

Mobile Computing and Networks (4351602) - Winter 2024 Solution

Milav Dabgar

November 25, 2024

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.

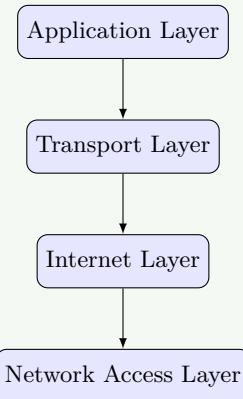


Figure 1. TCP/IP Model

Layer Functions:

Table 3. Layer Functions

| Layer | Function | Protocols |
|-----------------------|----------------------------------|-----------------|
| 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

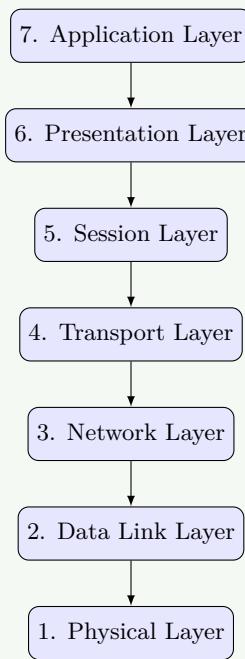
“All Transport Internet Network”

Question 1(c OR) [7 marks]

Explain OSI model with each layer functionality

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 |
|-------------------------|---------------------|--------------------|
| 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

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

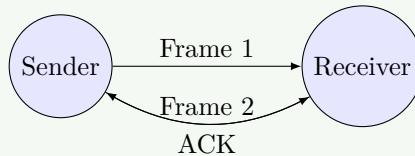


Figure 3. Stop and Wait ARQ

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.

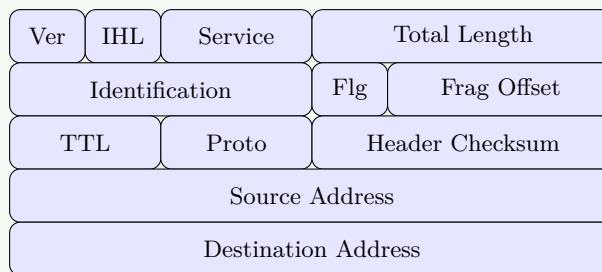


Figure 4. IPv4 Header

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 |
|----------|---------|--------------|-----------|-----------------|
| 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 |

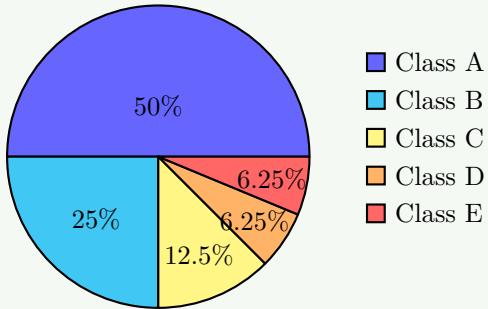


Figure 5. IPv4 Address Classes

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.

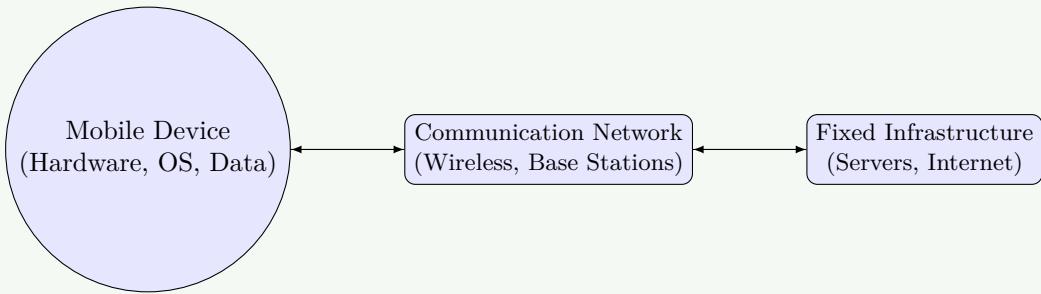


Figure 6. Mobile Computing Architecture

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 |
|-------------------|--------------------------------|
| 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

Solution

Communication Gateway manages data exchange between different network systems.

Key Functions:

Table 12. 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

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

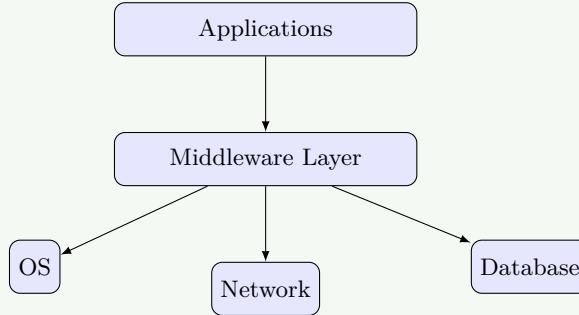


Figure 7. Middleware Layer

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 |
|------------------------|--------------------------------|
| 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****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 |
|----------------------|----------------------|
| 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**

Solution

Registration and Tunneling are core mechanisms enabling Mobile IP functionality.

Registration Process:

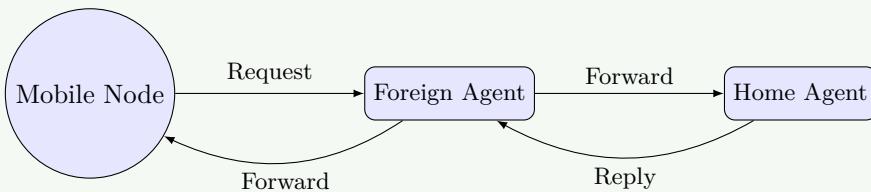


Figure 8. Registration Process

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 |
|-------------------------|--------------------------------------|
| 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

Solution

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

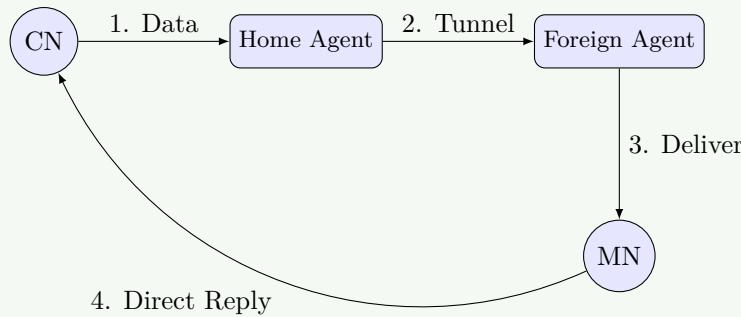


Figure 9. Packet Delivery

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”

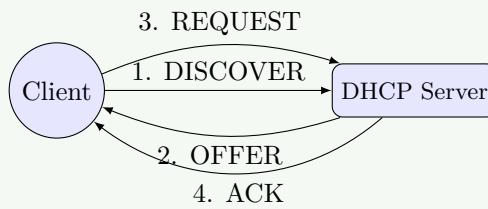
Question 4(c OR) [7 marks]

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 |
|--------------------|--------------------------------------|
| 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), 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.

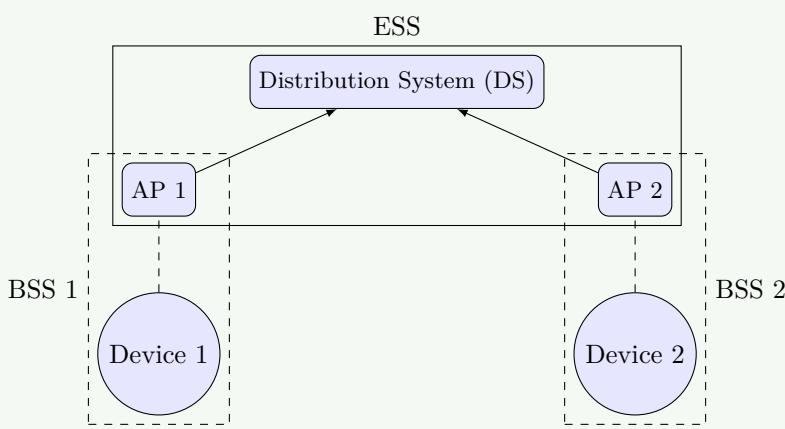


Figure 11. WLAN Architecture

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 ² |
| 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.

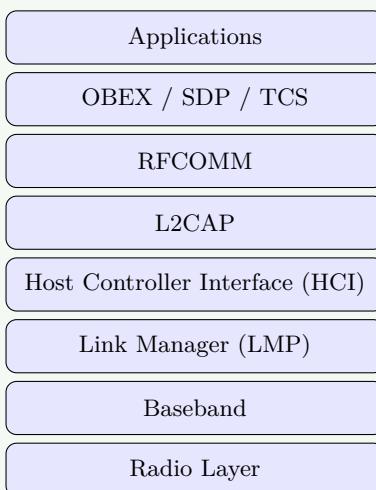


Figure 12. Bluetooth Stack

Protocol Stack Layers:

Table 23. Layers

| Layer | Function | Protocols |
|--------------------|--------------------|----------------------|
| 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 |

Key Features:

- Frequency Hopping, Piconet, Scatternet, Power Classes

Mnemonic

“Application Middleware Transport Network Interface Management DataLink Physical”