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Study Guide: Chapter 13 – TCP/IP Networking

Introduction to Networking

Computers are powerful on their own, but their true potential is unlocked when they are connected to a **network**. Networks allow us to:

- Send emails worldwide
- Stream videos
- Print to shared printers
- Communicate over the Internet

Topics Covered in This Chapter

- Basics of Networking Communication
- Device Addresses
- TCP/IP Networking
- Network Addressing
- Domain Name System (DNS)
- Address Resolution Protocol (ARP)

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1. Basics of Networking Communication

Network Types

- **Local Area Network (LAN):**
  - Connects computers and devices **within a single building or location** (e.g., home, office).
- **Wide Area Network (WAN):**
  - Connects multiple LANs over a **large geographic area** (e.g., connecting offices in different cities).
  - The Internet is the largest WAN.
- **Wireless Networks:**
  - **Wi-Fi** – Creates a **wireless LAN** for mobile devices like smartphones and laptops.
  - **Bluetooth (Personal Area Network – PAN):** Used for **short-range communication** (e.g., connecting headphones to a phone).
  - **Near Field Communication (NFC): Very short-range** (few inches), used for **contactless payments and security access**.

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2. TCP/IP Networking

What is TCP/IP?

TCP/IP is the protocol that **runs the Internet** and most local networks. It consists of:

- **Transmission Control Protocol (TCP)**
- **Internet Protocol (IP)**

Internet Protocol (IP)

- **Manages the routing of information** over a network.
- Each computer is assigned a **unique IP address** to identify it on the network.
- Data is broken into **packets** to improve reliability and efficiency.

Why Use Packets?

- Large files are divided into **small packets** (a few KB each).
- If a packet fails to send, **only that packet needs to be retransmitted**, not the entire file.
- Prevents **network congestion** (similar to how small cars move more efficiently in traffic than a single long train).

Transmission Control Protocol (TCP)

- Ensures **packets arrive correctly** at their destination.
- If a packet is lost or damaged, TCP **requests retransmission**.

Internet Control Message Protocol (ICMP)

- Helps systems communicate about network status.
- Used for:
    - **Checking if a system is online** (e.g., using the "ping" command).
    - **Detecting network issues**.

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3. Network Addressing

IP Addresses

- Unique identifiers for devices on a network.
- Written in **IPv4** (most common) or **IPv6** format.

IPv4 Addresses

- Written in **dotted quad notation** (e.g., **10.15.100.240**).
- **Each number (octet) ranges from 0-255**.
- **IPv4 addresses are 32-bit** (4 bytes).

Example Breakdown of IPv4 Address: 192.168.1.10

- **192** → First octet
- **168** → Second octet
- **1** → Third octet
- **10** → Fourth octet

IPv6 Addresses

- Uses **128-bit addresses** (8 groups of 4 hexadecimal digits).
- Designed to replace IPv4 due to **limited address space**.

IP Address Assignment

1. **Static IP Address:**
   - Manually assigned to a device.
   - Used for **servers and network equipment**.
2. **Dynamic IP Address (DHCP):**
   - Automatically assigned by a **Dynamic Host Configuration Protocol (DHCP)** server.
   - Used for **most end-user devices** (phones, laptops).
3. **Automatic Private IP Addressing (APIPA):**
   - Assigned when a device **fails to get an IP from a DHCP server**.
   - APIPA addresses **start with 169.254** (indicates a network issue).

Source and Destination IP Addresses

- **Source IP Address:** The sender's address.
- **Destination IP Address:** The recipient's address.
- When a response is sent, the **addresses swap roles**.

Rules for Valid IPv4 Addresses

- **No number in an IPv4 address should be higher than 255.**

- **An IPv4 address should never start with 127** (reserved for loopback).
- **The first number should be 223 or lower** (higher numbers are reserved).

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4. MAC Addresses

- **Media Access Control (MAC) address** is a **permanent** identifier assigned to a device's **network interface**.
- Used to **communicate on the local network**.
- Written in **hexadecimal format** (e.g., **14:9D:99:7F:3A:67**).
  - First 6 digits: **Manufacturer ID**
  - Last 6 digits: **Device's unique ID**

Differences Between IP and MAC Addresses

IP Address	MAC Address
Changes when moving between networks	Stays the same permanently
Assigned by a **network** (DHCP or manual)	Assigned by **device manufacturer**
Used for communication across the Internet	Used for communication within a **local network**

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5. Address Lookup Services

Domain Name System (DNS)

- Converts **website names into IP addresses**.
- Example:
  - You type **www.example.com**
  - DNS translates it to **192.168.1.100**
- **DNS Hierarchy:**
  - DNS servers store domain information.
  - If a local DNS server doesn't know an address, it asks other DNS servers.

Address Resolution Protocol (ARP)

- Translates **IP addresses into MAC addresses** for local network communication.

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6. Exam Tips & Essentials

Key Points to Remember:

✅ **Network Types:**

- **LAN (Local Area Network):** Small area (home, office).
- **WAN (Wide Area Network):** Large area (connects LANs, includes the Internet).
- **PAN (Personal Area Network – Bluetooth):** Short range (~30 feet).
- **NFC (Near Field Communication):** Very short range (inches).

✅ **TCP/IP Model:**

- **TCP ensures reliable communication** (checks for lost packets).
- **IP handles addressing and routing.**

✅ **IP Addressing:**

- **IPv4 uses four numbers (0-255).**
- **IPv6 uses hexadecimal and is longer (8 groups of 4 digits).**
- **Static IPs are manually assigned; DHCP assigns dynamic IPs.**
- **APIPA (169.254.x.x) means a network issue.**

✅ **MAC Addressing:**

- **Unique to each device** (doesn't change).
- **Used for local network communication.**

✅ **DNS & ARP:**

- **DNS translates website names to IP addresses.**
- **ARP translates IP addresses to MAC addresses.**

✅ **Valid IPv4 Address Rules:**

1. **No number should be greater than 255.**
2. **First octet should not be 127.**
3. **First octet should not be higher than 223.**

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This chapter covers essential networking concepts, including how data flows through the Internet using TCP/IP, how devices communicate using IP and MAC addresses, and how services like **DNS and ARP** help manage network communication.

By understanding **how networking works**, IT professionals can troubleshoot network issues, set up networks efficiently, and ensure smooth communication between systems. 🚀

📌 **Exam Tip:** Practice identifying **valid vs. invalid IP addresses** and remember the roles of **TCP, IP, MAC, DNS, and ARP**!

There are two IP addresses involved in every network communication.

- The source address indicates the system sending the information.
- The destination address indicates that the system is receiving information.

As two systems communicate back and forth, the source and destination addresses will swap places depending on who sends each packet. For example, examine a communication between a user with IP address 10.12.0.1 and a web server with address 10.51.1.2.

When the user sends data to the web server, the source IP address is the user's IP address and the destination server is the web service's IP address as shown below. When the red server replies and sends data back to the user, the direction switches and the web server's IP address is the source address and the user's IP address becomes the destination address, also shown in the same figure.

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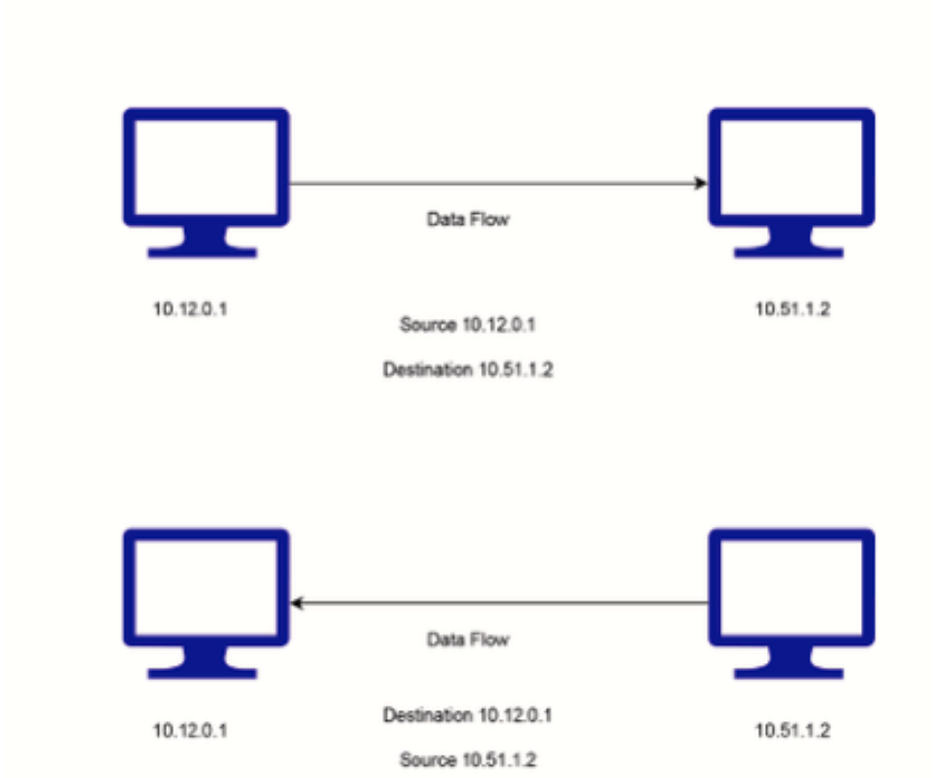

Play Each of these challenges as much as you can!

1. TCP/IP Networking Matching Game *(Match-Up Activity)*
   https://wordwall.net/play/88670/849/480
2. True or False Chap 13: TCP/IP
   https://wordwall.net/play/88671/482/439
3. TCP/IP Process Flow
   https://wordwall.net/play/88671/771/349
4. Who Am I?
   https://wordwall.net/play/88671/978/816
5. Maze
   https://wordwall.net/play/88672/247/340
6. Find the Match
   https://wordwall.net/play/88672/499/841
7. Quiz Show
   https://wordwall.net/play/88673/009/258

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