

Computer Networks Notes

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1. Network Overview

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What is a Network?

A **network** is a group of interconnected devices that can communicate and share resources. Think of it as a system where computers and other devices exchange information, collaborate, and access shared resources like printers or storage.

Computers use common **communication protocols** over **digital interconnections** to communicate with each other. These interconnections are built using **telecommunications network technologies**, which may be based on physical wiring, optical fiber, or wireless radio-frequency methods. These can be arranged in a variety of **network topologies**.

Network Packet

Most modern computer networks use protocols based on **packet-mode transmission**. A **network packet** is a formatted unit of data carried by a packet-switched network.

A packet consists of two types of data:

- **Control information**
- **User data** (also called the **payload**)

The control information provides the network with the necessary data to deliver the user payload correctly. This includes things like:

- Source and destination network addresses
- Error detection codes
- Sequencing information

Typically, the control information is found in the **packet header**, while the payload is carried in the body of the packet.

Types of Networks

Key examples include:

- **Local Area Networks (LANs)**
- **Wide Area Networks (WANs)**
- **Personal Area Networks (PANs)**
- **Metropolitan Area Networks (MANs)**
- **Campus Area Networks (CANs)**
- **Virtual Private Networks (VPNs)**

LAN

A LAN connects computers and devices within a **limited area**, such as a home, office, or building.

MAN

A MAN covers a **larger area than a LAN**, such as a city or a large campus.

WAN

A WAN spans a **very large geographical area**, such as multiple cities or continents.

PAN

A PAN is the **smallest and simplest type of network**, used to connect personal devices over a short range.

Network Topology

Network topology refers to the arrangement of different elements such as nodes, links, or devices in a computer network.

What is Network Topology?

There are two major categories:

- **Physical Topology**
- **Logical Topology**

Types of Topologies

- **Point-to-Point**
- **Mesh Topology**
- **Bus Topology**
- **Star Topology**
- **Ring Topology**
- **Tree Topology**
- **Hybrid Topology**

Client-Server vs Peer-to-Peer Models

Client-server model: A computing model where a server hosts, manages, and delivers resources and services to one or more clients.

Peer-to-peer model: A decentralized network where participants (peers) interact directly with each other, sharing resources.

Feature	Client-Server Model	Peer-to-Peer Model
Architecture	Centralized	Decentralized
Resource Management	Managed by the server	Shared by all peers
Scalability	Highly scalable	Limited by peers
Examples	Web services, email systems, databases	BitTorrent, blockchain
Dependency	Relies on central server	No central dependency
Maintenance	Easier to manage	Harder to manage

2. Layered Networking Architecture

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1. Concept of layering

KLayering in networking is the practice of breaking down complex communication systems into a series of **smaller, manageable, and well-defined layers**.

Key Characteristics:

- each layer is responsible for a **specific Aspect**
- layers **only communicate** with the layer above or below (encapsulation)
- Changes in one layer can be made **independently** (modularity)

Why networking is divided into layers?

1. **Modularity**
2. **Interoperability**
3. **Simplified Troubleshooting**
4. **Flexibility and Upgradability**
5. **Standardization**

Real-World Analogy

Think of sending a package:

- You write the letter (Application Layer)
- Put it in an envelope (Presentation Layer)
- Add sender/receiver info (Session Layer)
- Hand it to a delivery service (Transport Layer)
- The package is routed (Network Layer)
- Carried via trucks or planes (Data Link/Physical Layers)

What is an OSI/TCP-IP model?

OSI is a more general theoretical model with seven layers. TCP/IP is practical, used on the internet, with four layers.

OSI model

- 7. Application layer
- 6. Presentation layer
- 5. Session layer
- 4. Transport layer
- 3. Network layer
- 2. Data link layer
- 1. Physical layer

TCP-IP model

- 4. Application layer
- 3. Transport layer
- 2. Internet layer
- 1. Data link / Physical layer

3. Network Hardware and Transmission

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Network Interface Cards (NICs)

A Network Interface Card (NIC) is a hardware component that connects a computer to a network, either through cables (wired) or wirelessly (Wi-Fi). Inside the NIC, there is a specialized integrated circuit called the network interface controller.

Hubs, switches, routers, access points

What is a hub? Broadcasts data to all connected devices.

What is a switch? Sends data only to the intended recipient.

What is a router? Connects different networks and often provides Wi-Fi access.

The Access Point

The access point is a device that interconnects wireless communication devices, forming a wireless network. It allows client machines to connect without cables and without bandwidth limitation.

Transmission Media (wired/wireless)

A transmission media is the physical medium through which data is transmitted.

Guided media:

- Twisted pair cable
- Coaxial cable
- Optical fiber cable
- Stripline

Unguided media:

- Radio waves
- Microwaves
- Infrared

Signal encoding and modulation

Encoding transforms data into a suitable format for transmission, while modulation adapts a carrier signal to carry the encoded data.