Question 1(a) [3 marks]

List out types of congestion control and explain any one

Answer:

Type	Description
Open-Loop	Prevents congestion before it occurs
Closed-Loop	Manages congestion after detection

Open-Loop Congestion Control Explanation:

- **Prevention approach**: Takes action before congestion occurs
- **Traffic shaping**: Controls data rate at sender
- **Admission control**: Limits new connections during high traffic
- **Load shedding**: Drops packets when buffer full

Mnemonic: "Open Prevents Traffic Admission Load"

Question 1(b) [4 marks]

Explain Address Resolution Protocol briefly

Answer:

ARP (Address Resolution Protocol) maps IP addresses to MAC addresses in local networks.

Working Process:

- **ARP Request**: Broadcast message asking "Who has IP X?"
- **ARP Reply**: Target device responds with its MAC address
- **ARP Cache**: Stores IP-MAC mappings for future use
- **Dynamic mapping**: Updates entries automatically

Table: ARP Message Types

Type	Purpose	Broadcast
ARP Request	Find MAC address	Yes
ARP Reply	Provide MAC address	No

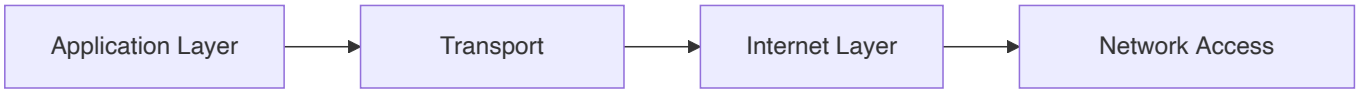
Mnemonic: "ARP Requests Broadcast, Replies Cache Dynamic"

Question 1(c) [7 marks]

Explain TCP/IP model with all layers and functionalities of each layer

Answer:

TCP/IP Model is a four-layer network protocol stack for internet communication.



Layer Functions:

Layer	Function	Protocols
Application	User interface, network services	HTTP, FTP, SMTP
Transport	End-to-end communication	TCP, UDP
Internet	Routing, addressing	IP, ICMP
Network Access	Physical transmission	Ethernet, WiFi

- **Application Layer**: Provides network services to applications
- **Transport Layer**: Ensures reliable data delivery with error control
- **Internet Layer**: Routes packets across networks using IP addressing
- **Network Access Layer**: Handles physical data transmission

Mnemonic: "All Transport Internet Network"

Question 1(c OR) [7 marks]

Explain OSI model with each layer functionality

Answer:

OSI Model is a seven-layer reference model for network communication.

Layer Functionalities:

Layer	Function	Examples
Physical (1)	Bit transmission	Cables, signals
Data Link (2)	Frame delivery	Ethernet, switches
Network (3)	Routing packets	IP, routers
Transport (4)	End-to-end delivery	TCP, UDP
Session (5)	Dialog management	NetBIOS
Presentation (6)	Data formatting	SSL, compression
Application (7)	User interface	HTTP, email

Mnemonic: "Physical Data Network Transport Session Presentation Application"

Question 2(a) [3 marks]

Explain subnetting in short

Answer:

Subnetting divides a large network into smaller sub-networks for better management.

Key Concepts:

- **Subnet mask**: Defines network and host portions
- **Network efficiency**: Reduces broadcast traffic
- **Address conservation**: Better IP utilization
- **Security**: Isolates network segments

Example:
Network: 192.168.1.0/24 → Subnets: 192.168.1.0/26, 192.168.1.64/26

Mnemonic: "Subnet Network Efficiency Address Security"

Question 2(b) [4 marks]

Explain stop and wait ARQ protocol of data link layer with example

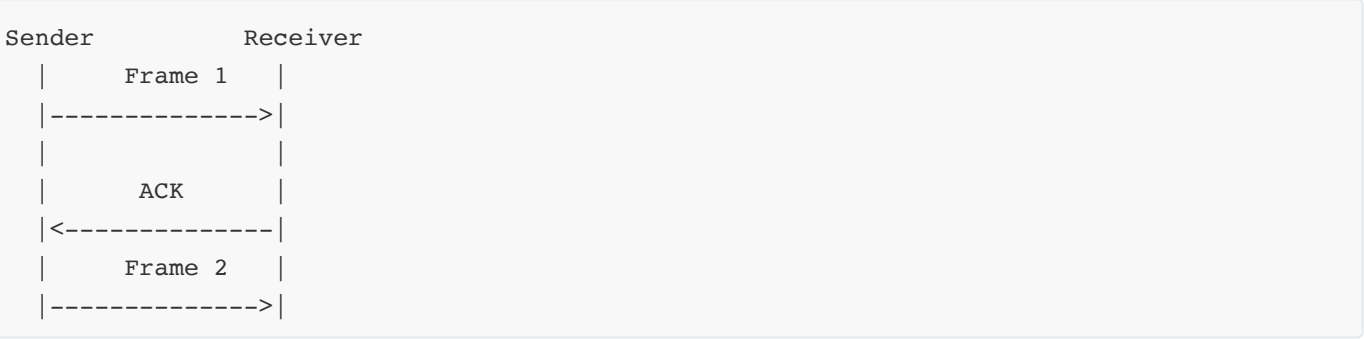
Answer:

Stop and Wait ARQ is a flow control protocol ensuring reliable data transmission.

Working Process:

- **Send frame**: Transmitter sends one frame
- **Wait for ACK**: Sender waits for acknowledgment

- **Timeout**: Retransmits if no ACK received
- **Next frame**: Sends next frame after ACK



Example: File transfer where each packet waits for confirmation before sending next.

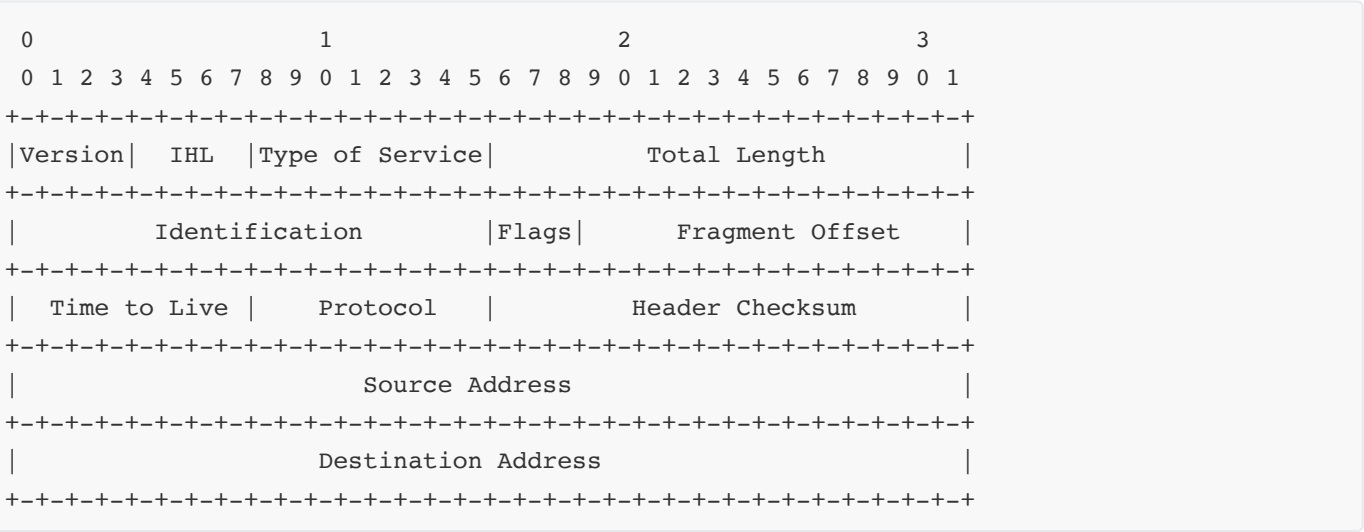
Mnemonic: "Send Wait Timeout Next"

Question 2(c) [7 marks]

Draw diagram of IPv4 datagram Header and explain it

Answer:

IPv4 Header contains control information for packet routing and delivery.



Field Explanations:

Field	Size	Function
Version	4 bits	IP version (4 for IPv4)
IHL	4 bits	Header length
Type of Service	8 bits	Quality of service
Total Length	16 bits	Packet size
TTL	8 bits	Hop limit
Protocol	8 bits	Next layer protocol
Source/Dest Address	32 bits each	IP addresses

Mnemonic: "Version IHL Service Total TTL Protocol Source Destination"

Question 2(a OR) [3 marks]

What is HTTPS? List important key features of HTTPS

Answer:

HTTPS (HTTP Secure) is encrypted HTTP using SSL/TLS for secure web communication.

Key Features:

- **Encryption**: Data encrypted in transit
- **Authentication**: Verifies server identity
- **Data integrity**: Prevents data tampering
- **Trust**: SSL certificates provide validation

Security Benefits:

- Protects sensitive information
- Prevents man-in-the-middle attacks
- Search engine ranking boost

Mnemonic: "HTTPS Encrypts Authentication Data Trust"

Question 2(b OR) [4 marks]

Give Answer of any two:

Answer:

1) How many bits HOST ID use by class B and C?

- **Class B**: 16 bits for Host ID (65,534 hosts)

- **Class C**: 8 bits for Host ID (254 hosts)

2) What is IP range for Class A and D?

- **Class A**: 1.0.0.0 to 126.255.255.255
- **Class D**: 224.0.0.0 to 239.255.255.255 (Multicast)

Class	Range	Host Bits
B	128.0.0.0 - 191.255.255.255	16 bits
C	192.0.0.0 - 223.255.255.255	8 bits
A	1.0.0.0 - 126.255.255.255	24 bits
D	224.0.0.0 - 239.255.255.255	Multicast

Mnemonic: "B=16, C=8, A=1-126, D=224-239"

Question 2(c OR) [7 marks]

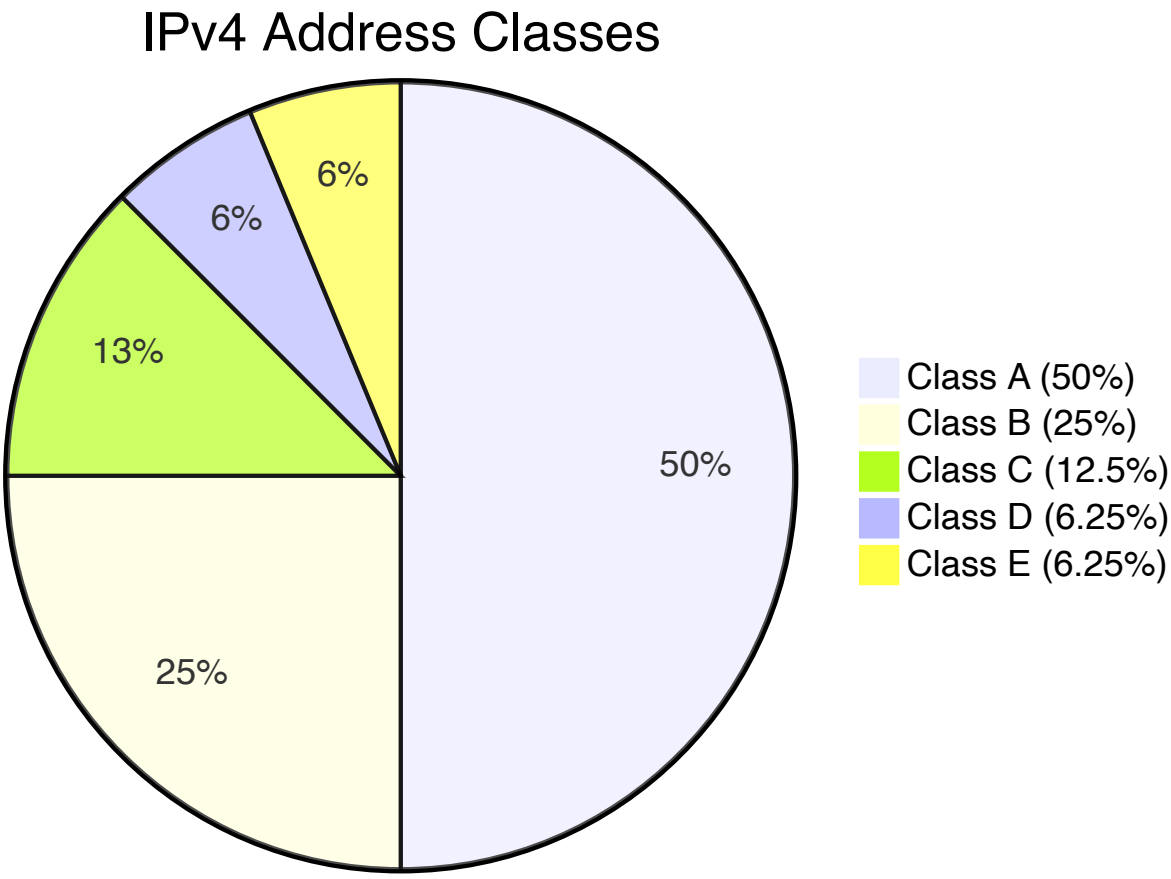
Explain classful IPv4 addresses scheme

Answer:

Classful IPv4 Addressing divides IP address space into five classes based on first octets.

Address Classes:

Class	Range	Network Bits	Host Bits	Usage
A	1-126	8	24	Large networks
B	128-191	16	16	Medium networks
C	192-223	24	8	Small networks
D	224-239	-	-	Multicast
E	240-255	-	-	Experimental



Characteristics:

- **Class A**: 16.7 million hosts per network
- **Class B**: 65,534 hosts per network
- **Class C**: 254 hosts per network
- **Limitations**: Address wastage, inflexible allocation

Mnemonic: "A-Large, B-Medium, C-Small, D-Multicast, E-Experimental"

Question 3(a) [3 marks]

List out types of applications uses mobile computing

Answer:

Mobile Computing Applications:

Type	Examples
Communication	WhatsApp, Email, Video calls
Navigation	GPS, Google Maps
E-commerce	Shopping apps, Mobile banking
Entertainment	Games, Streaming, Social media
Business	CRM, Sales tracking
Healthcare	Health monitoring, Telemedicine

- **Location-based services**: GPS navigation, location sharing
- **Mobile payments**: Digital wallets, UPI transactions
- **Social networking**: Facebook, Instagram, Twitter

Mnemonic: "Communication Navigation E-commerce Entertainment Business Healthcare"

Question 3(b) [4 marks]

Explain use of Gateways and list types of Gateways

Answer:

Gateway connects networks with different protocols and architectures.

Uses of Gateways:

- **Protocol conversion**: Translates between different protocols
- **Network bridging**: Connects dissimilar networks
- **Security**: Firewall and access control
- **Data filtering**: Manages traffic flow

Types of Gateways:

Type	Function
Network Gateway	Routes between networks
Internet Gateway	Connects to internet
Protocol Gateway	Protocol translation
Application Gateway	Application-level filtering

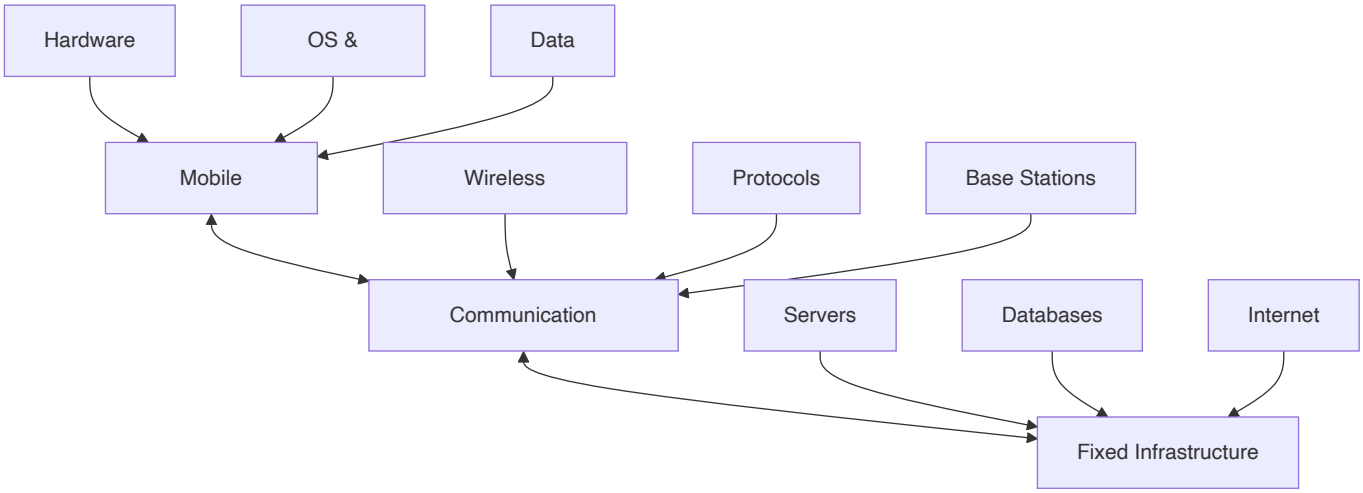
Mnemonic: "Gateways Convert Bridge Secure Filter"

Question 3(c) [7 marks]

Draw and explain architecture of mobile computing

Answer:

Mobile Computing Architecture consists of three main components working together.



Architecture Components:

Component	Elements	Function
Mobile Unit	Devices, OS, Apps	User interface, processing
Communication Network	Wireless links, protocols	Data transmission
Fixed Infrastructure	Servers, databases	Backend services

Key Features:

- **Mobility**: Users can move while maintaining connectivity
- **Wireless communication**: Radio waves for data transmission
- **Distributed computing**: Processing across multiple devices
- **Location independence**: Access services from anywhere

Challenges:

- **Limited bandwidth**: Wireless networks have capacity constraints
- **Battery life**: Mobile devices have power limitations
- **Security**: Wireless transmission vulnerable to attacks

Mnemonic: "Mobile Communication Fixed - Mobility Wireless Distributed Location"

Question 3(a OR) [3 marks]

List security standards in mobile computing

Answer:

Mobile Computing Security Standards:

Standard	Purpose
WPA3	WiFi security protocol
SSL/TLS	Secure data transmission
IPSec	IP layer security
EAP	Authentication framework
802.11i	Wireless LAN security
FIPS 140-2	Cryptographic module standards

- **Authentication protocols**: Verify user identity
- **Encryption standards**: Protect data confidentiality
- **Access control**: Manage resource permissions

Mnemonic: "WPA SSL IPSec EAP 802.11i FIPS"

Question 3(b OR) [4 marks]

Explain key functions of communication gateway

Answer:

Communication Gateway manages data exchange between different network systems.

Key Functions:

Function	Description
Protocol Translation	Converts between protocols
Data Format Conversion	Changes data formats
Routing	Directs messages to destinations
Security	Access control and filtering

Detailed Functions:

- **Message routing**: Determines optimal path for data
- **Error handling**: Manages transmission errors and recovery
- **Traffic management**: Controls data flow and congestion

- **Authentication**: Verifies sender and receiver identity

Benefits:

- Enables interoperability between different systems
- Centralizes network management
- Provides security checkpoint

Mnemonic: "Protocol Data Routing Security - Message Error Traffic Authentication"

Question 3(c OR) [7 marks]

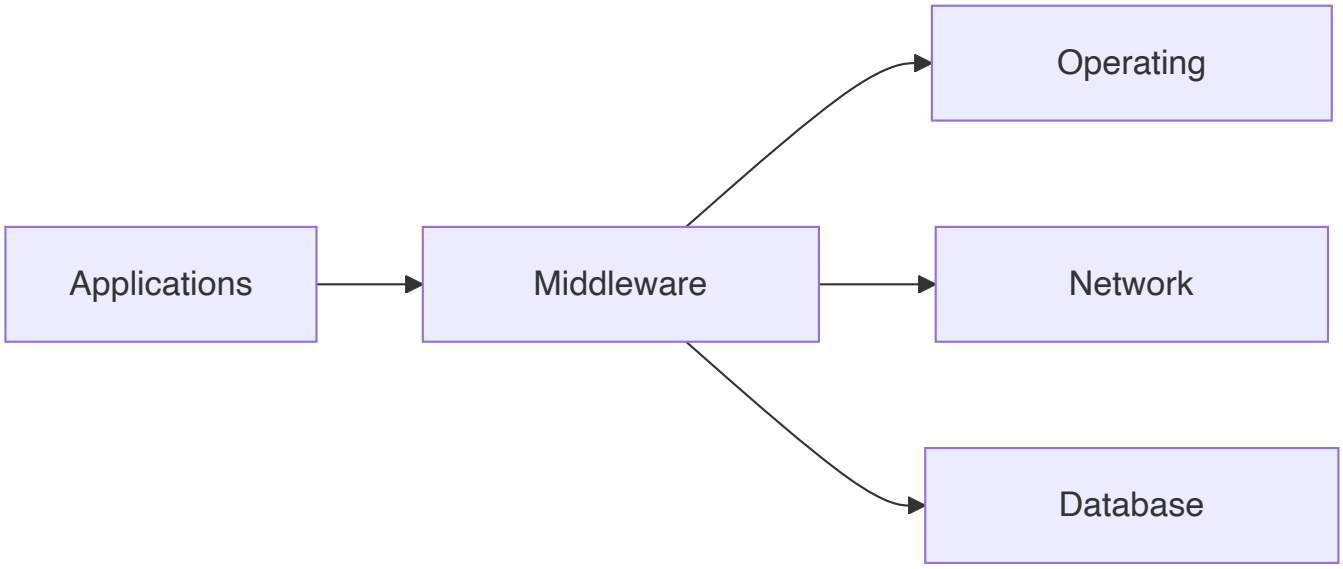
Explain use of middleware and list types of middleware

Answer:

Middleware provides software layer between applications and operating system for distributed computing.

Uses of Middleware:

- **Connectivity**: Links distributed applications
- **Interoperability**: Enables different systems to work together
- **Abstraction**: Hides complexity of underlying systems
- **Scalability**: Supports system growth and expansion



Types of Middleware:

Type	Function	Examples
Message-Oriented	Asynchronous communication	IBM MQ, RabbitMQ
Remote Procedure Call	Synchronous communication	gRPC, XML-RPC
Object Request Broker	Object communication	CORBA
Database Middleware	Database connectivity	ODBC, JDBC
Transaction Processing	Transaction management	Tuxedo
Web Middleware	Web services	Apache, IIS

Benefits:

- **Reduced complexity**: Simplifies application development
- **Reusability**: Common services for multiple applications
- **Maintainability**: Centralized management of services
- **Platform independence**: Works across different systems

Mnemonic: "Message RPC Object Database Transaction Web"

Question 4(a) [3 marks]

Explain working phases of Mobile IP

Answer:

Mobile IP Working Phases enable seamless mobility for mobile devices across networks.

Three Main Phases:

Phase	Function
Agent Discovery	Find home/foreign agents
Registration	Register with foreign agent
Tunneling	Forward packets to mobile node

Phase Details:

- **Agent Discovery**: Mobile node detects available agents through advertisements
- **Registration**: Mobile node registers current location with home agent
- **Tunneling**: Home agent encapsulates and forwards packets to foreign agent

Mnemonic: "Agent Registration Tunneling"

Question 4(b) [4 marks]

Explain Handover management in Mobile IP

Answer:

Handover Management maintains connectivity when mobile node moves between networks.

Handover Process:

- **Movement detection**: Identifies change in network attachment
- **New agent discovery**: Finds new foreign agent
- **Registration update**: Updates location with home agent
- **Data forwarding**: Redirects traffic to new location

Types of Handover:

Type	Description
Hard Handover	Break-before-make
Soft Handover	Make-before-break
Horizontal	Same technology
Vertical	Different technology

Challenges:

- **Packet loss**: During handover transition
- **Delay**: Registration and tunneling setup time
- **Resource management**: Efficient use of network resources

Mnemonic: "Movement Discovery Registration Forwarding"

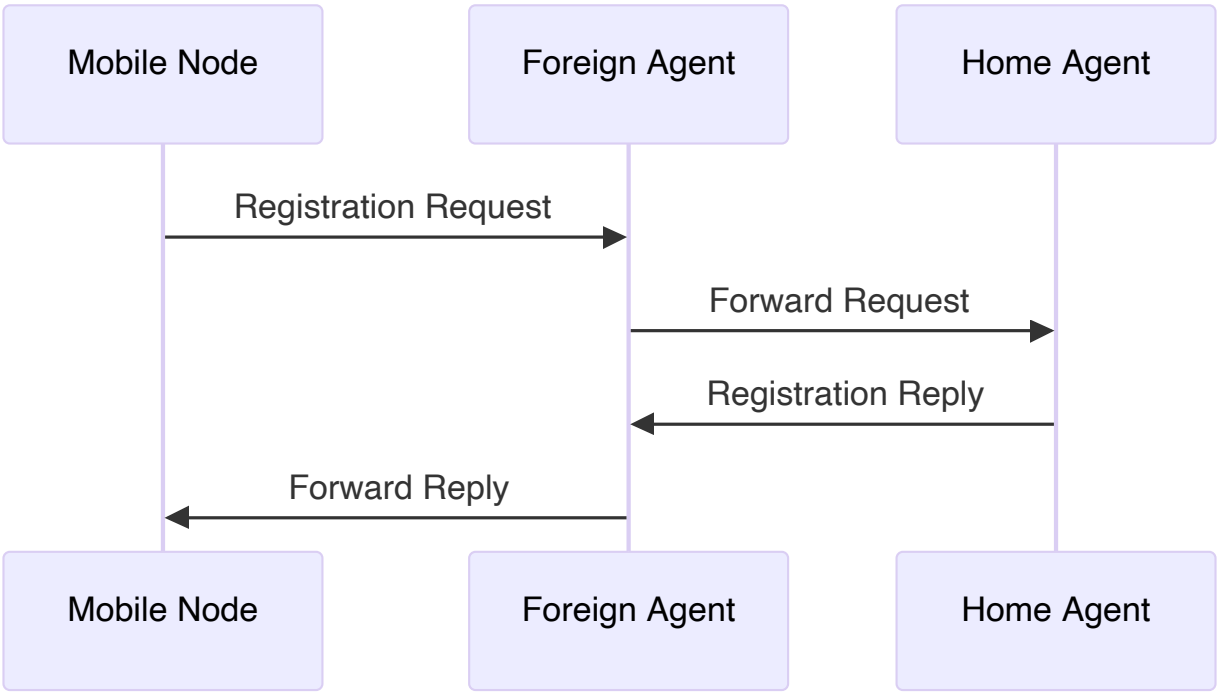
Question 4(c) [7 marks]

Explain Registration and Tunneling in Mobile IP

Answer:

Registration and Tunneling are core mechanisms enabling Mobile IP functionality.

Registration Process:



Registration Steps:

- **Request**: Mobile node sends registration request to foreign agent
- **Forward**: Foreign agent forwards request to home agent
- **Authentication**: Home agent verifies mobile node identity
- **Reply**: Home agent sends registration reply confirming registration

Tunneling Mechanism:

Component	Function
Encapsulation	Wraps original packet
Tunnel Endpoint	Home and foreign agents
Decapsulation	Unwraps packet at destination
Routing	Directs traffic through tunnel

Tunneling Process:

- **Packet arrival**: Data arrives at home agent for mobile node
- **Encapsulation**: Home agent wraps packet with foreign agent address
- **Tunnel transmission**: Packet travels through tunnel to foreign agent
- **Decapsulation**: Foreign agent unwraps and delivers to mobile node

Benefits:

- **Transparency**: Applications unaware of mobility

- **Connectivity**: Maintains communication during movement
- **Scalability**: Supports multiple mobile nodes

Security Considerations:

- **Authentication**: Prevents unauthorized registration
- **Encryption**: Protects data in tunnels

Mnemonic: "Registration Request Forward Authentication - Tunneling Encapsulation Transmission Decapsulation"

Question 4(a OR) [3 marks]

Explain snooping TCP

Answer:

Snooping TCP improves TCP performance over wireless networks by handling wireless link errors.

Working Mechanism:

- **Base station monitoring**: Observes TCP packets
- **Local retransmission**: Handles wireless link errors locally
- **Cache management**: Stores copies of transmitted packets
- **Error recovery**: Retransmits lost packets without involving sender

Key Features:

Feature	Benefit
Transparent	No changes to TCP endpoints
Local recovery	Faster error correction
Reduced timeouts	Prevents unnecessary retransmissions

Mnemonic: "Snooping Monitors Local Cache Recovery"

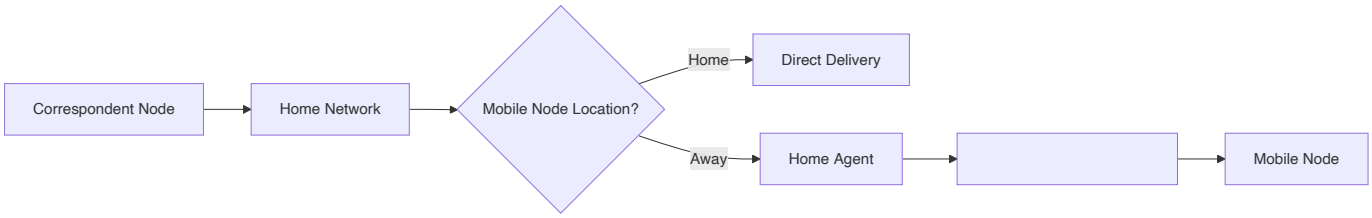
Question 4(b OR) [4 marks]

Explain Packet delivery in Mobile IP

Answer:

Packet Delivery in Mobile IP ensures data reaches mobile nodes regardless of location.

Delivery Process:



Delivery Scenarios:

Scenario	Path	Method
At Home	Direct	Normal IP routing
Away	Via HA/FA	Tunneling
Roaming	Triangle routing	Indirect path

Packet Flow Steps:

- **Address resolution**: Determine mobile node location
- **Route selection**: Choose direct or tunneled delivery
- **Encapsulation**: Wrap packet if tunneling required
- **Forwarding**: Send to appropriate destination
- **Decapsulation**: Unwrap packet at foreign agent
- **Final delivery**: Deliver to mobile node

Optimization Techniques:

- **Route optimization**: Direct communication when possible
- **Binding cache**: Store location information
- **Smooth handover**: Minimize packet loss during movement

Mnemonic: "Address Route Encapsulation Forward Decapsulation Delivery"

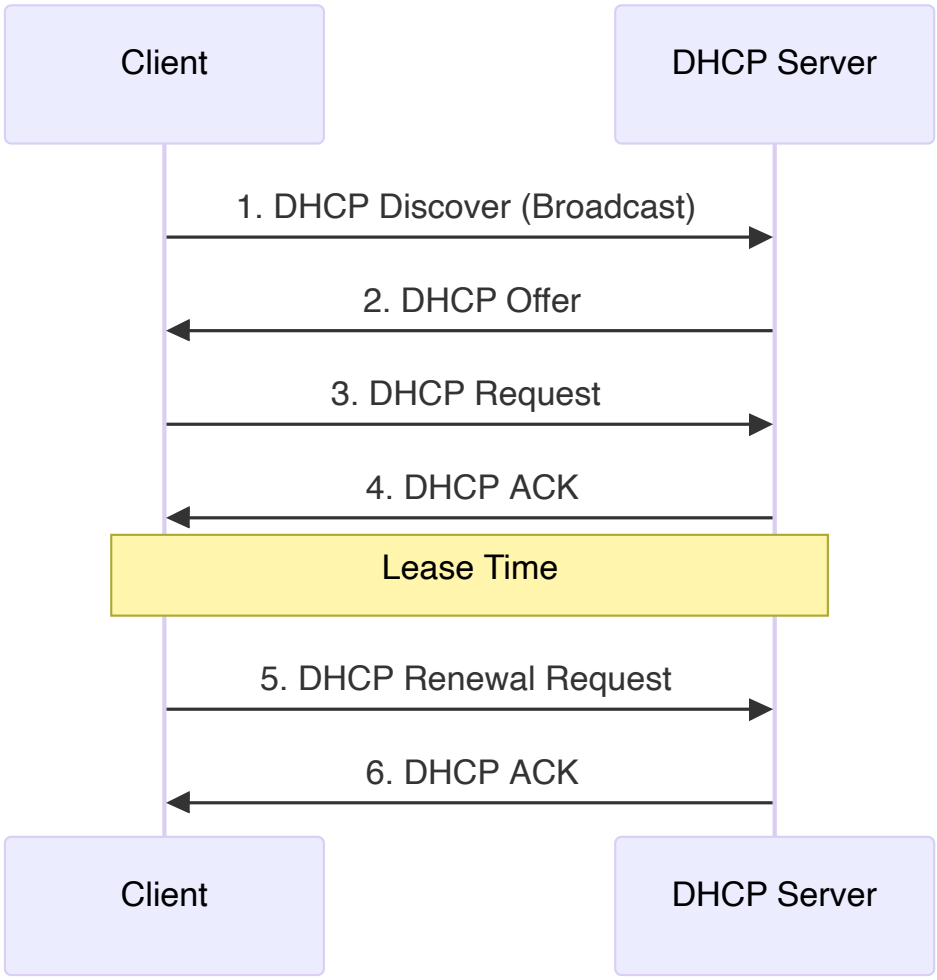
Question 4(c OR) [7 marks]

Describe how DHCP working with diagram

Answer:

DHCP (Dynamic Host Configuration Protocol) automatically assigns IP addresses and network configuration to devices.

DHCP Working Process:



Four-Step Process:

Step	Message	Function
1	DISCOVER	Client broadcasts request for IP
2	OFFER	Server offers available IP address
3	REQUEST	Client requests specific IP address
4	ACK	Server confirms IP assignment

DHCP Components:

- **DHCP Server**: Manages IP address pool and assignments
- **DHCP Client**: Requests and uses assigned configuration
- **DHCP Relay**: Forwards DHCP messages across subnets
- **Address Pool**: Range of available IP addresses

Configuration Information Provided:

- **IP Address**: Unique network identifier
- **Subnet Mask**: Network boundary definition

- **Default Gateway**: Route to other networks
- **DNS Servers**: Domain name resolution
- **Lease Time**: Duration of IP assignment

Benefits:

- **Automatic configuration**: No manual IP assignment needed
- **Centralized management**: Single point for network configuration
- **Efficient utilization**: Dynamic allocation prevents waste
- **Reduced errors**: Eliminates manual configuration mistakes

DHCP Message Types:

- **DISCOVER**: Locate available DHCP servers
- **OFFER**: Response with configuration offer
- **REQUEST**: Accept specific server offer
- **ACK**: Confirm configuration assignment
- **NAK**: Reject configuration request
- **RELEASE**: Return IP address to pool
- **RENEW**: Extend current lease

Mnemonic: "Discover Offer Request ACK - Server Client Relay Pool"

Question 5(a) [3 marks]

Give types of WLAN and explain any one

Answer:

WLAN Types:

Type	Standard	Frequency
Infrastructure	802.11	2.4/5 GHz
Ad-hoc	IBSS	2.4/5 GHz
Mesh	802.11s	Multiple

Infrastructure WLAN Explanation:

- **Access Point (AP)**: Central coordinator for all communications
- **BSS (Basic Service Set)**: Network coverage area of single AP
- **ESS (Extended Service Set)**: Multiple interconnected BSSs
- **Distribution System**: Backbone connecting multiple APs

Characteristics:

- All communication goes through access point
- Centralized network management
- Better security and performance control

Mnemonic: "Infrastructure Ad-hoc Mesh - AP BSS ESS Distribution"

Question 5(b) [4 marks]

Answer the following questions:

Answer:

1) List Uses of Ad hoc Network:

Use Case	Application
Emergency	Disaster recovery, rescue operations
Military	Battlefield communications
Conferences	Temporary meeting networks
Home	Device-to-device communication
Vehicular	Car-to-car networks

2) Enlist entities and terminology of mobile computing:

Entities:

- **Mobile Node (MN)**: Moving device
- **Home Agent (HA)**: Permanent network representative
- **Foreign Agent (FA)**: Temporary network coordinator
- **Correspondent Node (CN)**: Communication partner

Terminology:

- **Handover**: Network switching process
- **Roaming**: Moving between networks
- **Care-of Address**: Temporary IP address

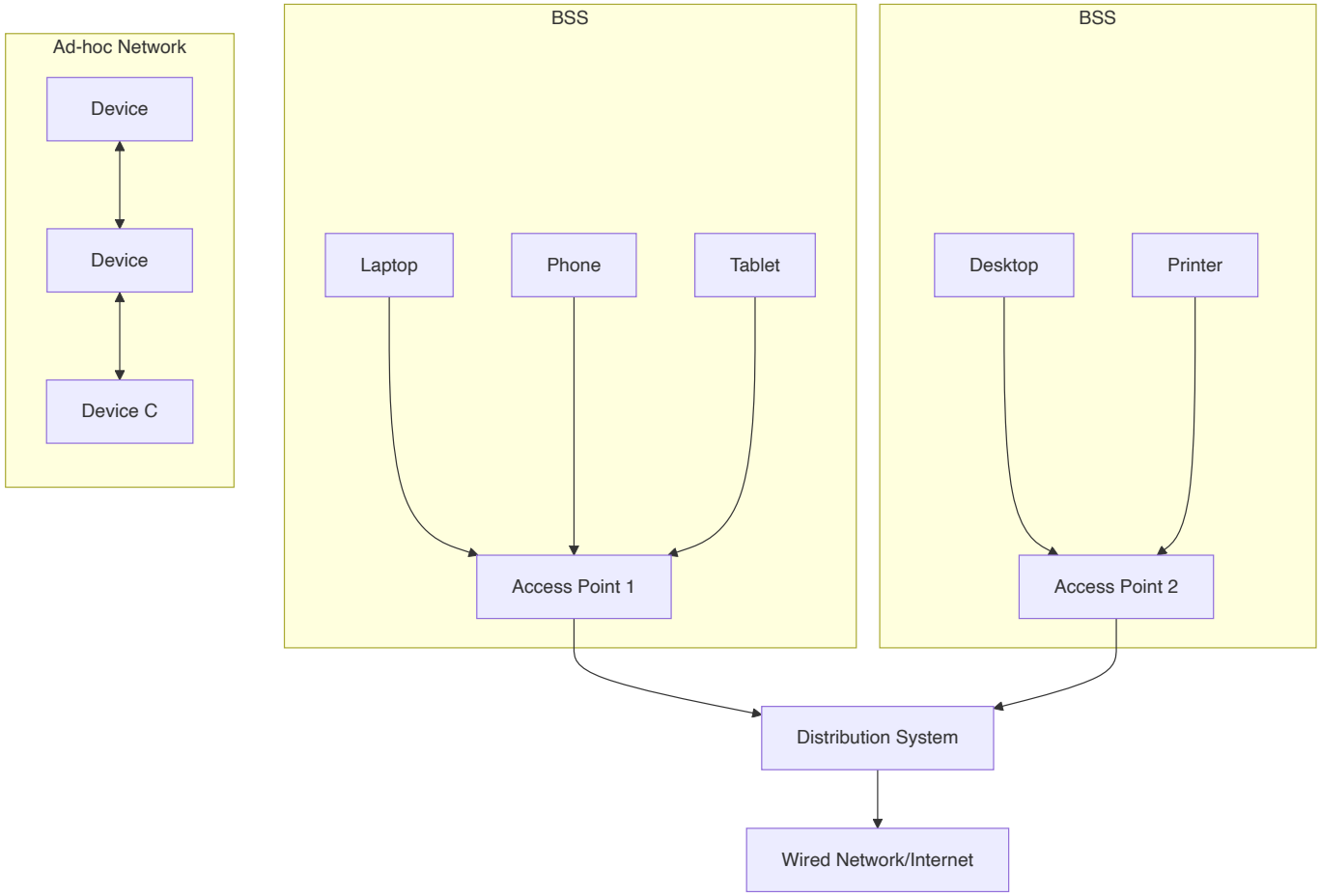
Mnemonic: "Emergency Military Conference Home Vehicular - MN HA FA CN"

Question 5(c) [7 marks]

Explain architecture of WLAN with neat diagram

Answer:

WLAN Architecture consists of wireless stations communicating through access points.



Architecture Components:

Component	Function	Coverage
STA (Station)	Wireless device	Point
AP (Access Point)	Network coordinator	BSS area
BSS (Basic Service Set)	Single AP coverage	~100m radius
ESS (Extended Service Set)	Multiple connected BSS	Large area
DS (Distribution System)	AP interconnection	Building/campus

Types of WLAN Architecture:

1. Infrastructure Mode:

- **Centralized**: All traffic through access points
- **Managed**: Network administration and security
- **Scalable**: Easy to expand coverage area

2. Ad-hoc Mode (IBSS):

- **Peer-to-peer**: Direct device communication
- **Decentralized**: No central coordinator
- **Temporary**: Quick setup for specific needs

Key Features:

- **Mobility**: Users can move within coverage area
- **Wireless medium**: Radio waves for communication
- **Shared bandwidth**: Multiple users share channel capacity
- **Security**: WPA/WPA2/WPA3 protocols for protection

Standards and Frequencies:

- **802.11a**: 5 GHz, up to 54 Mbps
- **802.11b**: 2.4 GHz, up to 11 Mbps
- **802.11g**: 2.4 GHz, up to 54 Mbps
- **802.11n**: 2.4/5 GHz, up to 600 Mbps
- **802.11ac**: 5 GHz, up to 6.93 Gbps

Mnemonic: "STA AP BSS ESS DS - Infrastructure Ad-hoc"

Question 5(a OR) [3 marks]

Write features of 5G

Answer:

5G Key Features:

Feature	Specification
Speed	Up to 10 Gbps
Latency	< 1 millisecond
Connectivity	1 million devices/km²
Reliability	99.999% availability
Bandwidth	100x increase
Energy	90% reduction

Advanced Capabilities:

- **Enhanced Mobile Broadband (eMBB)**: Ultra-fast data speeds

- **Ultra-Reliable Low Latency (URLLC)**: Mission-critical applications
- **Massive Machine Type Communication (mMTC)**: IoT connectivity

Mnemonic: "Speed Latency Connectivity Reliability Bandwidth Energy"

Question 5(b OR) [4 marks]

Answer the following questions:

Answer:

1) List Type of communication middleware:

Type	Function
Message-Oriented	Asynchronous messaging
RPC-based	Remote procedure calls
Object-Oriented	Distributed objects
Service-Oriented	Web services
Database	Data access layer

2) Define the term "Home Agent" in the context of Mobile IP:

Home Agent (HA) is a router on mobile node's home network that:

- **Maintains registration**: Tracks mobile node's current location
- **Tunnels packets**: Forwards data to mobile node's foreign location
- **Address management**: Manages mobile node's permanent IP address
- **Authentication**: Verifies mobile node identity during registration

Functions:

- Acts as proxy for mobile node when away from home
- Intercepts packets destined for mobile node
- Creates tunnels to foreign agents

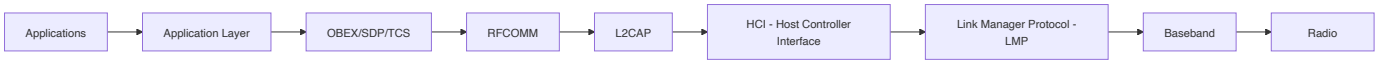
Mnemonic: "Message RPC Object Service Database - HA Maintains Tunnels Address Authentication"

Question 5(c OR) [7 marks]

Explain Bluetooth protocol stack with diagram

Answer:

Bluetooth Protocol Stack provides layered architecture for short-range wireless communication.



Protocol Stack Layers:

Layer	Function	Protocols
Application	User applications	Audio, File transfer
Middleware	Services	OBEX, SDP, TCS
Transport	Data delivery	RFCOMM
Network	Packet management	L2CAP
Interface	Host-Controller	HCI
Management	Link control	LMP
Data Link	Channel access	Baseband
Physical	Radio transmission	2.4 GHz ISM

Layer Details:

Upper Layers:

- **OBEX**: Object Exchange Protocol for file transfers
- **SDP**: Service Discovery Protocol finds available services
- **TCS**: Telephony Control Specification for voice calls
- **RFCOMM**: Serial port emulation over Bluetooth

Lower Layers:

- **L2CAP**: Logical Link Control manages multiple connections
- **HCI**: Host Controller Interface standardizes communication
- **LMP**: Link Manager Protocol handles connection setup
- **Baseband**: Manages time slots and frequency hopping

Key Features:

- **Frequency Hopping**: 1600 hops/second across 79 channels
- **Piconet**: Network of up to 8 devices
- **Scatternet**: Multiple overlapping piconets
- **Power Classes**: Class 1 (100m), Class 2 (10m), Class 3 (1m)

Advantages:

- **Low power consumption**: Suitable for battery devices

- **Automatic pairing**: Easy device connection
- **Interference resistance**: Frequency hopping spread spectrum
- **Cost effective**: Low implementation cost

Applications:

- **Audio streaming**: Headphones, speakers
- **Data transfer**: File sharing between devices
- **Input devices**: Keyboards, mice
- **IoT devices**: Sensors, smart home devices

Mnemonic: "Application Middleware Transport Network Interface Management DataLink Physical"