Scattering Measurement Due to Foliage of Western Rajasthan Region at 35 Ghz

Sandeep Rankawat, J.S.Purohit, D.R.Godara, S.K.Modi

Abstract- Abstract- Scattering phenomenon due to foliage plays an important role in millimeter band as the wavelength approaches to the order of the size of the obstacles. It is important to estimate the propagation attenuation due to scattering when the arid zone foliage leaves and twigs size affect adversely in millimeter band signal propagation. A 35 GHz trans-receiver link system was used to measure the attenuation through trees due to scattering pattern of tree foliage of western rajasthan region. Measurements were made to study the angular variations of the positioning of receiver unit around the target foliage. The measurements, which were made for HH polarization configurations over a wide range of the azimuth angle, provide a quantitative reference for the design of high speed data communication links and use of millimeter-wave bistatic radar, point to point communication systems.

Keywords- A35 GHz, millimeter wave, 35 GHz, scattering, Foliage, Western Rajasthan

I. INTRODUCTION

when they are transmitted, or propagated from one point to another, or into various parts of the atmosphere. Like light waves, radio waves are affected by the phenomena of reflection, refraction, diffraction, absorption, polarization and scattering. Understanding the effects of varying conditions on radio propagation has many practical applications, from choosing frequencies for international shortwave broadcasters, to designing reliable mobile telephone systems, radio navigation, radar systems in millimeter band.

Attenuation due to scattering recognized as a major limitation to reliable communication system operating at frequency above 10 GHz. It restricts the path length of radio communication systems and limits the use of higher frequencies for line-of-sight microwave links and satellite communications.

Scattering due to Foliage

In the classical electrodynamics, light is considered as electromagnetic wave, which is governed by the Maxwell Equations. Light waves incident on a material induce small oscillations of polarization in the individual atoms (or oscillation of electrons in metals) causing each particle to radiate a small secondary wave (in all directions, like a dipole antenna). All these waves add up to give specular reflection and refraction, according to the Huygens-Fresnel principle

Manuscript received March. 2014

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II. EXPERIMENTALSETUP

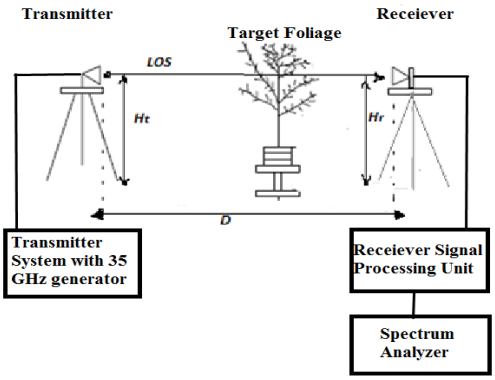

Figure.1 Block Diagram of 35 GHz Link System

the size of an obstacle is of the order of the wavelength of the signal or less, mie scattering occurs. An incoming signal is scattered into several weaker outgoing signals. The production of waves of changed direction, frequency, or polarization when radio waves encounter obstacles of the smaller size is called scattering. At typical cellular microwave frequencies, there are numerous objects, such as lamp posts and traffic signs, that can cause scattering. Thus, scattering effects are difficult to predict. Rayley Scattering occurs when an electromagnetic signal encounters a surface that is large relative to the wavelength of the signal. For example, suppose a ground-reflected wave near the mobile unit is received. Because the ground-reflected wave has a 1800 phase shift after reflection, the ground wave and the line-of-sight (LOS) wave may tend to cancel, resulting in high signal loss. Further, because the mobile antenna is lower than most human-made structures in the area, multipath interference occurs. These reflected waves may interfere constructively or destructively at the receiver. Power attenuated is measured with the help of spectrum analyzer at the end of receiver system. The locations of Govt. Engineering College Bikaner, Bikaner district of Rajasthan state are identified for extensive free-space point-to-point Path Loss, measurements in clear-sky and during natural weather conditions in Thar Desert region. Physical location of the transmitter and receiver systems heights of the transmitting and receiving antennas, distance of separation between the transmitting and receiving antennas, and calculated Line of Sight (LOS) propagation link lengths are observed. The tree leaves and branches also usually contain water and hence result in absorption and scattering of electromagnetic waves as they propagate through vegetation. Foliage can not only introduce attenuation and broadening of beam but also depolarization of electromagnetic waves. Transmission losses through

the vegetation are affected by various parameters such as the Dielectric ,density, physical size and shape.
The signal attenuations due to vegetation varies with height and is minimal at the trunk level, propagation results also indicate that signal attenuations increase sharply over shorter vegetation depths. However as the vegetations depth increase, scattering from trees tends to contribute toward the received signal and hence the increase in signal attenuation is not as sharp. The millimeter wave link system comprises a continuous-wave (CW) 35 GHz transmitter using a 100 mW Gunn source with a transmitting antenna of 18 degree beam width and 22 dB gain. The transmitter has provision for modulating the RF carrier.

III. OBSERVATION

Measurement Of Attenuation Due To Scattering

1. Power received at receiver in free space
(KHEJARI TREE (*Prosopis cieraria*))
Wind speed = 6km/hr Temperature = 32·C
Temperature: 24.2°C
Height of foliage: 3.5m
Depth of foliage: 1.9m
Height of transmitter: 2 m
Height of receiver: 2m
Distance between Tx and Rx: 8.8m
Reference Level: -12dBm

Table 1. Power received at receiver in free space

Sr. No.	Angle (°C)	Received Power (-dBm)	Attenuation (dB)
1	0	65.4	53.4
2	30	53	41
3	60	70.6	58.6
4	90	84.2	72.2
5	120	66.5	54.5
6	150	38	26
7	180	28.8	16
8	210	47.7	35.7
9	240	59.8	47.8
10	270	81.6	69.6
11	300	74.6	62.6
12	330	78	66
13	360	65.4	53.4

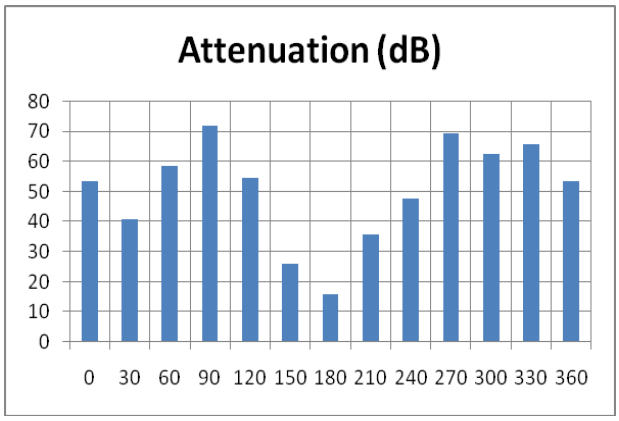

Figure.2 Graph between Angle and Attenuation

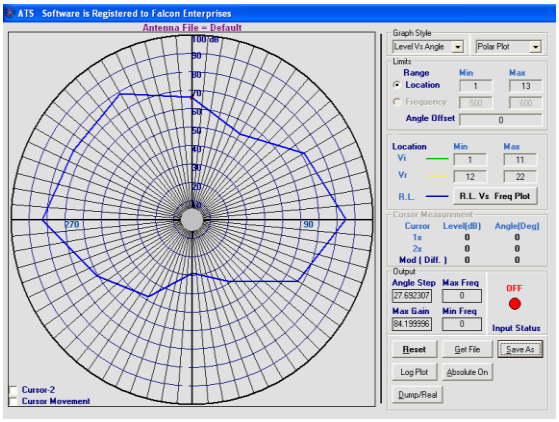

Figure.3 Radiation Pattern

IV. RESULTS OF SCATTERING

A minimum attenuation at 180° angle or at Line-of-sight angle and maximum attenuation at 90° angle from both side in case of Khejari tree and signal will be attenuate till 16dB is observed. The amount of attenuation is depending upon leaf structure of arid foliage. Signal scattering is more for 90o both side with compare to the back position for this case.

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