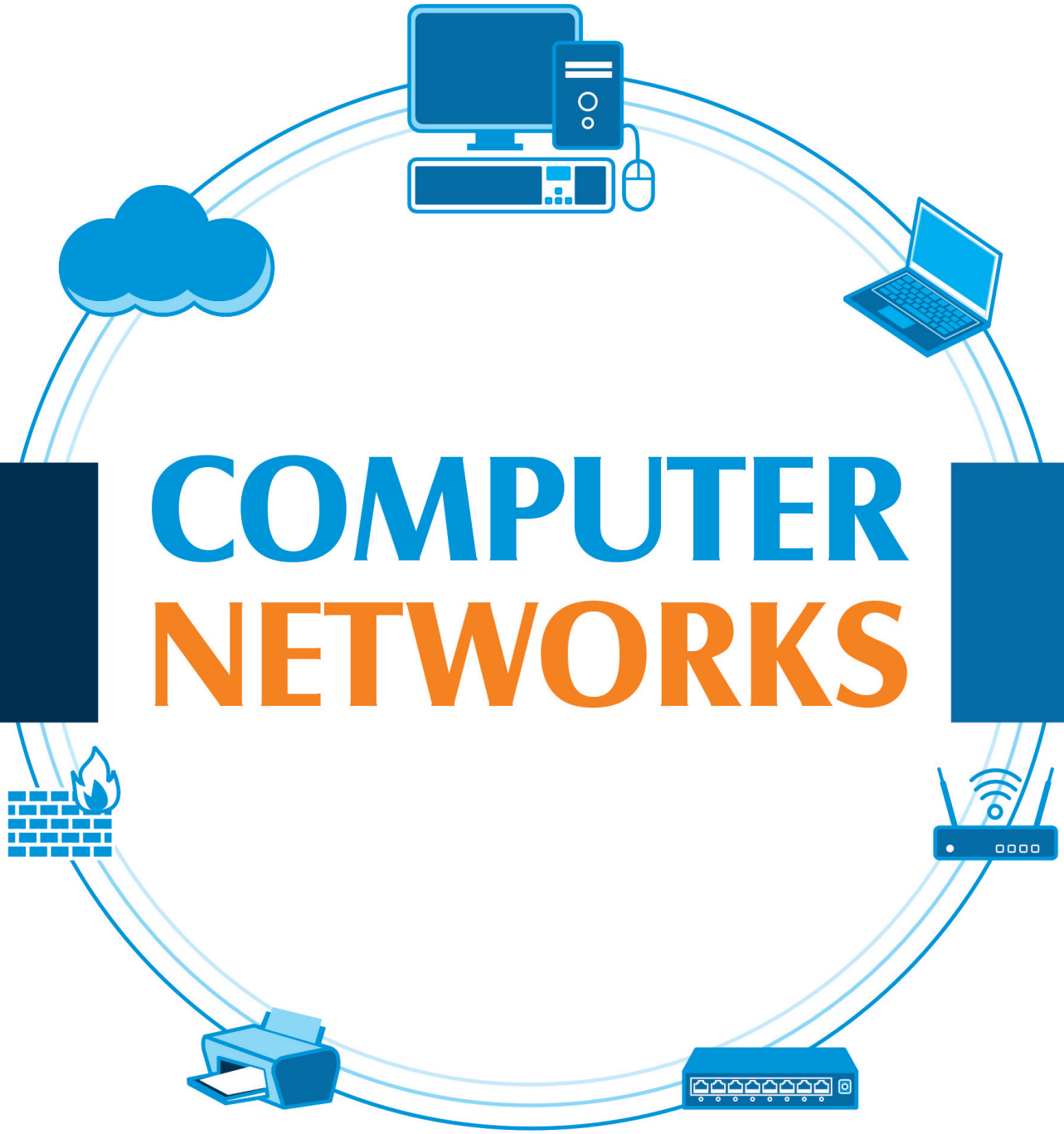

COMPUTER NETWORKS

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Preface

In today's digital age, **Computer Networks** form the backbone of modern communication, enabling seamless data exchange across the world. From the internet and cloud computing to IoT and 5G technology, networks play a crucial role in connecting devices, businesses, and individuals. This book provides a comprehensive introduction to computer networking, covering fundamental concepts, protocols, architectures, and emerging technologies.

Designed for students, academicians, and professionals, this book explains key topics such as network topologies, the OSI and TCP/IP models, routing and switching, network security, wireless communication, and cloud networking. The content is structured to build a solid theoretical foundation while incorporating practical applications and case studies.

A key strength of this book is its practical approach, with diagrams, real-world examples, and hands-on exercises that reinforce learning. Readers will explore networking tools, protocols like HTTP, FTP, DNS and DHCP, and security mechanisms such as firewalls, encryption, and VPNs. The book also delves into emerging trends like 5G, SDN, IoT, and cybersecurity, preparing learners for the evolving landscape of networking.

Whether you are a beginner exploring networking fundamentals or an IT professional looking to deepen your knowledge, this book provides a structured, easy-to-understand, and practical guide. By the end of this book, readers will have a strong grasp of networking principles and hands-on skills essential for designing and maintaining secure and efficient networks.

We also take this opportunity to express our sincere thanks to Shri Dineshbhai Furia, Shri Jignesh Furia, Mrs. Nirali Verma, Mrs. Deepali Lachake (coordinator), and the entire team at Nirali Prakashan for their keen interest and tireless efforts in publishing this book.

We extend our gratitude to Nirali Prakashan for their support and to the educators and professionals who have contributed to the advancement of networking technologies. We hope this book serves as a valuable resource and inspires learners to explore the ever-evolving world of computer networks.

The advice and suggestions of our esteemed readers to improve the text are most welcome and will be highly appreciated.

Happy Learning!

Authors

Contents

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Introduction to Networks

OUTLINE

1.1 PACKET TRACER–LOGICAL AND PHYSICAL MODE EXPLORATION

The network model in this Packet Tracer Physical Mode (PTPM) activity incorporates many of the technologies that you can master in Cisco Networking Academy courses. It represents a simplified version of how a small to medium-sized business network might look. Most of the devices in the Seward branch office and Warrenton data center are already deployed and configured. You have just been hired to review the devices and networks deployed. It is not important that you understand everything you see and do in this activity. Feel free to explore the network on your own. If you wish to proceed more systematically, follow the steps below. Answer the questions to the best of your ability.

IMPORTANT POINTS

1. ***Realistic Physical Layouts:*** *PTPM simulates physical device placement and cabling for practical network design.*
2. ***Integrated Technologies:*** *Explore routing, VLANs, ACLs, and WANs in a comprehensive business network model.*
3. ***Practical Troubleshooting:*** *Develop real-world skills by working with LEDs, cable connections, and device configurations.*

1.2 NETWORKS AFFECT OUR LIVES

1.2.1 Networks Connect Us

Among all of the essentials for human existence, the need to interact with others ranks just below our need to sustain life. Communication is almost as important to us as our reliance on air, water, food and shelter. In today's world, through the use of networks, we are connected like never before. People with ideas can communicate instantly with others to make those ideas a reality. News events and discoveries are known worldwide in seconds. Individuals can even connect and play games with friends separated by oceans and continents.

1.2.2 No Boundaries

Advancements in networking technologies are perhaps the most significant changes in the world today. They are helping to create a world in which national borders, geographic distances and physical limitations become less relevant, presenting ever-diminishing obstacles. The internet has changed the manner in which our social, commercial, political and personal interactions occur. The immediate nature of communications over the internet encourages the creation of global communities. Global communities allow for social interaction that is independent of location or time zone.

Fig. 1

The creation of online communities for the exchange of ideas and information has the potential to increase productivity opportunities across the globe. The creation of the cloud lets us store documents and pictures and access them anywhere, anytime. So whether we are on a train, in a park or standing on top of a mountain, we can seamlessly access our data and applications on any device.

IMPORTANT POINTS

1. ***Communication is Essential:*** *Networking connects people instantly, making ideas and information globally accessible.*
2. ***No Boundaries:*** *Advances in networking reduce geographic and physical limitations, creating global communities for social and professional interaction.*
3. ***Cloud Accessibility:*** *Cloud technology allows seamless access to data and applications from anywhere, enhancing productivity and convenience.*

1.3 NETWORK COMPONENTS

1.3.1 Host Roles

If you want to be a part of a global online community, your computer, tablet or smart phone must first be connected to a network. That network must be connected to the internet. This topic discusses the parts of a network. See if you recognize these components in your own home or school network! All computers that are connected to a network and participate directly in network communication are classified as hosts. Hosts can be called end devices. Some hosts are also called clients. However, the term hosts specifically refers to devices on the network that are assigned a number for communication purposes. This number identifies the host within a particular network. This number is called the Internet Protocol (IP) address. An IP address identifies the host and the network to which the host is attached. Servers are computers with software that allow them to provide information, like email or web pages, to other end devices on the network. Each service requires separate server software. For example, a server requires web server software in order to provide web services to the network.

A computer with server software can provide services simultaneously to many different clients. As mentioned before, clients are a type of host. Clients have software for requesting and displaying the information obtained from the server, as shown in the Fig. 2.

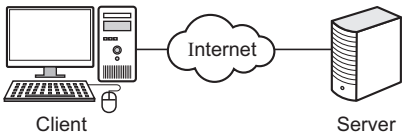

Fig. 2

An example of client software is a web browser, like Chrome or FireFox. A single computer can also run multiple types of client software. For example, a user can check email and view a web page while instant messaging and listening to an audio stream. The table lists three common types of server software.

Table 1

Type	Description
Email	The email server runs email server software. Clients use mail client software, such as Microsoft Outlook, to access email on the server.
Web	The web server runs web server software. Clients use browser software, such as Windows Internet Explorer, to access web pages on the server.
File	The file server stores corporate and user files in a central location. The client devices access these files with client software such as the Windows File Explorer.

1.3.2 Peer-to-Peer

Client and server software usually run on separate computers, but it is also possible for one computer to be used for both roles at the same time. In small businesses and homes, many computers function as the servers and clients on the network. This type of network is called a peer-to-peer network.

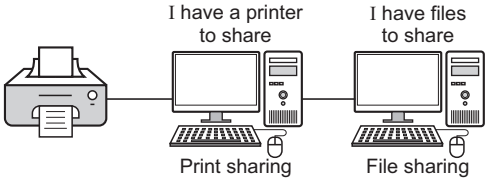

Fig. 3

Advantages of Peer-to-peer Networking

- Easy to set up.
- Less complex.
- Lower cost because network devices and dedicated servers may not be required.
- Can be used for simple tasks such as transferring files and sharing printers.

Disadvantages of Peer-to-peer Networking

- No centralized administration.
- Not as secure.
- Not scalable.
- All devices may act as both clients and servers which can slow their performance.

1.3.3 End Devices

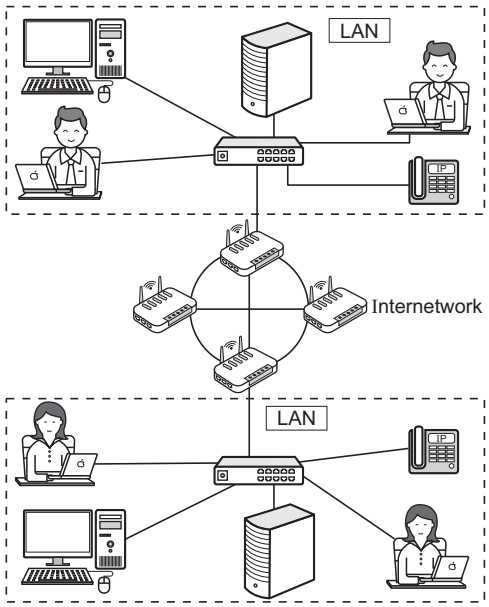

Fig. 4: Data originates with an end device, flows through the network the network and arrives at an end device

The network devices that people are most familiar with are end devices. To distinguish one end device from another, each end device on a network has an address.

When an end device initiates communication, it uses the address of the destination end device to specify where to deliver the message. An end device is either the source or destination of a message transmitted over the network.

1.3.4 Intermediary Devices

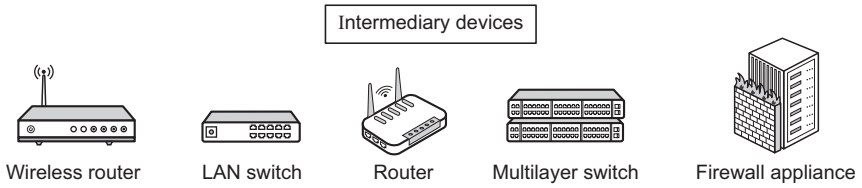

Fig. 5

Intermediary devices connect the individual end devices to the network. They can connect multiple individual networks to form an internetwork. These intermediary devices provide connectivity and ensure that data flows across the network. Intermediary devices use the destination end device address, in conjunction with information about the network interconnections, to determine the path that messages should take through the network. Examples of the more common intermediary devices and a list of functions are shown in the Fig. 5.

Intermediary network devices perform some or all of these functions:

1. Regenerate and retransmit communication signals
2. Maintain information about what pathways exist through the network and internetwork
3. Notify other devices of errors and communication failures
4. Direct data along alternate pathways when there is a link failure
5. Classify and direct messages according to priorities
6. Permit or deny the flow of data, based on security settings

Note: Not shown is a legacy Ethernet hub. An Ethernet hub is also known as a multiport repeater. Repeaters regenerate and retransmit communication signals. Notice that all intermediary devices perform the function of a repeater.

1.3.5 Network Media

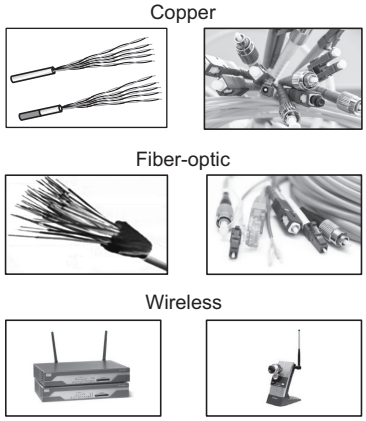

Fig. 6

Communication transmits across a network on media. The media provides the channel over which the message travels from source to destination. Modern networks primarily use three types of media to interconnect devices, as shown in the Fig. 6.

(i) Metal Wires within Cables: Data is encoded into electrical impulses.

(ii) Glass or Plastic Fibers within Cables (Fiber-Optic Cable): Data is encoded into pulses of light.

(iii) Wireless Transmission: Data is encoded via modulation of specific frequencies of electromagnetic waves.

Criteria to consider when choosing network media:

1. What is the maximum distance that the media can successfully carry a signal?
2. What is the environment in which the media will be installed?
3. What is the amount of data and at what speed must it be transmitted?
4. What is the cost of the media and installation?

Different types of network media have different features and benefits. Not all network media have the same characteristics, nor are they all appropriate for the same purpose.

IMPORTANT POINTS

1. ***Types of Media:*** *Data travels over metal wires (electrical signals), fiber-optic cables (light pulses) or wireless (electromagnetic waves).*
2. ***Media Selection Criteria:*** *Consider distance, environment, speed, and cost when choosing network media.*
3. ***Media Characteristics:*** *Different media offer unique features and benefits, suitable for specific networking needs.*

1.4 NETWORK REPRESENTATIONS AND TOPOLOGIES

1.4.1 Network Representations

Network architects and administrators must be able to show what their networks will look like. They need to be able to easily see which components connect to other components, where they will be located and how they will be connected. Diagrams of networks often use symbols, like those shown in the Fig. 7, to represent the different devices and connections that make up a network.

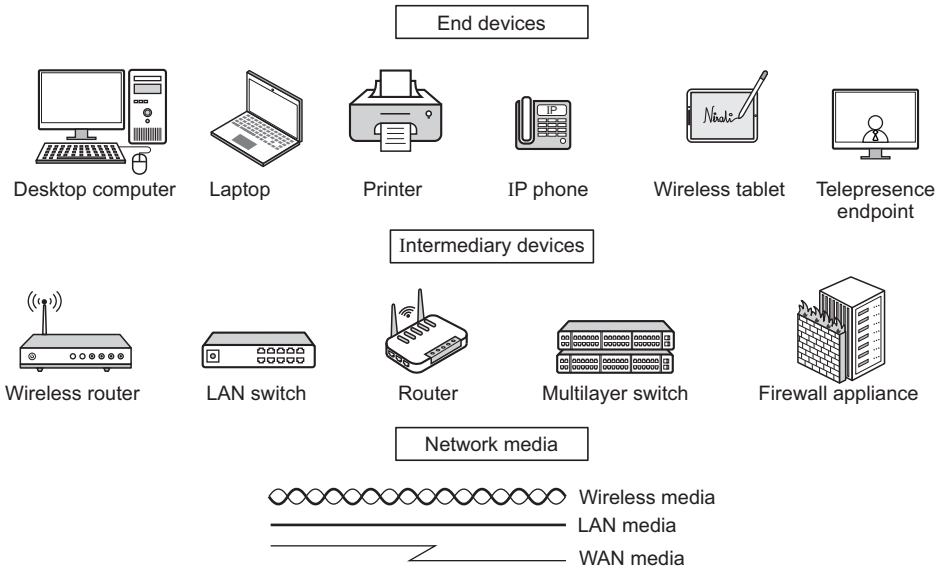

Fig. 7

A diagram provides an easy way to understand how devices connect in a large network. This type of "picture" of a network is known as a topology diagram. The ability to recognize the logical representations of the physical networking components is critical to being able to visualize the organization and operation of a network. In addition to these representations, specialized terminology is used to describe how each of these devices and media connect to each other.

1. **Network Interface Card (NIC):** A NIC physically connects the end device to the network.
2. **Physical Port:** A connector or outlet on a networking device where the media connects to an end device or another networking device.
3. **Interface:** Specialized ports on a networking device that connect to individual networks. Because routers connect networks, the ports on a router are referred to as network interfaces.

Note: Often, the terms port and interface are used interchangeably.

1.4.2 Topology Diagrams

Topology diagrams are mandatory documentation for anyone working with a network. They provide a visual map of how the network is connected. There are two types of topology diagrams, physical and logical.

(a) Physical Topology Diagrams

Physical topology diagrams illustrate the physical location of intermediary devices and cable installation, as shown in the Fig. 8. You can see that the rooms in which these devices are located are labeled in this physical topology.

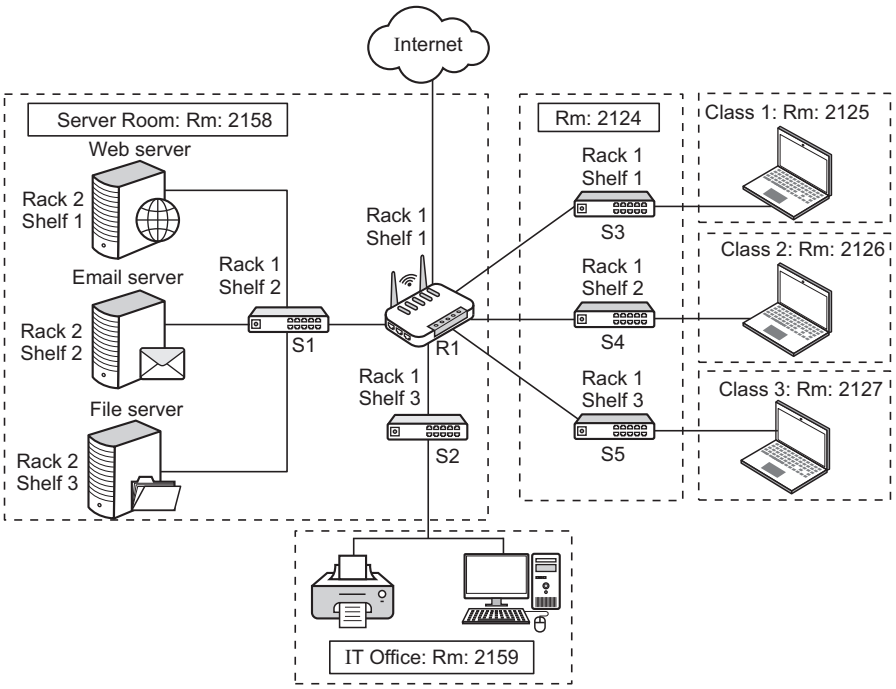

Fig. 8

(b) Logical Topology Diagrams

Logical topology Figure illustrate devices, ports and the addressing scheme of the network, as shown in the Fig. 9. You can see which end devices are connected to which intermediary devices and what media is being used. The topologies shown in the physical and logical diagrams are appropriate for your level of understanding at this point in the course. Search the internet for "network topology diagrams" to see some more complex examples. If you add the word "Cisco" to your search phrase, you will find many topologies using icons that are similar to what you have seen in these figures.

COMPUTER NETWORKS

- Key topics covered such as network topologies, the OSI and TCP/IP models, routing and switching, network security, wireless communication and cloud networking.
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