

# Mobile Computing and Networks (4351602) - Summer 2025 Solution

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## Question 1(a) [3 marks]

Explain working of POP protocol

### Solution

POP (Post Office Protocol) is an email retrieval protocol that downloads emails from server to client device.

**Working Process:**

**Table 1.** POP Protocol Steps

Step	Action	Description
1	Connection	Client connects to POP server on port 110
2	Authentication	User provides username and password
3	Download	Emails downloaded to local device
4	Deletion	Emails deleted from server after download

**Key Points:**

- **Download-based:** Emails stored locally on client device
- **Offline access:** Can read emails without internet connection
- **Single device:** Best suited for single device access

### Mnemonic

“POP Downloads Once Permanently”

## Question 1(b) [4 marks]

Compare OSI model with TCP/IP model

### Solution

Comparison between OSI and TCP/IP networking models:

**Table 2.** OSI vs TCP/IP Model

Aspect	OSI Model	TCP/IP Model
<b>Layers</b>	7 layers	4 layers
<b>Approach</b>	Theoretical model	Practical implementation
<b>Development</b>	ISO standard	DARPA project
<b>Complexity</b>	More complex	Simpler structure

**Key Differences:**

- **Layer count:** OSI has 7 layers vs TCP/IP's 4 layers
- **Real-world usage:** TCP/IP widely implemented, OSI mostly theoretical
- **Protocol independence:** OSI is protocol-independent, TCP/IP is protocol-specific
- **Header overhead:** OSI has more overhead due to additional layers

### Mnemonic

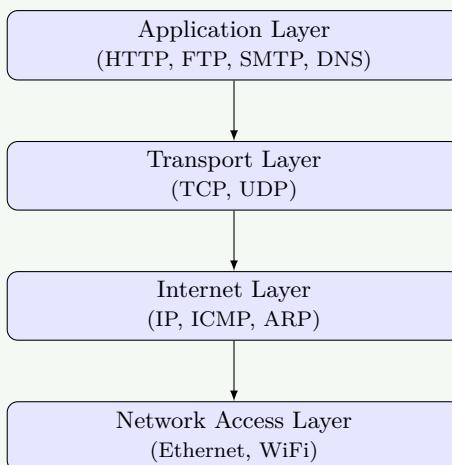
“OSI Seven Theoretical, TCP Four Practical”

## Question 1(c) [7 marks]

Explain protocols working at each layer in TCP/IP models

### Solution

TCP/IP model consists of 4 layers with specific protocols at each layer:



**Figure 1.** TCP/IP Protocols

### Layer-wise Protocol Functions:

**Table 3.** TCP/IP Layer Protocols

Layer	Protocols	Function
<b>Application</b>	HTTP, FTP, SMTP, DNS	User interface and services
<b>Transport</b>	TCP, UDP	End-to-end communication
<b>Internet</b>	IP, ICMP, ARP	Routing and addressing
<b>Network Access</b>	Ethernet, WiFi	Physical transmission

### Protocol Details:

- **HTTP/HTTPS:** Web communication and secure web communication
- **TCP:** Reliable, connection-oriented data transfer
- **UDP:** Fast, connectionless data transfer
- **IP:** Packet routing and addressing
- **ARP:** Maps IP addresses to MAC addresses

### Mnemonic

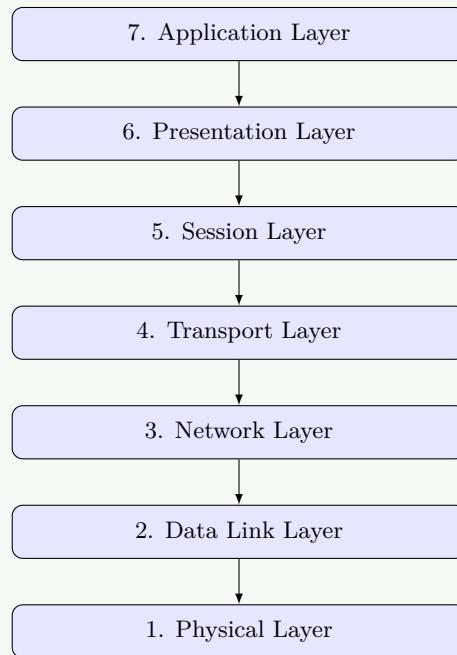
“Applications Transport Internet Networks Always”

## Question 1(c OR) [7 marks]

Briefly explain OSI model with all its layers and functionality of each layer

### Solution

OSI (Open Systems Interconnection) model has 7 layers for network communication:



**Figure 2.** OSI Model Layers

### Layer Functions:

**Table 4.** OSI Layers

Layer	Name	Function	Protocols
7	Application	User interface	HTTP, FTP
6	Presentation	Data formatting, encryption	SSL, JPEG
5	Session	Session management	NetBIOS, RPC
4	Transport	End-to-end delivery	TCP, UDP
3	Network	Routing	IP, ICMP
2	Data Link	Frame transmission	Ethernet, PPP
1	Physical	Bit transmission	Cables, Radio

### Key Features:

- **Modular design:** Each layer has specific responsibilities
- **Protocol independence:** Layers can use different protocols
- **Standardization:** Universal networking reference model

### Mnemonic

“All People Seem To Need Data Processing”

## Question 2(a) [3 marks]

Give the difference between ARP and RARP protocols

### Solution

ARP and RARP are address resolution protocols with opposite functions:

**Table 5.** ARP vs RARP

Aspect	ARP	RARP
<b>Full Form</b>	Address Resolution Protocol	Reverse Address Resolution Protocol
<b>Purpose</b>	IP to MAC address mapping	MAC to IP address mapping
<b>Direction</b>	Logical to Physical	Physical to Logical
<b>Usage</b>	Normal network communication	Diskless workstations

#### Working Process:

- **ARP:** "I know IP address, need MAC address"
- **RARP:** "I know MAC address, need IP address"
- **Cache:** Both maintain address tables for efficiency

### Mnemonic

"ARP Asks Physical, RARP Requests IP"

## Question 2(b) [4 marks]

Explain working of IMAP protocol

### Solution

IMAP (Internet Message Access Protocol) manages emails on server for multiple device access.

#### Working Process:

**Table 6.** IMAP Process

Step	Action	Description
1	Connection	Client connects to IMAP server (port 143/993)
2	Authentication	Login with credentials
3	Folder Access	Browse email folders on server
4	Synchronization	Changes sync across all devices

#### Key Features:

- **Server-based:** Emails remain on server
- **Multi-device:** Access from multiple devices
- **Synchronization:** Changes reflected everywhere
- **Selective download:** Download only needed emails

#### Advantages:

- **Storage efficiency:** Server manages storage
- **Accessibility:** Access from anywhere
- **Backup:** Server provides automatic backup

### Mnemonic

"IMAP Internet Messages Always Present"

## Question 2(c) [7 marks]

Explain Three-tier architecture of mobile computing with appropriate diagram

### Solution

Three-tier architecture separates mobile computing into distinct layers:



**Figure 3.** Three-Tier Mobile Architecture

### Tier Details:

**Table 7.** Architecture Tiers

Tier	Components	Responsibilities
<b>Presentation</b>	Mobile devices, UI	User interface and interaction
<b>Application</b>	App servers, middleware	Business logic and processing
<b>Data</b>	Databases, storage	Data management and storage

### Architecture Benefits:

- Scalability:** Each tier can scale independently
- Maintainability:** Separate concerns for easier updates
- Security:** Data protection through tier separation
- Performance:** Distributed processing reduces load

### Mnemonic

“Presentation Applies Data Processing”

## Question 2(a OR) [3 marks]

Explain the limitation of Stop-and-wait data link layer protocol

### Solution

Stop-and-wait protocol has several performance limitations:

#### Major Limitations:

**Table 8.** Stop-and-Wait Limitations

Limitation	Description	Impact
<b>Low Efficiency</b>	Waits for ACK before next frame	Poor bandwidth utilization
<b>High Delay</b>	Round-trip delay for each frame	Slow data transmission
<b>Error Sensitivity</b>	Single error stops transmission	Reduced reliability

#### Performance Issues:

- Bandwidth waste:** Link remains idle during wait time
- Timeout problems:** Lost ACK causes unnecessary retransmission
- Sequential processing:** Cannot send multiple frames simultaneously

**Mnemonic**

“Stop Waits, Bandwidth Wastes”

**Question 2(b OR) [4 marks]**

Explain Advantages of IPV6 over the older IPV4 addressing scheme

**Solution**

IPv6 provides significant improvements over IPv4:

**Key Advantages:**

**Table 9.** IPv4 vs IPv6

Feature	IPv4	IPv6
<b>Address Space</b>	32-bit (4.3 billion)	128-bit (Undecillion)
<b>Header</b>	Variable length	Fixed 40 bytes
<b>Security</b>	Optional IPSec	Built-in IPSec
<b>Configuration</b>	Manual/DHCP	Auto-configuration

**Major Benefits:**

- **Unlimited addresses:** Solves address exhaustion problem
- **Better performance:** Simplified header processing
- **Enhanced security:** Mandatory encryption support
- **Mobility support:** Better mobile device connectivity

**Mnemonic**

“IPv6 Improves Performance, Security, Addresses”

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

Enlist types of networks available in mobile computing. Explain one of them in detail

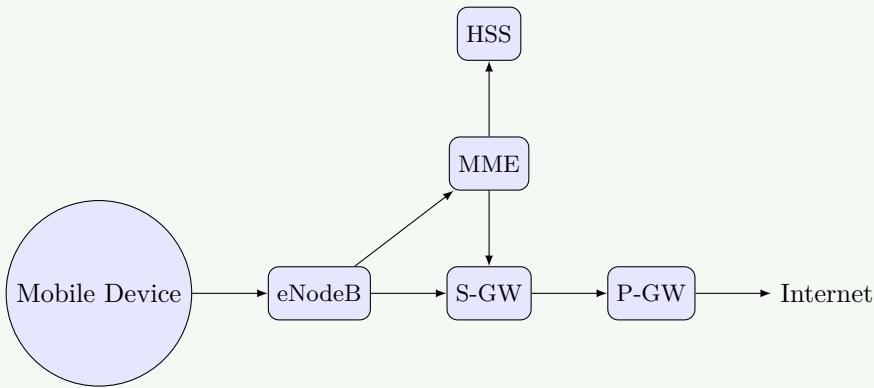
**Solution**

**Types of Mobile Networks:**

**Table 10.** Mobile Network Generations

Generation	Technology	Speed	Features
<b>2G</b>	GSM, CDMA	64 Kbps	Voice + SMS
<b>3G</b>	UMTS, CDMA2000	2 Mbps	Data services
<b>4G</b>	LTE, WiMAX	100 Mbps	High-speed internet
<b>5G</b>	New Radio (NR)	10 Gbps	Ultra-low latency

**Detailed: 4G LTE Network**

**Figure 4.** 4G LTE Architecture**4G LTE Features:**

- **High Speed:** Up to 100 Mbps download
- **Low Latency:** Less than 10ms for real-time applications
- **All-IP Network:** Packet-switched architecture
- **Advanced Antenna:** MIMO technology for better coverage

**Mnemonic**

“4G LTE: Long Term Evolution”

**Question 3(a) [3 marks]****Explain types of Routing****Solution**

Routing determines path for data packets across networks:

**Types of Routing:****Table 11.** Routing Types

Type	Description	Example
<b>Static</b>	Manual route configuration	Administrative setup
<b>Dynamic</b>	Automatic route discovery	RIP, OSPF protocols
<b>Default</b>	Fallback route	Gateway of last resort

**Routing Categories:**

- **Distance Vector:** Uses hop count (RIP)
- **Link State:** Uses network topology (OSPF)
- **Hybrid:** Combines both approaches (EIGRP)

**Mnemonic**

“Static Dynamic Default Routes”

**Question 3(b) [4 marks]****What is Subnetting and supernetting?**

### Solution

Subnetting and supernetting manage IP address allocation efficiently:

**Comparison:**

**Table 12.** Subnetting vs Supernetting

Aspect	Subnetting	Supernetting
Purpose	Divide large network	Combine small networks
Direction	Top-down approach	Bottom-up approach
Result	Multiple smaller subnets	Single larger network

**Benefits:**

- **Subnetting:** Better network management, security, reduced broadcast domain
- **Supernetting:** Simplified routing, route aggregation, reduced routing table size

### Mnemonic

“Subnetting Splits, Supernetting Sums”

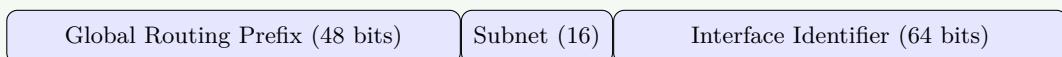
## Question 3(c) [7 marks]

Explain IPV6 Addressing. Why need of IPV6 migration?

### Solution

IPv6 addressing uses 128-bit addresses to solve IPv4 limitations:

**IPv6 Address Structure:**



**Figure 5.** IPv6 Address Format

**Need for IPv6 Migration:**

**Table 13.** Migration Drivers

Problem (IPv4)	IPv6 Solution
Address Exhaustion	340 undecillion addresses
NAT Complexity	End-to-end connectivity
Security Add-on	Built-in IPSec
Limited Mobile Support	Native mobility

**Migration Benefits:**

- **Unlimited growth:** Supports IoT expansion
- **Simplified configuration:** Auto-configuration features
- **Better performance:** Optimized header structure
- **Enhanced security:** Mandatory encryption

### Mnemonic

“IPv6 Infinite Possibilities, Enhanced Security”

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

Determine valid IPv4 address from below

### Solution

#### Analysis:

**Table 14.** IP Address Validation

Address	Validity	Class/Reason	Details
192.108.102.101	Valid	Class C	Network: 192.108.102.0
80.54.256.14	Invalid	Octet > 255	Third octet (256) invalid

#### Results:

- 192.108.102.101: Valid Class C address.
- 80.54.256.14: Invalid because 256 exceeds the maximum octet value of 255.

### Mnemonic

“Each Octet Maximum 255”

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

Write Short note on Network Address Translation

### Solution

NAT translates private IP addresses to public IP addresses for internet access.

#### NAT Types:

- **Static NAT:** One-to-one mapping (1 private = 1 public)
- **Dynamic NAT:** Pool mapping (First come, first served)
- **PAT/NAPT:** Port translation (Many private = 1 public)

#### Benefits:

- **IP conservation:** Multiple devices share one public IP
- **Security:** Hides internal network structure
- **Flexibility:** Easy internal network changes

#### Limitations:

- Breaks end-to-end connectivity model
- Adds packet processing overhead

### Mnemonic

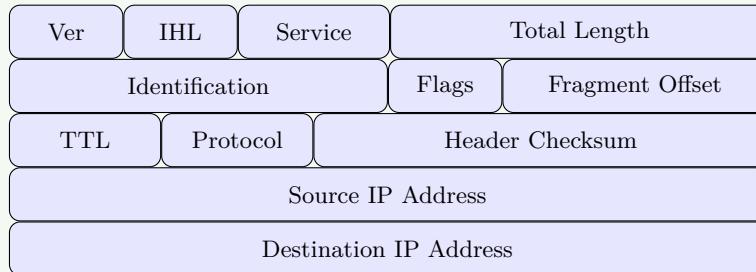
“NAT Networks Address Translation”

## Question 3(c OR) [7 marks]

Explain IPV4 Datagram Header in detail

### Solution

IPv4 header contains essential information for packet routing:

**Figure 6.** IPv4 Header Format**Key Fields:****Table 15.** Header Fields

Field	Purpose
<b>Version</b>	IP version (4)
<b>IHL</b>	Header length
<b>TTL</b>	Time To Live (hops)
<b>Protocol</b>	Next layer protocol (TCP/UDP)
<b>Source/Dest IP</b>	Routing addresses

**Key Functions:**

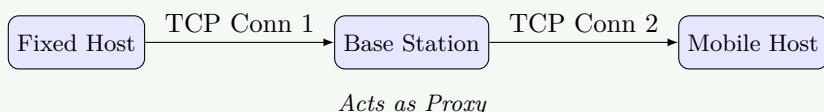
- **Routing:** Source and destination addresses
- **Fragmentation:** Identification, flags, offset
- **Loop Prevention:** TTL field decrements at each router

**Mnemonic**

“Header Has Routing Info”

**Question 4(a) [3 marks]****Explain working of Indirect TCP****Solution**

Indirect TCP splits TCP connection to handle mobile network challenges:

**Figure 7.** Indirect TCP**Working Process:**

- **Split Connection:** Connection 1 (Wired) + Connection 2 (Wireless)
- **Proxy:** Base station acts as proxy, buffering packets
- **Handoff:** Base station migrates state during movement

**Advantages:**

- Isolates wireless link errors from fixed network
- Optimized flow control for each link

**Mnemonic**

“Indirect TCP Through Proxy”

**Question 4(b) [4 marks]**

**Write Short note on Stop and Wait ARQ Protocol**

**Solution**

Stop and Wait ARQ ensures reliable data transmission with error detection.

**Protocol Operation:**

1. **Send:** Transmit frame with sequence number
2. **Wait:** Wait for ACK
3. **Timeout:** Retransmit if no ACK received
4. **ACK:** Receiver confirms delivery

**Features:**

- **Simplicity:** Easy to implement
- **Reliability:** Guarantees delivery via retransmission
- **Inefficiency:** Channel idle while waiting for ACK

**Mnemonic**

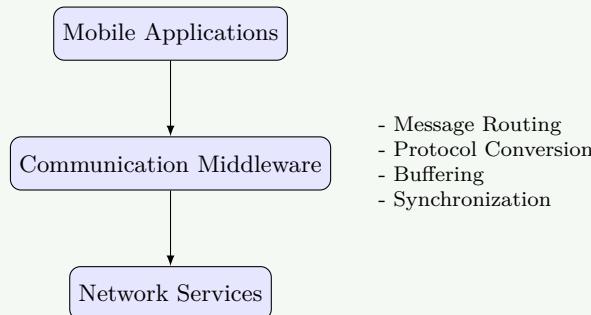
“Stop Send, Wait ACK, Repeat”

**Question 4(c) [7 marks]**

**Explain Communication Middleware in detail**

**Solution**

Communication middleware provides abstraction layer between applications and network.



**Figure 8.** Middleware Architecture

**Middleware Types:**

**Table 16.** Middleware Types

Type	Function
<b>Message-Oriented</b>	Asynchronous messaging (Queues)
<b>RPC-based</b>	Remote procedure calls (RMI)
<b>Event-driven</b>	Publish-subscribe notifications

**Mobile-Specific Features:**

- **Location transparency:** Hides mobility details
- **Disconnection handling:** Manages intermittent connectivity
- **Bandwidth adaptation:** Adjusts to varying network quality

**Mnemonic**

“Middleware Manages Mobile Communication”

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

**Explain Handover management in mobile IP**

**Solution**

Handover management maintains connectivity when mobile device moves between networks.

**Handover Process:**

1. **Detection:** Monitor signal strength
2. **Decision:** Select best available network
3. **Execution:** Switch to new network

**Types:**

- **Horizontal:** Same technology (e.g., cell to cell)
- **Vertical:** Different technology (e.g., WiFi to 4G)
- **Hard:** Break-before-make
- **Soft:** Make-before-break

**Mnemonic**

“Handover Helps Maintain Mobility”

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

**Explain key functions of Communication Gateways**

**Solution**

Communication gateways enable interoperability between different systems.

**Key Functions:**

**Table 17.** Gateway Functions

Function	Benefit
<b>Protocol Translation</b>	Interoperability between protocols
<b>Data Conversion</b>	Format compatibility
<b>Security</b>	Firewall, authentication
<b>Load Balancing</b>	Performance optimization

**Services:**

- **Caching:** Store frequently accessed data
- **Compression:** Reduce data size for transmission
- **Traffic Shaping:** Manage bandwidth usage

**Mnemonic**

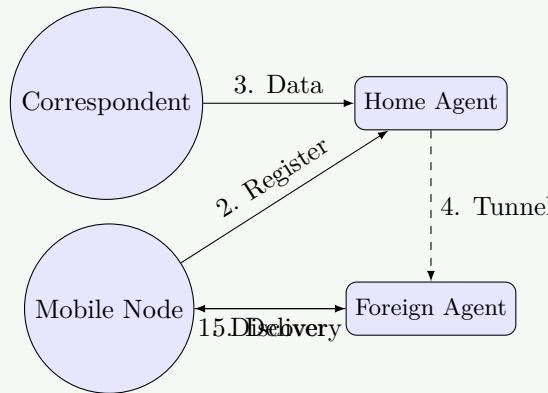
“Gateways Grant Protocol Interoperability”

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

Explain Process of mobile IP

### Solution

Mobile IP enables global connectivity for moving devices.



**Figure 9.** Mobile IP Process

#### Key Phases:

1. **Agent Discovery:** MN finds Foreign Agent
2. **Registration:** MN registers Care-of Address with Home Agent
3. **Tunneling:** HA intercepts packets and tunnels to FA
4. **Delivery:** FA decapsulates and delivers to MN

#### Components:

- **Home Agent (HA):** Router on home network
- **Foreign Agent (FA):** Router on visited network
- **Care-of Address (CoA):** Temporary address

### Mnemonic

“Mobile IP: Discover Register Tunnel Deliver”

## Question 5(a) [3 marks]

List advantages of WPANs

### Solution

WPAN (Wireless Personal Area Network) provides short-range connectivity (e.g., Bluetooth, Zigbee).

#### Advantages:

- **Low Power:** Extended battery life for devices
- **Low Cost:** Inexpensive implementation
- **Easy Setup:** Automatic discovery and pairing
- **Ad-hoc:** No infrastructure required

#### Applications:

- Connecting peripherals (keyboard, mouse)
- IoT and smart home integration
- Wearable devices (fitness trackers)

**Mnemonic**

“WPANs: Wireless Personal Area Networks”

**Question 5(b) [4 marks]**

Explain steps of packet delivery in mobile IP

**Solution**

**Packet Delivery Steps:**

**Table 18.** Packet Delivery Flow

Step	location	Action
1	Correspondent	Send packet to Home Address
2	Home Agent	Intercept packet
3	Tunneling	Encapsulate to Care-of Address
4	Foreign Agent	Decapsulate packet
5	Mobile Node	Receive packet

**Tunneling Mechanism:**

- **Encapsulation:** Original IP packet is wrapped in a new IP packet
- **Outer Header:** Source=HA, Dest=CoA
- **Inner Header:** Source=CN, Dest=Home Address

**Mnemonic**

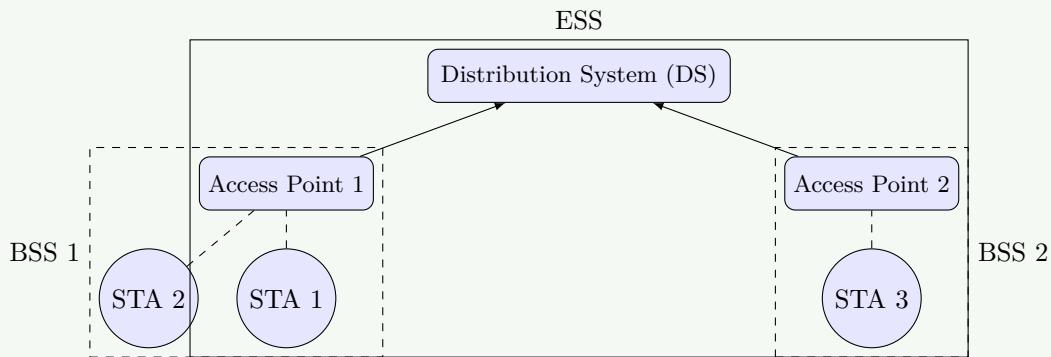
“Correspondent Home Foreign Mobile”

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

Briefly Explain architecture of WLAN with diagram

**Solution**

WLAN (Wireless Local Area Network) provides local wireless access.



**Figure 10.** WLAN Infrastructure Mode

**Components:**

**Table 19.** WLAN Components

Component	Function
Station (STA)	Wireless client device
Access Point (AP)	Wireless base station
BSS	Basic Service Set (AP + Stations)
DS	Wired backbone connecting APs
ESS	Extended Service Set (Multiple BSS)

**Modes:**

- **Infrastructure:** Uses APs (Home/Office WiFi)
- **Ad-hoc:** Direct device-to-device (IBSS)

**Mnemonic**

“WLAN: Wireless Local Area Network”

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

Explain 5G mobile network features in detail

**Solution**

5G is the fifth generation of mobile network technology.

**Key Features:**

- **Speed:** Up to 10 Gbps (100x faster than 4G)
- **Latency:** < 1ms (Ultra-low latency for realtime control)
- **Density:** Support for 1 million devices/km<sup>2</sup> (IoT)

**Technologies:**

- **Millimeter Wave:** High frequency for high speed
- **Massive MIMO:** Many antennas for capacity
- **Network Slicing:** Virtual networks for specific needs

**Mnemonic**

“5G: Fifth Generation Great Speed”

**Question 5(b OR) [4 marks]**

Explain how DHCP works in a mobile network context

**Solution**

DHCP assigns IP addresses. In mobile networks, it must handle movement.

**DHCP DORA Process:**

**Table 20.** DHCP Process

Message	Description
<b>Discover</b>	Client looks for server
<b>Offer</b>	Server offers IP
<b>Request</b>	Client requests IP
<b>ACK</b>	Server confirms

**Mobile Challenges:**

- **Fast Handover:** Need rapid IP assignment when moving
- **Lease Renewal:** Frequent renewal or long leases needed
- **Mobility:** COA assignment in Mobile IP often uses DHCP

### Mnemonic

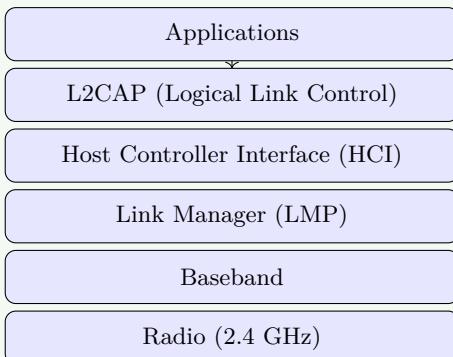
“DHCP: Discover Offer Request ACK”

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

Explain Bluetooth technology with a neat figure of its protocol stack

### Solution

Bluetooth is a short-range wireless standard for P2P communication.



**Figure 11.** Bluetooth Stack

### Layer Functions:

**Table 21.** Bluetooth Layers

Layer	Function
<b>Radio</b>	Physical transmission (FHSS)
<b>Baseband</b>	Timing, framing, error control
<b>LMP</b>	Connection setup, security, authentication
<b>L2CAP</b>	Multiplexing, segmentation, reassembly
<b>Applications</b>	Profiles (Audio, File Transfer)

### Features:

- **Piconet:** Master + up to 7 Slaves
- **Scatternet:** Interconnected Piconets
- **Low Cost/Power:** Designed for portable devices

### Mnemonic

“Bluetooth: Radio Baseband LMP HCI L2CAP Applications”