T.Y. Diploma : Sem. VI [EJ/ET/EN/EX]

Mobile Communication

Time : 3 Hrs. Prelim Question Paper Solution **Marks : 100**

Q.1(a) Attempt any THREE questions. **[12]**

Q.1(a) (i) Describe the effect of co-channel interference in mobile communication. How it affect system capacity? **[4]**

Ans.: Co-channel Interference and System Capacity : [4 marks]

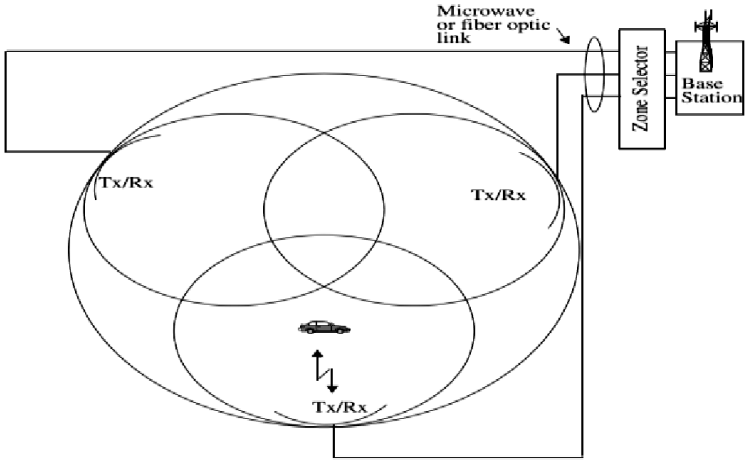
- As discussed in frequency reuse, there are number of cells using the same set of frequencies. Such cells are called as the co-channel cells.
- And the interference taking place between the signals from these cells is called as the co-channel interference.
- Note that we cannot reduce the co-channel interference by simply increasing the transmitter power. In fact increasing the transmitter power will increase the co-channel interference.
  The co-channel interference can be reduced by separating the co-channel cells physically by a minimum distance.
- If all the cells are of the same size and all the base stations are transmitting equal amount of power, the co-channel interference ratio is independent of the transmitted power, but it becomes a function of the cell radius (R) and the distance between centers of the co-channel cells (D).
- If we increase the ratio (D/R) then the co-channel interference will reduce.
- A parameter Q called as co-channel reuse ratio is related to the D/R ratio and the cluster size N as follows :

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

- If the value of Q is small then the cluster size N will also be small and the system capacity will be large. On the other hand, if the value of Q is large, then the cluster size N will be large and the system capacity will be low.
- However a large value of Q will reduce the co-channel interference. Hence the selection of Q is based on these two factors i.e. system capacity and co-channel interference.

Q.1(a)(ii) Describe the term microcell zone concept for capacity improvement. **[4]**

Ans.: Diagram : [2 marks]



Description : [2 marks]

- 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.

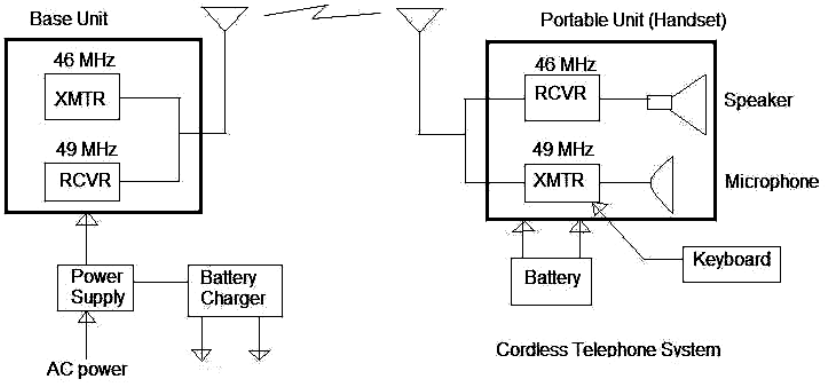
Q.1(a) (iii) State various 2.5 generations cellular standards based on TDMA and CDMA. State whether they are backward compatible with second generation (2G) standard. **[4]**

Ans.: [List - 2 marks, State compatibility - 2 marks]

HSCSD	For 2.5 G GSM	– Backward compatible to GSM
GPRS	For 2.5 G GSM and IS136	– Backward compatible to GSM
EDGE	For 2.5G GSM and IS136	– Backward compatible to GSM
IS-95B	For CDMA	– Backward compatible to IS-95A

Q.1(a)(iv) Illustrate operation of cordless telephone system with the help of neat sketch. **[4]**

Ans.: [Diagram - 2 marks Explanation - 2 marks]



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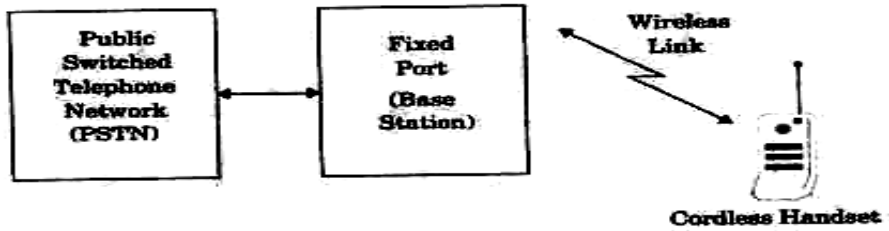

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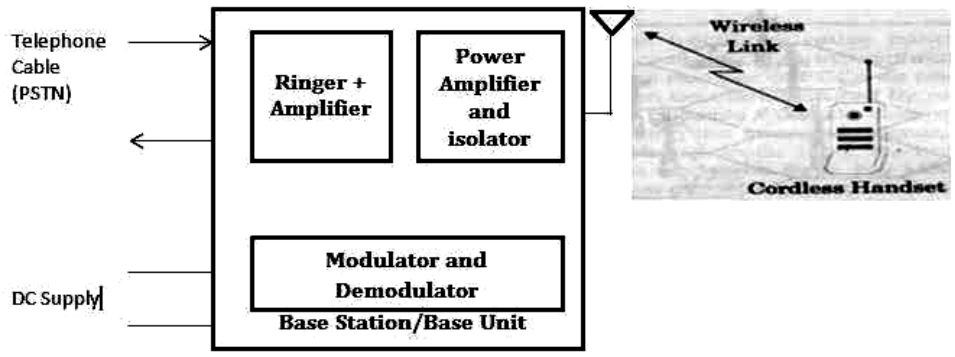


- Cordless Telephone Systems are full duplex communication systems that use radio to connect a portable handset to a dedicated base station, which is also connected to a dedicated telephone line with a specific telephone number on PSTN. Maintain a call if the user travels outside the range of the base station.
- The fixed port of a cordless telephone is nothing but the base unit on which cordless handset is placed, is connected to a telephone line and an adapter to produce a dc supply for various electronic circuits inside the base unit.
- The communication between the base unit and the handset is wireless and the range is limited to 50 meters.
- In the base unit all call processing circuits like amplifiers and also ring circuit is present. In addition a transceiver is also present which is used for communication with the handset.
- In handset also the transceiver along with an antenna, amplifier, microphone and loud speaker are present.
- 1st generation cordless telephone systems could cover only distance of a few ten meters (approximately50m) and can be operated solely as extension telephones to a transceiver connected to a subscriber line on the PSTN and are primarily for in-home use.
- 2nd generation cordless telephone systems could cover distance of a few hundred meters which allows subscribers to use their handsets at many outdoor locations within urban centers.
- Cordless telephone systems provide the user with limited range and mobility, as it is not possible to maintain a call if the user travels outside the range of the base station.

Q.1(b) Attempt any ONE questions. **[6]**

Q.1(b)(i) Write a short note on near-far effect in CDMA. **[6]**

Ans.: Near Far effect in CDMA :

A mobile station close to the base station has much lower path loss than mobiles that are far away from the base station. Hence, if all mobile stations were to use the same transmit power then users near the base station are received with high power while those far away are received with low power. This would cause the mobiles close to the base station to effectively jam the signals from the mobiles far away from the base station. This is the Near Far effect in CDMA.

The Near Far effect is more predominant when many mobile users share the same channel as is the case in CDMA.

To overcome the Near Far problem, Power control is used in most CDMA implementations. Power control is provided by each base station in a cellular system and ensures that each mobile within the base station coverage area provides the same signal level to the base station receiver. This solves the problem of a nearby subscriber overpowering the base station receiver and drowning out the signals of far away subscribers.

Q.1(b) (ii) Define the following components : **[6]**

(1) Mobile station **(2) Forward channel** **(3) Base station controller**
(4) MSC **(5) Roaming** **(6) Transceiver**

Ans.: (1) Mobile station [1 mark]

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).

(2) Forward channel [1 mark]

It is a radio channel used for transmission of information from the base station to the mobile.

(3) Base station controller [1 mark]

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).

(4) MSC [1 mark]

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 cellular base stations and the mobiles to the PSTN (Public Switched Telephone Network, PSTN is a global telecommunications network which connects convectional landline telephone switching centers, called central offices, with MSCs throughout the world).

(5) Roaming [1 mark]

A mobile station which operates in a service area (market) other than that from which service has been subscribed is called a roaming.

(6) Transceiver [1 mark]

A device capable of simultaneously transmitting and receiving radio signals.

Q.2 Attempt any FOUR questions. [16]

Q.2(a) State any four specifications of UMTS. [4]

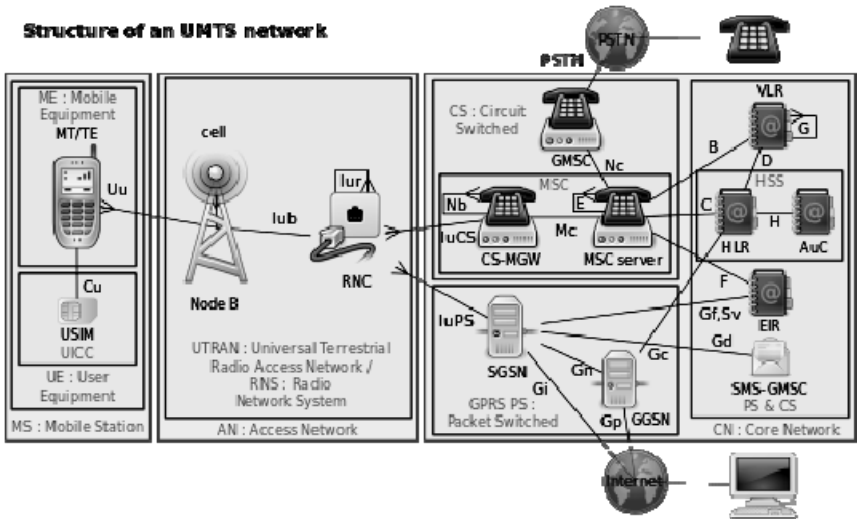
Ans.: Specifications of UMTS : [Any four - 1 mark each]

- It is more robust for multipath delays.
- It has very high packet data rates of 2.048 Mbps.
- It has very high channel bandwidth of 5 MHz.
- It has backward compatibility with GSM systems.
- It has high frame structure of 16 slots per frame.
- It gives signals of higher voice and data quality and also small bit error rates.
- It has a common world-wide spectrum band.
- It has global seamless connectivity (roaming).

Q.2(b) Describe Universal Mobile Telecommunication system with suitable block diagram. [4]

Ans.: The Universal Mobile Telecommunications System (UMTS) is a third generation mobile cellular system for networks based on the GSM standard. Developed and maintained by the 3GPP (3rd Generation Partnership Project), UMTS is a component of the International Telecommunications Union IMT-2000 standard set and compares with the CDMA 2000 standard set for networks based on the competing CDMA One technology. UMTS uses wideband code division multiple access (W-CDMA) radio access technology to offer spectral efficiency and bandwidth to mobile network operators.

UMTS specifies a complete network system, which includes the radio access network (UMTS Terrestrial Radio Access Network, or UTRAN), the core network (Mobile Application Part, or MAP) and the authentication of users via SIM (subscriber identity module) cards.

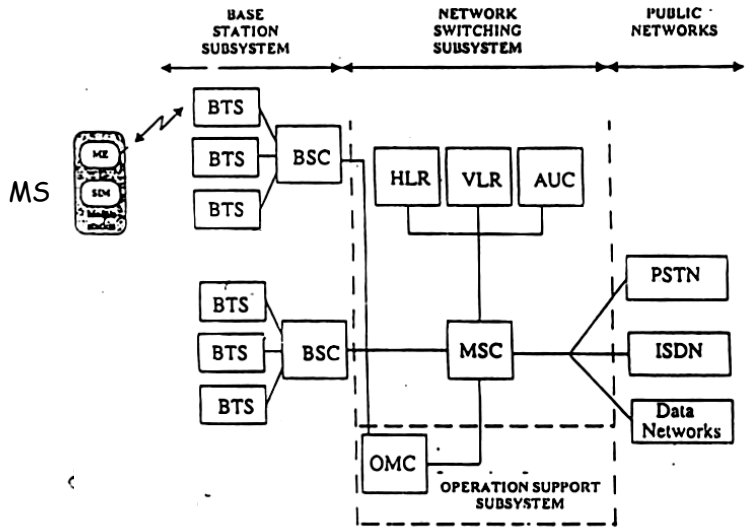


UMTS system uses the same core network as the GPRS and uses entirely new radio interface. The new radio network in UMTS is called UTRAN (UMTS Terrestrial Radio Access Network) and is connected to the core network (CN) of GPRS via Iu interface. The Iu is the UTRAN interface between the Radio network controller RNC and CN.

The mobile terminal in UMTS is called User Equipment (UE). The UE is connected to Node-B over high speed Uu (up to 2 Mbps) Interface. The Node-B are the equivalent of BTS in GSM and typically serve a cell site. Several Node-Bs are controlled by a single RNCs over the Iub interface. The RNCs are connected to CN through Iu interface. The packet switched data is transmitted through Iu-PS interface and circuit switched data is transferred over Iu-CS interface. One of the new interfaces in UTRAN is Iur interface which connects two RNCs and has no equivalent in GSM system. The Iur interface facilitates handling of 100 percent of RRM (Radio Resource Management) and eliminates the burden from CN. UMTS also supports GSM mode connections in which case the MS connect to the CN through Um interface to BSS and BSS connects through A (Gb interface in GPRS) interface to CN.

Q.2(c) Draw GSM architecture & state the function of : (i) HLR, (ii) AUC. [4]

Ans.: GSM architecture [Diagram - 2 marks, Each funcction - 1 mark]



Home Location Register (HLR) :

The HLR represents a centralised data base that has a permanent data fill about the mobile subscribers in a large service area (generally one per GSM network operator). The HLR is kept updated with the current locations of all its mobile subscribers, including those who may have roamed to another network operator within or outside the country.

Besides the up to date location information for each subscriber, which is dynamic, the HLR maintains the following subscriber data on a permanent basis

- International Mobile Subscriber Identity (IMSI), a unique number used to identify each home user.
- Service subscription information
- Service restrictions
- Supplementary services subscribed to
- Mobile terminal characteristics
- Billing/Accounting information

Authentication Centre [AuC]

As the radio interface and mobile stations are very vulnerable to malicious misuse, a separate Authentication Centre [AuC] has been defined to protect user identity and data transmission. The Authentication Centre is a strongly protected data base which is generally associated with the HLR. It contains the algorithms for authentication as well as the keys for encryption and generates the values needed for user authentication in the HLR.

Q.2(d) List the following parameters of 3G-TD-SCDMA system. (any four) [4]
(i) Bandwidth (ii) Data Rate (iii) Multiple Access
(iv) Backward Compatibility (v) Developed by

Ans.: (i) Bandwidth : 1.6 MHz [Any four - 1 mark each]
(ii) Data Rate : Up to 384 kbps of packet data rate
(iii) Multiple Access : Time division synchronous code division multiple access technology.
(iv) Backward Compatibility : GSM
(v) Developed by : China Academy at Telecomm (CATT) and Siemens Corporation jointly developed.

Q.2(e) State any four features of Third Generation (3G) standard systems and list various 3G standards. [4]

Ans.: Features of Third generation (3G) standard system : [Any Four - ½ mark each]
- Multi-megabit internet access
- Voice activated cells
- Unparalleled network capacity
- Ubiquitous " always on" access
- Next channel interference
- Communications using voice over internet protocol

Various 3G standards are : [½ mark each]
1) W-CDMA 2) IMT 2000 3) CDMA 2000 4) TDSCDMA

Q.3 Attempt any FOUR questions. [16]

Q.3(a) What is cell? Describe the concept of frequency reuse? Draw two frequency reuse patterns? State the Expression used to calculate distance between two same cells. [4]

Ans.: Cell [1 mark]
- Cell is a small geographic area. The base stations transmitting power is restricted to that area only.

Frequency Reuse [1 mark]
- Frequency reuse refers to the use of radio channels operating on the same frequency, to cover different areas, that are physically separate from each other.
- In frequency reuse it is necessary to see that the co-channel interference is not objectionable.
- Frequency reuse is an important concept because in this a single transmitter of higher power need not be used to cover the entire area. Instead many transmitter of small output power operating at the same frequency can be used.
- This technique also reduces the minimum height of the transmitting antenna, because now each antenna has to cover a small area.
- Frequency reuse is a very important concept of the cellular mobile radio system.
- The users located in different geographical areas i.e. different cells can use the same frequency simultaneously.
- The advantages of frequency reuse is that it drastically increases the spectrum efficiency but the disadvantage is that if the system is not designed properly then cochannel interference may take place.

Frequency Reuse Schemes : [2 marks]
- We can use the concept of frequency reuse in either time domain or in the space domain.
- In the time domain the same frequency is used by different users in different time slots. This is called as time division multiplexing (TDM).
- There are two categories of frequency reuse in the space domain as follows :

1. Same frequency is assigned in two different geographic areas, (such as two different cities).
2. To use the same frequency repeatedly in a same general area in one system. This scheme is popularly used in cellular systems.

- The second scheme is illustrated in Figure 1. The total frequency spectrum allocation is divided into 4 cochannel cells in the system as shown in Figure 1. The cells marked-1 will use the same frequency say f_i, the cells marked-2 will use same frequency and so on.

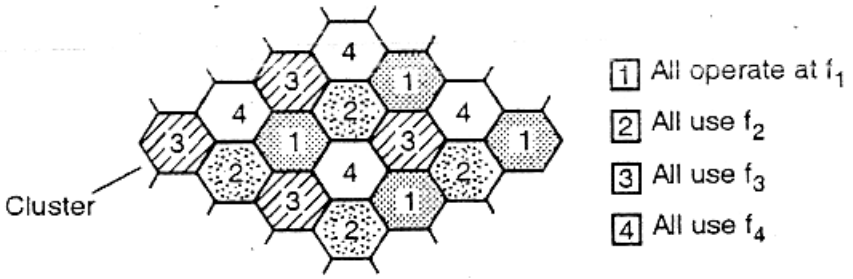
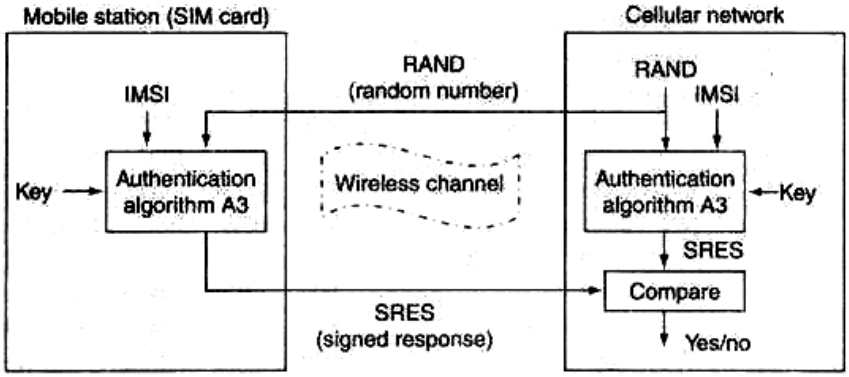


Fig. 1 : Frequency reuse

Q.3(b) Explain authentication process in GSM system with the help of appropriate sketch. [4]

Ans.: [Diagram - 2 marks]



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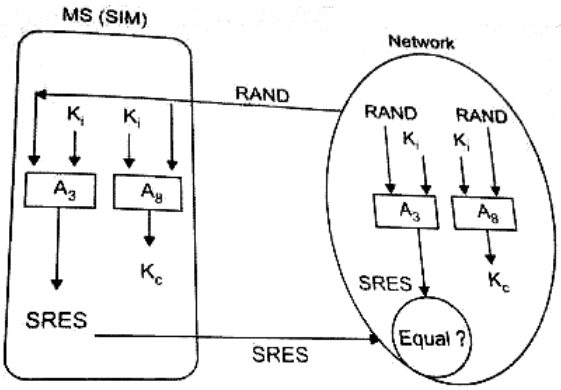


Explanation : [2 marks]

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 Ki associates them with IMSI and provides for each IMSI a set of triplets consisting of RAND (Random Number), SERS (signed Response), Kc (Cipher key)

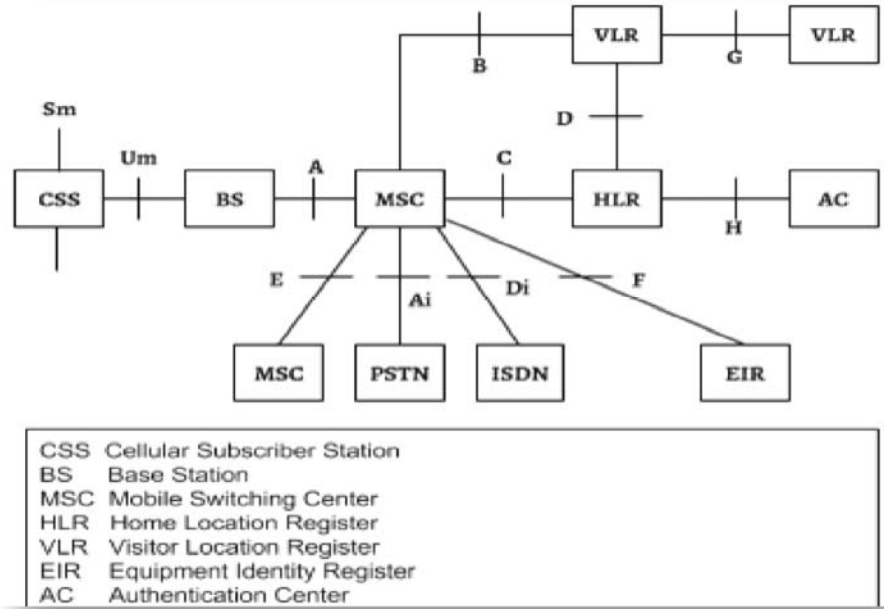
Authentication center first authenticate the subscriber mobile station and only then MSC provides service.

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.

Q.3(c) Draw system architecture of IS-95. Explain working of any two blocks. [4]

Ans.: [Diagram & Explanation - 2 marks each]



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 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 the Cellular Subscriber station that are allowed in a network as well as a database of all equipment that is banned, e.g. because it is lost or stolen.

Q.3(d) List any four features of third generation (3G) cellular standard state various 3G standards. (TDMA and CDMA based). **[4]**

Ans.: Features of third generation (3G) cellular standard [four features- 2 marks]

1) The main feature of 3G technology is that it supports greater voice and data capacity and high data transmission at low-cost. 3G mobiles can operate on 2G and 3G technologies.
2) The second major feature is the security: 3G offers greater security features than 2G like Network Access Security, Network Domain Security, User Domain Security, Application Security.
3) This technology provides localized services for accessing traffic and weather updates. Video calls and video conference is another major feature in 3G mobile technology. These features reduces the communication barriers between people, that were not sacked even with mobile phones.
4) Date transfer rates are high and can support even live TV channels over phone.
5) Online media is another exciting feature in 3G mobiles.
6) 3G mobiles highly attract the music lovers as they can listen to music and watch videos online and can download huge files with in less time.

Standards : [2 marks]

1) CDMA 2000 2) WCDMA-UMTS 3) 3GTD-SCD 4) IMT2000

Q.3(e) State the concept of signaling system No. 7 (SS7). Draw architecture of SS7 for NSP of the protocol. (Only lower three layers of OSI model). **[4]**

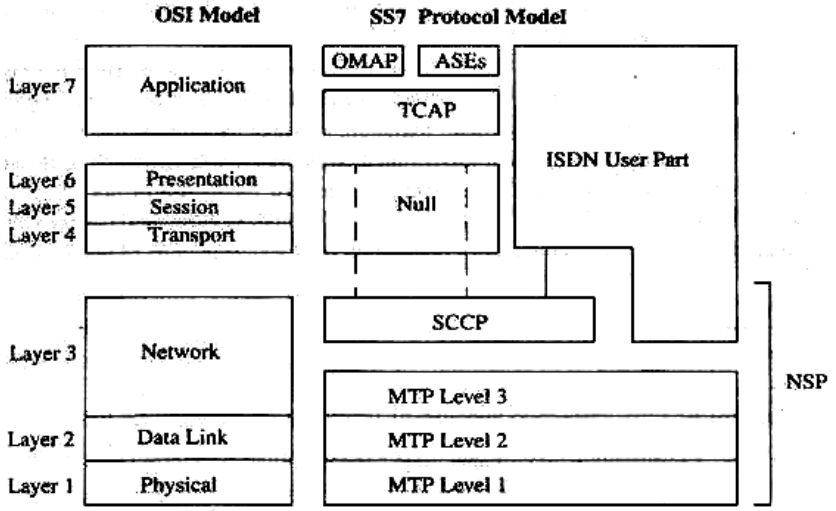
Ans.: [Concept of signaling system No 7 & SS7 Protocol Architecture - 2 marks each]

The signaling system SS7 is an out of band signaling method in which the common data channel is used to convey signaling information related to a large number of trunks (voice and data).

The signaling has traditionally supported the following functions:

1. Supervisory functions.
   Example : On hook/off hook to indicate idle or busy status.
2. Addressing function.
   Example : Called number.
3. Calling information.
   Example : Dial tone and busy signals.

The introduction of electronic processors in switching systems made it possible to provide common channel signaling.



OMAP: Operations Maintenance and Administration Part
ASE: Application Service Element
TCAP: Transaction Capabilities Application Part
SCCP: Signaling Connection Control Part
MTP: Message Transfer Part
NSP: Network Service Part

Q.3(f) Write features of Bluetooth. (4 points) **[4]**

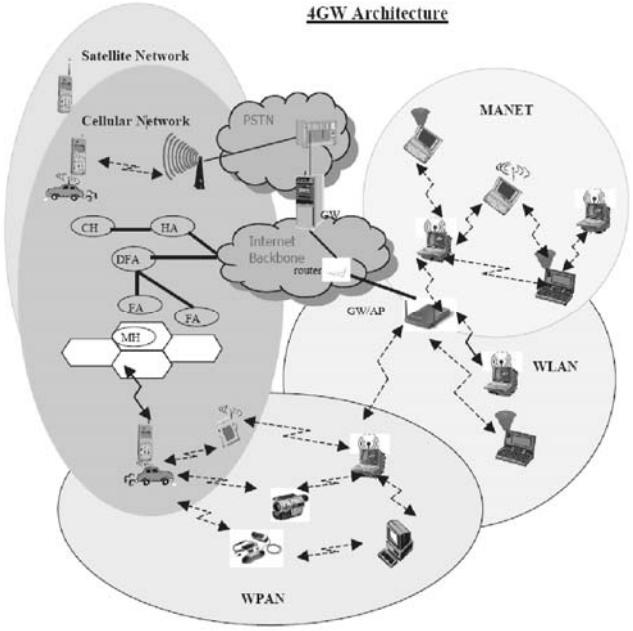
Ans.: Features of Bluetooth [Any Four - 1 mark each]

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 device scan 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 and Even video is contemplated in Bluetooth standard.

Q.4(a) Attempt any THREE questions. **[12]**

Q.4(a) (i) Draw and explain architecture of 4G wireless system. **[4]**

Ans.: Note : Any other relevant diagram can be considered. [Diagram - 2 marks]



Explanation : [2 marks]

- **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 LAND, WAN, and PAN as well as mobile adhoc networks; the second level includes the integration of wireless networks and fixed network-backbone infrastructure, the Internet and PSTN.
- **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 application 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 suers 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 hock 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 communication 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 users' 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.

Q.4(a) (ii) Explain HSCSD for 2.5 G GSM. [4]

Ans.: HSCSD for 2.5 G GSM [4 marks]

- 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.

Q.4(a) (iii) List the following specifications of IS-136 standard. [4]

(1) Frequency Spectrum (2) Channel Bandwidth

(3) Data Rate (4) Modulation Technique

Ans.: (1) Frequency Spectrum : Uplink 800 MHz, 1500 MHz, Downlink 869-894 MHz [1 mark]

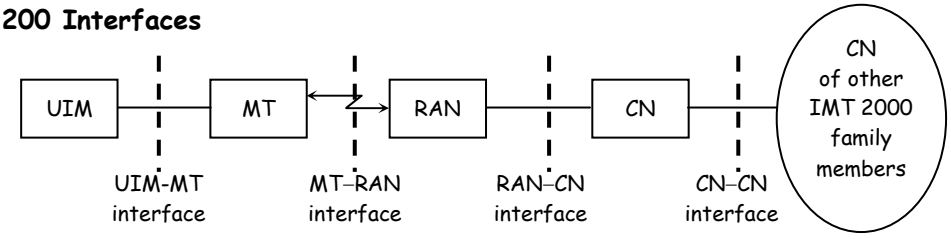
(2) Channel Bandwidth : 30 KHz. [1 mark]

(3) Data Rate : 24,300 symbols per second. [1 mark]

(4) Modulation Technique : $\pi/4$ DQPSK. [1 mark]

Q.4(a) (iv) Describe IMT 2000 Interfaces with a neat diagram. [4]

Ans.: IMT 200 Interfaces



UIM: User identity module
MT : Mobile terminal
RAM : Radio access network
CN : Core network

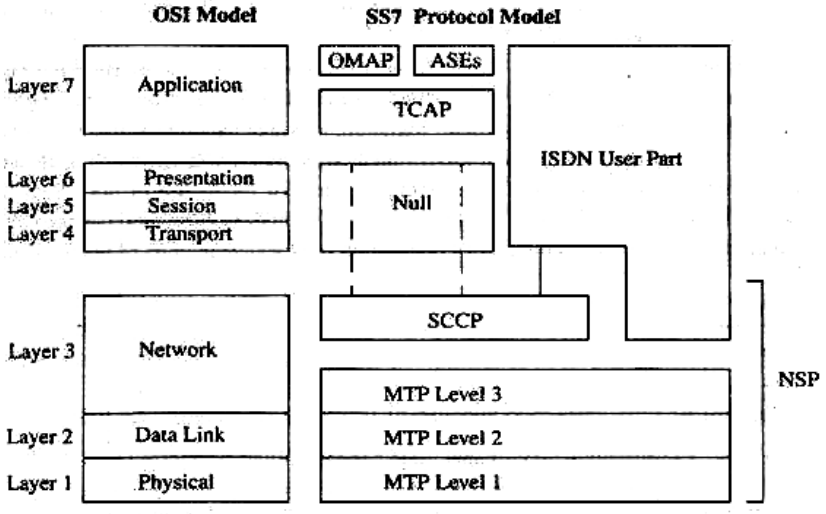
IMT 2000 Interfaces

- UIM–MT interface represents the interface between a removable user identity module and mobile terminal.
- This interface should be secure, ISO-compliant physical specification in terms of size, contacts, electrical specifications like voltage and basic protocols.
- MT–RAN is the air interface as specified by ITU given by 2000 MHz spectrum.
- RAN–CN interface has been deferred (to be explained later).
- CN–CN interface is a key interface for supporting global roaming across networks belonging to different family members.

Q.4(b) Attempt any ONE questions. **[6]**

Q.4(b) (i) Draw SS7 protocol architecture and state the function of NSP of SS7. **[6]**

Ans.: [Diagram - 3 marks]



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SCCP: Signaling Connection Control Part
MTP: Message Transfer Part
NSP: Network Service Part

Function of NSP : [3 marks]

- **Network Service Part of SS7 :** The NSP provides ISDN with a highly reliable and efficient means of exchanging traffic using connectionless services. The NSP consists of Message transfer Part(MTP), Signaling Connection Control Part(SCCP).
  - 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 in associated channel mode but the use of disassociated mode is also possible.
- The function of MTP is to ensure that signaling traffic can be transferred and delivered reliably between the end-users and the network.
- **Signaling data link functions (MTP Level 1) :** This level provide an interface to the actual physical channel (copper wire, fiber, satellite link etc) over whihc communication takes place.
- **Signaling link function (MTP Level 2) :** It provides a wide range of error detection and correction features.
- **Signaling Network Function (MTP Level 3) :** Provides procedure that transfer message between signaling nodes. It has two functions namely, Signaling Message Handling(SMH) and Signaling Network Management (SNM). SMH is used to provide routing, distribution and traffic discrimination.
- **Signaling Connection Control Part (SCCP) :** The SCCP provides enhancement to the addressing capabilities provided by the MTP.

Q.4(b) (ii) State and explain the three services offered by GSM system. [6]

Ans.: The three services offered by GSM systems are: [State - 1 mark, Explanation - 3 marks]

- 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.

Supplementary ISDN services : This service are digital in nature and include

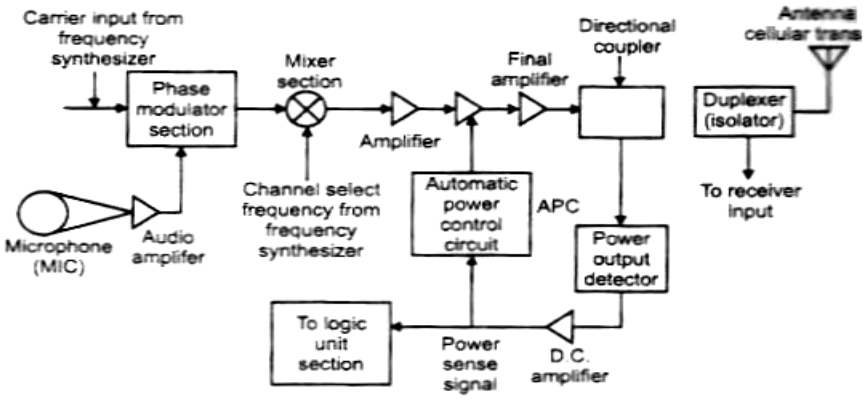
- Call diversion
- Caller line ID
- Closed user group
- Call barring
- Call waiting
- Call hold
- Connected line ID
- Multiparty (Teleconferencing)
- Call charge advice
- This service also include the Short Messaging Service (SMS) which allow GSM subscriber and BS to transmit alphanumeric pages of limited length (160 -7 ASCII characters) while simultaneously carrying normal voice traffic.

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.

Q.5 Attempt any FOUR questions. [16]

Q.5(a) Draw neat block diagram of transmitter unit of mobile handset. State function of APC loop and duplexer unit in unit. [4]

Ans.: [Block diagram - 2 marks, Function – 1 marks each]



Automatic Power Control Circuit and DC amplifier :

The automatic power control circuit controls the output power of the transmitter automatically, with the help of power output detector and DC amplifier.

Transmitter output is fed to duplexer. Carrier input for the phase modulator and the local oscillator frequency signal for mixer are produced by frequency synthesizer.
Transmitter output power is controlled by cell site and MTSO.
Receiver picks up the special control signals and sends to APC that sets transmitter output power level.

OR

APC

The receiver picks up the special control signals and send them to the APC (automatic power control) circuit which sets the transmitter output power level to one of the possible eight levels.
Due to APC, the received signal from the cell site becomes adequately strong and the interference is reduced with the other stations in the same or adjacent cells.
Cellular telephone unit uses the full duplex mode of duplexer.
The signal received by the antenna is isolated from the output stage of the transmitter with the help of a device called "Duplexer".
The duplexer will connect the received signal only to the cellular receiver input.
The duplexer output goes to the RF amplifier which boosts the level of input signal to a sufficient value and applies it to the first mixer.

Q.5(b) Compare IS-95 system with GSM system with respect to following points. (any four points) **[4]**

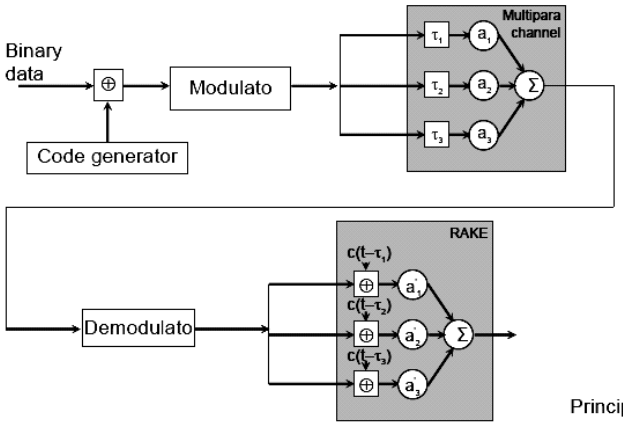
(i) frequency spectrum (ii) multiple access (iii) channel bandwidth
(iv) SMS length (v) type of hand-off

Ans.: [Relevant comparison - 4 marks]

Parameters	IS-95 system	GSM system
frequency spectrum	800 or 1900 MHz	880-915 MHz 935-960MHz
multiple access	CDMA	TDMA
channel bandwidth	1250KHz	200KHz
SMS length	120	160
type of hand-off	Soft	Hard

Q.5(c) Write a short note on RAKE receiver. **[4]**

Ans.: RAKE Receiver [4 marks]



Principle of RAKE receiver

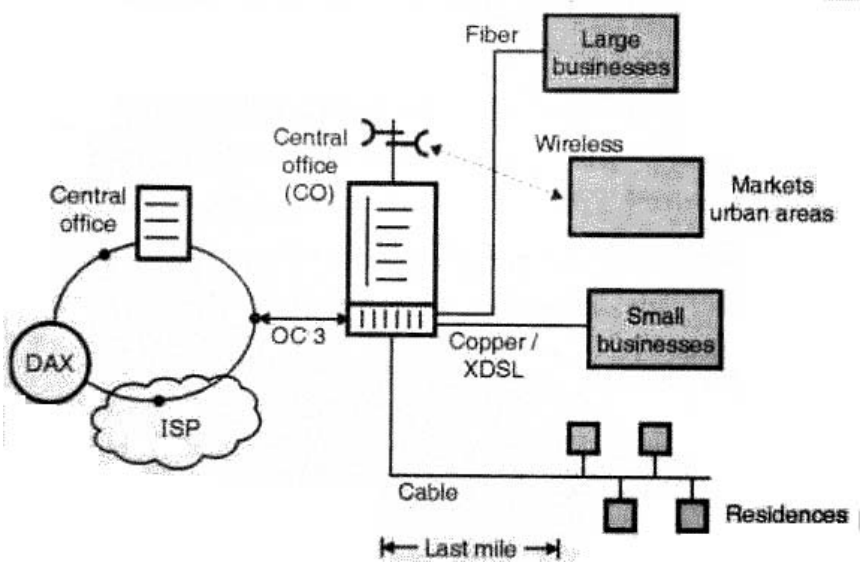
In a multi path environment, which is common in cellular systems, if the multiple versions of a signal arrive more than one chip interval apart from each other, the receiver can recover the signal by correlating the chip sequence with the dominant incoming signal. The remaining signals are treated as noise. However even better performance can be achieved if the receiver attempts to recover the signals from multiple paths and combine them, with suitable delays. This principle is used in Rake receiver.

The Figure above illustrates the principle of RAKE receiver. The original binary signal to be transmitted is spread by exclusive OR operation. The spread sequence is then modulated

for transmission over the wireless channel. Because of multi path effects, the channel generates multiple copies of the signal, each with a different amount of delay (τ_1, τ_2 etc.), and each with different attenuation factors (a_1, a_2 etc). At the receiver the combined signal is demodulated. The demodulated chip stream is then fed into multiple correlators, each delayed by a different amount. These signals then combine using weighted factors estimated from the channel.

Q.5(d) Draw neat block diagram of wireless local loop (WLL) network and state its importance. **[4]**

Ans.: [Diagram – 2 marks, importance 2 marks]



Importance :

A great advantage of the wireless equipment's however is that it can be deployed within a few hours. One more advantage of WLL technology is that we have to pay only once for the wireless equipment. After that there are no additional costs involved.

The WLL technology is capable of competing with the copper wire based Digital subscriber loop (DSL) technology which is growing very fast.

The WLL can greatly improve the telecommunication facilities and services in an inexpensive way.

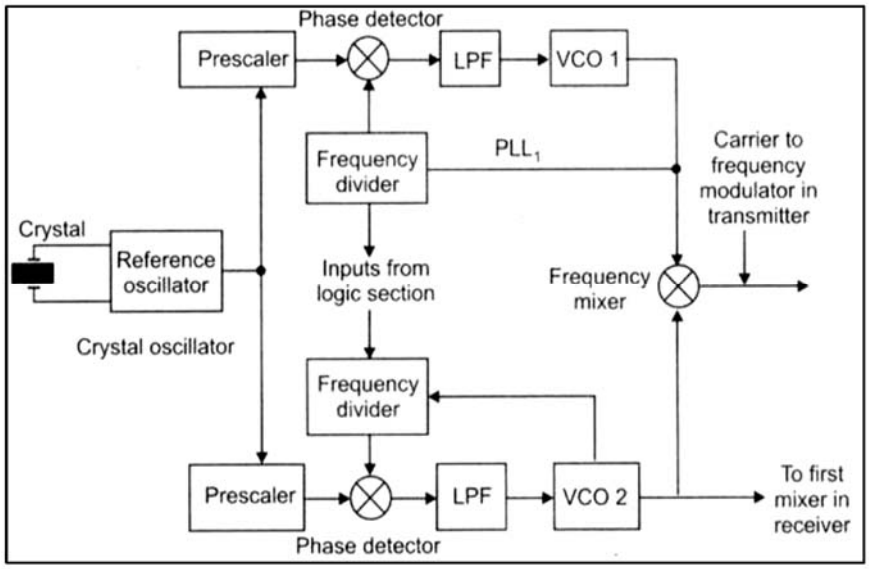
Q.5(e) Compare UMTS with CDMA 2000. **[4]**

Ans.: [Any four points - 1 mark each]

	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	3.84 Mcps	1.2288 Mcps or 3.6864 Mcps
3.	Frame duration	10ms or optional frame Duration 20ms (voice and data applications)	5ms, 10 ms or 20 ms
4.	Packet Data rates	It provides a data rate up to 2.048 Mbps per user	If 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	800 Hz
7.	Base Station Synchronization	Asynchronous	Synchronous

Q.5(f) Draw neat block diagram of frequency synthesizer and label the blocks. Explain its working. **[4]**

Ans.: Block Diagram: [2 marks]



Working: [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.
-

Q.6 Attempt any FOUR questions. **[16]**

Q.6(a) Explain EDGE for 2.5 G GSM and IS–136. **[4]**

Ans.: [Any correct Description - 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 requirement 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 kbp for a single dedicated user on single GSM channel.

Q.6(b) Describe Radio aspect and Security aspects of IS-95 system. [4]

Ans.: RADIO ASPECTS OF IS-95 [Proper explanation – 2 marks for each]

The IS-95 is specified for reverse link operation in the 824 to 894 MHz band and 869 to 894 MHz for the forward link. A forward and reverse channel pair is separated by frequency spectrum of 45 MHz for cellular band operation. Many users share a common channel for transmission. The maximum user data rate is 9.6 kbps. The IS-95 uses spread spectrum technology. The spreading process is different for the forward and reverse links in the original CDMA specification. On the forward link, the user data is encoded using a rate 1/2 convolution code, interleaved, and spread by one of 64 orthogonal spreading sequences .Each mobile in a given cell is assigned a different spreading sequence, providing perfect separation among the different users.

To reduce interference between mobiles that use the same spreading sequence in different cells and to provide the desired wide band special characteristics, all signals in a particular cell are scrambled. On the reverse link, a different spreading strategy is used since each received signal arrives at the base station via a different propagation path. The reverse channel user data stream is first convolution encoded with a rate of 1/3 code. After interleaving, each block of 6 encoded symbols is mapped. Another essential element of the reverse link is tight control of each subscriber's transmitter power, to avoid the *near end-far end* problem that arise from varying received powers of the users. A combination of open-loop and closed-loop power control is used to adjust the transmit power of each in-cell subscriber so that the base station receives each user with the same received power.
The commands for the closed-loop power control are send at a rate of 800 b/s and these bits are stolen from the speech frames. Without fast power control, the raid power changes due to fading would degrade the performance of all users in the system.

SECURITY aspects

The IS-95 CDMA systems also use the authentication and privacy procedures specified in IS-41.At the time of subscription, the mobile station is programmed with information specific to the subscriber or the terminal, such as Mobile Identification Number (MIN) and Electronic Serial Number (ESN), as well as the Cellular Authentication and Voice Encryption (CAVE) algorithm. Since it currently does not utilize a subscriber identity module (as in case of GSM), the private key (called the A key) is provided to the subscriber through a secure means (e.g., through registered mail).The subscriber then uses the terminal's keypad to enter the 64 bit 'A' key into the mobile station and its correct entry is verified by the security software within the mobile station. The A key also resides in the Home Location Register/Authentication Centre (HLR/AC) in the subscriber's home network. Once the subscriber specific data, the CAVE algorithm, and the A key have been successfully programmed into the mobile station, the HLR/AC asks the mobile station to generate the Secret Shared Data (SSD) by sending a random number for SSD generation (RANDSSD) parameters to the mobile station. This may take place when the mobile station makes the

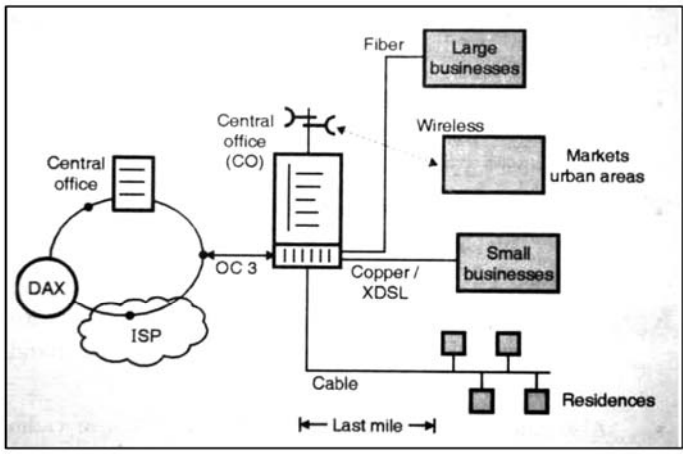
initial registration request. The mobile station utilizes RANDSSD, the A key and the ESM as input to the CAVE algorithm to generate the SSD. This SSD is then used for generating authentication results and cryptographic keys.

Q.6(c) What is WLL? Describe with suitable diagram. **[4]**

Ans.: [WLL – 1 mark, Diagram - 2 marks, Description - 1 mark]

WLL stands for Wireless Local Loop. Microwave wireless links can be used to create a wireless local loop such as shown in figure below.

Diagram:

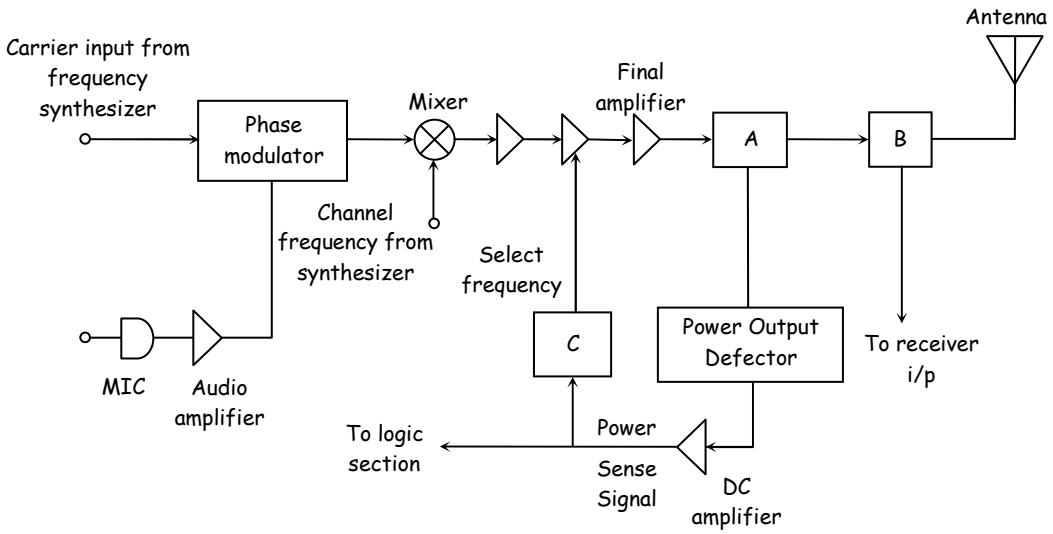


Local Loop is a network that resides between the central office (CO) and the individual homes and business in close proximity to the central office (CO). In most developed countries, copper or optical fiber cable already has been installed to residence and business one more advantage of WLL is that we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

Q.6(d) Identify the given block diagram and state function of blocks A, B and C. (Refer figure) **[4]**



Ans.: The block diagram is the **cellular transmitter** [Each answer-1 marks]

A-Directional Coupler

A- Duplexer/Isolator

B- Automatic Power Control Unit

Q.6(e) Describe the important features of 3G-CDMA-2000. [4]

Ans.: Features of 3G-CDMA-2000 [Any four features – 1 mark each]

(1) CDMA 2000 is an up gradation of 2 and 2.5G CDMA technology.
(2) It supports much higher data rates as compared to those of 2G and 2.5 G systems.
(3) Fundamental principle is the high speed data packet network designed for mobility using internet protocol.
(4) Channel bandwidth 1.25 MHz 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.
(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.

Q.6(f) Name the systems A and B which supports following features. [4]

	Parameter	A
1)	Frequency band	2400-2483.5 MHz
2)	Duplexing method with frequency hopping	TDD
3)	Channel BW	– 1 MHz
4)	Modulation Tech	GFSK

	Parameter	B
1)	Packet data rate	384 kbps
2)	Duplexing method	TDD
3)	Channel BW	1.6 MHz
4)	Antenna used	smart antenna

Ans.: System A is Bluetooth [2 marks]

System B is 3G TD-SCDMA [2 marks]

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