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8.1 — Network Basics

Definition: A computer network is a system of interconnected devices that can communicate and share resources.

Network Types by Size:

Type	Area	Example
PAN	Personal (~10m)	Bluetooth
LAN	Building/campus	Office Ethernet
MAN	City	City Wi-Fi
WAN	Country/globe	Internet

Network Models:

- **Client-Server** — centralized server serves multiple clients; more secure
- **P2P (Peer-to-Peer)** — each node is both client and server; decentralized

Topologies at a Glance:

Topology	Central Device	Single Point of Failure	Cost	Use
Bus	No	Yes (main cable)	Low	Legacy
Star	Yes (hub/switch)	Yes (hub)	Medium	Modern LAN
Ring	No	Yes (one node)	Medium	Older networks
Mesh	No	No (redundant)	High	Critical systems
Tree	Yes	Yes (root)	Medium	Hierarchical LAN
Hybrid	Varies	Varies	High	Complex enterprise

8.2 — Cables and Connectors

Three Cable Types:

Cable	Signal	Speed	Distance	Connector	EMI
Twisted Pair (UTP/STP)	Electrical	Up to 40 Gbps	100 m	RJ-45	Low/Med
Coaxial	Electrical	Moderate	Moderate	BNC/F-Type	Good

Cable	Signal	Speed	Distance	Connector	EMI
Fiber Optic	Light	100+ Gbps	Km	SC/LC/ST	Excellent

Key: RJ-45 = most common Ethernet connector; Cat6 = most common today for LAN

8.3 — Network Devices

Device	OSI Layer	Key Job	Addressing Used
Repeater	L1	Extend signal	None
Hub	L1	Broadcast to all	None
Bridge	L2	Filter between segments	MAC
Switch	L2	Send to specific device	MAC table
Router	L3	Route between networks	IP address
Gateway	Multi	Protocol conversion	Protocol-aware
Modem	L1/L2	Analog ↔ Digital	None

Hub vs Switch: Hub broadcasts to ALL ports; Switch sends to ONLY the target port.

Router vs Gateway: Router routes by IP; Gateway converts between different protocols.

8.3 (also) — OSI Model (7 Layers)

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7 — Application    → HTTP, FTP, SMTP, DNS
6 — Presentation   → SSL/TLS, JPEG, ASCII
5 — Session        → NetBIOS, RPC
4 — Transport      → TCP, UDP
3 — Network        → IP, ICMP (Routers)
2 — Data Link      → Ethernet, MAC (Switches)
1 — Physical       → Cables, Hubs, NICs
```

TCP/IP (4 layers):

- Application = OSI 7+6+5
- Transport = OSI 4
- Internet = OSI 3
- Network Interface = OSI 2+1

TCP vs UDP:

Feature	TCP	UDP
Connection	Connection-oriented	Connectionless

Feature	TCP	UDP
Reliability	Guaranteed delivery	No guarantee
Speed	Slower	Faster
Use	Web, email, file transfer	Streaming, gaming, DNS

8.4 — Cable Testing

Key Tools:

- **Cable Tester** — continuity and wire map
- **TDR (Time Domain Reflectometer)** — locates exact position of faults
- **Crimping Tool** — attaches RJ-45 connectors
- **Network Analyzer (Fluke)** — full bandwidth and performance testing

Wiring Standards: T568A or T568B (both ends same = straight-through; mixed = crossover)

8.5 — IP Addressing

IPv4 vs IPv6:

	IPv4	IPv6
Bits	32	128
Format	192.168.1.1	2001:db8::1
Addresses	~4.3 billion	~340 undecillion

IP Classes (IPv4):

Class	Range	Default Mask
A	1–126.x.x.x	255.0.0.0
B	128–191.x.x.x	255.255.0.0
C	192–223.x.x.x	255.255.255.0

Static vs Dynamic:

- Static = fixed, manually set → best for servers/printers
- Dynamic (DHCP) = auto-assigned, can change → best for client devices

DHCP Process (DORA): Discover → Offer → Request → Acknowledge

DNS: Translates `www.google.com` → IP address. Common DNS: `8.8.8.8` (Google), `1.1.1.1` (Cloudflare)

8.6 — Network Utilities

Utility	Purpose	Key Commands
IPCONFIG	View/manage IP config	`/all` `/release` `/renew` `/flushdns`
PING	Test host reachability	`ping google.com` → ICMP Echo
TRACERT	Trace route hop-by-hop	`tracert google.com` → TTL incrementing
NSLOOKUP	Query DNS records	`nslookup google.com` → A, MX, NS records

Troubleshooting order: `ping 127.0.0.1` → `ping own IP` → `ping gateway` → `ping 8.8.8.8` → `nslookup` → `tracert`

8.7 — Internet, Intranet, Extranet, WWW, Email

Term	Who Can Access	Purpose
Internet	Public (anyone)	Global network
Intranet	Internal employees only	Internal org resources
Extranet	Authorized external partners	B2B sharing
WWW	Public (via browser)	Web pages via HTTP/HTTPS

Email Protocols:

Protocol	Port	Job
SMTP	25/587	Send email
POP3	110	Download email (removes from server)
IMAP	143	Access email (stays on server — multi-device)

Common Internet Ports:
80 (HTTP) · 443 (HTTPS) · 22 (SSH) · 23 (Telnet) · 21 (FTP) · 53 (DNS) · 25 (SMTP)

8.8 — Internet Browsers

Browser	Developer	Engine
Chrome	Google	Blink
Firefox	Mozilla	Gecko
Edge	Microsoft	Blink (Chromium)
Safari	Apple	WebKit
Opera	Opera Software	Blink

Cache = stores local copies of web resources (speeds up loading)

Cookies = small data files stored by websites (sessions, preferences, tracking)

Incognito Mode = no local history, cookies, or cache saved

8.9 — Cloud Services

Service Models:

- **SaaS** — Software (Gmail, Dropbox, Office 365)
- **PaaS** — Platform (Google App Engine, Heroku)
- **IaaS** — Infrastructure (AWS EC2, Google Compute Engine)

Popular Cloud Storage:

Service	Free Storage	Best For
Dropbox	2 GB	File sync and sharing
Google Drive	15 GB	Google Workspace collaboration
iCloud	5 GB	Apple device ecosystem
OneDrive	5 GB	Windows/Microsoft 365

Security risks: Data breaches, account hijacking, privacy concerns → mitigate with 2FA, encryption, local backups.

Exam Frequency Table — Unit 8

Topic	MD Questions	Long Questions	Priority
Network types (LAN/MAN/WAN)	MD Q18, Q19	LQ 4B	⭐⭐⭐
Network devices	MD Q21	—	⭐⭐⭐
OSI Model	—	LQ 2B (10 marks)	⭐⭐⭐ HIGH
IP Addressing / Classes	MD Q33	—	⭐⭐⭐
Internet/Intranet/Extranet	MD Q26	LQ 1B	⭐⭐⭐
Networking topologies	MD Q24	—	⭐⭐
Protocol (TCP/UDP/SMTP etc.)	MD Q25	—	⭐⭐
Client-server vs P2P	—	LQ 10B	⭐⭐
Cloud computing	—	LQ 11B	⭐⭐
Network utilities	—	SQ	⭐
Cable testing	—	SQ	⭐