PROPAGATION IMPAIRMENTS AND SPACE LINK

3.1 Introduction

A signal traveling between an earth station and a satellite must pass through the earth's atmosphere, including the ionosphere.

3.2 Atmospheric Losses

Losses occur in the earth's atmosphere as a result of energy absorption by the atmospheric gases. These losses are treated quite separately from those which result from adverse weather conditions, which of course are also atmospheric losses. To distinguish between these, the weather-related losses are referred to as atmospheric attenuation and the absorption losses simply as atmospheric absorption.

3.3 Ionospheric Effects

Radio waves traveling between satellites and earth stations must pass through the ionosphere. The ionosphere has been ionized, mainly by solar radiation. The free electrons in the ionosphere are not uniformly distributed but form in layers. Clouds of electrons may travel through the ionosphere and give rise to fluctuations in the signal.
The effects include scintillation, absorption, variation in the direction of arrival, propagation delay, dispersion, frequency change, and polarization rotation.

Ionospheric scintillations:

- Are variations in the amplitude, phase, polarization, or angle of arrival of radio waves.
- Caused by irregularities in the ionosphere which changes with time.
- Effect of scintillations is fading of the signal. Severe fades may last up to several minutes.

Polarization rotation:

- porduce rotation of the polarization of a signal (Faraday rotation)
- When linearly polarized wave traverses in the ionosphere, free electrons in the ionosphere are sets in motion a force is experienced, which shift the polarization of the wave.
- Inversely proportional to frequency squared.
- Not a problem for frequencies above 10 GHz.

3.4 Rain Attenuation

Rain attenuation is a function of rain rate.

Rain rate, Rp = the rate at which rainwater would accumulate in a rain gauge situated at the ground in the region of interest (e. g., at an earth station). The rain rate is measured in millimeters per hour.

Of interest is the percentage of time that specified values are exceeded. The time percentage is usually that of a year; for example, a rain rate of 0.001 percent means that the rain rate would be exceeded for 0.001 percent of a year, or about 5.3 min during any one year.

3.5 Introduction

This chapter describes how the link-power budget calculations are made. These calculations basically relate two quantities, the transmit power and the receive power, and show in detail how the difference between these two powers is accounted for.

3.6 Equivalent Isotropic Radiated Power

A key parameter in link budget calculations is the equivalent isotropic radiated power, conventionally denoted as EIRP. The Maximum power flux density at some distance r from a transmitting antenna of gain G is

$$\psi_M = \frac{GP_S}{4\pi r^2}$$

An isotropic radiator with an input power equal to GPS would produce the same flux density. Hence this product is referred to as the equivalent isotropic radiated power, or

$$EIRP = GP_S$$

EIRP is often expressed in decibels relative to one watt, or dBW. Let PS be in watts; then

$$[EIRP] = [P_S] + [G] \; dBW$$

where [PS] is also in dBW and [G] is in dB.

The isotropic gain for a paraboloidal antenna is

$$G = \eta(10.472 fD)^2$$