MODEL ANSWER

SUMMER– 17 EXAMINATION

Subject Title: Mobile Communication Subject Code: 17657

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model 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 anyequivalent 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 judgement 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.

Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	A)	**Attempt any THREE of the following :**	12-Total Marks
	i)	**Describe the call making procedure from mobile handset to the landline phone unit, (PSTN).**	4M
	Ans:		4M

MSC			Receives call initiation request from base station & verifies that the mobile has a valid MIN, ESN pair.	Instructs FCC of originating base station to move mobile to a pair of voice channels.		Connects the mobile with the called party on the PSTN.	
BASE STATION	FCC				page for called mobile, instructing the mobile to move to voice channel.		
	RCC	Receives call initiation request and MIN,ESN,Station Class Mark.					
	FVC						Begin voice transmission
	RVC						Begin Voice reception
MOBILE	FCC				Receives page & matches the MIN with its own MIN. Receives instruction to move to voice channel.		
	RCC	Sends a call initiation request along with subscribe MIN & number of called party					
	FVC						Begin Voice reception
	RVC						Begin voice transmission

Timing diagram illustrating how a call initiated by mobile is established

OR

When a mobile originates a call, a call initiation request is sent on the reverse control channel. With this request the mobile unit transmits its telephone number (MIN), Electronic Serial Number (ESN) and the telephone number of the called party. **4M**

The base station receives the MIN, ESN of called party along with Station Class Mark (SCM) which indicates what is the maximum transmitting power level.The received details are forwarded to MSC.

The MSC validates the request by checking the MIN,ESN etc. in its records. after validation, MSC instructs the originating Base station to move mobile to a unused pair of voice channels(FORWARD & REVERSE VOICE CHANNEL).

The called party telephone number, is then broadcast as paging message over all forward control channel throughout the cellular system (If the called number is another mobile phone) .

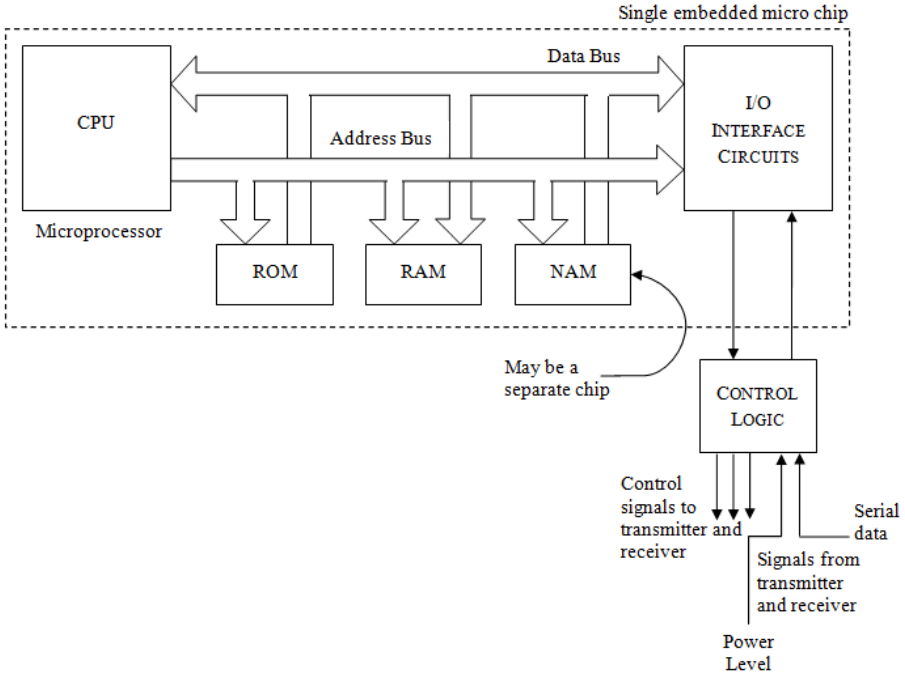
The mobile receives the Paging message sent by base station which it monitors, and matches the received MIN with its own MIN.

With MIN the called mobile phone number receives the instruction of moving itself to unused pair of voice channel. And then it makes connection to the called party.

This connection is made with the called party through the PSTN, if the called party number is a landline telephone.

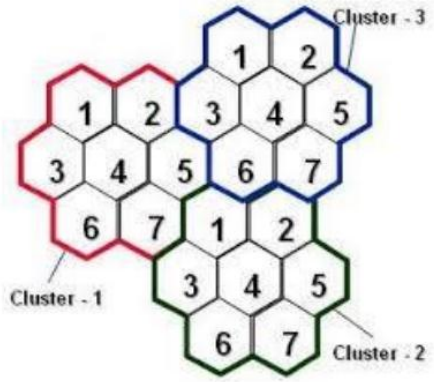
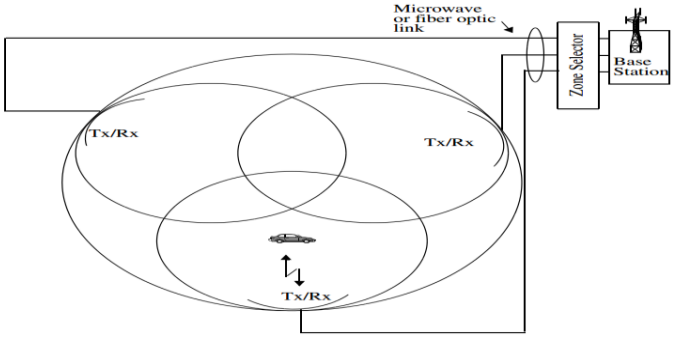
ii) Draw the block diagram of logic unit in mobile handset and explain it. **4M**

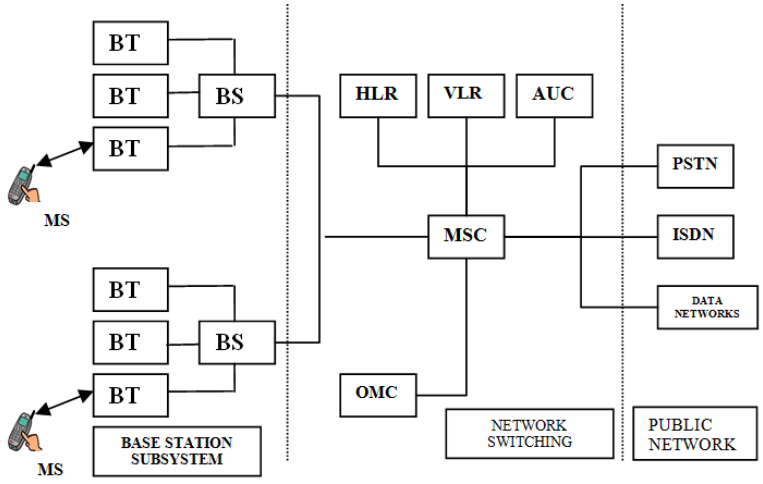
Ans: **Diagram:** **2M**



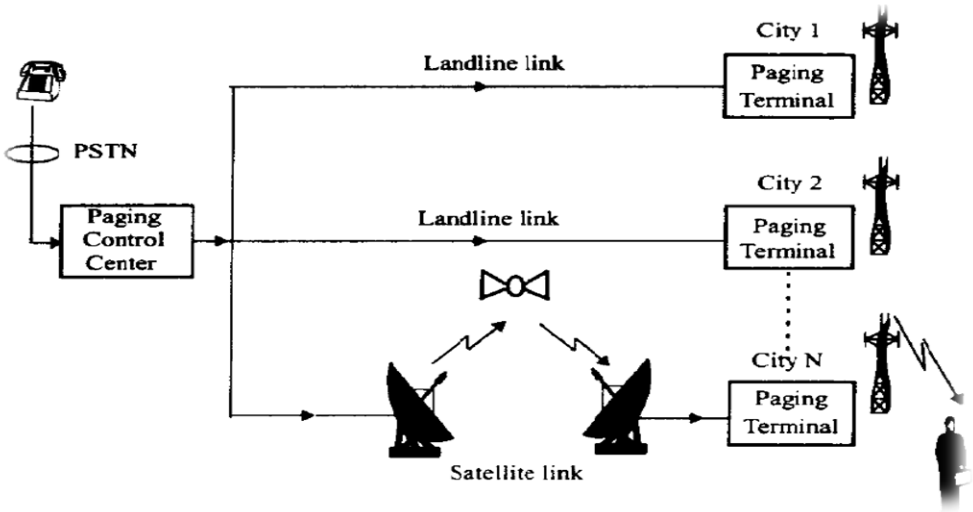
Explanation: **2M**

- It is made up of an embedded microprocessor with both ROM & RAM plus additional circuitry used for interpreting signals from MTSO and cell site & generating control signal for the transmitter & receiver.

		• A cellular radio contain a programmable read only memory chip called "Number Assignment Module (NAM)". The NAM contains the Mobile Identification Number (MIN), which is the telephone number assigned to the unit. The NAM PROM is 'burned' when the Cellular Radio is purchased & the MIN is assigned. • This chip allows the radio to identify itself when a call is initiated or when the radio is interrogated by the MTSO. • All cellular mobile radios are fully under control of the MTSO through the cell site. The MTSO sends a serial data stream at 10 kbps through the cell site to the radio to control the transmitter & receiver frequency & transmitter power. • The MTSO monitors the received cell signal strength at the cellular radio by way of RSSI signal & it monitors the transmitter power level. These are transmitted back to the cell site & MTSO. Audio tones are also used for signaling purpose.	
	iii)	**Explain concept of frequency reuse. Draw frequency reuse pattern with cluster size 7.**	**4M**
	Ans:	**<u>Concepts</u>** : The design process of selecting and allocating channels groups for all of the cellular base station within a system is called Frequency Reuse or Frequency Planning**.** **<u>Diagram:</u>** For cluster size 7: 	**2M** **2M**
	iv)	**Describe the term microcell zone concept for capacity improvement.**	**4M**
	Ans:	**<u>Diagram:</u>** 	**2M**

	Description: • The problem associated with the sectoring is the number of handoffs. This puts additional load on the switching and control link elements of the mobile system. A solution to this problem is based on microcell concept for seven cell reuse. • In this scheme, all the three or more zone sites represented as Tx/Rx are connected to the same base station and share the same radio equipment. The transmission media used for connecting the zones to the base station are coaxial cable, fiber optics cable or a microwave link. • So each cell consists of a base station and multiple zones. A mobile travelling within a cell, is served by the zone that has the strongest signal of all. • As shown in figure, the antennas in zones are placed at the outer edge of the cell and any base station channel can be assigned to any zone by the base station. As a mobile travels from one zone to the other within a cell, it uses the same channel. • This will avoid handoff. the base station will just switch the channel to the appropriate zone site. 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 space and time by all zones and are reused in the co channel cells. The microcell zone concept is very useful along highways or in the busy areas.	**2M**
B)	**Attempt any ONE :**	**6M**
a)	**Draw the GSM architecture and write function of each block.**	**6M**
Ans:	**Diagram:**  MS: MOBILE STATION BSC: BASE STATION CONTROLLER VLR: VISITOR LOCATION REGISTER AUC: AUTHENTICATION CENTER PSTN: PUBLIC SWITCH TELEPHONE NETWORK BTS: BASE TRANSCIVER STATION MSC: MOBILE SWITCHING CENTER HLR: HOME LOCATION REGISTER OMC: OPERATIONAL & MAINTAINANCE CENTER ISDN: INTEGRATED SERVICES DIGITAL NETWORK	**3M**

		Function: • A GSM network is composed of several functional entities, whose functions and interfaces are specified. Figure shows the layout of a generic GSM network. The GSM network can be divided into three broad parts. 1. The Mobile Station is carried by the subscriber. 2. The Base Station Subsystem controls the radio link with the Mobile Station. 3. The Network Subsystem, the main part of which is: • The **Mobile services Switching Center (MSC)**, performs the switching of calls between the mobile users, and between mobile and fixed network users. The MSC also handles the mobility management operations. • The **Operations and Maintenance Center**, which oversees the proper operation and setup of the network. • The Mobile Station and the Base Station Subsystem communicate across the Um interface, also known as the **air interface or radio link**. • The Base Station Subsystem communicates with the Mobile services Switching Center across the **A interface.** **Mobile Station** • The mobile station (MS) consists of the **mobile equipment** (the terminal) and a smart card called the **Subscriber Identity Module (SIM)**. • The SIM provides personal mobility, so that the user can have access to subscribed services irrespective of a specific terminal. By inserting the SIM card into another GSM terminal, the user is able to receive calls at that terminal, make calls from that terminal, and receive other subscribed services. **Base Station Subsystem:** The Base Station Subsystem is composed of two parts: 1. The Base Transceiver Station (BTS) and 2. The Base Station Controller (BSC). These communicate across the standardized Abis interface, allowing (as in the rest of the system) operation between components made by different suppliers. **Network Subsystem:** • The central component of the Network Subsystem is the Mobile services Switching Center (MSC). It acts like a normal switching node of the PSTN or ISDN, and additionally provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. • The Home Location Register (HLR) and Visitor Location Register (VLR), together with the MSC, provide the call-routing and roaming capabilities of GSM.	**3M**
	b)	**Define following components :** **(a) Mobile station** **(b) Forward channel** **(c) Base station controller** **(d) MSC** **(e) Roaming**	**6M**

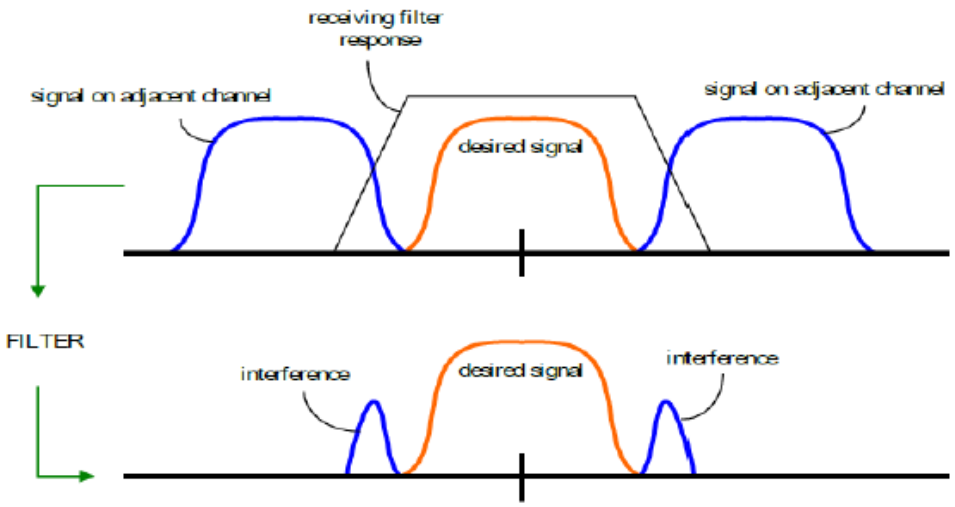
		(f) Transceiver	
	Ans:	**Mobile Station:** A station in the cellular radio system intended to use while in motion at unspecified locations is called a mobile station. Mobile stations may be hand-held personal units (portables) or installed in vehicles (mobiles) **Forward Channel:** It is a radio channel used for transmission of information from the **base station to the mobile.** **Base station controller:** The Base Station Controller manages the radio resources for one or more BTSs. It handles radio-channel setup, frequency hopping, and handovers, as described below. The BSC is the connection between the mobile station and the Mobile service Switching Center (MSC). **Mobile Switching Center (MSC):** An MSC also called a Mobile Telephone Switching Office (MTSO) is a switching center which coordinates the routing of calls in a large service area. In a cellular radio system, the MSC connects the cellular base stations and the mobiles to the PSTN (Public Switched Telephone Network, PSTN, is a global telecommunications network which connects conventional landline telephone switching centers, called central offices, with MSCs throughout the world). **Roaming:** A mobile station which operates in a service area (market) other than that from which service has been subscribed is called a roaming. **Transceiver:** A device capable of simultaneously transmitting & receiving radio signals.	**(Each Function-1M)**
Q 2		**Attempt any FOUR :**	**16M**
	i)	**Draw labelled block diagram of paging system and explain its operation.**	**4M**
	Ans:	**Diagram:**  	**2M**

Explanation: **2M**

- Paging systems are communication systems that send brief messgaes to subsciber. Message may be either a numeric, alpha numeric or voice message.
- 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.
- Paging system vary widely in their complexity and coverage area while simple paging systems may cover a limited range of 2 to 5 km or may even be confined to with in individual buildings, wide area paging systems can provide world wide coverage.
- Though paging receivers are simple and inexpensive, the transmission system required is quite sophisticated.
- Wide area paging systems consists of a network of telephone lines, many base station trasnmitters and large radio towers that simultaneously broadcast a page from each base station.(this is called *simulcasting*)
- Large trasnmitter power and low data rate are necessary for maximum coverage from each base station.

ii)	**Explain adjacent channel interference in cellular system and how they are reduced.**	**4M**

Ans:



Explanation : **2M**

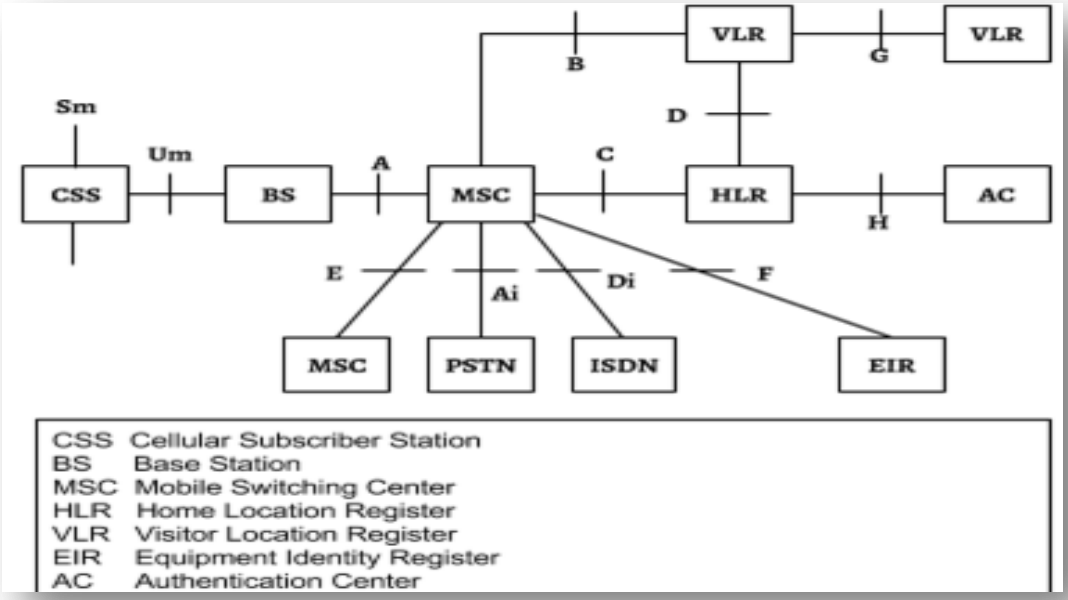
Adjacent channel interference: Interference resulting from signals which are close in frequency to the desired signal is called adjacent channel interference.

Adjacent channel interference results from imperfect receiver filters which allow nearby frequencies to leak in to pass band.

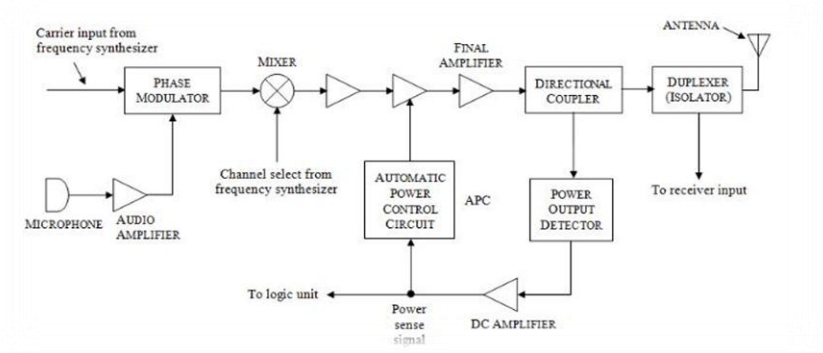
It is serious problem can be a particularly serious if an adjacent channel user is transmitting very close range to a subscribers receiver, while receiver attempts to receive a BS on the desired channel this is referred to as near far effect

	To reduce the interference: The adjacent channel interference can be reduced by 1) Careful filtering 2) Careful channel assignment. • There should be adequate frequency separation between the spectrums of the adjacent channels in a cell • If the frequency reuse factor is large or cluster size is small the adjacent channel at the base station will be too close to each other in the frequency domain and this will increase the interference.	**2M**
iii)	**Describe the function of HLR & OMC in GSM.**	**4M**
Ans:	**HLR** • 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 is assigned IMSI to identify home user **OMC** • To maintain all telecommunications hardware & Network operations with a particular market. • Manage all charging and billing procedures. • Manage all mobile equipment in the system. • 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's in the system.	**(Each 2M)** **2M**
iv)	**Describe IS-95 B for 2.5G CDMA.**	**4M**
Ans:	**Explanation:** • The interim data solution of CDMA is called IS-95B. • 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. • 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 units can rapidly tune to different base stations to maintain link quality.	**4M**
v)	**What is the need of adhocnetwork?**	**4M**
Ans:	**Explanation:** • Adhoc network inherit some common characteristic found in wireless network and add specific charateristic to adhoc networks.	**4M**

		• **Wireless:** nodes communicate wirelessly and share the same media(radio, infrared). • **Ad-hoc base:** a mobile adhoc network is a temporary network formed dynamically in an arbitary manner by collection of nodes as need arise. • **Autonomous and infrastructureless :** adhoc network do not depend on any established infrastructure or centralized administration. Each node acts as an independent router and generates independent data. • **Multihop routing:** no dedicated routers are necessary, every node acts as router and forwards each others packet to enable information sharing between mobile hosts. • **Mobility :** each node is free to move about while communicating with other nodes.	
Q. 3		**Attempt any FOUR:**	**16M**
	i)	**Explain IMT 2000 services.**	**4M**
	Ans:	• It provides global seamless roaming and service delivery across the IMT 2000 networks. • It supports multiple environments such as cellular, cordless satellite LAN"s. • 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. • Emergency and priority calls. • Circuit and packet bearer capability up to 144 kb/s in vehicular radio environment. • Circuit and packet bearer capability up to 384 kb/s in pedestrian radio environment. • Geographic position /location service.	**(Any four services & each 1M)**
	ii)	**Describe evolution for 2.5 G TDMA standards.**	**4M**
	Ans:	The 3 TDMA upgrade options include HSCSD, GPRS, EDGE. **HSCSD:** • High speed circuit switch data allows a single mobile user to the consecutive user timeslots in GSM standards. • Increase the available applicable data rate to 14.4 kbps. • 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. **GPRS:** • General packet radio service is a packet based data network which is well suited for non real time internet usage, including the retrieval of email, faxes & asymmetric web browsing where user downloads much more data than it uploads. • GPRS supports multi user network sharing of individual radio channel and time slots. • Requires operator to install new routers and internet gateways at base station	**(Naming standard - 1M, Explainatio n: 1M each)**

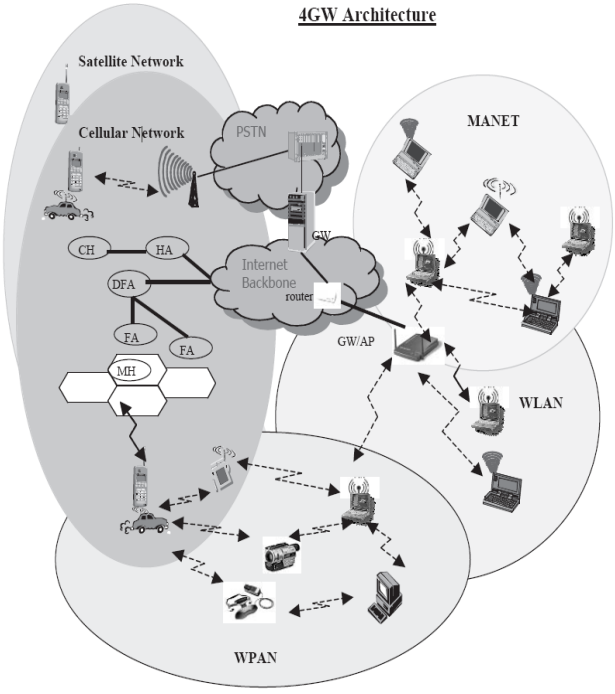
	along with new software. No new base station nad RF hardware is required. **EDGE:** • EDGE which stands for Enhanced Data rates for GSM for Global Evolution is more advanced upgrade to the GSM standard and requires additional hardware and software at existing base stations. • It introduces a new digital modulation format, 8-PSK (Octal Phase Shift Keying) which is used in addition to GSM and GMSK modulation	
iii)	**Draw system architecture of IS-95. Explain working of any two blocks.**	**4M**
Ans:	**Diagram:**  **Explanation :** **Cellular Subscriber station:**It is defined as a station in cellular radio service which is used when in motion at an unspecified location. **Home Location Register:** Permanent database about mobile subscribers in a large service area.Database contains subscriber & location information. Database contains prepaid/postpaid, roaming restrictions, supplementary services. **Authentication Center**: A unit called the AC provides authentication and encryption parameters that verify the user's identity and ensure the confidentiality of each call. The AC protects network operators from different types of fraud found in today's cellular world **Visitor Location Register:** Temporary database which stores 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	**2M** **2M**

	area. **Base station**: A fixed station in a mobile radio system used for radio communication with mobile stations. Stations are located at the center or on the edge of a coverage region and consists of radio and transmitter and receiver antennas mounted on a tower **Mobile Switching Center:** It co-ordinates the activities of all the base stations and connects the entire cellular system to the PSTN. A typical MSC handles 100,000 cellular subscribers and 5,000 simultaneous conversations at a time, and accommodates all billing and system maintenance functions as well. **EIR** : The Equipment Identity Register (EIR) is a database that contains a record of the all theCellular Subscriber stationthat are allowed in a network as well as a database of all equipment that is banned, e.g. because it is lost or stolen.	
iv)	**State and explain types of sectoring.**	**4M**
Ans:	**State :Cell partitioned into 3 , 120^0 sectors** **Cell partitioned into 6 , 60^0 sectors** **Types of sectoring :** **1)** • Cell partitioned into 3 , 120^0 sectors as shown in the figure below. • Involves replacing an omni- directional antenna at the base station by 3 directional antennas each radiating with in a specified sector.  **(a)** **2)** • Cell partitioned into 6 , 60^0 sectors as shown in the figure below. • Involves replacing an omni- directional antenna at the base station by 6 directional antennas each radiating with in a specified sector.  **(b)**	**1M** **1.5 M** **1.5 M**
v)	**Draw and explain cellular transmitter.**	**4M**

	Ans:	**Diagram:**  **Explanation:** **Phase modulator section and mixer**: It is a low power FM unit operating in the frequency range of 824 to 849 MHz. The Carrier is obtained from frequency synthesizer and is applied to phase Modulator along with the amplified voice signal. Modulator o/p converted using a mixer to final transmitter frequency. Mixer o/p is applied to Class C amplifier. Carrier i/p for the phase modulator & the local oscillator frequency signal for mixer are produced by frequency synthesizer. **Final Amplifier:** The final amplifier stage is designed to supply 3W to antenna. **Automatic Power Control Circuit and DC amplifier:** The automatic power control circuit controls the o/p power of the transmitter automatically, with the help of power o/p detector & DC amplifier. Receiver picks up the special control signals & sends to APC that sets transmitter o/p power level. Transmitter o/p is fed to duplexer. Transmitter o/p power is controlled by cell site & MTSO. **Directional coupler:** It taps off an accurate sample of the transmitter output power & rectifies it in to a proportional dc signal. This signal is used in the APC circuit & is transmitted back to cell site. **Duplexer :** It allows the transmitter and receiver to use the same antenna. Since cellular units are full duplex operation the transmitter and receiver will operate simultaneously.	**2M** **2M**
	vi)	**Write features of Bluetooth. (4 points).**	**4M**
	Ans:	1. Replacing chords that connect devices to one another with an invisible, low power ,short range wireless connection is one of the important features. 2. Ability to move equipment throughout an area. 3. Allows collaborative communication between individuals, their appliances and environment. **4.** Bluetooth devices can communicate at range of up to 10 meters. **5.** Bluetooth devices do not need to be in direct sight of each other. **6.** Each Bluetooth device has the capability of sharing all of its features with other Bluetooth devices in the surrounding area. **7.** Audio, text, data & even video is contemplated in Bluetooth standard.	**1 M each (Any 4 points)**
Q. 4	**A)**	**Attempt any THREE:**	**12M**

	i)	**Draw and explain architecture of 4G wireless system.**	**4M**
	Ans:	***Note: Any other relevant diagram can be considered.***	

Diagram:



Explanation:

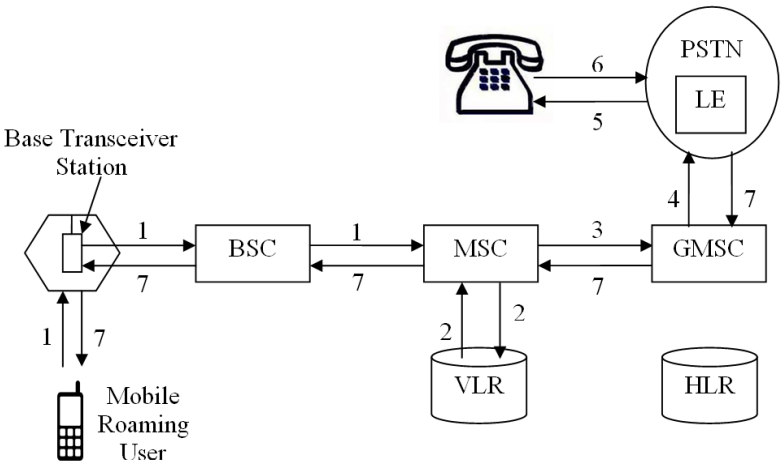
Network Integration: 4G networks are considered as the hybrid broadband networks that integrate different network topologies and platforms. The integration of various types of networks in 4G is represented by the overlapping of different network boundaries. There are two levels of integration: the first is the integration of heterogeneous wireless networks with varying transmission characteristics such as wireless LAN, WAN, and PAN as well as mobile ad hoc networks; the second level includes the integration of wireless networks and fixed network-backbone infrastructure, the Internet and PSTN. **2M**

All-IP Networks*:* 4G starts with the assumption that future networks will be entirely packet-switched using protocols evolved from those in use in today's Internet.

Lower Cost and Higher Efficiency*:* 4G IP-based systems are expected to be cheaper and more efficient. First, equipment costs are four to ten times lower than equivalent circuit-switched equipment for 2G and 3G wireless infrastructures.

Ultrahigh Speed and Multimedia Applications: 4G systems aim to provide ultrahigh transmission speeds of up to 100 Mbps, 50 times faster than those in 3G networks. This leap in transmission speed will enable high-bandwidth wireless services, allowing users to watch TV, listen to music, browse the Internet, access business programs, perform real-time video streaming, and other multimedia-oriented applications, such as E-Commerce.

Ubiquitous Computing: A major goal toward the 4G Wireless evolution is the provision of pervasive computing environments that can seamlessly and ubiquitously support users in accomplishing their tasks, in accessing information or communicating with other users

		at anytime, anywhere, and from any device. **Support of Ad Hoc Networking:** Non infrastructure-based mobile ad hoc networks (MANETs) are expected to become an important part of the 4G architecture. An ad hoc mobile network is a transient network formed dynamically by a collection of arbitrarily located wireless mobile nodes without the use of existing network infrastructure or centralized administration. Mobile ad hoc networks are gaining momentum because they help realize network services for mobile users in areas with no preexisting communications infrastructure. **Location Intelligence:**To support ubiquitous computing requirements, 4G terminals need to be more intelligent in terms of user's locations and service needs, including recognizing and being adaptive to user's changing geographical positions, as well as offering location-based services. Possible location-based services include finding nearest service providers, e.g., restaurants and cinemas; searching for special offers within an area; warning of traffic or weather situations; sending advertisements to a specific area; searching for other collocated users; active badge systems, and so on.	
ii)	**Explain HSCSD for 2.5 G GSM.**	**4M**
Ans:	• As the name implies, High Speed Circuit Switched Data is a circuit switched technique that allows a single mobile subscriber to use consecutive user time slots in the GSM standard. • That is, instead of limiting each user to only one specific time slot in the GSM TDMA standard, HSCSD allows individual data users to commandeer (officially take possession or control) consecutive time slots in order to offer higher speed data access to the GSM network. • HSCSD relaxes the error control coding algorithms originally specified in the GSM standard for data transmissions, and increases the available application data rate to 14,400 bps, as compared to the original 9,600 bps in the GSM specification. • By using up to 4 consecutive time slots, HSCSD is able to provide a raw transmission rate of up to 57.6 kbps to individual users, and this enhanced data offering can be billed as a premium service by the carrier. • 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.	**4M**
iii)	**Describe call processing in GSM system with suitable diagram.**	**4M**
Ans:	**Mobile call origination in GSM:** **Diagram:**  	**2M**

Description :

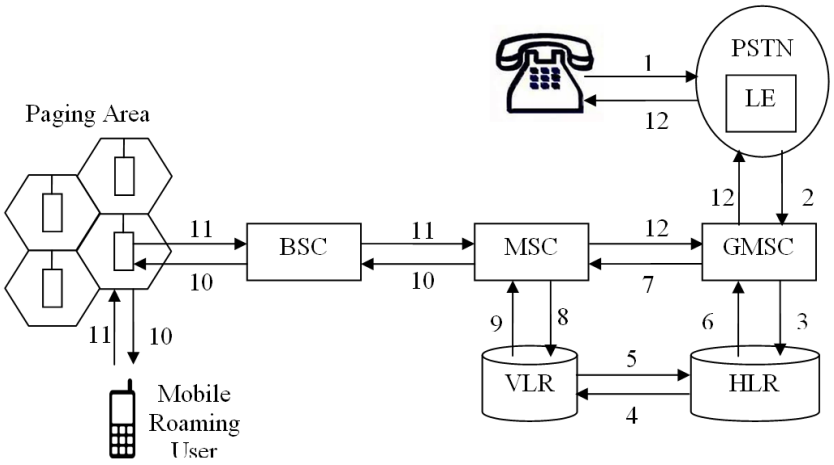
1. The MS sends the dialed number indicating service requested to the MSC(via BSS)
2. The MSC checks from the VLR if the MS is allowed the requested service. If so, MSC asks BSS to allocate necessary resources for the call.
3. If the call is allowed, the MSC routes the call to GMSC.
4. The GMSC routes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

2M

OR

Mobile call termination:

2M



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 VLR passes the MSRN to the HLR.
6. The HLR passes the MSRN to the GMSC.
7. Using the MSRN, the GMSC routes the call to the serving MSC.
8. The MSC interrogates the VLR for the current location area identity (LAI) for the MS.
9. The VLR provides the current location for the MS.
10. The MSC pages MS via the appropriate BSS. The MS responds to the page and sets up the necessary signaling links.
11. When the BSS has established the necessary radio links, the MSC is informed an the call is delivered to the MS.
12. When the MS answers the call, the connection is completed to the calling PSTN user.

2M

	iv)	**Compare CDMA, FDMA& TDMA in terms of concept, key resources, sharing of resources, bandwidth, system flexibility and system complexity.**	**4M**
	Ans:		**(1M each Concept; sharing of resources ½ M each rest points).**

Parameter	CDMA	FDMA	TDMA
Concept	Every bit of a conversation is been tagged with a specific and unique code.	It is a technology by which the total bandwidth available to the system is divided into frequencies. This division is done between non overlapping frequencies that are then assigned to each communicating pair	In TDMA the division of calls happens on time basis. The system first digitizes the calls, and then combines those conversations into a unified digital stream on a single radio channel.
key resources	Codes	Frequency	ActiveTime period
Sharing of resources	Sharing of resources is done through codes (PN sequence)	In FDMA each user is allotted a frequency, through which communication can be done all the time	In TDMA total available frequency is given to user for a particular time period
bandwidth	here entire bandwidth is shared among different users by assigning unique codes	here entire band of frequencies is divided into multiple RF channels/carriers. Each carrier is allocated to different users.	here entire bandwidth is shared among different subscribers at fixed predetermined or dynamically assigned time intervals/slots.
System flexibility	Flexible System	Less flexible than TDMA & CDMA	Less flexible than CDMA, More Flexible than FDMA
System complexity	Complex system	Less Complex than TDMA & CDMA	Less Complex than CDMA, More Flexible than FDMA

	B)	**Attempt any ONE:**	**6M**
	i)	**Illustrate SS7 protocol architecture with labelled diagram and state services offered by SS7 system.**	**6M**
	Ans:	**<u>Diagram:</u>**	**(Architecture-2M [Label - 1M + diagram-1M] explanation**

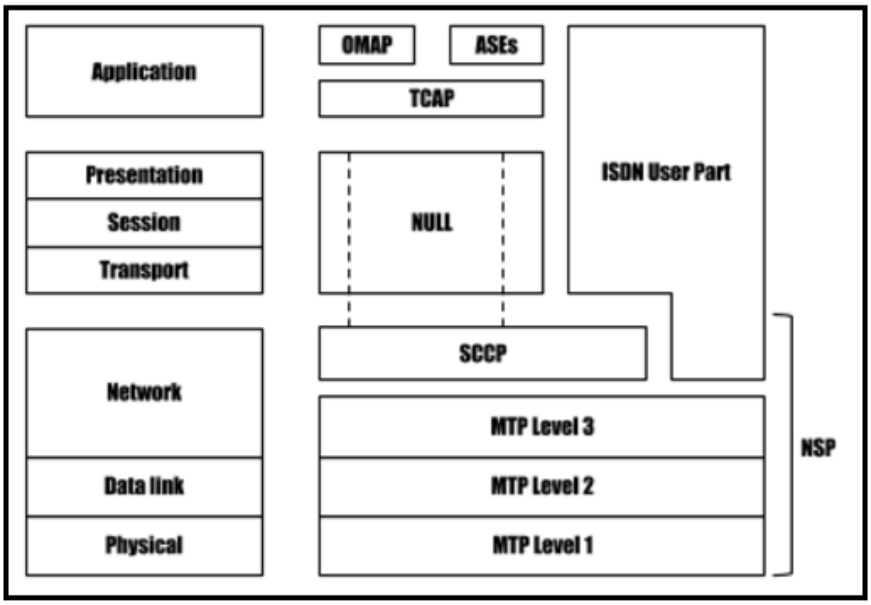


FIGURE: SS7 PROTOCOL ARCHITECTURE

-2M , services-2M)

Explanation:

I.NETWORK SERVICE PART (NSP) OF SS7:

- The NSP provides ISDN nodes with a highly reliable and efficient means of exchanging traffic using connectionless services.

MESSAGE TRANSFER PART (MTP) OF SS7:

- The function of MTP is to ensure that signaling traffic can be transferred and delivered reliably between the end-users and the network.
- MTP is provided at three levels.

1. Signaling Data Link Functions (MTP Level 1):

- This level provides an interface to the actual physical channel over which communication takes place.
- Physical channels may include copper wire, twisted pair, fiber, mobile radio or satellite link.
- This level uses 64 kbps transmission.

2. Signaling Link Function (MTP Level 2):

- It provides a reliable link for the transfer of traffic between two directly connected signaling points.
- Variable packet messages, called message signal units (MSUs) are defined in MTP level 2.
- MTP level 2 also provides flow control data between two signaling points as a means of sensing link failure.

3. Signaling Network Function (MTP Level 3):

- It provides procedures that transfer messages between signaling nodes.
- There are two types of MTP Level 3 functions: signaling message handling and signaling network management.

4. Signaling Message Handling:

- This is used to provide routing, distribution and traffic discrimination

(discrimination is the process by which a signaling point determines whether or not a packet data message is intended for it's user or not).

5. Signaling Network Management:

- This allows the network to reconfigure in case of node failures and has provisions to allocate alternate routing facilities in case of congestion or blockage in parts of the network.

II. SIGNALING CONNECTION CONTROL PART (SCCP):

- The SCCP provides enhancement to the addressing capabilities provided by the MTP.
- SCCP also provides the ability to address global title messages or non-billed numbers.
- Different classes of service provided by SCCP are:
  - **Class 0**: Basic connectionless.
  - **Class 1**: Sequenced connectionless.
  - **Class 2**: Basic connection-oriented.
  - **Class 3**: Flow control connection oriented.
  - **Class 4**: Error recovery and flow control connection oriented.

III. SS7 USER PART:

- SS7 user part provides call control and management functions and call setup capabilities to the network.

The SS7 user part includes the following:

a) Integrated Services Digital Network User Part (ISUP):

- The ISUP provides the signaling functions for carrier and supplementary services for voice, data and video in an ISDN environment.
- ISUP uses the MTP for transfer of messages between different exchanges.
- In addition to the basic bearer services in an ISDN environment, the facilities of user-to-user signaling, closed user group, calling line identification and call forwarding are provided.

b) Transaction Capabilities Application Part (TCAP):

- The TCAP part in SS7 refers to the application layer which invokes the services of the SCCP and the MTP in a hierarchical format.
- One application at a node is thus able to execute an application at another node and use these results.

c) Operation Maintenance and Administration Part (OMAP):

- The OMAP functions include monitoring, coordination and control function to ensure that trouble-free communications are possible.

SS7 Services:

- **Touch star:**

1. This kind of service is also known as CLASS and is a group of switch-controlled services that provide its users with certain call management capabilities.
2. Services such as call return, call forwarding, repeat dialing, call block, call tracing and caller ID are provided.

- **800 Services:**

1. These services were introduced by Bell Systems to provide toll-free access to the calling party and to the services and database which is offered by the private parties.
2. The costs associated with the processing of the calls are paid by the service subscriber.
3. The service is offered in two plans known as the 800-NXX plan and the 800 database plan.
4. In the 800-NXX plan the first six digits of an 800 call are used to select the

		interexchange carrier (IXC). 5. In the 800 database plan, the call is looked up in a database to determine the appropriate carrier and routing information. • **Alternate Billing Service and Line Information Database (ADB/LIDB):** 1. These services use the common channel signaling (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.	
	ii)	**What is Hand-off? List different types of hand-off. Explain any two in detail.**	**6M**
	Ans:	• 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 procedure is called **handoff**. • The handoffs are of following types: 1. Hard Handoff 2. Soft Handoff 3. Queued Handoff 4. Delayed Handoff 5. Intersystem Handoff 6. Intrasystem Handoff 7. Network controlled Handoff (NCHO) 8. Mobile Assisted Handoff (MAHO) **Hard Handoff:** • The definition of a hard handover or handoff is one where an existing connection must be broken before the new one is established. • Hard handoff allocate different frequency of user. • In hard hand off a handset always communicates with one BS at any given time • Hard handoff is typically used in TDMA and FDMA systems. • Hard handoff is not very complicated. • Since the radio link between the BS and the handset is broken before it is connected in hard handoff, the link transfer may fail due to long network response time even if radio channels are available in the new BS. **Soft handoff:** • Soft handoff is defined as a handover where a new connection is established before the old one is released. • Soft hand off allocate same frequency. • In soft handoff a handset may connect up to three or four radio links at the same time. • Soft handoff used in CDMA and some TDMA systems. • Soft handoff is more complicated than hard handoff. • On the other hand, soft handoff degrades channel availability because a handset may consume multiple radio channels. .	**(Definition-1M ; List-2M; 1.5M each for handoff)**

Delayed handoff

- A Delayed handoff is a two hand off level algorithm. It provides more opportunity for a successful hand off.
- The MTSO always handles the handoff first and the originating calls second. If no neighboring cells are available after the second handoff level is reached, the call continues until the signal strength drops below the threshold level then the call is dropped.
- Lower handoffs help in handling call processing more adequately.
- It makes the hand off occur at the proper location and eliminates possible interference in the system.

Queued hand off:

- Queued hand off is more effective than two threshold level handoffs.
- The MTSO will queue the requests of handoff calls instead of rejecting them if the new cell sites are busy..
- With Queuing of originating calls only, the probability of blocking is reduced.
- It is effective when implementing a simple queue for hand off calls which reduces call drops.

In **Intersystem Handoff,** If during an ongoing call a mobile unit moves from one cellular system to a different cellular system which is controlled by different MTSO, a handoff procedure which is used to avoid dropping of call referred as Intersystem Handoff takes place.

- An MTSO engages in this handoff system when a mobile signal becomes weak in a given cell and MTSO cannot find another cell within its system to which it can transfer the call then in progress.
- Before implementation of Intersystem Handoff, the MTSO compatibility must be checked and in an Intersystem Handoff a local call may become a long distance call as the mobile moves out of its home system and becomes a roamer in a neighboring system..

In **Intrasystem Handoff,** if during an ongoing call a mobile unit moves from one cellular system to an adjacent cellular system which is controlled by the same MTSO, a handoff procedure which is used to avoid dropping of call referred to as Intra System Handoff takes place.

- An MTSO engages in this handoff system when a mobile signal becomes weak in a given cell and the MTSO finds another cell within its system to which it can transfer the call in progress.
- In Intra System Handoff local calls always remain local calls only since after handoff also the call is handled by the same MTSO.

In first generation analog cellular systems, signal strength measurements are made by the base stations and supervised by the MSC.

- Each base station constantly monitors the signal strengths of all of its reverse voice channels to determine the relative location of each mobile user with respect

to the base station tower.

- In addition, to measuring the RSSI of calls in progress within the cell, a spare receiver in each base station, called the **locator receiver**, is used to scan and determine signal strengths of mobile users which are in the neighboring cells which appear to be in need of handoff.
- The locator receiver, which is controlled by the MSC, reports all RSSI values to the MSC. Based on the locator receiver signal strength information from each base station, the MSC decides if a handoff is necessary or not. This handoff is called as **NETWORK CONTROLLED HANDOFF (NCHO)**.

In **Mobile Assisted Handoff (MAHO)** every mobile station measures the received power from surrounding base stations and continually reports the results of these measurements to the serving base station.

- A handoff is initiated, when the power received from the base station of a neighboring cell begins to exceed the power received from the current base station by a certain level or for a certain period of time.
- In MAHO method call handed over between base stations is much faster than first generation analog systems .As handoff measurements are made by each mobile . MSC no longer constantly monitors signal strengths. MAHO is particularly suited for microcellular environments where handoffs are more frequent. During the course of a call, if a mobile moves from one cellular system to a different cellular system controlled by a different MSC, an intersystem handoff becomes necessary.
- An MSC engages in an intersystem handoff when a mobile signal becomes weak in a given cell and the MSC cannot find another cell within its system to which it can transfer the call in progress.

Q.5 **Attempt any FOUR :** **16M**

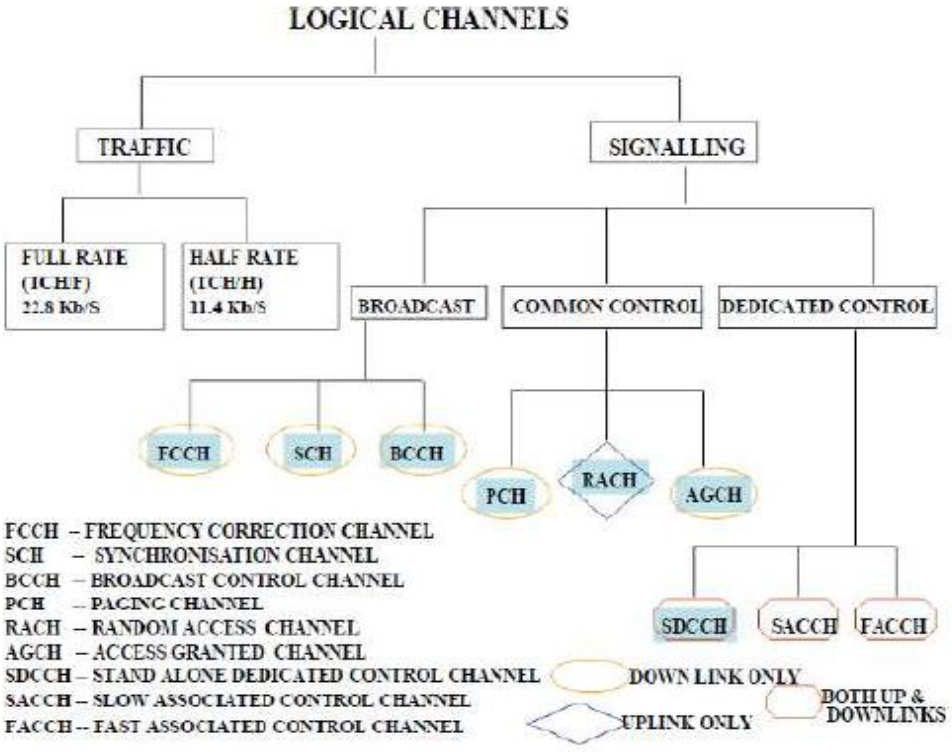
i) **Compare UMTS with CDMA 2000.** **4M**

Ans: **Comparison (Any four points 1M Each)**

Sr No	PARAMETERS	UMTS	CDMA 2000
1	Channel Bandwidth	The minimum spectrum requirement is 5 MHz.	The minimum spectrum requirement is 1.25 MHz.
2	Chip rate	3.84Mcps	1.2288 Mcps or 3.6864 Mcps
3	Frame duration	10ms or optional frame Duration 20ms (voice and data applications)	5ms,10ms or 20ms
4	Packet Data rates	It provides a data rate up to 2.048 Mbps per user	It provides a data rate up to 307Kbps for a user in packet mode and a typical throughput rate of 144 kbps per user.
5	Backward Comparability	GSM	CDMA
6	Power control frequency	1.5 MHz	800Hz
7	Base Station	Asynchronous	Synchronous

	Synchronization		

ii)	**Explain GPRS for 2.5 G GSM and IS-136.**	**4M**
Ans:	• General Packet radio service is a packet based data network, which is well suited for non-real-time Internet usage, including retrieval of real time email, faxes and asymmetric web browsing where user downloads much more data than it upload on the Internet. GPRS supports multi-user network sharing of individual, radio channel and time-slot. • GPRS can support many more users than HSCSD, but in burst manner. The GPRS standard provides a packet network on dedicated GSM or IS-136 radio Channels. GPRS retains the original modulation formats specified in the original 2G TDMA standards, but uses completely redefined air interface in order to better handle packet data access. • When all 8 Time-slots of a GSM radio channels are dedicated to GPRS, an individual user able to achieve as much as 171.2 kbps. • Applications are required to provide their own error correction scheme as a part of the carried data payload in GPRS. Implementations of GPRS mainly requires the GSM operate to install new routers and internet gateways at the base station, along with the new software that redefines the base station air interface standard for GPRS channels and time slot. No new base station RF hardware is required. • The dedicated peak 21.4kbps per channel data rate specified by GPRS works well with both GSM and IS-136 has successfully been implemented.	**(Description:4M)**
iii)	**Describe the function of GSM traffic channels & GSM control channels.**	**4M**
Ans:	***Note: Diagram is optional*** **Diagram:**	**(GSM traffic channels-2M, GSM control channels-2M)**



GSM traffic channel (TCH)

GSM TCH may be wither full rate or half rate and may carry either digitized speech or user data.

(a) Full rate TCH:

(I) **Full rate speech channel (TCH/FS):** This channel carries user speech which is digitized at a raw data rate of 13kbps. With GSM channel coding added to the digitized speech, this channel carries 22.8kbps.

(II) **Full rate data channel for 9600 bps(TCH/F9.6):** This channel carries raw user data which is sent at 9600bps. With additional forward error correction coding applied by GSM standard the 9600bps data is sent at 22.8kbps.

(III) **Full rate data channel for 4800bps(TCH/F4.8)**

This channel carries raw user data which is sent at 4800bps. With additional forward error correction coding applied by GSM standard the 4800bps data is sent at 22.8kbps.

(IV) **Full rate data channel for 2400bps (TCH/F2.4)**

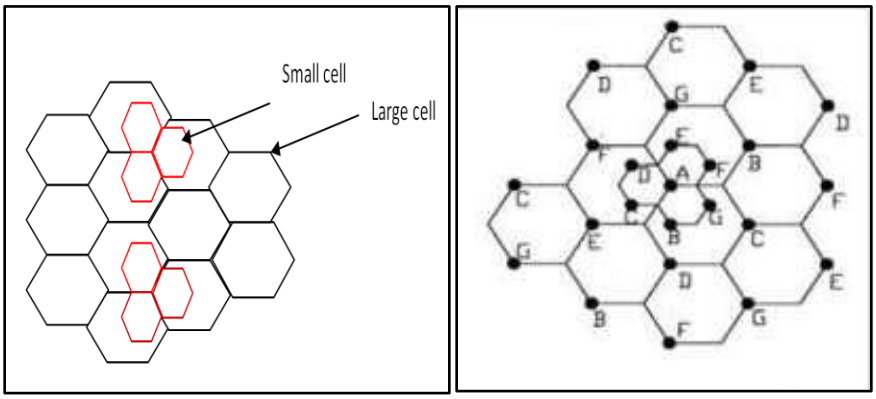
This channel carries raw user data which is sent at 2400bps. With additional forward error correction coding applied by GSM standard the 2400bps data is sent at 22.8kbps.

(b) Half rate TCH:

(I) **Half rate speech channel (TCH/HS):** This channel has been designed to carry digitized speech which is sampled at half rate of 6.5kbps. with GSM channel coding added to the digitized speech the half rate speech channel will carry 11.4kbps.

(II) **Half rate data channel for 4800bps (TCH/H4.8):** This channel carries raw user data which is sent at 4800bps. With additional forward error correction coding applied by GSM, this channel will carry data at 11.4kbps.

		(III) **Half rate data channel for 2400bps (TCH/H2.4)** This channel carries raw user data which is sent at 2400bps. With additional forward error correction coding applied by GSM, this channel will carry data at 11.4kbps **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 if 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 a 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.	
iv)	**Explain the concept of cell splitting using suitable diagram.**		**4M**
Ans:			



(Diagram: 2M, Explanation :2M)

OR

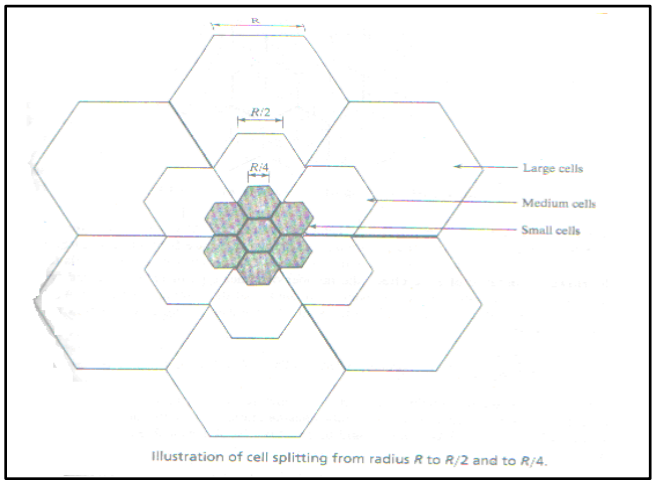


Illustration of cell splitting from radius *R* to *R*/2 and to *R*/4.

Concept:

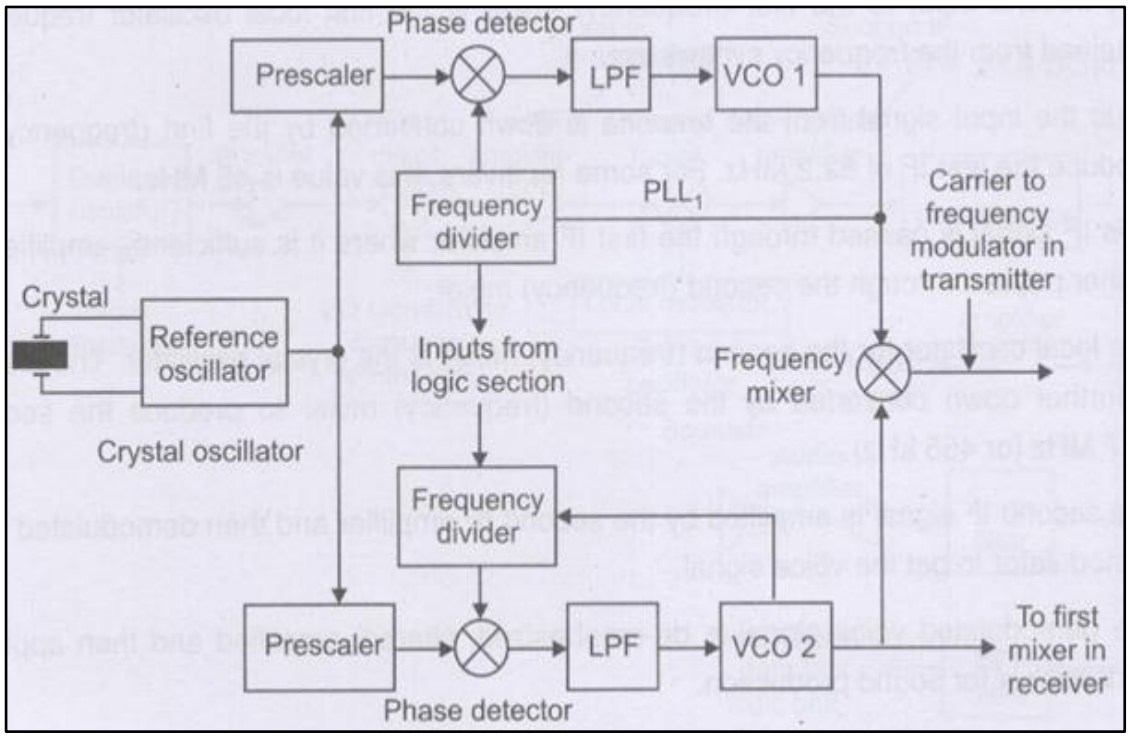
- The cell splitting achieve the capacity improvement by essentially rescaling the cellular system
- By decreasing the cell radius R and keeping the co-channel reuse ratio D/R unchanged, cell splitting increases the number of channels per unit area
- The cell splitting is the process of subdividing a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

Cell splitting helps in increasing system capacity:

- Cell splitting increases the capacity of a system since it increases number of times that channels are reused.
- In cell splitting original cell is split in to smaller cells. New cell radius is half of the original radius.
- In this the cell boundaries need to be revised so that the local area which was earlier considered as a single cell can now contain number of smaller cell ,these new cells are called microcells.

	v)	**Draw neat block diagram of frequency synthesizer and label the blocks. Explain its working.**	**4M**
	Ans:		**2M**

Block Diagram:



Working: **2M**

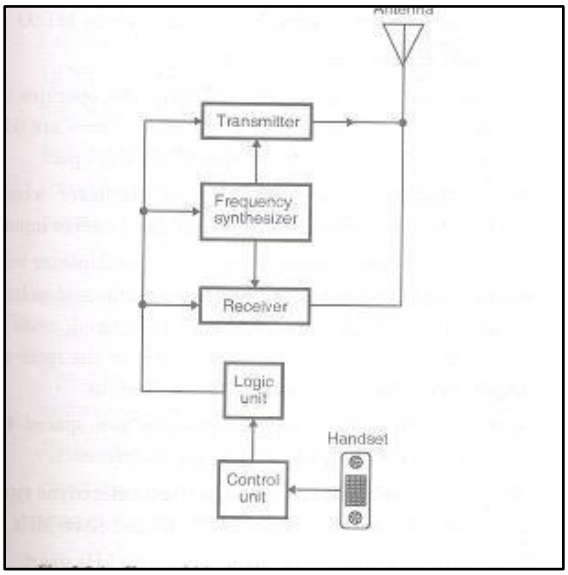
The synthesizer is used for developing all the signals used by the transmitter and receiver.

- 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.

	vi)	**State the various services offered by GSM system.**	**4M**
	Ans:		

		The three services offered by GSM systems are; Telephone services Bearer services Supplementary ISDN services **Telephone Services:** Teleservices include Standard mobile telephone Mobile-originated Base-originated traffic. emergency calling Fax Videotext Tele text, SMS MMS. **Bearer services:** The data services include the communication between computers and packet switched traffic. These services are limited to the first three layers of the OSI reference model. Data may be transmitted using either a Transparent Mode or Non-Transparent Mode. Transparent Mode:-Where GSM provides standard channel coding for user data Non-Transparent Mode: - Where GSM offers special coding efficiencies based on the particular data interface. **Supplementary ISDN services:** This service are digital in nature and include •Call diversion •Caller line ID •Closed user group •Call barring •Call waiting •Call hold •Connected line ID •Multiparty (Teleconferencing) •Call charge advice •This service also include the Short Messaging Service (SMS) which allow GSM subscriber and BS to transmit alphanumeric pages of limited length (160 -7 ASCII characters) while simultaneously carrying normal voice traffic.	**(State services 4 M)**
Q.6		**Attempt any of FOUR:**	**16M**
	i)	**Draw the block diagram of mobile unit. State the function of logic and control unit in mobile handset.**	**4M**
	Ans:		

Diagram :



(Diagram – 2 M, Function of logic unit -1 M, Function of control unit- 1M)

Logic Unit: This unit contains master control circuit for a cellular radio. It is made up of microprocessor with both RAM and ROM and additional circuit used for interpreting signals from MSC & BS and generates control signal for the transmitter and receiver.

Control unit: The control unit contains the handset with speaker and microphone. The control unit is operated by a separate microprocessor that drives the LCD display and other indicators.

ii) Compare GSM with IS-95. **4M**

Ans:

Comparison: (Any four points 1M Each)

Sr No	Parameter	GSM	IS-95
1	Frequency spectrum	890-915 MHz 935-960MHz	800 or 1900 MHz
2	Multiple access	TDMA	CDMA
3	Channel bandwidth	200KHz	1250KHz or 1.25MHz
4	SMS length	160	120
5	Type of hand-off	Hard	Soft
6	Type of modulation	GMSK	QPSK /BPSK
7	Number of voice channels	8 per channel	64 per channel

iii) Explain EDGE for 2.5 G GSM & IS-136. **4M**

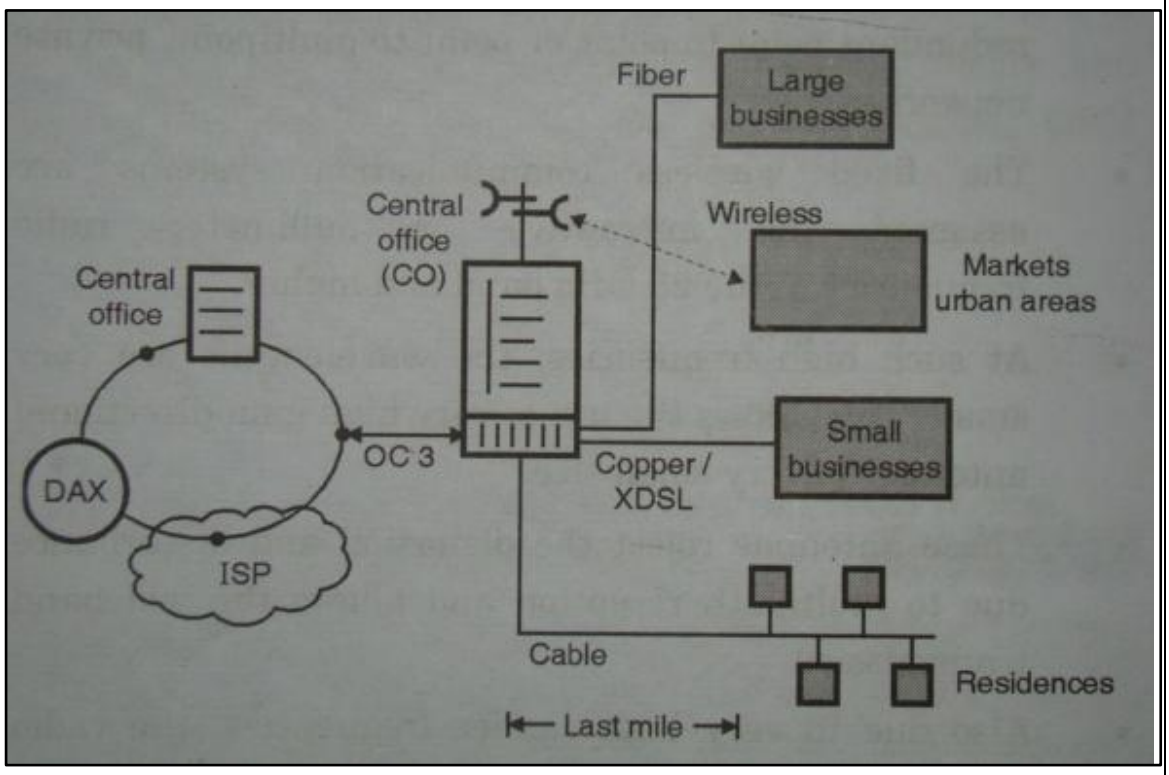
Ans:

(Any correct Description 4 M)

- 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.	
	iv)	**What is WLL? Describe with suitable diagram.**	**4M**
	Ans:	WLL stands for **Wireless Local Loop.** Microwave wireless links can be used to create a wireless local loop such as shown in figure below	**(WLL-1 M, Diagram – 2 M, Description 1 M)**

Diagram:

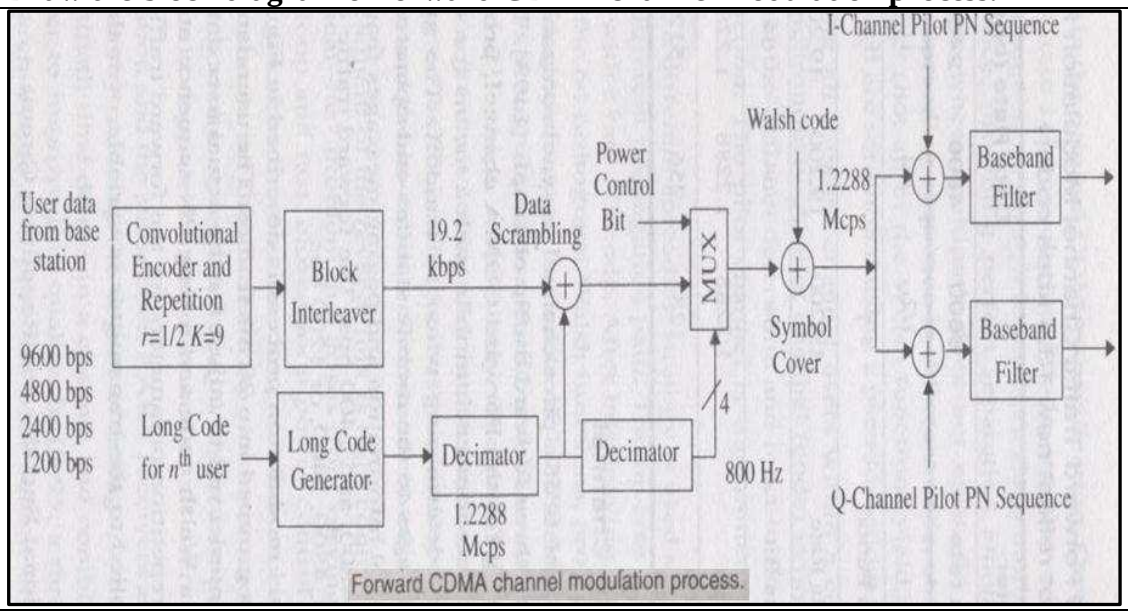


Local Loop is a network that resides between the central office (CO) and the individual homes and business in close proximity to the central office (CO). In most developed countries, copper or optical fiber cable already has been installed to residence and business. One more advantage of WLL is that we have to pay only once for that wireless equipment, after there is no additional costs involved. System WLL is based on Cellular, satellite, microcellular. The WLL can greatly improve the telecommunication facilities and services in an inexpensive way.

It provides-

1. High bandwidth is available
2. Faster deployment
3. Lower deployment costs
4. Lower network maintenance, management and operating cost

v)	**Describe the important features of 3G-CDMA -2000.**	**4M**
Ans:	1) CDMA 2000 is an up gradation of 2 and2.5G CDMA technology. 2) It supports much higher data rates as compared to those of 2G and 2.5G systems. 3) Fundamental principle is the high speed data packet network designed for mobility using internet protocol. 4) Channel bandwidth 1.25MHz per radio channel 5) Up gradation ensures backward compatibility with existing CDMA. 6) It has improved capabilities over W-CDMA at each cell can be introduced without changing the base station entirely. 7) Number of users that can be supported by 3G CDMA 2000 is almost twice the users supported by 2G CDMA system. 8) longer battery life.	**(Any 4 features, 1 M Each)**

		9) It has wide range of telecommunication services such as voice, data, multimedia, internet etc. 10) It can operate in multiple radio environment such as cellular, cordless, satellite ,LAN etc.	
	vi)	**Draw the block diagram of forward CDMA channel modulation process.**	**4M**
	Ans:	 Forward CDMA channel modulation process.	**(Correct diagram - 4 M)**