

CompTIA Network+ N10-009 Cert Guide PDF

Visit the link below to download the full version of the ebook

[DOWNLOAD NOW](#)

Save 10%
on Exam
Voucher
See Inside

PEARSON IT
CERTIFICATION

 Practice
Tests

 Flash
Cards

 Review
Exercises

 Study
Planner

Cert Guide

Advance your IT career with hands-on learning

CompTIA®

Network+

N10-009



ANTHONY
CCI



Scan to Download
or Type the Link

ebook.ac/comptia

PEARSON IT
CERTIFICATION

Save 10%
on Exam
Voucher

See Inside



Practice
Tests



Flash
Cards



Review
Exercises



Study
Planner

Cert Guide

Advance your IT career with hands-on learning

CompTIA®

Network+

N10-009



ANTHONY SEQUEIRA
CCIE® No.15626

Companion Website and Pearson Test Prep Access Code

Access interactive study tools on this book's companion website, including practice test software, review exercises, Key Term flash card application, a study planner, and more!

To access the companion website, simply follow these steps:

1. Go to www.pearsonITcertification.com/register by December 31, 2027.
2. Enter the **print book ISBN**: 9780135367889.
3. Answer the security question to validate your purchase.
4. Go to your account page.
5. Click on the **Registered Products** tab.
6. Under the book listing, click on the **Access Bonus Content** link.

When you register your book, your Pearson Test Prep practice test access code will automatically be populated with the book listing under the Registered Products tab. You will need this code to access the practice test that comes with this book. You can redeem the code at **PearsonTestPrep.com**. Simply choose Pearson IT Certification as your product group and log into the site with the same credentials you used to register your book. Click the **Activate New Product** button and enter the access code. More detailed instructions on how to redeem your access code for both the online and desktop versions can be found on the companion website.

If you have any issues accessing the companion website or obtaining your Pearson Test Prep practice test access code, you can contact our support team by going to pearsonitp.echelp.org.

This page intentionally left blank

CompTIA® Network+ N10-009 Cert Guide

Anthony Sequeira, CCIE No. 15626



Pearson

CompTIA® Network+ N10-009 Cert Guide

Copyright © 2025 by Pearson Education, Inc.

Hoboken, New Jersey

All rights reserved. This publication is protected by copyright, and permission must be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permissions, request forms, and the appropriate contacts within the Pearson Education Global Rights & Permissions Department, please visit <https://www.pearson.com/global-permission-granting.html>.

Please contact us with concerns about any potential bias at <https://www.pearson.com/report-bias.html>.

ISBN-13: 978-0-13-536788-9

ISBN-10: 0-13-536788-3

Library of Congress Cataloging-in-Publication Data is on file.

\$PrintCode

Trademarks

All terms mentioned in this book that are known to be trademarks or service marks have been appropriately capitalized. Pearson IT Certification cannot attest to the accuracy of this information. Use of a term in this book should not be regarded as affecting the validity of any trademark or service mark.

Microsoft and/or its respective suppliers make no representations about the suitability of the information contained in the documents and related graphics published as part of the services for any purpose. All such documents and related graphics are provided “as is” without warranty of any kind. Microsoft and/or its respective suppliers hereby disclaim all warranties and conditions with regard to this information, including all warranties and conditions of merchantability, whether express, implied or statutory, fitness for a particular purpose, title and non-infringement. In no event shall Microsoft and/or its respective suppliers be liable for any special, indirect or consequential damages or any damages whatsoever resulting from loss of use, data or profits, whether in an action of contract, negligence or other tortious action, arising out of or in connection with the use or performance of information available from the services.

The documents and related graphics contained herein could include technical inaccuracies or typographical errors. Changes are periodically added to the information herein. Microsoft and/or its respective suppliers may make improvements and/or changes in the product(s) and/or the program(s) described herein at any time. Partial screenshots may be viewed in full within the software version specified.

Microsoft® and Windows® are registered trademarks of the Microsoft Corporation in the U.S.A. and other countries. Screenshots and icons reprinted with permission from the Microsoft Corporation. This book is not sponsored or endorsed by or affiliated with the Microsoft Corporation.

**GM K12, Early Career
and Professional
Learning**

Soo Kang

**Director, ITP Product
Management**

Brett Bartow

Executive Editor

Nancy Davis

Development Editor

Christopher Cleveland

Managing Editor

Sandra Schroeder

Senior Project Editor

Tonya Simpson

Copy Editor

Bill McManus

Indexer

Timothy Wright

Proofreader

Donna E. Mulder

Technical Editor

Chris Crayton

Publishing Coordinator

Cindy Teeters

Cover Designer

Chuti Prasertsith

Compositor

codeMantra

Warning and Disclaimer

Every effort has been made to make this book as complete and as accurate as possible, but no warranty or fitness is implied. The information provided is on an “as is” basis. The author and the publisher shall have neither liability nor responsibility to any person or entity with respect to any loss or damages arising from the information contained in this book.

Contents at a Glance

Introduction xxxv

Part I: Networking Concepts

- CHAPTER 1 The OSI Model and Encapsulation 3
- CHAPTER 2 Networking Appliances, Applications, and Functions 35
- CHAPTER 3 Cloud Concepts 65
- CHAPTER 4 Networking Ports, Protocols, Services, and Traffic Types 81
- CHAPTER 5 Transmission Media and Transceivers 101
- CHAPTER 6 Network Topologies, Architectures, and Types 135
- CHAPTER 7 IPv4 Addressing 163
- CHAPTER 8 Evolving Use Cases 203

Part II: Network Implementation

- CHAPTER 9 Routing Technologies 229
- CHAPTER 10 Ethernet Switching Technologies 257
- CHAPTER 11 Configure Wireless Devices and Technologies 285
- CHAPTER 12 Physical Installations 311

Part III: Network Operations

- CHAPTER 13 Organizational Processes and Procedures 325
- CHAPTER 14 Network Monitoring 341
- CHAPTER 15 Disaster Recovery 363
- CHAPTER 16 IPv4 and IPv6 Network Services 385
- CHAPTER 17 Network Access and Management Methods 405

Part IV: Network Security

- CHAPTER 18 Network Security Concepts 425
- CHAPTER 19 Types of Network Attacks 457
- CHAPTER 20 Network Security Features 475

Part V: Network Troubleshooting

- CHAPTER 21** A Network Troubleshooting Methodology 489
- CHAPTER 22** Troubleshoot Common Cabling Problems 501
- CHAPTER 23** Troubleshoot Common Issues with Network Services 517
- CHAPTER 24** Troubleshoot Common Performance Issues 529
- CHAPTER 25** Network Troubleshooting Tools 543

Part VI: Final Preparation and Exam Updates

- CHAPTER 26** Final Preparation 577
- CHAPTER 27** *CompTIA Network+ N10-009 Cert Guide* Exam Updates 585

Part VII: Appendixes

- APPENDIX A** Answers to Review Questions 587
- Index 611

Online Elements

- APPENDIX B** Memory Tables
- APPENDIX C** Memory Tables Answer Key
- APPENDIX D** Study Planner
- Glossary of Key Terms

Table of Contents

Introduction xxxv

Part I: Networking Concepts

Chapter 1 The OSI Model and Encapsulation 3

Foundation Topics 4

The Purpose of Reference Models 4

The OSI Model 6

Layer 1: The Physical Layer 7

Layer 2: The Data Link Layer 11

Media Access Control 12

Logical Link Control 13

Layer 3: The Network Layer 14

Layer 4: The Transport Layer 17

Layer 5: The Session Layer 19

Layer 6: The Presentation Layer 20

Layer 7: The Application Layer 21

The TCP/IP Stack 22

Layers of the TCP/IP Stack 22

Common Application Protocols in the TCP/IP Stack 26

Real-World Case Study 27

Summary 28

Exam Preparation Tasks 28

Review All the Key Topics 28

Define Key Terms 29

Additional Resources 30

Review Questions 30

Chapter 2 Networking Appliances, Applications, and Functions 35

Foundation Topics 36

Physical and Virtual Appliances 36

Routers 36

Switches 36

Firewalls	45
Intrusion Detection System (IDS)/Intrusion Prevention System (IPS)	46
<i>IDS Versus IPS</i>	46
<i>IDS and IPS Device Categories</i>	47
<i>Signature-Based Detection</i>	48
<i>Policy-Based Detection</i>	48
<i>Anomaly-Based Detection</i>	48
Load Balancer	49
Proxy Servers	49
Network-attached Storage (NAS)	51
Storage Area Networks (SANs)	51
Access Points (APs)	52
Controllers	53
Networking Device Summary	53
Applications and Functions	54
Content Delivery Network (CDN)	54
Virtual Private Network (VPN)	55
Quality of Service (QoS)	55
Time to Live (TTL)	57
Real-World Case Study	57
Summary	58
Exam Preparation Tasks	58
Review All the Key Topics	58
Complete Tables and Lists from Memory	59
Define Key Terms	59
Additional Resources	59
Review Questions	60
Chapter 3 Cloud Concepts	65
Foundation Topics	66
Network Functions Virtualization (NFV)	66
Cloud Networking Components	67

Virtual Private Cloud (VPC)	67
Network Security Groups	68
Network Security Lists	69
Cloud Gateways	69
Deployment Models	71
Service Models	72
Key Cloud Concepts	73
Cloud Connectivity Options	73
Multitenancy	74
Elasticity	74
Scalability	75
Real-World Case Study	75
Summary	75
Exam Preparation Tasks	76
Review All the Key Topics	76
Define Key Terms	76
Additional Resources	76
Review Questions	77
Chapter 4 Networking Ports, Protocols, Services, and Traffic Types	81
Foundation Topics	82
Ports and Protocols	82
FTP (File Transfer Protocol)	82
SFTP	82
SSH	82
Telnet	82
SMTP	83
DNS (Domain Name System)	83
DHCP (Dynamic Host Configuration Protocol)	83
TFTP	83
HTTP	83
NTP	83
SNMP	84
LDAP	84

HTTPS	84
SMB	84
Syslog	84
SMTPS	85
LDAPS	85
Structured Query Language (SQL) Server	85
RDP	85
SIP	85
Protocol/Port Summary	85
Internet Protocol (IP) Types	87
Internet Control Message Protocol (ICMP)	87
Transmission Control Protocol (TCP)	88
User Datagram Protocol (UDP)	88
Generic Routing Encapsulation (GRE)	88
Internet Protocol Security (IPsec)	89
Internet Protocol (IP) Types Summary	89
Traffic Types	90
Unicast	90
Broadcast	91
Multicast	91
Anycast	92
Traffic Types Summary	94
Summary	95
Exam Preparation Tasks	95
Review All the Key Topics	95
Complete Tables and Lists from Memory	96
Define Key Terms	96
Additional Resources	96
Review Questions	97
Chapter 5 Transmission Media and Transceivers	101
Foundation Topics	102
Wireless	102
Transmission Methods	105

WLAN Standards (802.11)	106
802.11a	106
802.11b	106
802.11g	106
802.11n (Wi-Fi 4)	106
802.11ac (Wi-Fi 5)	107
802.11ax (Wi-Fi 6)	107
802.11 Standards Summary	108
Cellular	108
Satellite	109
Copper and Fiber Media and Connectors	111
Coaxial Cable	111
Twisted-Pair Cable	113
Shielded Twisted Pair	113
Unshielded Twisted Pair	114
Twisted-Pair Cable Connectors	116
Plenum Versus Non-plenum Cable	117
Fiber-Optic Cable	117
Multimode Fiber	118
Single-Mode Fiber	120
Fiber-Optic Cable Connectors	120
Fiber Connector Polishing Styles	121
Ethernet and Fiber Standards (802.3)	122
Distance and Speed Limitations	124
Transceivers	126
Multiplexing in Fiber-Optic Networks	127
Media Converters	127
Real-World Case Study	128
Summary	128
Exam Preparation Tasks	128
Review All the Key Topics	128
Complete Tables and Lists from Memory	129
Define Key Terms	129

Additional Resources	130
Review Questions	130
Chapter 6 Network Topologies, Architectures, and Types	135
Foundation Topics	136
Defining a Network	136
The Purpose of Networks	136
Network Types and Characteristics	137
LAN	137
WAN	138
WLAN	138
SAN	139
Other Categories of Networks	139
<i>CAN</i>	139
<i>MAN</i>	139
<i>PAN</i>	139
Networks Defined Based on Resource Location	140
Client/Server Networks	140
Peer-to-Peer Networks	141
Cloud Networking	143
Networks Defined by Topology	143
Physical Versus Logical Topology	143
Point-to-Point Topology	145
Star Topology	145
Hub-and-Spoke Topology	146
Full-Mesh Topology	147
Partial-Mesh Topology	148
The Three-Tier Hierarchical Model	150
The Access/Edge Layer	150
The Distribution/Aggregation Layer	151
The Core Layer	152
Spine and Leaf	153
Traffic Flows	155

	Real-World Case Study	155
	Summary	155
	Exam Preparation Tasks	156
	Review All the Key Topics	156
	Complete Tables and Lists from Memory	156
	Define Key Terms	157
	Additional Resources	157
	Review Questions	157
Chapter 7	IPv4 Addressing	163
	Foundation Topics	164
	Binary Numbering	164
	Principles of Binary Numbering	164
	Converting a Binary Number to a Decimal Number	165
	Converting a Decimal Number to a Binary Number	165
	Binary Numbering Practice	167
	<i>Binary Conversion Exercise 1</i>	167
	<i>Binary Conversion Exercise 1: Solution</i>	168
	<i>Binary Conversion Exercise 2</i>	168
	<i>Binary Conversion Exercise 2: Solution</i>	168
	<i>Binary Conversion Exercise 3</i>	168
	<i>Binary Conversion Exercise 3: Solution</i>	169
	<i>Binary Conversion Exercise 4</i>	169
	<i>Binary Conversion Exercise 4: Solution</i>	170
	IPv4 Addressing	170
	IPv4 Address Structure	171
	Classes of Addresses	173
	Assigning IPv4 Addresses	175
	IP Addressing Components	175
	Static Configuration	176
	Dynamic Configuration	180
	Automatic Private IP Addressing	180
	Subnetting	181

	Purpose of Subnetting	182
	Subnet Mask Notation	182
	Subnet Notation: Practice Exercise 1	184
	Subnet Notation: Practice Exercise 1 Solution	184
	Subnet Notation: Practice Exercise 2	184
	Subnet Notation: Practice Exercise 2 Solution	185
	Extending a Classful Mask	185
	Borrowed Bits	185
	Calculating the Number of Created Subnets	185
	Calculating the Number of Available Hosts	186
	Basic Subnetting Practice: Exercise 1	187
	Basic Subnetting Practice: Exercise 1 Solution	187
	Basic Subnetting Practice: Exercise 2	188
	Basic Subnetting Practice: Exercise 2 Solution	188
	Calculating New IP Address Ranges	189
	Advanced Subnetting Practice: Exercise 1	192
	Advanced Subnetting Practice: Exercise 1 Solution	192
	Advanced Subnetting Practice: Exercise 2	193
	Advanced Subnetting Practice: Exercise 2 Solution	193
	Additional Practice	195
	Classless Inter-domain Routing	196
	Real-World Case Study	197
	Summary	198
	Review All the Key Topics	198
	Complete Tables and Lists from Memory	199
	Define Key Terms	199
	Additional Resources	199
	Review Questions	199
Chapter 8	Evolving Use Cases	203
	Foundation Topics	205
	SDN and SD-WAN	205
	Software-Defined Networking (SDN)	205

Software-Defined Wide Area Network (SD-WAN)	206
Virtual Extensible Local Area Network (VXLAN)	208
Zero Trust Architecture (ZTA)	209
SASE and SSE	211
Infrastructure as Code (IaC)	212
IP Version 6	215
Need for IPv6	216
IPv6 Address Structure	217
IPv6 Address Types	217
IPv6 Data Flows	218
<i>Unicast</i>	219
<i>Multicast</i>	219
<i>Anycast</i>	220
Real-World Case Study	221
Summary	222
Exam Preparation Tasks	223
Review All the Key Topics	223
Define Key Terms	223
Additional Resources	224
Review Questions	224

Part II: Network Implementation

Chapter 9 Routing Technologies 229

Foundation Topics	230
Routing	230
Sources of Routing Information	233
Directly Connected Routes	233
Static Routes	234
Dynamic Routing Protocols	235
Routing Protocol Characteristics	237
Believability of a Route	237
Metrics	238
Interior Versus Exterior Gateway Protocols	238
Route Advertisement Method	238
Distance Vector	239

Link State	242
Routing Protocol Examples	242
Address Translation	244
NAT	244
PAT	246
First Hop Redundancy Protocol (FHRP)	248
Real-World Case Study	250
Summary	250
Exam Preparation Tasks	251
Review All the Key Topics	251
Complete Tables and Lists from Memory	252
Define Key Terms	252
Additional Resources	252
Review Questions	253
Chapter 10 Ethernet Switching Technologies	257
Foundation Topics	258
Principles of Ethernet	258
Carrier-Sense Multiple Access with Collision Detection	258
Distance and Speed Limitations	262
Ethernet Switch Features	263
Virtual LANs	263
Switch Configuration for an Access Port	266
Trunks	267
Switch Configuration for a Trunk Port	268
Spanning Tree Protocol	269
Corruption of a Switch's MAC Address Table	269
Broadcast Storms	270
STP Operation	271
Modern Enhancements to STP	274
Link Aggregation	275
LACP Configuration	276
Power over Ethernet	277
Other Switch Features	278

Real-World Case Study	279
Summary	279
Exam Preparation Tasks	280
Review All the Key Topics	280
Complete Tables and Lists from Memory	280
Define Key Terms	280
Additional Resources	281
Review Questions	281
Chapter 11 Configure Wireless Devices and Technologies	285
Foundation Topics	286
Introducing Wireless LANs	286
WLAN Concepts and Components	286
Wireless Routers	286
Wireless Access Point	287
Guest Networks	289
Antennas	289
Channel and Frequency Options	292
Deploying Wireless LANs	293
Types of WLANs	293
<i>IBSS</i>	293
<i>BSS</i>	294
<i>ESS</i>	295
<i>Mesh Topology</i>	295
Sources of Interference	296
Wireless AP Placement	297
Securing Wireless LANs	299
Security Issues	299
Approaches to WLAN Security	300
Security Standards	303
<i>WPA2</i>	303
<i>WPA3</i>	303
Additional Wireless Options	303
Real-World Case Study	304
Summary	305

Exam Preparation Tasks	305
Review All the Key Topics	305
Define Key Terms	306
Additional Resources	306
Review Questions	306
Chapter 12 Physical Installations	311
Foundation Topics	312
Important Installation Implications	312
Locations	313
Power	315
Environmental Factors	317
Real-World Case Study	318
Summary	320
Exam Preparation Tasks	320
Review All the Key Topics	320
Define Key Terms	320
Additional Resources	321
Review Questions	321
Part III: Network Operations	
Chapter 13 Organizational Processes and Procedures	325
Foundation Topics	326
Documentation	326
Processes and Procedures	329
Life-cycle Management	329
Change Management	332
Configuration Management	333
Real-World Case Study	334
Summary	335
Exam Preparation Tasks	336
Review All the Key Topics	336
Define Key Terms	336
Additional Resources	336
Review Questions	337

Chapter 14 Network Monitoring 341

Foundation Topics	342
Network Monitoring Methods	342
SNMP	342
Performance Metrics/Sensors	345
Port Mirroring	348
Port Mirroring Configuration	350
Logging	350
Syslog	351
Other Logs	353
NetFlow	354
API Integration	354
Monitoring Solutions	355
Real-World Case Study	357
Summary	357
Exam Preparation Tasks	358
Review All the Key Topics	358
Complete Tables and Lists from Memory	358
Define Key Terms	358
Additional Resources	359
Review Questions	359

Chapter 15 Disaster Recovery 363

Foundation Topics	364
High Availability	364
High-Availability Measurement	364
DR Metrics	364
Fault-Tolerant Network Design	365
Hardware Redundancy	367
Design Considerations for High-Availability Networks	368
High-Availability Best Practices	369
Content Caching	370
Load Balancing	370
Hardware Redundancy	370
Testing	372

Real-World Case Study: Network Design	372
Case Study Scenario	373
Suggested Solution	375
IP Addressing	375
Layer 1 Media	376
Layer 2 Devices	376
Layer 3 Devices	377
Wireless Design	378
Environmental Factors	379
Cost Savings Versus Performance	379
Topology	379
Summary	380
Exam Preparation Tasks	380
Review All the Key Topics	380
Define Key Terms	381
Additional Resources	381
Review Questions	381
Chapter 16 IPv4 and IPv6 Network Services	385
Foundation Topics	386
Dynamic Addressing	386
DHCP	386
SLAAC	389
Name Resolution	390
DNS	391
Hosts File	396
Time Protocols	397
NTP	397
PTP	398
NTS	399
Real-World Case Study	399
Summary	400
Exam Preparation Tasks	400
Review All the Key Topics	400
Complete Tables and Lists from Memory	401

Define Key Terms 401

Additional Resources 401

Review Questions 401

Chapter 17 Network Access and Management Methods 405

Foundation Topics 406

Virtual Private Networks (VPNs) 406

IPsec 408

IKE 408

Authentication Header and Encapsulating Security Payload 410

The Five Steps in Setting Up and Tearing Down an IPsec Site-to-Site
VPN Using IKEv1 412

IKEv2 413

Other VPN Technologies 413

Other Network Access Technologies 414

Authentication and Authorization Considerations 417

In-Band vs. Out-of-Band Management 418

Real-World Case Study 418

Summary 419

Exam Preparation Tasks 419

Review All the Key Topics 419

Complete Tables and Lists from Memory 420

Define Key Terms 420

Additional Resources 420

Review Questions 420

Part IV: Network Security

Chapter 18 Network Security Concepts 425

Foundation Topics 426

Core Security Concepts 426

Confidentiality, Integrity, and Availability (CIA) 426

Confidentiality 426

Symmetric Encryption 427

Asymmetric Encryption 428

Integrity 430

<i>Availability</i>	431
Threats, Vulnerabilities, Risks, and Exploits	431
<i>Threats</i>	432
<i>Vulnerabilities</i>	432
<i>Risks</i>	433
<i>Exploits</i>	433
Least Privilege	433
Role-Based Access Control	434
Defense in Depth	434
<i>Screened Subnet</i>	435
<i>Separation of Duties</i>	435
<i>Network Access Control</i>	435
<i>Honeypot</i>	435
Network Segmentation Enforcement	436
<i>IoT and IIoT</i>	436
<i>SCADA, ICS, and OT</i>	437
<i>Guest Networks</i>	437
<i>BYOD</i>	437
Authentication Methods	438
Multifactor	438
TACACS+	439
Single Sign-On	439
RADIUS	439
LDAP	440
Kerberos	440
SAML	441
Time-based Authentication	441
Local Authentication	441
Risk Management and SIEM	441
Risk Management	441
Security Risk Assessments	442
<i>Threat Assessment</i>	442
<i>Vulnerability Assessment</i>	442
<i>Penetration Testing</i>	442

<i>Posture Assessment</i>	442
Business Risk Assessment	442
<i>Process Assessment</i>	443
<i>Vendor Assessment</i>	443
Security Information and Event Management (SIEM)	443
Physical Security	444
Detection Methods	444
Prevention Methods	445
Audits and Regulatory Compliance	447
Real-World Case Study	448
Summary	449
Exam Preparation Tasks	449
Review All the Key Topics	449
Define Key Terms	450
Additional Resources	450
Review Questions	451
Chapter 19 Types of Network Attacks	457
Foundation Topics	458
Technology-Based Attacks	458
Denial-of-Service (DoS)	458
Distributed Denial-of-Service (DDoS)	459
On-Path Attack	459
DNS Poisoning	460
VLAN Hopping	460
ARP Poisoning	460
ARP Spoofing	461
Rogue DHCP	461
Rogue Access Point	461
Evil Twin	461
Ransomware	461
Password Attacks	462
MAC Spoofing	462
MAC Flooding	462

IP Spoofing	463
Deauthentication	463
Malware	463
Social Engineering Attacks	464
Other Miscellaneous Attacks	465
Real-World Case Study	469
Summary	470
Exam Preparation Tasks	470
Review All the Key Topics	470
Define Key Terms	471
Additional Resources	471
Review Questions	471
Chapter 20 Network Security Features	475
Foundation Topics	476
Device Hardening	476
Best Practices	476
Network Access Control (NAC)	480
Other Network Security Features	482
Real-World Case Study	483
Summary	483
Exam Preparation Tasks	484
Review All the Key Topics	484
Define Key Terms	484
Additional Resources	484
Review Questions	485
Part V: Network Troubleshooting	
Chapter 21 A Network Troubleshooting Methodology	489
Foundation Topics	490
Troubleshooting Basics	490
Troubleshooting Fundamentals	490
Structured Troubleshooting Methodology	492
Real-World Case Study	495
Summary	495

- Exam Preparation Tasks 496
- Review All the Key Topics 496
- Complete Tables and Lists from Memory 496
- Define Key Terms 496
- Additional Resource 496
- Review Questions 497

Chapter 22 Troubleshoot Common Cabling Problems 501

- Foundation Topics 502
- Specifications and Limitations 502
- Common Cable Issues 502
- Common Interface Issues 505
- Common Hardware Issues 506
- Common Tools 507
- Real-World Case Study 511
- Summary 512
- Exam Preparation Tasks 512
- Review All the Key Topics 512
- Define Key Terms 512
- Additional Resources 513
- Review Questions 513

Chapter 23 Troubleshoot Common Issues with Network Services 517

- Foundation Topics 518
- Considerations for General Network Troubleshooting 518
- Common Network Service Issues 519
- Real-World Case Study 523
- Summary 524
- Exam Preparation Tasks 524
- Review All the Key Topics 524
- Define Key Terms 524
- Additional Resources 525
- Review Questions 525

Chapter 24 Troubleshoot Common Performance Issues 529

- Foundation Topics 530
- Network Performance Considerations 530

Wireless Performance Considerations	531
Other Wireless Considerations	533
Antennas	533
Frequencies and Channels	533
More Considerations	534
Common Wireless Issues	534
Wireless Network Troubleshooting	536
Wireless Network Troubleshooting Solution	536
Real-World Case Study	537
Summary	538
Exam Preparation Tasks	538
Review All the Key Topics	538
Define Key Terms	538
Review Questions	539
Chapter 25 Network Troubleshooting Tools	543
Foundation Topics	544
Software Tools	544
Protocol Analyzer/Packet Capture	544
Bandwidth Speed Tester	544
Port Scanner	544
iperf	545
NetFlow Analyzers	546
TFTP Server	546
Terminal Emulator	546
IP Scanner	546
LLDP/CDP	546
Command-Line Tools	547
ping	547
ping with IPv6	549
ipconfig	549
ifconfig	553
ip	554

nslookup	554
dig	556
traceroute	557
traceroute for IPv6	558
arp	558
netstat	560
hostname	562
route	562
telnet	567
tcpdump	567
nmap	567
Basic Networking Device Commands	567
Hardware Tools	568
Wi-Fi Analyzer	568
Tone Generator	569
Cable Tester	569
Tap	569
Visual Fault Locator	569
Real-World Case Study	570
Summary	570
Exam Preparation Tasks	570
Review All the Key Topics	570
Complete Tables and Lists from Memory	571
Define Key Terms	571
Additional Resources	572
Review Questions	572

Part VI: Final Preparation and Exam Updates

Chapter 26 Final Preparation 577

Tools for Final Preparation	577
Video Training	578
Memory Tables	578
End-of-Chapter Review Tools	579

Suggested Plan for Final Review and Study 579

Strategies for Taking the Exam 581

Summary 582

Chapter 27 *CompTIA Network+ N10-009 Cert Guide Exam Updates* 585

Always Get the Latest at the Book's Product Page 585

Technical Content 586

Part VII: Appendixes

Appendix A Answers to Review Questions 587

Index 611

Online Elements

Appendix B Memory Tables

Appendix C Memory Tables Answer Key

Appendix D Study Planner

Glossary of Key Terms

About the Author

Anthony Sequeira (CCIE No. 15626) began his IT career in 1994 with IBM in Tampa, Florida. He quickly formed his own computer consultancy, Computer Solutions, and then discovered his true passion: teaching and writing about networking technologies. Anthony lectured to massive audiences around the world while working for Mastering Computers. Anthony has never been happier in his career than he is now, as a senior technical instructor for ACI Learning. ACI is a leader in audit, cybersecurity, and IT pro training in self-paced and instructor-led formats.

Dedication

This book is dedicated to my daughter, Bella Sequeira, who inspires me to do great work every day.

Acknowledgments

I cannot thank Nancy Davis and Chris Cleveland enough for their patience as I created this latest edition of the text. Also, huge thanks to my editors, Chris Crayton and Bill McManus. Their work on this text improved it dramatically.

About the Technical Reviewer

Chris Crayton is a technical consultant, trainer, author, and industry-leading technical editor. He has worked as a computer technology and networking instructor, information security director, network administrator, network engineer, and PC specialist. Chris has authored several print and online books on PC repair, CompTIA A+, CompTIA Security+, and Microsoft Windows. He has also served as technical editor and content contributor on numerous technical titles for several of the leading publishing companies. He holds numerous industry certifications, has been recognized with many professional and teaching awards, and has served as a state-level SkillsUSA final competition judge. Chris tech edited and contributed to this book to make it better for students and those wishing to better their lives.

We Want to Hear from You!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

We welcome your comments. You can email or write to let us know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that we cannot help you with technical problems related to the topic of this book.

When you write, please be sure to include this book's title and author as well as your name and email address. We will carefully review your comments and share them with the author and editors who worked on the book.

Email: community@informat.com

Reader Services

Register your copy of *CompTIA Network+ N10-009 Cert Guide* for convenient access to downloads, updates, and corrections as they become available. To start the registration process, go to www.pearsonITcertification.com/register and log in or create an account.* Enter the product ISBN 9780135367889 and click Submit. When the process is complete, you will find any available bonus content under Registered Products.

*Be sure to check the box that you would like to hear from us to receive exclusive discounts on future editions of this product.

Introduction

The CompTIA Network+ certification is a popular certification for those entering the computer networking field. Although many vendor-specific networking certifications are popular in the industry, the CompTIA Network+ certification is unique in that it is vendor neutral. It does not focus its content on the techniques and technologies of any one specific network vendor. The CompTIA Network+ certification often acts as a stepping-stone to more specialized and vendor-specific certifications, such as those offered by Cisco Systems.

On the CompTIA Network+ exam, the topics are mostly generic in that they can apply to networking equipment regardless of vendor. Although the CompTIA Network+ certification is vendor neutral, network software and systems are implemented by multiple independent vendors. Therefore, several of the exercises, examples, and simulations in this book include using particular vendors' configurations and technologies, such as Microsoft Windows operating systems or Cisco Systems routers and switches. More detailed training for a specific vendor's software and hardware can be found in books and training specific to that vendor.

Who Should Read This Book?

This book was written with two audiences in mind: those who want to learn all they can about networking technology and those who want to pass the CompTIA Network+ exam. I think that both groups are going to be very impressed with the breadth of technologies this book details. Although it would be impossible to cover every topic in networking today, this book manages to cover all the massive areas that make networking an exciting field that many people want to learn.

Readers will range from people who are attempting to attain a position in the IT field to people who want to keep their skills sharp or perhaps retain their job when facing a company policy that mandates they take the new exams. This book is also for those who want to acquire additional certifications beyond the Network+ certification (for example, the Cisco Certified Network Associate [CCNA] certification and beyond). The book is designed to enable an easy transition to future certification studies.

Resources

This book comes with a wealth of digital resources to help you review, practice, and assess your knowledge. The end of each chapter contains a review section that references several of these tools, and you should be sure to use them as you complete each chapter to help reinforce what you are learning. You can use them again after

you finish the book to help review and make sure you are fully prepared for the exam.

Here's a list of resources available on the companion website:

- Interactive glossary flash card application
- Interactive exam essentials appendix
- The Pearson Test Prep (PTP) practice test app
- Video training on key exam topics
- Memory table review exercises and answer keys
- A study planner tool
- Instructions to redeem your Network+ certification exam voucher, which provides a 10% discount on the exam

To access the companion website, follow these steps:

- Step 1.** Go to <https://www.pearsonITcertification.com/register> by December 31, 2027.
- Step 2.** Either log in to your account if you have an existing account already or create a new account.
- Step 3.** Enter the ISBN of this book (**9780135367889**) and click **Submit**.
- Step 4.** Answer the challenge questions to validate your purchase.
- Step 5.** In your account page, click the **Registered Products** tab and then click the **Access Bonus Content** link.

How to Access the Pearson Test Prep (PTP) App

You have two options for installing and using the Pearson Test Prep application: a web app and a desktop app. To use the Pearson Test Prep application, start by finding the registration code that comes with the book. You can find the code in these ways:

- You can get your access code by registering the print ISBN (9780135367889) on [pearsonITcertification.com/register](https://www.pearsonITcertification.com/register). Make sure to use the print book ISBN regardless of whether you purchased an eBook or the print book. Once you register the book, your access code will be populated on your account page under the Registered Products tab. Instructions for how to redeem the code are available on the book's companion website by clicking the Access Bonus Content link.

- **Premium Edition:** If you purchase the Premium Edition eBook and Practice Test directly from the Pearson IT Certification website, the code will be populated on your account page after purchase. Just log in at pearsonITcertification.com, click Account to see details of your account, and click the digital purchases tab.

NOTE After you register your book, your code can always be found in your account under the Registered Products tab.

Once you have the access code, to find instructions about both the PTP web app and the desktop app, follow these steps:

- Step 1.** Open this book's companion website as shown earlier on the first page of the book, under the "Companion Website and Pearson Test Prep Access Code" heading.
- Step 2.** Click the **Practice Exams** button.
- Step 3.** Follow the instructions listed there for both installing the desktop app and for using the web app.

Note that if you want to use the web app only at this point, just navigate to pearsonstestprep.com, log in using the same credentials used to register your book or purchase the Premium Edition, and register this book's practice tests using the registration code you just found. The process should take only a couple of minutes.

Customizing Your Exams

Once you are in the exam settings screen, you can choose to take exams in one of three modes:

- **Study mode:** Enables you to fully customize your exams and review answers as you are taking the exam. This is typically the mode you would use first to assess your knowledge and identify information gaps.
- **Practice Exam mode:** Locks certain customization options, as it is presenting a realistic exam experience. Use this mode when you are preparing to test your exam readiness.
- **Flash Card mode:** Strips out the answers and presents you with only the question stem. This mode is great for late-stage preparation when you really want to challenge yourself to provide answers without the benefit of seeing

multiple-choice options. This mode does not provide the detailed score reports that the other two modes do, so you should not use it if you are trying to identify knowledge gaps.

In addition to these three modes, you will be able to select the source of your questions. You can choose to take exams that cover all of the chapters or you can narrow your selection to just a single chapter or the chapters that make up specific parts in the book. All chapters are selected by default. If you want to narrow your focus to individual chapters, simply deselect all the chapters and then select only those on which you wish to focus in the Objectives area.

You can also select the exam banks on which to focus. Each exam bank comes complete with a full exam of questions that cover topics in every chapter. You can have the test engine serve up exams from all test banks or just from one individual bank by selecting the desired banks in the exam bank area.

There are several other customizations you can make to your exam from the exam settings screen, such as the time of the exam, the number of questions served up, whether to randomize questions and answers, whether to show the number of correct answers for multiple-answer questions, and whether to serve up only specific types of questions. You can also create custom test banks by selecting only questions that you have marked or questions on which you have added notes.

Updating Your Exams

If you are using the online version of the Pearson Test Prep software, you should always have access to the latest version of the software as well as the exam data. If you are using the Windows desktop version, every time you launch the software while connected to the Internet, it checks if there are any updates to your exam data and automatically downloads any changes that were made since the last time you used the software.

Sometimes, due to many factors, the exam data may not fully download when you activate your exam. If you find that figures or exhibits are missing, you may need to manually update your exams. To update a particular exam you have already activated and downloaded, simply click the **Tools** tab and click the **Update Products** button. Again, this is only an issue with the desktop Windows application.

If you wish to check for updates to the Pearson Test Prep exam engine software, Windows desktop version, simply click the **Tools** tab and click the **Update Application** button. This ensures that you are running the latest version of the software engine.

Goals and Methods

The goal of this book is to assist you in learning and understanding the technologies covered in the Network+ N10-009 blueprint from CompTIA. This book also helps you prepare for the N10-009 version of the CompTIA Network+ exam.

To aid you in mastering and understanding the Network+ certification objectives, this book uses the following methods:

- **Opening topics list:** This list spells out the Network+ objectives and topics that are covered in the chapter.
- **Foundation topics:** At the heart of a chapter, the sections under “Foundation Topics” explain the topics from hands-on and theory-based standpoints. These sections include in-depth descriptions, tables, and figures that build your knowledge so that you can pass the N10-009 exam. Each chapter is broken into multiple sections.
- **Key topics:** The “Review All Key Topics” section indicates important figures, tables, and lists of information that you need to review for the exam. Key Topic icons are sprinkled throughout each chapter, and a table at the end of each chapter lists the important parts of the text called out by these icons.
- **Memory tables:** You can find memory tables and their answer key on the book’s companion website in Appendixes B and C, respectively. Use them to help memorize important information.
- **Key terms:** Key terms without definitions are listed at the end of each chapter. Write down the definition of each term and check your work against the definitions in the Glossary. On the companion website, you will find a flash card application with all the glossary terms separated by chapter, and you can use it to study key terms as well.
- **Practice exams:** As previously described, this book comes complete with several full-length practice exams available to you in the Pearson Test Prep practice test software, which you can download and install from the companion website. The Pearson Test Prep software is also available to you online, at www.PearsonTestPrep.com. Follow the directions at the beginning of the book under “Companion Website and Pearson Test Prep Access Code.” Be sure to run through the questions in exam bank 1 as you complete each chapter in study mode. When you have completed the book, take a full practice test using exam bank 2 questions in practice exam mode to test your exam readiness.

For current information about the CompTIA Network+ certification exam, visit <https://www.comptia.org/certifications/network>.

Strategies for Exam Preparation

This book comes with a study planner tool on the companion website. It is a spreadsheet that helps you keep track of the activities you need to perform in each chapter and helps you organize your exam preparation tasks. As you read the chapters in this book, jot down notes with key concepts or configurations in the study planner. Each chapter ends with a summary and series of exam preparation tasks to help you reinforce what you have learned. These tasks include review exercises such as reviewing key topics, completing memory tables, defining key terms, answering review questions, and performing exercises. Make sure you perform these tasks as you complete each chapter to improve your retention of the material and record your progress in the study planner.

The book concludes with Chapter 26, “Final Preparation,” which offers you guidance on your final exam preparation and provides you with some helpful exam advice. Make sure you read over that chapter to help assess your exam readiness and identify areas where you need to focus your review.

Download the current exam objectives by submitting a form on the following web page: <https://www.comptia.org/certifications/network>.

Use the practice exams, which are included on this book’s companion website. As you work through the practice exams, use the practice test software reporting features to note the areas where you lack confidence and then review the related concepts. After you review those areas, work through the practice exams a second time and rate your skills. Keep in mind that the more you work through the practice exams, the more familiar the questions become, and the less accurately the practice exams judge your skills.

After you work through the practice exams a second time and feel confident with your skills, schedule the real CompTIA Network+ exam (N10-009).

CompTIA Network+ Exam Topics

Table I-1 lists general exam topics (*objectives*) and specific topics under each general topic (*subobjectives*) for the CompTIA Network+ N10-009 exam. This table lists the primary chapter in which each exam topic is covered. Note that many objectives and subobjectives are interrelated and are addressed in multiple chapters in the book.

Table I-1 CompTIA Network+ Exam Topics

Chapter	N10-009 Exam Objective	N10-009 Exam Subobjective
Chapter 1: The OSI Model and Encapsulation	1.0 Networking Concepts	1.1 Explain concepts related to the Open Systems Interconnection (OSI) reference model.
Chapter 2: Networking Appliances, Applications, and Functions	1.0 Networking Concepts	1.2 Compare and contrast networking appliances, applications, and functions.
Chapter 3: Cloud Concepts	1.0 Networking Concepts	1.3 Summarize cloud concepts and connectivity options.
Chapter 4: Networking Ports, Protocols, Services, and Traffic Types	1.0 Networking Concepts	1.4 Explain common networking ports, protocols, services, and traffic types.
Chapter 5: Transmission Media and Transceivers	1.0 Networking Concepts	1.5 Compare and contrast transmission media and transceivers.
Chapter 6: Network Topologies, Architectures, and Types	1.0 Networking Concepts	1.6 Compare and contrast network topologies, architectures, and types.
Chapter 7: IPv4 Addressing	1.0 Networking Concepts	1.7 Given a scenario, use appropriate IPv4 network addressing.
Chapter 8: Evolving Use Cases	1.0 Networking Concepts	1.8 Summarize evolving use cases for modern network environments.
Chapter 9: Routing Technologies	2.0 Network Implementation	2.1 Explain characteristics of routing technologies.
Chapter 10: Ethernet Switching Technologies	2.0 Network Implementation	2.2 Given a scenario, configure switching technologies and features.
Chapter 11: Configure Wireless Devices and Technologies	2.0 Network Implementation	2.3 Given a scenario, select and configure wireless devices and technologies.
Chapter 12: Physical Installations	2.0 Network Implementation	2.4 Explain important factors of physical installations.
Chapter 13: Organizational Processes and Procedures	3.0 Network Operations	3.1 Explain the purpose of organizational processes and procedures.
Chapter 14: Network Monitoring	3.0 Network Operations	3.2 Given a scenario, use network monitoring technologies.
Chapter 15: Disaster Recovery	3.0 Network Operations	3.3 Explain disaster recovery (DR) concepts.

Chapter	N10-009 Exam Objective	N10-009 Exam Subobjective
Chapter 16: IPv4 and IPv6 Network Services	3.0 Network Operations	3.4 Given a scenario, implement IPv4 and IPv6 network services.
Chapter 17: Network Access and Management Methods	3.0 Network Operations	3.5 Compare and contrast network access and management methods.
Chapter 18: Network Security Concepts	4.0 Network Security	4.1 Explain the importance of basic network security concepts.
Chapter 19: Types of Network Attacks	4.0 Network Security	4.2 Summarize various types of attacks and their impact to the network.
Chapter 20: Network Security Features	4.0 Network Security	4.3 Given a scenario, apply network security features, defense techniques, and solutions.
Chapter 21: A Network Troubleshooting Methodology	5.0 Network Troubleshooting	5.1 Explain the troubleshooting methodology.
Chapter 22: Troubleshoot Common Cabling Problems	5.0 Network Troubleshooting	5.2 Given a scenario, troubleshoot common cabling and physical interface issues.
Chapter 23: Troubleshoot Common Issues with Network Services	5.0 Network Troubleshooting	5.3 Given a scenario, troubleshoot common issues with network services.
Chapter 24: Troubleshoot Common Performance Issues	5.0 Network Troubleshooting	5.4 Given a scenario, troubleshoot common performance issues.
Chapter 25: Network Troubleshooting Tools	5.0 Network Troubleshooting	5.5 Given a scenario, use the appropriate tool or protocol to solve networking issues.

How This Book Is Organized

Although this book could be read cover to cover, it is designed to be flexible and allow you to easily move between chapters and sections of chapters to cover just the material that you need more work with. However, if you do intend to read all the chapters, the order in the book is an excellent sequence to use:

- **Chapter 1: The OSI Model and Encapsulation**—This chapter details the OSI model and its seven layers. This chapter also presents the encapsulation and deencapsulation processes associated with this important model.
- **Chapter 2: Networking Appliances, Applications, and Functions**—This chapter presents commonly used physical and virtual appliances in use in

networks today. This chapter also covers commonly used applications and network functions.

- **Chapter 3: Cloud Concepts**—This chapter covers some of the most important cloud concepts used in modern networking. Just some of the topics covered include deployment models, service models, and cloud connectivity options.
- **Chapter 4: Networking Ports, Protocols, Services, and Traffic Types**—This chapter ensures you are familiar with some of the most popular ports, protocols, and services in use today. This chapter also covers the traffic types of unicast, multicast, anycast, and broadcast.
- **Chapter 5: Transmission Media and Transceivers**—This chapter is all about the wireless and wired connections we make in modern networks. This chapter also covers the transceivers and connector types we often see in our networks today.
- **Chapter 6: Network Topologies, Architectures, and Types**—This chapter covers common network topologies, including mesh, hybrid, hub and spoke, and more. This chapter also covers common traffic flow types found in today's networking environments.
- **Chapter 7: IPv4 Addressing**—This chapter is all about IPv4 addressing. This includes coverage of public versus private IP addressing, subnetting, and the IPv4 address classes.
- **Chapter 8: Evolving Use Cases**—This chapter is all about some of the more cutting-edge technologies appearing in our most modern of networks today. Just some of the technologies that are covered include software-defined networking, Virtual Extensible Local Area Network (VXLAN), and IPv6 addressing.
- **Chapter 9: Routing Technologies**—This chapter tackles technologies that are specific to routing in our networks. This includes such topics as static versus dynamic routing, route selection, address translation, and first hop redundancy protocols.
- **Chapter 10: Ethernet Switching Technologies**—This chapter describes technologies related to switching in today's networks. This includes such topics as VLANs, switch interface configurations, and Spanning Tree Protocol.
- **Chapter 11: Configure Wireless Devices and Technologies**—This chapter examines topics related to Wi-Fi in networks today. This includes topics such as frequency options, network types, encryption, and many more.

- **Chapter 12: Physical Installations**—This chapter examines several important factors you should consider when you are planning and operating physical installations for networking equipment. This chapter includes topics like power and environmental factors.
- **Chapter 13: Organizational Processes and Procedures**—This chapter focuses on the purpose of organizational processes and procedures. Topics like documentation, life-cycle management, change management, and configuration management are all covered.
- **Chapter 14: Network Monitoring**—This chapter presents many different options and methods when it comes to monitoring modern networks. Topics include SNMP, SIEMs, and many more.
- **Chapter 15: Disaster Recovery**—This chapter focuses on disaster recovery (DR) topics. This includes things like DR metrics, DR sites, and high-availability approaches.
- **Chapter 16: IPv4 and IPv6 Network Services**—This chapter presents many examples of popular IPv4 and IPv6 services found in networks today. Topics in this chapter include dynamic addressing options, name resolution services, and time protocols.
- **Chapter 17: Network Access and Management Methods**—This chapter presents various options available today for network access and network management. Topics include VPNs, connection methods, and specific technologies like jump boxes.
- **Chapter 18: Network Security Concepts**—This chapter is a big one. Why? It tackles the hugely important topic of basic network security concepts. Here you will learn about things like logical security, physical security, and common security terminology.
- **Chapter 19: Types of Network Attacks**—What are some of the most common network attacks in use today? This chapter addresses this question head on and covers such topics as DoS and DDoS attacks, social engineering attacks, and many, many more.
- **Chapter 20: Network Security Features**—This chapter covers network security features, defense techniques, and solutions. This includes a discussion of device hardening, network access controls, key management, security rules, and zones.
- **Chapter 21: A Network Troubleshooting Methodology**—This chapter provides guidance on a well-planned and effective troubleshooting methodology. This methodology begins with problem identification and ends with the documentation of findings.

- **Chapter 22: Troubleshoot Common Cabling Problems**—This chapter covers troubleshooting common cabling and physical interface issues. The chapter focuses on three main areas: cable issues, interface issues, and hardware issues.
- **Chapter 23: Troubleshoot Common Issues with Network Services**—This chapter focuses on troubleshooting common issues with network services. This includes the two main areas of switching- and routing-based services.
- **Chapter 24: Troubleshoot Common Performance Issues**—These days, a network that is performing poorly can be nearly as disruptive as a network that is not functioning at all. This chapter guides you through troubleshooting the most common of performance issues. Both wired and wireless networks are discussed.
- **Chapter 25: Network Troubleshooting Tools**—This chapter focuses on the use of network troubleshooting tools that can help you solve common issues. This includes the three main categories of tools: software tools, hardware tools, and basic networking device commands.

Figure Credits

Figures 3-1 to 3-3 © 2024, Amazon Web Services, Inc.

Figures 13-3 and 20-1 © 2024, Linksys Holdings, Inc.

Figures 7-4 to 7-12, 13-2 and 16-2 © 2024, Microsoft

Figures 7-14 and 14-7 © 2024 SolarWinds Worldwide, LLC

Figures 14-3 and 25-1 © Wireshark Foundation

Figure 22-2, photo courtesy of Digi.Key Corporation (<http://www.digikey.com>)

Figure 22-3, photo courtesy of Coral.i Solutions (<http://www.coral.i.com>)

Cover image, Funtap/shutterstock

Figures 2-2 to 2-18, 4-1 to 4-4, 5-2, 6-1 to 6-10, 7-13, 8-1, 8-3 to 8-5, 9-1 to 9-16, 10-1, 10-4 to 10-8, 10-10 to 10-17, 11-1 to 11-7, 11-11, 14-1, 14-2, 14-4 to 14-6, 15-1 to 15-4, 15-6, 16-1, 16-3, 17-1, 17-2, 17-4, 18-1, 18-2, 19-1, 24-1 courtesy of Cisco Systems, Inc.



This chapter covers the following topics related to Objective 1.1 (Explain concepts related to the Open Systems Interconnection [OSI] reference model) of the CompTIA Network+ N10-009 certification exam:

- OSI model
 - Layer 1—Physical
 - Layer 2—Data link
 - Layer 3—Network
 - Layer 4—Transport
 - Layer 5—Session
 - Layer 6—Presentation
 - Layer 7—Application

The OSI Model and Encapsulation

Way back in 1977, the International Organization for Standardization (ISO) developed a subcommittee to focus on the interoperability of multivendor communications systems. This is fancy language for getting network “stuff” to communicate with other network “stuff,” even if different companies made the network “stuff.” What sprang from this subcommittee was the *Open Systems Interconnection (OSI) reference model* (also referred to as the *OSI model* or the *OSI stack*). Thanks to this model, you can talk about any networking technology and categorize that technology as residing at one or more of the seven layers of the model.

This chapter defines those seven layers and offers examples of what you might find at each layer. It also contrasts the OSI model with another model—the TCP/IP stack, also known as the Department of Defense (DoD) model—that focuses on Internet Protocol (IP) communications.

Foundation Topics

The Purpose of Reference Models

Throughout this book, various protocols and devices that play a role in your network (and your networking career) are introduced. To better understand how a technology fits in, it helps to have a common point of reference against which various technologies from different vendors can be compared. The OSI model provides us an ideal point of reference for our learning and discovery.

Understanding the OSI model is also very useful in troubleshooting networks. In fact, Chapter 21, “A Network Troubleshooting Methodology,” provides some concrete methods for using the OSI model in conjunction with thorough network troubleshooting.

One of the most common ways of categorizing the function of a network technology is to say at what layer (or layers) of the OSI model that technology runs. Understanding how that technology performs a certain function at a certain layer of the OSI model helps you determine whether one device is going to be able to communicate with another device, which might or might not be using a similar technology, at that layer of the OSI reference model.

For example, when your end-user device connects to a web server on the Internet, your service provider assigns your device an IP address. Similarly, the web server to which you are communicating has an IP address. As described in this chapter, an IP address lives at Layer 3 (the network layer) of the OSI model. Because your device and the web server use a common protocol (that is, IP) at Layer 3, they are capable of communicating with one another.

Notice also in this example that you are interested in receiving the data from the web server, which will be web pages filled with text and graphics and maybe even videos. This is the information you are really after. You (typically) do not care about the IP addresses in use or any of the other information required by the network devices to make this transfer happen. In technical terms, you are interested in the *payload* of the packets sent from the web server. The *payload* provides a simple and generic method of describing the data itself, which is separate and distinct from any of the other information required for proper transmission.

Personally, I have been in the computer-networking industry since 1996, and I have had the OSI model explained in many classes I have attended and books I have read. From this, I have taken away a collection of metaphors to help describe the operation of the different layers of the OSI model. Some of the metaphors involve sending a letter from one location to another or placing a message in a series of

envelopes. These are often excellent metaphors for encapsulation and decapsulation (covered later in this chapter), but they do not work all that well for the OSI model in general. My favorite way to describe the OSI model is to simply think of it as being analogous to a bookcase, such as the one shown in Figure 1-1.



Figure 1-1 A Bookcase Is Analogous to the OSI Model

If you were to look at this or any other bookcase in my home office, you would see that I have organized diverse types of books on different shelves. One shelf holds my collection of technical books, another shelf holds the books I wrote for Pearson and other publishers, another shelf holds books regarding self-improvement and finance. I have grouped similar books together on each shelf, just as the OSI model groups similar protocols and functions together in a layer.

A common pitfall my readers meet when studying the OSI model is to try to neatly fit all the devices and protocols in their network into one of the OSI model's seven layers. However, not every technology fits perfectly into these layers. In fact, some networks might not have any technologies running at one or more of these layers. This reminds me of my favorite statement about the OSI model. It comes from Rich Seifert's book *The Switch Book*. In that book, Rich reminds us that the OSI model is a *reference* model, not a *reverence* model. That is, no cosmic law states that all technologies must cleanly plug into the model. So, as you discover the characteristics of