

Introduction to Data Networks

Introduction to Data Networks – Study Notes

1. What Is a Data Network?

Aspect	Description
Definition	A collection of interconnected devices (computers, servers, routers, switches, etc.) that exchange digital information using communication protocols.
Purpose	Enable sharing of resources (files, printers, applications), support communication (email, messaging, video), and provide access to services (cloud, Internet).
Key Characteristics	• Packet-oriented transmission • Logical addressing (IP) • Layered architecture (OSI/TCP/IP) • Scalable and fault-tolerant

2. Basic Components

Component	Role
End Devices	Sources or destinations of data (PCs, smartphones, IoT sensors).
Transmission Media	Physical path for bits – copper (twisted-pair, coax), fiber-optic, wireless (radio, microwave, satellite).
Network Interface Card (NIC)	Provides electrical/optical conversion and MAC addressing.
Switches	Forward frames within a LAN based on MAC addresses; create separate collision domains.
Routers	Connect multiple networks; forward packets using IP addresses; perform routing decisions.
Access Points (APs)	Bridge wired LANs to wireless clients (Wi-Fi).
Firewalls / Security Appliances	Inspect and filter traffic according to security policies.
Servers	Host applications, files, DNS, DHCP, authentication, etc.

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3. Network Topologies

Topology	Description	Typical Use
Bus	All nodes share a single communication line.	Legacy Ethernet (10BASE2/5).
Star	Devices connect to a central hub/switch.	Modern Ethernet LANs.
Ring	Nodes connected in a closed loop; token passing.	Token Ring, some Metro Ethernet.
Mesh	Redundant interconnections; each node may have multiple paths.	WAN backbones, data center fabrics.
Hybrid	Combination of two or more basic topologies.	Campus networks, large enterprises.

4. Layered Architecture

4.1 OSI Model (7 layers)

1. **Physical** – Bits on the medium (cabling, signaling).
2. **Data Link** – Frames, MAC addressing, error detection (Ethernet, Wi-Fi).
3. **Network** – Packets, routing, IP addressing.
4. **Transport** – End-to-end reliability (TCP) or best-effort (UDP).
5. **Session** – Dialog control, synchronization.
6. **Presentation** – Data translation, encryption, compression.
7. **Application** – User-level services (HTTP, SMTP, DNS).

4.2 TCP/IP Model (4 layers)

TCP/IP Layer	OSI Equivalent(s)	Core Functions
Link	Physical + Data Link	NIC, MAC, Ethernet, Wi-Fi.
Internet	Network	IP addressing, routing, ICMP.
Transport	Transport	TCP (reliable), UDP (unreliable).
Application	Session + Presentation + Application	HTTP, FTP, DNS, SSH, etc.

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5. Addressing & Naming

Concept Details

MAC Address