

# Mobile Computing and Networks (4351602) - Winter 2024 Solution

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## Question 1(a) [3 marks]

List out types of congestion control and explain any one

### Solution

Types of Congestion Control:

Table 1. Congestion Control Types

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

### Solution

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

ARP Message Types:

Table 2. ARP Message Types

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

**Mnemonic**

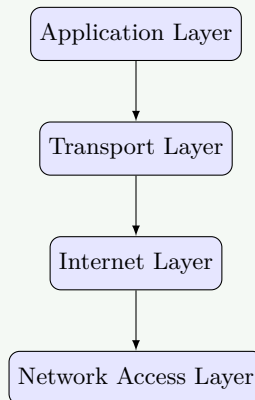
“ARP Requests Broadcast, Replies Cache Dynamic”

**Question 1(c) [7 marks]**

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

**Solution**

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



**Figure 1.** TCP/IP Model

**Layer Functions:**

**Table 3.** Layer Functions

Layer	Function	Protocols
<b>Application</b>	User interface, network services	HTTP, FTP, SMTP
<b>Transport</b>	End-to-end communication	TCP, UDP
<b>Internet</b>	Routing, addressing	IP, ICMP
<b>Network Access</b>	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

**Solution**

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

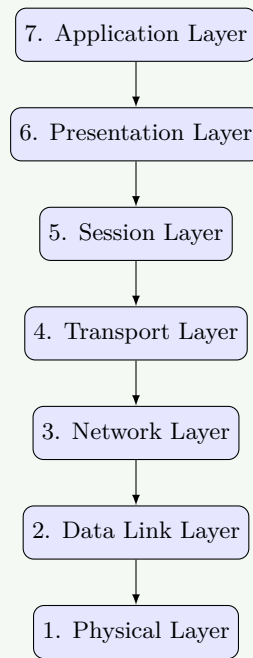


Figure 2. OSI Model

**Layer Functionalities:**

Table 4. Layer Functionalities

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

**Mnemonic**

“Physical Data Network Transport Session Presentation Application”

**Question 2(a) [3 marks]**

**Explain subnetting in short**

**Solution**

**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]**

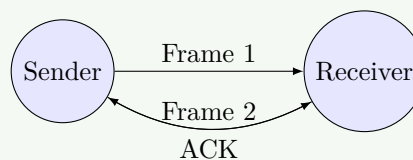
Explain stop and wait ARQ protocol of data link layer with example

**Solution**

**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



**Figure 3.** Stop and Wait ARQ

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

**Mnemonic**

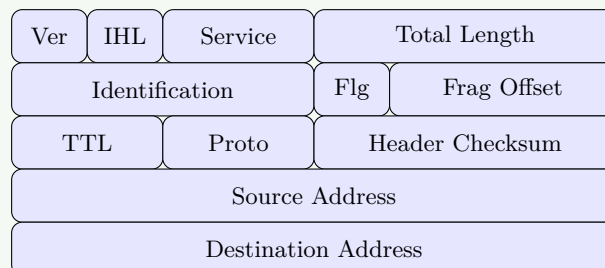
“Send Wait Timeout Next”

**Question 2(c) [7 marks]**

Draw diagram of IPv4 datagram Header and explain it

**Solution**

**IPv4 Header** contains control information for packet routing and delivery.



**Figure 4.** IPv4 Header

**Field Explanations:**

**Table 5.** 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

**Solution**

**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:

**Solution**

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)

**Table 6.** IP Classes

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]**

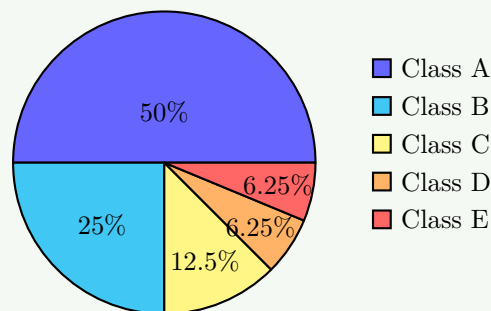
**Explain classful IPv4 addresses scheme**

**Solution**

**Classful IPv4 Addressing** divides IP address space into five classes based on first octets.  
**Address Classes:**

**Table 7.** Address Classes

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



**Figure 5.** IPv4 Address Classes

**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

#### Solution

Mobile Computing Applications:

Table 8. 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

#### Solution

**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:**

Table 9. 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

#### Solution

Mobile Computing Architecture consists of three main components working together.

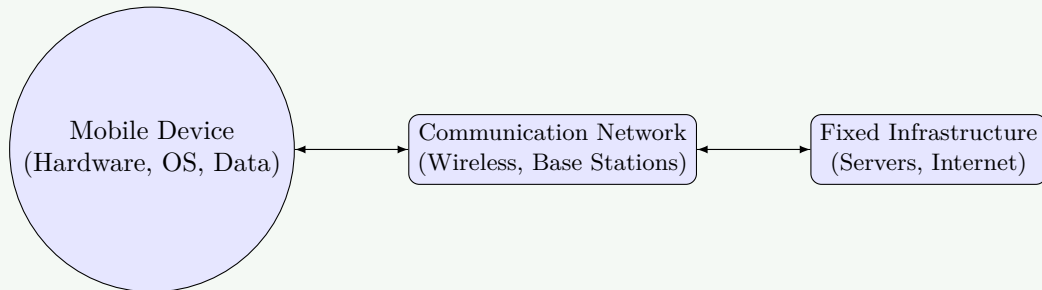


Figure 6. Mobile Computing Architecture

Architecture Components:

Table 10. 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

#### Solution

Mobile Computing Security Standards:

Table 11. Security Standards



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

#### Solution

**Communication Gateway** manages data exchange between different network systems.

**Key Functions:**

Table 12. Functions

Function	Description
<b>Protocol Translation</b>	Converts between protocols
<b>Data Format Conversion</b>	Changes data formats
<b>Routing</b>	Directs messages to destinations
<b>Security</b>	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]

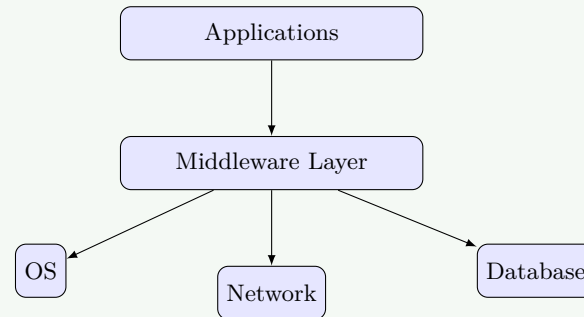
Explain use of middleware and list types of middleware

**Solution**

**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



**Figure 7.** Middleware Layer

**Types of Middleware:**

**Table 13.** 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**

**Solution**

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

**Three Main Phases:**

**Table 14.** Phases

Phase	Function
<b>Agent Discovery</b>	Find home/foreign agents
<b>Registration</b>	Register with foreign agent
<b>Tunneling</b>	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

**Solution**

**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:**

**Table 15.** Types of Handover

Type	Description
<b>Hard Handover</b>	Break-before-make
<b>Soft Handover</b>	Make-before-break
<b>Horizontal</b>	Same technology
<b>Vertical</b>	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”

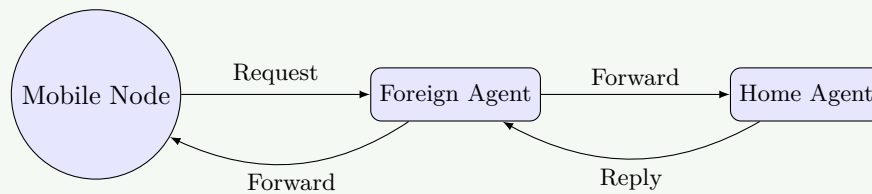
## Question 4(c) [7 marks]

Explain Registration and Tunneling in Mobile IP

**Solution**

**Registration and Tunneling** are core mechanisms enabling Mobile IP functionality.

**Registration Process:**



**Figure 8.** 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:**

- **Encapsulation:** Wraps original packet
- **Tunnel Endpoint:** Home and foreign agents
- **Decapsulation:** Unwraps packet at destination
- **Routing:** Directs traffic through tunnel

**Mnemonic**

“Registration Request Forward Authentication - Tunneling Encapsulation Transmission Decapsulation”

## Question 4(a OR) [3 marks]

**Explain snooping TCP**

**Solution**

**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:**

**Table 16.** Features

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

**Mnemonic**

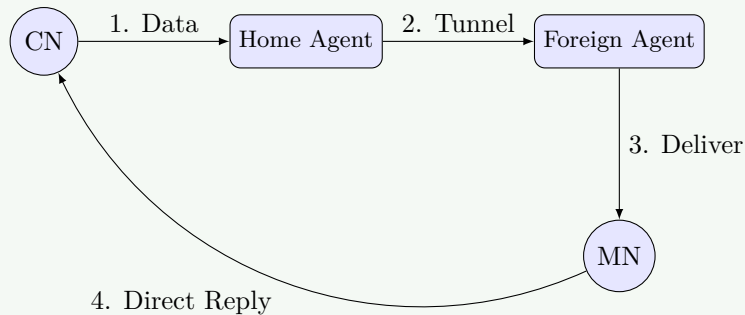
“Snooping Monitors Local Cache Recovery”

## Question 4(b OR) [4 marks]

Explain Packet delivery in Mobile IP

### Solution

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



**Figure 9.** Packet Delivery

**Delivery Scenarios:**

**Table 17.** 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

### Mnemonic

“Address Route Encapsulation Forward Decapsulation Delivery”

## Question 4(c OR) [7 marks]

Describe how DHCP working with diagram

### Solution

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

**DHCP Working Process:**

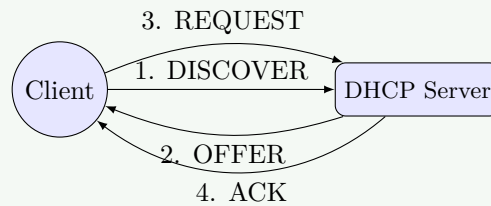


Figure 10. DHCP Process

**Four-Step Process:**

Table 18. Process Steps

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

**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

**Mnemonic**

“Discover Offer Request ACK - Server Client Relay Pool”

**Question 5(a) [3 marks]**

Give types of WLAN and explain any one

**Solution****WLAN Types:**

Table 19. 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:

### Solution

1) List Uses of Ad hoc Network:

**Table 20.** Uses

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

2) Enlist entities and terminology of mobile computing:

- **Entities:** Mobile Node (MN), Home Agent (HA), Foreign Agent (FA), Correspondent Node (CN)
- **Terminology:** Handover, Roaming, Care-of Address

### Mnemonic

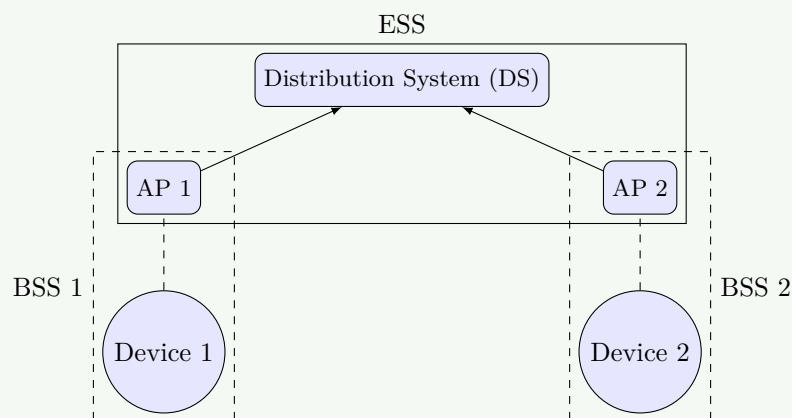
“Emergency Military Conference Home Vehicular - MN HA FA CN”

## Question 5(c) [7 marks]

Explain architecture of WLAN with neat diagram

### Solution

**WLAN Architecture** consists of wireless stations communicating through access points.



**Figure 11. WLAN Architecture****Architecture Components:****Table 21. 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:**

- **Infrastructure Mode:** Centralized, Managed, Scalable
- **Ad-hoc Mode (IBSS):** Peer-to-peer, Decentralized, Temporary

**Mnemonic**

“STA AP BSS ESS DS - Infrastructure Ad-hoc”

**Question 5(a OR) [3 marks]**

Write features of 5G

**Solution****5G Key Features:****Table 22. 5G Features**

Feature	Specification
Speed	Up to 10 Gbps
Latency	< 1 millisecond
Connectivity	1 million devices/km <sup>2</sup>
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:



**Solution****1) List Type of communication middleware:**

- **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. Functions:**

- **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

**Mnemonic**

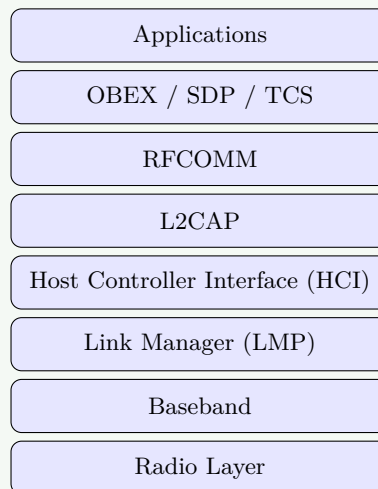
"Message RPC Object Service Database - HA Maintains Tunnels Address Authentication"

**Question 5(c OR) [7 marks]**

**Explain Bluetooth protocol stack with diagram**

**Solution**

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



**Figure 12.** Bluetooth Stack

**Protocol Stack Layers:**

**Table 23.** Layers

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

**Key Features:**

- Frequency Hopping, Piconet, Scatternet, Power Classes

**Mnemonic**

“Application Middleware Transport Network Interface Management DataLink Physical”