Cellular Mobile Communication :-

1) Principle of Cellular Mobile System :-

→ Most Common Example is Mobile phone n/w (Cell phone)
→ Mobile Phone is Portable used to receive / make Calls through a Cell sites (Base station) / transmitting Power.
→ Electromagnetic waves are used to transfer signal to and from the Cell Phones.
→ Radio frequencies are limited so modern mobile phones n/w use Cells.
→ A Cellular n/w is used by mobile phone operator to achieve both Coverage and Capacity for their subscriber where large geographical areas split in to smaller cell to avoid line of sight (LOS).
→ All Cell sites are Connected to telephone Exchanges (or) switches which in turn Connect to public telephone n/w (PSTN).
→ Coverage area of Cells :-
*) In cities ; Each cell site Each cell site may have a range up to ½ mile,
*) In rural areas the range Could be much as 5-miles
*) In clear open area user may receive signals from 25-miles away.

2) Components of Cellular Mobile network :-

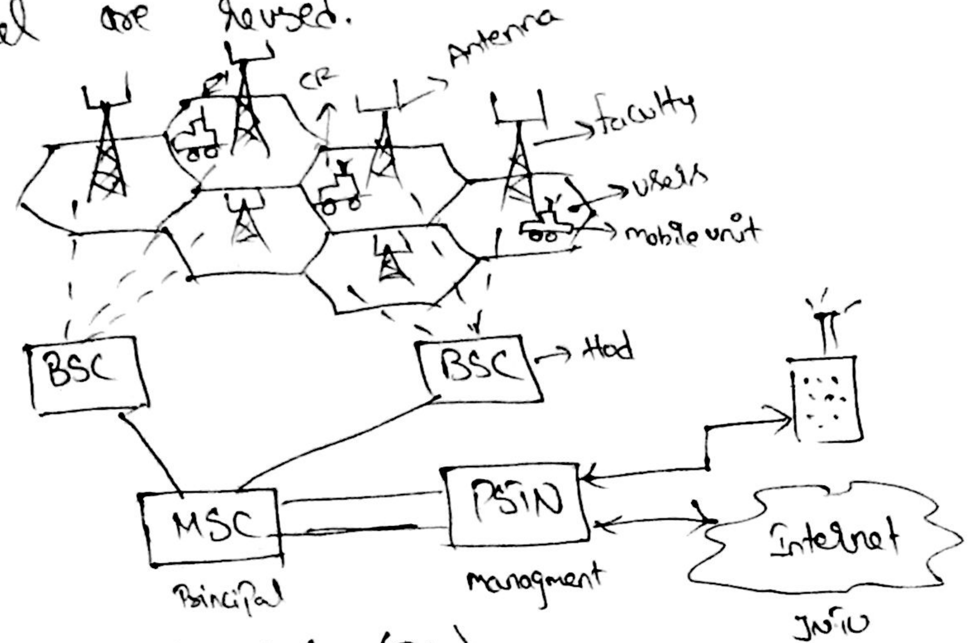
(a) Mobile station (MS)
(b) Base station (BS)
(c) Mobile switching Centre (MSC)
(d) Base station Controller (BSC)
(e) Public switched telephone (PSTN).

(a) Mobile Station:-

Mobile Phone consists a transreceiver (transmitter & receiver) an Antenna and Control circuitry antenna converts tx Rf signal in to Em waves and Recived Em waves in to Rf signal.

(b) Base station:-

Provides direct Communication with mobile phone and it defines the cell are grouped together a cluster is formed. within a cluster no channel are reused.



(c) Base station Controller:- (BSC):-

Introduction to Cellular Mobile Systems:-

1.1 Why Cellular Mobile Telephone Systems:-

① Limitations of Conventional mobile telephone system:-

One of many reasons for developing a cellular mobile - telephone system and deploying in many cities in operational limitations.

(a) Limited service capability
(b) Poor service capability
(c) Insufficient frequency spectrum utilization.

(a) Limited service capability:-

Designed for selecting one (or) more channels from a specific frequency allocation for use in autonomous geographic zones.

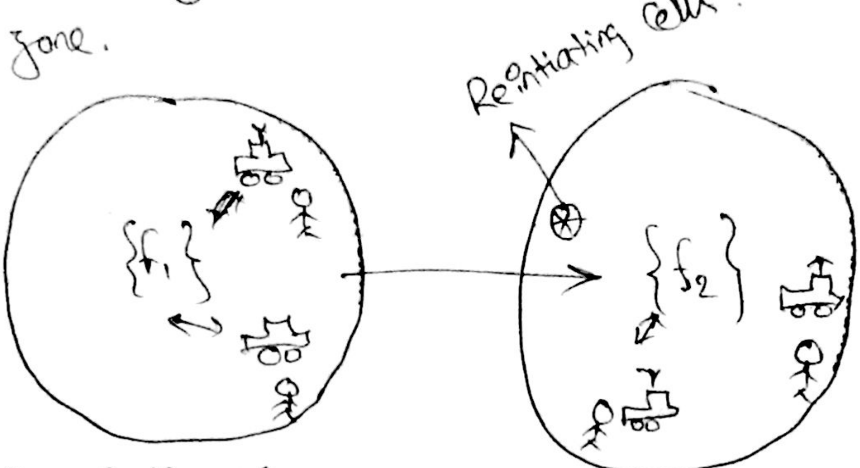
The communication coverage area of each zone is normally planned to be as large as possible which means that the transmitted power should be as high as federal specifications allows.

"The user who starts a call in one zone has to reinitiate the call when moving in to a new zone because the call be dropped. This is an undesirable radio telephone system since there is no guarantee that a call can be completed without a hand off capability.

The handoff is a process of automatically changing frequencies as the mobile unit moves in to different frequency zone so that conversation can be continued in a new frequency zone without ~~radiating~~ redialing.

Disadvantage:-

Conventional system is that the no:- of active user is limited to no:- of system channel assigned to a particular frequency zone.



(b) Poor service Performance:-

In past a total 33 channels are allocated to 3-mobile telephone systems.

(i) mobile Telephone services (MTS)
(ii) Improved MTS (IMTS) (MJ systems)
(iii) " " (IMTS) (MK ")

* MTS operates at 40 MHz
* MJ system operates at 150 MHz
* MK " " " 450 MHz

→ 11 channels

→ Provides → 12 channels

these 33-channel Covers an area 50 miles in diameter.

(c) Inefficient frequency spectrum utilization:-

In Conventional mobile telephone system frequency utilization measurement 'M_0' is defined as Maximum no:- of Customers that Could be served by one channel at busy hours.

$$M_0 = \frac{\text{no:- of Customers}}{\text{Channel}}$$ (Conventional systems).

(ω)

$M_0 = \begin{cases} 53 \text{ Customers/channel (MJ systems)} \\ 37 \text{ Customers/channel (MK systems)} \end{cases}$

② → Spectrum Efficiency Considerations:- for Conventional System:-

A Major Problem facing the radio Communication industry is limitation of available radio frequency spectrum.

in setting allocation policy system which need minimal bandwidth but provide high usage and consumer satisfaction.

The ideal mobile telephone system would operate within a limited assigned frequency band and would serve an almost unlimited no:- of users in unlimited areas.

(i) single side band (SSB):- which divides the allocated frequency band into max no:- of channels.

(ii) Cellular:- which reuse the allocated frequency band in different geographic locations.

(iii) spread spectrum (or) frequency-hopped:- Which generates many Codes over a wide frequency band.

③ → Technology, feasibility, & service affordability:-

Mp's & Mc's are now used for controlling many Complicated features and functions with less power and size than was previously possible.

Large-scale integrated (LSI) circuit technology reduced the size of mobile transceiver so that they easily fit in to standard automobile.

(4) → Why 800 MHz ?

Federal Communication Commission (FCC) decission to choose 800 MHz was made because of server spectrum utilization at lower frequency bands:

(a) FM → broad casting operates at (100 MHz)

(b) TV → " " services starts (41 MHz to 960 MHz)

(c) Air to ground system → uses (118 – 136 MHz)

(d) Military aircraft use → (225 – 400 MHz)

(e) Maritime ~~aircraft use~~ → mobile services allocated at (160 MHz)

(f) fixed station services is allocated portions of (30 –100) MHz.

∴ it was hard for FCC to allocate a spectrum in lower portions (30 – 400 MHz) band since the services of this band had becomes so crowded.

→ where 800 MHz originally assigned to educational TV channels.

Cable TV service shared load of providing TV channels.

This allocation opened up the 800 MHz band to some extent.

∴ FCC allocated 40 MHz system at 800 MHz for mobile radio cellular system.

(7)

2) History of 800 MHz Spectrum allocation:-

→ In 1958 the Bell system proposed a 75 MHz system at 800 MHz quite broadband proposal.

→ In 1970 the FCC decided to allocate 75 MHz for wire line Common Carrier

→ In 1974 the FCC allocated 40 MHz of spectrum which one cellular system to be licensed per market.

→ In 1980, the FCC reconsidered its one system - per - market strategy and studied possibility of introducing competition into previous one-carrier markets.

→ The frequencies will be assigned in 20 MHz groups identified as block 'A' and block 'B' (or) called 'A' Band and Band B'

2-bands serve to 2-different group in standard situations.

1 - for wire line Companies and other for non - wire line.

Band	Mobile	Base	Two systems/market
A	824 - 835 ; 845 - 846.5	869 - 880 ; 890 - 891.5	non - wire line
B	835 - 845 ; 846.5 - 849	880 - 890 ; 891.5 - 894	wire line.

Each company designs its own system and divides the area in to geographic area (or) cells. Each cell operates within its own bands.

∴ 30 kHz is specified BW, Each band operates nowdays consists 333 channels.

3) Trunking Efficiency :-

(*) In tele-Comm, trunking is a method for a system to provide n/w access to many clients by sharing a set of lines (or) frequencies instead of providing individually.

This is analogous to the structure of tree with one trunk and many branches.

Eg:- Port trunking has been applied in Computer networking.

(*) As trunk is a single transmission channel b/w two points, each point being either the switching center (or) node.

*) The trunking efficiency degradation inherent in licensing two (or) more carriers rather than one.

Compare the trunking efficiency b/w one cellular system per market operating 666 channels and two cellular system per market operating 333 channels.

→ Assume that all frequency channels are evenly divided into seven subareas called cells.

In each all blocking probability of 0.02 is considered also avg calling time is allowed to 1.76 min.

with $N_1 = \frac{666}{7} = 95$ & $B = 0.02$ to obtain offered load $A_1 = 83.1$

with $N_2 = \frac{333}{7} = 47.5$ & $B = 0.02$ to obtain $A_2 = 38$.

∴ two carriers each operating 333 channels are considered

∴ Total offered load $2A_2$ is then realized as

$A_1 > 2A_2$ → (a)

Converting Eq (a) to no. of user who can be served in busy hour with average calling time of 1.76 min introduced

The no. of call per hour served in cell is

$$Q_1 = \frac{A \times 60}{1.76} \text{ call/hr} \rightarrow (b)$$

where

$$Q_1 = \frac{A_1 \times 60}{1.76} = \frac{83.1 \times 60}{1.76} = 2832.95 \text{ call/hr}$$

$$Q_2 = \frac{A_2 \times 60}{1.76} = \frac{38 \times 60}{1.76} = 1295.45 \text{ call/hr}$$

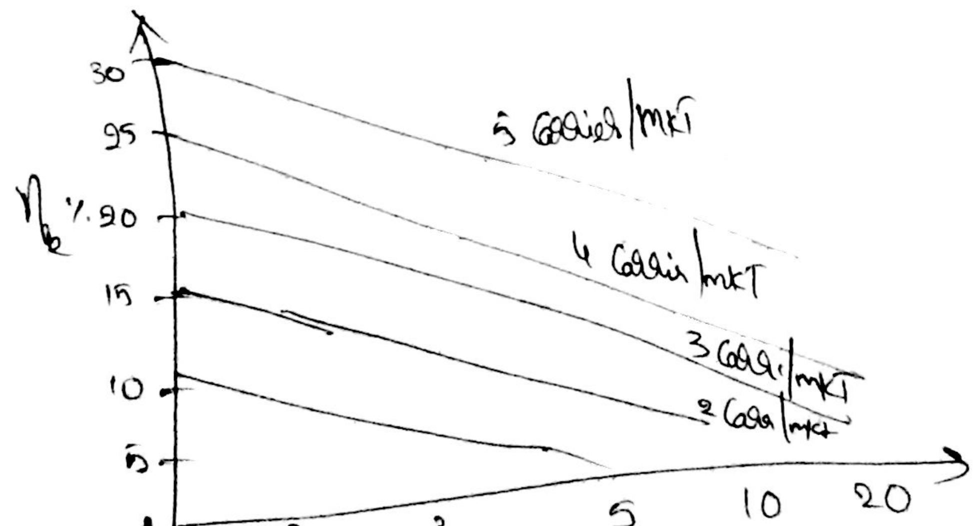
where

$$Q_i = \begin{cases} 2832.95 \text{ call/hr} & : (1 \text{ carrier/market}) \\ 1295.45 \times 2 = 2590.9 \text{ call/hr} & (2 \text{ carrier/market}) \end{cases}$$

∴ Trunking efficiency degradation factor is

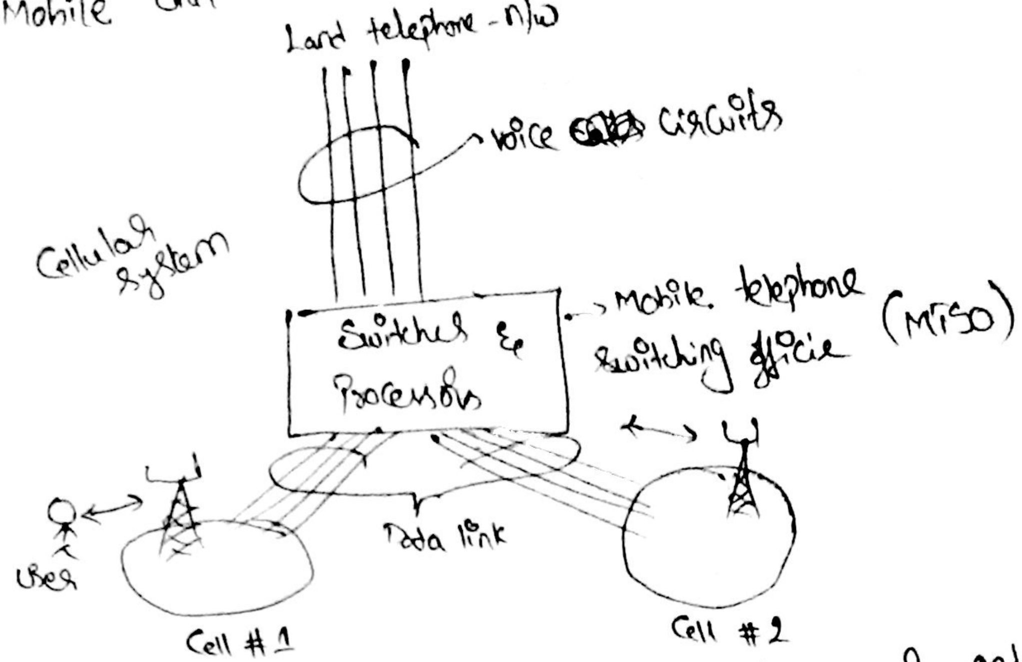
$$\eta_e = \frac{2832.95 - 2590.9}{2832.95} = 8.5\% \rightarrow (c)$$

for blocking probability 2%.



4) Basic Cellular System :- 3 - Parts

(a) Mobile unit (b) A Cell Site (c) Mobile telephone switching office (MTSO)



(a) Mobile unit :- Contains a Control unit, a transceiver, and Antenna system.

(b) Cell site :- Provides interface b/w the MTSO and mobile units. It has control unit, radio cabinets, antennas, a power plant & data terminals.

(c) MTSO :- The switching offices is the Central Co-ordinating Elements for all cell sites, which contains cellular processor and cellular switch. It interface with telephone company zone offices, controls call processing & handles billing activities.

(d) Connections :- The radio and high speed data links connect the 3 - subsystems. Each mobile unit can only use one channel at a time for its communication link.

→ The MTSO is heart of cellular mobile system.
→ The cellular switches which can be either analog (or) digital
→ The cellular switches which can be either analog (or) digital switches calls to connect mobile subscribers to other mobile subscribers and to nationwide

... wire telephone n/w.

It uses voice trunks similar to telephone company inter office wire trunks.

The radio link carriers the voice and signalling b/w the mobile unit and cell site. The high speed data link cannot be transmitted over the standard telephone trunks, therefore must use either microwave links (or) T-carriers (wire lines).

T-carriers carry both voice and data b/w the cell site & MTSO.

5) Performance criteria :- 3-categories

ⓐ Voice quality ⓑ Service quality ⓒ Special features.

ⓐ Voice quality:- It is very hard to judge with out subjective test from users opinions

In technical area engineers can not decide how to build a system with out knowing the voice quality.

In commercial communication systems the voice quality will be based upon the following criteria

Set value 'x' at which 'y' percent of customer rate the system voice quality (from t_x to R_x) as good (or) Excellent.

The top circuit merits (CM) of five listed below

CM	Score	Quality Scale
CM 5	5	Exellent (speech perfectly underable)
CM 4	4	Good (speech easily underable some noise)
CM 3	3	fair (speach underable only with slight effort).
CM 2	2	Poor (frequently repetion needed)
CM 1	1	unsatisfactory (speed not).

The average of the CM scores obtained from all listeners is called mean opinion score (MOS).

b) Service quality :-

(i) Coverage :- System should serve an area as large as possible with radio coverage. bcoz of irregular terrain configurations usually not possible to cover 100% of area for 2-reasons.

(a) the transmitted power would have to be very high. to illuminate weak spots with sufficient reception.

(b) the higher the transmitted power, the harder it becomes to control interfaces.

usually system try to cover 90% of area in flat reason and 75% of area in hilly terrian.

(ii) Required grade of service :- for normal start up system Grade of service (GOS) specified for blocking probability of 0.02 for initialing calls at busy hour.

(iii) Number of dropped calls :- During Q-calls in an hour if call is dropped and Q-1 calls are completed than call drop rate is $\frac{1}{Q}$ ...

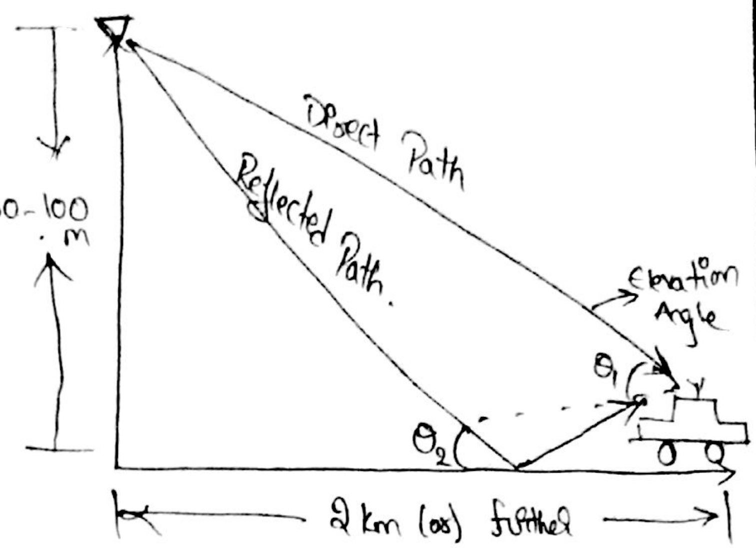
c) Special features :- System would like to provide many features like call forwarding, call waiting, voice stored box (VSR), automatic Roaming (or) navigation services.

where the customers may not be willing to pay extra charges for these special services.

5) Uniqueness of Mobile Radio Environment :-

(i) Mobile Radio transmission Medium :-

a) The Propagation attenuation :-



In general the Propagation Path loss increases not only with frequency but also distance.

If antenna height is 30-100m and mobile unit about 3m and distance b/w mobile unit and cell site usually 2km (or) more than. Incident angles of both the direct wave and reflected wave are very small.

The incident angle of direct wave is θ_1 and incident angle is of reflected wave is θ_2, where θ_1 is also called, Elevation angle.

The Propagation Path loss would be 40 dB/dec. (decade)

This means 40 dB loss at a signal receiver will be observed by mobile unit as move from 1-10 km.

$\therefore$ C is inversely Proportional to R^{+4}. $\Rightarrow$ $C \propto \frac{1}{R^4}$ (or) $C \propto R^{-4}$

$$\Rightarrow C \propto \frac{\alpha}{R^4} \Rightarrow \boxed{C \propto \alpha . R^{-4}} \rightarrow (a)$$

where $\alpha \rightarrow$ is Constant

R^{-4} = Distance b/w t_x & R_x

C = Received Carrier Power.

$\therefore$ the difference in Power reception at 2-different distance R_1 & R_2 is

$$\frac{C_2}{C_1} = \left(\frac{R_2}{R_1}\right)^{-4} \rightarrow (b)$$

$\therefore$ difference expression in Power reception is.

$$\Delta C \text{ (in dB)} = C_2 - C_1 \text{ (in dB)}.$$

$$= 10 \log \frac{C_2}{C_1} = 40 \log \frac{R_1}{R_2} \rightarrow (c)$$

$\because \Delta C = -12dB$; when $R_2 = 2R_1$

$\Delta C = -40dB$ when $R_2 = 10R_1$

the Propagation attenuation in real mobile radio Environment is

$$C \propto R^{-\gamma}$$

$$C = \alpha R^{-\gamma} \rightarrow (d)$$

The value of γ (gamma) varies b/w 2 and 5 based on Condition of Environment.

40 dB is general rule for mobile radio Environment.

It is Easy to Compare to free space Propagation rate of 20 dB/sec

the linear and decibel Expression are

$$C \propto R^{-2} \text{ (free space)} \rightarrow (e)$$

$$\Delta C = C_2 \text{ (in dB)} - C_1 \text{ (in dB)}$$

$$= 20 \log \left(\frac{R_1}{R_2}\right) \text{ free space}$$

in real mobile radio Environment the Propagation Path loss slop varies

$$C \propto R^{\gamma} \Rightarrow \alpha R^{-\gamma}$$

The decibel scale expression is

$$C = 10 \log \alpha - 10 \gamma \log R \text{ dB.}$$

b). Sever. fading :- Since the antenna height of mobile unit is lower than its typical surroundings and carrier frequency wavelength is much less than the sizes of surrounding structures, multipath waves are generated.

At mobile unit the sum of multipath waves causes a signal fading Phenomenon.

The signal fluctuates in range of 40dB (10dB above and 30dB below the avg signal).

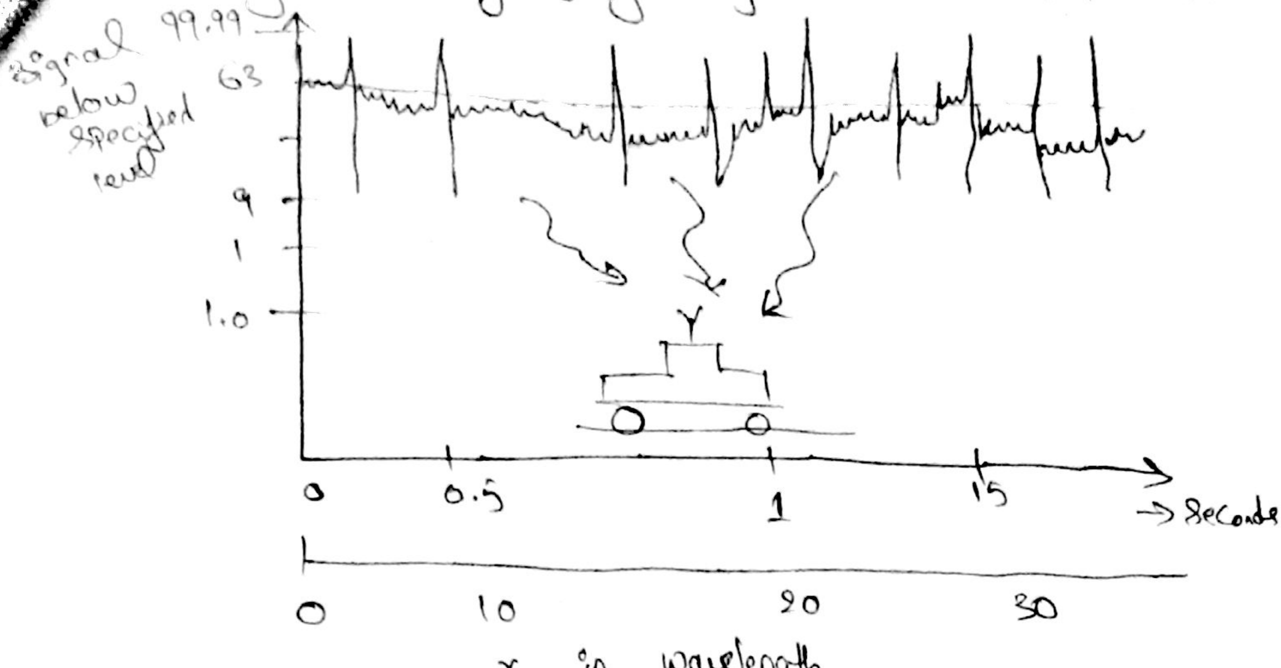
if mobile unit moves fast the rate of fluctuation is fast.

for instance at 850 MHz the wavelength is roughly 0.35m (1ft)

if speed of mobile unit is 24 km/hr (15 miles/hr) (or) 6.7 m/sec

the rate of fluctuation of signal reception at a 10-dB level

The average Power of fading signal is 15 nulls Per second.



(ii) Model of transmission Medium :-

A mobile radio signal $\gamma(t)$ can be artificially characterized by two components $m(t)$ and $\gamma_0(t)$ on natural Physical Phenomenon.

$$\gamma(t) = m(t) \cdot \gamma_0(t) \rightarrow (a)$$

where $m(t)$ is called local mean, long term fading (or) log normal fading at its variation is b/w base station and mobile unit. γ_0 → called multipath fading, short term fading and its variation is due to wave reflected from surrounding buildings & other structures.

∴ The long term fading $m(t)$ is obtained by

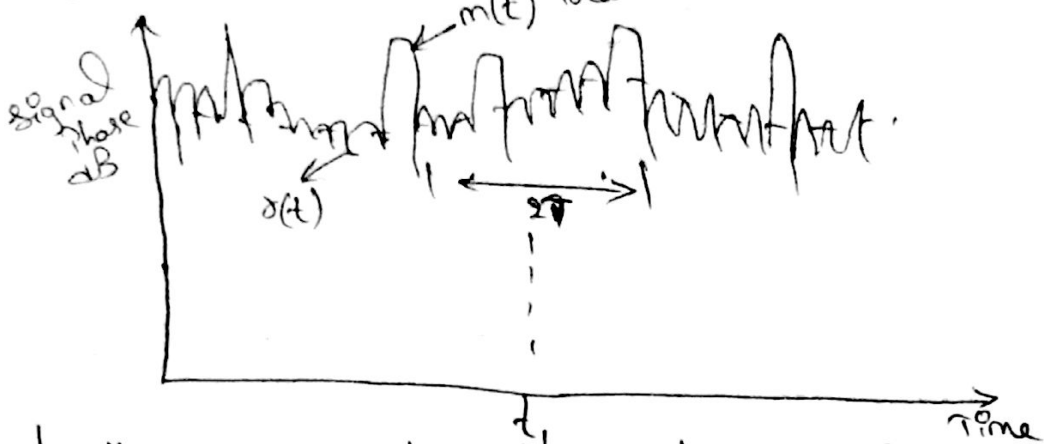
$$m(t_1) = \frac{1}{2T}\int_{t_1-T}^{t_1+T} \gamma(t)\,dt \rightarrow (b)$$

where $2T$ is time interval for averaging $\gamma(t)$

∴ Eq (b) can be written as spatial scale as

$$m(x_1) = \frac{1}{2L}\int_{x_1-L}^{x_1+L} \gamma(x)\,dx \rightarrow (c)$$

where T Can be determined based on fading rate of $r(t)$
usually at 40 - 80 fades.



The length 2L has been determined to be 20 to 40 wavelengths. The factor $m(t)$ (or) $m(x)$ is also formed on log normal distribution based on its characteristics caused by terrain control.

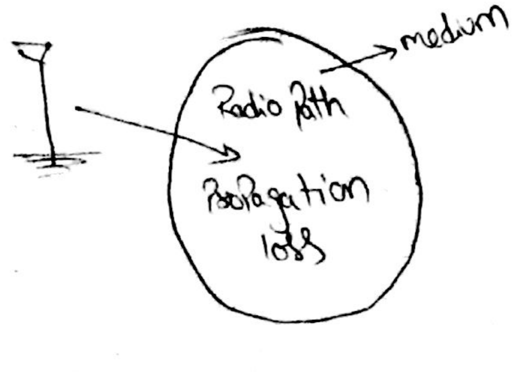
$\therefore$ Short term fading r_0 (in dB) $= r(t) - m(t)$. dB.

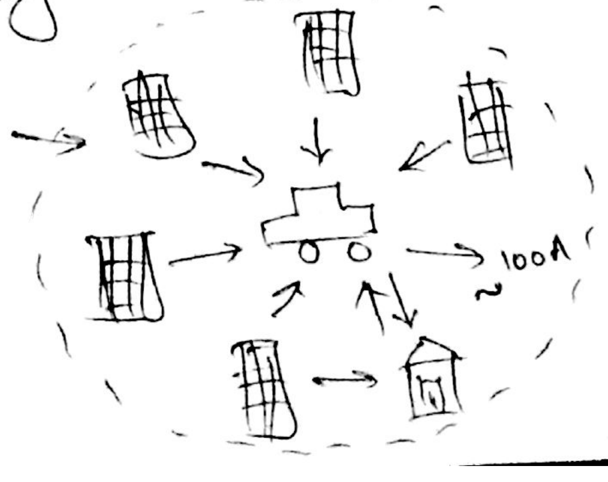
c) Mobile fading characteristics :-

Rayleigh fading is also called as multipath fading in mobile radio environment. When these multipath wave bounce back and forth due to buildings and houses they form many standing wave pairs in space.

The standing wave pairs are summed together and becomes an irregular wave fading structure.

When a mobile unit is standing still its receiver only receives a signal strength at that spot so constant signal is observed. When mobile unit is moving the fading structure of wave in space is received it is multipath fading.





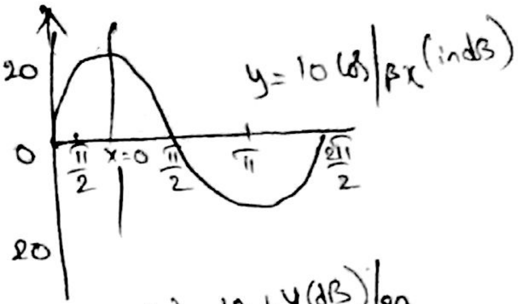
→ The radius of Active scatter region :-

" " " " at 850 MHz can be obtained indirectly where radius is roughly 100 wavelength when the active scatter region always move with mobile unit as its center.

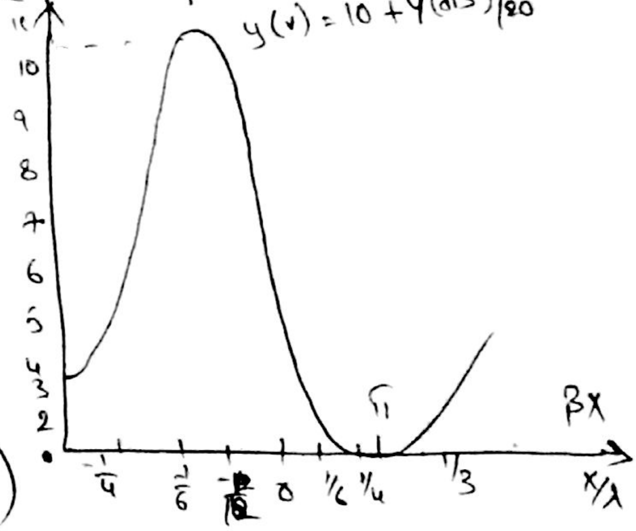
$\ast$ → Standing wave Expressed in a linear scale and log scale :-

If we introduce a sine wave in log scale

$$y = 10 \cos \beta x \rightarrow (a)$$



The linear Expression of eq (a) is the system material waveform in a log plot becomes an unsymmetrical waveform when plotted on linear scale.



Two sine wave the incident wave travelling along the x-axis (travelling to left) and the reflected wave travelling in opposite direction.

$$e_0 = E_0 \cdot e^{j(\omega t + \beta x)} \rightarrow (b)$$

ω = angular freq ; β = wave no :- $= \left(\frac{2\pi}{\lambda}\right)$

δ = Time phase lead of e_1 with respect to e_0 at $x = 0$.

$$e_1 = E_1 \cdot e^{j(\omega t - \beta x + \delta)} \rightarrow (c)$$

The two - sine waves standing wave pattern.

$$e = e_0 + e_1 = R \cos(\omega t - \delta) \rightarrow (d)$$

where amplitude 'R' becomes.

$$R = \sqrt{(E_0 + E_1)^2 \cdot \cos^2 \beta x + (E_0 - E_1)^2 \sin^2 \beta x} \rightarrow (e)$$

we are plotting 2 - cases.

Case (i) :- $E_0 = 1$; $E_1 = 1$ i.e reflection co-efficient '1'

Standing wave Ratio (SWR) = $\frac{E_0 + E_1}{E_0 - E_1} = \infty$ and $R = 2 \cos \beta x$.

Case (iii) $\epsilon_0 = 1$; $\epsilon_1 = 0.5$ ie reflection coefficient = 0.5

SWR = 3

$$R = \sqrt{(1.5)^2 \cos^2 \beta x + (0.5)^2 \sin^2 \beta x}.$$

*→ Delay Spread and Coherence Bandwidth:-

In Mobile radio Environment as a result of multipath reflection Phenomenon, the signal terminated at cell site reach the mobile unit takes different Paths.

*) Radio signal can take 2-Paths
① Direct Path
② Indirect Path.

① Direct Path :- signal from mobile unit is called direct Path and angle of direct Path is denoted by 'θ_i'.

② Indirect Path :- signal from cell site to surface and surface to mobile unit is indirect Path. the angle is known reflection (or) elevation angle.

*) Each Path has a different Path length, the time overall of each path is different.

*) the ~~~~ value of delay spread is valid depending upon type of Environment.

Type of Environment	Delay of spread Δ (μs)
1. Open area	< 0.2
2. urban Area	3
3. Sub urban area	0.5
4. Inside the building	< 0.1.

c. Coherence Bandwidth :-

is defined as the bandwidth in which either amplitudes (or) Phases of 2-received signal have a high degree of similarity.

A coherence bandwidth of 2-fading amplitudes of two received signal is

$$\boxed{B_c = \frac{1}{2\pi\Delta}}$$

Δ - delay spread

B_c - Coherence Bandwidth.

A Coherence Bandwidth for 2-random Phases of 2-received signal is

$$\boxed{B_c = \frac{1}{4\pi\Delta}}$$

d) Amplifier noise :-

A mobile radio signal received by a receiving antenna either at the cell site (or) at the mobile unit will be amplified by an amplifier.

we will like to understand how signal is affected by amplifier noise.

Assume an amplifier has available Power gain 'g' and available noise power at o/p 'N_0'.

The i/p signal to noise ratio (S/N) is $\frac{P_s}{N_0}$

The o/p " " " (S/N) is $\frac{P_o}{N_0}$

and internal noise ratio is 'N_0'.

The o/p $\frac{P_o}{N_0}$ becomes.

$$\frac{P_o}{N_0} = \frac{g P_s}{g(N_i) + N_a} = \frac{g P_s}{g[N_i + (N_a/g)]} \rightarrow (a).$$

$$\Rightarrow \frac{P_o}{N_o} = \frac{P_s}{N_i + (N_a/g)} \rightarrow (1)$$

The noise figure of amplifier (F) is given by

$$F = \frac{\text{max Possible S/N ratio}}{\text{Actual S/N ratio at o/p}}$$

$$\Rightarrow F = \frac{P_s / KTB}{P_o / N_o} = \frac{N_o}{(P_o/P_s)KTB} = \frac{N_o}{g(KTB)} \rightarrow (2)$$

$\left(\frac{P_s}{KTB}\right)$ is the maximum Possible signal - to noise (S/N) ratio when load is open circuit.

now:- eq (1) & (2)

$$F = \frac{P_s / KTB}{P_s / [N_i + (N_a/g)]} = \frac{N_i + (N_a/g)}{KTB} \rightarrow (3).$$

where term KTB is thermal noise //.

7) Operation of Cellular System :-

The operation is divided in to 4-Parts.

a) **Mobile unit initilization :-**

When mobile unit is turned on it scans and selects the strongest
Control used for system.

*) Cells with different frequency band respectively broad cast on
different setup channels.

*) the receiver selects the strongest setup channel and monitors
that channel.

*) with this mobile station has automatically selected the Base station
which it will operate.
antenna of the cell within which it will operate.

*) the hand shake takes place b/w the mobile unit and MTSO Controlling
this cell within which it will operate. ~~the mobile unit and MTSO for~~
~~*) the band state takes place b/w the~~ register its

*) Hand shake is used to identify the user and register its
location.

*) As long as the mobile station is on scanning is repeated Periodically
to account for the motion of unit.

*) If the unit enters a new cells than a new BS is selected.

b) **Mobile originated call :-**

A Mobile unit originates a call by sending the no. (Mobile identification
number (MIN)) of the called unit on the Pre selected setup channel.

*) The receiver of mobile unit checks if the forward channel from
BS is idle.

*) If idle the mobile may transmit over the reverse channel (To BS).

*) BS sends request to the MTSO...

Paging :-

*) MSO attempts to complete connection
*) MSO sends a paging message to certain BS's depending on called mobile no:-
*) BS sends paging signal on its own assigned setup channel.

c). Call Accepted :-
*) Called mobile unit recognizes its number on the setup channel being monitored and responds to that BS, which sends the response to the MSO
*) MSO sets up a circuit b/w calling and called BS's.
*) MSO selects available traffic channel within each BS's cell and notifies each BS, which in turn notifies its mobile unit called alert is transmitted over FVC to instruct the mobile ring.
*) The two mobile unit tune to their respective channels.

d) Ongoing Call :- While connection is maintained, two mobile stations exchange voice (or) data through . BS's and MSO.

e) Hand OFF :- If a mobile unit moves from ranges of one cell to another the traffic channel has to change.
*) System makes this changes without either interrupting the call (or) alerting the user.

f) Call blocking :- If all traffic channels are busy even after multiple attempts a busy tone is returned.

g) Call termination :- When one of the users hang up MSO is informed and the traffic channels are released.

h) Call drop :- during a connection because of interface (or) weak signal spots the BS cant maintain the minimum required signal strength for a certain period of time the traffic channel is dropped and MSO is informed.

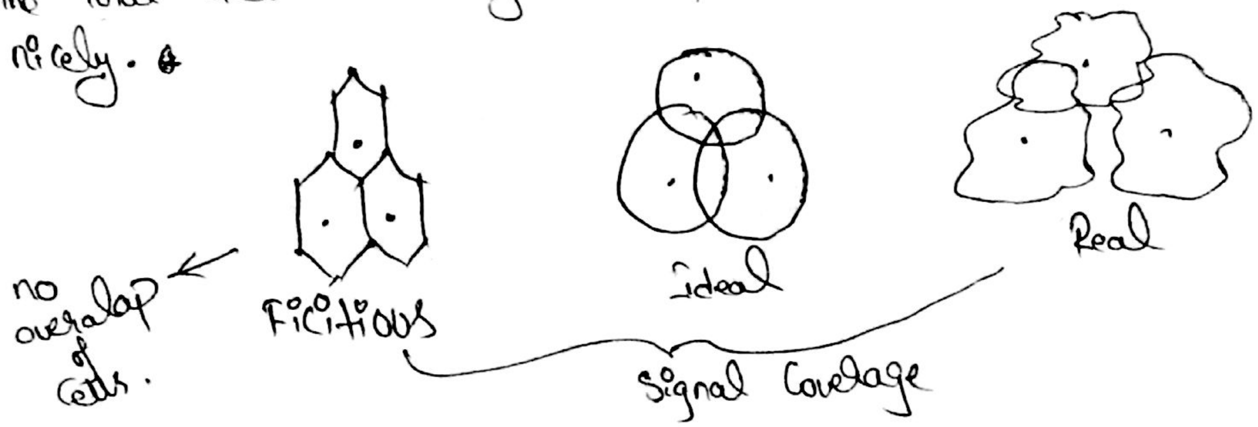
8) <u>Handoff</u> :- Is the Process of automatically changing the frequency when the mobile unit moves from one frequency zone to another frequency zone.

Handoff needed in two situations where the cell site receives weak signals from mobile unit.

① At the cell boundary say −100dBm, which is the level for requesting a handoff in a noise limited environment.

② When the mobile unit is reaching the signal strength holes (gaps) within the cell size.

<u>Cell Shape</u> :- The circular shape have overlapped areas it cannot cover the total area. The hexagonal shaped cells fit the planned area nicely.



9) <u>Planning of Cellular System</u> :- Planning of Cellular System is very crucial in the design of cellular system. The service provided by system is poor if we does not have the skill to develop a good plan.

① Regulation ② Market situation.

① <u>Regulation</u> :- The federal regulation controlled by Federal Communication Commission (FCC) are similar in every part of united states. the regulation may vary from state to state and with in the state, each city and town have their own building codes and zoning laws.

(2) Market Situations :-

(i) Prediction of gross income
(ii) understanding competitors
(iii) Decision of geographic coverage.

(i) Prediction of Gross income :- In this task we have to find out the population of market area (in which we are constructing the cellular system) we also need to find out the average income, business type and business zone. All this information is utilized to prediction of gross income.

(ii) understanding competitors :- we must have a knowledge of competitors coverage area, system performance and the no. of customers the competitor is serving. To overcome the competition we must design a system that provides unique and magnificient service.

(iii) Decision of geographic coverage :-
In this task, we need to answer the following questions before passing the decision onto the engineering department.
(a) what general area should ultimately be covered?
(b) what near-term service can be provided in a limited area?

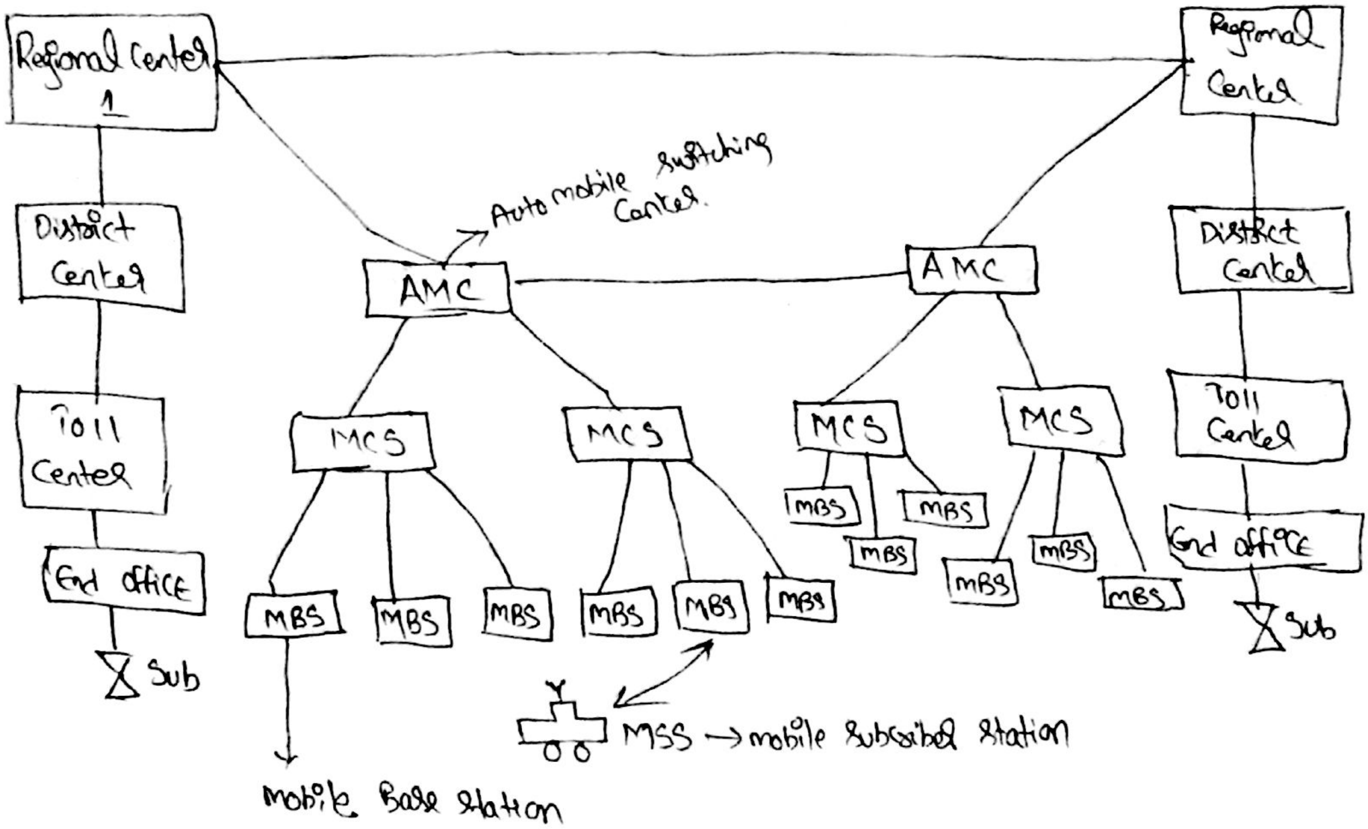
10> Analog & Digital Cellular Systems :-

a) Japanese Mobile Telephone service network configuration :-
NTT stands for Nippon Telegraph and Telephone corporation. The corporation has developed an 800 MHz band mobile telephone system in the year 1979 to provide service to Tokyo area.
The operation of this system is analogous to AMP (Advanced mobile phone) system.
This system provides service to approximately 40,000 subscriber in 500 cities. It serves 60 percent of Japan population, covers 25% of liveable areas and assists 75% of Japan cities.

As on february 1985 in Japan

*) 9 Automobile switching centers (ASC's)
*) 51 Mobile control stations (MCS's)
*) 465 Mobile base stations (MBS's)
*) 39,000 Mobile subscribers stations (MSS's).

In operation around 30,000 subscribers are served in metropolitan Tokyo area by the Japanese mobile Telephone n/w.
The system functions with a total band width 30MHz and contains 600 channels each with bandwidth of 25KHz.



11) **Analog and Digital Cellular Mobile System :-**

Cellular telephone systems can be analog/digital older systems (AMPS(Advanced mobile Phone Systems), TAC's, NMT) are analog and newer systems (GSM, PC's) are digital.

The major difference b/w two system is how the voice signal is transmitted b/w the phone and base station.

Analog refer like audio cassettes and digital like CD's.

In either system, the audio at the microphone always starts out as a voltage level that varies continously over time. High frequencies cause rapid changes and low frequencies cause slow changes with analog system, the audio is directly modulated on to a carrier. this is very much like FM (not identical) radio where the audio signal is translated to RF signal.

In digital system audio is converted to digitized samples at about 8000 samples per second (or) so. The digital samples are numbers that varying voltage level at specific points in time.

Where samples are transmitted as '1' & '0' at other end sample is converted back to voltage levels and smoothed out so that you get about the same audio signal.

With analog transmissions interference (RF noise (or) some other that affect the transmitted signal). gets translated directly in to the recovered signal there is no "check" that the signal makes sense. the neat thing about the digital is that the 1's and 0's can not be easily confused (or) distorted during transmission, plus extra data is typically included in transmission to help, detect and correct any errors.