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1.	a)	What is handover? Distinguish between hard handoff and Soft handoff.	4
	b)	Briefly describe the steps in accomplishing a handoff between two base stations with a common MSc.	6
	c)	What is Intracell and Intercell handover?	4
2.	a)	Draw and explain the GSM Network System Model.	6
	b)	What is handover criteria? What are the types of handoff?.	4
	c)	Distinguish between following- i) Vertical and Horizontal handover. ii)Internal and External handover.	2+2
3.	a)	What strategies can be used to determine the instant of the handover? Write down the handover metrices.	5
	b)	What are the handover challenges? Describe with examples.	4
	c)	Draw a flowchart of Vertical handover.	5
4.	a)	What is Mobile Controlled Handover (MCHO)? How measurement and decisions made by the MS.	5
	b)	How Network Controlled Handover(NCHO) works and What are the disadvantages of NCHO?	6
	c)	Define the terms: i) RSS ii) SIR iii) Cell load	3
5.	a)	How radio communication takes place in both directions (UL & DL)?	5
	b)	What is Transmission Control Scheme? Explain the types of Transmission Control Scheme with example.	5
	c)	How Frequency Division Duplex (FDD) Works?	4
6.	a)	Comparison among SDMA, TDMA, FDMA, CDMA.	6
	b)	What is Multiplexing?	2
	c)	Assume that a voice channel occupies a bandwidth of 4 kHz. We need to combine three voice channels into a link with a bandwidth of 12 kHz, from 20 to 32 kHz. Show the configuration, using the frequency domain. Assume there are no guard bands.	6
7.	a)	What is cell splitting? How to increase capacity of a cellular network	4
	b)	Explain the process of making a call and receiving a call in a celleular system.	4
	c)	If a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels, compute the number of channels available per cell if a system uses (a) 4-cell reuse, (b) 7-cell reuse (c) 12-cell reuse	6
8.	a)	What is frequency reuse?Draw a 7 cell reuse pattern.	3
	b)	Why hexagonal cell shape is perfect over square or triangular cell shapes in cellular architecture?	4
	c)	Write down the difference between HLR and VLR.	4
	d)	Write short notes on: i) IMEI ii) SIM iii) TMSI	3

1. a) What is handover? Distinguish between hard handoff and Soft handoff..

Ans:

Handover

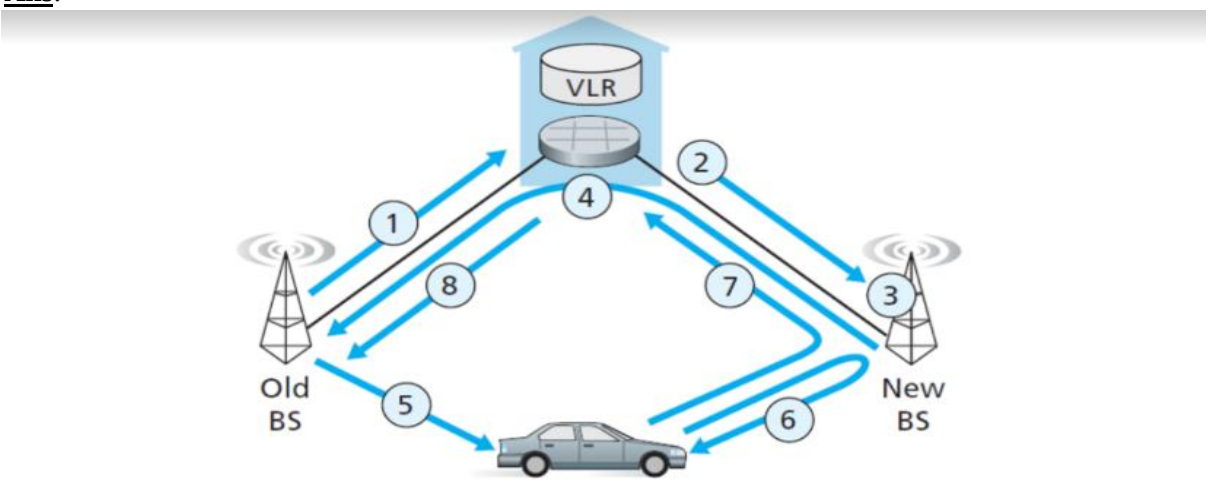
In cellular tele-communications, the term handover or handoff refers to the process of transferring in a seamless manner an On going call or data session from one cell to another cell.

Cells provide cellular access and cells are connected to each other through the core(backbone) network.

Sr No.	Hard Hand-off	Soft Hand-off
1	The definition of a hard-hand off is one where an existing connection must be broken when the new one is established	Soft hand-off is defined as a hand-off where a new connection is established before old one is released
2	It allocates Different frequency	It allocates same frequency
3	Hard hand-off typically used in TDMA and FDMA	Soft hand-off used in CDMA and some TDMA systems
4	Hard hand-off is not very complicated	More complex than hard hand-off
5	In hard hand-off handset always communicated with one BS at a time	Communicate up to three or four radio link at the same time

b**) Breifly describe the steps in accomplishing a handoff between two base stations with a common MSc**.

Ans:



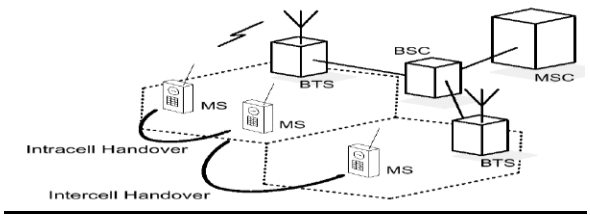
Steps in accomplishing a handoff between base stations with a common MSC

Step by Step Handoff Procedure

1. The old base station (BS) informs the visited MSC that a handoff is to be performed and the BS (or possible set of BSs) to which the mobile is to be handed off.
2. The visited MSC initiates path setup to the new BS, allocating the resources needed to carry the rerouted call, and signaling the new BS that a handoff is about to occur.
3. The new BS allocates and activates a radio channel for use by the mobile.
4. The new BS signals back to the visited MSC and the old BS that the visited-MSC-to-new-BS path has been established and that the mobile should be informed of the impending handoff. The new BS provides all of the information that the mobile will need to associate with the new BS.
5. The mobile is informed that it should perform a handoff. Note that up until this point, the mobile has been blissfully unaware that the network has been laying the groundwork for a handoff.
6. The mobile and the new BS exchange one or more messages to fully activate the new channel in the new BS.
7. The mobile sends a handoff complete message to the new BS, which is forwarded up to the visited MSC.
8. The visited MSC then reroutes the ongoing call to the mobile via the new BS. The resources allocated along the path to the old BS are then released.

c) **What is Intracell and Intercell handover?**

Ans:



Intracellhandover

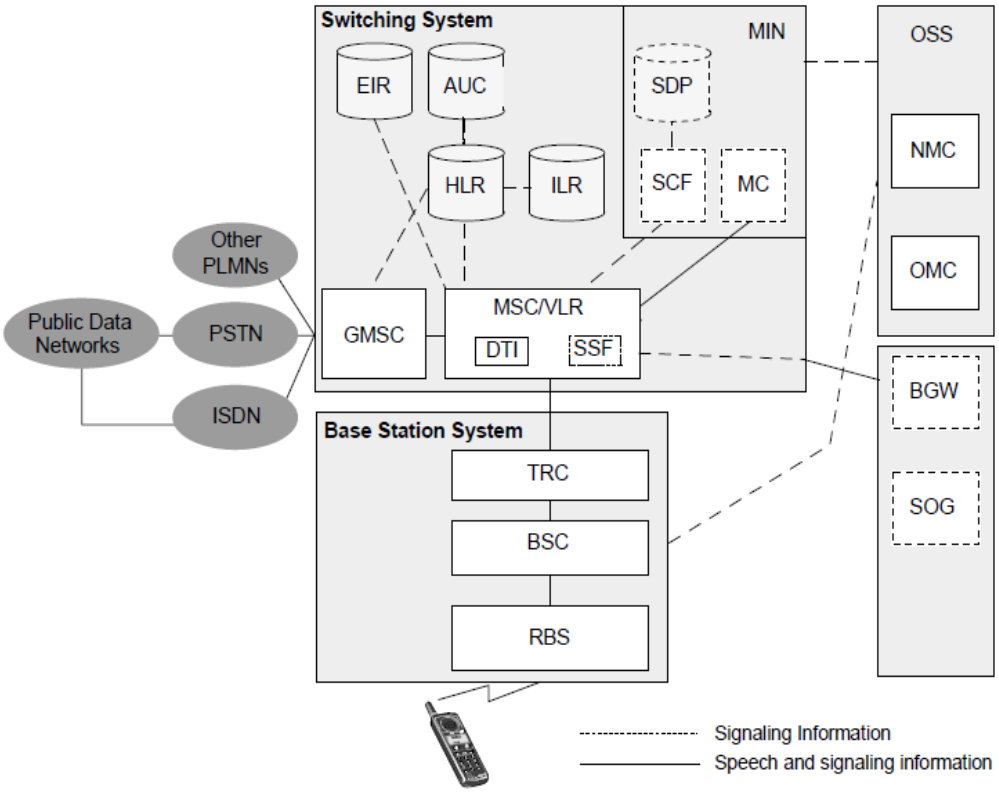
- Mobile station is assigned a new channel within the same cell
- Administrative or channel quality reasons
- Decision is made locally by the *Radio Resource Management*(RR) of the BSS

Intercellhandover

- Connection to an MS is transferred over the cell boundary to a new BTS
- Weak signal strength or bad channel quality or admission (traffic loading balancing) reasons

2. a) Draw and explain the GSM Network System Architecture.

Ans:



The Switching System (SS):

- Performs call processing and subscriber-related functions
- The system includes the following functional units:
    - Mobile Services Switching Center (MSC)
    - Home Location Register (HLR)
    - Visitor Location Register (VLR)
    - Authentication Center (AUC)
    - Equipment Identity Register (EIR**)**

The Base Station System (BSS)

- The Base Station Subsystem (BSS) section of the GSM network architecture that is fundamentally associated with communicating with the mobiles on the network. It consists of two elements:

  -The Base Transceiver Station (BTS)

  -The Base Station Controller (BSC)

b) What is handover criteria? What are the types of handoff?.

Ans:

Handover criteria
–Base Station Subsystem (BBS) criteria

•Received signal level

•channel quality

•distance between MS and BTS
–Network operation criteria

•Current traffic load of the cell

•Ongoing maintenance work

Handover types

- Intracell/Intercellhandover
- Internal/External handover
- Soft/Hard handover
- Vertical/Horizontal handover

c) Distinguish between following-

i) Vertical and Horizontel handover.

ii)Internel and Externel handover

Ans:

i) Internal and external handover

Internal handover

- BSS perform handover without participation of the MSC
- MSC is only informed about the successful execution

External handover

- Require participation of at least one MSC

ii) Horizontal and Vertical Handovers

Horizontal Handover

- In horizontal handover the users use the same network access technology and mobility perform on the same layers.

Vertical Handover

- In vertical handover the user can move between different network access technologies

3. a) What strategies can be used to determine the instant of the handover? Write down the handover metrices.

Ans:

Handover Strategies

Several strategies can be used to determine the instant of the handover:

- Relative signal strength
- Relative signal strength with threshold
- Relative signal strength with hysteresis
- Prediction techniques

Handover performance metrics

- **Cell blocking probability:** probability of a new call being blocked
- **Call dropping probability:** probability that a call is terminated due to ahandover
- **Call completion probability:** probability that an admitted call is not dropped before it terminates
- **Probability of unsuccessful handover:** probability that a handover is executed while the reception conditions are inadequate.
- **Handover blocking probability:** probability that a handover cannot be successfully completed
- **Handover probability:** probability that ahandover occurs before call termination
- **Rate ofhandover:** number ofhandovers per unit time
- **Interruption duration:** duration of time during ahandover in which a mobile is not connected to either base station

b) What are the handover challenges? Describe with examples.

Ans:

High-speed mobiles require frequent handovers

- Burdens MSC
- Can use “umbrella cells” to minimize handover

- Pedestrian users covered in small cells
- High-speed users covered in large umbrella cell
- Minimizes handovers for high-speed users while ensuring capacity for pedestrian users

Cell dragging

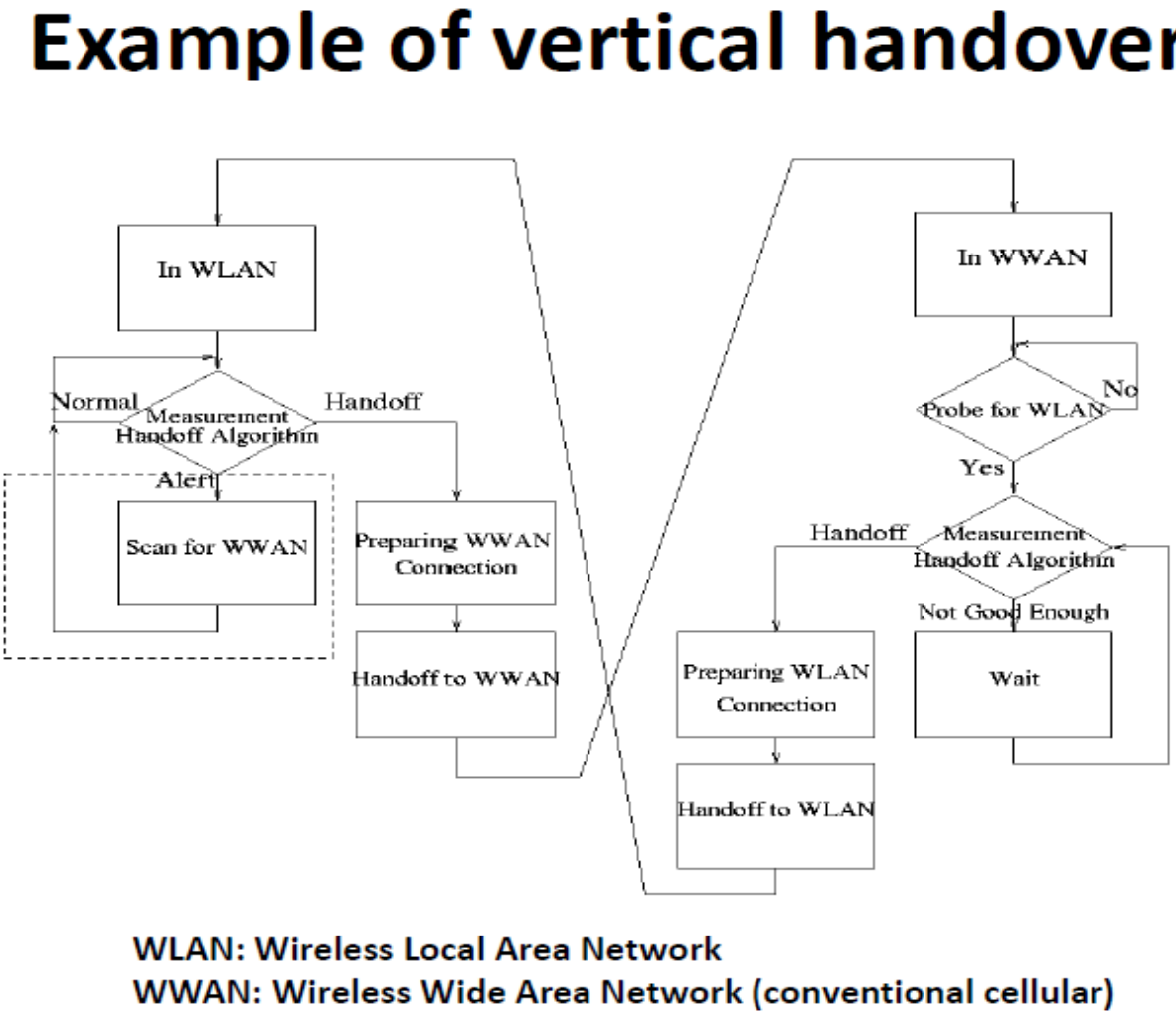
- If a user has a good LOS path to BS, SNR might be large even when user has left the cell
- Causes interference and traffic management problems (user in new cell but managed by old BS)

Handover times

- 1stgeneration analog systems: 10 s
- 2ndgeneration digital systems: 1-2 s(using MAHO)

c) Draw a flowchart of Vertical handover.

Ans:

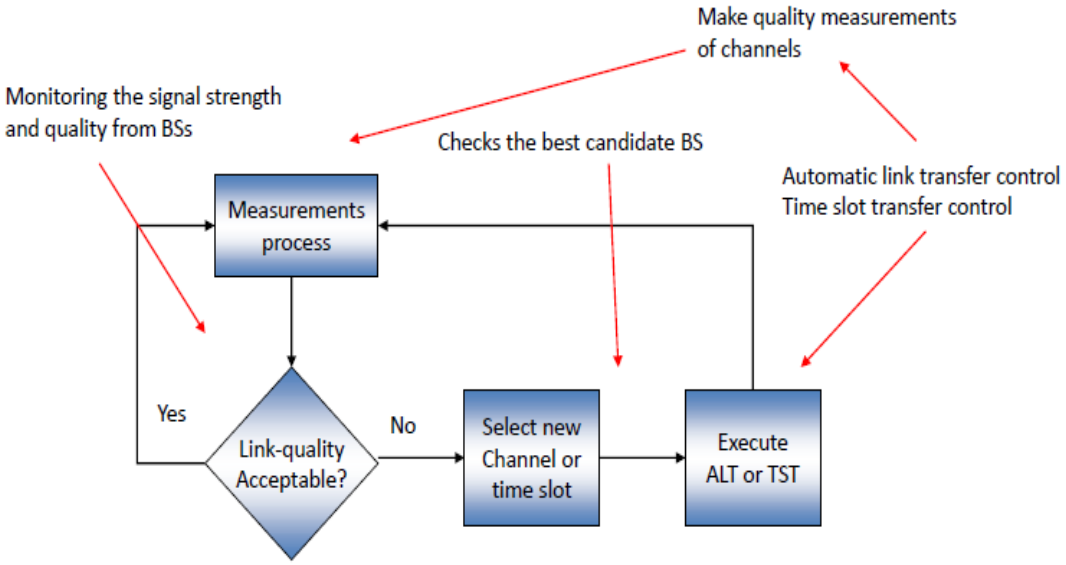


4. a) What is Mobile Controlled Handover (MCHO)? How measurement and decisions made by the MS..

Ans:

Mobile Controlled Handover (MCHO)

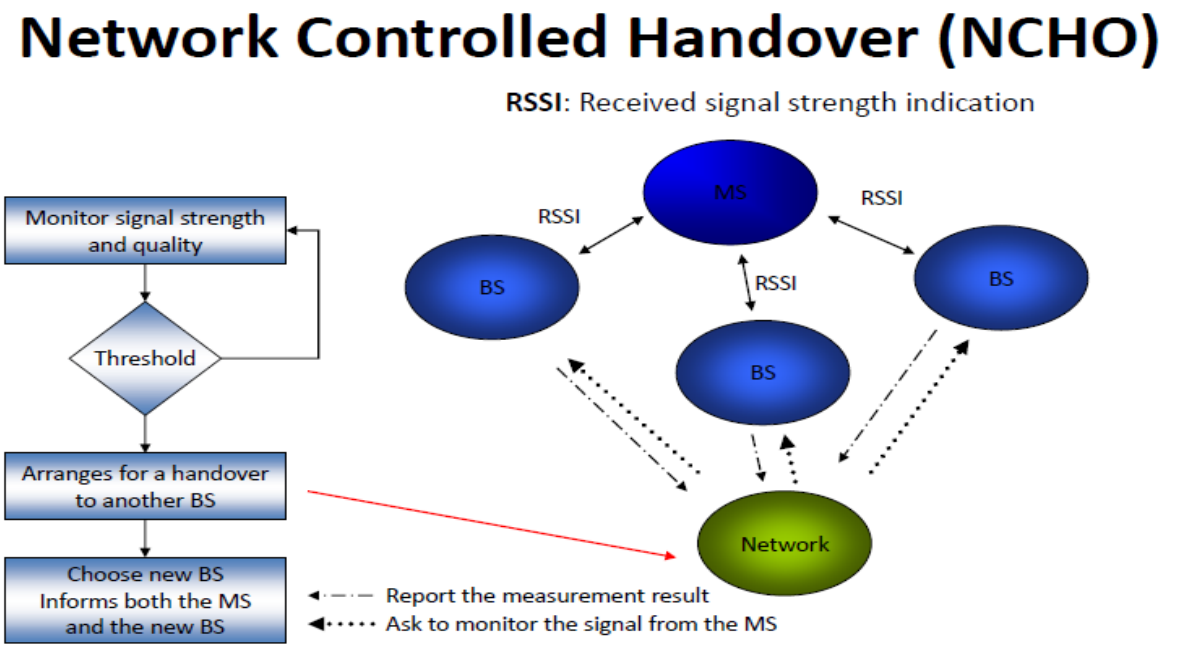
- MS totally controls and make decisions on handover.
- MCHO is the highest degree of handover decentralization, thereby enabling it to have a very fast handover speed, typically on the order of 0.1 s.



Measurements and decisions made by the MS

b) How Network Controlled Handover(NCHO) works and What are the disadvantages of NCHO?.

Ans:



Some disadvantages:

1) Heavy network signaling traffic to collect the information.
2) Lack of adequate radio resources at BSsto make frequent measurements of neighboring links.
3) In practice, handover time is in the order of seconds

c) Define the terms: i) RSS ii) SIR iii) Cell load

Ans:

Received Signal Strength (RSS)
The base station (BS) that receives the strongest signal strength from a given user is connected to the user. This criterion is widely-used since it is simple and can reduce the processing load. However, it does not indicate the interference conditions.

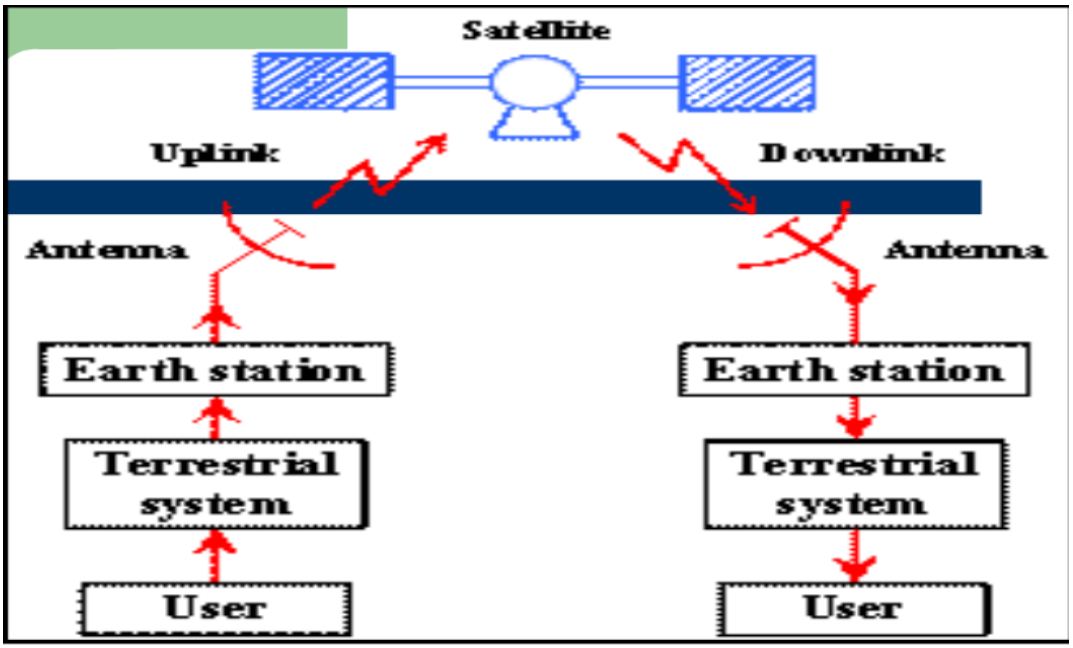
Signal-to-interference Ratio (SIR)
This criterion considers the interference experienced by the user. Handover occurs when the current cell's SIR is too low (or below a threshold or worse than the adjacent cell).

Cell load
Cell load/traffic conditions may have an impact on handover decisions. The network aims at having a balanced load distribution

5. a) How radio communication takes place in both directions (UL & DL)?

Ans:

- Two Stations on Earth want to communicate through radio broadcast but are too far away to use conventional means.
- The two stations can use a satellite as a relay station for their communication
- One Earth Station sends a transmission to the satellite. This is called a Uplink.
- The satellite Transponder converts the signal and sends it down to the second earth station. This is called a Downlink.



b)What is Transmission Control Scheme? Explain the types of Transmission Control Scheme with example.

Ans:

Transmission control schemes refer to the approaches used to control the traffic flow in both transmission directions.

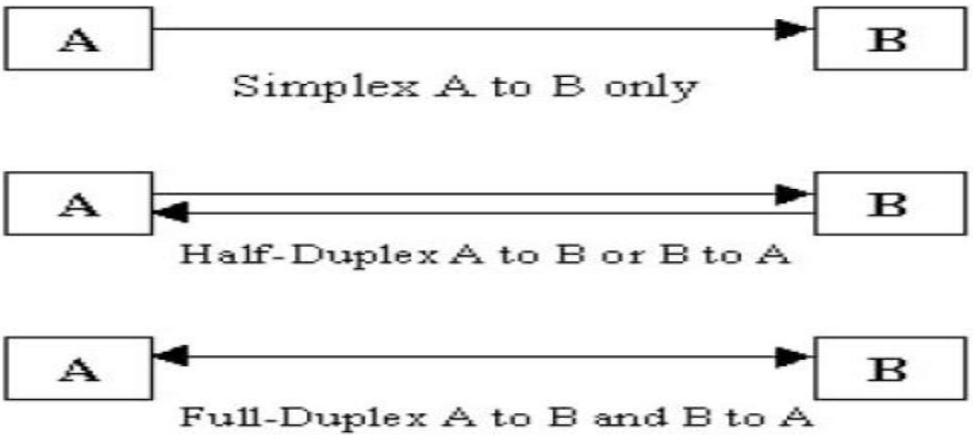
Three main schemes

- Simplex
- Half-duplex
- Full-duplex

Simplex: System supporting only one direction of transmission. Example: Broadcasting systems (radio, TV, etc.).

Half-duplex: Communication is possible in both directions, but communication is only possible in one direction at a time. If one transmitter is transmitting, the other one must wait until the first stops before transmitting.
-This form of communication is used for walkie-talkies, CB (Citizens' Band), etc.

Full-duplex: Sometimes referred to simply as **duplex** is a scheme whereby transmissions may be sent in both directions simultaneously.
-However it is still necessary for the transmissions to be separated in some way to enable the receivers to receive signals at the same time as transmissions are being made.
-There are two ways of achieving this. One is to use frequency separation frequency division duplex, FDD, and the other is to use time, time division duplex, TDD.



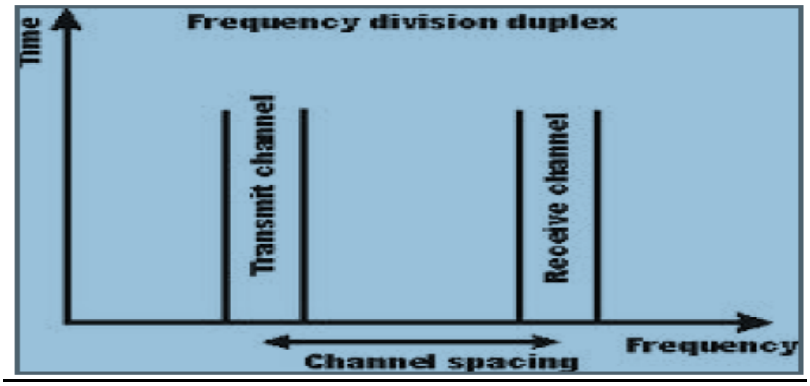
c) How Frequency Division Duplex (FDD) Works?

Ans:

Frequency division duplex (FDD) is based on the concept that transmission and reception of signals are achieved simultaneously (i.e., separated) using two different frequencies.

- FDD makes possible to transmit and receive signals **simultaneously** as receiver and transmitter are tuned to different frequencies.

- FDD requires that the channel separation between the transmission and reception frequencies must be sufficient to enable the receiver not to be unduly affected by the transmitter signal. This is known as the **guard band**



6. a) Comparison among SDMA, TDMA, FDMA, CDMA

Ans:

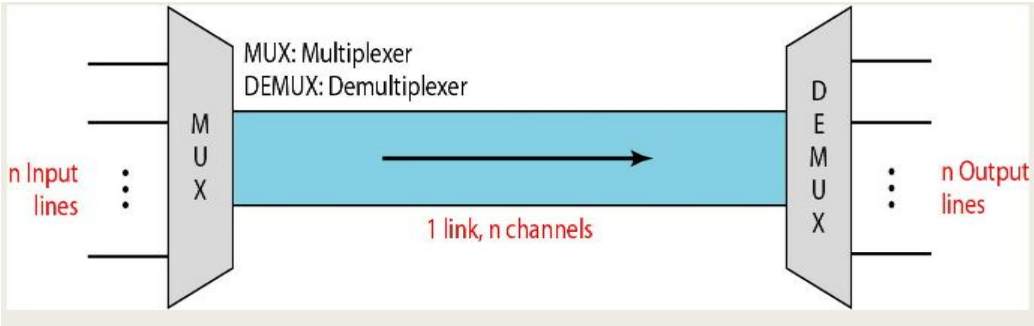
Approach	SDMA	TDMA	FDMA	CDMA
Idea	segment space into cells/sectors	segment sending time into disjoint time-slots, demand driven or fixed patterns	segment the frequency band into disjoint sub-bands	spread the spectrum using orthogonal codes
Terminals	only one terminal can be active in one cell/one sector	all terminals are active for short periods of time on the same frequency	every terminal has its own frequency, uninterrupted	all terminals can be active at the same place at the same moment, uninterrupted
Signal separation	cell structure, directed antennas	synchronization in the time domain	filtering in the frequency domain	code plus special receivers
Advantages	very simple, increases capacity per km²	established, fully digital, flexible	simple, established, robust	flexible, less frequency planning needed, soft handover
Dis-advantages	inflexible, antennas typically fixed	guard space needed (multipath propagation), synchronization difficult	inflexible, frequencies are a scarce resource	complex receivers, needs more complicated power control for senders
Comment	only in combination with TDMA, FDMA or CDMA useful	standard in fixed networks, together with FDMA/SDMA used in many mobile networks	typically combined with TDMA (frequency hopping patterns) and SDMA (frequency reuse)	still faces some problems, higher complexity, lowered expectations; will be integrated with TDMA/FDMA

b) What is Multiplexing?

Ans:

Multiplexing:

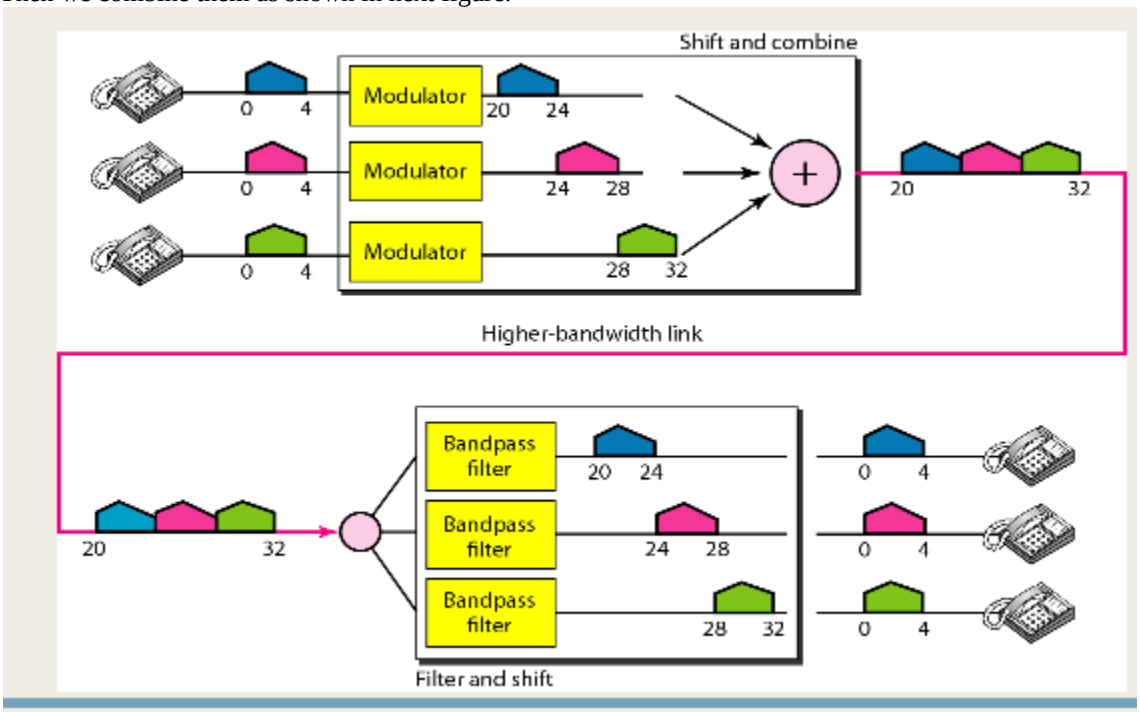
Multiplexing is the set of techniques that allows the simultaneous transmission of multiple signals across a single data link.



c) Assume that a voice channel occupies a bandwidth of 4 kHz. We need to combine three voice channels into a link with a bandwidth of 12 kHz, from 20 to 32 kHz. Show the configuration, using the frequency domain. Assume there are no guard bands.

Ans:

We shift (modulate) each of the three voice channels to a different bandwidth, as shown in Figure.
We use,
The 20- to 24-kHz bandwidth for the first channel,
the 24- to 28-kHz bandwidth for the second channel,
and the 28- to 32-kHz bandwidth for the third one.
Then we combine them as shown in next figure.



7. a) What is cell splitting? How to increase capacity of a cellular network?

Ans:

Cell splitting is the process of dividing the radio coverage of a cell site in a wireless telephone system into two or more new cell sites.

Add new channels

- Not all channels used to start with
- Frequency borrowing
- Taken from adjacent cells by congested cells
- Or assign frequencies dynamically

Cell splitting

- Non-uniform distribution of topography and traffic
- Smaller cells in high use areas
- Original cells 6.5 –13 km
- 1.5 km limit in general
- More frequent handoff
- More base stations

b) Explain the process of making a call and receiving a call in a celleular system.

Ans:

Making a call process

- the subscriber dials the receiver's number and sends it to the BTS
- the BTS sends to its BSC the ID, location and number of the caller and also the number of the receiver
- the BSC forwards this information to its MSC
- the MSC routes the call to the receiver's MSC which is then sent to the receiver's BSC and then to its BTS
- the communication with the receiver's cell phone is establishde

Receiving a call process

- when the receiver' phone is in an idle state it listens for the control channel of its BTS
- if there is an incoming call the BSC and BTS sends a message to the cells in the area where the receiver's phone is located
- the phone monitors its message and compares the number from the message with its own
- if the numbers matches the cell phone sends an acknowledgement to the BTS
- after authentication, the communication is established between the caller and the receiver

c) If a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels, compute the number of channels available per cell if a system uses
(a)4-cell reuse, (b) 7-cell reuse (c) 12-cell reuse

Ans:

Given, Total bandwidth = 33 MHz

Channel bandwidth = 25 kHz × 2 simplex channels = 50 kHz/duplex channel

Total available channels = 33,000/50 = 660 channels

(a) For N = 4, total number of channels available per cell = 660/4 ≈ 165 channels.

(b) For N = 7, total number of channels available per cell = 660/7 ≈ 95 channels.

(c) For N = 12, total number of channels available per cell = 660/12 ≈ 55 channels.

8. a) What is frequency reuse?Draw a 7 cell reuse pattern.

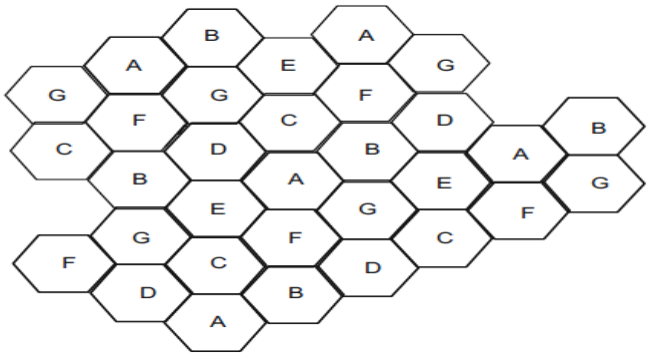
Ans:

Frequency re-use:

Frequency reuse is the concept of using the same radio frequencies within a given area that are separate by the considerable distance with minimal interference, to establish connection.

Frequency reuse offers the following benefits −
- Allows communications within cell on a given frequency
- Limits escaping power to adjacent cells

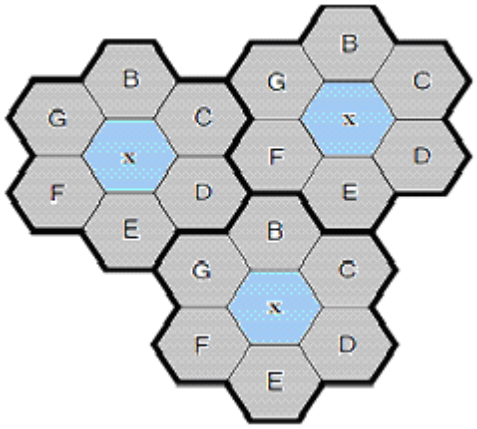
7 cell reuse pattern



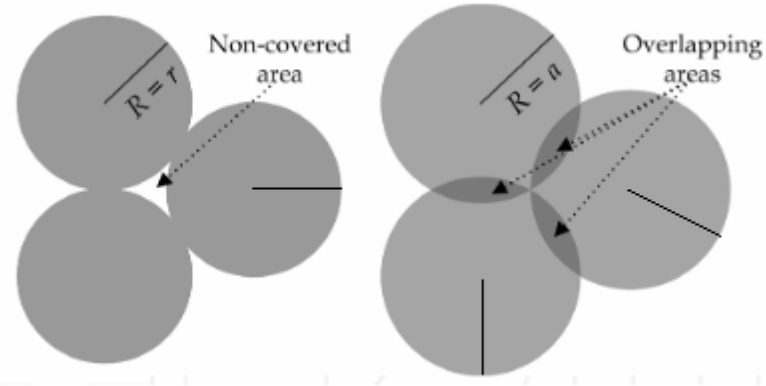
b). Why hexagonal cell shape is perfect over square or triangular cell shapes in cellular architecture?

Ans:

The geographic area or cellular service area is divided into small hexagonal region called cells. It is the basic unit of a cellular system. These cells collectively provide coverage over larger geographical areas.



Hexagonal cell shape is perfect over square or triangular cell shapes in cellular architecture because it cover an entire area without overlapping i.e. they can cover the entire geographical region without any gaps.



c) **Write down the difference between HLR and VLR.**

Ans

❖ **Home Location Registers (HLR)**

- o permanent database about mobile subscribers in a l service area(generally one per GSM network operat
- o database contains IMSI, MSISDN, prepaid/postpaid, roaming restrictions, MSC/VLR, supplementary servi

❖ **Visitor Location Registers (VLR)**

- o Temporary database which updates whenever new enters its area, by HLR database
- o Controls those mobiles roaming in its area
- o Reduces number of queries to HLR
- o Database contains IMSI, TMSI, MSISDN, MSRN, Loca Area, authentication key

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d) Write short notes on:

i) IMEI ii) SIM iii) TMSI

Ans:

International Mobile Equipment Identity (IMEI) key

- IMEI – a unique 15 digit number identifying each phone, is incorporated in the cellular phone by the manufacturer
- IMEI ex.: 994456245689001

Subscriber Identity Module (SIM) card

- SIM – a memory card (integrated circuit) holding identity information, phone book etc.

Temporary Mobile Subscriber Identity (TMSI) key

- TMSI – is a temporary number, shorter than the IMSI, assigned by the service provider to the phone on a temporary basis.