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ANALYSIS OF RELIABILITY CONSIDERATION TO OBTAIN AN ERROR FREE COMMUNICATION OVER A LONG HAUL DIGITAL MICROWAVE LINK

ABHISHEK PANDEY*, ANSHUL AGRAWAL*

ABSTRACT

In the system design of a digital microwave link the designer must be ensure that the link satisfies the regulatory requirement, it is compatible with the digital hierarchy and the link performs the well over a long path of communication system. Ideally, the performance of a digital microwave link is independent of the number of repeaters and the system length and topology. But in reality, transmission quality is not completely independent of length of the system or the number of the repeaters. The major factors, which affect the transmission qualities, are: multipath propagation, Rainfall, anomalous propagation disturbances, reflections etc. In this paper analysis of the reliability consideration has been carried out to obtain an error free communication over a long haul digital microwave link.

KEYWORDS: Digital Microwave, Communication Link, Rainfall, Multipath Propagation.

INTRODUCTION

Digital communication systems have an improved performance in high co-channel interference (CCI) and adjacent co-channel-interference (ACI) environments. Since microwave band offers several benefits like: high data transmission rates, higher bandwidth, smaller beam width and smaller earth receiving stations, which leads to greater mobility. The microwave digital communication systems finds extensive use in Cellular, personal communication system and public land mobile radio communication systems. But the attenuation of microwaves is of special interest. In addition to decreasing the intensity of waves, it is important for meteorology, aviation and navigation. Hydrologists find it useful in flood forecasting.

With an increasing demand in satellite communications, the current spectrum allocations at lower frequencies are quickly becoming overcrowded. Compared to propagation of electromagnetic waves by radio frequencies (<30GHz), propagation by microwave and millimeter waves (30-300GHZ) are severely affected by atmospheric constituents, in particular by rainfall, water vapor, sand and dust storms and different precipitants present in the atmosphere etc.

*Department of Electronics & Communication Engineering, Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh 462007. ***Correspondence E-mail Id:*** editor@eurekajournals.com

Further to absorption by atmospheric constituents (molecular absorption), propagation of Microwaves are affected by other reasons. The principal causes of attenuation in Microwave and mm waves are:

Molecular absorption in the atmosphere, Absorption and scattering by precipitated particles, e.g. rain, snow and hail, and also by cloud, fog and haze, Absorption by solid particles, viz., sand, dust and aerosols.

The atmospheric molecules whose rotational spectra appear in the Microwave and mm waves regions, are N2O, NO2, SO2 H2S, CO, H2O (dimmer and trimmer), O3 and O2. does not have electric dipole moment but possesses magnetic dipole moment which gives rise to a large number of absorption lines between 55 and 65 GHz. Absorption frequency of water are 22 and 184GHz. It possess asymmetric molecule having strong absorption. While there are certain windows at 18, 35 94 and 140 GHz at which absorption is less and these frequencies can be exploited for the communication system.

The fundamental parameters of link design are transmitter power and co-channel reuse distance which determines the specific transmission quality, that is, a specified bit-error-rate and allowable outage (where service is interrupted due to severe rainfall or due to other atmospheric impairments.). In Line-of-Sight operation the received power decreases by 1/r2 as the distance r between antenna increases.

If a digital microwave Radio link is to be maintained during a rainfall, it is necessary that enough extra power be transmitted to overcome the maximum additional attenuation induced by the rain. Hence it is necessary to give an accurate assessment of expected loss when evaluating link parameter. In the present paper analysis of rain induced attenuation using Mie Scattering theory has been carried out. Long-term meteorological data from different stations of India has been collected and analyzed. The attenuation of microwave through the atmosphere during rain along the direction of propagation for the path length is a function of rainfall, frequency and temperature.

The theoretical problem can be described by general equation:

E(r,t) = e-jk(η-1)Ei(r,t) Ei(r,t)=Ei ej2πft and the value of specific attenuation can be written as A=20kIm(η)ln10

Where, η is the refractive index of the water. By using Mie-scattering theory, regression analysis and curve fitting method a new modified distribution model have been developed. Based on available data attenuation is determined for different frequencies. Probability of excess attenuation caused by rain exceeds fade margin has been determined which gives service interruption (outage) due to rain.

A comparative study has been made with the theoretically obtained values of attenuation and measured values obtained at different frequencies. This help us to conclude the allowable fade margin to be provided in designing digital microwave communication systems.

OBSERVATIONS AND RESULTS

In India mostly C-band and frequencies below 10GHz are being used for communication, remote sensing and data transmission. Therefore there is need to explore the possibility of using Ku and 20/30GHz bands to meet ever increasing demand for more voice/video channels. Comparisons has been made on the basis of measured data and theoretical data obtained with empirical formula reported earlier. The results are presented in the form of curves as shown by fig. 1, 2, & 3.

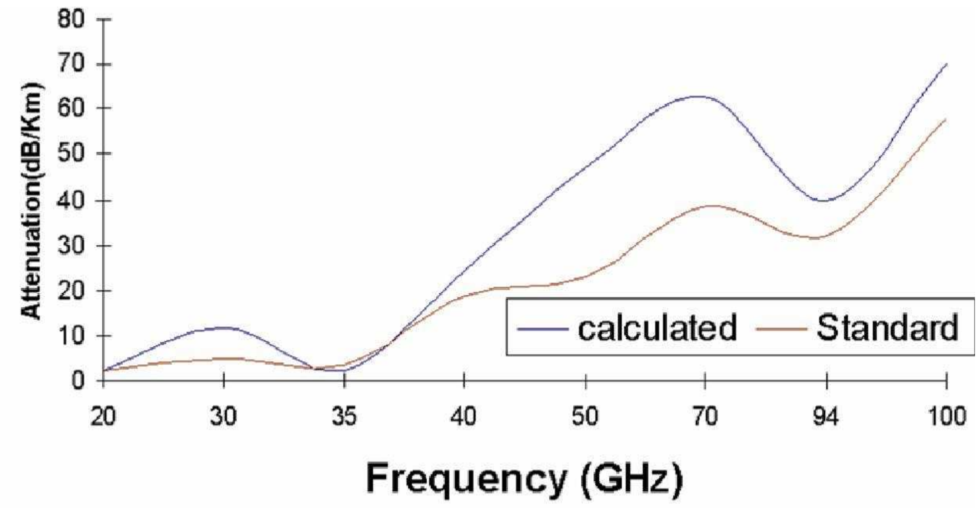

Figure 1.A comparison of Frequency Vs. Attenuation curve

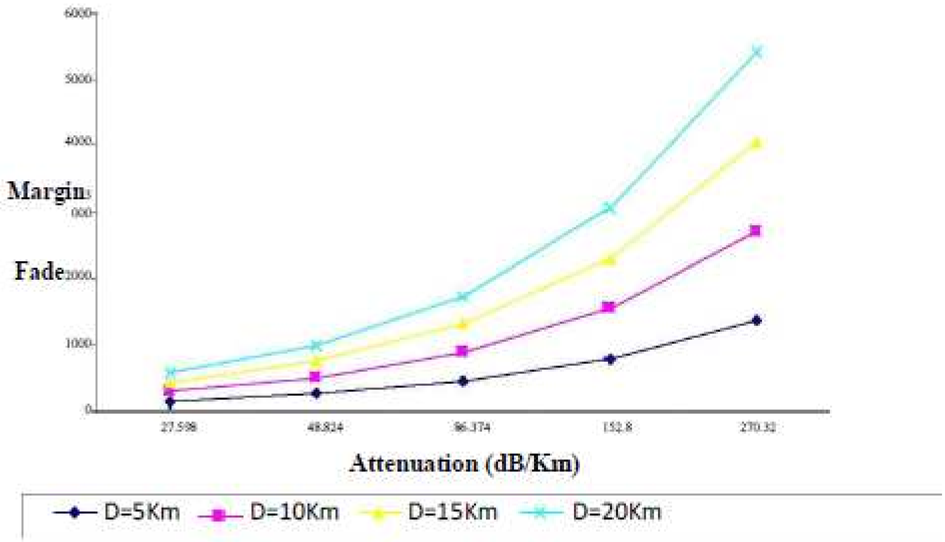

Figure 2.Attenuation Vs. fade margin curve for different Path length at 40GHz

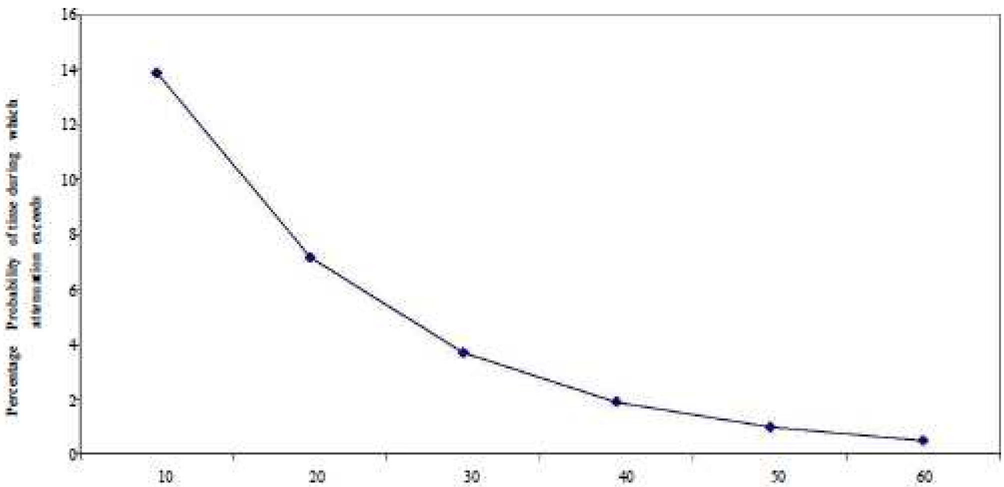

Figure 3.Percentage Probability of attenuation with exceeding Rain-rate

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