

Lecture-7

Introduction to Computer Networks

What Is a Computer Network?

A **computer network** is a set of interconnected **autonomous devices** that can communicate with each other and share resources.

Basic Components of a Computer Network

1. Nodes

Devices capable of sending or receiving data (e.g., computers, servers, routers).

2. Communication Links

Carry information between nodes.

- Can be **wired** (Ethernet, fiber)
- Or **wireless** (Wi-Fi, Bluetooth)

3. Protocols

A set of rules that govern communication between devices.

Computer Network (CN) vs Distributed System (DS)

Aspect	Computer Network (CN)	Distributed System (DS)
Purpose	Enables communication	Enables unified operation
Nature	Hardware-focused	Software-focused
Example	LAN, Wi-Fi network	Netflix, Cloud Computing

Data Representation and Transmission

Binary Representation

- All data transmitted over the Internet (text, audio, video) is represented as **binary (1s and 0s)**.
- Example:

- ASCII character 'H' = **01001000**
- 8 bits = 1 byte

Data Packets

- Data is transmitted in small blocks called **packets**.
- Similar to sending letters in envelopes.

Packet Structure

1. Header

- Destination address
- Sequence number
- Error checking
- Packet length


2. Payload (Data)

- The actual information being sent

Sequencing

- Large data is split into **multiple packets**.
- Each packet is given a **sequence number**.
- Packets may arrive **out of order**, so sequencing helps in **reassembly**.

Circuit Switching vs Packet Switching

Method	Description	Analogy	Result
Circuit Switching	Dedicated path reserved for entire transmission	Reserving a full lane on a highway	Blocks others while in use
Packet Switching	Data split into packets; shared network	Multiple cars sharing lanes	Efficient, shared access
 The Internet uses packet switching			

Network Classification

Classification by Transmission Type

1. Broadcast Networks

- All devices share a single communication channel
- Every machine receives messages, but only the intended one processes it

2. Point-to-Point Networks

- Direct links between devices
- Data may pass through intermediate nodes (**hops**)
- Used by larger networks

Classification by Scale

Network Type	Area Covered	Characteristics / Examples
PAN (Personal Area Network)	Around a single person	Bluetooth, NFC, RFID
LAN (Local Area Network)	Home, office	High speed, low latency (Ethernet, Wi-Fi)
MAN (Metropolitan Area Network)	City or campus	Medium speed (e.g., JANET – UK)
WAN (Wide Area Network)	Countries, continents	Lower speed; leased lines
Internetwork	Multiple networks connected	Internet (largest example)

Layered Protocols and Reference Models

Protocols vs Services

- **Protocol**

Rules for communication between **same layers on different devices**.

- **Service**

Functions a layer provides to the **layer above it**.

Layering reduces complexity by dividing communication into manageable levels.

Reference Models

OSI Reference Model (7 Layers)

Layer	Function
7. Application	User-level protocols (FTP, email)
6. Presentation	Data formatting, encryption, translation
5. Session	Session management between machines
4. Transport	Reliable data transfer, segmentation
3. Network	Routing packets across networks
2. Data Link	Framing, error detection/correction
1. Physical	Transmission of raw bits

TCP/IP Reference Model (4 Layers)

TCP/IP Layer	Corresponding OSI Layers	Function
Application	OSI 7–5	Web, email (HTTP, SMTP)
Transport	OSI 4	TCP (reliable), UDP (unreliable)
Internet	OSI 3	IP addressing and routing
Host-to-Network (Link)	OSI 2–1	Physical transmission

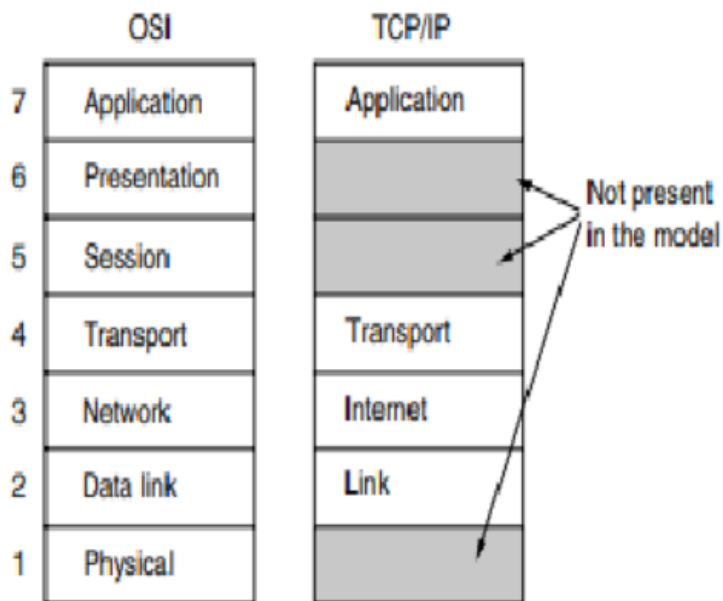


Figure 1-21. The TCP/IP reference model.

Encapsulation & De-encapsulation

Encapsulation (Sender Side)

- Data moves **downward** through layers.
- Each layer adds its own **header** (and sometimes trailer).

De-encapsulation (Receiver Side)

- Data moves **upward** through layers.
- Each layer **removes** the header added by the corresponding sender layer.

Data Units by Layer

Layer	Data Unit	Key Action
Application	Data	User data creation
Transport	Segment	Adds port numbers & sequence
Network	Packet	Adds IP addresses
Data Link	Frame	Adds MAC address & error check
Physical	Bits	Converts to electrical signals

