Lecture 4

PRINCIPLES OF SATELLITE COMMUNICATION

Introduction

The design of satellite link is quite important as it gives the estimate of power that the satellite would be able to receive from transmitting earth satellite & power received from satellite repeater by the receiving earth station.

Contt…

- Absorption, Scattering and reflection phenomena arising in the atmosphere
- Galactic noise and thermal noise emitted by the atmosphere
- The feasibility of constructing satellite antenna with gains approx to the service area required

Contt…

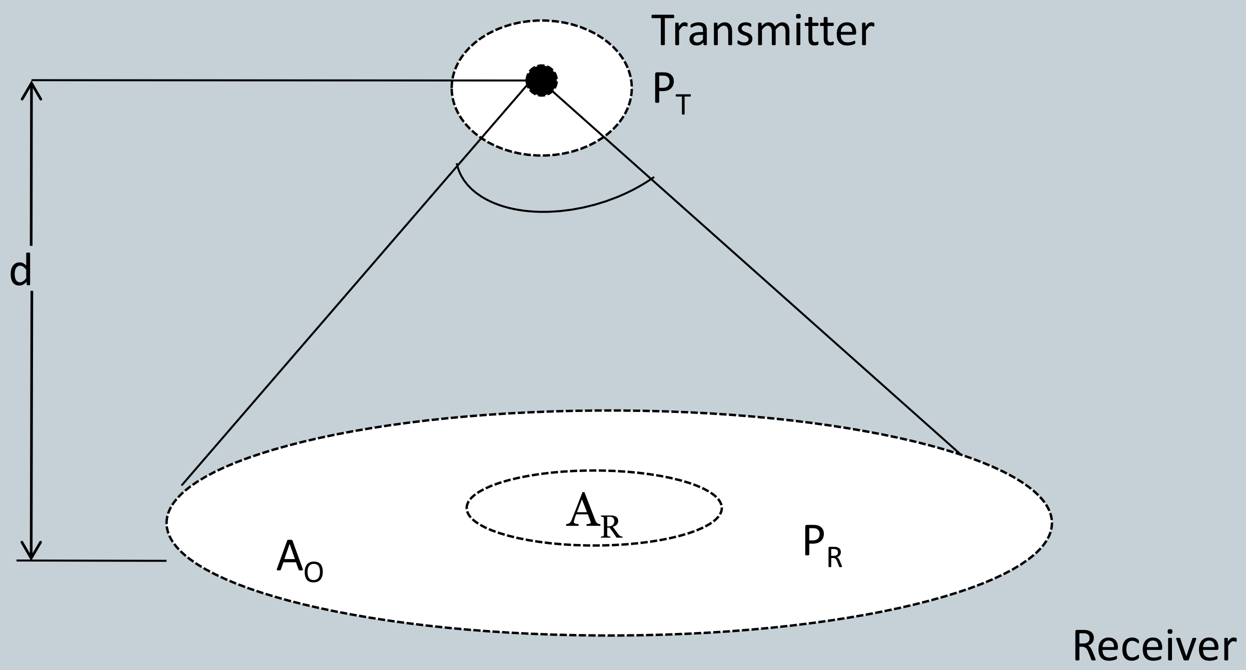
- Best frequency range serving the fixed earth station 1-10 GHz
- Lower limit is set mainly due to galactic noise and size and the mass of the antennas
- Lower minimum is appropriate for wide coverage system using a relatively high earth station –noise temperature

Contt…

- A higher minimum is preferred where relatively small area of earth surface is to be served
- Upper limit is usually set by attenuation due to heavy rain.
- Higher limit is acceptable where rain is seldom very heavy

General Link Design Equations

- In satellite communications links design the important calculations is the power received by the receiving stations.



General Link Design Equations

- The power received by the receiving antenna is given by:

$P_R = P_T A_R / A_O$ ....(1)

The directivity of antenna is described by its gain as:

$G_T = 4\prod d^2 / A_O$ ....(2)

From eqn 2 in eqn 1 we get:

$P_R = P_T G_T A_R / 4\prod d^2$ ....(3)

The product $P_T G_T$ is called effective isotropic radiated power(EIRP) of the transmitter & is a figure of merit for a transmitter.

The receiving antenna gain G_R is related to the effective area A_R by the relationship

$G_R = 4 \prod A_R / \lambda^2$ ....(4)

Substituting eqn 4 in eqn 3 we get:

$$P_R = P_T G_T G_R \left(\frac{\lambda}{4\pi d} \right)^2 \quad ......5$$

General Link Design Equation Contt...

$$\frac{P_T}{P_R} = \frac{1}{G_T G_R \left[\frac{\lambda}{4\pi d} \right]^2}$$

$$\alpha_{dB} = 10 \log_{10} \frac{P_T}{P_R} \text{ Thus} \qquad \text{..........(6)}$$

$$\alpha_{dB} = 22 + 20 \log_{10} \left(\frac{d}{\lambda} \right) - G_T - G_R \qquad \text{........(7)}$$

$$L_{FS} = 22 + 20 \text{ Log}_{10}(d/\lambda) \text{ dB}$$

The above Eqns. give power attenuation in decibels. G_T & G_R represent the antenna gains in decibels.

In eqn 6 the first 2 factors are path loss & free space los(L_{FS})

General Link Design Equation Contt…

- Path loss between a satellite in geo stationary orbit and earth station is 195.6 db and 199.1 db at 4 GHz and 6 GHz
- L= LFS* LA (LA being the additional losses)

$$\frac{P_R}{P_T} = \frac{G_T G_R}{L}$$

$$L_A = L_{FTX} * A_{AG} * A_{rain} * L_{Point} * L_{FRX}$$

General Link Design Equation Contt...

$$P_R = EIRP + G_R - L_{FTX} - A_{AG} - A_{rain} - L_{Point} - L_{FRX}$$

$$G = \frac{4\pi\eta A}{\lambda^2}$$