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
Layers	7 layers	4 layers
Approach	Theoretical model	Practical implementation
Development	ISO standard	DARPA project
Complexity	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:

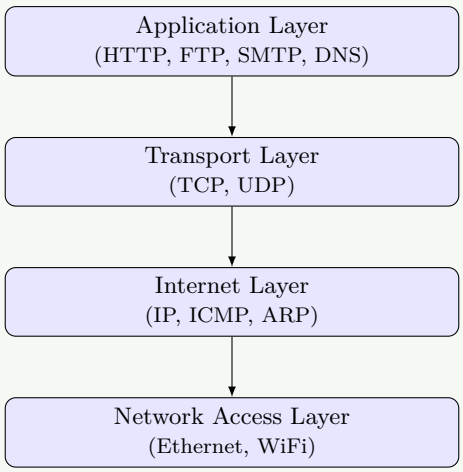

Figure 1. TCP/IP Protocols

Layer-wise Protocol Functions:

Table 3. TCP/IP Layer Protocols

Layer	Protocols	Function
Application	HTTP, FTP, SMTP, DNS	User interface and services
Transport	TCP, UDP	End-to-end communication
Internet	IP, ICMP, ARP	Routing and addressing
Network Access	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:

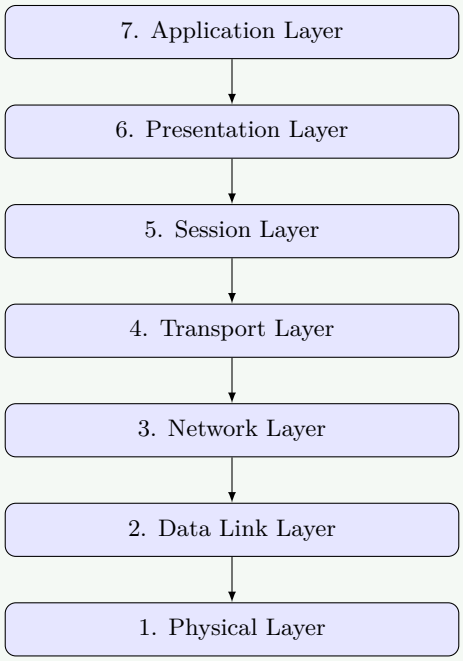

Figure 2. OSI Model Layers

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
Full Form	Address Resolution Protocol	Reverse Address Resolution Protocol
Purpose	IP to MAC address mapping	MAC to IP address mapping
Direction	Logical to Physical	Physical to Logical
Usage	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
Presentation	Mobile devices, UI	User interface and interaction
Application	App servers, middleware	Business logic and processing
Data	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
Low Efficiency	Waits for ACK before next frame	Poor bandwidth utilization
High Delay	Round-trip delay for each frame	Slow data transmission
Error Sensitivity	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
Address Space	32-bit (4.3 billion)	128-bit (Undecillion)
Header	Variable length	Fixed 40 bytes
Security	Optional IPSec	Built-in IPSec
Configuration	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
2G	GSM, CDMA	64 Kbps	Voice + SMS
3G	UMTS, CDMA2000	2 Mbps	Data services
4G	LTE, WiMAX	100 Mbps	High-speed internet
5G	New Radio (NR)	10 Gbps	Ultra-low latency

Detailed: 4G LTE Network

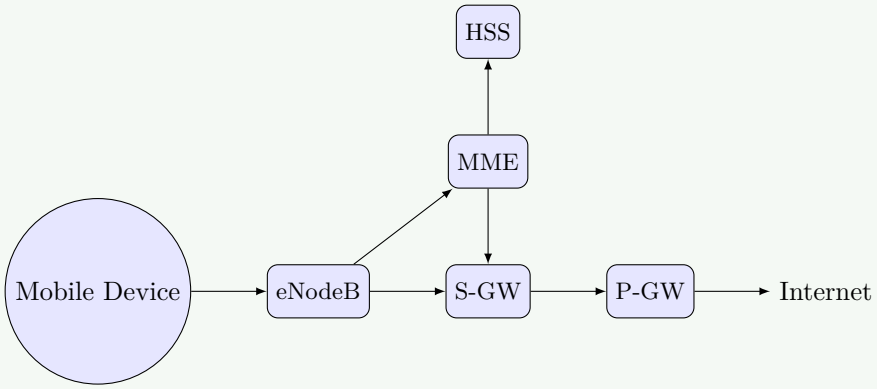

Figure 4. 4G LTE Architecture

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
Static	Manual route configuration	Administrative setup
Dynamic	Automatic route discovery	RIP, OSPF protocols
Default	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:

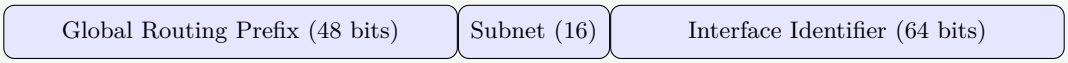

Figure 5. IPv6 Address Format

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:

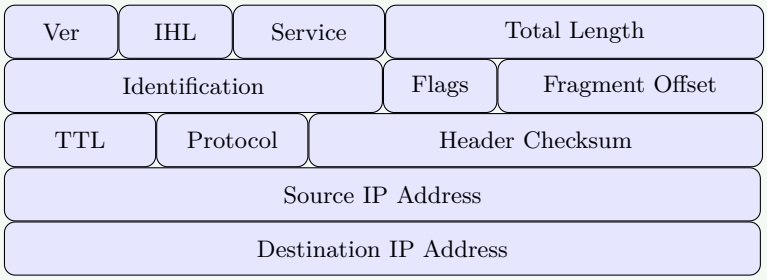

Figure 6. IPv4 Header Format

Key Fields:

Table 15. Header Fields

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

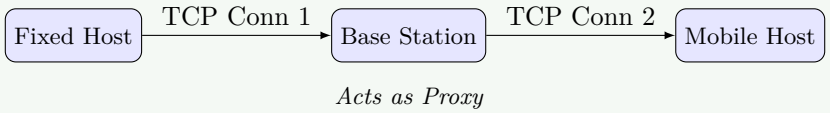

Figure 7. Indirect TCP

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.

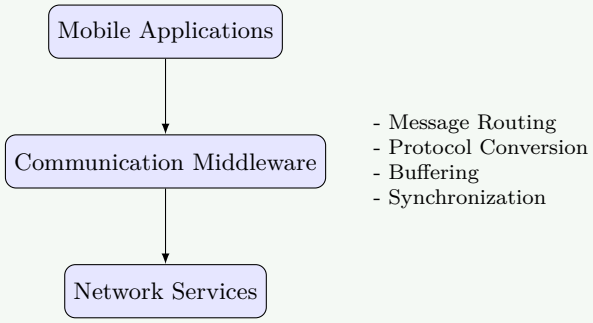

Figure 8. Middleware Architecture

Middleware Types:

Table 16. Middleware Types

Type	Function
Message-Oriented	Asynchronous messaging (Queues)
RPC-based	Remote procedure calls (RMI)
Event-driven	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
Protocol Translation	Interoperability between protocols
Data Conversion	Format compatibility
Security	Firewall, authentication
Load Balancing	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.

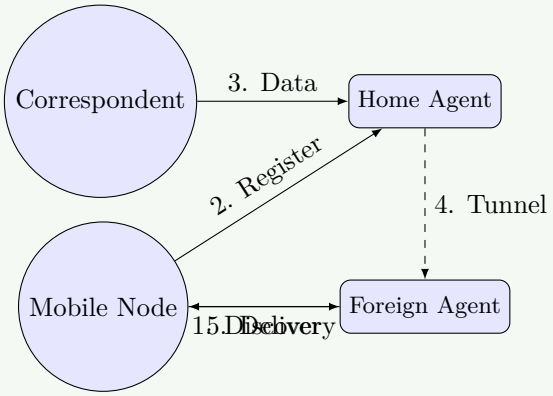

Figure 9. Mobile IP Process

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.

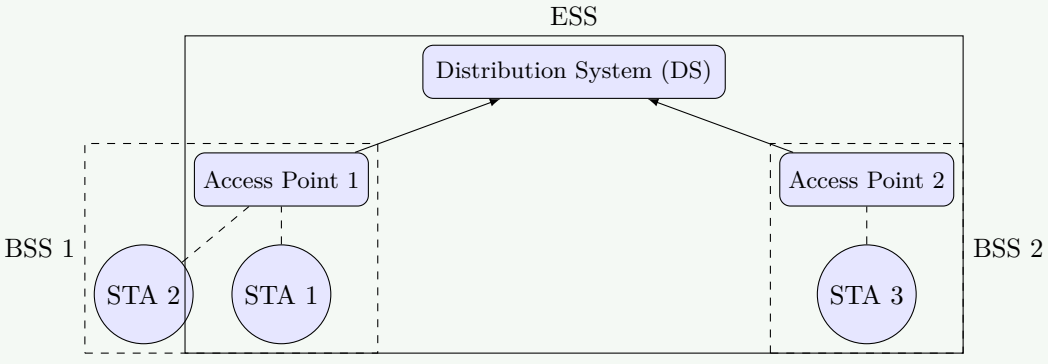

Figure 10. WLAN Infrastructure Mode

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^2 (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
Discover	Client looks for server
Offer	Server offers IP
Request	Client requests IP
ACK	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.

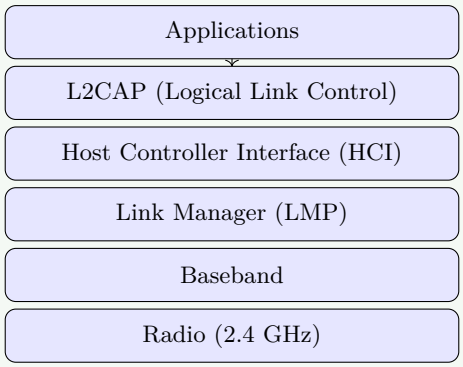

Figure 11. Bluetooth Stack

Layer Functions:

Table 21. Bluetooth Layers

Layer	Function
Radio	Physical transmission (FHSS)
Baseband	Timing, framing, error control
LMP	Connection setup, security, authentication
L2CAP	Multiplexing, segmentation, reassembly
Applications	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"