Mobile & Wireless Communication (4351104) - Summer 2024 Solution

Milav Dabgar

May 23, 2024

Question 1(a) [3 marks]

Explain selective cell.

Solution

Selective Cell Characteristics:

Table 1. Selective Cell Features

Feature	Description
Purpose	Provides coverage for specific areas
Size	Small coverage area
Application	Indoor locations, tunnels, buildings
Antenna	Directional antenna system

- **Selective coverage**: Targets specific geographical areas needing signal.
- **Indoor solution**: Primarily used for building coverage enhancement.
- **Directional transmission**: Uses focused beam patterns for efficiency.

Mnemonic

"Select Special Spots"

Question 1(b) [4 marks]

Draw and explain umbrella cell.

Solution

Umbrella Cell Structure:

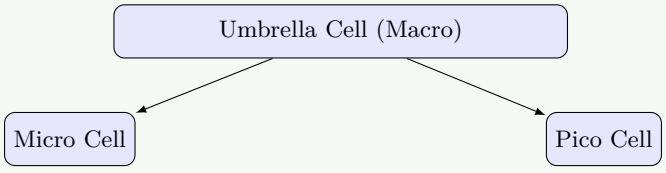

Figure 1. Umbrella Cell Concept

Features:

Table 2. Umbrella Cell Features

Parameter	Description
Coverage	Large area coverage
Purpose	Overlays smaller cells
Handoff	Manages inter-cell transitions
Capacity	Handles overflow traffic

- **Large coverage**: Provides wide area signal coverage over smaller cells.
- **Traffic management**: Handles overflow from micro and pico cells.
- **Seamless handoff**: Ensures continuous communication during movement.

Mnemonic

"Umbrella Covers All"

Question 1(c) [7 marks]

What is the cell? Explain frequency reuse.

Solution

Cell & Frequency Reuse:

Table 3. Concepts

Concept	Definition	Purpose
Cell	Geographic coverage area	Service provision
Frequency Reuse	Same frequency in diff cells	Spectrum efficiency
Cluster	Group with unique freqs	Interference control
Reuse Distance	Min distance same freq	Signal quality

Concept Map:

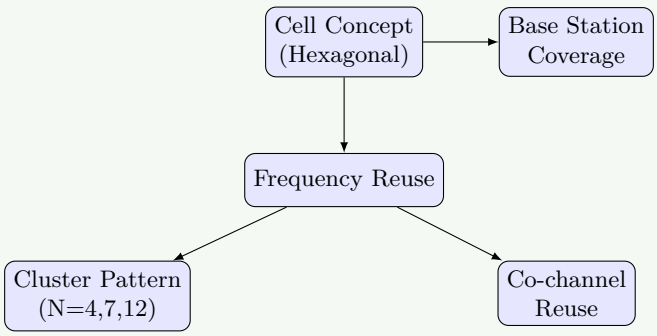

Figure 2. Frequency Reuse Structure

- **Cell definition**: Geographical area covered by one base station.
- **Hexagonal pattern**: Most efficient shape for coverage.
- **Frequency reuse**: Reusing same frequencies in non-adjacent cells.
- **Cluster size**: Determines reuse pattern (N).

Mnemonic

"Cells Reuse Frequencies Efficiently"

Question 1(c OR) [7 marks]

Explain cellular concept in detail.

Solution

Cellular System Components:

Table 4. Components

Component	Function	Benefit
Cell Division	Split area	Coverage optimization
Base Stations	Serve cells	Signal transmission
MSC	Routing	Network connectivity
Freq Planning	Allocation	Interference control

Cellular Concept Flow:

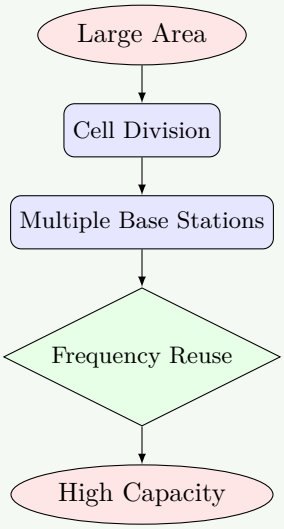

Figure 3. Cellular Concept

- **Area division**: Large area divided into small hexagonal cells.
- **Power control**: Low power transmitters reduce interference.
- **Frequency efficiency**: Frequencies reused in distant cells.
- **Capacity**: Supports more simultaneous users.

Mnemonic

"Divide Area For Better Service"

Question 2(a) [3 marks]

Define full forms: (i) IMEI (ii) LTE (iii) GSM

Solution

Table 5. Full Forms

Abbr	Full Form	Purpose
IMEI	International Mobile Equipment Identity	Device ID
LTE	Long Term Evolution	4G Standard
GSM	Global System for Mobile Communication	2G Standard

Mnemonic

"Identity Long-term Global"

Question 2(b) [4 marks]

Explain MAHO in detail.

Solution

MAHO (Mobile Assisted Handoff):

Table 6. Characteristics

Feature	Description
Function	Mobile helps in handoff decision
Measurement	Signal strength monitoring
Reporting	Mobile reports to network

Process Flow:

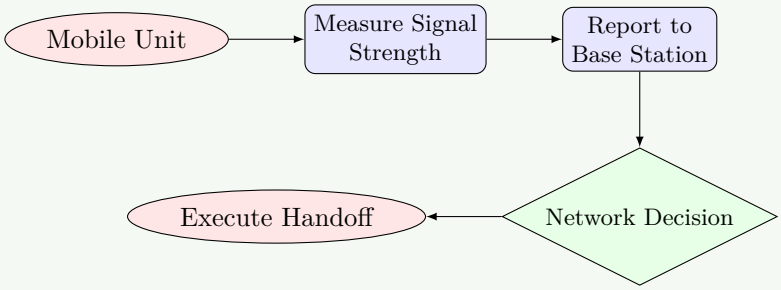

Figure 4. MAHO Process

- Mobile measures neighboring cell signals.
- Sends reports to the network.
- Network uses this data for better handoff decisions.

Mnemonic

"Mobile Assists Network Decisions"

Question 2(c) [7 marks]

Explain GSM architecture with diagram

Solution

GSM Architecture:

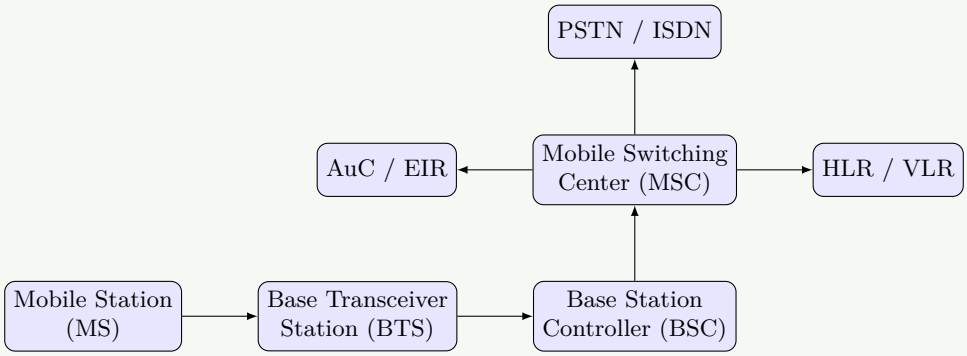

Figure 5. GSM Network Architecture

Table 7. Components

Component	Full Form	Function
MS	Mobile Station	User equipment
BTS	Base Transceiver	Radio interface
BSC	Base Controller	Resource mgmt
MSC	Mobile Switching	Call switching
HLR	Home Location	Perm. DB
VLR	Visitor Location	Temp. DB

- **Radio Subsystem**: BTS handles radio, BSC manages resources.
- **Network Subsystem**: MSC switches calls, HLR/VLR manage data.
- **Authentication**: AuC handles security.

Mnemonic

"Mobile Base Network Database"

Question 2(a OR) [3 marks]

Explain cell splitting.

Solution

Cell Splitting Process:

Table 8. Process Steps

Step	Action	Result
1	Reduce Power	Smaller coverage
2	Add Base Stations	Fill gaps
3	Freq Planning	Control interference
4	Incr Capacity	More users

- **Power reduction**: Shrinks original cell coverage.
- **New cells**: Added in gaps to maintain coverage.
- **Capacity gain**: Higher user density handling.

Mnemonic

"Split Cells Double Capacity"

Question 2(b OR) [4 marks]

What is handoff? Explain soft and hard handoffs.

Solution

Handoff Types:

Table 9. Hard vs Soft Handoff

Type	Process	Tech
Hard	**Break-then-make**	GSM, TDMA
Soft	**Make-then-break**	CDMA

Decision Flow:

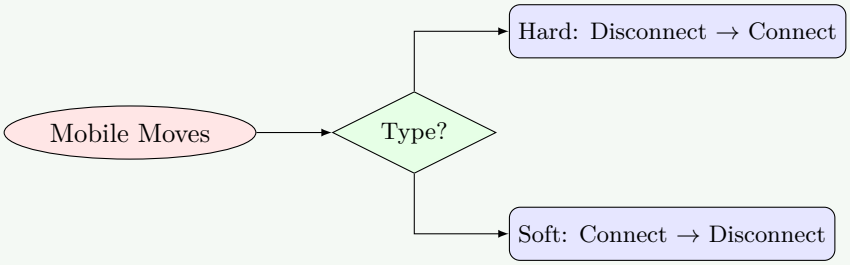

Figure 6. Handoff Mechanism

Mnemonic

"Hard Breaks Soft Connects"

Question 2(c OR) [7 marks]

Explain GSM signal processing with diagram

Solution

GSM Signal Chain:

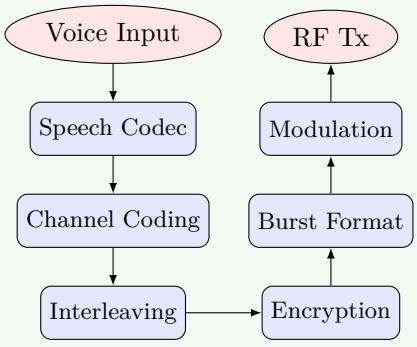

Figure 7. Signal Processing Steps

Processing Stages:

- **Speech Codec**: Compresses voice (RPE-LTP).
- **Channel Coding**: Adds error protection.
- **Interleaving**: Protects against burst errors.
- **Encryption**: Secures data (A5 algorithm).
- **Modulation**: GMSK for transmission.

Mnemonic

"Voice Coded Interleaved Encrypted Modulated"

Question 3(a) [3 marks]

Explain cell sectoring.

Solution

Cell Sectoring Benefits:

Table 10. Sectoring

Feature	Description
Antenna	Directional (not omnidirectional)
Sectors	3 or 6 per cell
Capacity	Increases (3x or 6x)
Interference	Reduced co-channel interference

- Uses directional antennas to divide cell.
- Each sector acts like a new cell, increasing capacity.
- Reduces interference by focusing energy.

Mnemonic

"Sector Antennas Triple Capacity"

Question 3(b) [4 marks]

Explain GSM call procedure.

Solution

Call Sequence:

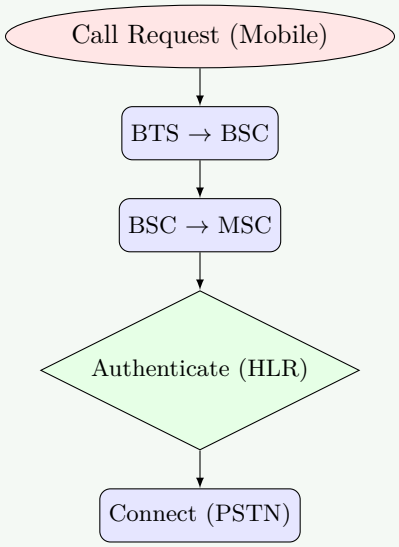

Figure 8. Call Setup Flow

Steps: 1. **Authentication**: Verify user. 2. **Allocation**: Assign channel. 3. **Routing**: Determine path. 4. **Connection**: Establish link.

Mnemonic

"Authenticate Allocate Route Connect"

Question 3(c) [7 marks]

Explain GPRS.

Solution

GPRS Features:
- **Packet Switched**: Info sent in packets.
- **Always On**: Constant connection.
- **Speed**: Up to 114 kbps.

GPRS Architecture:

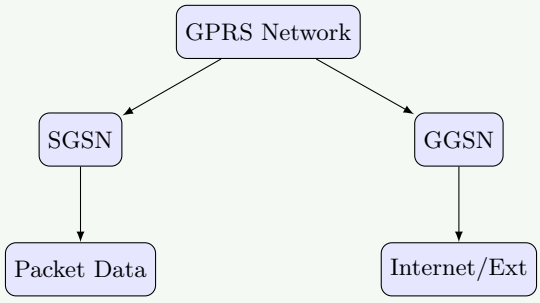

Figure 9. GPRS Nodes

- **SGSN**: Service GPRS Support Node (Mobility).
- **GGSN**: Gateway GPRS Support Node (External).
- Enables internet and email services.

Mnemonic

"General Packet Radio Service"

Question 3(a OR) [3 marks]

Explain advantage of CDMA

Solution

Advantages:

Table 11. CDMA Benefits

Advantage	Description
Capacity	Higher user capacity
Security	Built-in encryption (Spread Spectrum)
Quality	Better voice quality (Soft Handoff)
Power	Efficient power control

Mnemonic

"Capacity Security Quality"

Question 3(b OR) [4 marks]

Explain frequency hopping techniques.

Solution

Frequency Hopping (FH):

Table 12. FH Types

Type	Rate vs Symbol Rate
Slow FH	Rate < Symbol Rate (GSM)
Fast FH	Rate > Symbol Rate (Military)

Mechanism:

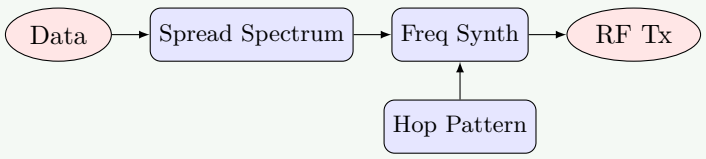

Figure 10. Frequency Hopping

- Reduces interference and jamming.
- Increases security.

Mnemonic

"Frequency Hops For Security"

Question 3(c OR) [7 marks]

Explain EDGE.

Solution

EDGE (Enhanced Data rates for GSM Evolution):

Table 13. EDGE Specs

Parameter	Value/Benefit
Data Rate	Up to 384 kbps (3x GPRS)
Modulation	8-PSK (Higher order)
Compatibility	Backward compatible with GSM

Enhancement Flow:

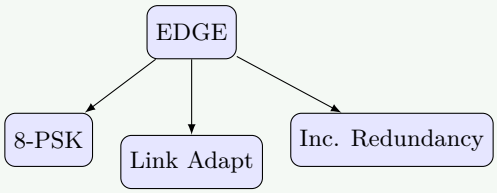

Figure 11. EDGE Improvements

- **8-PSK**: Increases throughput via higher order modulation.
- **Link Adaptation**: Adjusts to channel quality.
- **Bridge to 3G**: Step between 2G and 3G.

Mnemonic

"Enhanced Data Gets Excellence"

Question 4(a) [3 marks]

Draw FHSS transmitter block diagram

Solution

FHSS Transmitter:

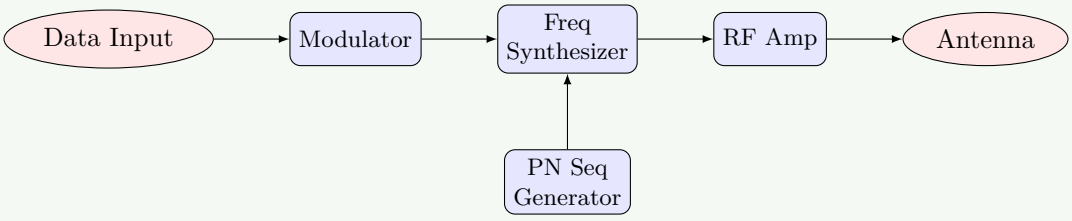

Figure 12. FHSS Transmitter Block Diagram

Mnemonic

"Data Modulated Frequency Hops"

Question 4(b) [4 marks]

Explain call processing in CDMA

Solution

Processing Phases:

Table 14. Call Stages

Phase	Process	Purpose
Access	Sync	Initial connection
Authentication	Verify	Security
Traffic	Comm	Data transfer
Release	Terminate	Cleanup

- **Access**: Mobile acquires pilot, syncs.
- **Auth**: Credentials verified.
- **Traffic**: Active call with power control.
- **Release**: Free resources.

Mnemonic

"Access Authenticate Transfer Release"

Question 4(c) [7 marks]

Draw OFDM receiver and explain its working

Solution

OFDM Receiver Diagram:

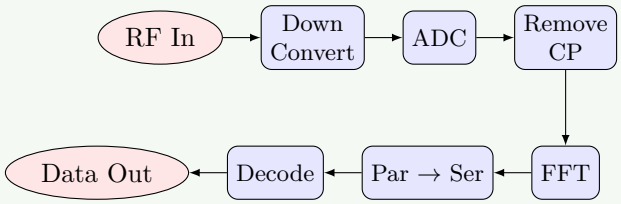

Figure 13. OFDM Receiver

Functions:

- **Down Converter**: RF to baseband.
- **Remove CP**: Eliminates Inter-Symbol Interference (ISI).
- **FFT**: Separates orthogonal subcarriers.
- **Decoder**: Corrects errors and recovers data.

Mnemonic

"Receive Convert Remove Transform Decode"

Question 4(a OR) [3 marks]

Explain radiation hazard due to mobile.

Solution

Radiation Effects:

Table 15. Hazards

Parameter	Effect/Details
SAR	Specific Absorption Rate (Heating)
Frequency	900/1800 MHz (Penetration)
Safety	Regulated limits for exposure

- **SAR**: Measures energy absorbed by body tissue.
- **Thermal**: High SAR causes tissue heating.

Mnemonic

"SAR Safety Absorption Rate"

Question 4(b OR) [4 marks]

Explain Li-Po type batteries used in mobile handset.

Solution

Li-Po Characteristics:

Table 16. Li-Po Features

Feature	Benefit
Chemistry	Lithium Polymer (Solid/Gel)
Shape	Flexible, thin form factor
Density	High energy density
Weight	Lightweight

- Uses polymer electrolyte, allowing flexible shapes.
- Safe and lightweight compared to liquid electrolytes.
- Supports fast charging.

Mnemonic

"Lithium Polymer Power"

Question 4(c OR) [7 marks]

Explain mobile handset block diagram.

Solution

Handset Diagram:

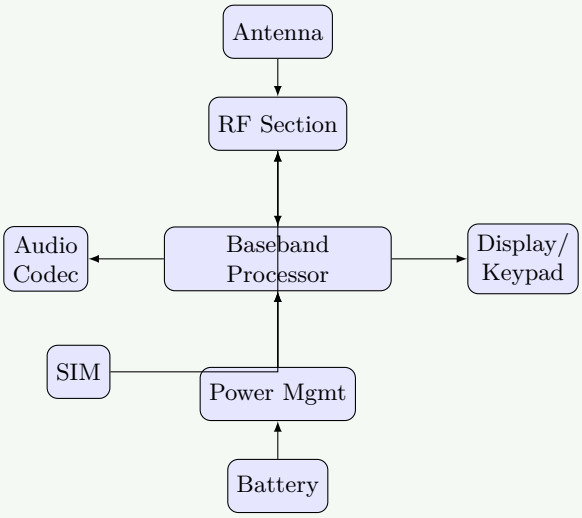

Figure 14. Mobile Handset Blocks

Components:

- **RF Section**: Radio transmission/reception.
- **Baseband**: Protocols and processing.
- **Audio**: Voice processing.
- **Power**: Manages battery and charging.
- **SIM**: User identity.

Mnemonic

"Radio Baseband Audio Power Interface"

Question 5(a) [3 marks]

Compare CDMA and GSM

Solution

Table 17. CDMA vs GSM

Feature	CDMA	GSM
Access	Code Division	Time Division
Capacity	Higher	Lower
Handoff	Soft	Hard
SIM	Not always req	Required

Mnemonic

"Code vs Time Division"

Question 5(b) [4 marks]

Explain HSDPA.

Solution

HSDPA (High Speed Downlink Packet Access):

Table 18. Features

Feature	Description
Data Rate	Up to 14.4 Mbps
Tech	3.5G (UMTS Enhancement)
Direction	Optimized for Downlink
Modulation	Adaptive (QPSK → 16-QAM)

- Improves 3G downlink speeds significantly.
- Faster scheduling (2ms) for responsiveness.

Mnemonic

"High Speed Download Access"

Question 5(c) [7 marks]

Explain architecture, features and advantage of Bluetooth.

Solution

Bluetooth Stack:

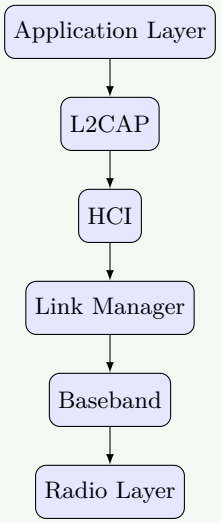

Figure 15. Bluetooth Protocol Stack

Features & Advantages:
- **Range**: 10m (PAN).
- **Freq**: 2.4 GHz ISM (Unlicensed).
- **Net**: Piconet (1 Master, 7 Slaves).
- **Low Power**: Battery efficient.

Applications: Audio, Data transfer, Peripherals.

Mnemonic

"Blue Personal Area Network"

Question 5(a OR) [3 marks]

Explain basic concept of RFID.

Solution

RFID (Radio Frequency Identification):

Table 19. Components

Component	Function
Tag	Stores ID data
Reader	Reads tag via RF
Antenna	Communication
Backend	Processing

- Contactless identification using RF waves.
- Automatic reading within range.

Mnemonic

"Radio Frequency Identifies"

Question 5(b OR) [4 marks]

Explain architecture of 5G system.

Solution

5G Architecture Components:

Table 20. Key Functions

Node	Function
gNodeB	5G Base Station
AMF	Access & Mobility Mgmt
SMF	Session Mgmt
UPF	User Plane Function

- **Service Based**: Modular functions.
- **Network Slicing**: Virtual networks.
- **Edge Compute**: Low latency.

Mnemonic

"Service Based Network Slicing"

Question 5(c OR) [7 marks]

Explain MANET in detail.

Solution

MANET (Mobile Ad-hoc Network):

- **Infrastructure-less**: No base stations.
- **Dynamic Topology**: Nodes move freely.
- **Multi-hop**: Relays messages via peers.

Topology Diagram:

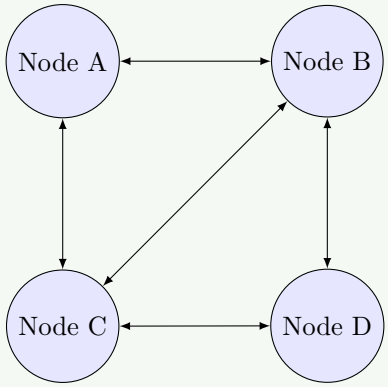

Figure 16. Mesh Topology

Comparison:

Table 21. MANET vs Cellular

Feature	MANET	Cellular
Infra	None	Towers req
Cost	Low	High
Range	Multi-hop	Single hop

Mnemonic

"Mobile Adhoc Network"