



Hands-On Microsoft Windows Server 2019



Third Edition



Jason W. Eckert
triOS College

Hands-On Microsoft Windows Server 2019

Third Edition



Jason W. Eckert
triOS College



Australia • Brazil • Mexico • Singapore • United Kingdom • United States

This is an electronic version of the print textbook. Due to electronic rights restrictions, some third party content may be suppressed. Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. The publisher reserves the right to remove content from this title at any time if subsequent rights restrictions require it. For valuable information on pricing, previous editions, changes to current editions, and alternate formats, please visit www.cengage.com/highered to search by ISBN#, author, title, or keyword for materials in your areas of interest.

Important Notice: Media content referenced within the product description or the product text may not be available in the eBook version.

***Hands-On Microsoft Windows Server
2019, Third Edition***

Jason W. Eckert

SVP, Higher Education Product
Management: Erin Joyner
VP, Product Management: Thais Alencar
Product Team Manager: Kristin McNary
Product Manager: Amy Savino
Senior Product Assistant: Anna Goulart
Director, Learning Design:
Rebecca von Gillern
Senior Manager, Learning Design:
Leigh Hefferon
Learning Designer: Natalie Onderdonk
Vice President, Marketing – Science,
Technology, & Math: Jason Sakos
Senior Marketing Director: Michele McTighe
Marketing Manager: Cassie Cloutier
Marketing Development Manager:
Samantha Best
Product Specialist: Mackenzie Paine
Director, Content Creation: Juliet Steiner
Senior Manager, Content Creation:
Patty Stephan
Senior Content Manager: Brooke Greenhouse
Director, Digital Production Services:
Krista Kellman
Digital Delivery Lead: Jim Vaughey
Technical Editor: Danielle Shaw
Developmental Editor: Ann Shaffer
Production Service/Composition: SPI-Global
Design Director: Jack Pendleton
Designer: Erin Griffin
Cover Designer: Joseph Villanova
Cover Image(s): iStockPhoto.com/nadla

Notice to the Reader

Publisher does not warrant or guarantee any of the products described herein or perform any independent analysis in connection with any of the product information contained herein. Publisher does not assume, and expressly disclaims, any obligation to obtain and include information other than that provided to it by the manufacturer. The reader is expressly warned to consider and adopt all safety precautions that might be indicated by the activities described herein and to avoid all potential hazards. By following the instructions

© 2021 Cengage Learning, Inc.

Unless otherwise noted, all content is © Cengage.

WCN: 02-300

ALL RIGHTS RESERVED. No part of this work covered by the copyright herein may be reproduced or distributed in any form or by any means, except as permitted by U.S. copyright law, without the prior written permission of the copyright owner.

Screenshots for this book were created using Microsoft® and all Microsoft-based trademarks and logos are registered trademarks of Microsoft Corporation, Inc. in the United States and other countries. Cengage is an independent entity from the Microsoft Corporation, and not affiliated with Microsoft in any manner.

For product information and technology assistance, contact us at **Cengage Customer & Sales Support, 1-800-354-9706 or support.cengage.com.**

For permission to use material from this text or product, submit all requests online at **www.cengage.com/permissions.**

Library of Congress Control Number: 2020907519

ISBN: 978-0-357-43615-8

Cengage

200 Pier 4 Boulevard
Boston, MA 02210
USA

Cengage is a leading provider of customized learning solutions with employees residing in nearly 40 different countries and sales in more than 125 countries around the world. Find your local representative at **www.cengage.com.**

Cengage products are represented in Canada by Nelson Education, Ltd.

To learn more about Cengage platforms and services, register or access your online learning solution, or purchase materials for your course, visit **www.cengage.com.**

contained herein, the reader willingly assumes all risks in connection with such instructions. The publisher makes no representations or warranties of any kind, including but not limited to, the warranties of fitness for particular purpose or merchantability, nor are any such representations implied with respect to the material set forth herein, and the publisher takes no responsibility with respect to such material. The publisher shall not be liable for any special, consequential, or exemplary damages resulting, in whole or part, from the readers' use of, or reliance upon, this material.

Printed in the United States of America

Print Number: 01

Print Year: 2020

Brief Contents

INTRODUCTION.....	xvii
MODULE 1	
Getting Started with Windows Server 2019.....	1
MODULE 2	
Configuring Windows Server 2019.....	65
MODULE 3	
Implementing Hyper-V and Rapid Server Deployment.....	149
MODULE 4	
Introduction to Active Directory and Account Management	217
MODULE 5	
Configuring Resource Access	295
MODULE 6	
Configuring Printing	367
MODULE 7	
Configuring and Managing Data Storage.....	421
MODULE 8	
Configuring and Managing Network Services.....	505
MODULE 9	
Configuring and Managing Remote Access Services.....	577
MODULE 10	
Configuring Web Services and Cloud Technologies.....	655
MODULE 11	
Managing and Securing Windows Networks.....	705
MODULE 12	
Monitoring and Troubleshooting Windows Server 2019.....	781
GLOSSARY	835
INDEX.....	867

Table of Contents

INTRODUCTION.....	xvii
-------------------	------

MODULE 1

Getting Started with Windows Server 2019.....	1
--	----------

USING WINDOWS SERVER 2019 WITHIN AN ORGANIZATION	2
---	----------

Understanding Windows Server Virtualization	3
---	---

Understanding Windows Containers	8
--	---

WINDOWS SERVER 2019 FEATURES.....	10
--	-----------

Active Directory	11
------------------------	----

Security	12
----------------	----

Volume and Filesystem Features.....	13
-------------------------------------	----

Performance and Reliability	14
-----------------------------------	----

Administration Tools	16
----------------------------	----

Small Footprint Installation Options.....	21
---	----

Hybrid Cloud Features	23
-----------------------------	----

Linux Application Support.....	24
--------------------------------	----

WINDOWS SERVER 2019 EDITIONS	24
---	-----------

Windows Server 2019 Essentials Edition	24
--	----

Windows Server 2019 Standard Edition	26
--	----

Windows Server 2019 Datacenter Edition	26
--	----

Windows Storage Server 2019	27
-----------------------------------	----

Microsoft Hyper-V Server 2019.....	27
------------------------------------	----

PREPARING FOR A WINDOWS SERVER 2019 INSTALLATION.....	27
--	-----------

INSTALLING WINDOWS SERVER 2019	30
---	-----------

Obtaining Installation Media.....	30
-----------------------------------	----

Starting the Installation Process	31
---	----

Completing the Installation Process	32
---	----

POST-INSTALLATION CONFIGURATION.....	39
---	-----------

Setting the Correct Time and Time Zone	40
--	----

Configuring the Network	40
-------------------------------	----

Configuring the Firewall	48
--------------------------------	----

Changing the Default Computer Name and Domain Membership.....	49
---	----

Installing a Modern Web Browser.....	51
--------------------------------------	----

Activating the Windows Server Operating System	51
--	----

SELECTING A WINDOWS SERVER 2019 LAB ENVIRONMENT	52
MODULE SUMMARY	53
KEY TERMS	54
REVIEW QUESTIONS	55
HANDS-ON PROJECTS	57
Project 1-1: Lab Environment 1	57
Project 1-2: Lab Environment 2	58
Project 1-3: Post-Installation Tasks.....	61
Discovery Exercises	63
MODULE 2	
Configuring Windows Server 2019	65
WORKING WITH SERVER MANAGER.....	66
Adding Roles and Features Using Server Manager	73
Using the BPA to Verify Server Roles.....	77
WORKING WITH THE WINDOWS ADMIN CENTER.....	78
Installing the Windows Admin Center.....	79
Using the Windows Admin Center	81
CONFIGURING SERVER HARDWARE DEVICES.....	84
Adding Hardware Using Control Panel	85
Using Device Manager	87
VERIFYING SYSTEM FILES.....	89
CONFIGURING WINDOWS SETTINGS	91
Configuring Performance Options	91
Configuring Environment Variables.....	98
Configuring Startup and Recovery.....	98
Configuring Power Options.....	99
THE WINDOWS REGISTRY	102
Windows Registry Contents	103
USING WINDOWS POWERSHELL	105
Working with Windows PowerShell	105
System Administration Commands.....	114
Using WMI within Windows PowerShell.....	117
Creating PowerShell Scripts.....	119
MODULE SUMMARY	131
KEY TERMS	132

REVIEW QUESTIONS	133
HANDS-ON PROJECTS	135
Project 2-1: Server Manager	135
Project 2-2: Windows Admin Center	137
Project 2-3: Configuration Utilities	138
Project 2-4: Cmdlets	139
Project 2-5: Cmdlet Output	140
Project 2-6: PowerShell Providers	141
Project 2-7: WMI.....	143
Project 2-8: PowerShell Customization.....	144
Project 2-9: PowerShell Scripting.....	145
Discovery Exercises	146

MODULE 3

Implementing Hyper-V and Rapid Server Deployment ... 149

IMPLEMENTING HYPER-V	150
Installing Hyper-V	150
Understanding Virtual Networks.....	155
Creating Virtual Machines.....	160
Configuring Virtual Machines	167
Working with Virtual Machines	177
Managing Hyper-V Features	179
RAPID SERVER DEPLOYMENT	185
Using Virtual Machine Templates.....	185
Using Windows Deployment Services.....	191
MODULE SUMMARY	200
KEY TERMS	201
REVIEW QUESTIONS	202
HANDS-ON PROJECTS	204
Project 3-1: Hyper-V Installation.....	204
Project 3-2: Virtual Switches	205
Project 3-3: WDS Configuration	206
Project 3-4: WDS Deployment	208
Project 3-5: Templates	209
Project 3-6: Checkpoints	210
Project 3-7: Virtual Machine Settings.....	212
Discovery Exercises	214

MODULE 4

Introduction to Active Directory and Account Management	217
WORKING WITH LOCAL USERS AND GROUPS.....	218
ACTIVE DIRECTORY BASICS.....	223
Active Directory Objects.....	225
Active Directory Forests, Trees, and Trusts.....	227
Active Directory Groups.....	230
Domain and Forest Functional Levels.....	232
Sites and Active Directory Replication.....	234
Global Catalog.....	237
FSMO Roles.....	238
Azure Active Directory.....	240
INSTALLING ACTIVE DIRECTORY	241
Installing a Forest Root Domain.....	242
Installing a Domain within an Existing Forest.....	247
Installing a Domain Controller within an Existing Domain.....	249
CONFIGURING ACTIVE DIRECTORY.....	251
Raising Functional Levels.....	251
Creating Trust Relationships	253
Managing FSMO Roles.....	257
Configuring Sites and Replication	257
Configuring Global Catalog and UGMC.....	263
MANAGING ACTIVE DIRECTORY OBJECTS.....	265
Working with Organizational Units	265
Working with User Objects	267
Working with Group Objects	271
Working with Computer Objects	273
Using the Active Directory Administrative Center.....	274
READ-ONLY DOMAIN CONTROLLERS.....	275
MODULE SUMMARY.....	277
KEY TERMS	279
REVIEW QUESTIONS	280
HANDS-ON PROJECTS	281
Project 4-1: Cleanup.....	282
Project 4-2: Active Directory Installation.....	282
Project 4-3: Functional Levels.....	284
Project 4-4: Trusts.....	284
Project 4-5: Sites.....	286
Project 4-6: Global Catalog.....	287

Project 4-7: Objects	287
Project 4-8: Active Directory Admin Center	290
Project 4-9: RODCs	290
Discovery Exercises	292

MODULE 5

Configuring Resource Access	295
CONFIGURING FOLDER AND FILE ATTRIBUTES	296
Working with Basic Attributes	296
Working with Advanced Attributes	298
MANAGING FOLDER AND FILE SECURITY	303
Configuring Folder and File Permissions	303
Configuring Folder and File Ownership.....	309
Troubleshooting Folder and File Permissions.....	310
Configuring Folder and File Auditing	311
CONFIGURING SHARED FOLDERS	314
Sharing Folders Using SMB.....	314
Sharing Folders Using NFS.....	324
Publishing a Shared Folder in Active Directory	330
IMPLEMENTING DISTRIBUTED FILE SYSTEM	332
Configuring DFS Namespaces	332
Configuring DFS Replication.....	337
IMPLEMENTING QUOTAS AND FILE SCREENS	341
Configuring User Quotas.....	342
Configuring Folder Quotas.....	343
Configuring File Screens	345
MODULE SUMMARY.....	347
KEY TERMS	347
REVIEW QUESTIONS.....	348
HANDS-ON PROJECTS	350
Project 5-1: Host Setup.....	351
Project 5-2: Member Server Setup.....	351
Project 5-3: Permissions	353
Project 5-4: Auditing	355
Project 5-5: Attributes	356
Project 5-6: Sharing Folders.....	358
Project 5-7: DFS	360
Project 5-8: Quotas and File Screens.....	362
Discovery Exercises	364

MODULE 6

Configuring Printing	367
WINDOWS PRINTING BASICS	368
The Printing Process	369
Printing to a Shared Printer	371
The Printing Process for a Shared Printer	375
CONFIGURING A WINDOWS SERVER 2019 PRINT SERVER	375
Installing Print and Document Services	376
Configuring a Print Server	377
Adding Printers to a Print Server	383
Configuring Printer Properties	386
Using Group Policy to Deploy Shared Printers.....	397
Configuring Branch Office Direct Printing.....	398
MANAGING PRINT JOBS.....	398
MONITORING AND TROUBLESHOOTING PRINTERS.....	402
MODULE SUMMARY.....	407
KEY TERMS	408
REVIEW QUESTIONS.....	409
HANDS-ON PROJECTS	411
Project 6-1: Enhanced Session Mode Removal.....	411
Project 6-2: Print Server Installation.....	411
Project 6-3: Print Server Configuration.....	412
Project 6-4: Printer Properties.....	413
Project 6-5: Adding Shared Printers.....	415
Project 6-6: Print Job Management	416
Project 6-7: Printer Troubleshooting.....	417
Discovery Exercises	418

MODULE 7

Configuring and Managing Data Storage.....	421
WINDOWS SERVER 2019 LOCAL STORAGE OPTIONS.....	421
Storage Devices	422
Partitions, Filesystems, and Volumes	422
Partition Types and Strategies	424
RAID Types and Strategies	427
CREATING AND MANAGING LOCAL VOLUMES.....	431
Using Disk Management	431
Using Server Manager.....	440
Using Storage Spaces Direct	454

ACCESSING AND CONFIGURING SAN STORAGE.....	455
Connecting Windows Server 2019 to an iSCSI SAN Device	456
Connecting Windows Server 2019 to a Fibre Channel SAN Device	459
Using MPIO to Connect to Multiple SAN Devices	460
Configuring Windows Server 2019 as an iSCSI SAN Device	462
MANAGING VOLUME DATA	468
Enabling Data Deduplication	468
Optimizing Volumes	470
Repairing Volumes	472
Backing Up and Restoring Data	475
MODULE SUMMARY.....	484
KEY TERMS	485
REVIEW QUESTIONS.....	486
HANDS-ON PROJECTS	488
Project 7-1: Adding Storage Devices	488
Project 7-2: Disk Management (Simple Volumes)	490
Project 7-3: Disk Management (RAID)	493
Project 7-4: Server Manager and Storage Spaces	495
Project 7-5: iSCSI Target Server	497
Project 7-6: Managing Volume Data	499
Project 7-7: Backup and Restore	501
Discovery Exercises	502

MODULE 8

Configuring and Managing Network Services	505
UNDERSTANDING DNS	506
The DNS Lookup Process	506
Authoritative DNS Server Types	509
Accessing DNS Servers in Other Organizations	510
Resource Records	510
CONFIGURING A DNS SERVER.....	512
Configuring Primary Zones	514
Creating Secondary Zones.....	529
Creating Stub Zones	529
Configuring Conditional Forwarders	530
Configuring Default Forwarders	531
TROUBLESHOOTING DNS.....	532
Using nslookup.....	533
Using DNS Manager	535
Using Log Files	536

CONFIGURING WINS	537
Using WINS for NetBIOS Name Resolution	538
Configuring a WINS Server.....	540
UNDERSTANDING DHCP	542
The DHCP Lease Process	543
DHCP Relay.....	544
CONFIGURING A DHCP SERVER	545
Creating a New Scope	547
Configuring Scopes	553
Configuring Filters	557
Configuring DHCP Fault Tolerance	557
TROUBLESHOOTING DHCP	559
MODULE SUMMARY	561
KEY TERMS	561
REVIEW QUESTIONS	562
HANDS-ON PROJECTS	564
Project 8-1: Configuring DNS Zones	564
Project 8-2: DNS Zone Properties and Resource Records.....	566
Project 8-3: Configuring DNS Secondary Zones.....	568
Project 8-4: Installing and Configuring WINS.....	569
Project 8-5: Installing and Configuring DHCP	570
Project 8-6: DHCP Testing and Fault Tolerance.....	572
Discovery Exercises	574

MODULE 9

Configuring and Managing Remote Access Services	577
UNDERSTANDING ORGANIZATION NETWORKS AND REMOTE ACCESS	578
UNDERSTANDING VPNs	583
Using VPNs for Remote Access.....	583
Using VPNs to Protect Network Traffic.....	585
VPN Protocols.....	587
VPN Authentication	588
Using RADIUS	589
IMPLEMENTING VPNs	590
Configuring a Remote Access Server	591
Configuring RADIUS	601
Connecting to a VPN Server.....	610
Creating a Demand-Dial Interface.....	612
UNDERSTANDING DIRECTACCESS	616

IMPLEMENTING DIRECTACCESS.....	617
UNDERSTANDING REMOTE DESKTOP	622
IMPLEMENTING REMOTE DESKTOP SERVICES	625
Installing Remote Desktop Services	625
Configuring Remote Desktop Services.....	630
Configuring Collections.....	633
Connecting to Remote Desktop Services	637
MODULE SUMMARY.....	637
KEY TERMS	638
REVIEW QUESTIONS.....	639
HANDS-ON PROJECTS	640
Project 9-1: Cleanup Tasks	641
Project 9-2: Configuring a VPN Server.....	642
Project 9-3: Connecting to a VPN.....	643
Project 9-4: RADIUS.....	645
Project 9-5: DirectAccess	647
Project 9-6: Remote Desktop Services.....	649
Project 9-7: Remote Desktop Connection	651
Discovery Exercises	653
MODULE 10	
Configuring Web Services and Cloud Technologies.....	655
UNDERSTANDING THE CLOUD	656
Defining the Cloud.....	656
Cloud Types.....	658
Cloud Delivery Models.....	659
Cloud Storage.....	661
Understanding Continuous Deployment	662
CONFIGURING WEB SERVICES	663
Installing IIS	664
Configuring IIS.....	666
CONFIGURING CONTAINERS.....	670
Installing Docker	671
Obtaining Container Images	672
Running Containers	675
Running Hyper-V Containers.....	678
Common Docker Commands.....	679
CONFIGURING THE WINDOWS SUBSYSTEM FOR LINUX.....	681
Installing and Using WSL	682
Hosting Web Services using WSL.....	684

CONFIGURING LINUX CONTAINERS ON WINDOWS	685
IMPLEMENTING WINDOWS SERVER 2019 IN A CLOUD ENVIRONMENT ...	687
Hosting Web Apps in a Public Cloud.....	687
Hosting Web Apps in a Private Cloud	689
MODULE SUMMARY.....	690
KEY TERMS	691
REVIEW QUESTIONS	691
HANDS-ON PROJECTS	693
Project 10-1: Configuring IIS	693
Project 10-2: Windows Containers.....	696
Project 10-3: WSL	698
Project 10-4: Linux Containers on Windows.....	700
Project 10-5: Nano Server	702
Discovery Exercises	702

MODULE 11

Managing and Securing Windows Networks.....	705
CONFIGURING GROUP POLICY	706
Configuring GPOs.....	708
Configuring GPO Settings	710
Managing GPOs.....	721
DEPLOYING PUBLIC KEY CERTIFICATES.....	723
Understanding Public Key Certificates.....	723
Installing an Enterprise CA	728
Configuring an Enterprise CA for Certificate Enrollment.....	729
Enrolling for Certificates	735
IMPLEMENTING 802.1X WIRELESS.....	740
Configuring RADIUS for 802.1X Wireless.....	742
Configuring a WAP for 802.1X Wireless	745
CONFIGURING WINDOWS SERVER UPDATE SERVICES	746
Installing WSUS	747
Configuring WSUS	749
Configuring a WSUS GPO	754
CONFIGURING WINDOWS DEFENDER.....	756
Configuring Windows Defender Features.....	756
Configuring Windows Defender Firewall with Advanced Security	758
MODULE SUMMARY.....	765
KEY TERMS	765
REVIEW QUESTIONS	766

HANDS-ON PROJECTS	768
Project 11-1: Configuring Group Policy	768
Project 11-2: Configuring Active Directory Certificate Services.....	772
Project 11-3: Configuring 802.1X Wireless	775
Project 11-4: Configuring WSUS.....	776
Project 11-5: Configuring Windows Defender	777
Discovery Exercises	779
MODULE 12	
Monitoring and Troubleshooting Windows Server 2019	781
MONITORING AND TROUBLESHOOTING METHODOLOGY	782
MONITORING AND TROUBLESHOOTING TOOLS.....	784
Task Manager	785
Resource Monitor.....	792
Performance Monitor.....	793
Data Collector Sets	798
Event Viewer.....	805
Reliability Monitor	811
RESOLVING COMMON SYSTEM PROBLEMS	812
Hardware-Related Problems.....	813
Performance-Related Problems	814
Software-Related Problems	816
Operating System-Related Problems.....	816
Network-Related Problems	817
MODULE SUMMARY.....	822
KEY TERMS	823
REVIEW QUESTIONS.....	823
HANDS-ON PROJECTS	825
Project 12-1: Monitoring Performance and Processes.....	825
Project 12-2: Creating a Baseline	827
Project 12-3: Creating Data Collector Sets	828
Project 12-4: Viewing Events	830
Project 12-5: Testing Connectivity and Service Access.....	831
Project 12-6: Accessing Advanced Boot Options.....	832
Discovery Exercises	833
GLOSSARY	835
INDEX.....	867



Introduction

The Microsoft Windows family of operating systems has dominated both the personal and business computing world for the past three decades. Within organizations, Windows Server operating systems support the computing needs of Windows users, as well as users of other operating systems, such as Linux and macOS. Windows Server 2019, Microsoft's latest server operating system, offers a comprehensive set of services and features aimed to increase user productivity and data security in a wide range of different environments.

Hands-On Microsoft Windows Server 2019, Third Edition, is the perfect resource for learning Windows Server 2019 administration from the ground up. You will learn how to deploy Windows Server 2019 in a variety of different environments, including data center and cloud environments that rely on virtualization and containers. Additionally, you will learn how to configure and manage server storage, troubleshoot performance issues, as well as work with common Windows Server technologies and network services, including Active Directory, Certificate Services, DNS, DHCP, WSUS, IIS, file sharing, printing, and remote access.

You'll find a focus on quality throughout with an emphasis on preparing you for valuable real-world experiences. Hands-On Projects help you practice skills using one of two different lab environments suitable for both classroom-based and independent learning, and Discovery Exercises allow you to apply these skills within real-life environments, as well as explore advanced topics. Review questions and key terms are provided to reinforce important concepts. Together, these features give you the experience and confidence you need to function as a Windows Server 2019 administrator and provide a solid foundation for pursuing server- and cloud-focused certification.

Intended Audience

Hands-On Microsoft Windows Server 2019, Third Edition, is intended for anyone who wants to learn how to configure and support Windows Server 2019 systems. It also can be used as a starting point in preparing for the Microsoft Azure certification exam track. No prior Windows Server experience is required, but some

basic experience with Windows client operating systems, such as Windows 7, 8/8.1, or 10, is helpful. If you are already an experienced Windows Server administrator, this book provides a fast way to upgrade your skills to Windows Server 2019.

Module Descriptions

Module 1, “Getting Started with Windows Server 2019,” introduces the features and editions of the Windows Server 2019 operating system, as well as the server configurations available in an on-premises or cloud environment. This module also details the Windows Server 2019 installation process, as well as common post-installation configuration tasks.

Module 2, “Configuring Windows Server 2019,” outlines the tools that you can use to configure Windows Server 2019, including Server Manager, Windows Admin Center, Control Panel, Device Manager, Registry Editor, and Windows PowerShell. Additionally, this module introduces the use of PowerShell scripts for automating system configuration tasks.

Module 3, “Implementing Hyper-V and Rapid Server Deployment,” discusses the process used to configure and manage Windows Server 2019 virtualization. This module also discusses how to rapidly deploy Windows Server 2019 using virtual machine templates and WDS.

Module 4, “Introduction to Active Directory and Account Management,” details how to install and manage Active Directory in an enterprise environment. This module also discusses the procedures used to create and manage Active Directory objects, including users, computers, and groups.

Module 5, “Configuring Resource Access,” introduces folder and file attributes, permissions, ownership, and auditing, as well as the process used to share folder contents to users using SMB and NFS. Additionally, this module discusses how to extend the functionality of shared folders using DFS, quotas, and file screens.

Module 6, “Configuring Printing,” details the print process, as well as the procedures used to share printers to network users using SMB, and LPD. This module also discusses how to manage print jobs and troubleshoot printer problems.

Module 7, “Configuring and Managing Data Storage,” introduces the different data storage configurations available within Windows Server 2019, as well as the procedures used to create and manage simple and software RAID volumes. Additionally, this module discusses the configuration of SAN storage and data deduplication, as well as the tools that can be used to optimize, repair, and back up volumes.

Module 8, “Configuring and Managing Network Services,” discusses the procedures used to provide name resolution and IP configuration on a Windows network. More specifically, this module covers the configuration, management, and troubleshooting of DNS, WINS, and DHCP services.

Module 9, “Configuring and Managing Remote Access Services,” details the procedures used to configure remote access using VPNs, DirectAccess, and Remote Desktop Services. This module also discusses how RADIUS can be configured to support remote access.

Module 10, “Configuring Web Services and Cloud Technologies,” introduces key cloud concepts and configurations, including the role of Web servers, Web apps, and Linux in a cloud environment. Furthermore, this module covers the configuration of the IIS Web server, Windows and Linux containers, and the Windows Subsystem for Linux.

Module 11, “Managing and Securing Windows Networks,” discusses the configuration of Group Policy and public key certificates in an enterprise environment. This module also discusses the configuration of 802.1X Wireless, WSUS, Windows Defender, firewalls, and IPSec.

Module 12, “Monitoring and Troubleshooting Windows Server 2019,” introduces the processes and tools used to monitor and troubleshoot Windows Server 2019 systems. Additionally, this module discusses common troubleshooting procedures for resolving different hardware, software, operating system, performance, and network problems.

Features

To ensure a successful learning experience, this book includes the following pedagogical features:

- *Module objectives*—Each module in this book begins with a detailed list of the concepts to be mastered within that module. This list provides you with a quick reference to the contents of that module as well as a useful study aid.
- *Illustrations and tables*—Numerous illustrations of server screens and components aid you in the visualization of common setup steps, theories, and concepts. In addition, many tables provide details and comparisons of both practical and theoretical information and can be used for a quick review of topics.
- *End-of-module material*—The end of each module includes the following features to reinforce the material covered in the module:
 - *Summary*—A bulleted list is provided that gives a brief but complete summary of the module.
 - *Key Terms list*—This is a list of all new terms. Definitions for each key term can be found in the Glossary.
 - *Review Questions*—A list of review questions tests your knowledge of the most important concepts covered in the module.
 - *Hands-On Projects*—Hands-On Projects help you to apply the knowledge gained in the module.
 - *Discovery Exercises*—These are additional projects that build upon the Hands-On Projects, as well as guide you through real-world scenarios and advanced topics.

New to this Edition

The content within *Hands-On Microsoft Windows Server 2019, Third Edition*, has been completely revamped from the previous editions to provide several new features and approaches:

- Topics have been reorganized and rewritten to provide a more concise and logical flow.
- Additional focus is placed on new and emerging technologies within Windows Server, such as virtualization, containers, enterprise storage, cloud, and security.
- Inline Activities within each module have been replaced by comprehensive Hands-On Projects designed to work better within a classroom or home environment.
- Two different lab environments are made available in Module 1 that allow students to perform Hands-On Projects within a classroom or home environment using Windows Server 2019 running natively, or within a Hyper-V virtual machine on Windows 10.
- Discovery Exercises have been added to the end of each module to provide additional ways to explore and reinforce key concepts and real-world application.
- Windows PowerShell and server virtualization have been integrated into topics throughout the book.
- A new module has been added to discuss cloud technologies.

Text and Graphic Conventions

Wherever appropriate, additional information and exercises have been added to this book to help you better understand what is being discussed in the module. Special headings throughout the text alert you to additional materials:

Note

The Note heading is used to present additional helpful material related to the subject being described.

Hands-On Project

The Hands-On Project heading indicates that the projects following it give you a chance to practice the skills you learned in the module and acquire hands-on experience.

Discovery Exercise

The Discovery Exercise heading indicates that the projects following it provide additional ways to explore and reinforce key concepts and real-world application.

MindTap

MindTap activities for *Hands-On Microsoft Windows Server 2019, Third Edition*, are designed to help you master the skills you need in today's workforce. Research shows that employers need critical thinkers, troubleshooters, and creative problem-solvers to stay relevant in this fast-paced, technology-driven world. MindTap helps you achieve this goal with assignments and activities that provide hands-on practice and real-life relevance. You are guided through assignments that help you master basic knowledge and understanding before moving on to more challenging problems.

All MindTap activities and assignments are tied to defined learning objectives. Readings support the course objectives, while Networking for Life assignments allow you to explore industry-related news and events. Reflection activities encourage self-reflection and open sharing with your classmates to help improve your retention and understanding of the material.

Labs provide hands-on practice and give you an opportunity to troubleshoot, explore, and try different solutions using the Windows Server 2019 operating system.

Use the interactive Flashcards and PowerPoint slides in each module to help you study for exams. Measure how well you have mastered the material by taking the Review Quizzes and Think Critically Quizzes offered with each module. The Post-Assessment Quiz helps you assess all that you have learned throughout the course, see where you gained deeper knowledge, and identify the skills where you need additional practice!

Instructors can use the content and learning path as they are, or choose how these materials wrap around their own resources. MindTap supplies the analytics and reporting to easily see where the class stands in terms of progress, engagement, and completion rates. To learn more about shaping what students see and scheduling when they see it, instructors can go to www.cengage.com/mindtap/.

Instructor Resources

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

- *Instructor's Manual*—The Instructor's Manual that accompanies this book includes additional instructional material to assist in class preparation, including items such as overviews, module objectives, teaching tips, quick quizzes, class discussion topics, additional projects, additional resources, and key terms.

- *Test bank*—Cengage Testing Powered by Cognero is a flexible, online system that 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 provides PowerPoint slides to accompany each module. Slides can be used to guide classroom presentations, to make available to students for module review, or to print as classroom handouts. Files are also supplied for every figure in the book. Instructors can use these files to customize PowerPoint slides, illustrate quizzes, or create handouts.
- *Solutions*—Solutions to all end-of-module review questions and projects are available.
- *Sample Syllabus*—A sample syllabus is provided to help you plan what objectives you will cover in your course and how you will give your students a sense of what the course will be like, including your criteria for grading and evaluation.
- *MindTap Educator’s Guide*—This guide helps you navigate the unique activities that are included in the MindTap, which will better enable you to include the exercises in your curriculum.
- *Transition Guide*—This guide will help you navigate what has changed from the second edition of this book to the third edition of the book and highlight any new materials that are covered in each module.

Author Biography

Jason W. Eckert is an experienced technical trainer, consultant, and best-selling author in the Information Technology (IT) industry. With 45 industry certifications, over 30 years of IT experience, 4 published apps, and 25 published textbooks covering topics such as UNIX, Linux, Security, Windows Server, Microsoft Exchange Server, PowerShell, BlackBerry Enterprise Server, and Video Game Development, Mr. Eckert brings his expertise to every class that he teaches at triOS College, and to his role as the Dean of Technology. For more information about Mr. Eckert, visit jasoneckert.net.

Acknowledgments

Firstly, I would like to thank the staff at Cengage for an overall enjoyable experience writing a textbook on Windows Server that takes a fundamentally different approach than traditional textbooks. Additionally, I wish to thank Ann Shaffer, Danielle Shaw, Brooke Greenhouse, Natalie Onderdonk, and Praveen Kumar R.S for working extremely hard to pull everything together and ensure that the book provides a magnificent student experience. I also wish to thank Frank Gerencser of triOS College for providing the

necessary project motivation, the Starbucks Coffee Company for keeping me ahead of schedule, and my dog Pepper for continually reminding me that taking a break is always a good idea.

Readers are encouraged to e-mail comments, questions, and suggestions regarding *Hands-On Microsoft Windows Server 2019, Third Edition*, to Jason W. Eckert: jason.eckert@trios.com.

Reviewers

Jeff Riley
Director of Learning Solutions
Box Twelve Communications
Apex, NC

Scott D. Rhine
IT Instructor and Program Coordinator of IT-Network Administration
Lake Land College
Mattoon, IL

Roger Zimmerman, M.Ed.
Instructor, CIS
Portland Community College
Portland, OR

Dedication

This book is dedicated to everyone with a red line under their name in Microsoft Word.

Computer and Lab Setup Guide

The following is the minimum requirement for the Hands-On Projects at the end of each module:

- A 64-bit computer with a recent-generation processor that supports virtualization extensions (Intel VT/AMD-V + SLAT)
- 16 GB of memory
- 500GB hard disk or SSD storage (SSD strongly recommended)
- A DVD or USB flash drive that contains bootable installation media for Windows Server 2019 Datacenter Edition
- A network that provides Internet access

GETTING STARTED WITH WINDOWS SERVER 2019

After completing this module, you will be able to:

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

Microsoft Windows Server systems serve a critical role in nearly all organizations today, from small businesses to large, multinational corporations. Windows Server 2019, Microsoft's newest server platform, offers even more roles for servers, better security, easier server management, new desktop features, and more reliable computing than its predecessors.

This book is intended to give you a solid grounding in how to install, administer, and support Windows Server 2019 in a wide variety of different environments. In this module, you learn the different ways that Windows Server can be implemented within

an organization, in addition to the key features and editions of Windows Server 2019. Additionally, you'll learn how to plan for and install Windows Server 2019, as well as perform post-installation configuration tasks.

Note

Many of the Windows Server 2019 features and supporting topics introduced within this module are properly covered in more depth throughout this book. They are introduced within this module so that you can select the correct Windows Server 2019 edition and installation features to support your environment.

Using Windows Server 2019 within an Organization

Since the introduction of the IBM PC in 1981, Microsoft operating systems have been at the forefront of personal and business computing. By 1990, over three quarters of all personal computers (PCs) ran the Microsoft MS-DOS or Windows operating system on IBM-compatible hardware, and the term PC became synonymous with Microsoft.

During the rise of computer **networks** and the Internet in the 1990s, most organizations started using PCs to connect to other computers across a computer network to obtain access to shared resources such as files, databases, and printers. The PC connecting to the shared resource was called the **client**, and the computer sharing the resource was called the **server**. While any operating system can function as a server if it shares resources with other computers, specialized operating systems geared toward resource sharing on the network also became common during the 1990s. Microsoft released their Windows NT Server operating system in 1993 and it quickly became the standard server operating system that client PCs connected to within organizations. By 2000, Windows NT Server was renamed “Windows Server,” with new versions released every three to five years. In 2018, Windows Server operating systems were installed on over 80% of all servers located within organizations worldwide.

Note

Servers that are located within organizations are referred to as **on-premises servers**. Today, many servers exist within data centers outside the organization and are accessed via the Internet. These servers are referred to as **cloud servers** and the collective of servers publicly available on the Internet is referred to as the **cloud**.

Server hardware has a different form factor compared to desktop PCs. Nearly all servers within an organization are housed within a rackmount case that is mounted alongside other servers on a vertical server storage rack. Consequently, we call these servers **rackmount servers**.

Each rackmount server in the rack may contain a different operating system (or multiple operating systems if virtualization software is used) and will connect to a shared monitor/keyboard/mouse. This shared monitor/keyboard/mouse often folds away into the rack for storage and is necessary for initial configuration tasks such as server installation. All other server administration is normally performed remotely from a PC running remote administration tools.

Most racks also contain one or more **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, which provide backup battery power to servers and SANs within the rack in the event of a power loss.

The minimum height of a rackmount server is 1.75 inches. Servers of this size are called **1U servers**. (The letter “U” is short for unit.) Most 1U servers have up to two hard drives (or SSDs) and up to two processors. Other rackmount servers take up more than one spot on the rack and have a height that is a multiple of a 1U server. For example, a 2U server is twice as high as a 1U server and often contains up to four processors and eight hard disks (or SSDs). Rackmount servers rarely exceed 4U, but SAN devices are often 4U or more.

Figure 1-1 shows 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.

Note

A single rackmount server may contain multiple smaller, modular servers. In this case, the modular servers are called **blade servers**.

Note

If **Non-Volatile Memory Express (NVMe)** SSDs are used, then the number of SSDs within a rackmount server or SAN may be substantially higher due to the small physical size of NVMe devices.

Understanding Windows Server Virtualization

Virtualization is the process of running more than one operating system at the same time on a single computer. It has been used in various capacities since the dawn of computing in the 1960s. To implement virtualization, you must use software that allows the hardware to host multiple operating systems. This software, called a **hypervisor**, serves to handle simultaneous requests for underlying hardware efficiently. **Type 2 hypervisors** are designed to run on top of an existing workstation operating system

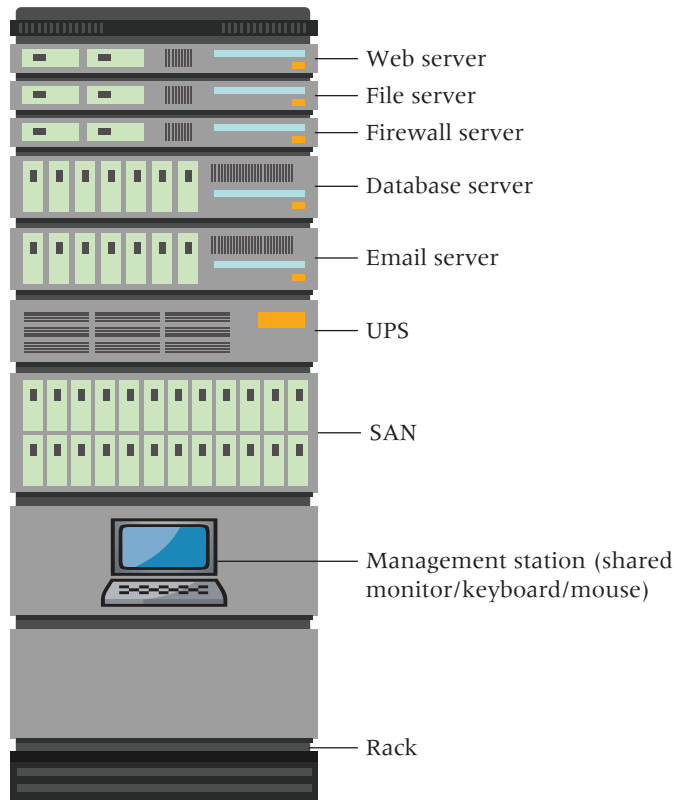


Figure 1-1 A sample server rack

(referred to as the **host operating system**). All additional operating systems (called **guest operating systems** or **virtual machines**) must access the hardware through both the hypervisor and underlying host operating system. Type 2 hypervisors are common today for software testing and development. For example, a software developer can test a specific application or Web app on a variety of operating systems without requiring separate computers. Many college technology courses today also take advantage of Type 2 hypervisors to run multiple operating systems within a classroom or lab environment.

Note 

Common Type 2 hypervisors include VMWare Workstation, Oracle VirtualBox, and Parallels Workstation.

By the mid-2000s, a typical server closet or data center contained many individual rackmount servers. To maintain security and stability, each rackmount server contained a single (or small number of) separate server software applications. One rackmount server

might host Web server software, while another might host file sharing services, and so on. Unfortunately, most of these server software applications only used a small fraction of the actual rackmount server hardware, and supplying power and cooling to the large number of rackmount servers was expensive. To solve these problems, many IT administrators turned to server virtualization, but with a **Type 1 hypervisor** to ensure that each virtual machine runs as efficiently as possible. A Type 1 hypervisor interacts with the hardware directly, and contains a small operating system to manage the hypervisor configuration and virtual machines. Figure 1-2 shows the difference between Type 1 and Type 2 hypervisors.

Note 

Microsoft **Hyper-V** is a Type 1 hypervisor. Other common Type 1 hypervisors used today include VMWare ESX/ESXi and Linux KVM.

Note 

Hyper-V is available on Windows Server 2012 and later, as well as on Windows 8 and later (Professional and Enterprise editions).

Note 

Nearly all hypervisors today require that your processor supports hypervisor acceleration; this feature is referred to as **Intel VT** (for Intel) or **AMD-V** (for AMD). Most hypervisors, including Hyper-V, also require that your processor supports **Second Level Address Translation (SLAT)** extensions.

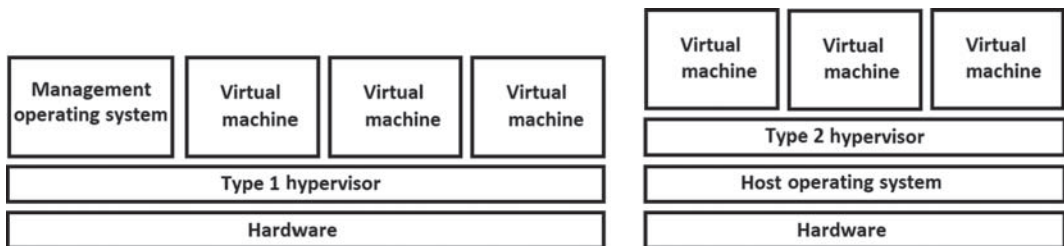


Figure 1-2 Comparing Type 1 and Type 2 hypervisors

Regardless of the hypervisor used, all virtual machines store their configuration within a small configuration file specific to the hypervisor. Meanwhile, they store the actual operating system data for the virtual machine in a virtual hard disk file. When

you create a virtual machine, you must choose the size of this virtual hard disk file. You must also choose between allocating a fixed space for the virtual hard disk file when it is created (called **thick provisioning**) or dynamically allocating space as the virtual machine needs it (called **thin provisioning**). For example, if you create a 250 GB fixed-sized virtual disk, then 250 GB is reserved on the storage device immediately. Thin provisioning creates a small virtual disk file that grows up to 250 GB as the virtual machine stores more data. Thin provisioning is often preferred for server virtualization as it conserves space on the underlying server storage hardware.

Note 

Hyper-V virtual hard disk files have a `.vhdx` extension, VMWare virtual hard disk files have a `.vmdk` extension, Oracle VirtualBox virtual hard disks have a `.vdi` extension, and KVM virtual hard disks have either a `.qcow2` extension or omit the extension altogether.

Note 

Microsoft supports a wide range of operating systems for installation within Hyper-V virtual machines, including Windows 7 and later, Windows Server 2008 and later, Linux, and FreeBSD UNIX. Additionally, Hyper-V can emulate slower, legacy hardware for older operating systems (called a **Generation 1 virtual machine**) instead of modern hardware for newer operating systems (called a **Generation 2 virtual machine**).

Note 

Hyper-V also supports virtual machine **checkpoints** (often called **snapshots** in other hypervisors). If you take a checkpoint of a virtual machine, it 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.

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. 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. Consequently, most servers today that run a hypervisor and virtual machines are 1U, allowing the rack to

accommodate more rackmount servers in the same space. For example, virtualization could be used to consolidate the five sample server operating systems shown in Figure 1-1 into two 1U servers running Hyper-V and five virtual machines, as shown in Figure 1-3.

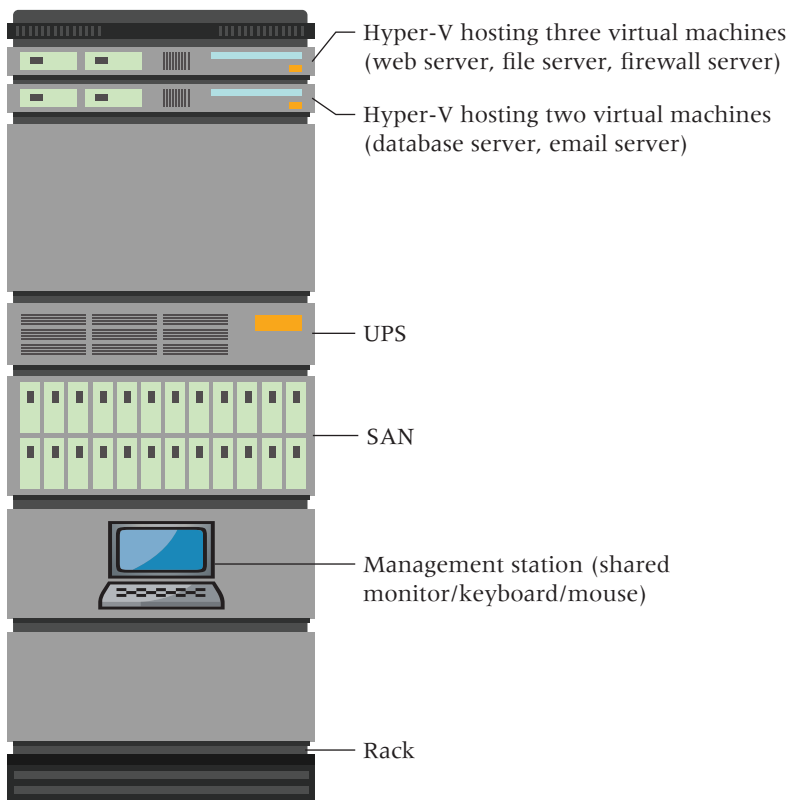


Figure 1-3 A sample server rack that utilizes virtual machines

Unlike most other hypervisors today, Hyper-V allows you to run other virtual machines within an existing virtual machine. This feature, called **nested virtualization**, is shown in Figure 1-4. 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.

Nested virtualization gives cloud data centers the ability to implement a more complex virtualization structure that suits their needs. Additionally, 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. For example, you can install a Windows Server 2019 Hyper-V virtual machine on a Windows 10 PC, and then install additional Hyper-V virtual machines within the Windows Server 2019 virtual machine.

Nested virtualization must be enabled in the underlying Hyper-V using a Windows PowerShell command (Windows PowerShell is discussed in the next section). For example, to ensure that the virtual machine named VM1 can install and use Hyper-V

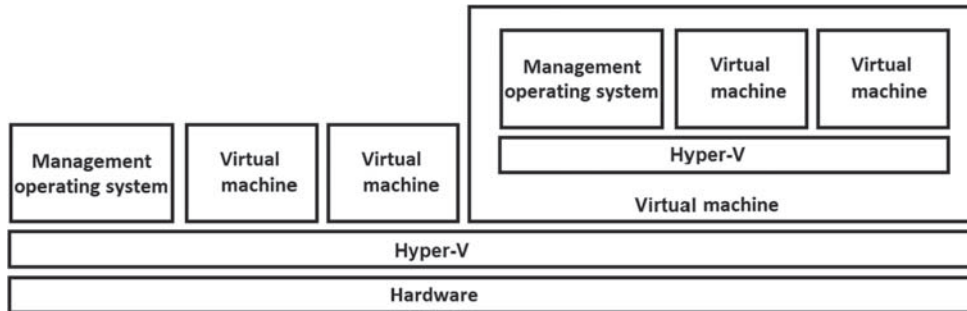


Figure 1-4 Nested virtualization using Hyper-V

to create additional virtual machines, you can power off VM1 and run the following command within Windows PowerShell on the management operating system:

```
Set-VMProcessor -VMName VM1 -ExposeVirtualizationExtensions $true
```

After you power on VM1, you will be able to install and configure Hyper-V on VM1 to host additional virtual machines. To ensure that virtual machines created by VM1 can access the network connected to the underlying Hyper-V hypervisor (to access the Internet, for example), you also need to run the following command within Windows PowerShell on the management operating system to allow MAC address spoofing:

```
Get-VMNetworkAdapter -VMName VM1 | Set-VMNetworkAdapter  
-MacAddressSpoofing On
```

Understanding Windows Containers

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.

Unlike virtual machines, **containers** do not have a complete operating system. Instead, 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. As a result, containers must be run on an existing operating system that has container software installed, as shown in Figure 1-5.

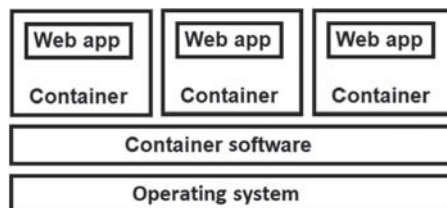


Figure 1-5 Using containers to run multiple Web apps

When you run a container, the enclosed Web apps are executed in a way that is isolated from Web apps running within other containers and the underlying operating system; this type of execution is often called **sandboxing**. 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.

Although separate virtual machines could instead be used to run Web apps on the same computer in an isolated fashion, containers are much smaller and use far fewer underlying system resources as a result. This makes containers well-suited for cloud environments, where resource efficiency and scalability are important for controlling data center costs.

Say, for example, that you create an IoT device that can be controlled remotely from a Web app running on a cloud server, and that you plan on selling thousands of these devices to customers. In this case, you don't need to create a large, complex Web app that is designed to connect to thousands of devices simultaneously, and that is hosted within a large virtual machine on a cloud server. Instead, you can create a small, simple Web app that can connect to a single device, and run that Web app within a container that can be run thousands of times on a cloud server. When a customer connects to their device, a new container is run on the cloud server to start a unique copy of the Web app for that customer's device. Similarly, when a customer disconnects from their device, the cloud server stops running the customer's container to free up system resources.

The most common container software used to implement containers on operating systems today is **Docker**, and the underlying component within Windows Server 2016 and later that allows you to install and use Docker is called **Windows Containers**.

Note

Docker is also available for many non-Windows operating systems, including Linux, UNIX, and macOS.

The core component of an operating system that executes all other components of the operating system is called the **kernel**. 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. This means that the three Web apps shown in Figure 1-5 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. It also means that the underlying operating system kernel is a single point of failure; too many containers on a single underlying operating system may slow down the performance of the kernel or cause it to crash. Furthermore, one container could potentially access another container running on the same underlying kernel if a security loophole were exploited.

To solve these problems, Hyper-V can be used alongside containers to provide a separate copy of the underlying kernel to each container. These **Hyper-V containers** use the