Computer Networks

Computer Networks enable communication between devices.

OSI MODEL (7 Layers):

1. Physical Layer
   - Transmits raw bits over medium
   - Hardware: Cables, hubs, repeaters
   - Standards: RS-232, Ethernet physical
2. Data Link Layer
   - Frame transmission, error detection
   - MAC addressing
   - Protocols: Ethernet, PPP, HDLC
3. Network Layer
   - Routing and IP addressing
   - Packet forwarding
   - Protocols: IP, ICMP, IGMP, ARP
4. Transport Layer
   - End-to-end communication
   - Protocols: TCP (reliable), UDP (fast)
   - Port numbers identify applications
5. Session Layer
   - Session establishment, management
   - Synchronization, dialog control
6. Presentation Layer
   - Data format translation
   - Encryption, compression
   - Formats: JPEG, MPEG, ASCII
7. Application Layer
   - User interface, services
   - Protocols: HTTP, FTP, SMTP, DNS

TCP/IP MODEL:

Simplified 4-layer model:

1. Network Access (Physical + Data Link)
2. Internet (Network)
3. Transport
4. Application (Session + Presentation + Application)

IP ADDRESSING:

IPv4:

- 32-bit address (e.g., 192.168.1.1)
- Classes: A, B, C, D, E
- Subnetting: Divides network into subnets
- CIDR notation: 192.168.1.0/24

IPv6:

- 128-bit address (e.g., 2001:0db8::1)
- Larger address space
- No NAT required

ROUTING ALGORITHMS:

1. Distance Vector (RIP)
   - Bellman-Ford algorithm
   - Periodic updates to neighbors
   - Count-to-infinity problem
2. Link State (OSPF)
   - Dijkstra's algorithm
   - Maintains complete topology
   - Faster convergence
3. Path Vector (BGP)
   - Used between ISPs
   - Policy-based routing

PROTOCOLS:

1. HTTP/HTTPS
   - Port 80/443
   - Request-Response model
   - Methods: GET, POST, PUT, DELETE
2. DNS (Port 53)
   - Domain name to IP translation
   - Hierarchical structure
   - Caching for performance
3. FTP (Port 20/21)
   - File transfer protocol
   - Separate control and data connections
4. SMTP (Port 25)
   - Email sending protocol
   - POP3/IMAP for receiving

NETWORK SECURITY:

1. Firewalls
   - Packet filtering
   - Stateful inspection
   - Application-level gateway
2. Encryption
   - Symmetric: AES, DES (same key)
   - Asymmetric: RSA (public/private key)
   - SSL/TLS for secure communication
3. VPN (Virtual Private Network)
   - Secure tunnel over public network
   - IPSec, L2TP protocols

NETWORK DEVICES:

- Hub: Broadcasts to all ports (Layer 1)

- Switch: Forwards to specific port (Layer 2)
- Router: Routes between networks (Layer 3)
- Gateway: Protocol conversion (Layer 7)