

CHAPTER 2: COMMUNICATION AND NETWORKING

2.1 NETWORKS INCLUDING THE INTERNET

2.1.1 Introduction to Networks

Definition: Networking devices are interconnected devices that enable fast data transmission within a network.

Benefits of Networking:

1. **File Sharing:** Easily share data between different interconnected devices
2. **Resource Sharing:** Use network-connected output devices like printers or share software
3. **Higher Storage:** Files can be stored in network-connected storage mediums
4. **Communication:** Email and messaging between users
5. **Centralized Management:** Easier to backup and secure data

2.1.2 Types of Networks

LAN (Local Area Network):

Characteristic	Description
Geographic Area	Small area, often within the same building
Ownership	Private ownership
Transmission Medium	Twisted pair cables, coaxial cables, or Wi-Fi
Data Transfer Rate	Higher (100 Mbps to 10 Gbps)

Characteristic	Description
Congestion	Less congestion
Setup Cost	Lower initial cost

WAN (Wide Area Network):

Characteristic	Description
Geographic Area	Large area - city, country, or globally
Ownership	Private or public ownership
Transmission Medium	PSTN, satellite links, leased lines
Data Transfer Rate	Lower
Congestion	Higher congestion
Setup Cost	Higher initial cost

2.1.3 Network Models

Client-Server Model:

- A dedicated server provides applications (administration of users, security, and resources)
- Clients access resources from the server
- Server manages all central functions

Server Types:

- Print Server: Manages print jobs from client computers
- File Sharing Server: Clients access software and user data files stored on the server
- Proxy Server: Acts as intermediary for internet requests
- Email Server: For sending, receiving, and storing emails
- Database Server: Manages DBMS
- Domain Controller Server: Manages user accounts (IDs & passwords)

Client-Server Login Process:

1. Client sends login request to server

2. Server processes request
3. Server grants access if user ID & password are recognized

Thin Clients vs Thick Clients:

Thin Clients	Thick Clients
Runs solely on server resources	Processes most application locally
No local storage	Has local storage and processing power
Smaller purchase cost	More expensive
Requires constant server connection	Can work offline
Improved security	More vulnerable to unauthorized software

Peer-to-Peer (P2P) Network:

- Decentralized network
- Each computer operates independently as a 'peer'
- Acts as both client and server
- No central server required
- Common in file sharing applications (BitTorrent)

Comparison:

Feature	Client-Server	Peer-to-Peer
Centralized backup	Yes	No
Initial setup cost	Higher	Lower
Network traffic	Higher (goes through server)	Lower (direct)
Security	Better (centralized control)	Weaker
Reliability	Server failure affects all	Peer failure affects one

2.1.4 Network Topologies

Bus Topology:

- Single line (bus) connects all devices
- Terminators at each end
- All computers can read data being sent between any two computers
- **Disadvantage:** Unsuitable for heavy traffic due to frequent collisions
- Uses CSMA/CD for collision detection

Star Topology:

- Central server/switch with all computers connected via dedicated connections
- Server can send packets to different devices simultaneously
- No collisions possible
- Most common in modern networks

Mesh Topology:

- Every device (node) is directly interconnected with all other devices
- Commonly used for wireless networks
- High redundancy (if one path fails, another can be used)

Hybrid Topology:

- Combination of two or more topologies
- Example: Connection between two or more LANs of different topologies

2.1.5 Transmission Media

Wired Networks:

Copper Cable:

Advantages	Disadvantages
Less expensive	Doesn't perform well with small charges
Easier to install	Affected by electromagnetic interference
Flexible	Signal degradation over distance
Easy to make terminations	

Fibre-Optic Cable:

Advantages	Disadvantages
Greater bandwidth	Needs expensive optical transmitters/receivers
Improved security	More difficult to install
Lightweight	
Less signal boosting required	
Used in long-distance communications	
Immune to electromagnetic interference	

Wireless Networks:

Type	Advantages	Disadvantages
Radio Waves	Can travel over large distances; inexpensive	Low frequency = less data; affected by interference
Microwaves	Larger bandwidth	Physical obstacles interfere; expensive towers
Satellites	Cost-effective for long-distance	Expensive setup; susceptible to interference

2.1.6 Ethernet

Definition: The most common wired medium for data transmission in LANs or WANs.

CSMA/CD (Carrier Sense Multiple Access with Collision Detection):

Process:

1. Device checks if channel is busy before transmitting
2. If busy, device waits a random time before retrying
3. During transmission, device listens for other transmissions
4. If collision occurs, transmission is aborted
5. Both devices wait random times before retrying

2.1.7 Bit Streaming

Definition: Sequence of digital signals (bits) transferred over a communication path at high speeds.

Types:

Real-time Streaming:

- Live events captured and transmitted directly
- Cannot be paused, fast-forwarded, etc.
- Example: Live TV, video conferencing

On-demand Streaming:

- Pre-existing files are converted and streamed as requested
- Can be paused, fast-forwarded, etc.
- Example: YouTube, Netflix

Importance of High Broadband Speed:

- User has to download and display bits simultaneously
- Higher quality media requires faster speeds
- Real-time streaming needs higher speeds for simultaneous data requests

2.1.8 Cloud Computing

Definition: On-demand provision of computing services over the internet.

Services:

- **Infrastructure:** Storage capacity and higher processing power
- **Platform:** Software, testing & debugging resources

Public Cloud vs Private Cloud:

Feature	Public Cloud	Private Cloud
Access	Third-party providers, shared among multiple users	Single organization, exclusive access
Management	Managed by service providers	Can be managed internally or outsourced

Benefits:

- Less technical knowledge required
- Easy to implement
- Flexibility to scale with growth

Drawbacks:

- Cannot access resources if bandwidth issues
- Poor data privacy (potential data leakage in multi-tenant architecture)

2.1.9 Internet and World Wide Web**Internet:**

- Massive, open network of networks
- Uses TCP/IP protocol
- IP addresses identify devices

World Wide Web (WWW):

- Collection of web pages stored on websites
- Uses protocols (HTTP/HTTPS) to transmit data

2.1.10 Network Hardware

Device	Function
Router	Connects two networks; translates IP addresses; acts as gateway and firewall
Switch	Connects devices in LAN; broadcasts to all devices simultaneously
Server	Provides specific functions for computers in the network
NIC (Network Interface Card)	Provides unique MAC address for wired connection
WNIC (Wireless NIC)	Provides unique address for WiFi connection
WAP (Wireless Access Point)	Allows devices to connect via WiFi
Bridge	Connects two LANs using same protocol

Device	Function
Repeater	Regenerates signal to prevent attenuation
Modem	Converts digital to analogue signals for telephone lines

2.1.11 IP Addressing

IPv4:

- 32-bit address
- 4 blocks separated by dots (e.g., 192.168.1.1)
- Each block: 0-255

IPv6:

- 128-bit address
- 8 blocks separated by colons
- Each block: 4 hex values (0000-FFFF)
- Can be shortened by removing consecutive zero blocks

IP Address Structure:

- **Network Identifier (NetID):** Identifies the network
- **Host Identifier (HostID):** Identifies the device within the network

Subnetting:

- Practice of dividing a network into two or more sub-networks
- IP address broken into: NetID + SubnetID + HostID

Public vs Private IP:

- Public IP: Provided by ISP; unique; accessible from internet
- Private IP: Issued by LAN's router; only accessible within LAN
- NAT (Network Address Translation) required for private IPs to access internet

Static vs Dynamic:

- Static: Never changes; used for servers, VPNs
- Dynamic: Changes regularly; more secure; used for general users

2.1.12 DNS (Domain Name Service)

Definition: A naming system that maps domain names to IP addresses.

Function:

- Hierarchy of DNS servers
- Database of URLs and corresponding IP addresses
- Translates human-readable domain names to IP addresses

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