

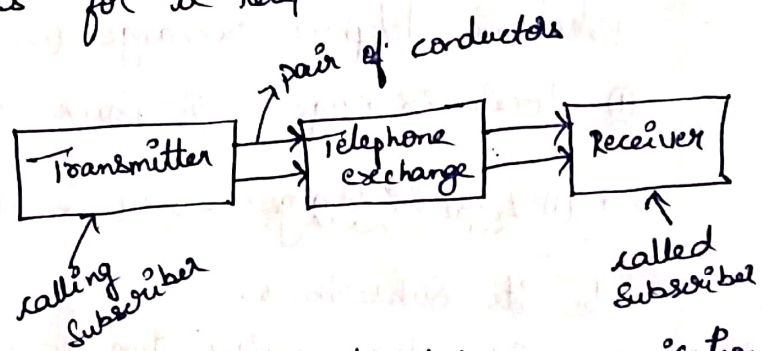
3.1) Introduction to Telephone Systems:-

→ Telephone is a system of communication in which the subscribers will be able to speak with one another. It is a two-way communication system.

→ This requires conversion of sound energy into electrical signals, transmitting them over a line, and at the receiver, the electrical signal converts into sound.

→ The basic requirements for a telephone connections are:-

- a) Transmitter
- b) Receiver
- c) Telephone exchange
- d) pair of conductors



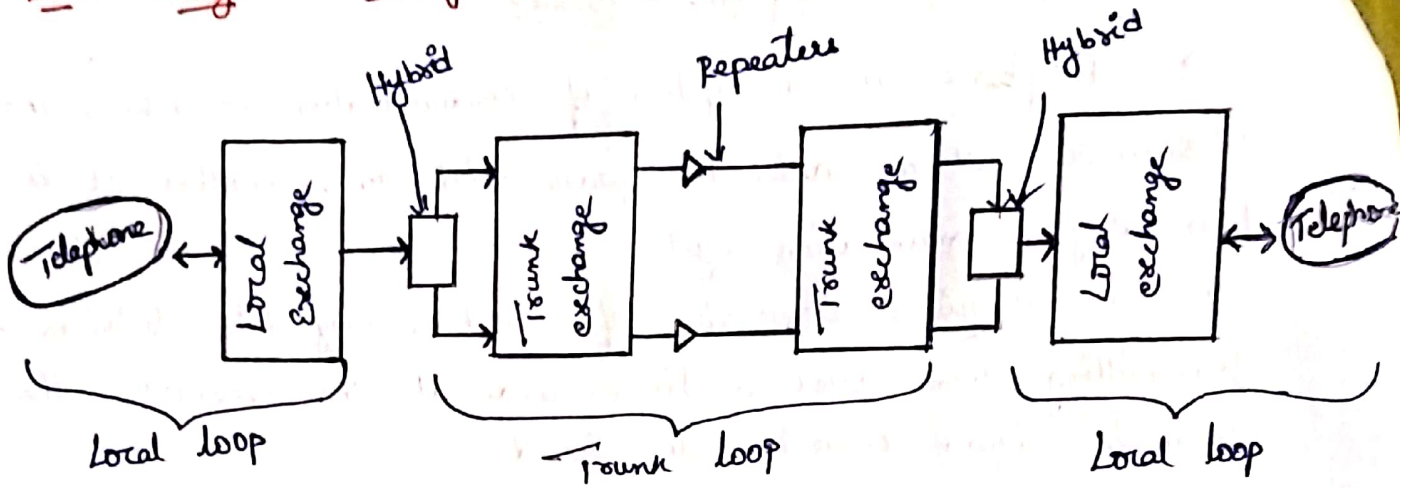
Basic requirement of Telephone communication

→ A Signalling System is also required to provide a signal from calling subscriber to exchange, and from exchange to the called subscriber.

3.2) Advantages of Electronic Telephony over Manual Telephony :-

- ① Time Saving
- ② No Need of Man power
- ③ Small in size
- ④ Noise free
- ⑤ Fast Switching
- ⑥ Highly reliable
- ⑦ High flexibility
- ⑧ Easily Manageable.

3.3) Block diagram showing hierarchy of a Telephony System :-



Electronic telephone exchange (or) Telephony system consists of

- ① Local exchange
- ② Trunk exchange
- ③ Hybrid
- ④ Repeaters

→ ① Local exchange :- It must provide two-wire connections to its subscribers.

→ It also provides two-wire to four-wire conversion for trunk routes.

→ ② Trunk exchange :-

→ Trunk is the bundles of wires (or) fibres joined as one cable.

→ Trunk Exchange is the communication channel between telephone exchanges. It involves more than one Telephone exchange.

→ Its main function is to interconnect Trunks.

③ Hybrid :- Hybrid is used for conversion of two-wire circuit to four-wire and vice-versa.

④ Repeater :- Attenuation in trunk routes is high due to length of Trunk lines. Hence Repeater amplifiers are used for amplification.

The basic requirement of Subscriber line interface with local exchange must provide BORSCHT, which stands for Battery feed, over voltage protection, Ringing, Supervision, coding, Hybrid and Test.

① Battery feed :- It must include,

- DC Voltage to the telephone
- Allowing Signalling to and from the telephone set
- Low DC resistance but high AC impedance.

② over-voltage protection :-

Over-voltage protection is necessary to safeguard the equipment against high voltage or induction from power lines.

③ Ringing :- The local exchange should produce ringing signals for the subscribers when a call is incoming.

④ Supervision :- When a subscriber lifts his handset, dials a number and when a call is in progress, these conditions are detected by the exchange. This is done by supervising the presence or absence of current in the loop.

It must detect current pulse while dialling is in progress.

⑤ coding :- Local exchange must include an encoder for encoding outgoing signals and a decoder to decode incoming signals.

Encoder and decoder circuits are combined into an integrated circuit known as coder.

⑥ Hybrid :- Hybrid is used for conversion of two-wire circuit to four-wire and vice-versa.

⑦ Test :- Testing is necessary to detect faults and provide maintenance to the local loop and switching equipment.

5.4) State the concept of in-band and out-band telephone Signalling

→ Every communication channel system transmits data and control signals.

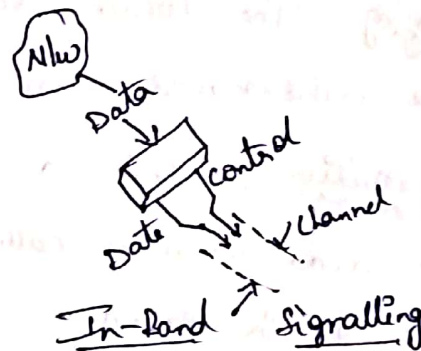
→ Data signals are used for transmission

→ control signals are used to start, stop and manage the session.

In-Band Signalling:-

In-Band Signalling uses the same channel for data and control signals i.e., for sending of voice data and control information (DTMF, busy signal, ringing signal etc) in the same voice band (300 Hz to 3.4 KHz) on the same channel.

→ When data and control signals are transmitted within the same channel or frequency, the signalling is said to be in-band.



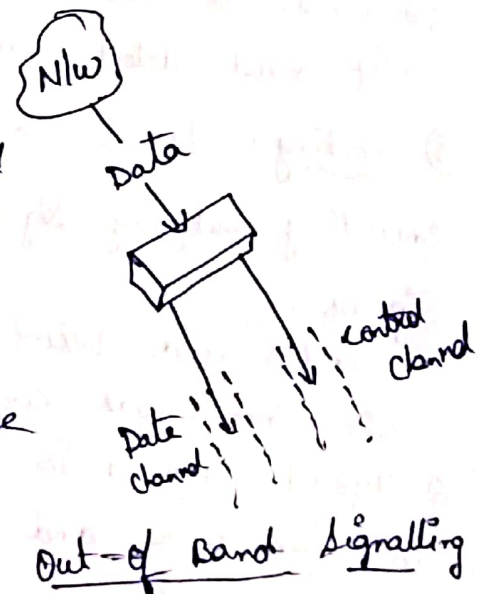
Out-of-Band Signalling

→ It uses separate channels for data and control signals.

→ It uses frequencies above voice band but below 4 KHz i.e., above 3.4 KHz & below 4 KHz.

→ Out-of-Band Signalling establishes a separate digital channel for exchange of signalling information. This channel is called as signalling link.

→ When data and control signals are transmitted in different channels, it is said to be out-of-band.



Distinguish between pulse and DTMF Dialling :-

Dialling circuits provide a way for entering the telephone number to be called.

→ There are two types of Dialling.

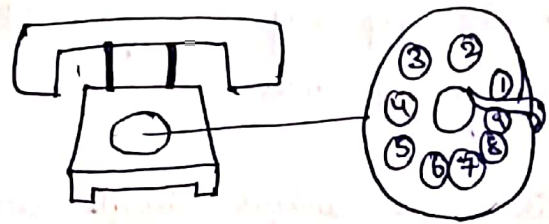
① pulse Dialling:-

→ This is old telephone rotary dial type.

→ It indicates each digit in the phone number by a series of clicks that corresponds only to that digit.

→ It takes longer time.

→ Number of interrupts are more



pulse Dialling

② Dual Tone Multi Frequency (DTMF)

→ DTMF works by assigning ^{seven} ~~eight~~ different audio frequencies to the rows and columns of keypad.

→ columns in the keypad are assigned high-frequency signals.

→ Rows in the keypad are assigned low-frequency signals.

→ When each number is pressed

on the keypad, two tones (row & column frequency tones) are produced i.e.,

Tone of each digit is the sum of column and row tones. Hence

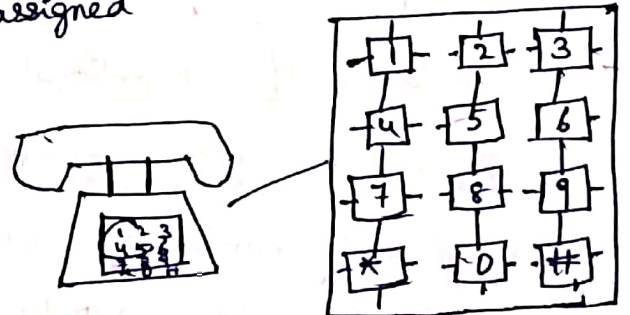
it is called as "Dual Tone multi frequency (DTMF)" Dialling.

→ Easy dialling

→ Takes less time

→ we can dial quickly without any interruption

→ DTMF has ^{now} become standard for telephone communication.



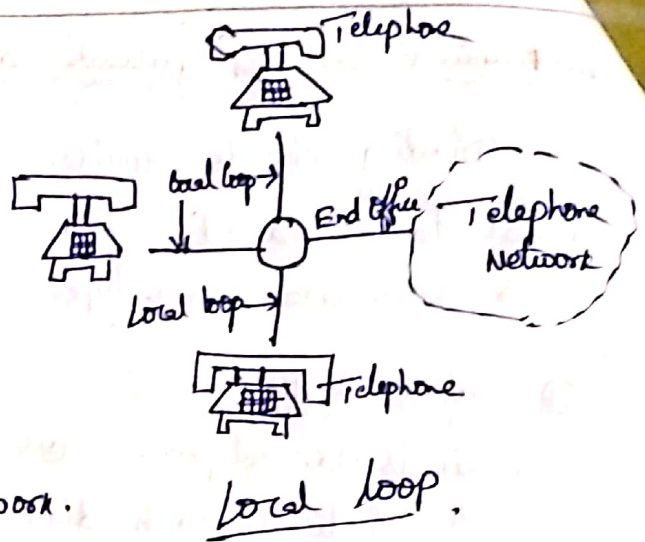
DTMF Dialling

3.6) Define Local Loop?

→ Local loop is a two-wire connection between the subscriber's house and end office of telephone company.

→ It is commonly referred to as "last mile" of the telephone network.

→ The loop may run from 1 km to as far as 10 km.



3.7) List the Various Signals present on Local loop

Local loop includes signals like:

- ① Electric power lines.
- ② cable connections used with television, internet and telephone
- ③ Satellite connections for beamed signal
- ④ optical or fiber optic services.

3.8) Limitations of Conventional Mobile phone System:-

① Limited Service capability:- → Conventional mobile phone system is designed by number of coverage geographical zones.
→ If each zone allocates a separate frequency slot for each user
→ When a user starts call in one zone must be continue the call when moving into a new zone. But the call will be dropped.

② Limited user capability:-

→ The number of active users in a particular zone is limited due to limited allocation of frequency slots.

~~→~~

③ Poor Service performance

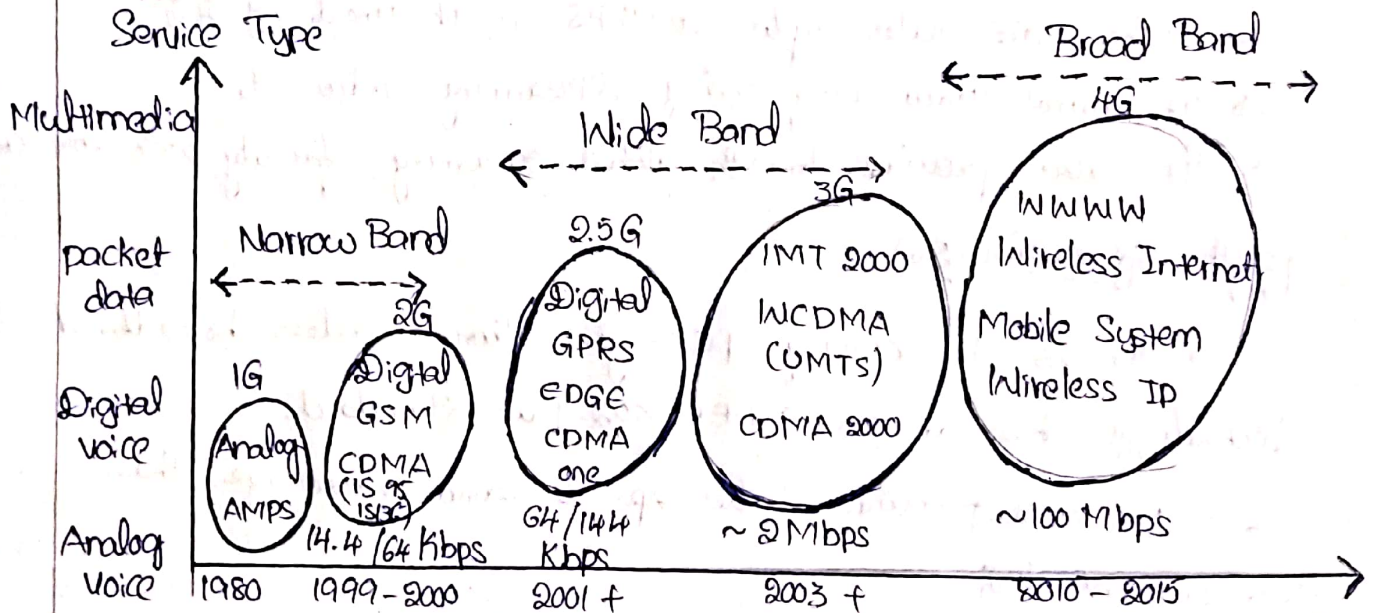
Limited number of channels are available in conventional cellular system.

④ Inefficient frequency spectrum utilization

Frequency utilization is defined as the maximum number of customers use the one channel at busy hour.

→ conventional system does not utilize spectrum efficiently
since each channel can only serve one customer at a time in a whole area.

3.9) Evolution of cellular mobile communication system



First Generation (1G):- 1G mobile phone system was introduced in 1980

→ 1G has only voice facility with Analog circuit switched technology with FDMA operating at 800-900 MHz frequency band.

Second Generation (2G):- 2G mobile phone system was introduced in 1990

→ Need for more user capacity per cell led to the development of 2G Technologies

→ 2G Technology supports data, FAX, Speech, SMP

Example - GSM

Interium Generation (2.5G):- → 2.5G is between 2G and 3G
→ 2.5G started in 1998 which supports wireless access protocol (WAP)
Example → GPRS and EDGE

Third Generation (3G) :-

→ Need for high speed internet, simultaneous voice and data led to the development of 3G cellular networks.
→ It also provides global roaming with guaranteed quality of service.

Example → IMT-2000

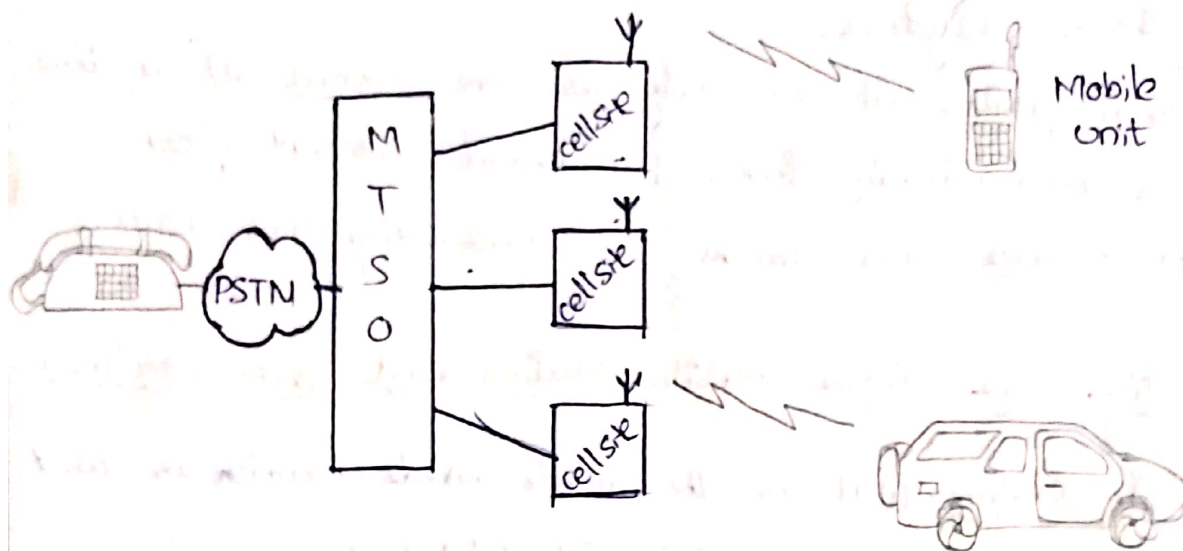
Fourth Generation (4G):-

→ The true broadband access is achieved by 4G Technology.
→ The data rates upto 20 Mbps is obtained by 4G.
→ It allows video conferencing, streaming video etc.
→ It also provides smooth global roaming facility with low cost

Fifth Generation (5G) :-

→ It is the coming fifth-generation wireless broadband technology based on IEEE 802.11 ac Standard.
→ 5G will provide better speeds and coverage than the current 4G.
→ 5G operates with a 5GHz signal

Block diagram of a Basic Cellular System :-



A Basic cellular system consists of three units i.e., Mobile unit, a cell site (or) Base Station, Mobile Telephone Switching office.

① Mobile unit :- A mobile unit is a subscriber or user equipment which contains a control unit, a transceiver and an antenna system with duplexer to communicate with base station antenna.

② Cell site (or) Base Station :-

- It acts as an interface between mobile unit and MTSO
- It is a fixed station in a mobile radio system used for radio communication with mobile station.
- It consists of control unit, radio channels, Transceiver with an antenna mounted on a tower.

③ Mobile Telephone Switching office (MTSO) :-

- MTSO is the central coordinating element for all cell sites.
- It contains cellular processor and cellular switch.
- cellular switch is used to switch the calls to connect mobile subscribers to another mobile subscribers & to nationwide ^{telephone} network (PSTN).

connections:

- The radio and high speed data links connect the the three subsystems.
- Each mobile unit can only use one channel at a time for its communication link. But channel is not fixed.
- MTSO uses Voice Trunks for transmitting voice calls.

3.11)

Define the Terms Mobile Station and Base Station:

Mobile Station: ① It is the mobile handset which is used by the user to communicate with other user.
② It consists of control unit, Transceiver, duplexer and, an Antenna.

Base Station (or) Cell Site:

① It is a fixed station in a cellular wireless network, used for communicating with mobile stations.

② It consists of radio channels, Transceiver with an antenna mounted on a Tower.

③ Base Stations are also linked to a power source for transmission of radio signals for communication.

→ A Mobile Station (MS) communicates to a fixed Base Station (BS) which in-turn communicates to the desired user at the other end.

State the functions of Mobile Switching Center (MSC).

- Mobile Switching Center (MSC) is the centerpiece of a network Switching Subsystem (NSS).
- MSC is associated with communication switching functions such as call set-up, release and routing.
- It also performs other duties including routing SMS messages, conference calls, fax and service billing as well as interfacing with other networks such as PSTN (Public Switched Telephone Network).
- The different components interconnected with MSC are:
 - ① Mobile unit
 - ② Base Station Subsystem (BSS)
 - ③ Network Switching Subsystem (NSS)

① Mobile Station:- The Mobile Station consists of mobile handset with battery and Subscriber Identity Module (SIM).

→ It is also a Subsystem but considered to be part of the BSS.

② Base Station Subsystem (BSS):-

→ It is sometimes called as radio system because it provides and manages radio-frequency transmission paths between MS & MSC.

→ It consists of 2 main parts. They are:

① Base Transceiver Station (BTS)

② Base Station Controller (BSC).

→ BTS:- It consists of antennas that transmit and receive to directly communicate with mobiles. BTS's are connected to BSC.

→ BSC:- It has multiple BTS. It manages channel allocation and handoff of calls from one BTS to another BTS.

→ BSC's are connected to MSC.
→ It provides path from MS to MSC.

③ Network Switching Subsystem (NSS)

It provides main control and interfacing for whole mobile network.

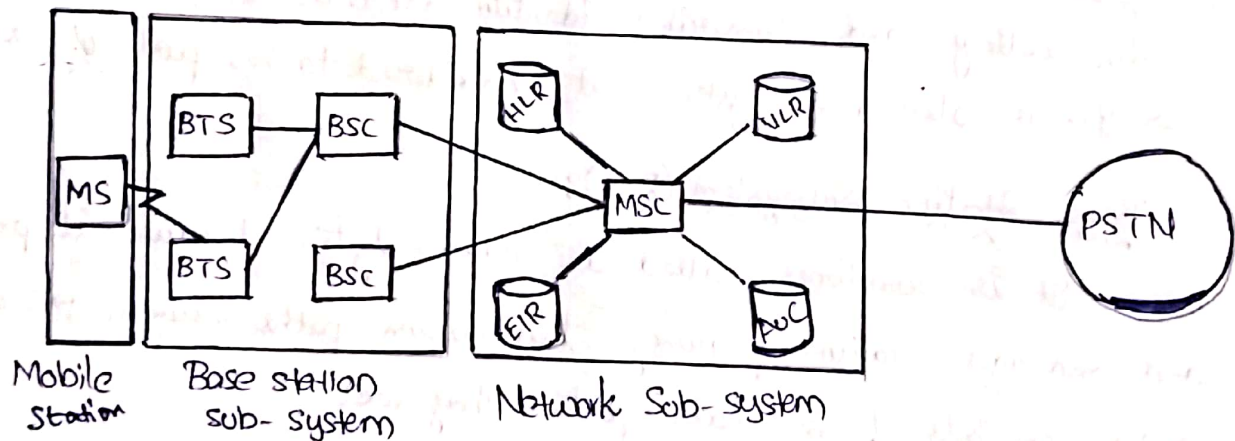
It allows MSC's to communicate with other telephone networks such as PSTN & ISDN.

→ NSS consists of MSC, HLR, VLR, AUC and EIR.

- ① Mobile Switching Centre: - ① It is the heart of entire network connecting the fixed line networks (ISDN, PSTN etc) to the mobiles.
- ② It manages all call-related functions and billing information.

② Home Location Register (HLR): ① All the Subscriber data is stored in HLR.

- ② It has a permanent database of all the registered Subscriber.
- ③ It contains your ID proof, caller tune etc.



③ Visitor Location Register

① It has a temporary database which contains exact location of all the subscribers currently present in service area of MSC.

② If you are moving from one state to another state, then your entry is marked in VLR.

④ AUC (Authentication centre) :-

- ① It is used to Authenticate the mobile subscriber who is connected to the Network.
- ② Authentication is a process to verify the subscriber SIM
- ③ Secret data and Verification algorithms are stored in AUC

⑤ EIR (Equipment identity register) :-

- ① All the subscriber's mobile handset data is stored in EIR
- ② Each mobile equipment has a International mobile equipment identity (IMEI).
- ③ This IMEI is installed in the equipment and is checked by the network during registration.

PSTN (Public Switched telephone network) :-

It is a fixed line network to the mobiles.

Eg 1- Fixed Telephone (Landline).

3.13) Forward and Reverse channels in mobile communication :-

cellular channels are the sets of frequency bands assigned for each base station in order to communicate with the mobile stations.

Forward channel :- A forward channel refers to the frequencies used by Base Station (BS) to communicate with Mobile Station (MS)

Reverse channel :- A reverse channel refers to the frequencies used by Mobile Station (MS) to communicate with Base Station (BS).

3.14) Cellular channels (voice and control channels in mobile communication).

- cellular channels are the set of frequency bands assigned for each base station in order to communicate with mobile stations.
- whenever a mobile handset is activated in a particular base station site, it scans the available channels and selects the strongest channel and gets locked to it.
- further communication of MS with BS is done via locked channel.

In each cell, there are two types of channels that take active part during a mobile call. They are

- ① Control channel
- ② Voice channel.

1) Control channel: control channels are used for controlling the activity of the call i.e., for setting up calls & to divert the call. Hence these are called set-up channels.

→ Forward control channel: This is used for control signalling from BS to MS.

→ Reverse control channel: This is used for call control purpose from MS to BS.

2) Voice channel: 0.95% of total channels are used as voice channels, remaining 5% used as control channels. After a call is established, control channel becomes free and communication takes place on voice channel.

③ Voice channel is defined as the channels which carry actual data or voice.

④ They are also called as Traffic channels.

→ Forward voice channel: This is used for voice transmission from BS to MS.

→ Reverse voice channel: This is used for voice transmission from MS to BS.

