

UNIT 5

Data Communication and Computer Network

(10 Hours) — Operating Systems

5.1 Introduction to Communication System

Communication is the process of exchanging information between two or more entities. A data communication system carries data from a source to a destination through a medium, using a defined set of rules. Every communication system, whether it carries voice, text, or video, is built around the same five basic components: the source that generates the message, the transmitter that converts it into a transmittable signal, the channel through which the signal travels, the receiver that converts the signal back into a usable form, and the destination that consumes it.

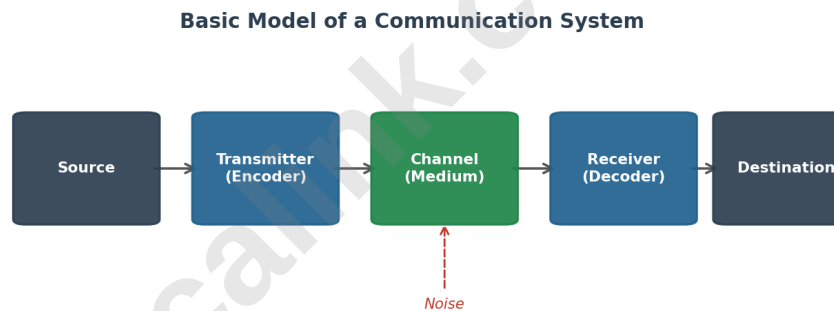


Figure 5.1 — Basic model of a communication system.

During transmission, the signal may be corrupted by noise — unwanted disturbances that distort the original message. Good system design aims to maximize the ratio of signal to noise so the destination can reliably recover the original information.

Example 5.1 — Everyday Communication System

In a phone call, your voice (source) is converted to an electrical/digital signal by the microphone (transmitter), sent over the mobile network (channel), converted back to sound by the receiver's speaker (receiver), and heard by the listener (destination).

5.2 Mode of Communication

The mode (or direction) of communication describes how data flows between two devices over a link.

Mode	Direction of Data Flow	Example
Simplex	One direction only; the sender cannot receive	Television broadcast, keyboard to CPU
Half-Duplex	Both directions, but only one at a time	Walkie-talkie, old modems
Full-Duplex	Both directions simultaneously	Telephone call, modern computer networks

Note: Full-duplex communication effectively doubles the usable bandwidth compared to half-duplex, since both ends can transmit at once.

5.3 Introduction to Computer Network

A computer network is a collection of interconnected computing devices that can exchange data and share resources with one another, using a common set of communication protocols over wired or wireless links.

Computer networks offer several important benefits:

- Resource Sharing — printers, files, and applications can be shared among many users.
- Communication — email, messaging, and video calls connect people instantly.
- Centralized Data Management — data can be stored and backed up in one place.
- Cost Efficiency — expensive hardware and software licenses can be shared rather than duplicated.
- Reliability — data can be replicated across machines to guard against loss.

5.4 Types of Computer Network

Networks are commonly classified by the geographic area they span.

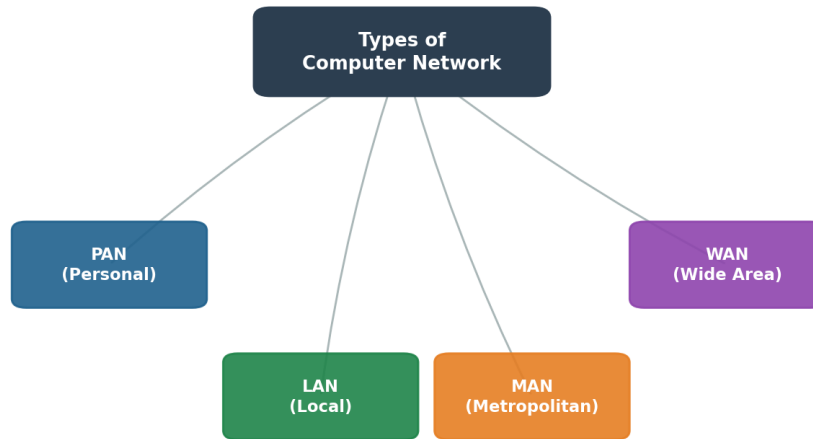


Figure 5.2 — Types of computer network by geographic scope.

Type	Typical Coverage	Example
PAN — Personal Area Network	A few metres, around one person	Bluetooth earphones, smartwatch link
LAN — Local Area Network	A single building or campus	Office network, school computer lab
MAN — Metropolitan Area Network	A city or large campus	Cable TV network, city-wide Wi-Fi
WAN — Wide Area Network	Country or global scale	The Internet, bank ATM network

5.5 LAN Topologies

A network topology is the arrangement of nodes and links that make up a network. It can refer to the physical layout of cables and devices or the logical path data takes.

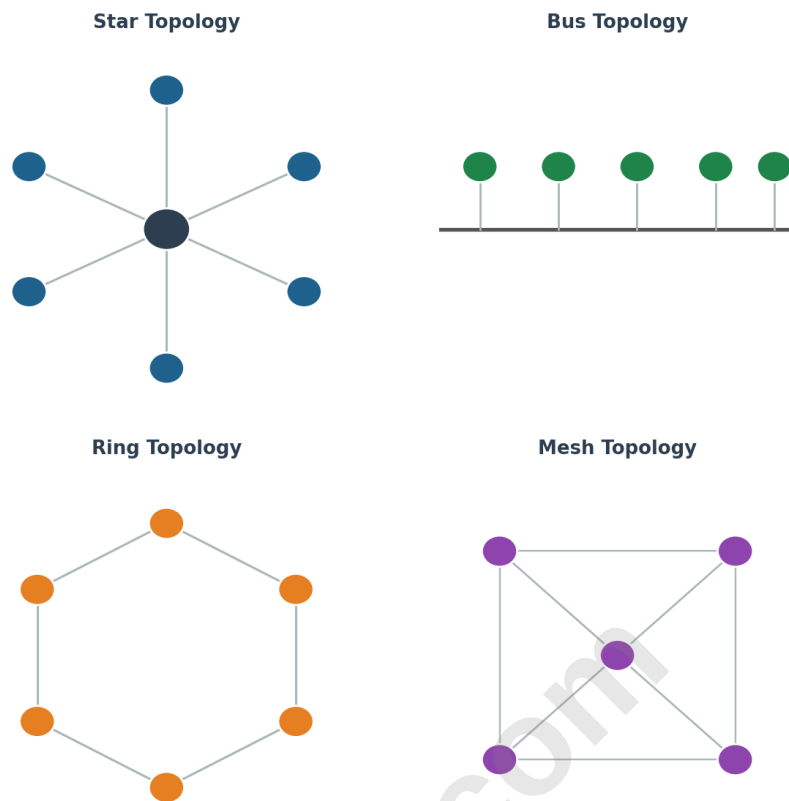


Figure 5.3 — Common LAN topologies: Star, Bus, Ring, and Mesh.

Topology	Description	Key Trade-off
Star	All nodes connect to a central device (hub/switch)	Easy to manage; central point is a single point of failure
Bus	All nodes share a single common cable (backbone)	Cheap to install; a cable break disables the whole segment
Ring	Each node connects to exactly two neighbours, forming a loop	Predictable performance; one broken link can disrupt the ring
Mesh	Nodes are interconnected, often with multiple paths between them	Highly reliable and fault-tolerant; expensive to cable and maintain

5.6 Transmission Media

Transmission media are the physical or wireless pathways that carry signals between devices. They are broadly divided into guided (wired) and unguided (wireless) media.

Category	Medium	Notes
Guided	Twisted Pair Cable	Low cost; used in telephone lines and Ethernet LANs

Category	Medium	Notes
Guided	Coaxial Cable	Better shielding than twisted pair; used in cable TV
Guided	Optical Fibre	Carries light signals; very high bandwidth, immune to electrical noise
Unguided	Radio Waves	Omnidirectional; used in Wi-Fi and mobile networks
Unguided	Microwave	Line-of-sight, point-to-point links between towers
Unguided	Infrared	Very short range, line-of-sight only; used in remote controls

5.7 Network Devices

Device	Function
Repeater	Regenerates a weak signal so it can travel further along the medium.
Hub	Broadcasts incoming data to every connected device; operates at the physical layer.
Switch	Forwards data only to the intended destination device using MAC addresses.
Bridge	Connects and filters traffic between two segments of the same network.
Router	Forwards data packets between different networks based on IP addresses.
Gateway	Connects networks using different protocols, translating between them.
Modem	Converts digital signals to analogue for transmission and back again.
Access Point	Allows wireless devices to connect to a wired network.

5.8 OSI Reference Model

The Open Systems Interconnection (OSI) model is a conceptual framework, developed by the ISO, that divides network communication into seven distinct layers. Each layer performs a specific function and provides services to the layer above it.

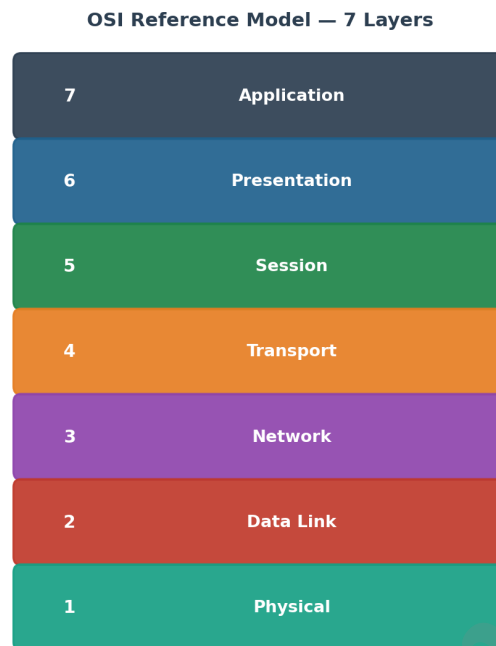


Figure 5.4 — The seven layers of the OSI reference model.

Layer	Name	Key Responsibility
7	Application	Provides network services directly to end-user applications (e.g., browsers, email)
6	Presentation	Handles data translation, encryption, and compression
5	Session	Establishes, manages, and terminates sessions between applications
4	Transport	Ensures reliable, ordered delivery of data (e.g., TCP) or fast delivery (UDP)
3	Network	Handles logical addressing and routing of packets (e.g., IP)
2	Data Link	Provides node-to-node delivery and error detection using MAC addresses
1	Physical	Transmits raw bits over the physical medium (cables, radio waves)

Note: A common mnemonic to remember the layers from top to bottom is: 'All People Seem To Need Data Processing' (Application, Presentation, Session, Transport, Network, Data Link, Physical).

5.9 Communication Protocols

A protocol is a formal set of rules that governs how data is formatted, transmitted, and received across a network, ensuring that devices from different manufacturers can communicate correctly.

Protocol	Purpose
TCP/IP	The foundational suite of protocols for reliable data delivery across the Internet.
HTTP/HTTPS	Governs the transfer of web pages between browsers and web servers.
FTP	Transfers files between a client and a server.
SMTP/POP3/IMAP	Send (SMTP) and retrieve (POP3, IMAP) electronic mail.
DNS	Translates human-readable domain names into IP addresses.
DHCP	Automatically assigns IP addresses to devices on a network.

Example 5.2 — Protocols at Work

When you type a web address into a browser, DNS resolves the domain name to an IP address, TCP/IP delivers the data reliably across the Internet, and HTTPS ensures the page content is transferred securely.

5.10 Centralized vs. Distributed System

Computing systems can also be classified by how processing and control are organized across machines.

Aspect	Centralized System	Distributed System
Processing	All processing happens on one central computer	Processing is spread across multiple independent computers
Control	Single point of control and administration	Control is shared among cooperating nodes
Reliability	A single failure can bring down the whole system	Failure of one node need not stop the whole system
Scalability	Limited by the capacity of the central machine	Can scale by adding more nodes
Cost	Often cheaper to set up initially	Higher setup and coordination cost
Example	Traditional mainframe systems	Cloud computing platforms, peer-to-peer networks

Key Takeaways — Unit 5

- ✓ Every communication system shares the same core components: source, transmitter, channel, receiver, and destination.
- ✓ Data can flow in simplex, half-duplex, or full-duplex mode.
- ✓ Networks are classified by scope (PAN, LAN, MAN, WAN) and by physical layout (Star, Bus, Ring, Mesh).
- ✓ Transmission media may be guided (twisted pair, coaxial, fibre) or unguided (radio, microwave, infrared).
- ✓ The OSI model's seven layers organize network functions from raw bit transmission up to application services.
- ✓ Protocols such as TCP/IP, HTTP, and DNS let heterogeneous devices communicate reliably.
- ✓ Centralized systems rely on one control point, while distributed systems spread processing and control across many nodes.

— *End of Unit 5* —