Mobile Computing and Networks (4351602) - Summer 2024 Solution

Milav Dabgar

May 18, 2024

Question 1(a) [3 marks]

Define Peer to Peer network

Solution

A Peer-to-Peer (P2P) network is a distributed network architecture where each node (peer) acts as both client and server, sharing resources directly without centralized control.

Table 1. Peer to Peer Network Features

Aspect	Description
Structure	Decentralized network
Role	Each peer is client and server
Control	No central authority
Examples	BitTorrent, Skype

Mnemonic

"Peers Share Equally"

Question 1(b) [4 marks]

Compare SMTP, POP and IMAP

Solution

Email protocols serve different purposes in email communication system.

Table 2. Comparison of Email Protocols

Feature	SMTP	POP3	IMAP
Purpose	Send emails	Download emails	Access emails
Port	25, 587	110, 995	143, 993
Storage	Server forwards	Local storage	Server storage
Access	One-way sending	Single device	Multiple devices

Mnemonic

"Send-Pop-Internet Mail Access"

Question 1(c) [7 marks]

Illustrate OSI model with responsibilities of each layer

Solution

The OSI (Open Systems Interconnection) model has seven layers, each with specific responsibilities for network communication.
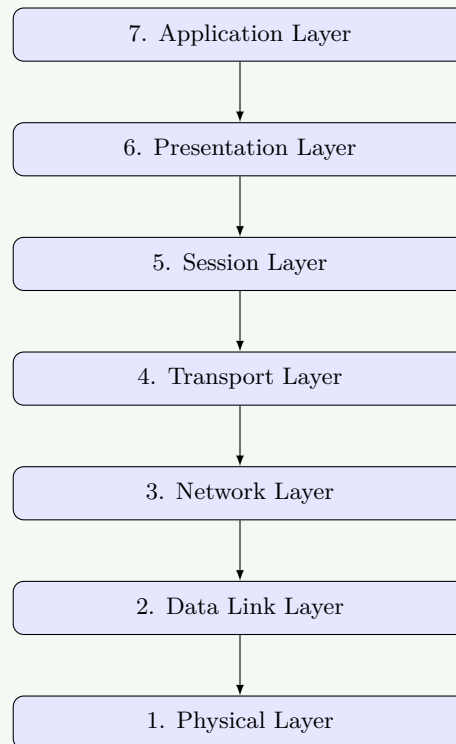

Figure 1. OSI Model Layers

Table 3. OSI Layers and Responsibilities

Layer	Name	Responsibilities
7	Application	User interface, network services
6	Presentation	Data encryption, compression
5	Session	Session management, dialogue control
4	Transport	End-to-end delivery, error control
3	Network	Routing, logical addressing
2	Data Link	Frame formatting, error detection
1	Physical	Bit transmission, hardware

Key Points:
- **Application Layer**: Provides network services to applications
- **Transport Layer**: Ensures reliable data delivery
- **Network Layer**: Handles routing between networks

Mnemonic

"All People Seem To Need Data Processing"

Question 1(c OR) [7 marks]

Compare the TCP/IP model with OSI model

Solution

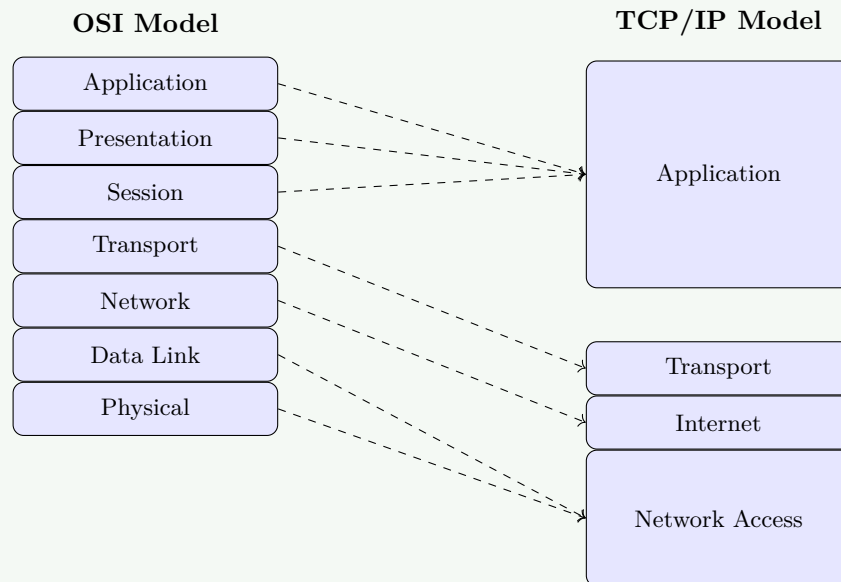TCP/IP and OSI models are network architecture frameworks with different layer structures.

Figure 2. OSI vs TCP/IP Model Comparison

Table 4. OSI vs TCP/IP Model

Aspect	OSI Model	TCP/IP Model
Layers	7 layers	4 layers
Development	Theoretical	Practical
Usage	Reference model	Internet standard
Complexity	More detailed	Simplified

Key Points:
- **OSI**: Theoretical framework with detailed separation
- **TCP/IP**: Practical implementation for internet
- **Mapping**: Top 3 OSI layers = Application layer in TCP/IP

Mnemonic

"OSI Seven, TCP Four"

Question 2(a) [3 marks]

Explain Network Address Translation (NAT)

Solution

NAT translates private IP addresses to public IP addresses, enabling multiple devices to share a single public IP.
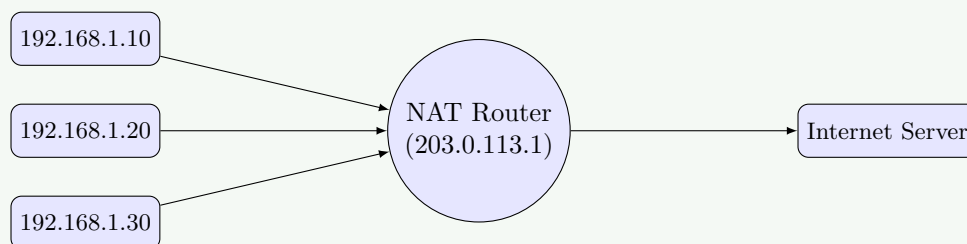

Figure 3. Network Address Translation

Key Points:
- **Purpose**: IP address translation between networks
- **Benefit**: Conserves public IP addresses
- **Security**: Hides internal network structure

Mnemonic

"Network Address Translation"

Question 2(b) [4 marks]

Define Subnetting and Supernetting

Solution

Subnetting and Supernetting are IP addressing techniques for efficient network management.

Table 5. Subnetting vs Supernetting

Technique	Definition	Purpose
Subnetting	Dividing network into smaller subnets	Better organization
Supernetting	Combining multiple networks	Route aggregation

Key Points:
- **Subnetting**: Increases network bits, reduces host bits
- **Supernetting**: Decreases network bits, increases routing efficiency
- **CIDR**: Classless Inter-Domain Routing enables both

Mnemonic

"Sub-divides, Super-combines"

Question 2(c) [7 marks]

Demonstrate Classful and Classless notation addressing scheme of IPv4

Solution

IPv4 addressing uses classful and classless schemes for network identification.

Table 6. Classful Addressing

Class	Range	Default Mask	Networks	Hosts
A	1-126	/8 (255.0.0.0)	126	16M
B	128-191	/16 (255.255.0.0)	16K	65K
C	192-223	/24 (255.255.255.0)	2M	254

Classless (CIDR) Examples:
- **192.168.1.0/25**: 128 hosts
- **10.0.0.0/16**: 65,536 hosts
- **172.16.0.0/20**: 4,096 hosts

Key Points:
- **Classful**: Fixed network/host boundaries
- **Classless**: Variable Length Subnet Mask (VLSM)
- **CIDR**: More efficient address allocation

Mnemonic

"Class-Fixed, CIDR-Flexible"

Question 2(a OR) [3 marks]

Discuss goals of mobile IP

Solution

Mobile IP enables seamless connectivity for mobile devices across different networks.
Key Points:
- **Transparency**: Applications unaware of mobility
- **Compatibility**: Works with existing protocols
- **Efficiency**: Minimal routing overhead

Mnemonic

"Transparent Compatible Efficient"

Question 2(b OR) [4 marks]

Define ARP and RARP

Solution

ARP and RARP are address resolution protocols for mapping between different address types.

Table 7. ARP vs RARP

Protocol	Full Name	Purpose	Direction
ARP	Address Resolution Protocol	IP to MAC mapping	Logical to Physical
RARP	Reverse ARP	MAC to IP mapping	Physical to Logical

Mnemonic

"ARP-asks, RARP-reverses"

Question 2(c OR) [7 marks]

Demonstrate Stop and Wait, Stop and Wait ARQ data link layer protocols

---

Solution

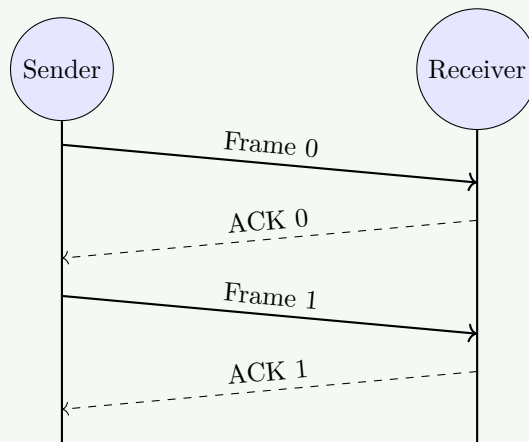These protocols ensure reliable data transmission at the data link layer.

Figure 4. Stop and Wait Protocol Interaction

Table 8. Protocol Comparison

Protocol	Error Detection	Efficiency	Complexity
Stop and Wait	Basic	Low	Simple
Stop and Wait ARQ	Advanced	Medium	Moderate

Key Points:
- **Stop and Wait**: Send frame, wait for acknowledgment
- **ARQ**: Automatic Repeat reQuest on errors
- **Timeout**: Resend if no acknowledgment received

Mnemonic

"Stop-Wait-Acknowledge"

Question 3(a) [3 marks]

Explain Wireless networks

Solution

Wireless networks use radio waves for communication without physical connections.
Key Points:
- **Technology**: Radio frequency transmission
- **Types**: WiFi, Bluetooth, Cellular
- **Benefits**: Mobility, easy installation

Mnemonic

"Wireless-Radio-Mobile"

Question 3(b) [4 marks]

Define Communication Middleware in mobile computing

Solution

Communication middleware provides abstraction layer for mobile application communication.

Table 9. Communication Middleware

Aspect	Description
Purpose	Simplify communication
Location	Between app and network
Features	Protocol handling, data conversion
Examples	CORBA, RMI

Mnemonic

"Middle-Communication-Layer"

Question 3(c) [7 marks]

Discuss the architecture of Mobile Computing

Solution

Mobile computing architecture consists of multiple interconnected components supporting mobile applications.
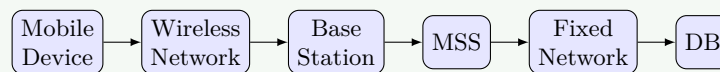

Figure 5. Mobile Computing Architecture

Table 10. Architecture Components

Component	Function
Mobile Device	User interface, local processing
Wireless Network	Radio communication
Base Station	Network access point
MSS	Mobility management
Fixed Network	Backbone infrastructure

Key Points:
- **Three-tier**: Mobile device, wireless network, fixed network
- **Mobility Support**: Handoff management
- **Data Management**: Caching and synchronization

Mnemonic

"Mobile-Wireless-Fixed"

Question 3(a OR) [3 marks]

Demonstrate ad-hoc networks

Solution

Ad-hoc networks are self-organizing wireless networks without fixed infrastructure.
Key Points:
- **Structure**: Peer-to-peer topology
- **Routing**: Dynamic route discovery
- **Applications**: Emergency, military

Mnemonic

"Ad-hoc-Self-Organizing"

Question 3(b OR) [4 marks]

Define Transaction Processing Middleware in mobile computing

Solution

Transaction processing middleware ensures ACID properties in mobile database transactions.

Table 11. ACID Properties

Property	Description
Atomicity	All or nothing execution
Consistency	Database integrity maintained
Isolation	Concurrent transaction separation
Durability	Permanent transaction effects

Mnemonic

"ACID-Properties"

Question 3(c OR) [7 marks]

Discuss the applications and services of mobile computing

Solution

Mobile computing enables diverse applications across multiple domains.

Table 12. Applications and Services

Domain	Applications	Services
Business	CRM, ERP	Data synchronization
Healthcare	Patient monitoring	Remote diagnosis
Education	E-learning	Content delivery
Entertainment	Gaming, streaming	Media services
Navigation	GPS, maps	Location services

Key Points:
- **Location-based**: GPS navigation, geo-fencing
- **Communication**: Email, messaging, video calls
- **Commerce**: Mobile banking, shopping

> **Mnemonic**
>
> "Business-Health-Education-Entertainment"

Question 4(a) [3 marks]

Describe Indirect TCP in mobile computing

> **Solution**
>
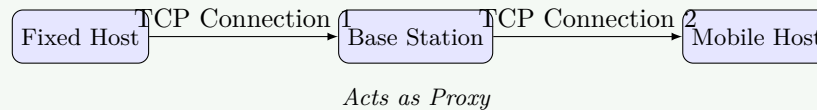> Indirect TCP splits TCP connection to handle mobile host mobility efficiently.
>
>
> *Acts as Proxy*
>
> **Figure 6.** Indirect TCP Split Connection
>
> **Key Points:**
> - **Split Connection**: Two separate TCP connections
> - **Base Station**: Acts as proxy
> - **Advantage**: Faster handoff

> **Mnemonic**
>
> "Indirect-Split-Proxy"

Question 4(b) [4 marks]

Explain the steps of the packet delivery in Mobile IP

> **Solution**
>
> Mobile IP packet delivery involves registration, tunneling, and delivery steps.
> **Steps:**
> 1. **Registration**: Mobile node registers with home agent
> 2. **Tunneling**: Home agent creates tunnel to foreign agent
> 3. **Encapsulation**: Original packet wrapped in new header
> 4. **Delivery**: Foreign agent delivers to mobile node

> **Mnemonic**
>
> "Register-Tunnel-Encapsulate-Deliver"

Question 4(c) [7 marks]

Write following three processes of mobile IP: (1) Registration (2) Tunneling (3) Encapsulation
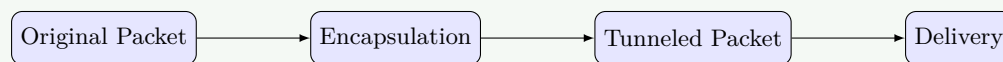
Solution

1. Registration Process:
- Mobile node discovers foreign agent
- Registers care-of address with home agent
- Authentication and binding update

2. Tunneling Process:
- Home agent creates virtual tunnel
- Packets forwarded through tunnel
- Maintains end-to-end connectivity

3. Encapsulation Process:
- Original packet becomes payload
- New IP header added with care-of address
- Packet delivered to foreign network

Original Packet → Encapsulation → Tunneled Packet → Delivery

Figure 7. Mobile IP Encapsulation Flow

Key Points:
- **Registration**: Location update mechanism
- **Tunneling**: Virtual connection establishment
- **Encapsulation**: Packet wrapping technique

Mnemonic

"Register-Tunnel-Encapsulate"

Question 4(a OR) [3 marks]

Describe Snooping TCP in mobile computing

Solution

Snooping TCP improves performance by caching and monitoring TCP segments at base station.
Key Points:
- **Local Retransmission**: Base station handles losses
- **Buffer Management**: Caches unacknowledged segments
- **Transparency**: End-to-end TCP maintained

Mnemonic

"Snoop-Cache-Retransmit"

Question 4(b OR) [4 marks]

Explain the Handover Management in mobile IP

Solution

Handover management maintains connectivity when mobile node changes networks.

Table 13. Handover Phases

Phase	Process
Discovery	Find new foreign agent
Registration	Update care-of address
Data Forwarding	Redirect packets
Cleanup	Release old resources

Mnemonic

"Discover-Register-Forward-Cleanup"

Question 4(c OR) [7 marks]

Write the goals and the requirements for the Mobile IP

Solution

Goals:
- **Transparency**: Seamless mobility for applications
- **Compatibility**: Work with existing internet protocols
- **Scalability**: Support large number of mobile nodes
- **Security**: Authenticate mobile nodes and protect data

Requirements:
- **Home Agent**: Maintains mobile node location
- **Foreign Agent**: Provides local services
- **Care-of Address**: Temporary address in foreign network
- **Tunneling**: Packet forwarding mechanism

Table 14. Mobile IP Goals vs Requirements

Aspect	Goals	Requirements
Mobility	Seamless movement	Care-of address
Connectivity	Maintain sessions	Tunneling
Performance	Minimal overhead	Efficient routing
Security	Authentication	Secure protocols

Mnemonic

"Transparent-Compatible-Scalable-Secure"

Question 5(a) [3 marks]

Write the features of 6G in mobile networks

Solution

6G represents the next generation of mobile networks with advanced capabilities.

Key Points:
- **Speed**: 1 Tbps theoretical speed
- **Latency**: Sub-millisecond latency
- **AI Integration**: Native artificial intelligence

Question 5(b) [4 marks]

Describe Dynamic Host Configuration Protocol (DHCP)

Solution

DHCP automatically assigns IP addresses and network configuration to devices.

Table 15. DHCP Process (DORA)

Process	Description
Discover	Client broadcasts request
Offer	Server offers IP address
Request	Client requests specific IP
Acknowledge	Server confirms assignment

Question 5(c) [7 marks]

Describe the architecture of Wireless Personal Area Network (WLAN)

Solution

WLAN architecture provides wireless connectivity within local area using IEEE 802.11 standards.
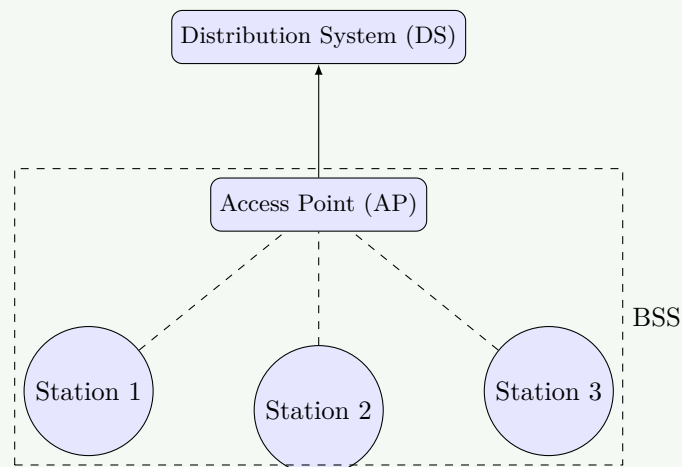

Figure 8. WLAN Architecture (Infrastructure Mode)

Table 16. WLAN Components

Component	Function
Access Point	Central wireless hub
Station	Wireless client device
Distribution System	Backbone network
BSS	Basic Service Set
ESS	Extended Service Set

Key Points:
- **Infrastructure Mode**: Uses access points
- **Ad-hoc Mode**: Direct device communication
- **Standards**: 802.11a/b/g/n/ac/ax protocols

Mnemonic

"Access-Station-Distribution"

Question 5(a OR) [3 marks]

Write the features of 5G in mobile networks

Solution

5G provides enhanced mobile broadband with ultra-low latency.
Key Points:
- **Speed**: Up to 10 Gbps download
- **Latency**: 1ms ultra-low latency
- **Density**: 1 million devices per km^2

Mnemonic

"10G-1ms-1Million"

Question 5(b OR) [4 marks]

Explain WWW and HTTP

Solution

World Wide Web uses HTTP protocol for web page communication.

Table 17. WWW vs HTTP

Aspect	WWW	HTTP
Purpose	Information sharing	Communication protocol
Components	Web pages, browsers	Request/response
Format	HTML documents	Text-based protocol
Port	Various	80, 443

Mnemonic

"Web-Hypertext-Transfer"

Question 5(c OR) [7 marks]

Describe the architecture of Bluetooth

Solution

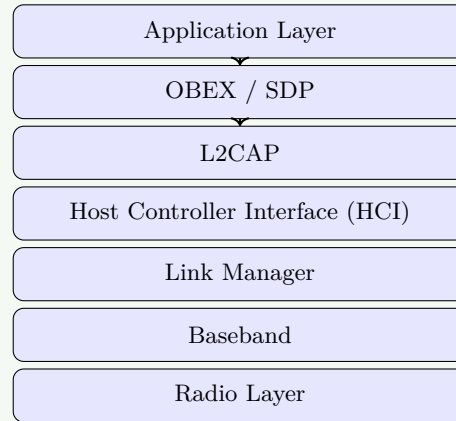Bluetooth architecture provides short-range wireless communication using protocol stack.

Application Layer
OBEX / SDP
L2CAP
Host Controller Interface (HCI)
Link Manager
Baseband
Radio Layer

Figure 9. Bluetooth Protocol Stack

Table 18. Bluetooth Layers

Layer	Function
Radio	Physical transmission
Baseband	Timing and frequency hopping
Link Manager	Connection management
HCI	Host Controller Interface
L2CAP	Logical Link Control
Applications	User services

Key Points:
- **Piconet**: Master-slave network topology
- **Frequency Hopping**: 79 frequency channels
- **Power Classes**: Different transmission ranges

Mnemonic

"Radio-Baseband-Link-Host-Logic"