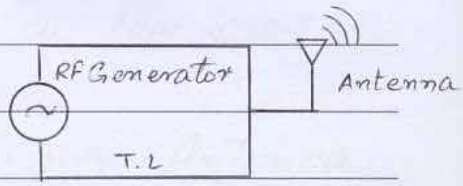
ANTENNA THEORY

Date: 15 OCT 2008
M T W T F S S

ANTENNA THEORY

INTRODUCTION:

* An antenna is defined as a "usually metallic device (as a rod or wire) for radiating or receiving radio waves.
* The IEEE standard for antenna is IEEE std 145-1973.
* The IEEE defines anta or arial as a radiating or receiving radio waves, in other word ata is a transitional structure b/w free space and a guided device.



* The guiding device or tx-line may be in form of coaxial link or hollow pipe (like waveguide) and it used to transport Em energy from txr source to ata & ata to rxr.
* The anta must act as a directional device in addition to a probing device.
* It must take various form to meet the particular point or transreciever. and it may be a piece of wire (conducting), an aparture, an assembly of element (Array), a reflector, a lens or etc.

(Antenna → anta or ata)

Date: 16 OCT 2008
M T W P F S S

* A device that generate or collect Em energy is called antenna. eg Bulb.
* In a txing system a radio frequency develop, amplified, modulated and applied to anta. The RF current flowing through anta produce Em waves that radiate into atmosphere.
* Very efficient ata is used for reception of adequatic signals to obstract out the "information" from a high power txr
* The property of interchangability for tx/rxing ata is known as ata Reciprocity.
* In active ata for high frequency comm. rxr or an FM or TV broadcast rxr describe the combination of a rxg ata with a low noise pre-amplifier.

T_x/R_x (Antenna) ⟶ Passive Antenna.

T_x (ata) ⟶ Active Antenna (+LNA)

* A horizantal ata horizotally wave (polarized) and vertical as vertically polarized. It is important that polarization be same at both ends (R_x/T_x) in a comm path.
* Ground wave propogation, mobile & portable comm. systems usually use vertical polarized while H.F & V.H.F needs horizontal polarization.
* The rxg signal strength is inversly proportional to distance b/w T_x and R_x

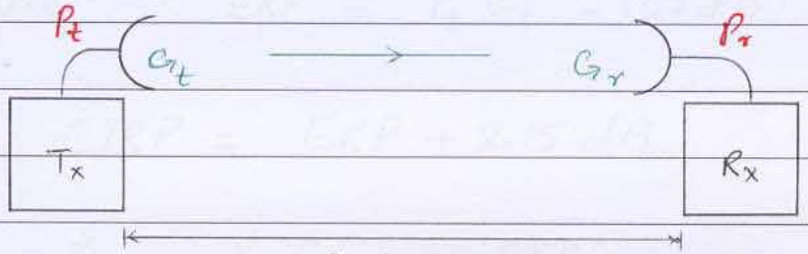
$$R_x \text{ Signal Strength} = \frac{\text{Recieved Signal}}{d}$$

Date: 16 OCT 2008
M T W T F S S

- Let's assume that 2m long ata reciere signal of 10μV.

$$\text{Signal Strength} = \frac{10\mu V}{2} = 5\mu V.$$

Free Space Propogation

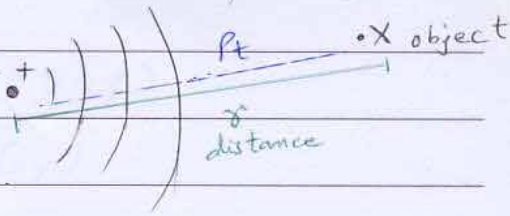


Here, Antenna Gain = 1

means $G_t = G_R = 1$ (T_x/R_x) → Receprocity

Power density = $\frac{\text{Power Txd}}{\text{Area}} = \frac{P_t\ (P_d)}{4\pi r^2}$ ___ ①

at 'x' object.



And we know the efield at rxg end or 'x' object

$$P_D = \frac{E^2}{Z} = \frac{E^2}{120\pi \text{ or } 377} \quad \text{___ ②}$$

Equating ① and ②

$$E = \sqrt{\frac{P_t}{4\pi r^2} \times Z} = \sqrt{\frac{120\pi}{4\pi} \times \frac{P_t}{r^2}}$$

$$E = \frac{5.477}{r}\sqrt{P_t}$$

Intensity confined within one direction.

Date: 16 OCT 2008
M T W T F S S

Free Space Propogation with Antenna Gain:

$$\text{Total Power} = P_t G_t$$

Effected Isotropic Radiated Power = EIRP = $P_t G_t$

Effected Radiated Power = ERP = EIRP − 2.15 dB

Due to isotropic → ERP = $P_t G_t$ − 1.07 dB − 1.07 dB

region.

$$EIRP = ERP + 2.15\ dB$$

$$P_D = \frac{P_t G_t}{4\pi r^2} = \frac{EIRP}{4\pi r^2}$$

* Effective area of an antenna dependent on two factors:
  (i) Wavelength & frequency. (λ, f)
  (ii) Gain of ata itself (G_r)

* Effective area of an ata is fns of signal wavelength (λ) and gain of the rxg ata (G_r) is given by

$$A_{eff} = \frac{\lambda^2 G_r}{4\pi}$$

And we know that

$$P_D = \frac{P_r}{Area}$$

$$P_r = P_D \times Area$$

$$= \frac{P_t G_t}{4\pi r^2} \times \frac{\lambda^2 G_r}{4\pi}$$

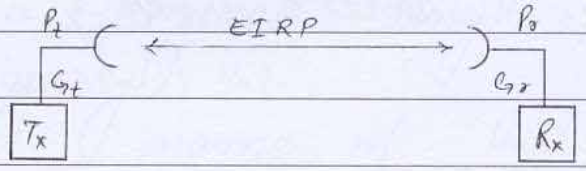
Date: 16 OCT 2008

M T W T F S S

$$P_r = P_t G_t G_r \left(\frac{\lambda}{4\pi r}\right)^2$$

$$P_r = \underbrace{P_t G_t} G_r \left(\frac{c}{f 4\pi r}\right)^2 \Rightarrow \text{Friis's equation.}$$

EIRP



$$\frac{P_r}{P_t} = G_t G_r \left(\frac{c}{f 4\pi r}\right)^2$$

Free Space Path Loss:

$$\text{Loss} = \frac{P_t}{P_r} = \frac{1}{G_t G_r}\left(\frac{f 4\pi r}{c}\right)^2$$

in dB Scale:

$$10\log\left(\frac{P_t}{P_r}\right) = 10\log\left[\frac{1}{G_t G_r} \times \left(\frac{f 4\pi r}{c}\right)^2\right]$$

$$10\log\left(\frac{P_t}{P_r}\right) = 10\log\left[\left(\frac{4\pi}{c}\right)^2\right] + 20\log(f) + 20\log(r) - G_T(dB_i) - G_R(dB_i)$$

$$= 10\log\left[\left(\frac{4\pi \times 10^{+3} \times 10^{6}}{3 \times 10^{8}}\right)^2\right] + 20\log(f) + 20\log(r) - G_T(dB_i) - G_R(dB_i)$$

$$LF_S = 32.44 + 20\log(f_{\text{in MHz}}) + 20\log(r_{\text{in km}}) - G_T(dB_i) - G_r(dB_i).$$