1. Introduction to Networking

Data Flow

1. **Simplex**: One-way communication (e.g., Keyboard to Monitor).
2. **Half-Duplex**: Two-way communication, but not simultaneously (e.g., Walkie-Talkie).
3. **Full-Duplex**: Two-way communication simultaneously (e.g., Telephone).

Network Topology

1. **Bus**: All devices connected to a single cable.
2. **Star**: All devices connected to a central hub.
3. **Ring**: Each device connected to two others, forming a ring.
4. **Mesh**: Every device connected to every other device.
5. **Hybrid**: Combination of two or more topologies.

Categories of Networks

1. **LAN (Local Area Network)**: Small geographical area (e.g., office, home).
2. **MAN (Metropolitan Area Network)**: Covers a city (e.g., cable TV network).
3. **WAN (Wide Area Network)**: Covers a large geographical area (e.g., the Internet).

2. Protocols and Standards

OSI Model

- **7 Layers**:
    1. **Physical**: Transmits raw bits over a physical medium.
    2. **Data Link**: Provides node-to-node communication.
    3. **Network**: Handles routing and forwarding.
    4. **Transport**: Ensures end-to-end communication.
    5. **Session**: Manages sessions between applications.
    6. **Presentation**: Translates data into a readable format.
    7. **Application**: Provides network services to applications.

TCP/IP Protocol Suite

- **4 Layers**:

1. **Network Interface**: Physical and Data Link layers.
2. **Internet**: Network layer (IP, ICMP).
3. **Transport**: Transport layer (TCP, UDP).
4. **Application**: Application layer (HTTP, FTP, DNS).

Addressing

1. **Physical Address (MAC)**: Unique identifier for network interfaces.
2. **Logical Address (IP)**: Identifies devices on a network.
3. **Port Address**: Identifies specific processes or services.

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3. Internetworking

IPv4 and IPv6

- **IPv4**: 32-bit address (e.g., 192.168.1.1).
- **IPv6**: 128-bit address (e.g., 2001:0db8:85a3::8a2e:0370:7334).

Routing Protocols

1. **Distance Vector Routing**:
   - Uses the Bellman-Ford algorithm.
   - Example: RIP (Routing Information Protocol).
2. **Link State Routing**:
   - Uses Dijkstra's algorithm.
   - Example: OSPF (Open Shortest Path First).
3. **Path Vector Routing**:
   - Example: BGP (Border Gateway Protocol).

Transmission Control Protocol (TCP)

- Connection-oriented, reliable, and ensures data integrity.
- **Three-Way Handshake**:
   1. SYN
   2. SYN-ACK
   3. ACK

User Datagram Protocol (UDP)

- Connectionless, unreliable, but faster than TCP.

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4. Quality of Service (QoS)

Congestion Control

1. **Open Loop**: Prevents congestion before it occurs (e.g., traffic shaping).
2. **Closed Loop**: Detects and mitigates congestion (e.g., congestion avoidance).

Techniques to Improve QoS

1. **Leaky Bucket Algorithm**: Limits data rate.
2. **Token Bucket Algorithm**: Allows bursty traffic.
3. **Priority Queuing**: Prioritizes certain types of traffic.

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5. DNS and Web

Domain Name System (DNS)

- Resolves domain names to IP addresses.
- **Hierarchy**: Root → Top-Level Domains (TLDs) → Second-Level Domains.

HTTP and Web Documents

- **HTTP**: Protocol for transferring web pages.
- **Web Documents**: Static (HTML), Dynamic (PHP, ASP), Active (JavaScript).

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6. Network Security

Cryptography

1. **Symmetric Key**:
   - Same key for encryption and decryption.
   - Example: DES, AES.
2. **Asymmetric Key**:
   - Different keys for encryption and decryption.
   - Example: RSA, Diffie-Hellman.

Digital Signature

- Ensures authenticity and integrity of a message.

- **Steps**:
    1. Hash the message.
    2. Encrypt the hash with the sender's private key.

Firewalls

- **Packet Filter**: Filters packets based on rules.
- **Stateful Inspection**: Tracks the state of active connections.

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7. Practice Questions

Group-A (Very Short Answer Type)

1. **Data Communication**: Exchange of data between devices via a transmission medium.
2. **IP Protocol**: Internet Protocol, used for addressing and routing packets.
3. **Multicasting**: Sending data to multiple destinations simultaneously.
4. **Throughput**: Amount of data transferred per unit time.
5. **DNS**: Domain Name System.
6. **DES**: Data Encryption Standard (symmetric key cryptography).
7. **LAN Topologies**: Bus, Star, Ring, Mesh.
8. **ICMP**: Internet Control Message Protocol (used for error reporting).
9. **Supernetting**: Combining multiple IP networks into a larger network.
10. **DHCP**: Dynamic Host Configuration Protocol.

Group-B (Short Answer Type)

1. **Digital Signature**:
    - Ensures authenticity and integrity.
    - Example: RSA-based digital signature.
2. **Reliability in Data Flow**:
    - Ensures data is delivered accurately and in order.
3. **Logical, Physical, and Port Addresses**:
    - Logical: IP address (e.g., 192.168.1.1).
    - Physical: MAC address (e.g., 00:1A:2B:3C:4D:5E).
    - Port: Identifies a process (e.g., port 80 for HTTP).
4. **Distance Vector Routing**:
    - Uses the Bellman-Ford algorithm.
    - Example: RIP.

Group-C (Long Answer Type)

1. **RSA Algorithm**:
   - Choose two large primes, p and q.
   - Compute $n = p * q$ and $\varphi(n) = (p-1)*(q-1)$.
   - Choose e such that $1 < e < \varphi(n)$ and $gcd(e, \varphi(n)) = 1$.
   - Compute d such that $(d * e) \% \varphi(n) = 1$.
   - Public key: (e, n), Private key: (d, n).
2. **Diffie-Hellman Key Exchange**:
   - Allows two parties to securely exchange a key over an insecure channel.
3. **Leaky Bucket Algorithm**:
   - Limits data rate by allowing a fixed number of packets per unit time.

Tips for Exam Preparation

1. Practice numerical problems on IP addressing and subnetting.
2. Understand the working of routing algorithms (Distance Vector, Link State).
3. Revise key concepts like TCP/IP, DNS, and network security.
4. Solve previous year's question papers.

Good luck with your exam! 🚀