CHAPTER 5: NETWORKING and SECURITY OVERVIEW

Network

A network is a group of connected devices (nodes) that share data, resources, and services using communication protocols to transmit information reliably.

- **Node – any** device connected to a network (e.g., computer, printer, router).
- **Bandwidth (Data Transfer Rate) –** maximum speed of data transfer between nodes.
- **Throughput –** actual speed of data transfer in practice.

Networking Architecture

- **Client-Server Network** – a central server provides resources or services to many clients.
- **Peer-to-Peer (P2P) Network –** each device acts as both client and server; resources are shared equally among all devices.

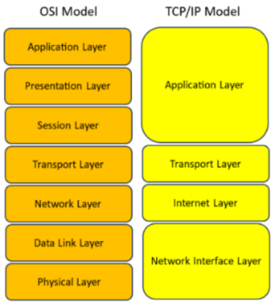
Network Models

Open Systems Interconnection (OSI) Model – divides networking into seven layers (ISO, 1994; Forouzan, 2017). Each layer handles a specific part of communication:

1. **Physical Layer – sends raw bits over cables.**
2. **Data Link Layer –** handles frames, MAC address, and error control.
3. **Network Layer –** routes data using IP addresses.
4. **Transport Layer –** ensures reliable delivery and error recovery.
5. **Session Layer –** manages connections between apps.
6. **Presentation Layer –** formats data and handles encryption.
7. **Application Layer –** provides services directly to the user.

Transmission Control Protocol/Internet Protocol (TCP/IP) Model: also called the **Internet protocol suite**, is a practical framework used for communication over the Internet.

1. **Network Interface Layer** – physical data transmission.
2. **Internet Layer** – routing with IP addresses.
3. **Transport Layer** – reliable (TCP) or fast (UDP) data delivery.
4. **Application Layer** – services and apps for users.



Key Networking Devices and Protocols

Networks need **media, hardware, and software** for communication.

Types of Transmission Media

Types of Transmission Media

- **Guided (Wired)** – cables.
- **Unguided (Wireless)** – air/radio signals.

Twisted Pair Cable – common in LAN;

- **UTP** – unshielded, cheaper.
- **STP** – shielded, better interference protection.

Coaxial Cable – higher interference resistance.

Fiber-Optic Cable – transmits data as light, very fast and long-distance.

Radio Waves – wireless data transmission.

Network Hardware

NIC (Network Interface Card) – connects a device to a network.

Modem – converts digital to analog signals and vice versa.

Switch – connects devices in a LAN.

Router – directs data between networks.

Access Point (AP) – provides Wi-Fi connectivity.

Firewall – protects networks by filtering traffic.

Network Software

Network Operating System (NOS) – manages network resources and services.

Protocols – rules for data transmission and formatting.

Drivers/Utilities – allow hardware (like NICs) to work with the OS.

Security Fundamentals

Confidentiality – only authorized users can access data.

Integrity – data remains accurate and unaltered.

Availability – systems and data must always be accessible.

Common Security Threats

- **Malware –** harmful software (virus, worm, ransomware).
- **Phishing –** fake emails/websites stealing info.
- **DoS/DDoS –** floods a network to make it unavailable.
- **Man-in-the-Middle (MitM) –** intercepts or alters communication.
- **Insider Threats –** misuse of access by internal users.

Shared Responsibility Model in Cloud Security

Cloud Service Provider (CSP) – secures infrastructure (data centers, hardware, virtualization).

Customer – secures their own data, apps, and access within the cloud.

CHAPTER 6: DATABASES

A **database** is a structured collection of data that can be stored, managed, and retrieved electronically.

Database Management System (DBMS) - A DBMS is software that allows users to create, maintain, and interact with databases.

Functions of a DBMS

- **Data Storage and Retrieval** – efficiently stores and retrieves data.
- **Data Security** – controls access and protects sensitive information.
- **Data Integrity and Consistency** – ensures accurate and reliable data.
- **Backup and Recovery** – keeps data available in case of system failure.
- **Concurrency Control** – manages simultaneous user access without conflict.

Database Architecture

Understanding DBMS architecture is vital for designing and managing databases. It includes:

- **Query Processor –** interprets and executes queries.
- **Storage Manager –** manages data storage and retrieval.
- **Disk Storage –** physical data storage.

Types of DBMS Architecture

1. **Centralized Architecture –** all data stored in one location; simple but less scalable.
2. **Distributed Architecture –** data spread across multiple sites; improves reliability but adds complexity.
3. **Cloud-Based Architecture –** hosted via cloud services (e.g., Amazon RDS, Google Cloud SQL); offers scalability and flexibility.

RELATIONAL DATABASES (SQL) Overview

Relational databases organize data into tables consisting of rows and columns.

They use **Structured Query Language (SQL)** to manage and query data.

Example

An online store may have tables for:

- Customers
- Orders
- Products

Managed by an RDBMS such as MySQL, PostgreSQL, or Oracle Database.

Strengths

- Strong data integrity and ACID compliance.
- Structured and easy to manage relationships.
- Supports complex queries and transactions.

Weaknesses

- Not ideal for unstructured data.
- Hard to scale horizontally.

- Schema changes can be complex.

NOSQL DATABASES

Overview

NoSQL databases are designed for large-scale, unstructured, or semi-structured data.
They use flexible data models such as:

- Key-Value pairs
- Documents
- Graphs
- Wide-columns

Example
Social media platforms use:

- MongoDB (Document Store)
- Redis (Key-Value Store)

Strengths

- Highly scalable and flexible schema.
- Ideal for cloud-native applications.
- Supports real-time data processing.

Weaknesses

- May lack full ACID compliance.
- Not suitable for complex multi-table transactions.

CLOUD DATABASE SERVICES

Overview

Cloud databases provide fully managed services that remove the need for manual maintenance such as hardware setup, backups, and updates.

Benefits

- Reduced administrative work
- Automated backups and recovery
- Elastic scalability
- Global accessibility and high availability

Type	Description	Examples
Relational Cloud Databases	Managed RDBMS with SQL and ACID support	Amazon RDS, Google Cloud SQL, Azure SQL
NoSQL Cloud Databases	Optimized for unstructured data	MongoDB Atlas, Amazon DynamoDB, Google Firestore

DATABASE SCALING

1. Horizontal Scaling (Scaling Out)

- Adds multiple database nodes or instances to share the load.
- Common in NoSQL databases.
- Example: MongoDB Atlas for large social media data.

2. Vertical Scaling (Scaling Up)

- Increases resources (CPU, RAM, storage) of one database instance.
- Common in relational databases.
- Example: Amazon RDS for e-commerce transactions.