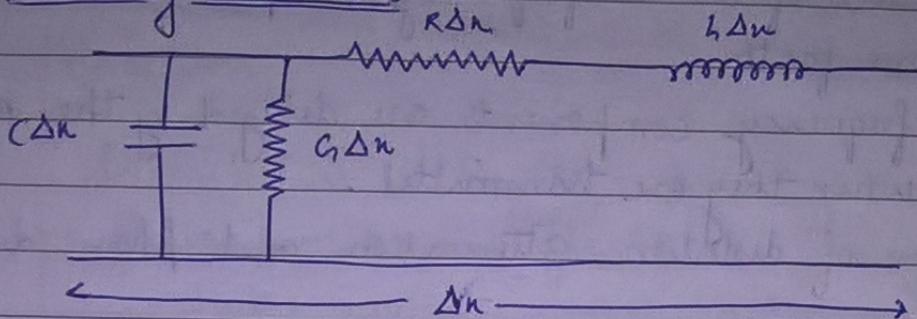


→ Transmission Media → Guided Media and Unguided Media

① Transmission line characteristics:-

(i) Primary Parameters :-



- Series resistance per unit length (R) of the conductors
- Inductance per unit length (L) of the conductors
- Capacitance per unit length (C) between the two conductors
- Leakage conductance per unit length (G_L)

(ii) Secondary Parameters :-

- Characteristic impedance (Z_C) (Input impedance)

$$Z_C = \sqrt{\frac{R + j\omega L}{G_L + j\omega C}}$$

- Propagation constant (γ) (Determines attenuation & phase change)

$$\gamma = \alpha + j\beta = \sqrt{(R + j\omega L)(G_L + j\omega C)}$$

(iii) Phase Velocity & Phase delay t-

$$v = \frac{\Delta n}{\Delta t} = \frac{\omega}{B} \quad T = \frac{1}{v} = \frac{B}{\omega}$$

(iv) Frequency dependence of secondary Parameters :-

At low frequency, $\omega L \ll R$ and if $G_L = 0$ - then

$$Z_C \approx \sqrt{\frac{R}{j\omega C}}, \quad \gamma = \sqrt{j\omega RC}$$

At high frequency, $\omega L \gg R$ and if $G_L = 0$ - then

$$Z_C = \sqrt{L/C}, \quad \gamma = \sqrt{-\omega^2 LC + j\omega RC}$$

② Distortion :-

Distortion is when received signal is different from transmitted signal. For distortionless transmission,

→ amplitudes of all its frequency components are multiplied by the same factor

→ all its frequency components are delayed by the same amount when they are transmitted.

Two types of distortion, attenuation and phase distortion.

③ Crosstalk :-

When two transmission lines are very close, they interfere with each other and it results in crosstalk i.e. signals of one line cross over to the other. Crosstalk occurs due to three types of mutual coupling between the lines:-

- Galvanic coupling:- due to common resistance of the two lines
- Capacitive coupling:- due to capacitance between the conductors
- Inductive coupling:- due to mutual inductance of the two lines

④ Guided Media :-

→ Twisted Pair Cable

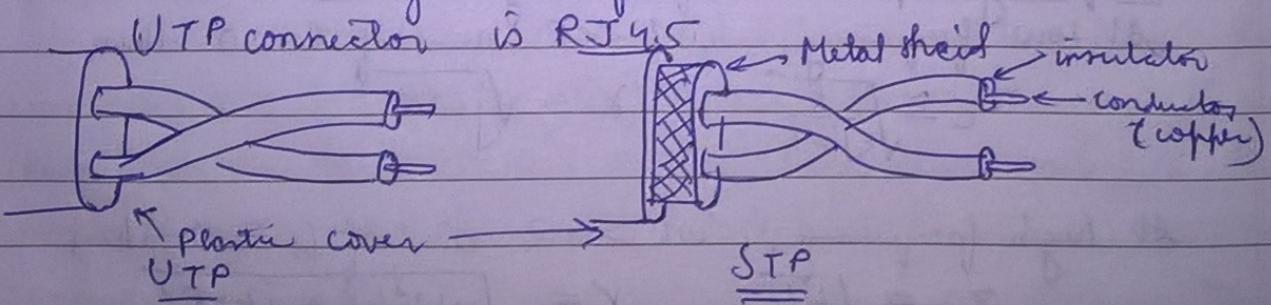
 └ Unshielded Twisted Pair Cable (UTP)

 └ Shielded Twisted Pair Cable (STP)

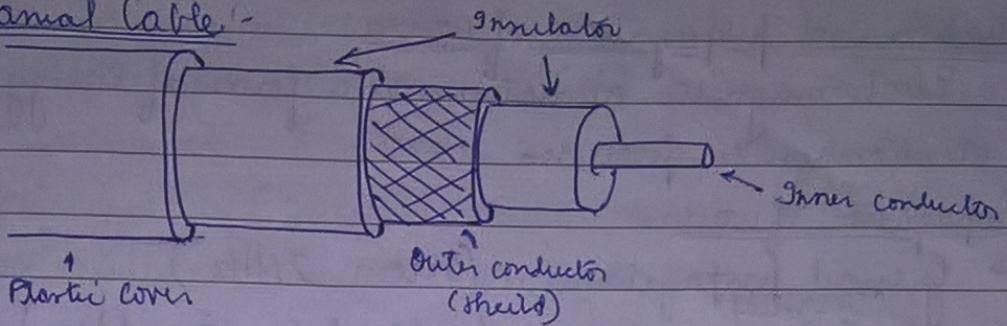
One wire → carry signals to the receiver

another wire → ground reference.

UTP connector is RJ45



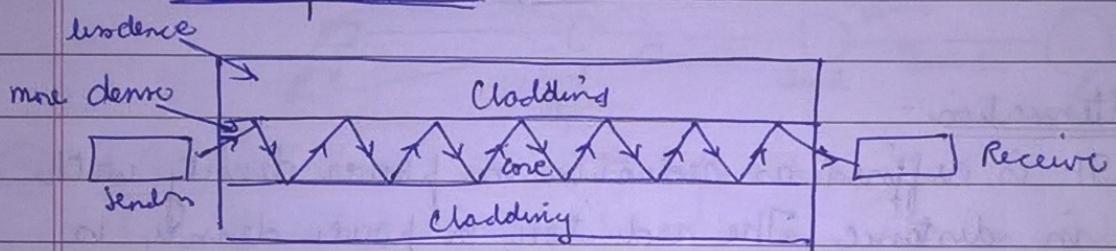
→ Coaxial Cable:-



Connector is BNC, high frequency range.

- Baseband → transmit ^{single} digital signal, frequency range, → 4 KHz digital signalling, 50Ω cables
- Broadband → transmit multiple signals, frequency range → above analog signalling; 70Ω cables, 4 KHz

→ Fibre Optic cable:-



(5) Unguided Media:-

Electromagnetic Polarization:-

It is the property of EM waves that can oscillate with more than one direction. It means polarization of electric field.

Ray:-

It is an idealized model of light, obtained by choosing a line that is perpendicular to the wavefronts of the actual light.

Wavefront:-

It is a line representing all parts of a wave that are in phase and an equal number of wavelengths from the source of the wave.

Electromagnetic Spectrum:-

Radio wave & Microwave	Infrared	light wave
3 KHz	300 GHz	400 THz

Radiation and propagation of waves-

Electromagnetic Radiation is a form of energy released by electromagnetic processes.

Propagation of waves-

- Ground propagation (below 2 MHz)
- ^{Terrestrial} Sky propagation (reflected by ionosphere) (2-30 MHz)
- Line of sight propagation (above 30 MHz)

Inverse square law-

An intensity of light is inversely proportional to the square of the distance from the source.

$$\boxed{\text{Intensity} \propto \frac{1}{(\text{distance})^2}}$$

Wave attenuation-

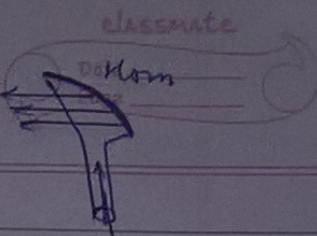
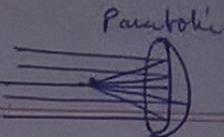
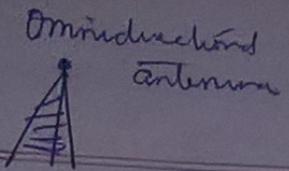
It is defined as reduction in power density with increase in distance. The reduction in power density is equivalent to power loss hence it is called attenuation.

Wave absorption-

The earth atmosphere consists of particles. They can absorb electromagnetic energy. The reduction in power due to energy absorbed by particles is called absorption loss.

Skip distance-

It is a distance on the Earth's surface between the two points where radio waves from a Transmitter, refracted downward by different layers of the ionosphere, fall.



⑥ Wireless transmission

→ Radio Waves ($3\text{KHz} - 1\text{GHz}$)

(all directions)

→ Microwaves ($1\text{GHz} - 300\text{GHz}$)

Omnidirectional antenna

→ Infrared ($300\text{GHz} - 400\text{THz}$)

Unidirectional antenna

→ Satellite communication system.

(parabolic dish antenna or horn antenna)

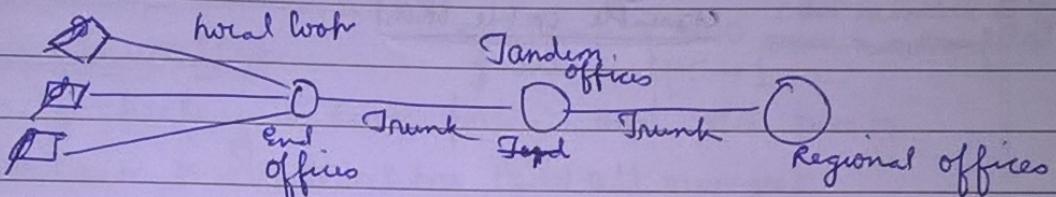
→ Telephone Network :-

① Components :-

→ two local loops

→ Trunks

→ switching offices.



② LATA's (Local Access Transport Areas) :-

→ It is handled by end offices and tandem switches.

→ Intra-LATA services (telephone companies)

→ Inter-LATA services (long-distance companies)

③ Signalling :-

→ in band signalling (same circuit for voice and signalling with communication)

→ out band signalling (different circuit)

④ Services :-

Analog services

→ Analog switched services

→ Analog leased services.

Digital services

→ switched 56 services → 56 Kbps

→ Digital data services. → digital version of analog leased service
64 Kbps.

⑤ DSL (Digital subscriber line) -

- to provide higher speed access to the Internet
- ADSL (asymmetric DSL) → 56 K modem, residential uses
 - VDSL (very high bit rate DSL) → 25-55 Mbps
 - HDSL (high bit rate DSL) → nearly 2 Mbps
 - SDSL (symmetric DSL) → 768 Kbps, business uses

⑥ Cable TV network for data transfer :-

