



**MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION**  
(Autonomous)  
(ISO/IEC - 27001 - 2005 Certified)

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**Winter – 15 EXAMINATIONS**

Subject Code: **17657**      **Model Answer**

**Important Instructions to examiners:**

- 1) The answers should be examined by key words and not as word-to-word as given in the answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

**Winter – 15 EXAMINATIONS**

**Q.1 a) Attempt any THREE of the following**

**12 Marks**

(i) Define

(1) Mobile Switching Center

(3) Dwell Time

(2) Base Station

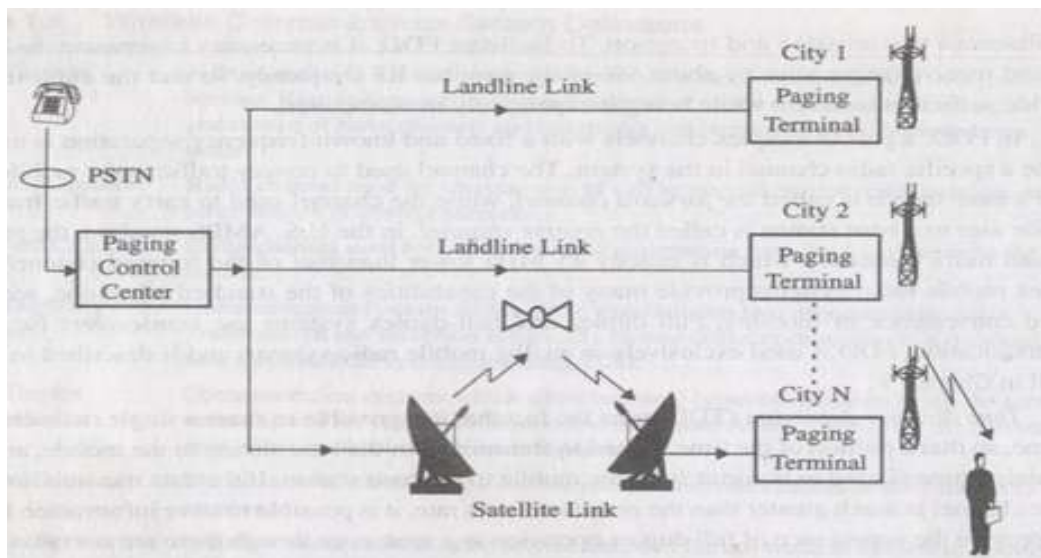
(4) Hand off

Ans: (each correct definition – 1 mark each)

- **Mobile Switching Center** - Switching Center which co-ordinates the routing of calls in a large service area. In a cellular radio system, MSC connects the cellular base station and the mobiles to the PSTN. An MSO is also called as Mobile Telephone Switching Office (MTSO).
- **Base Station** – A fixed station in a mobile radio system used for radio communication with mobile stations. Base stations are located at the center or on the edge of a coverage region and consist of radio channels and transmitter and receiver antennas mounted on a tower.
- **Hand off** - In cellular telecommunications, the term **handoff** refers to the process of transferring an ongoing call from one channel connected to the core network to another, when a mobile moves into a different cell while a conversation is in progress.
- **Dwell Time** - The time over which a call may be maintained within a cell, without handoff, is called the dwell time.

(ii) Describe working principle of paging system with neat block diagram.

Ans: (diagram 2 marks, working principle – 2 marks)



Pager is a Simplex Communication Device. Paging Systems are communication systems that send messages to a subscriber. Message can be numeric or alphanumeric. Paging Systems are used to notify a subscriber of the need to call a particular telephone number or to travel to a location to receive further instructions. In modern paging systems, news headlines, faxes can also be sent.

A message is sent to a paging subscriber via the paging system access number with a telephone keypad or modem. The issued message is called a 'Page'. The paging system then transmits the page throughout the service area using base stations which broadcast the page on a radio carrier.

The coverage area of a simple paging system ranges from 2 to 5 km while a wide paging system can have a worldwide coverage area. Whenever a sender wants to send a message to a receiver he dials the 10 digit pager number of receiver through his telephone.

Then this call is accepted by the operator present in the paging control center to whom the receiver pager number and the message to be sent has to be sent. Then the operator will broadcast the message and the receiver paging number to all the paging terminals or the base stations. Then a particular base station under the area where the receiver is present will transmit the message to the receiver pager. Then the receiver's pager device will receive all messages and will verify whether the sender number is stored in its memory or not. If it is stored then the pager device will give beep which indicates the receiver that a message is sent by sender to his pager and the message will be displayed in the LCD.

(iii) State advantages of sectoring in cellular system (any 4 points)

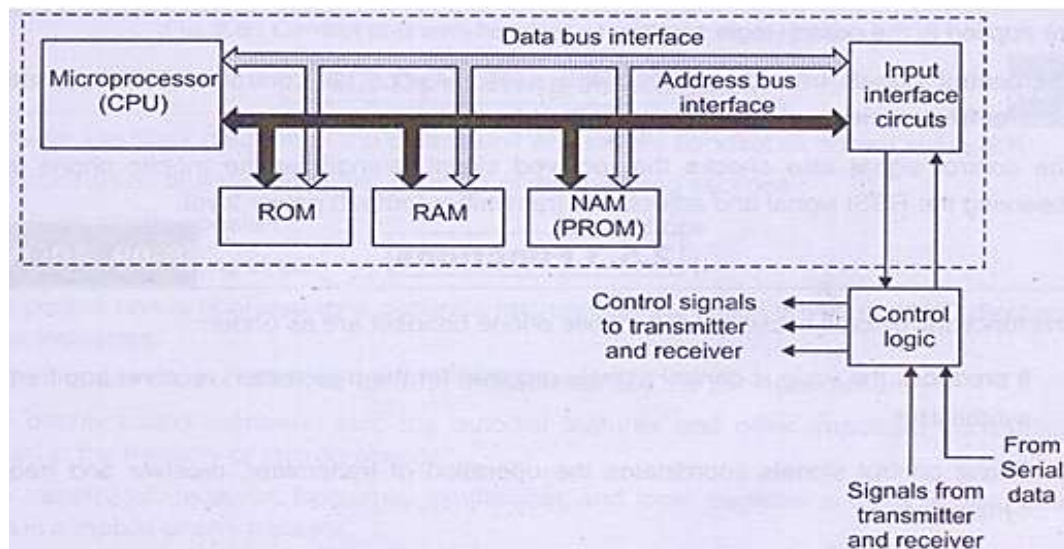
Ans: (any relevant four correct points – 1 mark each)

#### Advantages of sectoring in cellular system

1. Sectoring reduces co-channel interference.
2. Sectoring improves Signal to interference (S/I) ratio.
3. Sectoring improve frequency reuse and thus system capacity.
4. Sectoring improves capacity of the system.
5. The cluster size is reduced & thus the channel are shared which increase capacity of the system.
6. Need of handoff is reduced.

(iv) Draw the block diagram of logical unit of mobile handset and explain its working.

Ans: (diagram – 2 marks, explanation – 2 marks)



The logical unit contains the main control circuitry for the cellphone unit. The logical unit consists of a CPU, RAM, ROM, I/O interface circuit and control logic. NAM (Number Assignment Module) is a programmable read only memory (PROM). The NAM holds the Mobile Identification Number (MIN) i.e. the telephone number of the mobile phone.

The serial data comes from the MTSO. The bit rate of this signal is 10kbps. The MTSO keeps a full control over all the cell phones using this serial data. This signal controls the transmitting and receiving frequencies and transmitted power. The MTSO checks the received signal strength at the mobile by observing the RSSI signal and adjust the transmitted power level. Control signals from control logic section are applied to transmitter and receiver section of mobile unit.



**Q 1. b) Attempt any ONE of the following**

**6 marks**

(i) Explain any three mobile radio systems around the world in brief.

Ans: (any relevant three radio systems explanation – 2 marks each)

**AMPS Radio System**

- To increase the capacity in large AMPS markets, Motorola developed an AMPS- like system called N- AMPS (narrowband AMPS) in 1991.
- N-AMPS were a useful transition technology before 2 G equipment became available. N AMPS provided three users in a 30 kHz AMPS channel by using FDMA and 10 kHz channels, and provided three times the capacity of AMPS.
- By replacing AMPS channels with three N- AMPS channels at one time, service providers were able to provide more trunked radio channels (and thus a much better grade of service) at base stations in heavily populated areas.
- N- AMPS used the SAT and ST signalling and blank and burst functions in exactly the same manner as AMPS, except the signalling was done by using sub-audible data streams.
- Since 10 kHz channels are used, the FM deviation is decreased in N-AMPS. This in turn reduces the S/ (N+1) which degrades the audio quality with respect to AMPS. To counteract this, N-AMPS uses voice companding to provide a synthetic voice channel quieting.
- To counteract this, N-AMPS, except the signalling was done by using sub-audible data streams.
- N-AMPS specify a 300Hz high pass audio filter for each voice channel so that supervisory and signalling data may be sent without blanking the voice.
- The SAT and ST signalling is sent using a continuous 200 bps NRZ data stream that is FSK modulated. SAT and ST are called as DSAT and DST in N- AMPS because they are sent digitally and repetitiously in small, predefined code blocks.

**IS – 95B**

- The interim data solution of CDMA is called IS-95B. Like GPRS, IS-95B is already being deployed worldwide, and provides high speed packet and circuit switched data access on a common CDMA radio channel by dedicating multiple orthogonal user channels (Walsh functions) for specific users and specific purposes.
- Each IS-95 CDMA radio channel supports up to 64 different user channels. The original IS-95 throughput rate specification of 9.6 kbps was not implemented in practice but was improved to the current rate of 14.4 kbps as specified in IS-95A.
- The 2.5G CDMA solution, IS-95B supports medium data rate (MDR) service by allowing a dedicated user to command up to 8 different user Walsh codes simultaneously and in parallel for an instantaneous throughput of 115.2 kbps per user (8\*14.4 kbps)
- However, only about 64 kbps of practical throughput is available to a single user in IS-95B due to the slotting techniques of the air interface.
- IS-95B also specifies hard hand-off procedures that allow subscriber units to record different radio channels in the network without instructions from the switch so that the subscriber

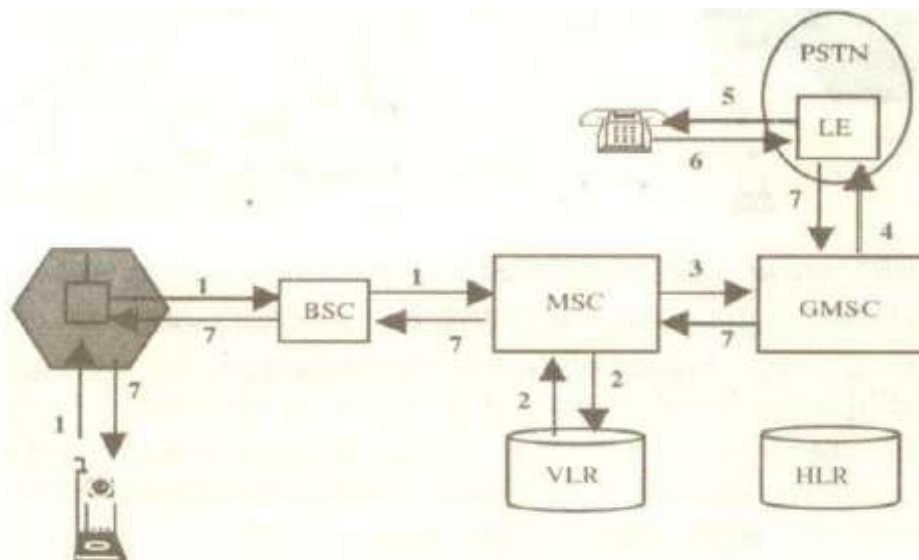
**GSM**

- Second Generation Cellular Technology
- Introduced in the year 1990 by Europe
- Multiple Access used is TDMA
- Modulation Technique used is GMSK

- Duplexing used is FDD
- Reverse Link :- 890 to 915 MHz
- Forward Link :- 935 to 960 MHz
- Spacing between forward & reverse channel pair :- 45MHz
- Bandwidth of channel :- 200 kHz
- No of Duplex RF channels – 125
- Introduced in US as PCS (Personal Communication System)
- Further Generations are
  - ❖ HSCSD (2.5th Generation)
  - ❖ GPRS (2.5th Generation)
  - ❖ EDGE (2.5th Generation)

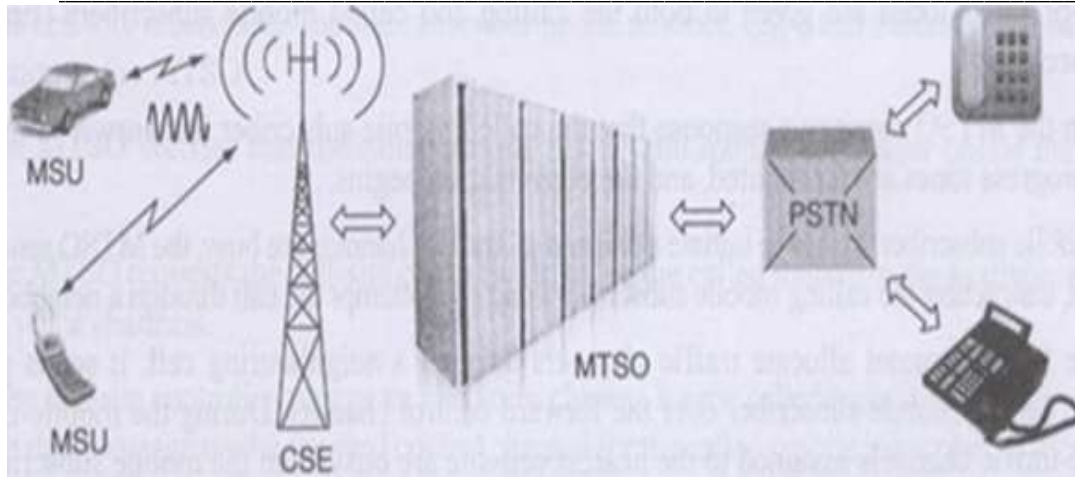
(ii) Describe call making procedure from mobile handset to landline phone with neat timing diagram.

Ans: (any relevant correct diagram – 4 marks and its explanation – 2 marks)



The MS sends the dialed number indicating service requested to the MSC(via BSS) .The MSC checks from the VLR if the MS is allowed the requested service. If so, MSC asks BSS to allocate necessary resources for the call. If the call is allowed, the MSC routes the call to GMSC. The GMSC routes the call to the local exchange of called user. The LE alerts (applies ringing) the called terminal. Answer back (ring back tone) from the called terminal to LE. Answer back signal is routed back to the MS through the serving MSC which also completes the speech path to the MS.

**(OR)**



The MS sends the dialed number indicating service requested to the MSC(via BSS) .The MSC checks from the VLR if the MS is allowed the requested service. If so, MSC asks BSS to allocate necessary resources for the call. If the call is allowed, the MSC routes the call to PSTN (Public Switch Telephone Network) without which landline communication is not possible.

In PSTN there is a local exchange which gets alert of the incoming call and it alerts the called terminal with a ring. Answer back (ring back tone) from the called terminal to LE. Answer back signal is routed back to the MS through the serving MSC which also completes the speech path to the MS.

**Q 2. Attempt any FOUR of the following**

**16 Marks**

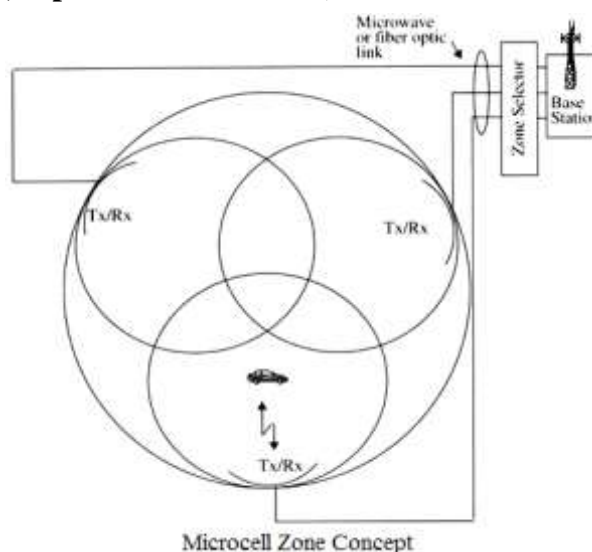
- a) Compare CT2 and DECT with respect to range of frequency and modulation type.

Ans: (Correct points – 2 marks each)

Sr. No	Parameter	CT2	DECT
1	Frequency Range	864 – 868 MHz	1880 – 1900 MHz
2	Modulation Type	GFSK	GFSK

- b) Describe microcell zone with suitable diagram.

Ans: (Diagram – 2 marks, explanation – 2 marks)





- The problem associated with sectoring technique is the increase in number of handoffs. This puts an additional load on the switching and control link elements of the mobile system.
- A solution to this problem is microcell concept. Antennas are placed at the outer edges of the cell. Any channel may be assigned to any zone by the base station. Mobile is served by the zone with the strongest signal.
  - Handoff within a cell-No channel re-assignment
    - Switch the channel to a different zone site
  - Reduce interference-Low power transmitters are employed
- Each of the three (or possibly more) zone sites are connected to a single base station and share the same radio equipment.
- The zones are connected by coaxial cable, fiber optic cable, or microwave link to the base station. So each cell consists of a base station and multiple zones. As a mobile travels within the cell, it is served by the zone with the strongest signal.
- As a mobile travels from one zone to the other within a cell, it uses the same channel. This will avoid hand-off. The base station will just switch the channel to the appropriate zone sit.
- This approach superior to sectoring since antennas are placed at the outer edges of the cell. Any base station channel may be assigned to any zone by the base station.
- This technique is particularly useful along highways or along urban traffic corridors. Thus a given channel is being used only in a particular zone in which the mobile is travelling.
- So the base station radiation is localized. This will reduce interference. The channels are distributed in time and space by all the zones are also reused in the co- channels cells.

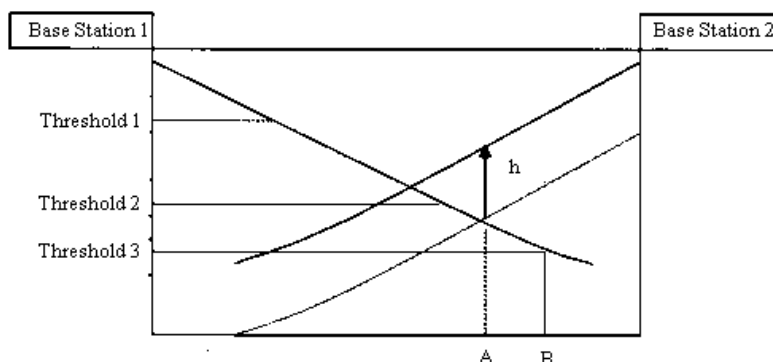
c) Explain two level hand off with suitable diagram.

Ans: (any relevant neat sketch – 2 marks, explanation – 2 marks)

In many situations, instead of one level two level handoff procedure is used. Handoff is requested after certain delay of time. It can be delayed if no available cell could take the call.

When the signal drops below the first handoff level request is initiated. If due to some reason the neighboring cell is busy handoff requested after 5sec.If the signal strength becomes lower and reaches second hand off level then hand off will take place. A handoff could be delayed if no available cell could take the call or the neighboring cells are busy.

Operation termed as Delayed Handoff.

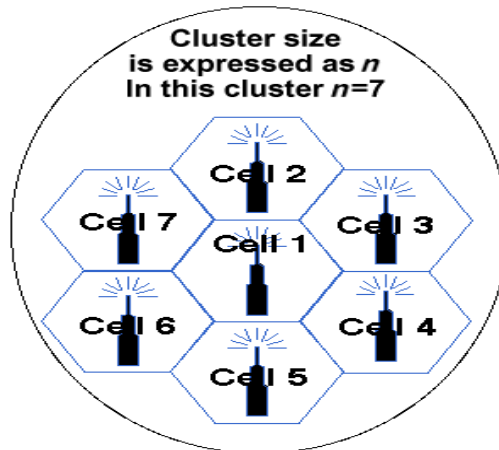


d) Describe the concept of cluster. Explain effect of cluster size on system capacity and co-channel interference.

Ans: (concept of cluster – 2 marks, effect of cluster size – 2 marks)

- The  $N$  cells which collectively use the complete set of available frequencies is called a **cluster**.
  - A cluster is a group of cells.

- No channels are reused within a cluster.



- If a cluster is replicated  $M$  times within the system, the total number of duplex channels,  $C$ , can be used as a measure of capacity and is given by,

$$C = k MN = MS$$

- The capacity of a cellular system is directly proportional to the number of times a cluster is replicated in a fixed service area.
- The factor  $N$  is called the *cluster size* and is typically equal to 4, 7, or 12.
- If the cluster size  $N$  is reduced while the cell size is kept constant, more clusters are required to cover a given area, and hence more capacity (a larger value of  $C$ ) is achieved.
- A large cluster size indicates that the ratio between the cell radius and the distance between co-channel cells is small.

#### Effect of cluster size on Co-channel Interference and System Capacity

- Frequency reuse implies that in a given coverage area several cells use the same set of frequencies.
- These cells are called co-channel cells.
- To **reduce** co-channel interference:
  - Co-channel cells must be physically separated by a minimum distance when the size of each cell is approximately same.
  - Base stations transmit the same power
- **Co-channel interference ratio** is independent of the transmitted power but dependent on:
  - Radius of the cell ( $R$ )
  - Distance between centers of the nearest co-channel cells ( $D$ )
- By increasing the ratio of  $D/R$ , co-channel interference can be reduced.
- By increasing  $D/R$ , the spatial separation between co-channel cells relative to the coverage distance of a cell is increased.
- Thus, interference is reduced from improved isolation of RF energy from the co-channel cell.
- The parameter  $Q$  called the *co-channel reuse ratio* is related to the cluster size
- For a hexagonal geometry

$$Q = D/R = \sqrt{3N}$$

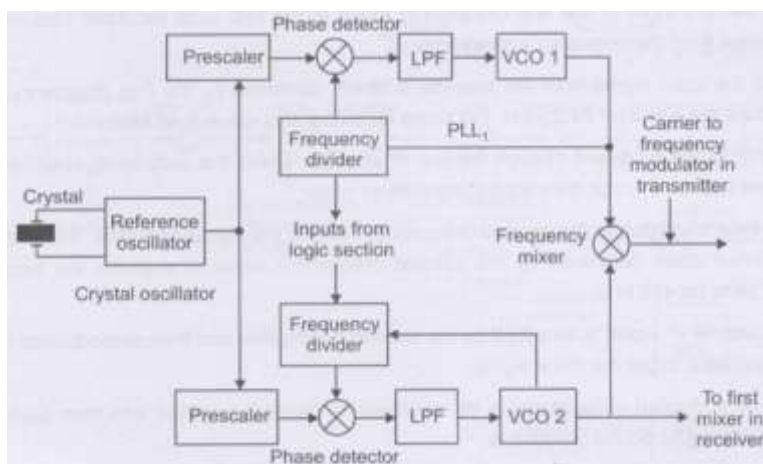
- A small value of  $Q$  provides larger capacity since the cluster size  $N$  is small.



- A large value of  $Q$  improves the transmission quality due to a smaller level of co-channel interference.
- One way to cope with increased traffic i.e. increasing number of users is to split a cell into several smaller cells.
- Additional base station needs to be established at the center of each new cell that has been added so that high density of calls can be handled effectively.
- As the coverage area of new split cell is smaller the transmitting power levels are lower, this helps in reducing co channel interference.

e) Describe working of frequency synthesizer used in mobile handset.

Ans: (diagram – 2 marks, explanation – 2 marks)



The synthesizer is used for developing all the signals used by the transmitter and receiver.

It uses the PLL circuits and a mixer. The crystal oscillator provides a reference for the two PLLs.

The output of VCO-2 is used as a local oscillator frequency for the first mixer in the receiver.

The outputs of the two VCOs are mixed together to produce the transmitter output frequency.

The frequency divider block receives the divide by numbers from the logic section.

These numbers are given by the MTSO computer. The divide by numbers will set the transmitting and receiving channel frequencies. The two outputs produced by the frequency synthesizer are applied to the modulator box in the transmitter and the first mixer in receiver respectively. Thus the frequency synthesizer acts a local oscillator which can produce a wide range of frequencies with high stability.

- f) A mobile communication system is allocated RF spectrum of 25 MHz with RF channel bandwidth of 25 kHz and if service area is divided into 20 cells with cluster size of 4. Compute the system capacity.

Ans: Given: RF Spectrum ( $f_o$ ) = 25 MHz

RF channel bandwidth ( $f_c$ ) = 25 kHz

No of cells in the area ( $n$ ) = 20

Cluster size ( $N$ ) = 4

To find: System Capacity

Solution:

$$\text{No of channels available for area (S)} = \frac{f_o}{f_c} = \frac{25 \text{ MHz}}{25 \text{ kHz}} = 1000.$$

(1 mark)

No of clusters in the service area (M) =  $\frac{n}{N} = \frac{20}{4} = 5$ . (1 mark)

System Capacity C = KMN = MS = 1000 x 5 = 5000 (2 marks)

**Q3 Attempt any four of the following:**

**a) With neat sketch of proper and improper situation of hand off explain when should hand off take place and justify what will happen if hand off is not done at proper signal level.**

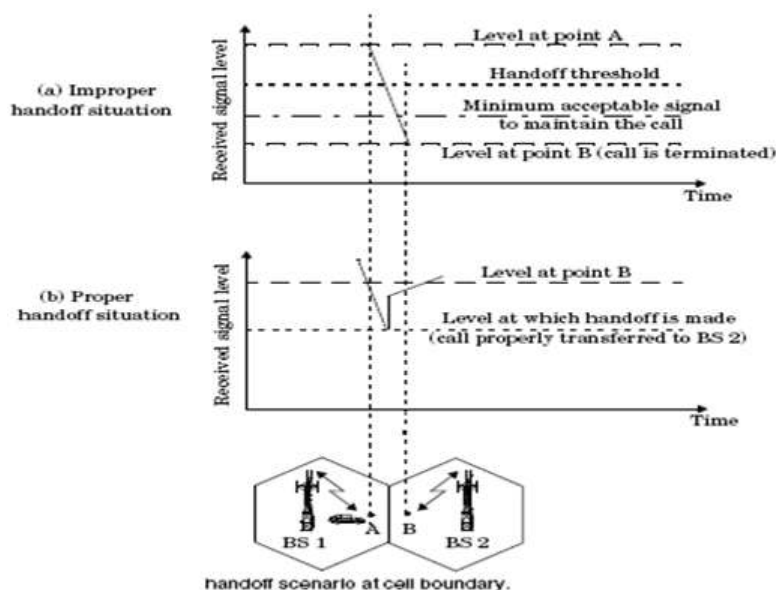
**Ans. Note: Any relevant answer should be consider: (2 marks diagram and 2 marks explanation)**

### Handoff

When a mobile moves into a different cell while a conversation is in progress, the MSC automatically transfers the call to a new channel belonging to the new base station. This process of transferring call to a new base station is called as Hand off.

### Hand-off process

The most important application of LMDS is the Local Exchange Carrier (LEC) network. It is shown in



### Explanation (2 Marks)

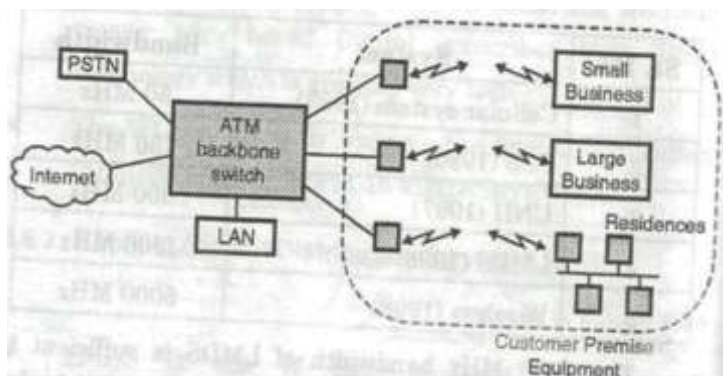
- The term hand-off does not mean a physical change in the assigned channel but rather than a different base station handles the radio communication task.
- Hand-off is a process of automatically transferring the call to a new frequency channel belonging to a new base station, when the cellular mobile phone moves into a different frequency zone so that the conversation can be continued in a new frequency zone without dialing.
- The processing of hand-off is an important task in a cellular telephone system.

- In the hand-off strategies higher priority is given to the hand-off request than the call initiation request in the cellular system.
- The procedure of hand-off should be performed successfully and it should not be repeated frequently.
- The system designers must specify the optimum signal level at which the hand-off is to be initiated.
- The minimum signal level  $P_r$ , minimum is first decided for maintaining the call. Then the slightly stronger signal levels used as a hand-off  $P_r$ , threshold for maintaining the call.
- The difference between these two levels of the signal is denoted by a symbol delta,  $\Delta$  and it is given by:  $\Delta = P_r, \text{ threshold} - P_r, \text{ minimum}$
- As the value of delta is very critical, it should not be too small or too large.
- If the value of delta is too small, then the call may lost due to weak signal and if the value of delta is too large, then unnecessary hand-off may take place at any time.
- Before initiating the hand-off, it is always necessary to ensure that the reduction in the measured signal level is not due to the momentary signal fading and that the mobile is actually moving.

Hence from above explanation, the value of  $\Delta$  should not be too small or too large because only then handoff will be done at proper signal level.

- **b) Describe operation of LMDS with suitable diagram.**

Ans:(diagram-2Marks,Explanation-2 Marks)



LMDS is suitable for LEC because of following reasons.

- The 1300MHz bandwidth of LMDS is sufficient to provide more than 200TV channels or 65000 full duplex voice channels.
- The US LMDS band is 27.5 - 28.35 GHz, 29.1 – 29.25 GHz and 31.075 – 31.225 GHz. In this network the LEC uses a very wide bandwidth ATM (asynchronous transfer mode) or SONET (synchronous optical network) backbone switch. Such a switch can connect hundreds of megabits per second traffic to the internet, PSTN, or to its own private network.
- The LMDS thus provides wireless broadband connectivity to the customers without using the cables.

- **c) State the function of VLR, HLR, AUC and OMC in GSM system.**



**Ans; (Each function-1mark)**

**Home Location Registers (HLR) (1 Mark)**

- Permanent database about mobile subscribers in a large service area (generally one per GSM Network operator)
- Database contains subscriber & location information.
- Database contains IMSI (International Mobile Subscriber Identity), prepaid/postpaid, roaming restrictions, supplementary services.
- Each Subscriber assigned IMSI to identify home user

**2. Visitor Location Registers (VLR) (1 Mark)**

- Temporary database which stores IMSI & customer information for each roaming subscriber visiting the coverage area of particular MSC.
- It updates whenever new MS enters its area, by HLR database.
- It controls the mobiles roaming in its area.

**3. Authentication Center (AUC) (1 Mark)**

- A unit called the AUC provides authentication and encryption parameters that verify the user's identity and ensure the confidentiality of each call.
- The AUC protects network operators from different types of fraud found in today's cellular world.

**4. Operation maintenance center (OMC) (1 Mark)**

- Network operation and maintenance functions, subscription, management including charging and billing and also mobile equipment management.
- The OMC also has provision for adjusting all base station parameter and billing procedure as well as providing system operators with the ability to determine the performance and integrity of all equipment in the system.

**d) Define co-channel cells. Determine distance from nearest co-channel cell having radius**

**0.64km and co-channel reuse factor of 12.**

**Ans:- (definition-1 Mark, Problem-3 Marks)**

**Co-channel cells:** Frequency reuse implies that in a given coverage area, there are several cells that use the same set of frequencies. These cells are called co-channel cells.

Effects of co-channel interference on system capacity:

The parameter  $Q$ , called the co-channel reuse ratio, is related to cluster size  $N$ ,  
 $Q = D/R = \sqrt{3N}$

Given:  $R = 0.64\text{km}$ ,  $Q = 12$

Therefore  $D = 12 \times 0.64 = 7.68\text{km}$

So distance from nearest co channel cell is 7.68km

**e) List four features of HSCSD for 2.5GSM system.**

**Ans: (Any 4 features-1Mark each)**



- High speed circuit switch data allows a single mobile user to the consecutive user timeslots in GSM standards.
- HSCSD allows individual data users to command consecutive timeslots in order to obtain higher speed data access on the GSM network.
- HSCSD relaxes the error control coding algorithm originally specified in the GSM for the data transmissions and increase the available applicable data rate to 14.4 kbps as compared to the original 9.6 kbps in the GSM specifications
- HSCSD is ideal for dedicated streaming internet access or real-time interactive web sessions and simply requires the service provider to implement a software change at existing GSM base stations.

**f) State signaling traffic load in S7 for:**

- i) Call origination from mobile                      ii) Inter MSC hand off.**

**Ans:- ( 2 MKS EACH)**

- i) Call origination from mobile** - Signaling System 7 (SS7) is an international telecommunications standard that defines how network elements in a public switched telephone network (PSTN) exchange information over a digital signaling network. Nodes in an SS7 network are called signaling points. SS7 consists of a set of reserved or dedicated channels known as signaling links. There are three kinds of network points signaling points: Service Switching Points (SSPs), Signal Transfer Points (STPs), and Service Control Points (SCPs). SSPs originate or terminate a call and communicate on the SS7 network with SCPs to determine how to route a call or set up and manage some special feature. Traffic on the SS7 network is routed by packet switches called STPs. SCPs and STPs are usually mated so that service can continue if one network point fails.

SS7 uses out-of-band signaling, which means that signaling (control) information travels on a separate, dedicated 56 or 64 Kbps channel rather than within the same channel as the telephone call. Historically, the signaling for a telephone call has used the same voice circuit that the telephone call traveled on (this is known as in-band signaling). Using SS7, telephone calls can be set up more efficiently and special services such as call forwarding and wireless roaming service are easier to add and manage.

- ii) Inter MSC hand off.** - Handover mechanism is extremely important in cellular network because of the cellular architecture employed to maximize spectrum utilization. Handover is the procedure that transfers an ongoing call from one cell to another as the user's moves through the coverage area of cellular system. One way to improve the cellular network performance is to use efficient handover prioritization schemes when user is switching between the cells. Some advance schemes namely, guard channels, call admission control and handover queuing are utilized. All these of prioritizations schemes have a common characteristic reducing the call dropping probability at the expense of increased call blocking probability. Efficient prioritization scheme accommodates a number of new calls while guarantees the quality of service (QOS) of handover call. This idea is based on the neighboring cells have an overlapping (the area served by more



than one cell) coverage area. Capacity enhancement is achieved by balancing the load in neighboring cells.

**Q4. a) Attempt any three of the following:**

**i) List any four features of IS-95 CDMA.**

**Ans: 1 mark –each feature (any four features)**

1. Diversity
2. Power control
3. Soft handoff
4. IS-95 system capacity
5. Soft capacity
6. Quality of service

**1. Diversity**

- The cellular system are having tendency to multipath fading and diversity methods of some are required to mitigate the effect of fading.
- Type of diversity in CDMA is:
  - Time diversity: - Provided by symbol interleaving, error detection& correction coding
  - Frequency diversity: - provided by 1.25MHz
  - Space (path) diversity: - Multipath signals accepted by Receiver

**2. Power control**

- For the CDMA system to work efficiently the RF power in the system need to be controlled.
- All the transmission from mobile must receive at base station receiver at approximately the same strength (within 1dB).
- To maximize the no. of users sharing a cell, only minimum RF power required for reliable communication.

**3. Soft handoff**

The soft handoff in a CDMA system results from system capability to simultaneously deliver signal to mobile through more than one cell.

**4. System capacity**

Key parameters that determine capacity of CDMA are as follow:

- Processing gain ratio of spreading code information data rate ( $W/R$ ).
- Ratio of energy per bit to noise power ( $E_b/N_o$ )
- Voice activity factor

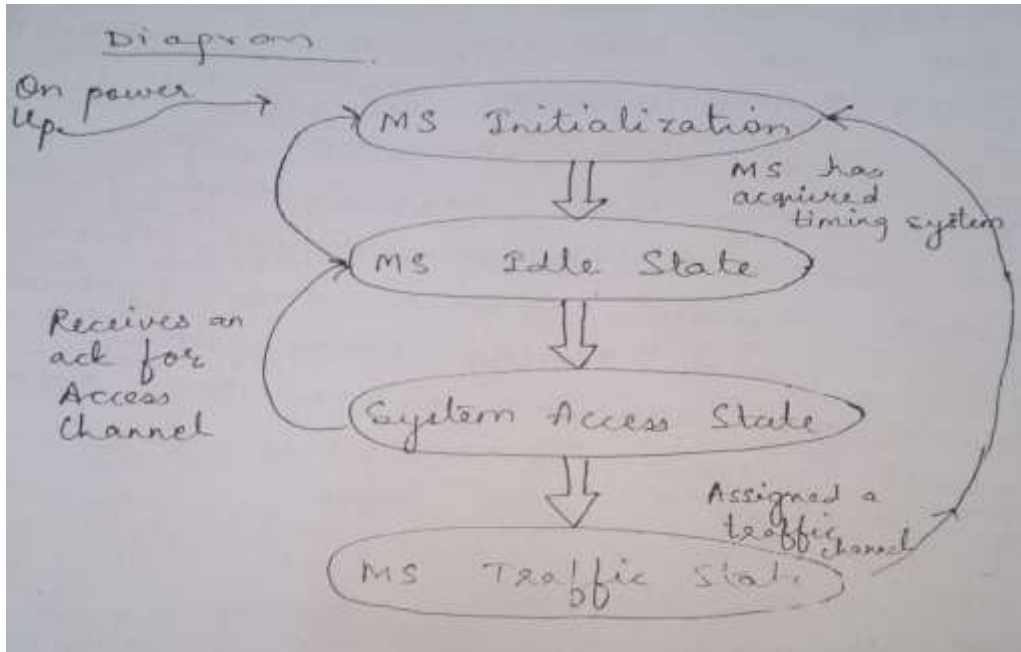


**ii) Describe call processing in IS-95.**

Ans: (1- mark diagram, 3 marks explanation)

**Call Processing Operation:**

The operation of call processing in IS-95 CDMA system is as follows:



**i) System initialization state:**

- The mobile acquires a pilot channel of a CDMA system.
- It searches all the PN offset possibilities and selects the strongest pilot signal.
- It acquires the synchronization channel and detects the pilot channels.
- It obtains the system configuration and timing information for the CDMA system.

**ii) System idle state:**

- The mobile performs the monitoring procedure of paging channel.
- It transmits an acknowledgement in the response to any message received that addressed to this mobile.
- It also maintains all active registration timers.

**iii) System access state:**

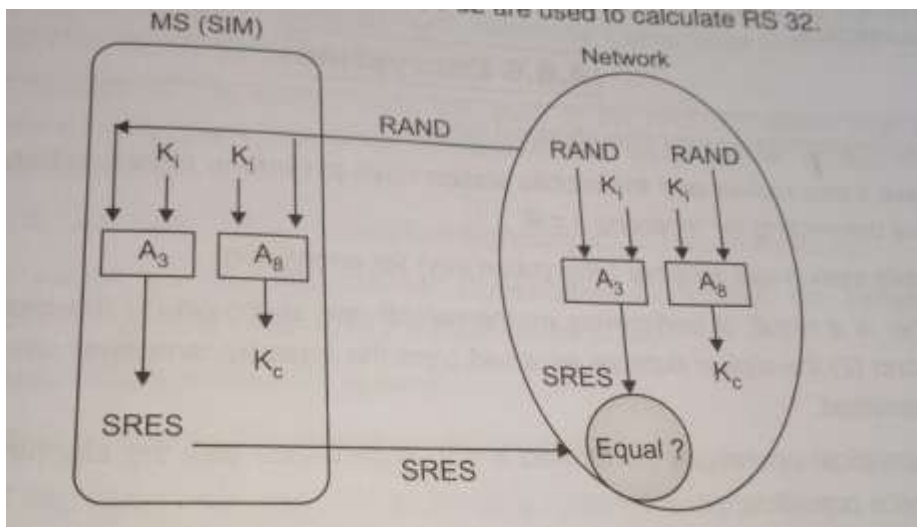
- If cell is being placed or received by the mobile it enters into the access, it exchange the necessary parameters.
- The mobile transmit its response messages or request message to the base station on the access channel and receives the message from the base station on the paging channel.
- Similarly the base station transmits its messages to the mobile, the paging channel and receive message from the mobile on the access channel.
- The entire process of transmitting one message and receiving an acknowledgement for that message is called an access attempt .the access attempt ends after an acknowledgement is received.

iv) Traffic channel state: If the access attempt is successful, then the mobile enters into the last state called as traffic state in which the transactions of voice and data take places.

- The mobile station communicates with the base station using forward and reverse traffic channels.

iii) Explain authentication process in GSM with suitable diagram.

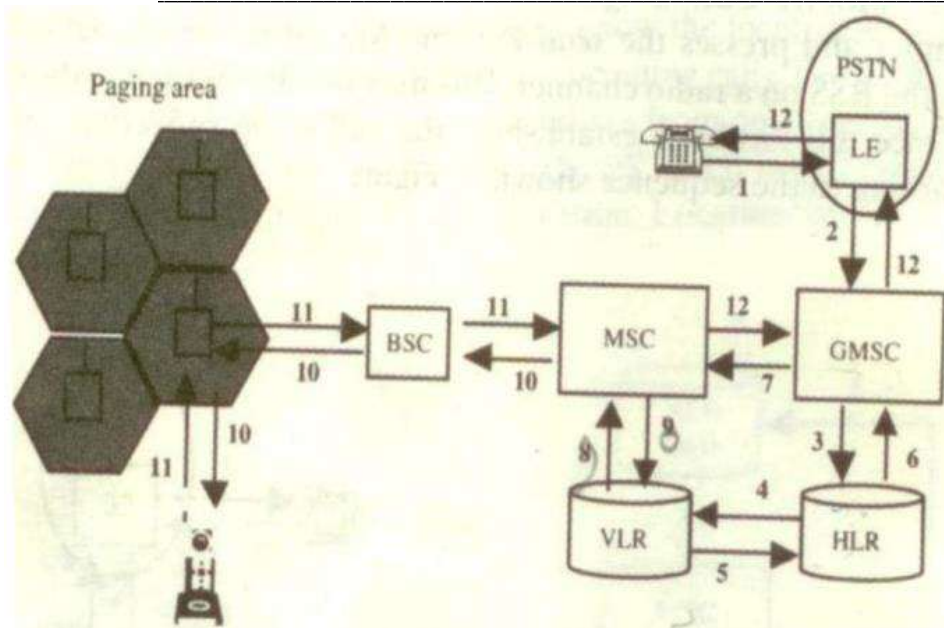
Ans. (Any other relevant diagram 2 marks, any relevant explanation – 2 Marks)



**Explanation** Authentication refers to process by which station confirms the identity of mobile station. It protects GSM network against unauthorized access. The Authentication Centre is responsible for all security aspects. The AUC generates the K<sub>i</sub>'s associates them with IMSI and provides for each IMSI a set of triplets consisting of **RAND (Random Number)**, **SERS (signed Response)**, **K<sub>c</sub> (Cipher key)** Authentication center first authenticate the subscriber mobile station and only then MSC provides service. At MS- SIM contains the entire authentication data along with A3 and A8 algorithm and signed response is generated using this. At network side signed response is generated using same algorithm and random number and if both the signed response matches then mobile phone authenticated.

iv) Describe process of mobile terminated call in GSM with neat call flow sequence diagram

Answer: (2M Diagram & 2M Explanation)



#### Mobile call termination:

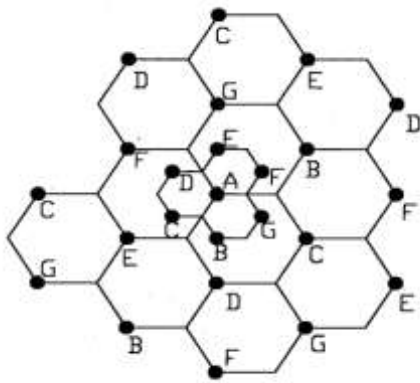
1. The PSTN user dials the MSISDN of the called user in GSM.
2. The LE routes the call to the GMSC of the called GSM user.
3. The GMSC uses the dialed MSISDN to determine the serving HLR for the GSM user and interrogates it to obtain the required routing number
4. The HLR requests the current serving VLR for the called MS for a MSRN (MS roaming number) so that the call can be routed to the correct MSC.
5. The HLR passes the MSRN to the GMSC.
6. Using the MSRN, the GMSC routes the call to the serving MSC.
7. The MSC interrogates the VLR for the current location area identity (LAI) for the MS.
8. The VLR provides the current location for the MS.
9. The MSC pages MS via the appropriate BSS. The MS responds to the page and sets up the necessary signaling links.
10. When the BSS has established the necessary radio links, the MSC is informed and the call is delivered to the MS.
11. When the MS Answer the call, the connection is completed to the calling PSTN user.
12. The VLR passes the MSRN to the HLR

**b) Attempt any one of the following:**

**06**

**i) Explain concept of cell splitting with neat diagram. Show that if cell radius is reduced by factor of 4. Assume shape of cell as circular.**

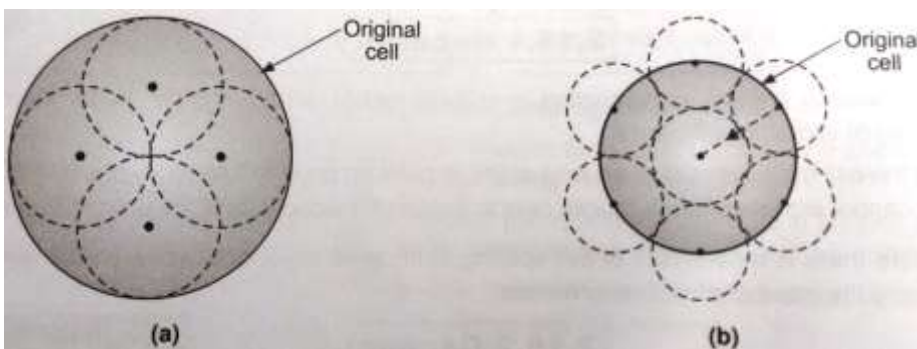
**Ans: (Diagram-1 Mark, concept-1 Mark, explanation-2 Mark)**



### Concept:

- The cell splitting achieve the capacity improvement by essentially rescaling the cellular system
- By decreasing the cell radius  $R$  and keeping the co-channel reuse ratio  $D/R$  unchanged, cell splitting increases the number of channels per unit area
- The cell splitting is the process of subdividing a congested cell into small cells with its own base station having the corresponding reduction in the antenna heights and the transmitted power

**Explanation for - When cell radius is reduced by a factor of half then the traffic load is increased by factor of four**



Let every cell have radius reduced to half. The new base stations are therefore needed in the region to increase the number of channels in the area to reduce the area served by a single base station.

The original base station is surrounded by six new microcells. As shown in the diagram the smaller cells are added in such a way as to preserve the frequency reuse plan of the system.

$$\text{New Cell Radius} = (\text{Old cell radius}) / 2$$

$$\text{Since cell shape is circular, the New Cell Area} = (\text{Old cell area}) / 4$$

Let each new cell carry the same maximum traffic load of the old cell, then in theory

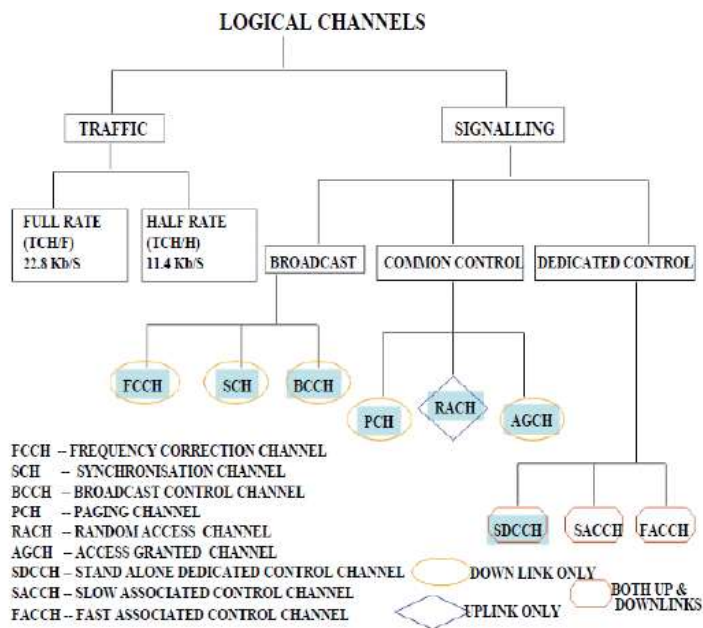
$$(\text{New Traffic Load}) / (\text{Unit Area}) = 4 * (\text{Traffic Load}) / (\text{Unit Area})$$

In order to cover the entire service area with smaller cells, approximately four times as many cells will be required. This can be shown by considering a circle of radius R.

The area covered by such a circle is four times as large area covered by a circle with radius R/2

**ii) State GSM control channels. Give functions of each channel.**

**Ans: (List-1 Mark, Functions-3 Marks)**



**1) GSM control channel (CCH):**

**1) Broadcast channel (BCH):**

**Broadcast control channel (BCCH):**

The BCCH is a forward control channel that is used to broadcast information such as cell and network identity, operating characteristics of the cell (current control channel structure, channel availability and congestion).

The BCCH also broadcast a list of channels that are currently in use within the cell.

**(a) Frequency correction channel (FCCH):**

The FCCH allows each subscriber unit to synchronize its internal frequency standard (local oscillator) to the exact frequency of the base station.

**(b) Synchronization channel (SCH):** SCH is used to identify the serving BS while allowing each mobile to frame synchronizes with the BS. The frame number (FN) is sent with the base station identity code (BSIC) during the SCH burst.



2) **Common control channel (CCCH):**

- (a) **Paging channel (PCH):** The PCH provides paging signals from the BS to all mobiles in the cell, and notifies a specific mobile of an incoming call which originates from PSTN. PCH may be used to provide cell broadcast ASCII text messages to all subscribers.
- (b) **Random Access Channel (RACH):** The RACH is a reverse link channel used by a subscriber unit to acknowledge a page from the PCH and is also used by mobiles to originate a call.
- (c) **Access grant channel (AGCH):** The AGCH is used by the BS to provide forward link communication to the mobile, and carries data which instructs the mobile to operate in a particular physical channel.

3) **Dedicated control channel (DCCH):**

- (a) **Stand-alone Dedicated control channel (SDCCH):** The SDCCH carries signaling data following the connection of the mobile with the BS, and just before TCH assignment issued by the BS. The SDCCH ensures that the mobile station and base station remain connected while the BS and MSC verifies subscriber unit.
- (b) **Slow Associated Control Channel (SACCH):** On the forward link the SACCH is used to send slow but regularly changing control information to the mobile such as transmit power level instruction. On the reverse link the SACCH carries information about the received signal strength.
- (c) **Fast Associated Control Channel (FACCH):** FACCH carries urgent messages and contains essentially the same type of information as SDCCH.

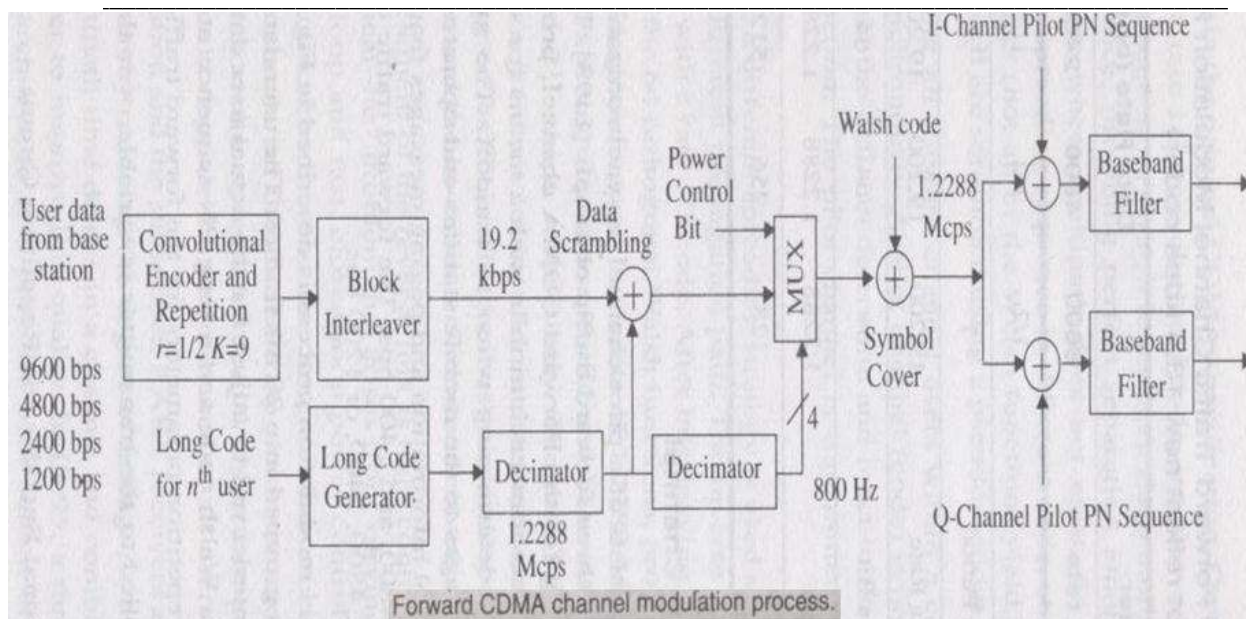
**Q. 5 Attempt any Four of the following:**

**(marks 16)**

- a) **Draw block diagram of forward CDMA channel modulation process.**

**Ans(correct diagram -4 marks)**





**b) Describe any four SS7 services.**

**Ans: (4 SS7 Services – 1 mark each)**

1. **Touch star** -It is also known as CLASS. It is a group of switch Controlled Services that provides its users with certain call management capabilities. It provides services such as call return, call forwarding, repeat dialing, call block, call tracing & caller ID.

2. **800 services** -It was introduced by bell System to provide toll-free access to the calling party to the services & database which is offered by private parties. Cost associated with the processing of calls is paid by the service subscriber. 800 Service is offered under two plans:

- **800-NXX plan:** The first 6 digits of an 800 call are used to select the interexchange carrier (IXC)
- **800 database plan:** The call is looked up in the database to determine the appropriate carrier & routing information.

### 3. Alternate Billing Service & Line Information Database (ADB/LIDB)

These services use the CCS network to enable the calling party to bill a call to a personal number (third party number, calling card, or collect etc.) from any number

#### 4. Performance of SS7

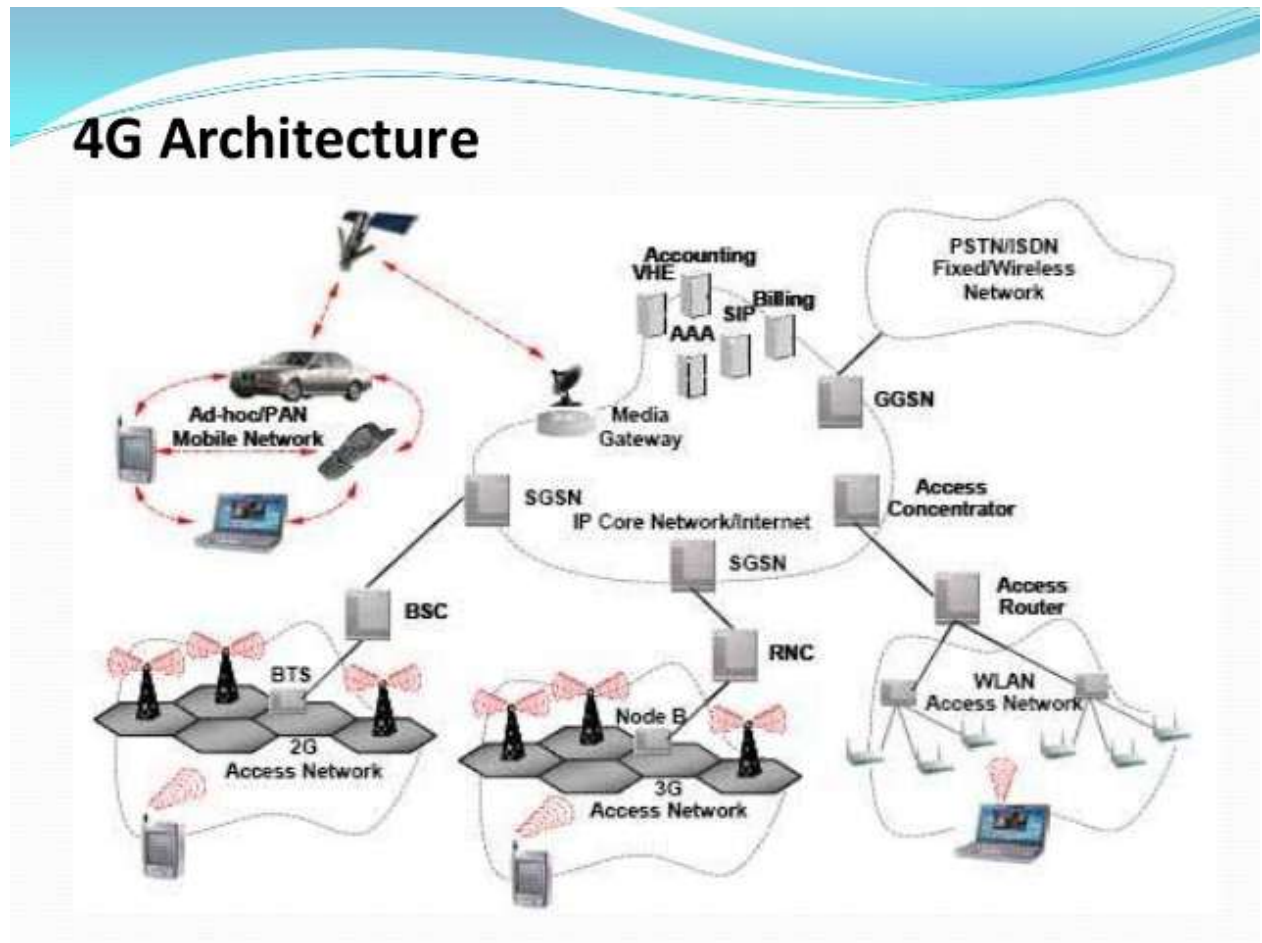
1) Performance of signalling network is studied by connection set-up time (response time) or the end-to-end Signalling information transfer time. The delays in the signalling point (SP) and the STP depend on the specific hardware configuration & switching software implementation.

## 2) Congestion control in SS7 networks:

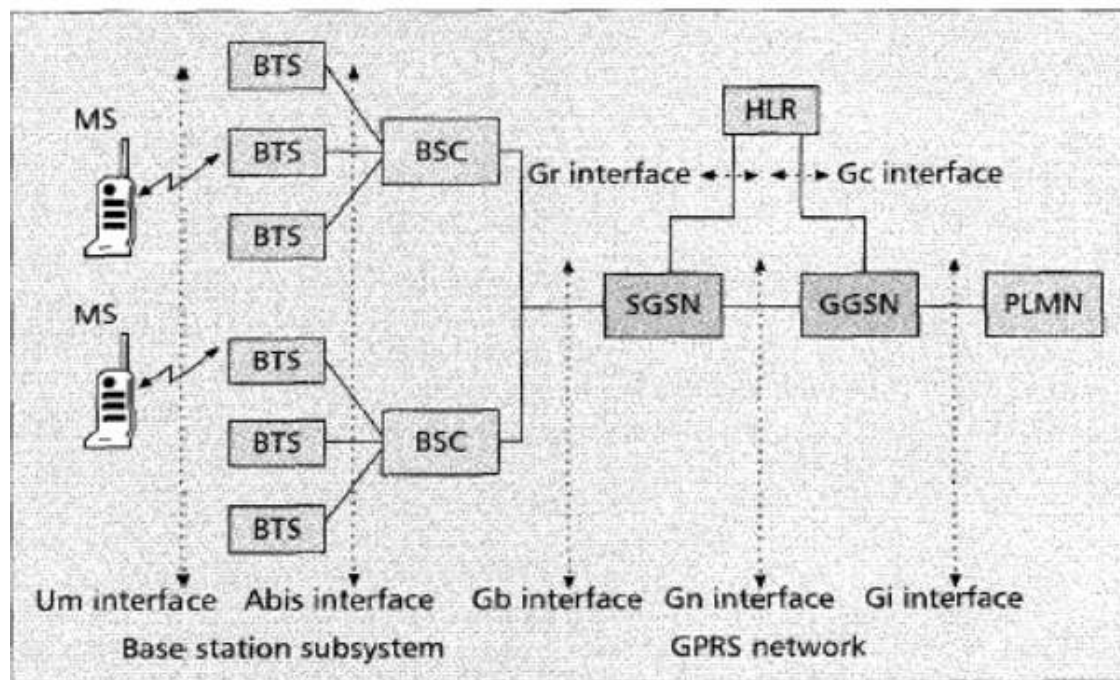
With the increase in subscribers it is important to avoid congestion in the signaling network under heavy traffic conditions. SS7 networking protocols provide several congestion control schemes, allowing traffic to avoid failed links & nodes.

**c) Draw architecture of 4G wireless system.**

Ans (Any correct diagram – 4 Marks)



d) Draw architecture diagram of GPRS network.



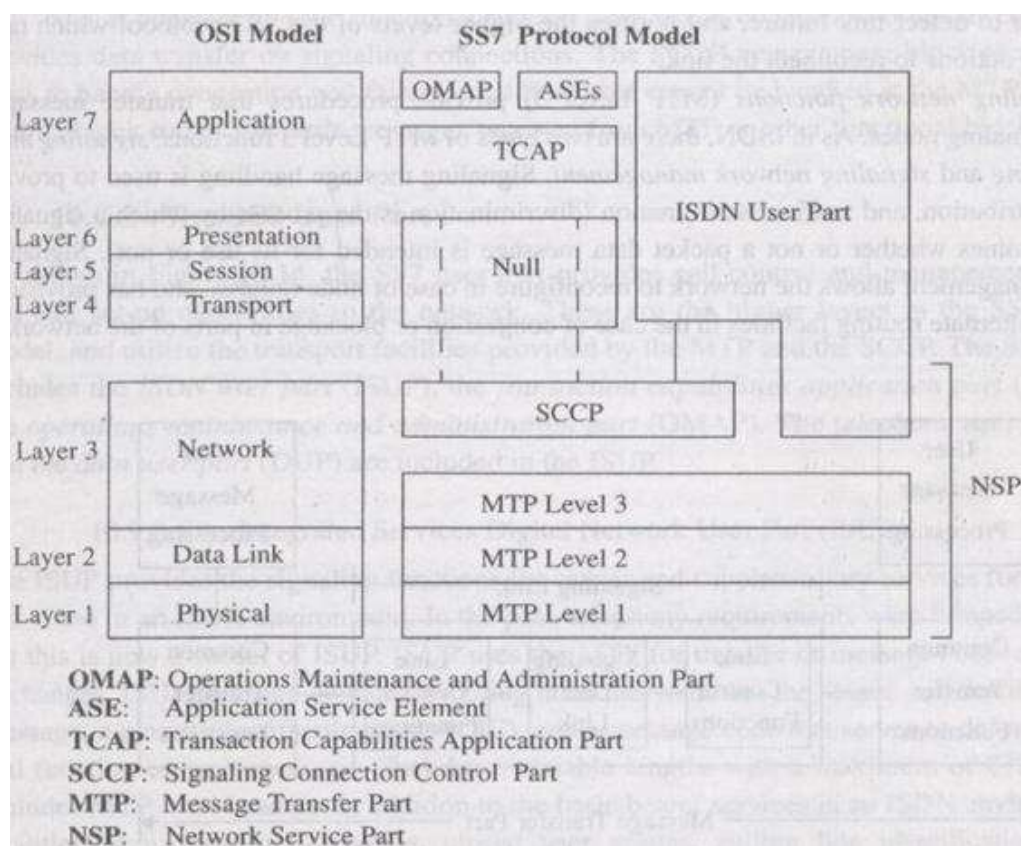
e) State any four features of Bluetooth.

**Ans:(any 4 features-1 Mark each)**

1. Each Bluetooth device has the capability of sharing all of its features with other Bluetooth devices in the surrounding area.
2. For example, a Bluetooth phone can share information with a Bluetooth-enabled computer or printer, just like one Bluetooth-enabled computer can link to another
3. Bluetooth-enabled computer, sharing all the features, such as the Internet.
4. Bluetooth devices can communicate at ranges of up to 10 meters.
5. Bluetooth devices do not need to be in direct sight of each other.

**f) Draw SS7 protocol architecture. Write any two features of SS7.**

**Ans:(Architecture diagram- 3 Marks,2 Features- ½ Mark each)**



**Features of SS7 are as under:**

- The control messages are routed through the network for different functions such as set up, maintenance management, termination etc.
- The control signaling is implemented using the packet switching technology network (PSTN).
- The mode used is associated channel mode but the use of disassociated mode is also possible.

**Q. 6 Attempt any Four of the following:**

**16**





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**a) List any four features of MANET**

**Ans: (any four features – 1 mark each)**

- Mobile Adhoc Network (MANET) is an autonomous collection of mobile devices such as laptops, smart phone etc. that communicate with each other over wireless link and cooperate in a distributed manner to provide necessary network functionality in the absence of a fixed infrastructure.
- This type of network operating as a standalone network or multiple point of attachment to the cellular networks paves the way for numerous new and exciting applications
- MANET can be categorized into first, second and third generation.
- It has evolved to be a robust, reliable, operational experimental network.
- MANET allows users to access and exchange information regardless of their geographic position or proximity to infrastructure
- All nodes in MANET are mobile and their connections are dynamic
- It offers an advantageous decentralized character to the network

**b) State any four characteristics of adhoc networks.**

**Ans: (Any 4 characteristics—Each 1 Mark)**

**Characteristics of adhoc networks:**

- In MANET, each node act as both host and router. That is it is autonomous in behavior.
- Multi-hop radio relaying- When a source node and destination node for a message is out of the radio range, the MANETs are capable of multi-hop routing.
- Distributed nature of operation for security, routing and host configuration. A centralized firewall is absent here.
- The nodes can join or leave the network anytime, making the network topology dynamic in nature.
- Mobile nodes are characterized with less memory, power and light weight features.
- The reliability, efficiency, stability and capacity of wireless links are often inferior when compared with wired links. This shows the fluctuating link bandwidth of wireless links.
- Mobile and spontaneous behavior which demands minimum human intervention to configure the network.
- All nodes have identical features with similar responsibilities and capabilities and hence it forms a completely symmetric environment.
- High user density and large level of user mobility.
- Nodal connectivity is intermittent.

**c) Explain EDGE system for 2.5 GSM.**

**Ans: (Any correct Explanation-4 Marks)**

EDGE which stands for Enhanced Data rates for GSM for Global Evolution is more advanced upgrade to the GSM standard and requires additional hardware and software at existing base stations.

It introduces a new digital modulation format, 8-PSK (Octal Phase Shift Keying) which is used in addition to GSM and GMSK modulation.



EDGE allows nine air interface formats, known as Multiple Modulation and Coding Schemes with varying degree of error control protection.

Because of the higher data rates and relaxed error control covering in many of the selectable air interface formats, the coverage range is smaller in EDGE than in GPRS.

Edge is sometimes referred to as Enhanced GPRS

It uses higher order 8-PSK modulation and family of MCSs for each GSM radio channel time slots so that each user connection may adaptively determine the best MCS setting for the particular radio propagation conditions and data access requirements of the user.

This adaptive capability to select the best air interface is called incremental redundancy whereby packets are transmitted first with maximum error protection and maximum data rate throughput and then subsequent packets are transmitted until the link has an unacceptable delay.

Rapid feedback between the base station and subscriber unit then restores the provision acceptable air interface state, which is presumably at an acceptable level but with required coding and minimum bandwidth and power drain.

Incremental redundancy ensures that the radio link for each user will quickly reach a condition that uses the minimum amount of overhead thereby providing acceptable link quality for each user while maximizing user capacity on the network.

When EDGE uses 8 PSK modulations without any error protection and all 8 timeslots of a GSM radio channel dedicated to single user, a raw peak throughput data rate of 547.2 kbps can be provided.

In practice the slotting schemes use in EDGE when combined with practical network connection issues and error control coding requirement, limits practical data rates to about 384 kbps for a single dedicated user on single GSM channel.

**d) Compare 3G WCDMA (UMTS) and 3G CDMA 2000 with respect to carrier spacing, chip rate, power control frequency and coding.**

**Ans: (4 differences - Each 1 Mark)**

Parameters	3G WCDMA (UMTS)	3G CDMA 2000
Carrier spacing	5 MHz	3.75MHz
Chip rate	4.096MHz	3.6864MHz
Power control frequency	1.5MHz	800Hz
Coding	Turbo and conventional	Turbo and convolution

**e) List any four vision of IMT 2000.**

**Ans: (Any 4 features - Each 1 Mark)**

- It supports multiple environments such as cellular, cordless satellite LAN"s.
- It provides global seamless roaming and service delivery across the INT 2000 networks.



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- It supports the VHE (Virtual Home Entertainment) and UPT (Universal Personal telecommunication). It provides security and enhances performances.
- It provides global coverage by integrating the terrestrial and satellite systems.
- It provides 2 Mbps data rates for indoor environments. It makes use of Intelligent Networks capabilities.

**f) State any four advantages of 3G wireless network system.**

**Ans (Any four advantages - Each 1 Mark)**

Advantages of 3G are:

- Multi-megabit internet access.
- Voice activated cells
- Unparalleled network capacity
- Ubiquitous “always on” access
- Communications using Voice Over Internet Protocol.