

# MAWLANA BHASHANI SCIENCE AND TECHNOLOGY UNIVERSITY



## DEPARTMENT OF ICT

### Assignment No : 02

Course Code : ICT-4101

Course Title : Telecommunication Engineering

Assignment name : Cellular Communication

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Session : 2016-2017

Year : 4<sup>th</sup> Semester : 1<sup>st</sup>

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Date of Submission : 05 December 2020

## Assignment - 02

### Questions:

1] (a) classify signaling techniques ?

Explain the mode of operation of ces.

(b) What does you mean by network traffic measurement ? On an average, suppose one call arrives every 5 seconds.

During a period of 10 seconds, what is the probability that :

(i) No will call arrive

(ii) One call will arrives

(iii) Two calls will arrive.

(c) Describe Cellular Telephony ?

2] (a) What are the objectives of numbering plan?

(b) Describe the telephone number structure.

(c) Draw the cell structure that has a frequency allocation such that there is a separation of at least two cells between that reuse the same frequency.

Ensure that the total number of frequencies used are minimum.

3] (a) What are the difference between in-channel and common channel signaling?

(b) Why do we use a channel access method?

(c) Explain the fundamental types of channel access schemes with diagram.

4] (a) Why is sampling necessary? What are the problems in sampling?

(b) Write down the different type of frequency bands used for satellite communications?

(c) Distinguish between public telephone network and private telephone network.

5] (a) Explain the major components of a telephone system?

(b) What do you know about wireless sensor network?

(c) Discuss the five characteristic regions in the normalized event reliability with respect to reporting frequency that are define in the paper titled "event-to-sink reliable transport in wireless sensor network."

6] (a) What is cell? Write the importance of D/R in cell geometry.

(b) Differentiate soft handoff and hard handoff?

(c) Differentiate between HLR and VLR?

7 (a) Discuss about charging Plan ?

(b) Classify the handoff procedure ? Draw the figure of step by step handoff procedure.

(c) Describe the function when anyone call to a mobile subscriber.

8 (a) Describe the GSM system model with the network components.

(b) Describe the GSM transmission process inside the mobile equipment.

(c) Write short note on

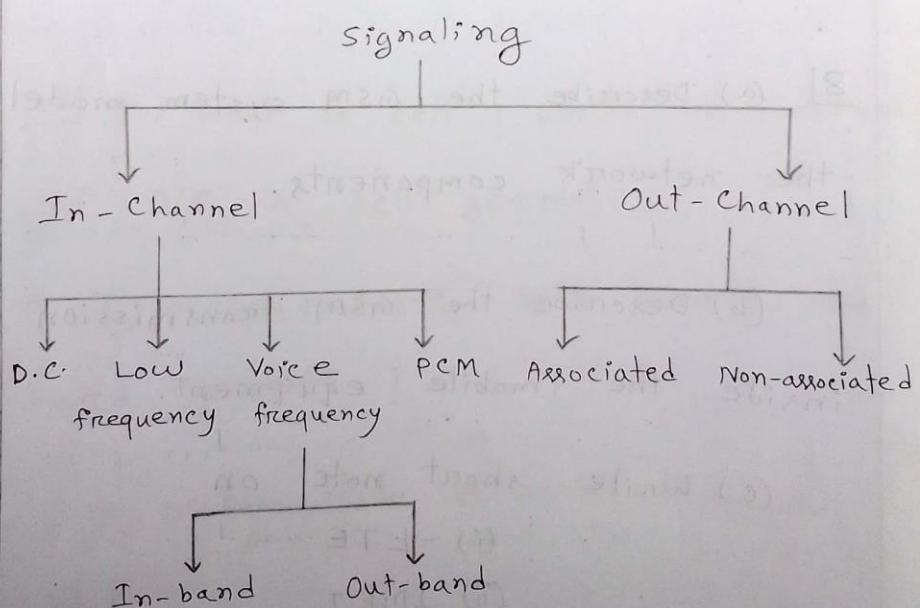
(i) LTE

(ii) IMEI

Answer to the Ques. No-1(a)

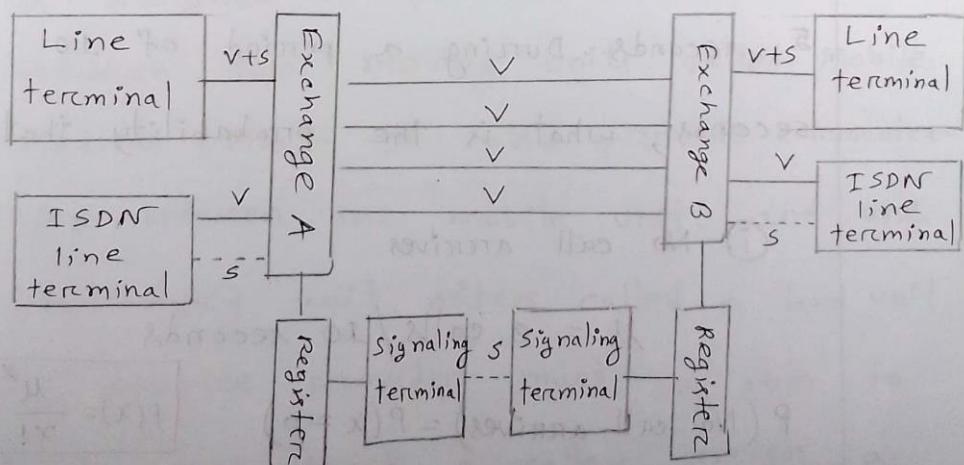
Types of Signaling Techniques: The signaling techniques are categorized into two, the In-channel signaling and the common channel signaling.

The division is as shown in the following figure —



Common channel Signaling (CCS) : In telephony, Common Channel Signaling (CCS), is the transmission of signaling information (control information) on a separate channel from the data, and more specifically, where that signaling channel controls multiple data channels.

Common channel signaling system :



Ans. to the Ques. No-1 (b)

Network traffic measurement : deals with the process of monitoring and controlling the activities of network besides transforming the network into a managed resource by improving performance, efficiency and security.

\* On average one call arrives every 5 seconds. During a period of 10 seconds, what is the probability that:

i) No call arrives

$$\mu = 2 \text{ calls} / 10 \text{ seconds}$$

$$P(\text{No call arrives}) = P(x=0)$$

$$P(x) = \frac{\mu^x}{x!} e^{-\mu}$$

$$= \frac{2^0}{0!} e^{-2}$$

$$= 0.135$$

⑩ One call arrives,  $P(1) = \frac{2^1}{1!} e^{-2}$   
 $= 0.27$

⑪ More than one call arrives,

$$P(x > 1) = 1 - P(0) - P(1)$$
$$= 0.595$$

Ans. to the Ques. No - 1 (c)

Cellular Telephony: cellular telephony is designed to provide communications between two moving units called mobile stations (MSS). It also provides communication between one mobile unit, and one stationary unit, often called a land unit. A service provider must be able to locate and track a caller, assign a channel to the call. To make this

tracking possible, each cellular service area is divided into small regions called cells. Each cell contains an antenna and is controlled by a network station, called the Base Station (BS). Each base station, in turn, is controlled by a switching office, called a mobile switching center (MSC).

It is a computerized center that is responsible for connecting calls, recording call information and billing.

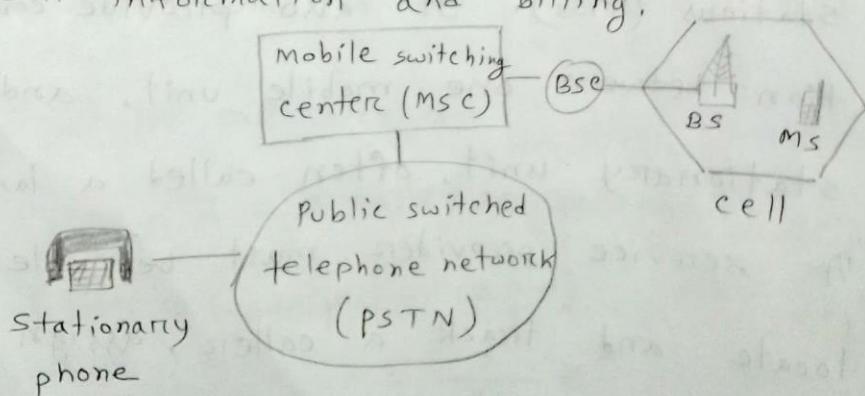


fig: cellular system

Ans. to the Ques. No - 2(a)

A telephone numbering plan is a type of numbering scheme used in telecommunication to assign telephone numbers to subscriber telephones or other telephony endpoints.

The objective of numbering plan is to uniquely identify every subscriber connected to a telecommunication network.

Ans. to the Ques. No - 2(b)

Every international number consists of three main parts :

Country code (cc)	Area code (AC)	Directory/subscriber Number	
1-3/4	1-3	Central office code	Destination number
		1-3	1-4

- ↳ The country calling code is a prefix number, not exceeding 3 digits, which identifies a specific country or group of countries.
- ↳ The area code is a variable number, for particular country, state or province, also known as number plan area (NPA).
- ↳ The central office code is a number, not exceeding 3 digits, identifies a particular district within an area in a country.
- ↳ The destination number is a 4 digit suffix number, which identifies a particular subscriber, or telephone line number.

Ans. to the Ques. No-2(c)

The design process of selecting and allocating channel groups for all of the cellular base stations within a system is called frequency reuse or frequency planning.

The figure illustrates the concept of cellular frequency reuse, where cells labeled with the same letter use the same group of channels.

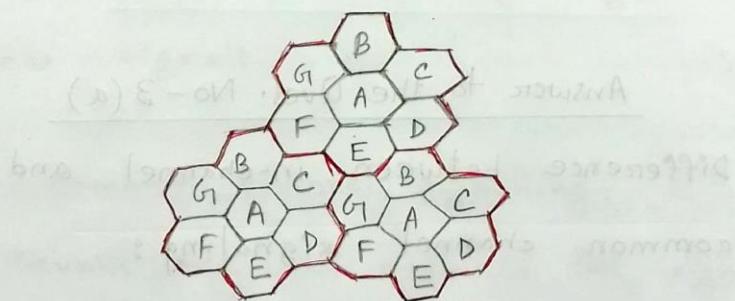


fig: Illustration of the cellular frequency reuse concept. Cells with the same letter use the same set of frequencies. A cell cluster is outlined in bold and replicated over the coverage area. In this example, the cluster size,  $N$ , is equal to seven and the frequency reuse factor is  $1/7$  since each cell contains one-seventh of the total number of available channels.

The frequency reuse plan is overlaid upon a map to indicate where different frequency channels are used. The hexagonal cell shape shown in figure is conceptual and is a simplistic model of the radio coverage for each base station, but it has been universally adopted since the hexagon permits easy and manageable analysis of a cellular system.

### Answer to the Ques. No-3(a)

Difference between in-channel and common channel signalling :

in-channel signalling :-

- i. Trunks are held up during signalling
- ii. Interference between Voice and control signals may occur.

iii. Separate signaling equipment is required in each trunk hence expensive.

iv. Can be misused by customers since it is easy to mimic voice signaling.

v. Signalling is relatively slow.

vi. Speech circuit continuity is assured when signaling is received.

vii. It is difficult to change signals or add new signals.

#### Common channel signalling:

i. Trunks are not required for signaling.

ii. No interference since the voice and control channels are separate.

iii. Only one set of signaling equipment is required for a large group of trunk circuits hence economical.

iv. Control channel is in-accessible to users.

v. Signalling is much faster.

vi. State of speech circuit not automatically assured.

vii. There is flexibility to add new signals or change existing signals.

Ans. to the Ques. No - 3(b)

Channel Access Method (CAM) is used in telecommunications and computer networks to allow network terminals to share media capacity through a multipoint transmission medium. CAM examples include bus, hub, wireless and ring networks.

A channel access scheme is based on

a multiplexing method, which allows several data streams or signals to share the same communication channel or physical medium. Furthermore, it is also based on a multiple access protocol and control mechanism known as media access control (MAC).

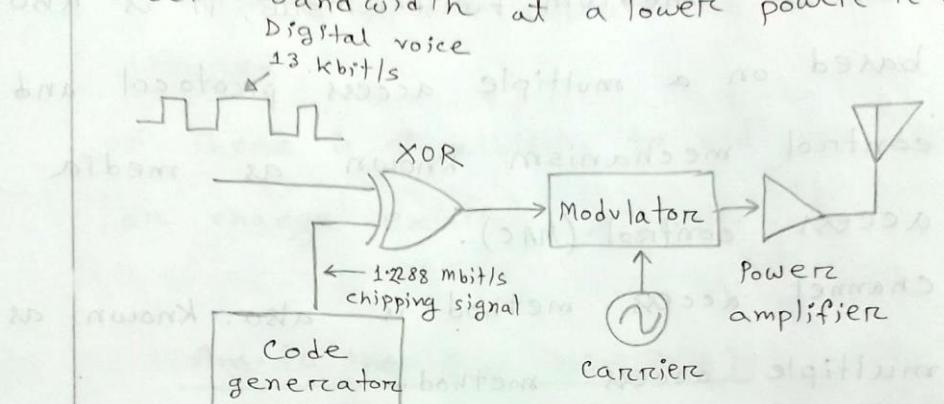
Channel access method is also known as multiple access method.

#### Answer to the Ques. No- 3(c)

Channel access allows multiple users in the same system to share a given bandwidth allocation. Some fundamentals of communications access technologies: FDMA, TDMA, CDMA, OFDMA and SDMA.

Hence. Code Division Multiple Access (CDMA)

is also known as spread spectrum because it takes the digitized version of an analog signal and spreads it out over a wider bandwidth at a lower power level.



#### Answer to the Ques. No - 4(a)

Sampling is defined as, "The process of measuring the instantaneous values of continuous time signal in a discrete form."

To convert a signal from continuous

time to discrete time, a process called sampling is used.

Problems of sampling:

- i. chances of bias,
- ii. difficulties in selecting truly a representative sample.
- iii. Need for subject specific knowledge
- iv. changeability of sampling units
- v. impossibility of sampling.

Answer to the Ques. No - 4 (b)

Frequency bands for satellite communications:

Different kinds of satellites use different frequency bands:

- ① L-Band: 1 to 2 GHz, used by MSS
- ② S-Band: 2 to 4 GHz, used by MSS, NASA, deep space research.

- (iii) C-Band : 4 to 8 GHz, used by FSS.
- (iv) X-Band : 8 to 12.5 GHz, used by FSS and in terrestrial imaging, ex: military and meteorological satellites.
- (v) Ku-Band : 12.5 to 18 GHz : used by FSS and BSS (DBS)
- (vi) K-Band : 18 to 26.5 GHz : used by FSS and BSS.
- (vii) Ka-Band : 26.5 to 40 GHz : used by FSS.

Answer to the Ques. No - 4(c)

Public telephone network : Public Switched Telephone Network (PSTN) makes use of circuit-switched telephony between two points during a call.

It is the age-old traditional telephone system. Copper wires are responsible for carrying analog voice data, thus facilitating communication. Presently, this voice data is no longer analog but digital. It is carried over the phone network itself and is different from internet traffic. PSTN is like putting together telephone networks spread worldwide into one system. It includes everything from telephone lines, cellular networks, switching centers, and cable systems to fiber optic cables. These lines facilitate communication between telephones.

private telephone network: A private network where a closed group of telephones are connected primarily to each other and use a gateway to reach the outside world. This is usually used inside companies and call centres and is called a Private Branch Exchange (**PBX**).

A PBX is a private telephone system used within an enterprise.

#### Answer to the Ques. No-5 (a)

The telephone system model is organized as a highly redundant, multilevel hierarchy. It comprises of the following components—

- ↳ Telephone of the subscriber or end user.
- ↳ End office — Local central office directly connected to end user at a distance of 1-10 km.

- ↳ Local loop - A two-way connection between the telephone and the end office.
- ↳ Toll office - switching centres which are called tandem offices when located within the same local area.
- ↳ Toll connecting trunk - Lines that connect end offices with toll offices.
- ↳ Intermediate switching offices - Interconnected non-hierarchical switching offices for connecting toll offices.
- ↳ Inter toll trunk - Very high bandwidth channels that connect either two toll offices via intermediate switching offices.

The model can be diagrammatically represented as follows —

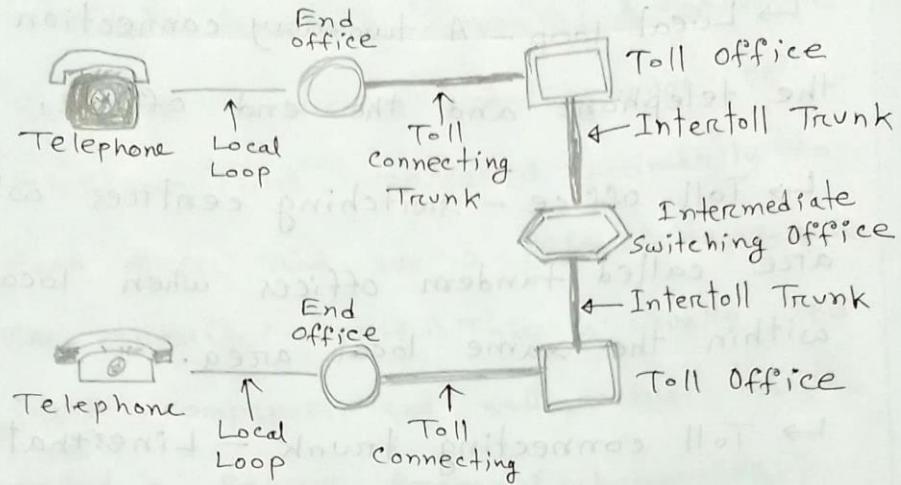


fig: Structure of the Telephone System

Answer to the Ques. No - 5(b)

Wireless Sensor Network (WSN) : is an infrastructure-less wireless network that is deployed in a large number of wireless sensors in an ad-hoc manner that is used to monitor the system, physical or environmental conditions.

Sensor nodes are used in WSN with the onboard processor that manages and monitors the environment in a particular area. They are connected to the base station which acts as a processing unit in the WSN system.

Base station in a WSN system is connected through the Internet to share data. WSN can be used for processing, analysis, storage and mining of the data.

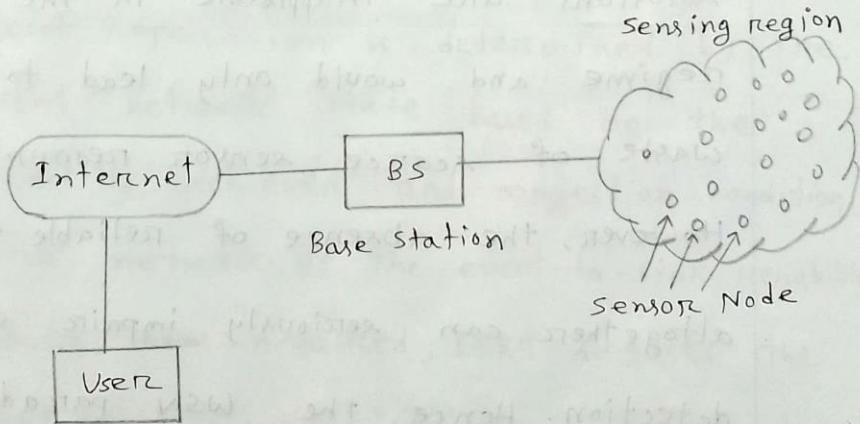


fig: WSN

Answer to the Ques. No - 5(c)

Wireless Sensor Networks (WSN) are event based systems that rely on the collective effort of several microsensor nodes. Reliable event detection at the sink is based on collective information provided by source nodes and not on any individual report. Hence, conventional end-to-end reliability definitions and solutions are inapplicable in the WSN regime and would only lead to a waste of scarce sensor resources. However, the absence of reliable transport altogether can seriously impair event detection. Hence, the WSN paradigm necessitates a collective event-to-sink

reliability notion rather than the traditional end-to-end notion.

A new reliable transport scheme for WSN, the event-to-sink reliable transport (ESRT) is a novel transport solution developed to achieve reliable event detection in WSN with minimum energy expenditure. It includes a congestion control component that serves the dual purpose of achieving reliability and conserving energy. ESRT protocol operation is determined by the current network state based on the reliability achieved and congestion condition in the network. If the event-to-sink reliability is lower than required, ESRT adjusts the reporting frequency of the source nodes aggressively in order to reach the target

reliability level as soon as possible.

If the reliability is higher than required, then ESRT reduces the reporting frequency conservatively in order to conserve energy while still maintaining reliability. This self-configuring nature of ESRT makes it robust to random, dynamic topology in WSN.

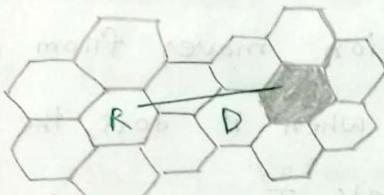
#### Answer to the Ques. No - 6(a)

cell: To provide communication, in a cellular network each cellular service area is divided into small regions called cells.

In a cellular network, each cell can cover a limited number of mobile subscribers within its boundaries. Each cell can have a base station with

a number of RF channels.

Frequencies used in a given cell area will be simultaneously reused at a different cell which is geographically separated. For example, a typical seven-cell pattern can be considered.



We assume a cellular system having a cell radius "R" and co-channel distance "D" and the cluster size "N". Since the cell size is fixed, co-channel interference will be independent of power.

Co-chi interference is a function of " $q$ " =  $D/R$ .

Higher value of " $q$ " means less interference.

Lower value of " $q$ " means high interference.

Advantages of D/R is

↳ Decrease co-channel interference

↳ Increase system capacity

### Answers to the Ques. No - 6(b)

Handoff (Handover): During a conversation, the mobile station moves from one cell to another. When it does, the signal may become weak. To solve this problem,

the MSC (Mobile switching center) monitors the level of signal every few seconds.

If the strength of the signal diminishes, the MSC seeks a new cell that can better accommodate the communication.

This is called Handoff (Handover).

### Types of Handoff:

#### i) Hard Handoff:

Early systems used a hard handoff. In a hard handoff, a mobile station only communicates with one base station. When the MS moves from one cell to another, communication must first be broken with the previous base station before communication can be established with the new one. This may create a rough transition.

#### ii) Soft Handoff:

New systems use a soft handoff. In this case, a mobile station can communicate with two base stations at the same time. This means

that, during handoff, a mobile station may continue with the new base station before breaking off from the old one.

#### Answer to the Ques. No- 6(c)

Differentiate between HLR and VLR :

HLR :

- i. Home Location Register,
- ii. HLR contains entries for each and every subscriber (MSISDN number) within a mobile network.
- iii. Mostly HLR contains static and permanent information about a subscriber.
- iv. For example, subscriber status, service subscriptions (Voice, Data, SMS etc),

supplementary services, permissions etc.

Other than this static information, it has temporary information such as current VLR number and MSC number.

v. HLR works as the central location to route calls within the respective mobile operator's network. Most of the administrative activities regarding the subscribers are controlled and centralised around the HLR.

vi. HLR contains authentication information as well.

### VLR:

i. Visitor Location Register

ii. VLR is a database that contains part of the data available in the HLR and other dynamic information about the mobile station's

currently roaming in the administrative areas of the associated VLR. Data in the VLR are more dynamic than the others because of the mobility nature of the mobile stations.

iii. When a mobile station moves from one Location Area to another their information is updated in the VLR, so as to locate the mobile stations.

iv. When a subscriber moves out to new VLR area then HLR inform the old VLR to remove the information related to the given subscriber.

v. Information about location such as LAI (Location Area Information), attached status and Temporary mobile Subscriber Identity (TMSI) are stored in the VLR.

vi. Also some of the authentication information is passed from HLR to VLR for the authentication requirements.

Answer to the Ques. No - 7(a)

Charging plan: The cost of providing a telecommunication network consists of the capital cost and the current operating expenses. The capital cost includes switching systems, buildings, lines and land. Operating cost includes staff salaries, maintenance costs, water and electricity charges and miscellaneous expenses. All of these costs must be met by the income obtained by the telecom operator from its subscribers. The telecom operator

charges the subscriber for its services by the following three ways.

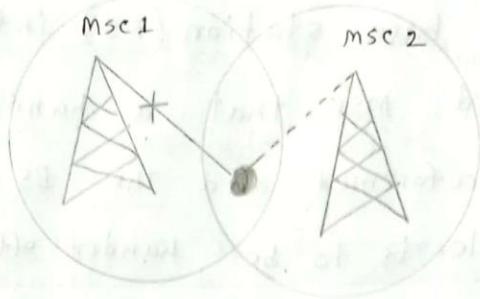
- i. An initial charge for providing a network connection (as installation charges).
- ii. A rental or leasing charge
- iii. call charges.

#### Answer to the Ques. No - 7 (b)

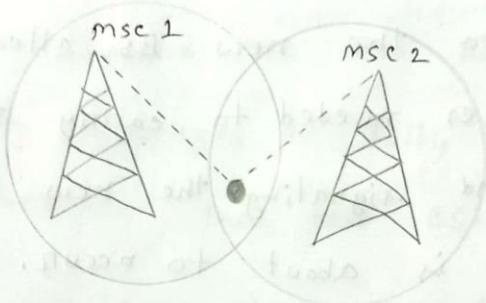
In cellular telecommunications, the terms handover or handoff refers to the process of transferring ongoing call or data connectivity from one Base station to other Base Station.

#### Classify Handoff :

- i. Hard Handoff



### ii. Soft Handoff:



### # Step by step Handoff Procedure:

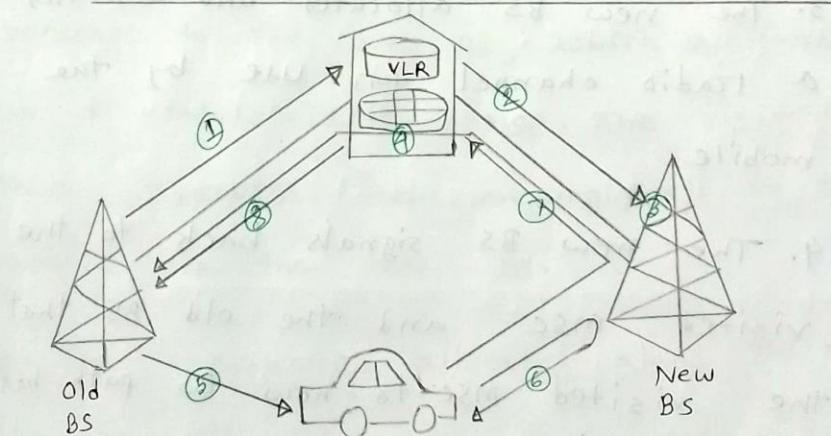


fig: Steps in accomplishing a handoff  
betn base stations with a common msc

### 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 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.
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. The visited MSC then reroutes the ongoing call to the mobile via the new BS.
8. The resources allocated along the path to the old BS are then released.

### Answer to the Ques. No - 7(c)

How we make a call:

- ↳ To place a call from a mobile station, the caller enters a phone number and presses the send button.
- ↳ The mobile station then scans the band and sends the data (phone number) to the closest base station using that channel.
- ↳ The base station relays the data to the MSC.
- ↳ The MSC sends the data on to the telephone central office.
- ↳ If the called party is available, a connection is made.

### Answer to the Ques. No - 8(a)

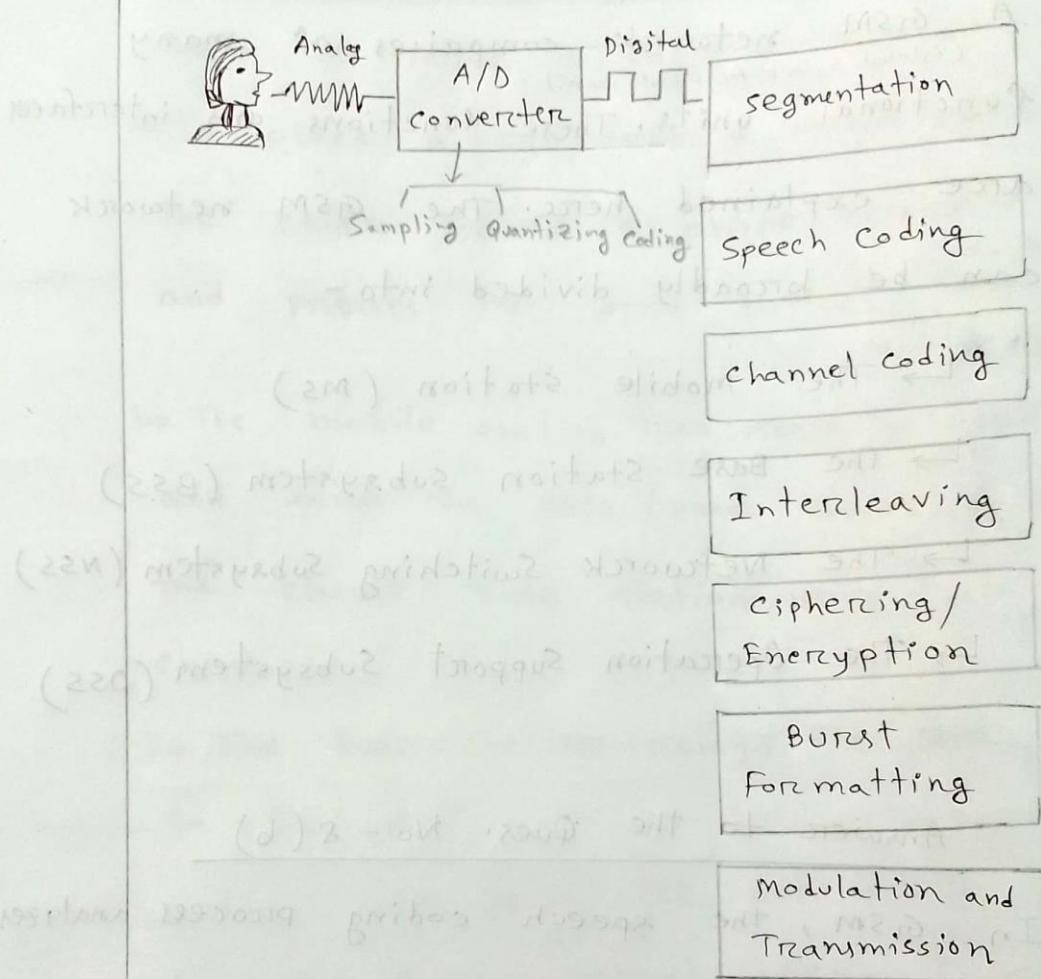
A GSM network comprises of many  
(Global System for Mobile Comm)  
functional units. These functions and interfaces  
are explained hence. The GSM network  
can be broadly divided into -

- ↳ The Mobile station (ms)
- ↳ The Base station subsystem (BSS)
- ↳ The Network Switching Subsystem (NSS)
- ↳ The Operation Support Subsystem (OSS)

### Answer to the Ques. No - 8(b)

In GSM, the speech coding process analyzes  
speech samples and outputs parameters  
of what the speech consists of the  
tone, length of tone, pitch etc. This is  
then transmitted through the network to  
another MS, which generates the speech  
based on these parameters.

## GSM Transmission Process & Steps



Answers to the Ques. No - 8 (c)

- (i) LTE : LTE stands for Long Term Evolution and is sometimes referred to as 4G. LTE is a standard.

for wireless data transmission that allows you to download your favourite music, websites and video really fast - much faster than you could with the previous technology, 3G. It supports data transfer rates of up to 100 Mbps downstream and 50 Mbps upstream.

(ii) IMEI : IMEI stands for International Mobile Equipment Identity and is a unique number given to every single mobile phone, typically found behind the battery.

IMEI numbers of cellular phones connected to a GSM network are stored in a database containing all valid mobile phone equipment.

When a phone is reported stolen or is not type approved, the number is marked invalid.

The number consists of four groups that look like this:

nnnn-nnnn-nnnn-nnnn

Indicates not about TIME (1)

→ & has utitizable incoming slides  
Offices being at movie studios implies  
an invited guest, possibly, mostly slides  
• printed

• busses, roads, railroads to consider TIME

→ & boats, sea routes, ships  
and slides between locations