. You’ll also learn how to work with Windows install images and configure Windows services.
- **Chapter 4**, “Configuring Storage and File Systems,” describes the methods available for storage provisioning, including working with local and virtual disks and using disk partition and format options. You learn about the types of volumes you can create on a Windows server and how to work with virtual disks. This chapter also discusses how Windows implements file sharing. This chapter also explains default and administrative shares and how to manage shared folders. Finally, you learn how to secure access to files by using permissions and see how permission inheritance works.
- **Chapter 5**, “Configuring Advanced Storage Solutions,” discusses how to implement Storage Spaces, a method for providing flexible and fault-tolerant storage without using expensive RAID controllers. Next, you learn to configure an iSCSI Storage Area Network (SAN) with Windows as the iSCSI client and iSCSI server. You’ll also explore data deduplication and Storage Replica. Data deduplication helps reduce storage requirements by eliminating duplicated data, while Storage Replica provides server-to-server and cluster-to-cluster volume replication for high-availability applications.
- **Chapter 6**, “Implementing Virtualization with Hyper-V: Part 1,” focuses on how to use the Hyper-V server role for a virtualization platform. You learn the requirements for installing Hyper-V and how to install and configure the Hyper-V role. You’ll learn how to manage Hyper-V both locally and remotely, create virtual machines, and manage and optimize virtual machines. In the next chapter, you’ll learn how to work with Hyper-V virtual disks and Hyper-V virtual networks.
- **Chapter 7**, “Implementing Virtualization with Hyper-V: Part 2,” covers virtual hard disks including dynamically expanding, fixed, differencing, and pass-through disks. You also look at shared VHDX files. Next, you examine the three types of virtual switch and deployment scenarios for each. Along with configuring virtual switches, you’ll learn about configuring virtual network adapters including hardware acceleration and advanced features such as MAC address spoofing, protected network, and port mirroring. You’ll also learn how to create and configure NIC teaming both on the host server and in a virtual machine. In addition, you’ll learn how to properly configure your Hyper-V host to enable nested virtualization, and finally, you’ll briefly look at deploying Linux and FreeBSD VMs in Hyper-V.
- **Chapter 8**, “Implementing High Availability: Server Clusters,” discusses two high-availability options in Windows Server 2016: network load balancing and failover clustering. You’ll learn about the requirements for implementing a NLB cluster and install the Network Load Balancing feature. Next, you’ll examine the requirements for network and storage to implement workgroup, single domain, and multi-domain clusters.

- **Chapter 9**, “Implementing High Availability: Advanced Failover and Virtual Machines,” covers advanced failover cluster configurations including quorum settings, adding and removing cluster nodes, moving core cluster resources, and configuring Active Directory-detached clusters. Next, you’ll learn to configure highly available virtual machines and implement several virtual machine movement technologies.
- **Chapter 10**, “Maintaining Server Installations,” discusses the Windows Update program for downloading and installing available updates with Windows Server Update Services (WSUS). This chapter discusses how to install the WSUS role and then configure the role and the client computers using WSUS. Microsoft’s solution to malware is Windows Defender. This chapter discusses how to configure Windows Defender using Group Policy and PowerShell and how to integrate WSUS with Windows Defender to ensure your antimalware software and definitions are up to date on all computers throughout the enterprise.
- **Chapter 11**, “Server Monitoring and Backup,” covers backup and restore features in Windows Server 2016 that can help IT administrators sleep better knowing they can recover a system from failure or data loss. You learn about Windows Server Backup, and strategies for backing up server roles, including file servers, domain controllers, virtualization servers, and web servers.
- **Chapter 12**, “Nano Server and Windows Containers,” discusses Nano Server, a new headless deployment option for Windows Server 2016 that has a very small footprint, consumes few resources, and starts very quickly. It has limited usage scenarios because it supports only a few server roles and features, but it’s likely to find a niche in virtual and cloud applications. Next, you’ll learn about containers, and the open source container management environment called Docker. Like Nano Server, containers are likely to be deployed in highly virtualized and cloud computing environments, but they may also find a spot in a moderately sized datacenter.
- **Appendix A**, “MCSA 70-740 Exam Objectives,” maps each 70-740 exam objective to the chapter and section where you can find information on that objective.

Features

This book includes the following learning features to help you master the topics in this book and the 70-740 exam objectives:

- *Chapter objectives*—Each chapter begins with a detailed list of the concepts to be mastered. This list is a quick reference to the chapter’s contents and a useful study aid.
- *Hands-on activities*—More than 80 hands-on activities are incorporated into this book, giving you practice in setting up, configuring, and managing a Windows Server 2016 server. The activities give you a strong foundation for carrying out server installation and configuration tasks in production environments. Much of the learning about Windows Server 2016 comes from doing the hands-on activities, and a lot of effort has been devoted to making the activities relevant and challenging.
- *Requirements for hands-on activities*—A table at the beginning of each chapter lists the hands-on activities and what you need for each activity.
- *Screen captures, illustrations, and tables*—Numerous screen captures and illustrations of concepts help you visualize theories and concepts and see how to use tools and desktop features. In addition, tables are used often to give you details and comparisons of practical and theoretical information and can be used for a quick review.
- *Chapter summary*—Each chapter ends with a summary of the concepts introduced in the chapter. These summaries are a helpful way to recap and revisit the material covered in the chapter.
- *Key terms*—All terms in the chapter introduced with bold text are gathered together in the Key Terms list at the end of the chapter. This list gives you a way to check your understanding of all important terms. All key term definitions are listed in the Glossary at the end of the book.
- *Review questions*—The end-of-chapter assessment begins with review questions that reinforce the concepts and techniques covered in each chapter. Answering these questions helps ensure that you have mastered important topics.

- *Critical Thinking*—Each chapter closes with one or more case projects to provide critical thinking exercises. Many of the case projects build on one another, as you take a small startup company to a flourishing enterprise.
- *Exam objectives*—Major sections in each chapter show the exam objective or objectives covered in that section, making it easier to find the material you need when studying for the MCSA exam.

Text and Graphics Conventions

Additional information and exercises have been added to this book to help you better understand what's being discussed in the chapter. Icons throughout the book alert you to these additional materials:

Tip

Tips offer extra information on resources, how to solve problems, and time-saving shortcuts.

Note

Notes present additional helpful material related to the subject being discussed.

Caution

The Caution icon identifies important information about potential mistakes or hazards.

Activity

Each hands-on activity in this book is preceded by the Activity icon.

Critical Thinking

The end-of-chapter case projects are scenario-based assignments that ask you to apply critical thinking skills to what you have learned in the chapter.

Certification

- Certification icons under chapter headings list exam objectives covered in that section.

Instructor Companion Site

Everything you need for your course in one place! This collection of book-specific lecture and class tools is available online via www.cengage.com/login. Access and download PowerPoint presentations, images, the Instructor's Manual, and more.

- *Electronic Instructor's Manual*—The Instructor's Manual that accompanies this book includes additional instructional material to assist in class preparation, including suggestions for classroom activities, discussion topics, and additional quiz questions.
- *Solutions Manual*—The instructor's resources include solutions to all end-of-chapter material, including review questions and case projects.
- *Cengage Testing Powered by Cognero*—This flexible, online system allows you to do the following:
 - Author, edit, and manage test bank content from multiple Cengage solutions.
 - Create multiple test versions in an instant.
 - Deliver tests from your LMS, your classroom, or wherever you want.
- *PowerPoint presentations*—This book comes with Microsoft PowerPoint slides for each chapter. They're included as a teaching aid for classroom presentation, to make available to students on the network for chapter review, or to be printed for classroom distribution. Instructors, please feel free to add your own slides for additional topics you introduce to the class.
- *Figure files*—All the figures and tables in the book are reproduced in bitmap format. Similar to the PowerPoint presentations, they're included as a teaching aid for classroom presentation, to make available to students for review, or to be printed for classroom distribution.

MindTap

MindTap for Tomsho/MCSA *Guide to Installation, Storage, and Compute with Windows Server 2016, Exam 70-740* is a personalized, fully online digital learning platform of content, assignments, and services that engages students and encourages them to think critically, while allowing instructors to easily set the course through simple customization options.

MindTap is designed to help students master the skills they need in today's workforce. Research shows employers need critical thinkers, troubleshooters, and creative problem solvers to stay relevant in our fast-paced, technology-driven world. MindTap helps you achieve this with assignments and activities that provide hands-on practice, real-life relevance, and certification test prep. Students are guided through assignments that help them master basic knowledge and understanding before moving on to more challenging problems.

The live virtual machine labs provide real-life application and practice. Based on the textbook's Hands-On Projects, the live virtual machine labs provide more advanced learning. Students work in a live environment via the Cloud with real servers and networks that they can explore. The IQ certification test prep engine allows students to quiz themselves on specific exam domains, and the pre- and post-course assessments are mock exams that measure exactly how much they have learned. Readings and labs support the lecture, while "In the News" assignments encourage students to stay current.

Instant Access Code: (ISBN: 9781337400688)

Printed Access Code: (ISBN: 9781337400695)

Acknowledgments

I would like to thank Cengage Product Team Manager Kristin McNary and Associate Product Manager Amy Savino for their confidence in asking me to undertake this challenging project. In addition, thanks go out to Michelle Ruelos Cannistraci, the Senior Content Developer, who assembled an outstanding team to support this project. A special word of gratitude goes to Deb Kaufmann, the Development Editor, who took an unrefined product and turned it into a polished manuscript. Danielle Shaw, the Technical Editor tested chapter activities diligently to ensure that labs work as they were intended, and for that, I am grateful. I also want to include a shout-out to a former student of mine, Shaun Stallard, who was instrumental in the creation of the end of chapter material including Chapter Summary, Key Terms, and Review Questions.

Finally, my family: my beautiful wife, Julie, lovely daughters Camille and Sophia, and son, Michael, deserve special thanks and praise for going husbandless and fatherless 7 days a week, 14 hours a day, for the better part of a year. Without their patience and understanding and happy greetings when I did make an appearance, I could not have accomplished this.

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I would like to hear from you. Please email me at w2k16@tomsho.com with any problems, questions, suggestions, or corrections. I even accept compliments! Your comments and suggestions are invaluable for shaping the content of future books. You can also submit errata, lab suggestions, and comments via email. I have set up a website to support my books at <http://books.tomsho.com>, where you'll find lab notes, errata, web links, and helpful hints for using my books. If you're an instructor, you can register on the site to contribute articles and comment on articles.

Before You Begin

Windows Server has become more complex as Microsoft strives to satisfy the needs of enterprise networks. In years past, you could learn what you needed to manage a Windows Server-based network and pass the Microsoft certification exams with a single server, some good lab instructions, and a network connection. Today, as you work with advanced technologies—such as Hyper-V, Storage Spaces, and failover clusters, just to name a few—your lab environment must be more complex, requiring several servers. Setting up this lab environment can be challenging, and this section was written to help you meet this challenge. Using virtual machines in Hyper-V on Windows 10 or Windows Server 2016 is highly recommended; other virtual environments work, too, but you'll want to choose one that allows nested virtualization, which means running a virtual machine within a virtual machine so you can do some of the Hyper-V activities that require it. Using virtual machines is also highly recommended because it allows you to easily change the storage and network configuration of your servers and allows you to revert your lab to its original state for each chapter.

Note

The MindTap digital online learning platform for this text includes access to live virtual machine labs based on the textbook's Hands-On Projects, without the need to set up your own lab environment.

Lab Setup Guide

Note

If you can't set up a lab environment exactly as described in this section, you might be able to configure a partial lab with just one Windows Server 2016 server and still do many of the hands-on activities. Having two servers is even better, and having three enables you to do the majority of the book's activities. If you can't do an activity, it's important to read the activity steps to learn important information about Windows Server 2016.

Because of the flexibility and availability of using a virtual environment, the lab setup guide is designed with the assumption that virtualization is used, whether Hyper-V, VMware, VirtualBox, or some other product. The lab environment is designed so that the initial configuration of the virtual machines will take you through any chapter except for Chapter 9, which requires the successful completion of Chapter 8 activities. Each chapter (except for Chapter 9) starts with an activity that instructs the reader to revert the virtual machines used in the chapter to the initial configuration using a saved snapshot/checkpoint.

A total of five virtual machines (VMs) with Windows Server 2016 installed are used throughout the book. However, they are not all used at the same time; some activities use as many as four VMs while some require only one or two. No client OS is used. This decision was made primarily on the basis that many readers will be using evaluation versions of Windows on their VMs and the evaluation period for Windows client OSs such as Windows 10 is very short compared to Windows Server 2016's evaluation period. In addition, Windows 10 is continually being upgraded and the upgrades may affect the outcome of some of the activities. Therefore, any activities that require a client will use a VM that has Windows Server 2016 installed. Readers should see little to no difference between using Windows Server 2016 as a client OS and using Windows 10.

There are two configurations for the lab activities. Configuration 1 uses four VMs running Windows Server 2016 in which one server is a domain controller (DC) and two servers are domain members. The fourth server is configured as a stand-alone server that is operating in workgroup mode. Configuration 1 will be used in the activities in most of the chapters. Some activities require your VMs to access the Internet. An easy way to accommodate this is to install the Remote Access role on your Hyper-V host (if you're using Hyper-V and Windows Server 2016 for your host computer) and configure NAT so your Hyper-V host can route packets to the physical network and the Internet. After installing the Remote Access role with the Routing role service, configure NAT and select the interface connected to the physical network as the public interface and the interface connected to the Hyper-V internal switch as the private interface. The interface connected to the Hyper-V internal switch should be configured with address 192.168.0.250/24. Figure 1 shows a diagram of this network.

Configuration 2 uses one VM running Windows Server 2016 with the Hyper-V role installed and some VMs pre-installed (see Figure 2). Configuration 2 is used in the Hyper-V chapters (Chapters 6 and 7) and for activities in which the reader installs Windows Server 2016.

A few words about this diagram:

- The router address is an example; you can use a different address. You can do most activities without a router to the Internet, except those requiring Internet access.
- ServerDC1 is a domain controller for domain MCSA2016.local and has both the Active Directory Domain Services (AD DS) and DNS server roles installed.
- The host Hyper-V server is the only physical server, and it is running routing and remote access with routing and NAT to allow the VMs access to the physical network and the Internet.
- Specific installation requirements for each server are explained in the following sections.

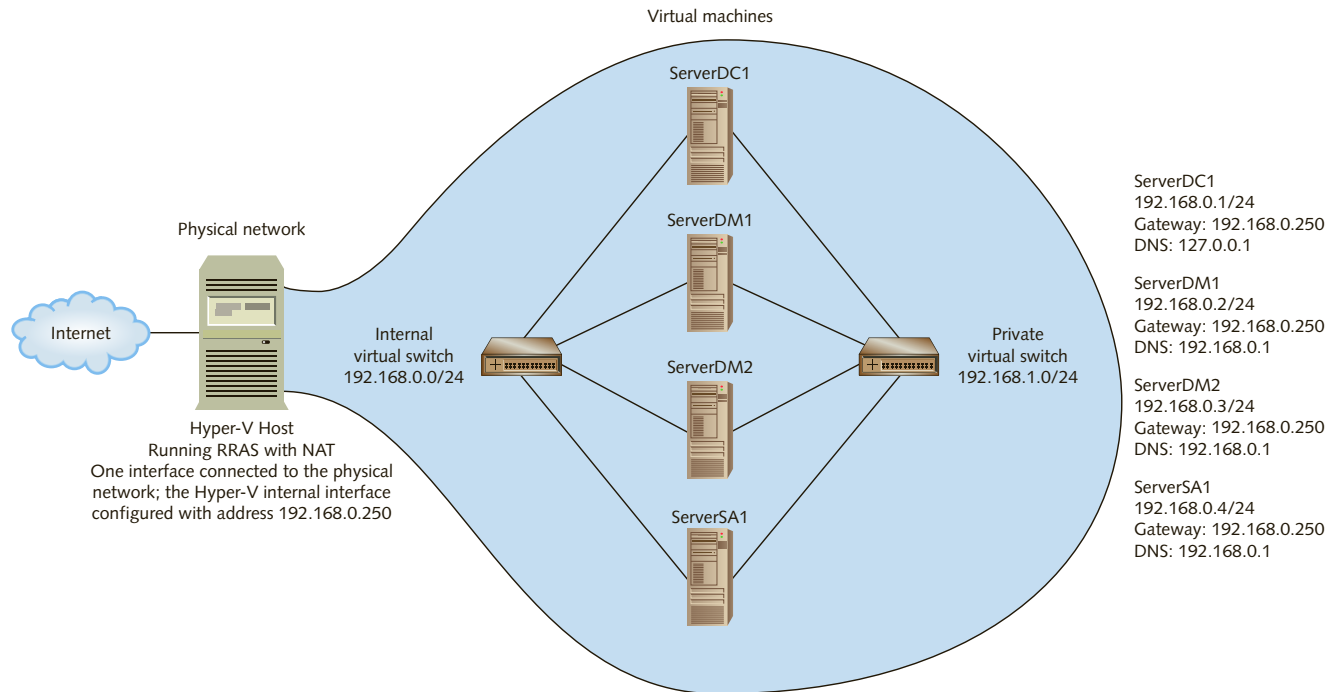


Figure 1 A diagram of lab Configuration 1

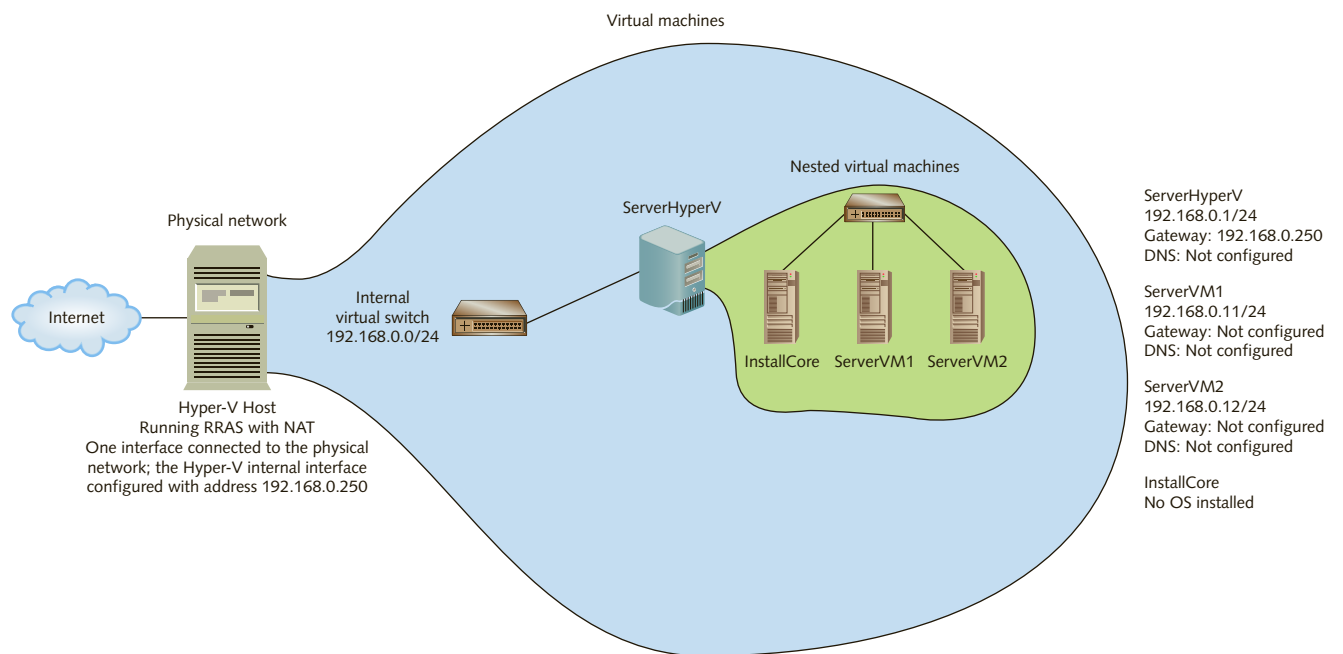


Figure 2 A diagram of lab Configuration 2

Host Computer Configuration

The following are recommendations for the host computer when you're using virtualization:

- Dual-core or quad-core CPU with Intel-VT-x/EPT support. You can see a list of supported Intel processors at <http://ark.intel.com/Search/Advanced?ExtendedPageTables=True>.

Note:

Most activities can be done without a CPU that supports EPT, but you can't install Hyper-V on a VM if the host doesn't support EPT for Intel CPUs.

- 8 GB RAM; more is better.
- 200 GB free disk space.
- Windows Server 2016 or Windows 10 if you're using Hyper-V.
- Windows 10 or Windows 8.1 if you're using VMware Workstation or VirtualBox.

Configuration 1

ServerDC1

This virtual machine should be configured as follows:

- Windows Server 2016 Datacenter—Desktop Experience
- Server name: ServerDC1
- Administrator password: Password01
- Memory: 2 GB or more
- Hard disk 1: 60 GB or more
- Ethernet connection—connected to Internal Virtual Switch
 - IP address: 192.168.0.1/24
 - Default gateway: 192.168.0.250 (or an address supplied by the instructor)
 - DNS: 127.0.0.1
- Ethernet 2 connection—connected to Private Virtual Switch
 - IP address: 192.168.1.1/24
 - Default gateway: Not configured
 - DNS: Not configured
- Active Directory Domain Services and DNS installed:
 - Domain Name: MCSA2016.local
- Windows Update: Configured with most recent updates
- Power Setting: Never turn off display
- Internet Explorer Enhanced Security Configuration: Turned off for Administrator
- User Account Control: Lowest setting
- After fully configured, create a checkpoint/snapshot named InitialConfig that will be applied at the beginning of each chapter's activities where this VM is used. Turn off the VM before you create a checkpoint/snapshot.

ServerDM1

This virtual machine should be configured as follows:

- Windows Server 2016 Datacenter—Desktop Experience
- Server name: ServerDM1
- Administrator password: Password01
- Memory: 2 GB or more

- Hard disk 1: 60 GB or more
- Hard disk 2: 20 GB
- Hard disk 3: 15 GB
- Hard disk 4: 10 GB
- Ethernet connection—connected to Internal Virtual Switch
 - IP address: 192.168.0.2/24
 - Default gateway: 192.168.0.250 (or an address supplied by the instructor)
 - DNS: 192.168.0.1 (the address of ServerDC1)
- Ethernet 2 connection—connected to Private Virtual Switch
 - IP address: 192.168.1.2/24
 - Default gateway: Not configured
 - DNS: Not configured
- Member of domain: MCSA2016.local
- Windows Update: Configured with most recent updates
- Power Setting: Never turn off display
- Internet Explorer Enhanced Security Configuration: Turned off for Administrator
- User Account Control: Lowest setting
- After fully configured, create a Checkpoint/Snapshot named InitialConfig that will be applied at the beginning of each chapter's activities where this VM is used.

ServerDM2

This virtual machine should be configured as follows:

- Windows Server 2016 Datacenter—Server Core
- Server name: ServerDM2
- Administrator password: Password01
- Memory: 2 GB or more
- Hard disk 1: 60 GB or more
- Hard disk 2: 20 GB
- Hard disk 3: 15 GB
- Hard disk 4: 10 GB
- Ethernet connection—connected to Internal Virtual Switch
 - IP address: 192.168.0.3/24
 - Default gateway: 192.168.0.250 (or an address supplied by the instructor)
 - DNS: 192.168.0.1 (the address of ServerDC1)
- Ethernet 2 connection—connected to Private Virtual Switch
 - IP address: 192.168.1.3/24
 - Default gateway: Not configured
 - DNS: Not configured
- Member of domain: MCSA2016.local
- Windows Update: Configured with most recent updates
- Power Setting: Never turn off display
- Internet Explorer Enhanced Security Configuration: Turned off for Administrator
- User Account Control: Lowest setting
- After fully configured, create a Checkpoint/Snapshot named InitialConfig that will be applied at the beginning of each chapter's activities where this VM is used.

ServerSA1

This virtual machine should be configured as follows:

- Windows Server 2016 Datacenter—Desktop Experience
- Server name: ServerSA1
- Administrator password: Password01

- Memory: 2 GB or more
- Hard disk 1: 60 GB or more
- Hard disk 2: 20 GB
- Hard disk 3: 15 GB
- Hard disk 4: 10 GB
- Ethernet connection—connected to Internal Virtual Switch
 - IP address: 192.168.0.4/24
 - Default gateway: 192.168.0.250 (or an address supplied by the instructor)
 - DNS: 192.168.0.1 (the address of ServerDC1)
- Ethernet 2 connection—connected to Private Virtual Switch
 - IP address: 192.168.1.4/24
 - Default gateway: Not configured
 - DNS: Not configured
- Workgroup: MCSA2016 (The workgroup name doesn't matter)
- Windows Update: Configured with most recent updates
- Power Setting: Never turn off display
- Internet Explorer Enhanced Security Configuration: Turned off for Administrator
- User Account Control: Lowest setting
- After fully configured, create a Checkpoint/Snapshot named InitialConfig that will be applied at the beginning of each chapter's activities where this VM is used.

Configuration 2

ServerHyperV

This virtual machine should be configured as follows:

- Windows Server 2016 Datacenter—Desktop Experience
- Server name: ServerHyperV
- Administrator password: Password01
- Memory: 4 GB or more (Dynamic memory disabled)
- Hard disk 1: 100 GB or more
- DVD: Assigned to D: drive and mapped to the Windows Server 2016 installation media ISO file
- Nested virtualization must be configured before installing Hyper-V. If you are using Hyper-V on the host server, use the following steps:

From a PowerShell window:

```
Set-VMProcessor -VMName ServerHyperV -ExposeVirtualizationExtensions  
$true
```

```
Get-VMNetworkAdapter -VMName ServerHyperV | Set-VMNetworkAdapter  
-MacAddressSpoofing On
```

- Configure the firewall to allow ping messages:

```
Set-NetFirewallRule FPS-ICMP4-ERQ-In -Enabled True
```

- Ethernet connection—connected to Internal Virtual Switch
 - IP address: 192.168.0.1/24 (You can also use 192.168.0.5 if you might have ServerDC1 running at the same time)
 - Default gateway: 192.168.0.250 (or an address supplied by the instructor)
 - DNS: Not configured
- Hyper-V role installed
- Workgroup: MCSA2016 (The workgroup name doesn't matter)
- Windows Update: Configured with most recent updates
- Power Setting: Never turn off display
- Internet Explorer Enhanced Security Configuration: Turned off for Administrator
- User Account Control: Lowest setting

Hyper-V should be configured as follows:

1. Create a private virtual switch named PrivateNet
2. Create a virtual machine named InstallCore with a 40 GB HDD and 1 GB RAM; the VM should be located in a folder named C:\VMs. This VM will be used to install Windows Server Core in Chapter 2.
3. Create two Generation 2 VMs named ServerVM1 and ServerVM2 for use in Chapters 6 and 7 activities:

ServerVM1:

- Windows Server 2016 Datacenter—Desktop Experience
- Server name: ServerVM1
- Memory: 1 GB
- Hard disk: 40 GB
- Ethernet connection—connected to PrivateNet
 - IP address: 192.168.0.11/24
 - Default gateway: Not configured
 - DNS: Not configured
- Configure the firewall to allow ping messages:


```
Set-NetFirewallRule FPS-ICMP4-ERQ-In -Enabled True
```

ServerVM2:

- Windows Server 2016 Datacenter—Desktop Experience
- Server name: ServerVM2
- Memory: 1 GB
- Hard disk: 40 GB
- Ethernet connection—connected to PrivateNet
 - IP address: 192.168.0.11/24
 - Default gateway: Not configured
 - DNS: Not configured
- Configure the firewall to allow ping messages:


```
Set-NetFirewallRule FPS-ICMP4-ERQ-In -Enabled True
```

4. After fully configured, create a Checkpoint/Snapshot named InitialConfig that will be applied at the beginning of each chapter's activities where these VMs are used.

Using an Evaluation Version of Windows Server 2016

You can get a 180-day evaluation copy of Windows Server 2016 from the Microsoft Evaluation Center at <https://www.microsoft.com/en-us/evalcenter/evaluate-windows-server-2016/>. You will need to sign in with your Microsoft account or create a new account. You can download an ISO file that can then be attached to your virtual machine's DVD drive to install Windows Server 2016.

If your evaluation version of Windows Server 2016 gets close to expiring, you can extend the evaluation period (180 days) up to five times. To do so, follow these steps:

1. Open a command prompt window as Administrator.
2. Type **slmgr -xpr** and press **Enter** to see the current status of your license. It shows how many days are left in the evaluation. If it says you're in notification mode, you need to rearm the evaluation immediately.
3. To extend the evaluation for another 180 days, type **slmgr -rearm** and press **Enter**. You see a message telling you to restart the system for the changes to take effect. Click **OK** and restart the system.
4. After you have extended the evaluation period, you should take a new checkpoint/snapshot and replace the InitialConfig checkpoint/snapshot.

Where to Go for Help

Configuring a lab and keeping everything running correctly can be challenging. Even small configuration changes can prevent activities from running correctly. The author maintains a website that includes lab notes, suggestions, errata, and help articles that might be useful if you're having trouble, and you can contact the author at these addresses:

- Website: <http://books.tomsho.com>
- Email: w2k16@tomsho.com



INTRODUCING WINDOWS SERVER 2016

After reading this chapter and completing the exercises, you will be able to:

Explain the role a server operating system has in a network

Describe Windows Server 2016 roles and features

Explain the core technologies of Windows Server 2016

Summarize the new features of Windows Server 2016

Windows Server 2016 builds upon previous Windows Server versions, particularly in the areas of virtualization, workload management, and cloud computing. This new version is chockfull of new tools and features designed to help server administrators increase the availability of network services and limit security risks. Windows Server 2012 was all about the “private cloud” with a heavy emphasis on virtualization and virtual storage and using software to help you get more out of the hardware. Windows Server 2016 continues that trend and can be summed up as being all about the software-defined datacenter with new features such as Nano Server, containers, and Storage Spaces Direct.

Most networks are set up so that the people using computers on them can communicate with one another easily. One of a server’s functions is to facilitate communication between computers and, therefore, between people. The administrator of a computer network has the job of configuring servers and computers on the network to provide services that facilitate this communication. These services include, but aren’t limited to, file sharing, device sharing (such as printers and storage), security, messaging, remote access, web services, and many other services that work in the background to ensure a user-friendly and secure experience.

This chapter discusses the roles a server operating system plays in a computer network and the many features in Windows Server 2016 designed to perform these roles. As the Windows Server operating system (OS) becomes more complex with more features to facilitate the software-defined datacenter, there is

less emphasis on the core technologies upon which Windows Server is built. This chapter introduces you to those core features such as NTFS, Active Directory, and Hyper-V while other chapters or other books in the MCSA series will cover them in more detail. Finally, we take a brief look at the new features in Windows Server 2016, most of which are front and center in the Microsoft MCSA certification exams. All of these new features will be covered in detail in other chapters.

About the Hands-On Activities

Be sure to read and complete the activities in the “Before You Begin” section in the Introduction to this book. The hands-on activities in this chapter and all that follow require setting up your lab environment so that it’s ready to go. The hands-on activities in this chapter use a Windows Server 2016 Standard or Datacenter Edition computer that’s already installed and initially configured. The “Before You Begin” section gives you step-by-step instructions on setting up your lab for use with all activities in this book.

Completing the hands-on activities in this book is important because they contain information about how Windows Server 2016 works and the tools to manage it that are best understood by hands-on experience. If for some reason you can’t do some of the activities, you should at least read through each one to make sure you don’t miss important information. Table 1-1 summarizes the requirements of the hands-on activities in this chapter.

Table 1-1 Activity requirements

Activity	Requirements	Notes
Activity 1-1: Resetting Your Virtual Environment	ServerSA1	You need to perform this activity only if you are using virtual machines with snapshots and you are performing the activities in this chapter an additional time.
Activity 1-2: Reviewing System Properties and Exploring Server Manager	ServerSA1	Windows Server 2016 Datacenter Edition is installed according to instructions in “Before You Begin” section of this book’s Introduction.
Activity 1-3: Examining NTFS Permissions and Attributes	ServerSA1	
Activity 1-4: Working with MMCs	ServerSA1	
Activity 1-5: Creating a Volume and Sharing a Folder	ServerSA1	
Activity 1-6: Exploring Windows Networking Components	ServerSA1	
Activity 1-7: Working with PowerShell	ServerSA1	

The Role of a Server Operating System

A server or collection of servers is usually at the center of most business networks. The functions a server performs depend on several factors, including the type of business using the server, size of the business, and extent to which the business has committed to using technology to aid operations. The latter factor is the crux of the matter. Technology is designed to help a person or an organization do things more efficiently or more effectively, and a server is used to provide services a business has deemed can help its operations. Before you explore these services in more detail, a few definitions are in order.

Server: Hardware or Software?

When most people hear the word *server*, they conjure up visions of a large tower computer with lots of hard drives and memory. This image is merely a computer hardware configuration that may or may not be used as a server, however. In short, a computer becomes a server when software is installed on it that provides a network service to client computers. In other words, you could install certain software on an inexpensive laptop computer and make it act as a server. By the same token, a huge tower computer with six hard drives and 128 gigabytes (GB) of random access memory (RAM) could be used as a workstation for a single user. So although some computer hardware configurations are packaged to function as a server and others are packaged as desktop computers, what makes a computer a server or desktop computer is the software installed on it.

Of course, with modern operating systems (OSs), the lines between desktop and server computers are blurred. OSs such as Windows 10 and its predecessors are designed to be installed on desktop computers or workstations (and in the case of Windows 10, tablet computers and phones); to run web browser, word processing, spreadsheet, and similar programs; and generally to act as a personal computer. However, these OSs can perform server functions, such as file and printer sharing, and even act as a web server. Although Windows Server 2016 and its predecessors are designed as **server operating systems**, there's nothing to stop you from installing a word processor or web browser and using Windows Server 2016 on your desktop computer. So what are the differences between a desktop OS, such as Windows 10, and a server OS, such as Windows Server 2016? The following section explains.

Server Operating Systems Versus Desktop Operating Systems

Both Windows Server 2016 and Windows 10 can perform some server functions and some desktop functions, but important differences distinguish them. Windows 10 is configured to emphasize the user interface and is performance-tuned to run desktop applications. Windows Server 2016, on the other hand, deemphasizes many of Windows 10's user interface bells and whistles in favor of a less flashy and less resource-intensive user interface. In fact, Microsoft makes the Server Core version with no graphical user interface the default Windows Server 2016 installation option. And, as you will see, a new Windows Server 2016 installation option, known as "Nano Server," nearly strips away the user interface altogether. In addition, Windows Server 2016 is performance-tuned to run background processes so that client computers can access network services faster. Speaking of network services, most Windows Server 2016 editions can run the following network services, among others:

- File and Printer Sharing
- Web Server
- Routing and Remote Access Services (RRAS)
- Domain Name System (DNS)
- Dynamic Host Configuration Protocol (DHCP)
- File Transfer Protocol (FTP) Server
- Active Directory
- Distributed File System (DFS)
- Hyper-V
- Fax Server

Of these services, Windows 10 supports only Hyper-V, File and Printer Sharing, Web Server, and FTP Server and in a limited capacity. In addition, Windows 10 is restricted to 20 signed-in network users, whereas on a Windows Server 2016 computer running Standard or Datacenter Edition, signed-in users are limited only by the number of purchased licenses and available resources. In addition, because a server is such a critical device in a network, Windows Server 2016 includes fault-tolerance features, such as a redundant array of independent disks (RAID) 5 volumes, load balancing, and clustering, which aren't standard features in Windows 10 or other Windows desktop OSs. Windows Server 2016 is also capable of supporting up to 64 processors; Windows 10 supports a maximum of 2.

Windows Server 2016 Roles and Features

In Windows, a **server role** is a major function or service that a server performs. Probably the best known and most common server role is a file server (the File Server role in Windows Server 2016), which allows the server to share files on a network. **Role services** add functions to the main role. For example, with the File and Storage Services role, you can install role services such as Distributed File System, Server for NFS, and File Server Resource Manager. Windows server roles and role services are installed in Server Manager by clicking Manage and clicking Add Roles and Features (see Figure 1-1).

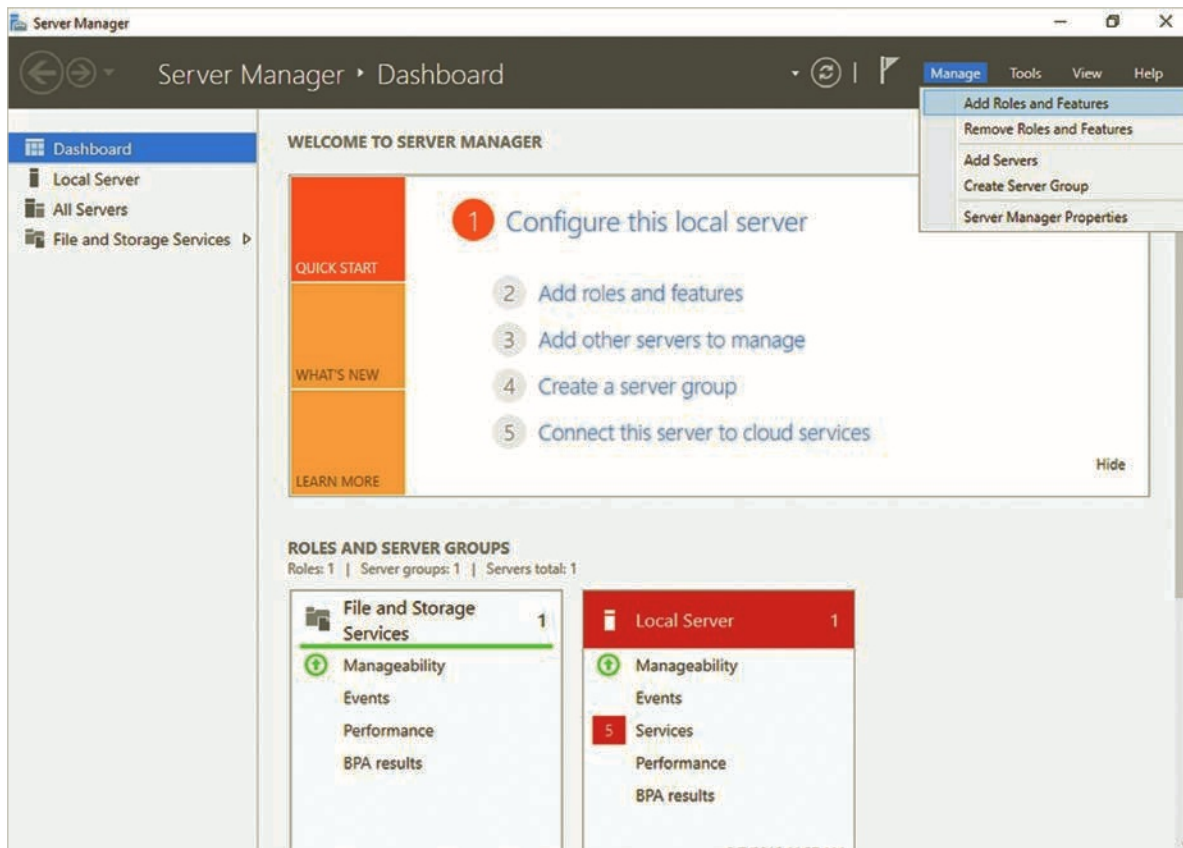


Figure 1-1 Adding roles and features with Server Manager

You can also add **server features**, which provide functions that enhance or support an installed role or add a standalone function. For example, you can add the Failover Clustering feature to provide fault tolerance for a file server or database server. An example of a standalone feature is Internet Printing Client, which enables clients to use Internet Printing Protocol to connect to printers on the Internet. A server can be configured with a single role or several roles, depending on the organization's needs and the load a role puts on the server hardware. Figure 1-2 shows the list of available server roles in Windows Server 2016. Several of these roles, particularly those covered in Exam 70-740, are explained in detail in later chapters.

Windows Server 2016 Core Technologies

Many of the topics of this book require that you understand the core technologies in Windows Server 2016. Some of these core technologies are discussed in more detail in this book or in one of the other MCSA titles (*MCSA Guide to Networking with Windows Server 2016, Exam 70-741* and *MCSA*

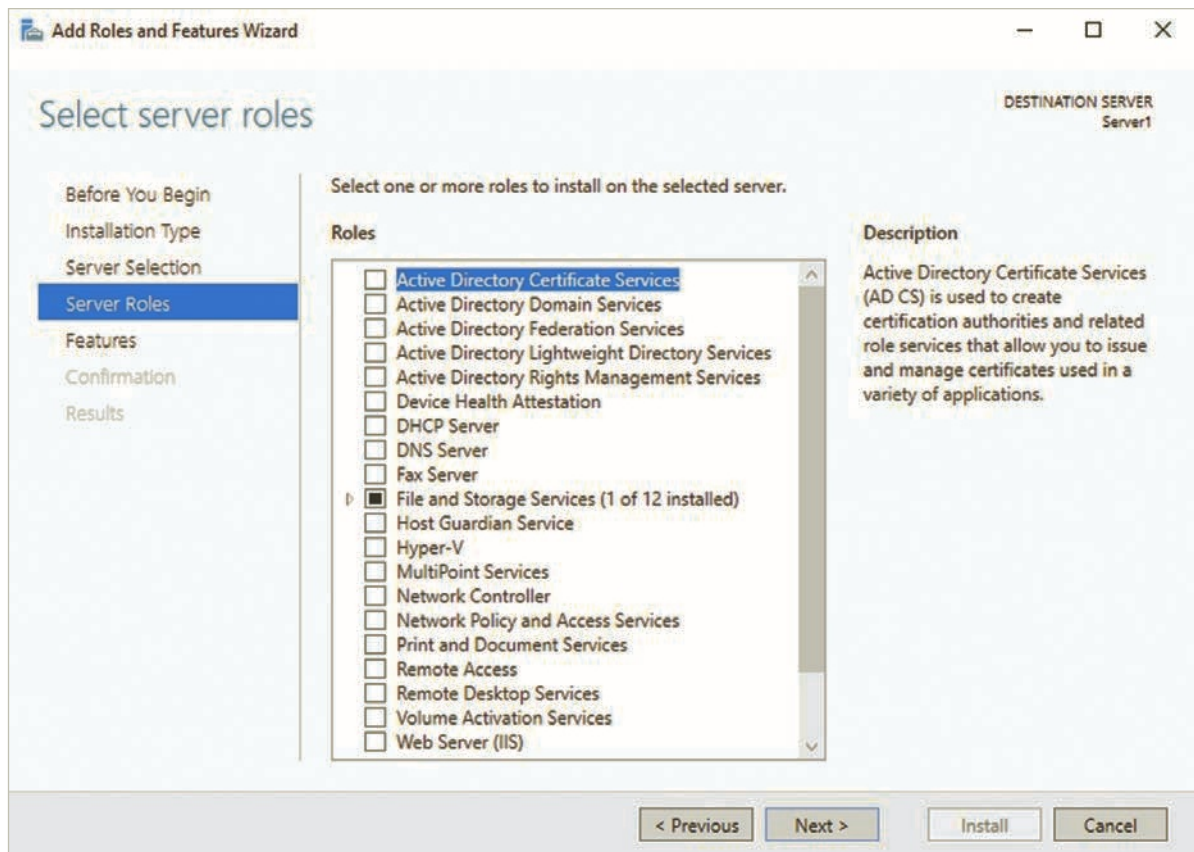


Figure 1-2 Available server roles in Windows Server 2016

Guide to Identity with Windows Server 2016, Exam 70-742 [Cengage, 2018]). However, this section gives you a brief overview of these technologies so you will be familiar with them when you need to use them later on. The following is a list of some of the technologies on which Windows Server 2016 is built:

- Server Manager
- NT File System (NTFS)
- Active Directory
- Microsoft Management Console (MMC)
- Disk Management
- File and Printer Sharing
- Windows networking
- PowerShell
- Hyper-V and cloud computing
- Storage Spaces

The following sections describe these technologies briefly; some are covered in detail in later chapters.

Server Manager

Server Manager provides a single interface for installing, configuring, and removing a variety of server roles and features on your Windows server. It also summarizes your server's status and configuration and includes tools to diagnose problems, manage storage, and perform general configuration tasks. Server Manager can be used to manage all servers in your network and access all the server administration tools from a single console.

When you start Server Manager, you see the Dashboard view, shown in Figure 1-3. The Dashboard shows a list of tasks you can perform, summarizes the installed roles, and shows the servers that are available to manage. The Welcome section can be hidden after you're familiar with Server Manager. This tool is used to access most of the configuration and monitoring tools for administering Windows servers, and you learn more about it throughout this book.

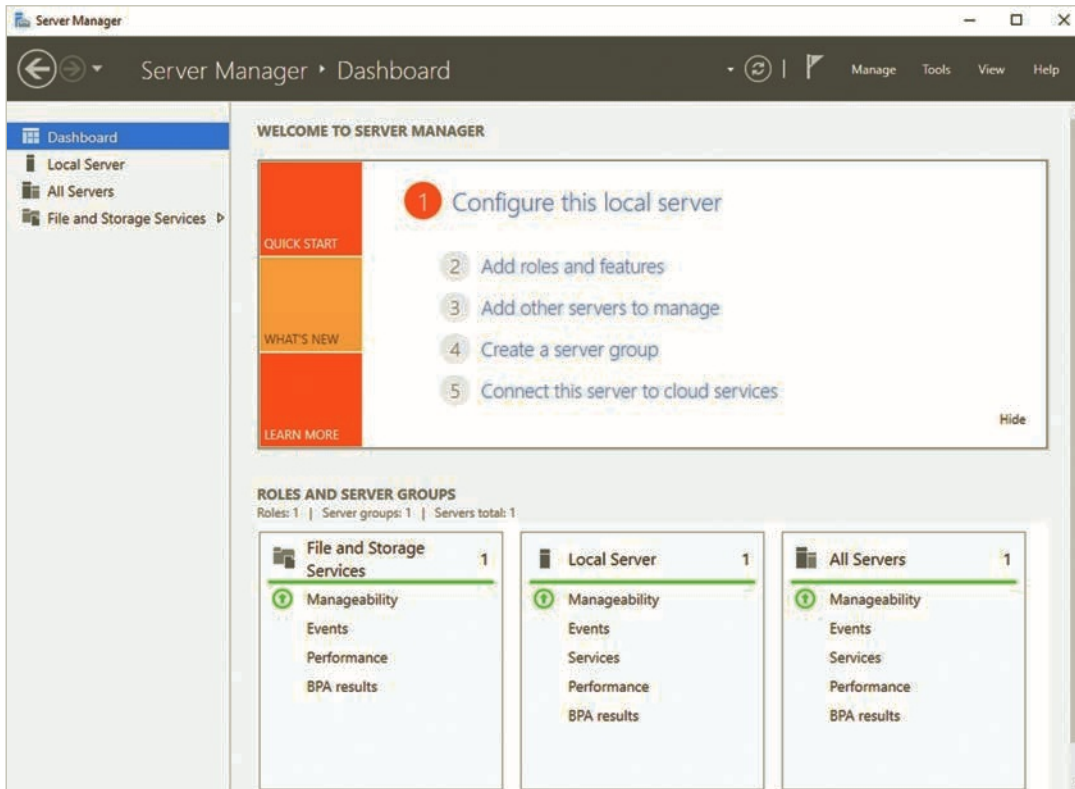


Figure 1-3 Server Manager Dashboard view

The forward and backward arrows at the upper left are used to navigate through recently opened windows. Moving to the right, your current location is displayed, followed by the refresh button and the notifications icon (shaped like a flag) that you click to view recent messages from Server Manager. Next is the Manage menu, used to perform major tasks, such as adding and removing roles and features and creating server groups. The Tools menu gives you quick access to administrative tools, such as Computer Management, Event Viewer, and Task Scheduler. Management consoles for server roles or features that you install are added to this menu. You can use the View menu to choose a magnification option for fonts in Server Manager, and the Help menu is self-explanatory.

The left pane of Server Manager displays the major views: Dashboard (described previously), Local Server, and All Servers. You use the Local Server view to manage just the server where you're running Server Manager and the All Servers view to manage aspects of all servers. To add servers you want to manage, right-click All Servers and click Add Servers or use the Manage menu. Under the All Servers item in the left pane is a node for each installed server role. In Figure 1-3, you see File and Storage Services, which is a preinstalled role. Clicking a server role puts Server Manager into role management mode so that you can manage each role in the Server Manager interface. When you're managing a role, the options for the role are displayed.

NT File System (NTFS)

One of a server's main jobs is to store a variety of file types and make them available to network users. To do this effectively, a server OS needs a robust and efficient file system. **NT File System (NTFS)** was introduced in Windows NT in the early 1990s. Although it has been updated throughout the years, NTFS has remained a reliable, flexible, and scalable file system. Its predecessor was File Allocation Table (FAT)/FAT32, which had severe limitations for a server OS. It lacked features such as native support for long

file names, file and folder permissions, support for large files and volumes, reliability, compression, and encryption. NTFS supports all these features and more.

Perhaps the most important feature of NTFS is the capability to set user and group permissions on both folders and files. With this feature, administrators can specify which users can access a file and what users can do with a file if they're granted access, which increase a server environment's security. FAT/FAT32 has no user access controls.

Note

The exFAT file system is similar to FAT/FAT32 except that you can create volumes larger than 32 GB; with FAT32, you are limited to a maximum volume size of 32 GB.

An NTFS volume has a number of advantages over a FAT/FAT32 volume. So what good is a FAT or FAT32 volume? One reason to use FAT or FAT32 on a Windows computer now is having a volume that will be used by another OS that might not support NTFS. In addition, removable drives, USB flash drives, and flash memory cards are often formatted with FAT32 or, for larger removable drives, exFAT. NTFS and other supported file systems are covered in detail in Chapter 4.

Tip

A FAT/FAT32-formatted disk can be converted to NTFS without losing existing data by using the `convert` command-line utility.

Microsoft Management Console

A server OS requires a multitude of tools that administrators must use to manage, support, and troubleshoot a server system. One challenge of having so many tools is the numerous user interfaces an administrator has to learn. Microsoft has lessened this challenge by including the Microsoft Management Console (MMC), a common framework for running most administrative tools. The MMC alone isn't very useful; it's just a user interface shell, as you can see in Figure 1-4. What makes it useful is the bevy of snap-ins you can install. Each snap-in is designed to perform a specific administrative task, such as the Disk Management snap-in shown in Figure 1-5.

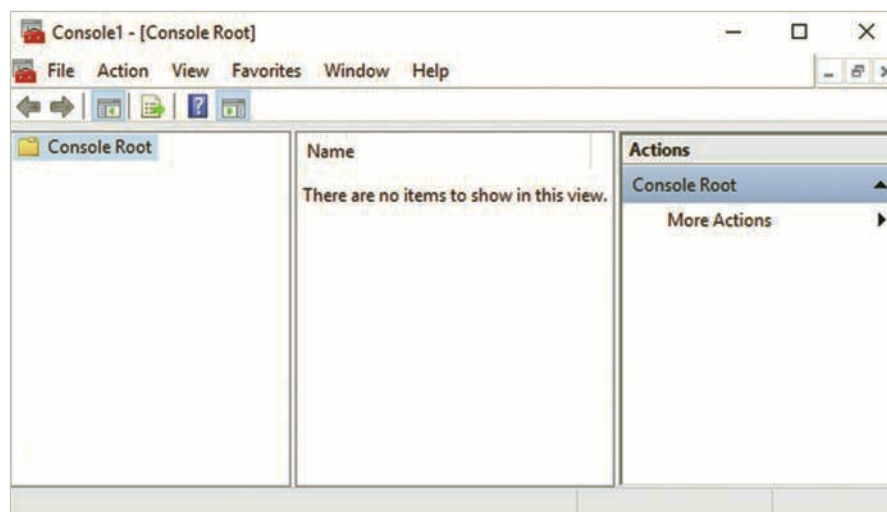


Figure 1-4 The Microsoft Management Console

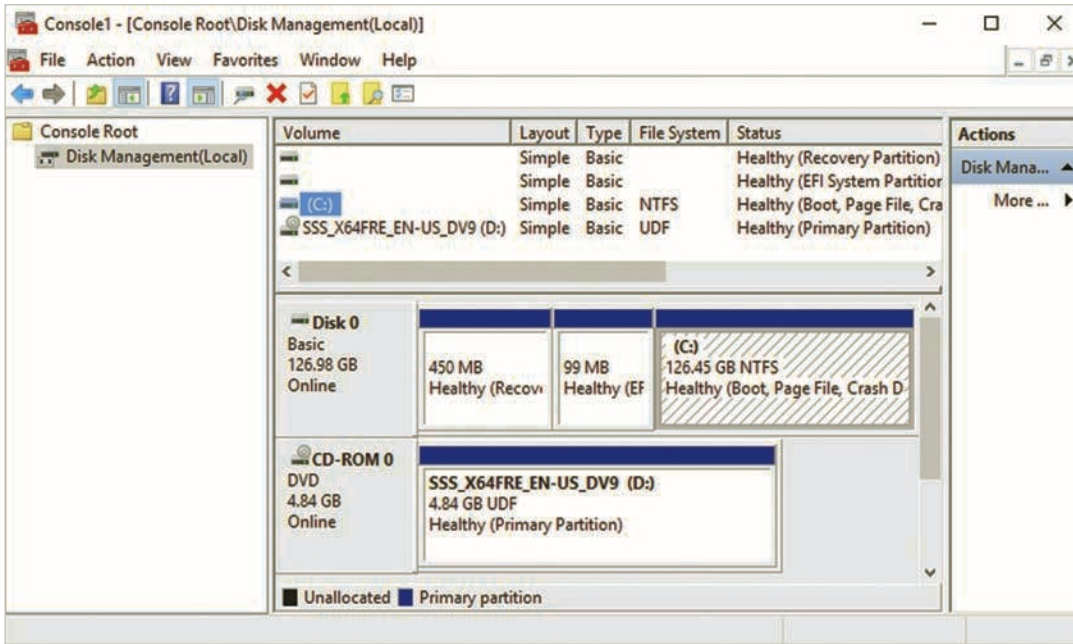


Figure 1-5 An MMC with the Disk Management snap-in

A number of MMCs are available in Server Manager's Tools menu, depending on the roles and features installed on the server. For example, after you install Active Directory, several new MMCs for managing it are created and added to the Tools menu. Not all administrative functions can be accessed from these prebuilt MMCs, however; you might have to create a customized MMC to access some functions or keep an MMC handy on your desktop with the administrative snap-ins you use most often. An important feature of an MMC is the capability to connect to servers remotely. Using this feature, you can install management tools on a Windows 10 workstation, for example, and manage a Windows Server 2016 computer without having to sign in at the server console.

Disk Management

To manage the disks and volumes on a Windows Server 2016 computer, you might use the Disk Management snap-in or the File and Storage Services role, which is integrated into Server Manager. With these tools, you can monitor the status of disks and volumes, initialize new disks, create and format new volumes, and troubleshoot disk problems. Both tools enable you to configure redundant disk configurations, such as RAID 1 and RAID 5 volumes. File and Storage Services also lets you create storage pools for Storage Spaces, discussed later in the "Storage Spaces" section of this chapter. These tools are also covered in more detail in Chapter 4, and Activity 1-5 walks you through using Disk Management.

File and Printer Sharing

Probably the most common reason for building a network and installing a server is to enable users to share files, printers, and other resources. Windows Server 2016 has a full-featured system for file and printer sharing, offering advanced features such as shadow copies, disk quotas, and the Distributed File System (DFS). At its simplest, sharing files or a printer is just a few clicks away. More complex configurations that offer redundancy, version control, and user storage restrictions are also readily available. Windows Server 2016 offers myriad tools and options for configuring file sharing; most are discussed in more detail in Chapter 4.

Windows Networking Concepts

Administering a Windows server requires extensive knowledge of networking components and protocols as well as a solid understanding of the network security models used in Windows. In a Windows network environment, computers can be configured to participate in one of two network security models: workgroup or domain.

The Workgroup Model

A **Windows workgroup** is a small collection of computers with users who typically have something in common, such as the need to share files or printers with each other. A workgroup is also called a *peer-to-peer network* sometimes because all participants are represented equally on the network with no single computer having authority or control over another. Furthermore, logons, security, and resource sharing are decentralized, so each user has control over his or her computer's resources. This model is easy to configure, requires little expertise to manage, and works well for small groups of users who need to share files, printers, an Internet connection, or other resources. A Windows Server 2016 server that participates in a workgroup is referred to as a **standalone server**.

The Domain Model

A **Windows domain** is a group of computers that share common management and are subject to rules and policies defined by an administrator. The domain model is preferred for a computer network that has several computers and/or requires centralized security and resource management. Unlike the workgroup model, a domain requires at least one computer configured as a domain controller running a Windows Server OS. In the domain model, a computer running a Windows Server OS can perform one of two primary roles: a domain controller or a member server.

A **domain controller** is a Windows server that has Active Directory installed and is responsible for allowing client computers access to domain resources. The core component of a Windows domain is Active Directory. A **member server** is a Windows server that's in the management scope of a Windows domain but doesn't have Active Directory installed.

Windows Networking Components

Every OS requires these hardware and software components to participate on a network: a network interface, a network protocol, and network client or network server software. Current OSs usually have both client and server software installed. In Windows, this collection of networking components working together is a **network connection**.

Network Interface

A **network interface** is composed of two parts: the network interface card (NIC) hardware and the device driver software containing specifics of how to communicate with the NIC. In Windows Server 2016, you configure the network interface in the Network Connections window (see Figure 1-6). To open it from Server Manager, click Local Server, and then click the address next to the Ethernet label. Alternatively, right-click Start and click Network Connections.

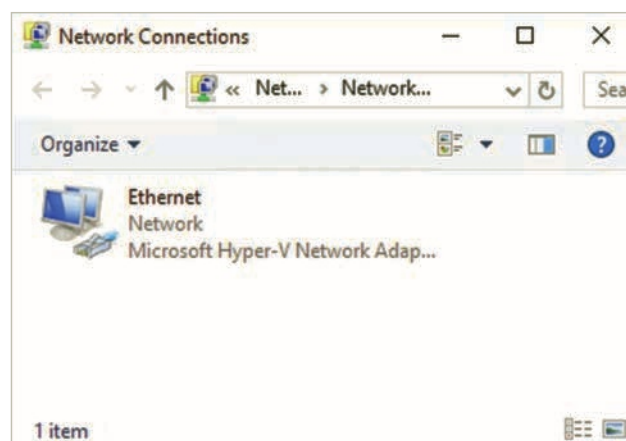


Figure 1-6 The Network Connections window

If you right-click a network connection and click Properties, a Properties dialog box similar to Figure 1-7 opens. The network interface used in this connection is specified in the Connect using text box. You can view details about the interface, including the device driver and configurable settings, by clicking the Configure button.