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Path Propagation Modelling at Frequency 2.45GHz in a building of Rajasthan

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***Abstract*— Numerous models are available for estimating RF signals using path propagation modelling for indoor as well as outdoor scenarios. Since all models are site specific, there is a vital need for such models for every propagation scenarios. In this paper we have tried to place boundaries for wireless systems for indoor RF as well as outdoor RF propagation at frequency of 2.45GHz. In our investigation we have worked upon a simplistic single slope model and have calculated path loss index for various scenarios in indoor and outdoor conditions. This calculated path loss index can be directly used to estimate the received power at any position of cell site in similar outdoor conditions modeled in our investigation.**

Keywords: Path loss index, LOS, NLOS, Attenuation, propagation models.

I. INTRODUCTION

The startling success and incredible expansion of wireless services has paved towards breaking the location barriers. Wireless communication is a global organization in telecom, which was founded in August 2001. The objective of wireless world is to formulate vision on strategic future research direction field among industry, scientific , medical and to generate and identify and promote research areas and technical trends for mobile and wireless system technologies [1]. This communication involves the transmission of information over a distance without wire, cables or any other forms of electrical conductors. The transmitted distance can be anywhere between a few meters and thousands of kilometers. The wireless method of communication uses low powered radio waves to transmit data between devices[2]. It is commonly used in telecommunication systems which use some form of energy to transfer information.

II. Measurement tools for propagation modeling

Transmitter	*Receiver*	*Antenna*
		

FIGURE 2.1 TRANSMITTER, RECEIVER AND ANTENNA USED FOR INVESTIGATION [1]

(a) Transmitter

The transmitter used for the investigation was an Agilent N9310A RF signal generator which provided a wide frequency range of 9 KHz to 3GHz with power level ranging from -127 to +3dbm. The modulation options available were AM, FM and pulse modulation.[1]

(b) Receiver

The Agilent N9340B is a handheld spectrum analyzer with a frequency range of 100 kHz to 3 GHz, tunable to 9 kHz. It has several different measurement modes. Each mode offers a set of automatic measurements that pre-configure the analyzer settings for ease of use. It provides ultimate measurement flexibility. The typical specifications include frequency range from 9 KHz to 3GHz and -144dbm average noise level with ±1.5 dB amplitude accuracy.[1]

(c)Antenna

At transmitter we used a sector antenna and at receiver we used a monopole antenna of suitable bandwidth at the given frequency of 900MHz & 2.1GHz.[1]

III. MEASUREMENT METHODOLOGY

For this exploration we have chosen three scenarios i.e. at first floor same corridor, in open field and in workshop. For this purpose we will set the transmitter at a definite power i.e. 0dBm, 5dBm, 10dBm, 15dBm and 20dBm. We will set the transmitter at the height of 2meters above the ground and will measure the received power at the receiver, the hand held receiver will slowly move in both LOS and NLOS. [7, 9]

FIGURE 3.1 MEASUREMENT CAMPAIGN

Scenario 1: Single side open gallery on a same floor:

In this exploration we used a RF signal generator and spectrum analyzer. This work is carried out on the first floor of electronics department. The transmitter was fixed at a height of 1.22 meters and receiver at a height of 1.20meters above the ground. The hand held receiver was slowly moved in LOS, the received power readings were taken at a distance of 30meters. The corridor was typically open on one side, the open end had concrete pillar at a regular distance of 2.16meters.The other end of corridor were classrooms with concrete wall and wooden door/window. This exploration was carried at frequency 2.45GHz and the transmitter was kept at 0dBm, 5dBm and 10dBm.

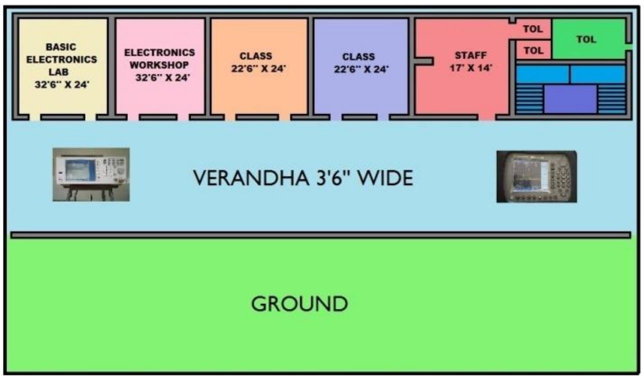

FIGURE 3.2: SCENARIO 1: SINGLE SIDE OPEN GALLERY ON SAME FLOOR:

Scenario 2: Transmitter and receiver in an open field: In this investigation we have chosen an open field area of approximate 2500 square feet with one side have two story college building and a workshop shades with asbestos roofing. In this we have kept the transmitter at a corner of this Quadra angle and then slowly move the hand held spectrum analyzer. The transmitter was kept at the height 1.69 meters above the ground on three different paths to calculate the received power. These three paths were category chosen as path1 was pure line of sight propagation with not obstacles in between. Path2 have little vegetation and also tall trees in between the propagation path. In path 3 a two story building was between the transmitter and receiver as demonstrated in figure 4.3.

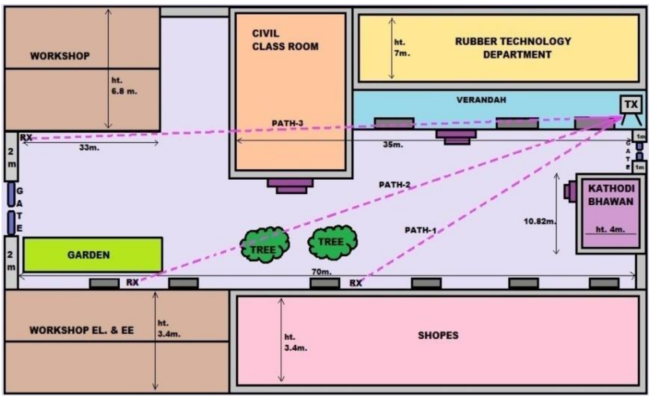

FIGURE 3.3: SCENARIO 2: SCHEMATIC DIAGRAM OF SCENARIO 2 (PATH 1)

Scenario 3: Transmitter and receiver in mechanical workshop: In this we have chosen our investigation area to be our college workshop. This workshop was measured 33×13.20m with approximate height of 10 meters with asbestos sheets placed over iron frame structure. The LOS contains plenty of wooden work benches, iron cupboards and machines such as lath, drilling, milling, welding etc. the transmitter was kept at a height of 1.29m and was slowly moved.

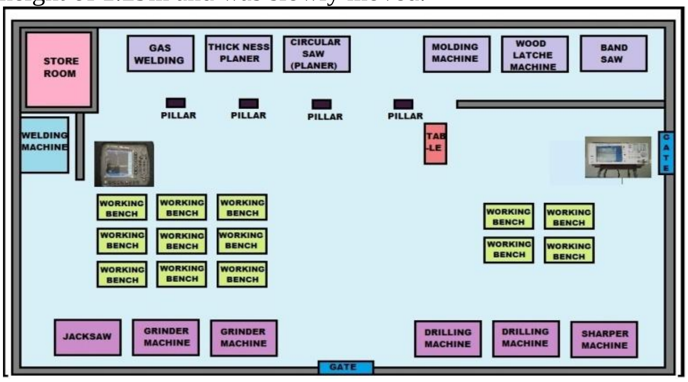

FIGURE 3.4: SCENARIO 3: SCHEMATIC DIAGRAM OF SCENARIO 3

IV. RESULT

Measurement of path loss index using single slope model.

Single Slope Model

The overall mean signal attenuation as a function of distance follows ‘a $1\backslash d^{n}$’ law, where d is the distance between the transmitter and the receiver and n is the slope index ranging typically from 2 to 6 depending on the environment.where n = 2 depict the attenuation in free space i.e. fall of 20 dB power per decade of distance, the characterization of signal attenuation with a single decay factor (n) is very useful[10-12]. Once a site specific factor n is estimated, a system designer finds it easy to use the factor for his calculation purpose. Several empirically based path loss models have been developed for different propagation environments, a similar effort has been done for developing models for Indoor, Indoor-Outdoor and Outdoor scenario using field measurements typically at 900 MHz and 2.1 GHz [2, 3, 4, 19].

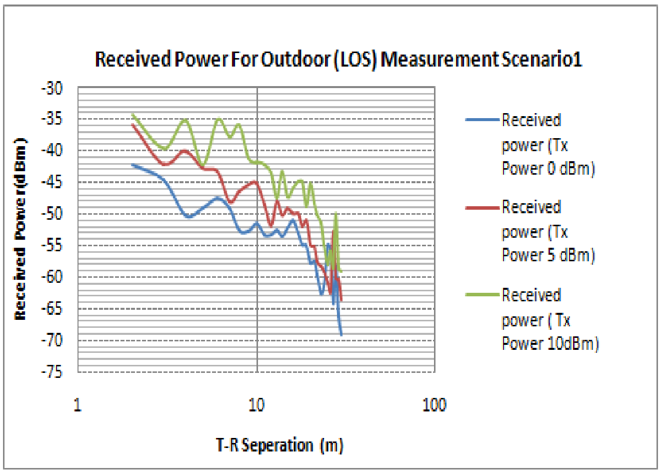

FIGURE 4.1: GRAPH FOR RECEIVED POWER AS A FUNCTION OF DISTANCE FOR OUTDOOR (LOS) MEASUREMENT AT 2.45GHZ

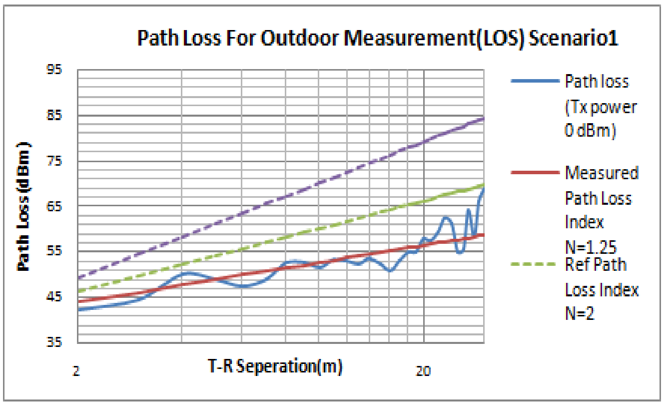

FIG 4.2: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 0DBM

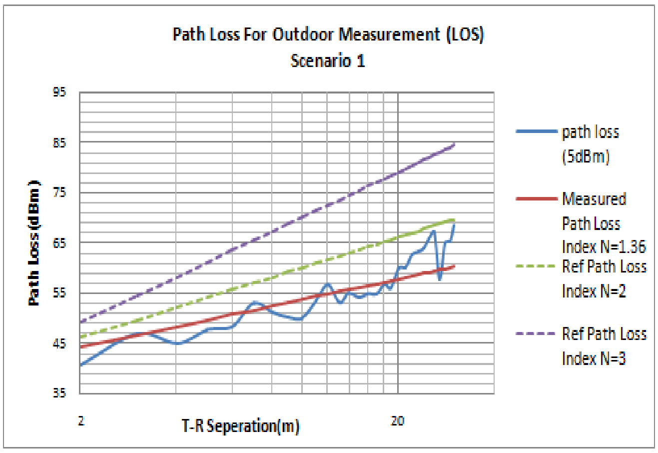

FIG 4.3: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 5DBM

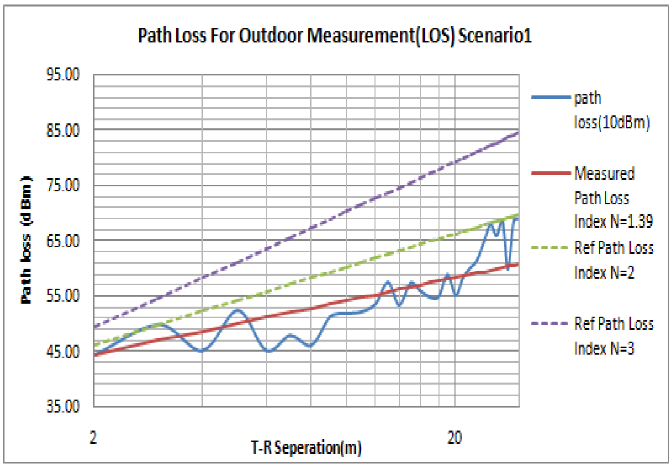

FIG 4.4: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 10DBM

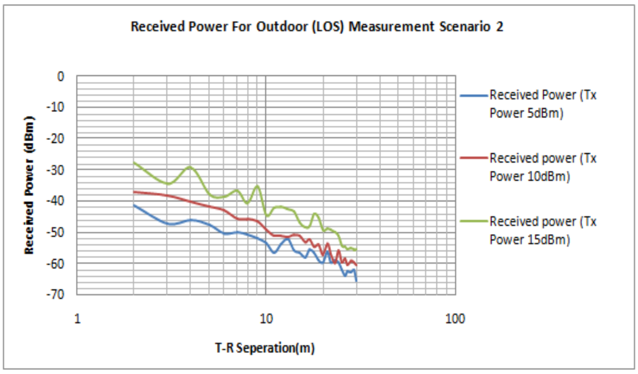

FIG 4.5: GRAPH FOR RECEIVED POWER AS A FUNCTION OF DISTANCE FOR OUTDOOR (LOS) MEASUREMENT AT 2.45GHZ

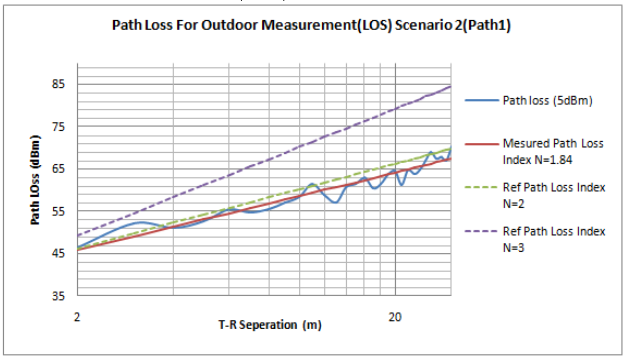

FIG 4.6 : : GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 5DBM

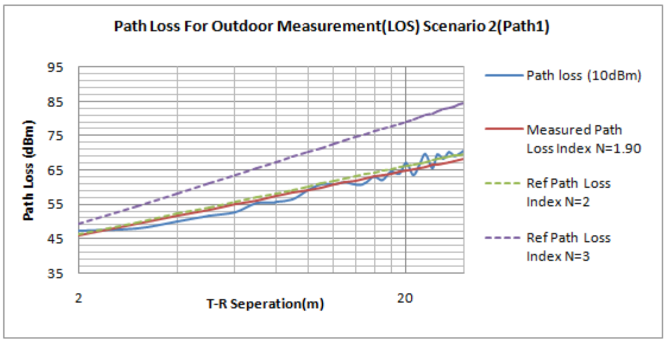

FIG 4.7: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 10DBM

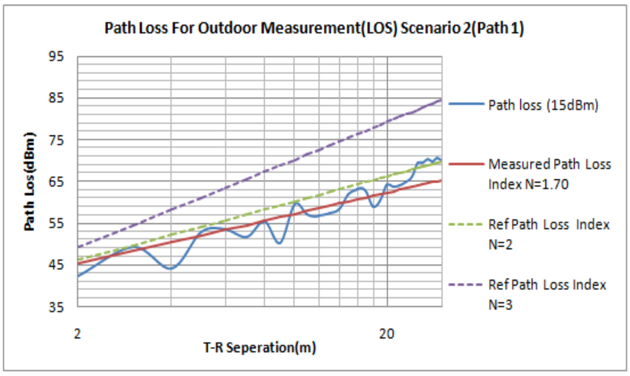

FIG4.8: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 15DBM

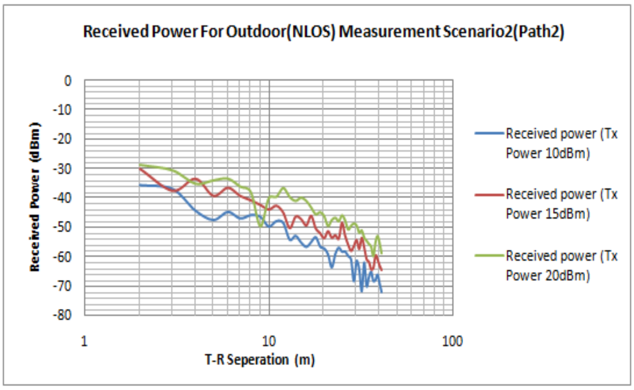

FIG 5.9: GRAPH FOR RECEIVED POWER AS A FUNCTION OF DISTANCE FOR OUTDOOR (NLOS) MEASUREMENT AT 2.45GHZ

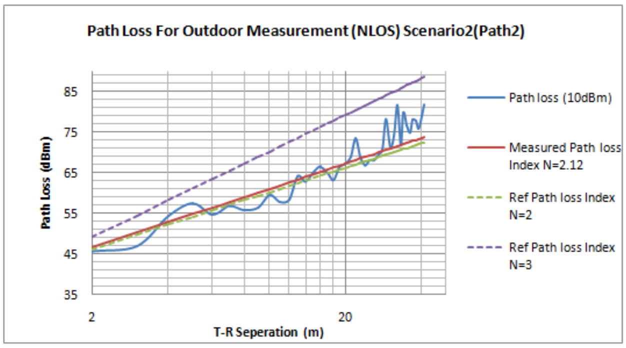

FIG 5.10: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 10DBM

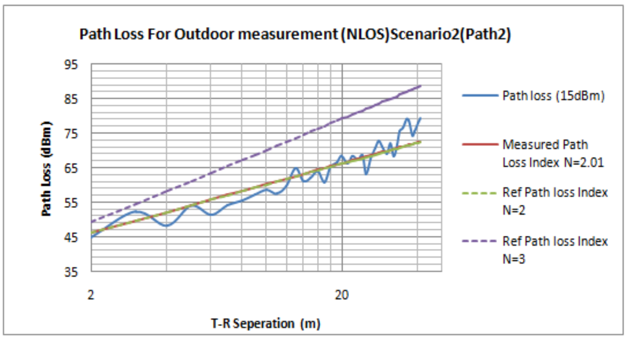

FIG 5.11: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 15DBM

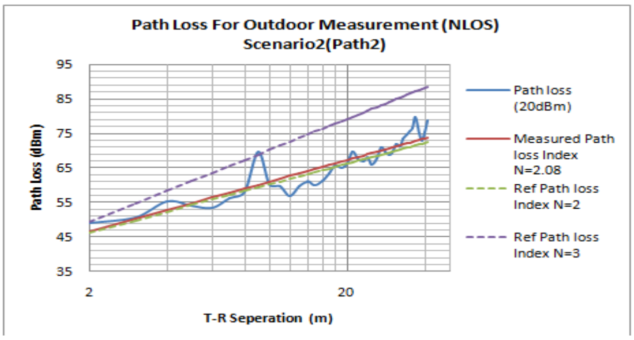

FIG 5.12: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 20DBM

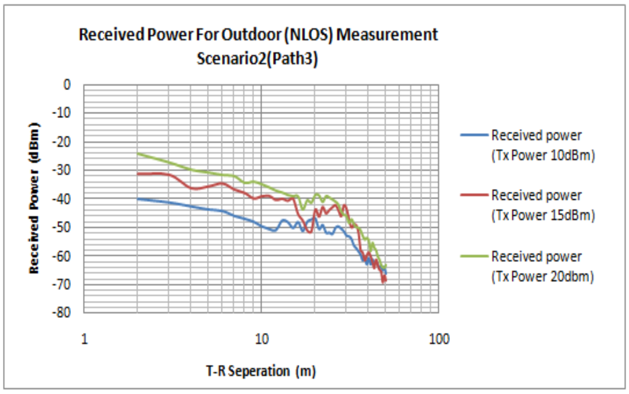

FIG 4.13: GRAPH FOR RECEIVED POWER AS A FUNCTION OF DISTANCE FOR OUTDOOR (NLOS) MEASUREMENT AT 2.45GHZ

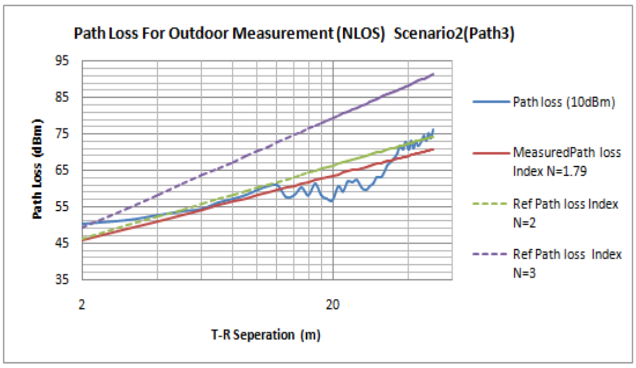

FIG 4.14: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 10DBM

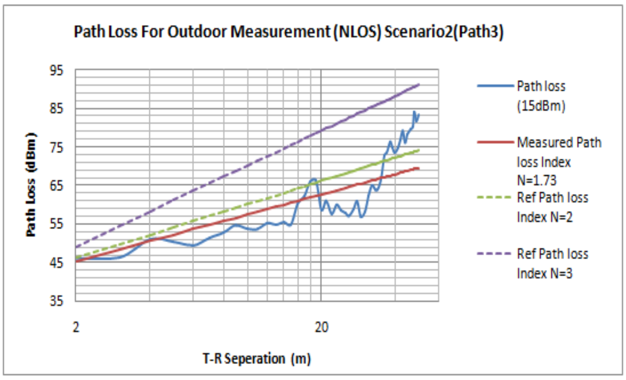

FIG 4.15: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 15DBM

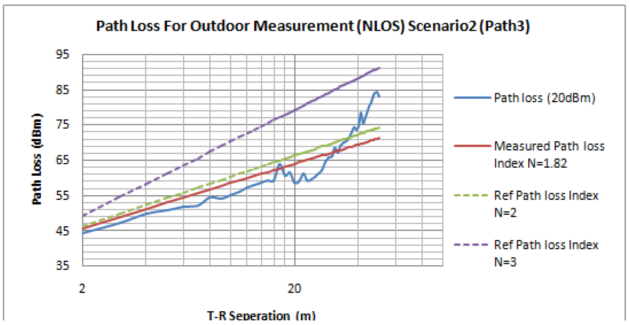

FIG 4.16: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 20DBM

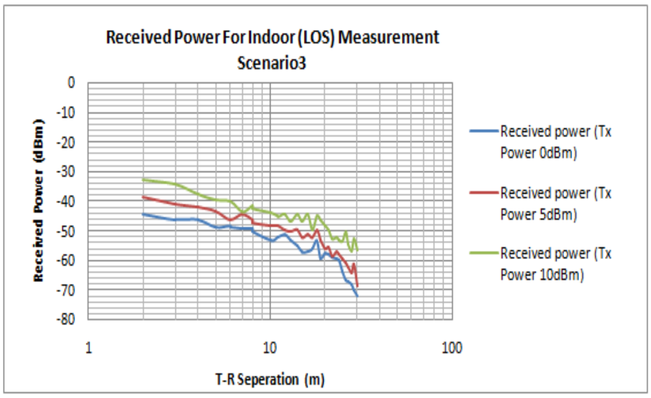

FIG 4.17: GRAPH FOR RECEIVED POWER AS A FUNCTION OF DISTANCE FOR INDOOR (LOS) MEASUREMENT AT 2.45GHZ

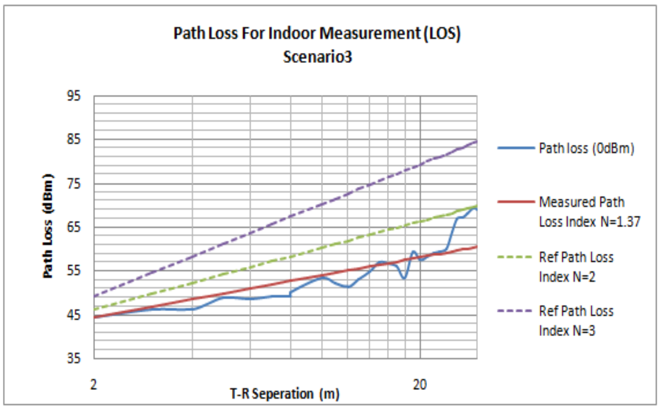

FIG 4.18 : : GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 0DBM

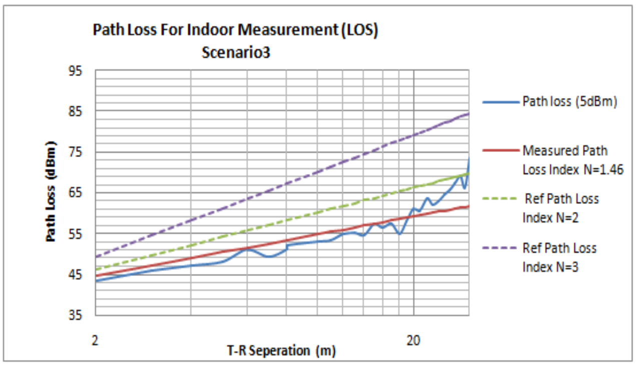

FIG 4.19: : GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 5DBM

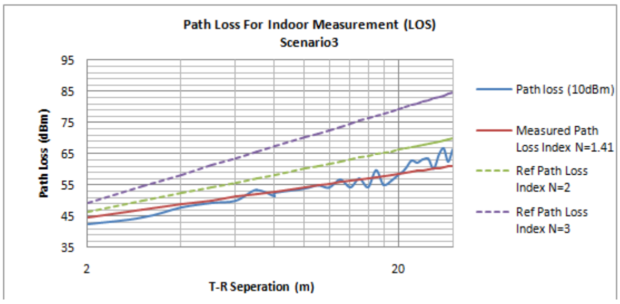

FIG 4.20: GRAPH FOR PATH LOSS AS A FUNCTION OF DISTANCE FOR OUTDOOR MEASUREMENT AT 2.45GHZ AT TRANSMIT POWER 10DBM

V. OBSERVATIONS

.	path loss index at various Tx powers					Average Path Loss Index
	0dbm	5dbm	10dbm	15dbm	20dbm	
1. first floor (In a Corridor with LOS)	1.25	1.36	1.39	-	-	1.33
2. In an Open field with no Obstacles	-	1.84	1.9	1.7	-	1.8
3. In an open field with few trees as Obstacles	-	-	2.12	2.01	2.08	2.07
4. In open field with building as obstacles	-	-	1.79	1.73	1.82	1.78
5. In mechanical workshop with machines and working benches as obstacles	1.37	1.46	1.41	-	-	1.41

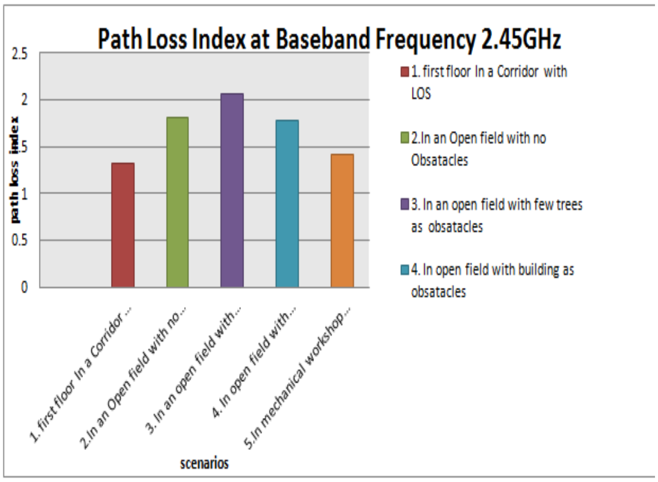

FIGURE 5.1 : PATH LOSS INDEX AT DIFFERENT FREQUENCY AND SCENARIOS

VI. CONCLUSION:

The basic aim for this investigation was to determine path loss index using simple single slope attenuation model. The path loss index was determined for two frequencies i.e. at 900MHz and 2.1GHz for both LOS and NLOS scenarios. This path loss index will act as a very simple tool to calculate power at the site of any similar cell, before actual installation of the transmitter and receiver. The experimental finding proved that the path loss index was generally higher by 25% to 50% for 2.1GHz as compare to 900MHz. In scenarios 1 i.e. gallery model the path loss index was even less than 2 which is a free path loss index, this result leads to the conclusion that the gallery effect supports the RF propagation and probably it acts somewhat like a waveguide. Also the path loss index increase substantially as the number of floors increases. The result can be summarized as between transmitter and receiver path loss index increase with frequency and also with number of floors between transmitter and receiver.

VII. FUTURE SCOPE

Finally with a futuristic whim the present work leaves some more brain storming thoughts. For the upcoming research work in RF planning. The work presented in this paper can be extended to the case of multiple carrier frequencies.

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Dr. Deepak Gupta was born in Jodhpur, India in 1973. He received B.E. (Hons) in 1995 in Electronics & Communication Engineering and M.E. in Digital Communication from MBM Engineering College, JNV University, Jodhpur (India). He joined as lecturer in Electronics in Vidya Bhawan Polytechnic College, Udaipur in 1996; presently he is Head of Electronics Department and Computer science department in the Institute. His Ph.D. work is on "Channel Optimization Techniques in Urban Outdoor and Indoor Indian Environment using Multiple Input Multiple-Output Technology".