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1. (a) What are the major systems that a telecommunication network consists of?
(b) Explain Public Switched Telephone Network.
(c) What methods are used while routing on a particular connection?
(d) Categorize long distance transmission system and radio transmission system.
(e) Explain numbering plans.
2. (a) Explain network topologies.
(b) Draw and explain signalling technique classification.
(c) Write down the advantages of In-band signalling.
(d) Explain Private Branch Exchange (PBX) and write down its parts in PBX machine.

3. (a) What parts are in a national number?
- (b) Explain the parts in a national number.
- (c) Describe the changing plan.
- (d) Define common channel signaling. Explain its two modes.
4. (a) Define signaling techniques.
- (b) Which forms of signaling techniques are involved in telecommunication network?
- (c) Explain different forms of signaling technique.
- (d) What are in-band signaling? Write down its advantages.

5. (a) What is telecommunication.
- (b) What are the basic concepts of telecommunication engineering?
- (c) Write down the features of FM consumer mobile phone system.
- (d) Explain the cellular telephony.

6. (a) When was wireless transmission started?
- (b) Write down the frequency reuse patterns.
- (c) Explain the fading in the transmission.
- (d) Explain small scale fading.
- (e) What is roaming?
7. (a) What is C/I ratio?
- (b) Explain flat fading in transmission.
- (c) What is registration? Classify registration.
- (d) Explain multi-path fading with example.

8. (a) What is PSTN stands for. Explain call initiated from PSTN.
- (b) Explain call initiation from mobile.
- (c) What are duplexing methods. Explain frequency equalization.
- (d) What is sectorization? Write down the features of advanced mobile phone system.

Question:

- a) What are the major systems that a telecommunication network consists of?
- b) Explain public switched telephone network (PSTN).
- c) What methods are used while routing on a particular connection?
- d) Categorize long distance transmission system and radio transmission system.
- e) Explain numbering plans.

Answer to the question no. 1 (a)

Any telecommunication network may be viewed as consisting of the following major systems:-

1. Subscriber end instruments or equipments
2. Subscriber loop systems
3. Switching systems
4. Transmission systems and
5. Signalling systems.

Answer to the question no. 1(b).

The public switched telephone network is understood as an aggregate of world's circuit switched telephone networks, used for providing public telecommunication. The PSTN networks are called POTS (Plain Old Telephone Systems). These networks are operated regionally, locally, nationally and internationally using telephone lines, fiber optic cables, microwave transmission links or cellular communications.

PSTN consists of switches at centralized points on the networks, which act as nodes for communication between any point and any other point on the network.

Answers to the question no. 1(c)

To decide the routing on a particular connection, the following three methods are used :-

- 1] Right through routing
- 2] Own-exchange routing
- 3] Computer controlled routing

Answers to the question no. 1(d)

Modern long distance transmission systems can be placed under three broad categories :-

- 1] Radio systems
- 2] Coaxial cable systems
- 3] Optical fibre systems

Depending on the mechanism of propagation, long distance radio communication can be placed under four

categories :-

- 1] Sky wave or Ionosphere communication
- 2] Line of sight (LOS) microwave communication

limited by horizon

- 3] Tropospheric scatter communication
- 4] Satellite communication

Answer to the question no. 1(e)

The different types of numbering plans are given below:-

1. Open numbering plan: This is also called the Non-Uniform numbering plan and it permits wide variation in the number of digits to be used to identify a subscriber within a multi-exchange area or within a country.

2. Semi - Open Numbering plan: This plan permits number lengths to differ by almost one

are two digits. The semi open numbering plan is commonly used in countries such as India, Sweden, Switzerland and UK.

3. Closed Numbering plan This is also called the Uniform numbering plan where the number of digits in a subscriber number are fixed.

Answer to the question no. 2(a)

In the process of interconnecting exchanges, there are three basic topologies, such as —

1) Mesh Topology It is a fully connected network. The number of trunk groups in a mesh network is proportional to the square of the exchanges being interconnected. They are widely used in metropolitan areas where there is heavy traffic.

2) Star Topology Star topology is connected in the shape of a star, which utilizes an intermediate exchange called a tandem exchange through which all other

exchanges communicate. The star network is used when traffic levels are comparatively low.

3) Hierarchical: It is used to handle heavy traffic with minimal number of trunk groups. The traffic flows through the final route which is the highest level of hierarchy.

④ Answer to the question no. 2 (b).

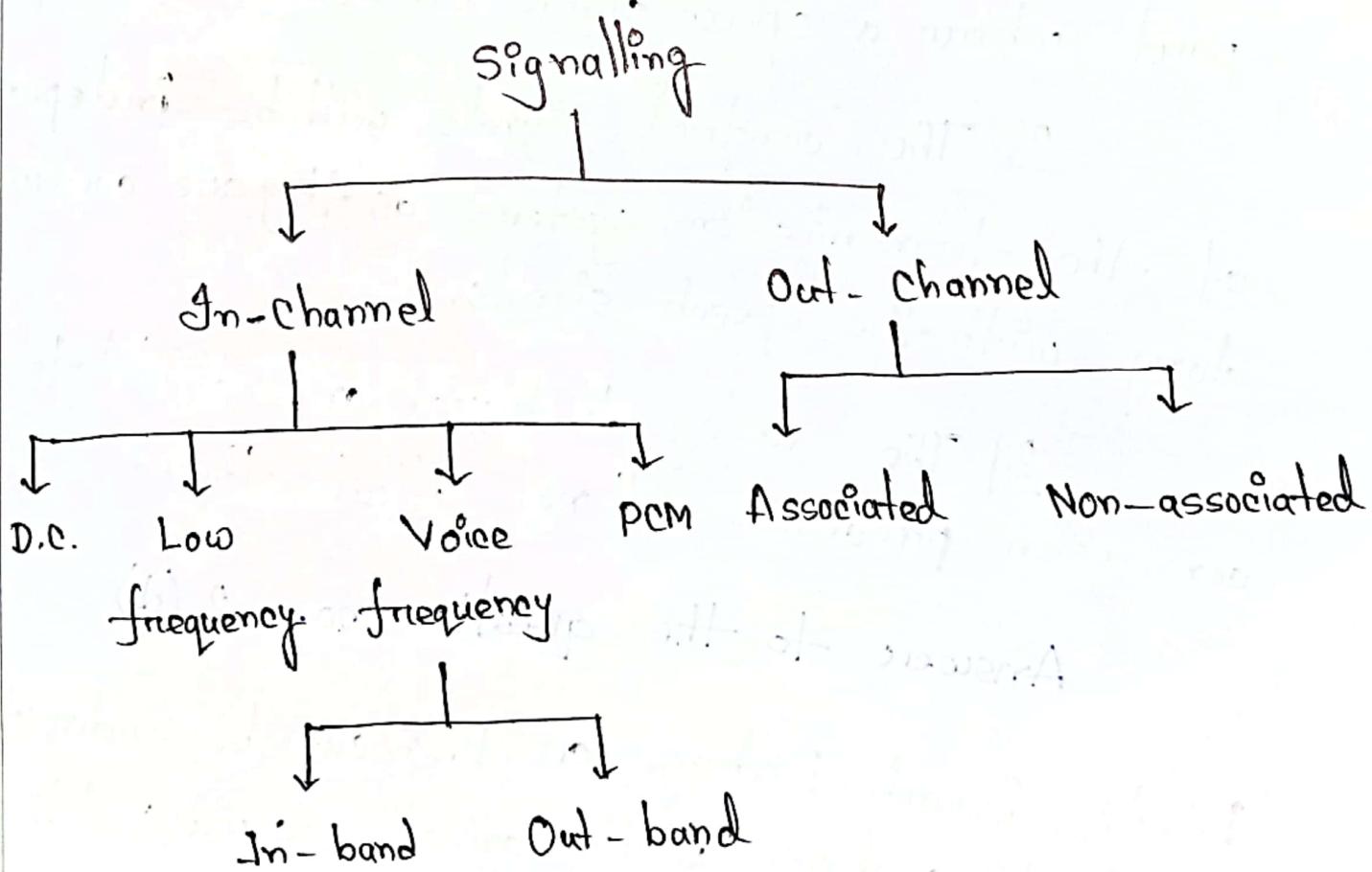
Signalling techniques enable the circuit to function as a whole by inter connecting all varieties of switching systems. There are two main types of signalling techniques are:-

1. In-channel Signalling: In - channel signaling is also known as Per Trunk Signaling. This uses the same channel, which carries user voice or data to pass control signals related to that

call or connection. No additional transmission facilities are needed.

2. Common channel signalling: Common channel

signalling uses a common channel for passing control signals for a group of trunks or information paths. This signalling does not use the speech on the data path for signalling.



Answer to the question no. 2(c)

In band-signalling voice frequency uses the same frequency band as the voice, which is 300 - 3400 Hz, which has to be protected against false operation by speech. The advantages of In-band signaling are:-

- 1) The control signals can be sent to every part where a speech signal can reach.
- 2) The control signals will be independent of the transmission systems as they are carried along with the speech signals.
- 3) The analog to digital and digital to analog conversion processes will not affect them.

Answer to the question no. 2(d)

Private Branch Exchange or PBX can be understood as a local exchange within an office or a building.

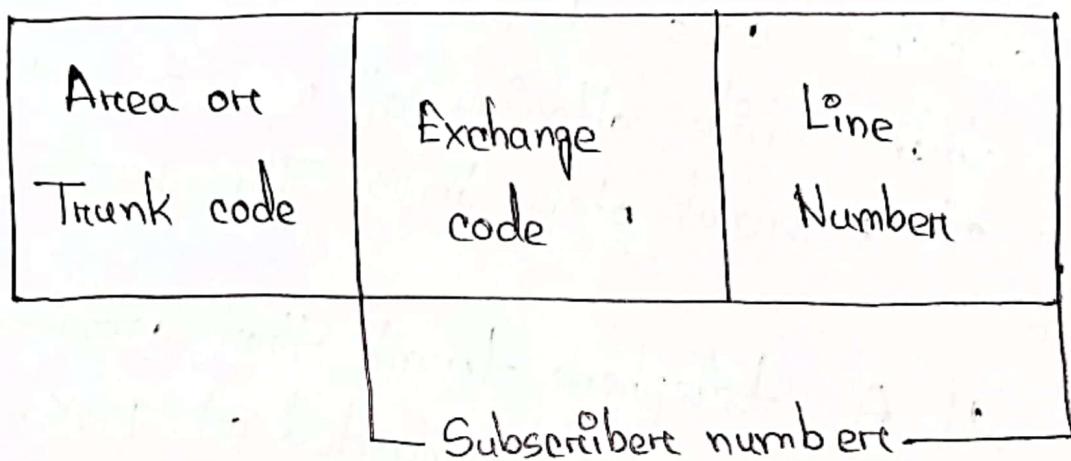
in order to communicate within themselves. As the theme implies, it's a private exchange, which is a branch to the main exchange similar to a local loop connected to the main loop as a branch.

PBX is a telephone system within a local area that switches calls between those users on local lines while allowing all users to share a certain number of external phone lines. The parts of a PBX include:-

- 1) A telephone trunk that contains many phone lines, which are terminated at PBX.
- 2) A computer that handles the incoming and outgoing calls of PBX along with switching between different calls within the local loop.
- 3) The network of lines within the PBX.
- 4) A human operator console, which is optional.

Answer to the question no. 3(a)

There are three parts in a national number.
They are given below:-



Answer to the question no. 3.(b)

A national number consists of three parts. These parts are described below:-

1. The area code or trunk code: This code identifies a particular numbering area or the multi-exchange area of the called subscriber. It is with

this code, the routing for a trunk call is determined and charged for it.

2. Exchange code: This code identifies a particular exchange within a numbering area. It determines the routing for incoming trunk call from another numbering area or for a call originating from one exchange and destined to another in the same numbering area.

3. Subscriber line number: It is used to select the called subscriber line at the terminating exchange. The combination of the exchange code and the subscriber line number is called the subscriber line number in CCITT terminology.

Answer to the question no. 3.(c)

Charging Plan: The calls are charged as accounted by the metering instrument connected to each subscriber line or are per a metering register that is assigned

to each subscriber in case of electronic exchanges. A meter counts the number of charging units and that count is incremented by sending a pulse to the meter. For the number of units, the meter reads, a bill is raised by assigning a rate to the charging unit.

The individual calls can be charged based on the following categories:-

- ↳ Duration independent charging
- ↳ Duration dependent charging

Local calls within a numbering area are usually charged on a duration independent basis. For duration dependent charging, the meter starts incrementing, once the called subscriber answers the call.

Answers to the question no. 3.(d)

Common channel Signalling: It uses a separate common channel for passing control signals for a group of trunks or information paths as it does not use the speech or the data path for signalling. This common channel signalling is implemented in two modes:

1. channel associated mode: In this mode, the channel closely tracks the trunk groups along the entire length of the connection. Here, the signalling is done on a separate channel; the signalling path passes through the same set of switches, as does the speech path.

2. channel non-associated mode: In this mode, there is no close or simple assignment of the control channels to trunk groups. It follows a different path from that of the speech signal, as

6. Answer to the question no. 4 (a)

Signaling Techniques:

Signaling techniques enable the circuit to function as a whole by interconnecting all varieties of switching systems.

Answer to the question no. 4. (b)

There are three types of signalling involved in a telecommunication network :-

1. Subscriber loop signaling
2. Intraexchange or register signaling
3. Interexchange or inter-register signaling

④ Answer to the question no.: 4.(c)

Different types of signaling are explaining below:-

The subscriber loop signaling depends on the type of telephone instrument used. The intra exchange signaling refers to the internal portion of a switching system that is heavily dependent upon the type and design of a switching system, which varies depending upon the model. The inter exchange signaling takes place between exchanges. This helps in the exchange of address digits, which pass from exchange to exchange on a link-by-link basis. The network wide signaling that involves end-to-end signaling between the originating exchange and the terminating exchange is called the line signaling.

⑥ Answe~~r~~ to the question no. 4 (d)

In-band voice frequency uses the same frequency band as the voice, which is 300-3400 Hz, which has to be protected against false operation by speech. One such instant took place when a lady's voice which has generated a tone at around 2600 Hz lasting for a duration of 100 ms was detected as the line disconnect signal due to which here calls were frequently being disconnected in the middle of her conversation. Such problems precluded the in-band signaling during such speech phase.

The advantages of in-band signaling is given below:-

1. The control signals can be sent to every

part where a speech signal can reach.

2. The control signals will be independent of the transmission systems as they are carried along with the speech signals.
3. The analog to digital and analog to digital conversion processes will not affect them.

Answer to the question no. 5(a)

Telecommunication can be defined as distant connection or transfer of meaningful information from one location to another.

It came from the Greek word "tele" that means distant and Italian word "communicatio" which means connection. Today telecommunication means the transfer of information such as voice, video, data etc.

Answer to the question no. 5. (b)

The basic concepts of telecommunication engineering are—

1. Traffic engineering
2. Telephony principles, digital coding of speech.
3. Wireless
4. Cellular
5. Transmission system design, fibre optics.
6. Switching systems
7. Internet
8. Optical networking.

Answer to the question no. 5(c)

The features of FM consumer mobile phone system is given below—

1. A group of frequencies allocated to a large geographic zone.
2. When moving to a new zone, calls had to be reinitiated.
3. 120 kHz per channel due to poor technology
4. Half duplex system
5. Most users not connected to PSTN
6. Later progressed to GMSK.

Answer to the question no. 5.(d)

A geographic area can be divided into several hexagonal areas, or cells, with an transmitter located in the centre of each cell.

1. Allows for frequency reuse as two cells in the same geographic area can use the same frequency.
2. Increases the spectral efficiency of the system, but increases infrastructure expense
3. Technology to implement cellular telephony was available only in the late 1970's
4. Base station provides access between mobile users and the mobile switching centre

Answer to the question no. 6(a)

Wireless transmission was originally shown as a method to remain in continuous contact with ships (Marconi in 1897).

Answer to the question no. 6(b)

frequency reuse patterns :-

1. Reuse allows a small set of frequencies, K to service a large area (numbers of transmitters with same frequencies)
2. Reuse patterns are designed to minimize co-channel interference (interference from other base stations using the same frequency)
3. A larger reuse pattern results in a larger distance between base stations that use the same frequency.

Answer to the question no. 6(c)

During transmission from base station to the mobile, the received power fluctuates. We can generalize the factors that affect the received power level into 3 main groups.

1. Path Loss (does not change in time)

- changes only with distance from transmitter
- there are also losses associated with the frequency of transmission size/height of transmit/receive antenna etc.

2. Long term fading or shadowing

- caused by buildings or tunnels shadowing transmission from BS
- changes with mobile position.

3. Short term fading (or small scale fading)

- due to multiple paths of transmission arriving at the mobile at the same time
 - If there are other paths that arrive with some delay, it is called multi path fading

Answer to the question no. 6(d)

Small scale fading -

1. The signal may take different 'paths' to the mobile customer.
2. Reflections off moving objects, cause a shift in frequency in the signal. Each path also arrives at a various angles and phases.
3. Some paths arrive at the mobile at the same time. Other paths arrive much later due to a longer distance traveled.

Answer to the question no. 6(e)

Roaming is when a phone is outside its home area or local region.

- If the phone registers outside its home area, the MSC contacts the phone's home area and

confirms that the phone is OK.

- MSC then notifies home area of the phone's current location and provides instructions for routing incoming calls to the phone.

Answer to the question no. 7(a)

C/I ratio: The carrier-to-interference ratio, C/I, of the signal at the mobile from the transmitter in a given cell, can be found in an approximate manner by summation of interference from all base stations using the same frequency. Usually expressed in dB.

$$\frac{C}{J} = \frac{R^{-n}}{\sum_{i=1}^M D_i^{-n}}$$

If we assume all base stations are identically spaced, and are at the centres of their cells, we have the C/J approximation of :

$$\frac{C}{J} = \frac{(\sqrt{3k})^n}{M}$$

where, M = number of base stations in the first tier

Answer to the question no. 7(b)

flat fading -

1. Derivation of fading based on electromagnetic fields.
2. Several paths arrive at the receiver at nearly at same instant.
3. Each path has been shifted in frequency due to the relative motion of mobile.

4. The maximum Doppler shift is given by $f_m = v/\lambda$, where v = mobile velocity, λ = carrier wavelength.
5. The paths interfere constructively and destructively causing the received power at the mobile to vary with time.

6. The coherence time is the time over which the received power does not change significantly.

$$T_c \approx \frac{9}{16\pi f_m} \approx \frac{9c}{16\pi v f_c}$$

7. The received envelope fluctuates due to interfering waves.

8. 'Flat' fading is called so because the gain across the signal bandwidth is ~constant or flat.

Answer to the question no. 7(c)

Registration is the process of notifying the network that a phone is active on the system.

- When a phone is switched on, it registers by signaling to the MSC via the base station on a setup or control channel.

1. Periodic registration is when the phone

announces itself on a regular basis.

2. Forced registration is when the phone

monitors a control channel which provides information including the cell identification.

Answer to the question no. 7(d)

Multi-path fading -

1. If one or more paths arrives somewhat later than the first group of paths, the gain over

the transmission bandwidth will not be constant.

2. The coherence bandwidth is the bandwidth over which the channel response is somewhat flat. This is approximately:

$$B_c \approx \frac{1}{5\sigma_t}$$

Example: Consider 2 cosine waves, one arriving 1 μs later than the other at the same amplitude. At the instant $t = 0$:

→ at 800 MHz

$$\cos(2\pi 800t) + \cos(2\pi 800(t+1)) = 2 \text{ volts}$$

(b) If we tune off at 800.4 MHz:

$$\cos(2\pi 800.4t) + \cos(2\pi 800.4(t+1)) = 0.191 \text{ volts}$$

(a) Answer to the question no. A 8(a)

PSTN stands for Public Switched Telephone Network.

Call initiation from PSTN :-

1. MSC receives call from PSTN, sends requested MIN to all base stations (BS)
2. Base stations transmits page for user.
3. Mobile receives, and confirms MIN match with electronic serial number (ESN).
4. BS relays info to MSC
5. MSC verifies ESN/MIN pair
6. MSC tell BS to select used voice channel pair and informs mobile to move to those channels.
7. MSC connect BS with PSTN to begin call.

(b) 2 Answer to the question no. A 8(b)

Call initiation from mobile :-

1. Mobile sends MIN and ESN
2. BS passes to MSC; MSC verifies ESN and MIN pair
3. MSC tells BS to select used voice channel pair
4. BS selects voice channel pair
5. Mobile receives page, verifies MIN and moves to specified channels.
6. MSC connects PSTN with mobile through BS.

(b)2 . Answer to the question no. 8(c)

Duplexing methods—

→ Frequency division duplex:- voice channels for the downlink and uplink are separate in frequency.

→ Time division duplex:- The downlink and uplink transmission alternate in time over the same channel.

Frequency equalization- If the transmission bandwidth of the channel is much greater than the approximate coherence bandwidth of the channel, frequency equalization may be required at the receiver.

(d) Answer to the question no. 8(d)

Sectorization

1. Dividing the cell into 3 or more radial sections
2. In case of 3 sectors per cell, three 120° antennas are used at the base station to service the cell.
3. As the antennas are directional the interference from other cells is dramatically reduced at the expense of increased antennas per cell.
4. Common for CDMA systems.

The features of advanced mobile phone

system is given below -

- Since 1986, bandwidth increased from 666 to 832 channels.
- 30 kHz channels.
- Channel 1: downlink = 870.03 MHz,
uplink = 825.03 MHz
- 416 channels / systems per block
- 21 control channels / 395 voice channels per system.