Installing and Configuring Windows Server 2022

Learn the ins and outs of Windows Server 2022 administration

Bekim Dauti

www.bpbonline.com

First published: 2024

Published by BPB Online
WeWork
119 Marylebone Road
London NW1 5PU

UK | UAE | INDIA | SINGAPORE

ISBN 978-93-55516-015

www.bpbonline.com

Dedicated to

To all the children who dream of a better future. May this book inspire them to pursue their passions and achieve their goals, just as it has inspired me.

About the Author

Bekim Dauti is a qualified and experienced computer technology expert specializing in server administration, computer networking, and training, focusing on Cisco, CompTIA, and Microsoft technologies. He earned his bachelor's in informatics from the University of Tirana, a master's in information technology from UMGC Europe, and a doctorate in Computer Science from Aspen University.

Bekim has over 20 years of experience as a **Cisco Certified Academy Instructor** (**CCAI**) and over 15 years of experience as a **Microsoft Certified Trainer** (**MCT**). In addition, he holds several IT certifications from reputable vendors, including ECDL, Certiport, CompTIA, Cisco, Microsoft, and Sun Microsystems.

As a prolific writer, Bekim has contributed to nearly 20 books and published dozens of articles in renowned publications such as PC World Albanian and CIO Albanian. In addition, he founded InfoTech (Academy) and Dautti and is working as a Microsoft Certified Trainer at Elev8. Bekim's passion for technology extends to maintaining a blog called *Bekim Dauti's Blog*. Bekim is grateful for his parents' support.

Given the persistent extreme poverty in numerous countries worldwide, would it be more prudent to redirect the efforts currently devoted to building a global economy towards the primary goal of achieving global equality? Prioritizing global equality, in conjunction with the worldwide economy could pave the way for numerous international initiatives to enhance the overall quality of life worldwide.

— Bekim Dauti

Acknowledgement

I express my deepest gratitude towards my parents and family for their constant love, support, and encouragement, as this book would not have been achievable without them. Their sacrifices and guidance were a continuous source of motivation throughout this journey.

To my colleagues at Elev8 and Dautti, thank you for your support and encouragement.

I am also grateful to BPB Publications for their guidance and expertise in bringing this book to fruition. Revising this book was a long journey, with valuable participation and collaboration of reviewers, technical experts, and editors.

Above all, I thank God for granting me life, good health, and the chance to contribute to knowledge sharing. Additionally, I hope that God rewards my family, relatives, friends, colleagues, and all those who supported me in completing this book. Finally, I wish peace and blessings to every reader.

Preface

Windows Server 2022 is the server operating system developed by Microsoft as part of the Windows NT family of operating systems, developed concurrently with Windows 10 version 1809. This book is designed to get you started with Windows Server 2022. At the same time, this book aims to introduce you to the roles that Windows Server 2022 supports. In addition, the book teaches you how to install roles by using both Add Roles and Features Wizard and Windows PowerShell cmdlets. Furthermore, the book provides instructions for configuring client/server network services using the various **Graphical User Interface** (**GUI**) wizards, tools, and Windows PowerShell cmdlets.

The book begins with the introduction of computer networks and Windows Server 2022. Then, it continues with the installation and post-installation tasks of Windows Server 2022. You will then move on to a more advanced aspect of working with Windows Server 2022, such as installing roles and configuring client/server network services like AD DS, DNS, DHCP, WDS, PDS, WSUS, Web Server, Hyper-V, and other essential network services. Next, with the help of real-world examples, you will get to grips with the fundamentals of Windows Server 2022, which will help you solve complex tasks the easy way. Later, the book also shows you maintenance and troubleshooting tasks, where with the help of best practices, you can easily manage Windows Server 2022. By the end of this book, you will have the knowledge required to administer and manage Windows Server environments.

Chapter 1: Understanding Networks and their Components - This chapter is designed to introduce Windows Server in general. Besides introducing Windows Server, at the beginning of this chapter, there is a reminder of the basic concepts of computer network components. Definitions such as hosts, nodes, peer-to-peer, and clients/servers are covered in the Computer Network Overview section. In addition, the reader will learn about general concepts of clients, servers, NOS, hardware and software, and networking architectures.

Chapter 2: Introduction to Windows Server 2022 - This chapter is designed to introduce Windows Server 2022. Windows Server 2022 is the server's operating system developed by Microsoft as part of the Windows NT family of operating systems and developed concurrently with Windows 10 version 1809. The Windows

Server Overview section uncovers the essentials of Windows Server 2022. The reader will learn Microsoft's new server OS, Windows Server 2022. In addition, the reader will learn Windows Server 2022 editions, compare Windows Server 2022 with Windows Server 2016, minimum and recommended system requirements, and download Windows Server 2022.

Chapter 3: Windows Server 2022 Installation - This chapter provides detailed instructions for installing Windows Server 2022. The step-by-step instructions, driven by easy-to-understand graphics, explain and show you how to master the installation of Windows Server 2022. In addition, the reader will learn about Windows Server 2022 installation options. For each option, a step-by-step approach will be presented.

Chapter 4: Initial Configuration of Windows Server 2022 - This chapter explains steps to take in Windows Server 2022 post-installation, including managing devices and device drivers, checking the registry and the status of services, and taking care of the initial server configuration. The reader will learn about the server's device drivers and play with them by installing, upgrading, uninstalling, troubleshooting, etc. Additionally, the reader will learn about services and how to manage them in a server environment.

Chapter 5: Installing Roles Using Server Manager and PowerShell - This chapter provides step-by-step installation how-to instructions for roles in Windows Server 2022 using the Add Roles and Features Wizard from the Server Manager and cmdlets from Windows PowerShell. The reader will learn to use the Server Manager Add Roles and Feature Wizard and Windows PowerShell to add roles in Windows Server 2022. At the same time, the reader will get to know and learn each role's purpose.

Chapter 6: Service Management with GUI and PowerShell - This chapter provides step-by-step installation how-to instructions for configuring client/server network services in Windows Server 2022 by using various Graphical User Interfaces (GUI) and Windows PowerShell cmdlets. The reader will learn to use multiple Graphical User Interface (GUI) wizards and Windows PowerShell cmdlets to configure client/server network services in Windows Server 2022.

Chapter 7: Tuning Windows Server 2022 for Peak Performance - This chapter is designed to teach you the best practices and considerations for server hardware. By understanding the importance of a server's role in a computer network and possessing knowledge of each server component, a sys admin can be vigilant when

selecting server hardware. In addition, this chapter teaches server performance monitoring methodologies and procedures. The reader will learn how to tune the performance of Windows Server 2022. The reader will also become familiar with the maintenance process and understand the maintenance techniques.

Chapter 8: Maintaining and Resolving Issues in Windows Server 2022 - This chapter teaches the most challenging part of working with servers. Thus, understanding the importance of troubleshooting, updating, and maintaining servers increases the potential to have a high business continuity standard. Also, this chapter teaches the server startup process, advanced boot options and Safe Mode, backup and restore disaster recovery plan, and updating the OS, hardware, and software. The Event Viewer is also included, which helps you monitor different logs on your system, thus allowing you to troubleshoot and solve the problem. The reader will become familiar with the importance of keeping Windows Server 2022 up-to-date while learning the options available for updating Windows Server 2022. Additionally, the reader will understand troubleshooting and be able to troubleshoot errors and problems in Windows Server 2022, too.

Chapter 9: Getting Ready for Microsoft Certifications - This chapter comprehensively introduces Microsoft certifications, encompassing insights into the competencies evaluated within the examination. Moreover, it outlines the significance of Microsoft certifications aligned with specific roles and elucidates the procedure for exam enrollment. Furthermore, you will uncover invaluable sources to aid you in accumulating extensive insights about the examination in a broader context, discern the requisites for its successful completion, and, in the process, embark on a prosperous professional journey.

Chapter 10: Answers to Chapter Questions - This chapter provides responses to the inquiries posed in the chapter. Furthermore, numerous queries are presented alongside each chapter to assist you in solidifying your grasp of the concepts and definitions. This supplementary section empowers you to verify your solutions to those queries.

Coloured Images

Please follow the link to download
the ***Coloured Images*** of the book:

https://rebrand.ly/1gnuzf5

We have code bundles from our rich catalogue of books and videos available at **https://github.com/bpbpublications**. Check them out!

Errata

We take immense pride in our work at BPB Publications and follow best practices to ensure the accuracy of our content to provide with an indulging reading experience to our subscribers. Our readers are our mirrors, and we use their inputs to reflect and improve upon human errors, if any, that may have occurred during the publishing processes involved. To let us maintain the quality and help us reach out to any readers who might be having difficulties due to any unforeseen errors, please write to us at :

errata@bpbonline.com

Your support, suggestions and feedbacks are highly appreciated by the BPB Publications' Family.

Piracy

If you come across any illegal copies of our works in any form on the internet, we would be grateful if you would provide us with the location address or website name. Please contact us at **business@bpbonline.com** with a link to the material.

If you are interested in becoming an author

If there is a topic that you have expertise in, and you are interested in either writing or contributing to a book, please visit **www.bpbonline.com**. We have worked with thousands of developers and tech professionals, just like you, to help them share their insights with the global tech community. You can make a general application, apply for a specific hot topic that we are recruiting an author for, or submit your own idea.

Reviews

Please leave a review. Once you have read and used this book, why not leave a review on the site that you purchased it from? Potential readers can then see and use your unbiased opinion to make purchase decisions. We at BPB can understand what you think about our products, and our authors can see your feedback on their book. Thank you!

For more information about BPB, please visit **www.bpbonline.com**.

Join our book's Discord space

Join the book's Discord Workspace for Latest updates, Offers, Tech happenings around the world, New Release and Sessions with the Authors:

https://discord.bpbonline.com

Table of Contents

1. Understanding Networks and their Components 1
Introduction 1
Structure 1
Objectives 2
Birth of the internet 2
Computer networks 3
Network components 4
Hosts and nodes 5
Clients and servers 6
Network interface 7
Peripheral devices 7
Shared apps and data 8
Hubs and switches 8
Routers 9
Firewall 9
Networking mediums 10
Network architectures 11
Peer-to-peer applications 12
Network topologies 12
Types of physical topologies 13
Internet Protocol addresses and subnets 16
Internet Protocol version 4 16
Internet Protocol version 6 17
Subnets 18
Network operating system 18
Windows server 19
Linux server 20
Mac OS X Server 21
Technology trends 21
Conclusion 22
Exercise 1.1—Enabling Hyper-V using settings 23

Exercise 1.2—Enabling Hyper-V using PowerShell 24
Questions 24

2. Introduction to Windows Server 2022 25
Introduction 25
Structure 26
Objectives 26
Server hardware and its specifics 26
Four critical hardware components 27
The server's size and form factor 30
Overview of Windows Server 2022 31
Cloud-oriented Windows Server 32
Editions of Windows Server 2022 33
Comparing Windows Server versions 34
System requirements 35
Minimum system requirements 35
Recommended hardware requirements 36
New features in Windows Server 2022 36
Microsoft Edge 37
Azure Hybrid Center 37
Secured-core server 38
Conclusion 39
Exercise 2.1—Downloading Windows Server 2022 40
Exercise 2.2—Downloading Windows Admin Center 41
Questions 42

3. Windows Server 2022 Installation 43
Introduction 43
Structure 43
Objectives 44
Getting to know partition schemes 44
The boot option 44
Advanced Startup Options 45
Getting to know installation methods 47
Getting to know installation options 48

Conclusion 48
Exercise 3.1—Setting up virtual switches in Hyper-V client 49
Exercise 3.2—Setting up a virtual machine in Hyper-V client 52
Exercise 3.3—Performing Windows Server 2022 installation 55
Questions 57

4. Initial Configuration of Windows Server 2022 59
Introduction 59
Structure 59
Objectives 60
Overview of devices and device drivers 60
Discussing plug and play, IRQ, DMA, interrupts, and driver signing 61
Understanding the registry and services 63
Describing registry entries, service accounts, and dependencies 65
Initial configuration of Windows Server 2022 67
Exercise 4.1—Device Manager access 69
Exercise 4.2—Performing initial configuration with Server Manager and sconfig.cmd 71
Changing the server name using the Server Manager 71
Changing the server name using the Server Configuration 72
Joining server to an existing domain using Server Manager 72
Joining server to an existing domain using Server configuration 73
Enabling remote desktop using Server Manager 74
Enabling remote desktop using Server configuration 75
Setting up the IP address using Server Manager 76
Setting up the IP address using Server configuration 77
Checking for updates using Server Manager 78
Checking for updates using Server configuration 79
Changing the time zone using Server Manager 80
Changing the time zone using the Server Configuration 81
Activating Windows Server using Server Manager 81
Activating Windows Server using Server Manager 82
Conclusion 83
Questions 83

5. Installing Roles Using Server Manager and PowerShell....85
Introduction....85
Structure....86
Objectives....86
Understanding Role, Role Service, and Feature....86
Understanding the Active Directory Domain Services role....87
Active Directory consoles....88
Active Directory structure....90
Exercise 5.1—Adding AD DS role....93
Adding AD DS role using Server Manager....93
Adding AD DS role using Windows PowerShell....94
Understanding the Domain Name System role....95
DNS zones....95
How does DNS work?....96
Components of name resolution....97
Exercise 5.2—Adding DNS server role....98
Adding DNS server role using Server Manager....98
Adding DNS server role using Windows PowerShell....99
Getting to know the Dynamic Host Configuration Protocol role....100
How does DHCP work?....100
Exercise 5.3—Adding DHCP server role....101
Adding DHCP server role using Server Manager....101
Adding DHCP server role using Windows PowerShell....102
What is Hyper-V's role?....103
Modes of virtualization....103
The architecture of Hyper-V....104
Nesting the virtualization....104
Prerequisite for virtualization....105
Exercise 5.4—Adding Hyper-V role....105
Adding Hyper-V role using Server Manager....106
Adding Hyper-V role using Windows PowerShell....107
What is the use of a Web server role?....108
Web elements and technologies....109
Exercise 5.5—Adding Web Server Role....110

Adding Web Server role using Server Manager *110*
Adding Web Server role using Windows PowerShell *112*
Getting to know the Print and Document Services role 112
PDS role services *113*
Printer and printing concepts *113*
Exercise 5.6—Adding PDS role 115
Adding PDS role using Server Manager *115*
Adding PDS role using Windows PowerShell *116*
What is unique about the Remote Access Role? 117
Remote access' network access technologies *117*
Understanding Virtual Private Network *118*
Remote support and management *119*
Exercise 5.7—Adding remote access role 119
Adding remote access role using Server Manager *120*
Adding remote access role using Windows PowerShell *121*
The need for a Remote Desktop Services role 122
Various RDS role services and features *123*
Exercise 5.8—Adding Remote Desktop Services role 124
Adding Remote Desktop Services role using Server Manager *124*
Adding Remote Desktop Services role using Windows PowerShell *125*
Understanding Windows Server Update Services role 126
WSUS deployment methods *127*
WSUS connection modes *128*
Exercise 5.9—Adding Windows Server Update Services role 128
Adding Windows Server update services role using Server Manager *128*
Adding Windows Server Update Services role using Windows PowerShell *130*
Conclusion 130
Questions 131

6. Service Management with GUI and PowerShell 133
Introduction 133
Structure 133
Objectives 134
Promoting the server to a domain controller 134
Exercise 6.1—Configuring domain controller 135

Configuring domain controller using Server Manager *135*
Configuring domain controller using Windows PowerShell *138*
Adding an A Record in the DNS manager 138
Exercise 6.2—Configuring an A Record in the DNS server 139
Configuring an A record using the DNS manager *139*
Configuring an A Record using Windows PowerShell *140*
Configuring a DHCP server 141
Exercise 6.3—Configuring a DHCP Scope 142
Configuring a DHCP scope using a DHCP console *142*
Configuring a DHCP scope using Windows PowerShell *146*
Configuring a virtual machine 147
Exercise 6.4—Configuring a virtual machine 147
Configuring a virtual machine using Hyper-V manager *148*
Configuring a virtual machine using Windows PowerShell *150*
Configuring a website 151
Exercise 6.5—Configuring a Website 152
Configuring a website using IIS manager *152*
Configuring a website using Windows PowerShell *153*
Configuring the print server 155
Exercise 6.6—Configuring the print server 155
Configuring print server using print management *155*
Configuring print server using Windows PowerShell *157*
Configuring Remote Desktop users 157
Exercise 6.7—Configuring Remote Desktop Users 158
Configuring Remote Desktop users using Active Directory users and computers ... *158*
Configuring Remote Desktop users using Windows PowerShell *159*
Configuring the WSUS server 160
Exercise 6.8—Configuring the WSUS Server 161
Configuring the WSUS server using the WSUS manager *161*
Conclusion 163
Questions 164

7. Tuning Windows Server 2022 for Peak Performance 165
Introduction 165
Structure 166

Objectives 166
Server hardware components and their roles 166
Server's miscellaneous hardware *169*
Performance monitoring basics 170
Overview of performance monitoring procedures *170*
Importance of server baselines *171*
Understanding performance monitor *172*
Exercise 7.1—Setting up data collector sets for Windows Server performance monitoring 173
Getting to know resource monitor *174*
Overviewing task manager *175*
Best practices for server maintenance 176
Information Technology Infrastructure Library *177*
Overview of Windows Admin Center 178
Windows Admin Center tools and features *178*
Exercise 7.2—How to download Windows Admin Center 179
Exercise 7.3—How to Install Windows Admin Center 180
Exercise 7.4—How to connect to a server from the Windows Admin Center 182
Logs and alerts for server performance 183
Exercise 7.5—Enabling performance logs and alerts service 183
Exercise 7.6—Exploring the PerfLogs folder 184
Exercise 7.7—Creating and configuring performance data logs 184
Exercise 7.8—Performance counter alert configuration 185
Conclusion 186
Questions 186

8. Maintaining and Resolving Issues in Windows Server 2022 187
Introduction 187
Structure 188
Objectives 188
Starting up your server 188
Maintaining business continuity 192
Overview of Disaster Recovery Plan *193*
Understanding data redundancy *193*
Getting to know clustering *194*

What is folder redirection? *194*
Exercise 8.1—Group policy folder redirection setup 194
Overview of backup and restore *195*
Exercise 8.2— How to add the Windows Server backup feature? 196
Understanding Directory Services Restore Mode *197*
Overview of Uninterruptible Power Supply *198*
Updating the OS and applications 198
What is a Windows update? *198*
How do you update Microsoft programs? *200*
The importance of updating non-Microsoft programs *200*
Getting to know Windows Server Update Services *201*
Troubleshooting errors and problems 201
Understanding troubleshooting process *202*
Understanding troubleshooting approaches *202*
Understanding troubleshooting procedures *203*
Understanding the Event Viewer 203
Exercise 8.3—Central Monitoring Configuration 204
Exercise 8.4—Event Viewer log filtering 205
Exercise 8.5—Log location configuration 206
Conclusion 207
Questions 208

9. Getting Ready for Microsoft Certifications 209
Introduction 209
Structure 210
Objectives 210
What is Microsoft certification? 210
Understanding Microsoft role-based certifications 212
Who should take the Microsoft certification exam? 213
Skills measured in the Microsoft certification exam 215
Deploy and manage AD DS in on-premises and cloud environments (30%–35%) *216*
Manage Windows Servers and workloads in a hybrid environment (10%–15%) *218*
Manage virtual machines and containers (15%–20%) *219*

Implement and manage an on-premises and hybrid networking infrastructure (15%–20%) 220
Manage storage and file services (15%–20%) 222
What to expect and how to succeed in the Microsoft certification exam 223
Preparing for the Microsoft certification exam 224
How to register for the Microsoft certification exam 225
On the day of your Microsoft certification exam 227
New Microsoft Certification validity and renewal requirements 229
Conclusion 230

10. Answers to Chapter Questions 231
Introduction 231
Structure 232
Objectives 232
Answers to Chapter 1 questions 232
Q1: In your own words, define a computer network. 232
Q2: How many types of computer networks can you name? 233
Q3: How many types of network components can you name? 234
Q4: List three differences between IPv4 and IPv6 addressing technologies. 235
Q5: In your own words, define a Network Operating System. 235
Answers to Chapter 2 questions 236
Q1: What are the server's four hardware key components, and what is their function? 236
Q2: Can you name each era of the Windows Server and list the corresponding versions? 237
Q3: What do you mean by minimum system requirements? 238
Q4: List three new features in Windows Server 2022. 238
Q5: What do you like most about Windows Server 2022? 239
Answers to Chapter 3 questions 240
Q1: What are the two primary partition schemes typically used in computers and servers? 240
Q2: What is the boot option? 240
Q3: Can you provide the names of installation methods? 240
Q4: What installation options should be considered before installing Windows Server 2022? 241

Q5: What is the purpose of a virtual switch in Hyper-V? *241*
Answers to Chapter 4 questions 242
Q1: What are device drivers? *242*
Q2: What is Windows Registry? *243*
Q3: What are Windows services? *244*
Q4: Why is initial configuration essential for Windows Server? *244*
Q5: Which tools can you use to run the initial configuration in Windows Server 2022? *244*
Answers to Chapter 5 questions 246
Q1: What is AD DS role? *246*
Q2: What is DNS role? *246*
Q3: What is the DHCP role? *247*
Q4: What is the Web Server role? *247*
Q5: What is WSUS role? *248*
Answers to Chapter 6 questions 248
Q1: What is the WDS role? *248*
Q2: What is PDS role? *248*
Q3: What is remote access? *248*
Q4: What is RDS role? *249*
Q5: What is NPAS role? *250*
Answers to Chapter 7 questions 250
Q1: Mention some of the server's miscellaneous hardware *250*
Q2: What is a Performance Monitor? *251*
Q3: What is a Resource Monitor? *251*
Q4: What is a Task Manager? *252*
Q5: What is Windows Admin Center? *253*
Answers to Chapter 8 questions 253
Q1: What is the startup process? *254*
Q2: How is business continuity maintained? *254*
Q3: What is a Windows Update? *254*
Q4: What is troubleshooting? *255*
Q5: What is Event Viewer? *255*
Conclusion 256

Index 257-266

Chapter 1
Understanding Networks and their Components

Introduction

The most recent version of Microsoft's server operating system and part of the Windows NT series, Windows Server 2022 boasts improved security, versatility, and stability. Moreover, it supports hybrid deployments through a specially developed edition of Windows Server 2022 Datacenter Azure. All these new features and capabilities of Windows Server 2022 show that anyone interested in learning how to use a **Network Operating System** (**NOS**) must have a basic understanding of the computer network, especially the essential network components. Therefore, this chapter introduces the network and its features. Definitions such as computer networks, network components, hosts, nodes, clients and servers, network architectures, IP address and subnet mask, and the NOS itself are discussed in this chapter. These concepts will help you understand networks' essentials and their components. Finally, you can configure the Hyper-V client in Windows 10/11 with the help of this chapter's exercise.

Structure

In this chapter, we will cover the following topics:

- Birth of the internet

- Computer networks
- Network components
- Network architectures
- Network topologies
- Internet Protocol addresses and subnets
- Network operating system
- Technology trends

Objectives

This chapter aims to supply a basic introduction to networking. It will also discuss the details of essential networking components. This chapter begins with the most fundamental concepts about computer network types and networks to delve into a detailed explanation of network components. Finally, we will conclude the chapter with a first-hand example of configuring Hyper-V in Windows 11 Pro using settings and Windows PowerShell.

Birth of the internet

The internet itself is the ultimate authority when explaining its history. It all began with the US government's initiative to create a reliable and resilient communication network called the **Defense Advanced Research Projects Agency** (**DARPA**). Through the involvement of research centers and academic institutions, this endeavor gradually transformed into two distinct projects: the ARPANET and the **Military Network** (**MILNET**). MILNET focused on meeting operational requirements, whereas ARPANET was primarily developed to cater to research needs. By 1985, the internet had already established its identity, thereby signifying the formal conclusion of ARPANET's prosperous era. This progression can be summarized with the phrase, "Every new beginning is some beginning's end."

As stated on **internetsociety.org**, the **Federal Networking Council** (**FNC**) adopted a resolution on October 24, 1995, after consulting with internet community members and considering intellectual property rights. This resolution aimed to define the term "internet." According to the resolution, the internet refers to a global information system that possesses the following characteristics:

- It is logically connected by a globally unique address space established on the **Internet Protocol** (**IP**) or its subsequent updates.
- It can support communication through the TCP/IP protocol suite or its subsequent updates, along with other compatible protocols.

- It provides, utilizes, and grants accessibility, whether publicly or privately, to high-level layered services on the communications and related Infrastructure outlined in the document previously mentioned.

In essence, this resolution serves as a comprehensive definition of the internet, outlining its interconnectedness, communication protocols, and the provision of accessible services.

As computer network technologies progressed, a growing demand emerged to effectively connect and interconnect an increasing number of computers across various geographical locations. Consequently, the necessity arose for precise terminology and concepts to describe the field of computer networking. That resulted in the development of distinct types of computer networks, diverse network topologies, varied network architectures, and an array of network components.

Undoubtedly, computer networks stand as one of humanity's most significant inventions in communication. Merely mentioning the internet demonstrates the tremendous advantages that computer networks bring to society.

Note: To learn more about the history of the internet, visit the following URL: **https://www.internetsociety.org/internet/history-internet/**. It directs to a Web page hosted by the Internet Society, providing a concise and comprehensive overview of the history of the internet. From its origins to its evolution, the Web page covers significant milestones, developments, and contributions of various individuals and organizations, offering valuable insights into the remarkable journey of the internet and its impact on the world.

Computer networks

The intention of this section is not to engage in a comparison of computer networks and network components. Instead, its primary objective is to define a computer network and expound upon its components. Hence, without delving into intricate academic or professional explanations, a computer network can connect two or more computers for resource sharing. From this fundamental definition, we deduce that a pair of computers is the minimum requirement for constructing a network. Moreover, factors such as network coverage, accessibility of services, and the purpose of network servers is to determine the different types of computer networks. Therefore, various networks can be classified as follows:

- A **Personal Area Network** (**PAN**) refers to a computer network designed to establish connections between devices and enable the transmission and reception of data within an individual's workspace. An excellent illustration

of a PAN is the **Wireless Personal Area Network** (**WPAN**), which uses Bluetooth technology for interconnecting devices.

- On the other hand, a **Local Area Network** *(***LAN***)* is a computer network that connects devices and facilitates data exchange within a specific area, such as a floor or a building. A **Wireless Local Area Network** (**WLAN**) is a prime example of a LAN that uses radio waves for interconnection. The most prevalent radio wave technology used in WLANs is Wi-Fi, commonly called Wireless Fidelity, which typically operates at 2.4 GHz and, more recently, at 5 GHz.
- A **Campus Area Network** (**CAN**) is a computer network that interconnects LANs and enables data transmission within a limited geographical area. An extended LAN illustrates a CAN, facilitating network connectivity across multiple buildings or campuses.
- A **Metropolitan Area Network** (**MAN**) is a computer network that connects LANs and allows data exchange within a town, city, or metropolitan area. It encompasses a larger geographical area compared to a CAN.
- Furthermore, a **Wide Area Network** (**WAN**) is a computer network that extends across a vast geographical expanse and facilitates data transfer between MANs. The internet is a well-known example of a WAN, connecting networks worldwide and enabling global communication and information exchange.

Network components

Once we have clearly understood what constitutes a computer network, it becomes easier to identify its different elements. These elements encompass computers, the medium used for networking, networking devices, and the resources used within the network, as mentioned earlier in this chapter and represented in *Figure 1.1*.

In this context, the computers within the network are interconnected with a network device, specifically a switch, through the networking medium. In our case, the medium used is a twisted pair cable. Furthermore, these computers can share various resources their operating system facilitates, such as Windows 10 or 11. For instance, a resource in this context could be a file or a printer.

Refer to *Figure 1.1:*

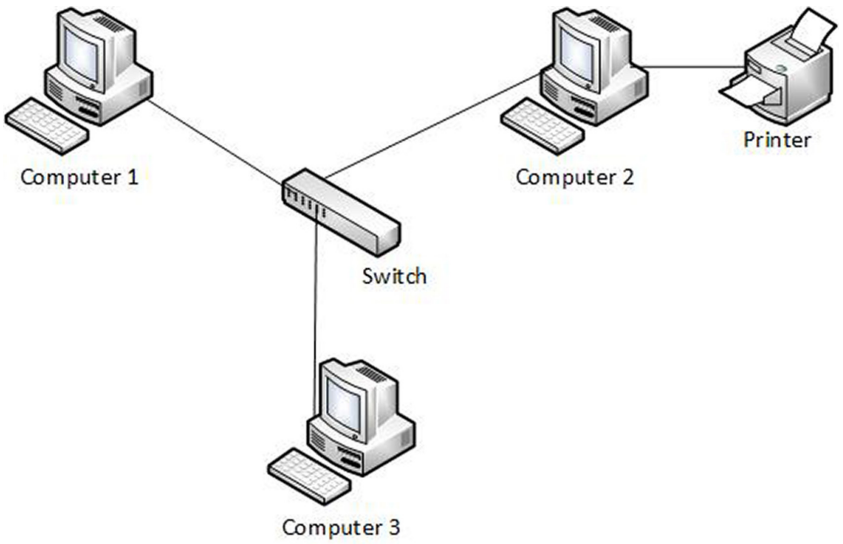

Figure 1.1: *The computer network and network components*

The subsequent sections will delve into the critical components of computer networks and provide a comprehensive understanding of their functionality and importance.

Hosts and nodes

By examining the computer network shown in *Figure 1.1*, we can identify computers 1–3 as hosts, the switch as a node, and the printer as a peripheral device. Although you may have understood this description, the question remains: What are hosts and nodes?

At first glance, hosts and nodes might appear interchangeable but have different meanings. In computer networks, the term *node* is generally used in a broader sense to refer to any device connected to the network. However, a node lacks a network interface with an assigned IP address, which is crucial for locating the node within the network, enabling data transmission, and granting access to network services. This specific attribute is found only in hosts. A *host* is a device with a network interface with an assigned IP address. It uses this address to communicate with other devices and utilize network services. Therefore, it can be said that all hosts can be considered nodes, but not all nodes are hosts.

To further illustrate this distinction, consider *Figure 1.2*, which depicts a network with clients, servers, and a router identified as hosts. In contrast, the switch is classified as a node within the same network. Please refer to the following figure:

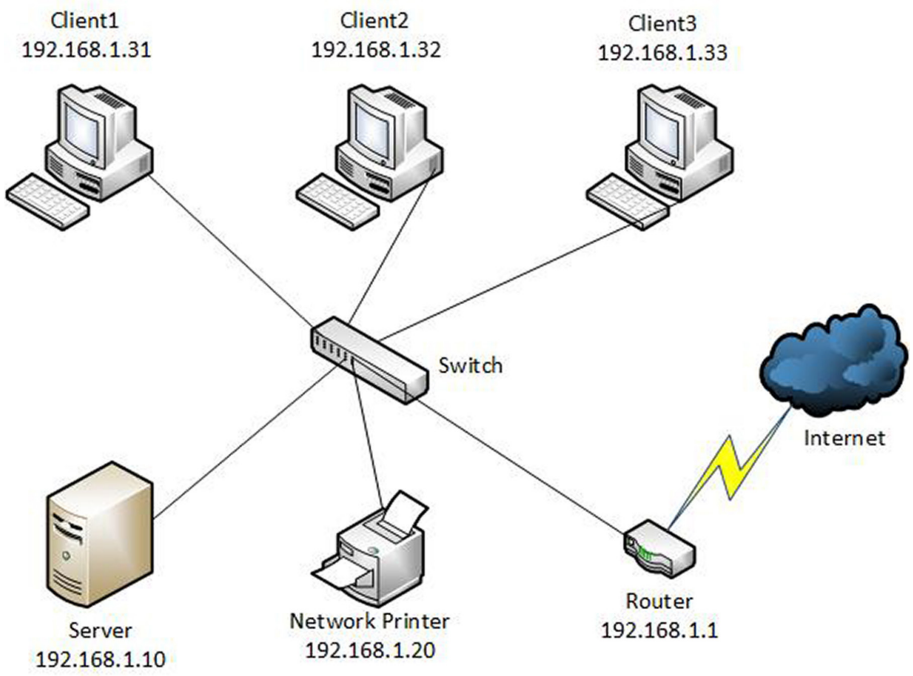

Figure 1.2: *The hosts and nodes in a computer network*

Note: It is important to note that hosts and nodes are two different terms in computer networking. While all hosts can be considered nodes, not all nodes have the essential attributes of hosts, such as a network interface with an assigned IP address. However, network nodes have network interfaces with assigned IP addresses, but these addresses are solely used for management purposes.

Clients and servers

Within the computer network illustrated in *Figure 1.2*, the computers labeled 1–3 are categorized as clients, while the server represents the central server entity. On the other hand, the switch and the router function as nodes, and the network printer serves as a peripheral device. The information provided shows that *clients* are responsible for initiating requests to access resources in computer networks, whereas *servers* are designed to provide services. More precisely, servers respond to access requests by delivering the services themselves. Hence, the term *server* is assumed to originate from its role in serving the needs of its clients by providing the required services.

This distinction between clients and servers highlights their roles and responsibilities within a computer network. Clients actively seek resources or services, whereas servers fulfill those requests and deliver the requested services. It is essential to understand this differentiation to grasp the functioning and dynamics of computer networks effectively.

Network interface

As shown in *Figure 1.3*, a network interface refers to hardware components such as a network card or LAN port on various network devices. Its primary function is facilitating the connection and communication between clients, servers, peripheral devices, and other network equipment. The network interface plays a dual role in the computer network, acting as both a passive and active component. In its passive role, the network interface serves as a connector, allowing devices to connect to the network physically. It provides the necessary ports and connectors to establish a link between the device and the network infrastructure. This passive function enables the transmission of data packets to and from the connected device. Please refer to the following figure:

Figure 1.3. *USB-based network interface*

In its active role, the network interface takes on a more dynamic and manageable role, particularly in the case of network equipment such as switches or routers. These functional network interfaces include additional features and capabilities that enable the device to actively manage network traffic, perform routing functions, and enforce network policies. Active network interfaces can be configured, monitored, and controlled to optimize network performance, security, and reliability.

Peripheral devices

Peripheral devices encompass hardware components, such as printers, scanners, and storage, which offer client resources via a **Local Area Network** (**LAN**) or as shared devices on a network. These devices serve both passive and active roles within the

computer network. In their passive role, peripheral devices provide resources or services to clients without actively participating in network management or control. For example, a printer may accept print jobs from client devices and produce physical copies without actively managing network traffic. However, specific peripheral devices, such as **Storage Area Networks** (**SANs**) and **Network-Attached Storage** (**NAS**), are active in the network. SANs and NAS systems actively manage and control data storage and retrieval operations within the network, offering centralized and efficient storage solutions.

Shared apps and data

Shared applications and data are virtual network components representing the presence of applications and shared files within the network. Typically, servers host these components. While applications and shared data primarily play a passive role in the computer network, the server responsible for hosting these services assumes an active role. In their passive role, applications and shared data are resources available to network users. Users can access these applications and share files without directly participating in network management or control.

On the other hand, as said above, the server hosting these services assumes an active role in the computer network. The server controls the availability, delivery, and security of applications and shared data. It handles client requests, processes data, and ensures the efficient functioning of its network services.

Hubs and switches

Hubs and switches are essential components in Ethernet communication technology that serve as central points in a computer network. They facilitate the interconnection and communication between clients, servers, and peripheral devices. Hubs are generally passive devices, whereas switches actively participate in the operation of the computer network. Hubs function as essential connectivity devices that allow multiple devices to connect and share the same network segment. However, they do not actively manage or control network traffic. Instead, they replicate incoming data packets and broadcast them to all connected devices, regardless of the intended recipient. That can lead to network congestion and inefficient data transmission.

In contrast, *switches* (depicted in *Figure 1.4*) are active devices that manage and control network traffic. They make intelligent forwarding decisions based on the destination MAC addresses of the data packets. By maintaining a table of MAC addresses and associated port connections, switches can selectively forward packets to the appropriate devices, improving network efficiency and reducing congestion.