

**PARAMETER OPTIMIZATION FOR INDOOR COMMUNICATION
NETWORK USING CSP TECHNIQUE**Jyoti¹, Tarun Dala²¹ Mtech Student CSE Deptt., CBS Group Of Institutions, Jhajjar, Haryana, India² Asst. Professor, CSE Deptt., CBS Group Of Institutions, Jhajjar, Haryana, India

Abstract:- Indoor communication Network is an ad-hoc network that is limited to a small area such as a room or the building. It is an open standard for wireless connectivity. In such network, the communication strength depends on the propagation type used in the network. There are number of such propagation methods to provide effective communication over the network. To achieve the effective communication, an effective propagation must be selected for the communication. This propagation method deals with the channel selection, channel sensing and to perform the effective communication over the network. There are number of constraints that affect the communication over a network. To achieve the effective output from the network, it is required to define network under defined constraints. These all constraint depends on type of network, its topology and the type of communication performed in that network. The presented work is focused on the communication analysis for an indoor mobile network. These propagation methods also affected from different network, environmental and communication parameters. The presented work is to perform the parametric analysis under density, distance and energy constraints so that effective communication will be drawn, also to reduce the BER in a noisy channel. The work is performed on three different models, they are: ray-leigh indoor propagation model, friis model ,log distance shadowing model. The work is to define a constraint specification approach for the optimization of communication in indoor communication network.

Keywords- Indoor mobile network, CSP ,Fading, Rayleigh propagation model, Friis equation, Log distance shadowing propagation model, BER,.

I. INTRODUCTION

Indoor Propagation is a short range radio link wireless connectivity to connect the peripherals with in a room or small area in a building. With indoor radio communication, there is rarely a line of sight between the transmitter and receiver, and multiple signal propagation paths exist. The wireless indoor communications can be used in a wide range of applications to provide for user mobility, easy setup, and reconfiguration of terminals, telephones, and so forth. Industry-wide Indoor Propagation promises very substantial benefits for wireless network tasks, end workers and content developers of impressive new applications. This article explores into the implementation and architecture of Indoor Propagation. It also describes the functional overview and applications of Indoor Propagation, and deals with the development of a model for recounting, printing, supervising, and controlling of eight process variables at the same time, using a dispersed control system.

II. INDOOR MOBILE NETWORK

Predicting the propagation characteristics between a transmitter and a receiver antenna is fundamental for designing wireless networks. The investments are highly related to the spectrum availability and associated authorization options in case of indoor mobile network. A radio reproduction model which is also known as the Radio Wave Propagation Model is a factual mathematical formulation for the characterization of radio wave propagation as a function of frequency, distance and energy etc. The main factors which affect the indoor radio propagation are walls and indoor obstacles. Studies show that there is no linear relationship between the radio wave attenuation and floors number in multistoried buildings and the reasons are reflection between the buildings and diffraction generated by the windows. A single model is usually developed to envision the behavior of propagation for all similar links under similar constraints. Designed with the target of determining the way radio waves are propagated from one place to another, such models predict the path loss along a link or the effective coverage area of a transmitter. The ITU indoor generation model, also known as ITU model for indoor fading, is a radio reproduction model that finds the path loss inside a room or a closed area inside a building delimited by walls of any kind. Sufficient for appliances designed for indoor use, this model calculates the total path loss an indoor link may experience. This model is applicable to only the indoor environments.

The ITU indoor path loss model is formally expressed as:

$$L = 20 \log f + N \log d + P_f(n) - 28 \dots \dots \dots (1)$$

Where

L = energy loss of signal

f = spectrum frequency of the signal

d = space measured between the transmitter & receiver

N = distance power loss coefficient

P_f = floor loss factor

n = no. of users

Estimation of distance power loss coefficient

The distance power loss collateral, N is the portion that expresses the loss of signal power with distance. This collateral is an empirical one.

Estimation of floor penetration loss factor

The floor penetration loss factor is a constant dependent on the number of floors the waves need to penetrate.

Mean received power is just one aspect of the first-order behavior of radio channels. In order to have a better understanding of the first-order behavior of radio channels, the received signal power or envelope Probability Density Function (PDF) is necessary. Since power P is just the square of envelope, the power PDF and the envelope PDF can be interconvert according to:

$$f_p(p) = (1 / 2\sqrt{p}) f_u(\sqrt{p}) \dots \dots \dots (2)$$

$$f_u(u) = 2u f_p(u^2) \dots \dots \dots (3)$$

III. RAY-LEIGH PROPAGATION MODEL

In wireless communications, fading is deviation of the attenuation affecting a signal over certain propagation media. The attenuation may vary with time, geological locations or radio frequency, and is often formed as a regular process. A fading channel is a communication channel consisting fading. In wireless environment, fading may either be due to multipath propagation, referred to as multipath induced fading, or because of shadowing from rovers affecting the wave motion, sometimes referred to as shadow fading. Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal, that used by wireless devices.

Rayleigh fading models assume that the magnitude of a signal that has passed through such a transmission medium (also called a communications channel) will vary regularly, or attenuate, according to a Rayleigh distribution — the radial component of the sum of two uncorrelated Gaussian variables.

Rayleigh fading is a reasonable model for tropospheric and ionospheric signal propagation as well as the effect of heavily built-up urban environments on radio signals.^{[1][2]} Rayleigh fading is most applicable when there is no dominant propagation along a line of sight between the transmitter and receiver.

Rayleigh fading is a reasonable model when there are many objects in the environment that scatter the radio signal before it arrives at the receiver. The main limit theorem states that, if there is suitably much scatter, the channel influence response will be well-modelled as a Gaussian process irrespective of the distribution of the individual components. If there is no prevailing component to the scatter, so that operation will have zero mean and phase evenly distributed between 0 and 2π radians. The case of the channel response will therefore be distributed. Calling this random variable R , it will have a probability density function:^[1]

$$p_R(r) = \frac{2r}{\Omega} e^{-r^2/\Omega}, \quad r \geq 0 \dots \dots \dots (4)$$

Where $\Omega = E(R^2)$

Often, the gain and phase elements of a channel's distortion are conveniently represented as a complex number. In this case, Rayleigh fading is presented by the assumption that the real and imaginary parts of the response are modeled by independent and identically distributed zero-mean Gaussian processes so that the amplitude of the response is the sum of two such processes

IV. LOG DISTANCE SHADOWING PROPAGATION MODEL

The log-distance path loss model is a radio propagation model that predicts the path loss, a signal confrontation inside a building or densely populated areas over distance. The model is used to predict the propagation loss for a wide range of environments. The model Log-distance path loss model is formally expressed as:

$$PL = P_{Tx_{dBm}} - P_{Rx_{dBm}} = PL_0 + 10\gamma \log_{10} \frac{d}{d_0} + X_g,$$

Where

PL = total path loss ,units in Decibel (dB)

$$P_{Tx_{dBm}} = 10 \log_{10} \frac{P_{Tx}}{1mW}$$

is transmitted power in dBm

P_{Tx} is the transmitted power in watt.

$$P_{Rx_{dBm}} = 10 \log_{10} \frac{P_{Rx}}{1mW}$$

is the received power in dBm, where

P_{Rx} = is the received power in watt.

PL_0 = is the path loss at the reference distance d_0 . Unit: Decibel (dB)

d = is the length of the path.

d_0 = is the reference distance, usually 1 km (or 1 mile).

γ = is the path loss exponent.

X_g = is a normal (or Gaussian) random variable with zero mean , reflecting the attenuation (in decibel) caused by flat fading.

In case of no fading, this variable is zero. In shadow fading or slow fading, only this random variable may have Gaussian distribution having σ standard deviation in decibel, arise in log-normal distribution of the received power in Watt. In only

fast fading, caused by multipath propagation, the corresponding gain in Watts $F_g = 10^{\frac{-X_g}{10}}$ may be modeled as a random variable with Rayleigh distribution or Rician distribution.

V. FRIIS MODEL

In telecommunication ,free-space path loss (FSPL) is the loss in signal strength of an electromagnetic wave that would result from a line –of-sight path through free space, with no obstacles nearby to cause reflection or diffraction.The FSPL appears in vaccum under ideally conditions, e.g. a radio communication between satellites.

The Friis transmission equation is used in telecommunications engineering, and feeds the power accepted by one antenna under idealized conditions given another antenna some distance away transmitting a known amount of power. In its simplest form, the Friis transmission equation is as follows. Taken two antennas, the ratio of power at the input of receiving antenna, P_r , to output power of transmitting antenna, P_t , is :

$$\frac{P_r}{P_t} = G_t G_r \left(\frac{\lambda}{4\pi R} \right)^2 \dots\dots\dots(5)$$

where G_t and G_r are the antenna gains (with respect to an isotropic radiator) of the transmitting and receiving antennas respectively, λ is wavelength, and R is the space between the antennas. The reciprocal of the factor in parentheses is the so-called free-space loss of path. The wavelength and distance units must be the same. We introduce one of the most fundamental equations in antenna approach i.e.the Friis Transmission Equation. The Friis Transmission Equation used to find the power received from one antenna (with gain G_1), when transmitted from another antenna (with gain G_2), by a distance R , and operating at frequency f or wavelength λ .

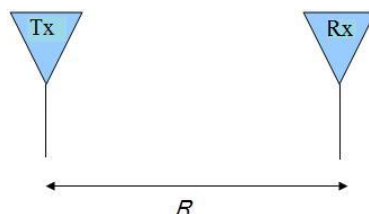


Figure 1. Transmit (Tx) and Receive (Rx) Antennas separated by R.

Another useful form of the Friis Transmission Equation is given in Equation [2]. Since wavelength and frequency f are related by the speed of light c , the Friis Transmission Formula in terms of frequency:

$$P_R = \frac{P_T G_T G_R c^2}{(4\pi R f)^2} \quad \text{[Equation 2]}$$

.....(6)

shows that more power is lost at higher frequencies. This is a result of the Friis Transmission Equation. This understood that for antennas with specified gains, the energy transfer will be peak at lower frequencies. The distinction between the power received and the power transmitted is known as path loss. Friis Transmission Equation cleared that the path loss is higher for higher frequencies.

VI. BIT ERROR RATE (BER)

The Bit Error Rate (BER) is a key parameter for measuring the quality of radio links. . The BER provides an end-to-end measure of radio links. Unlike other parameters stated above which reflects radio link quality indirectly, the BER measures the link quality directly, i.e. the SNR, the average fade duration etc reflect the radio link quality through their impacts on the BER. Hence, the BER is the fundamental parameter for radio link quality and it has been widely used. Another relevant parameter is the Bit Error Probability (BEP). The BER can be considered as the estimate of the BEP. The larger the total number of the transferred bits is, the more accurate the estimate becomes.

It is defined as the ratio of the number of error bits to the total number of transferred bits

$$BER = \frac{N_{error}}{N_{total}} \quad \text{.....(7)}$$

where N_{error} and N_{total} are the number of error bits and the number of transferred bits, respectively.

In radio propagation channels, the received signal power fluctuates as a function of the time, space and frequency. To quantify the impacts of fading channels on the system performance, a wireless network designer must quantify first the distribution of the received signal power or voltage envelope. Mean received signal power, SNR and SINR

Among all the first-order fading statistics, the mean received signal power is may be the most common parameter since it is the most intuitive measure of the radio link quality. According to the Shannon's Theorem, the achievable channel capacity C is a function of the available bandwidth B and the Signal-to-Noise Ratio (SNR) as follows

$$C = B \log_2(1 + S/N) \quad (3.22) \quad \text{.....(8)}$$

Where S and N are the mean received signal power and the mean noise power, respectively. The Ratio S/N is the SNR.

In AWGN channels, the SNR has an explicit relationship with the BER of radio channels. The bigger the SNR, the smaller the BER (i.e. the better the radio channels).

VII. RESULTS

The results are figured out based on the Rayleigh propagation model, Friis transmission model, Log distance shadowing propagation model .The initial parameters are set as the creation of 30 nodes is done in a topological environment. The network topology coverage area is set as :

$$\text{Coverage area} = (2 * \text{width} * \text{height}) / \text{total no. of nodes} \quad \text{.....(9)}$$

Where the height & width is set to 100 & 100. Then, the graph between capacity of signal & distance is figured out. On that signal strength basis the spectrum frequency is figured out against the time. Then the Energy Loss of signal transmission is the final output. The Energy Loss is :-

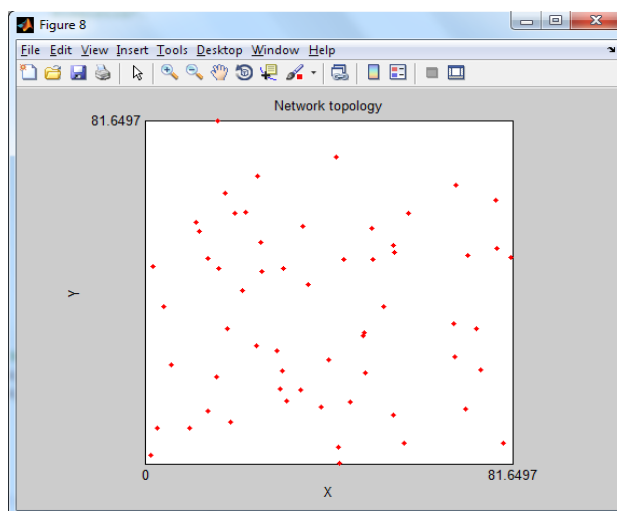


Fig 1: Network topology of 30 nodes

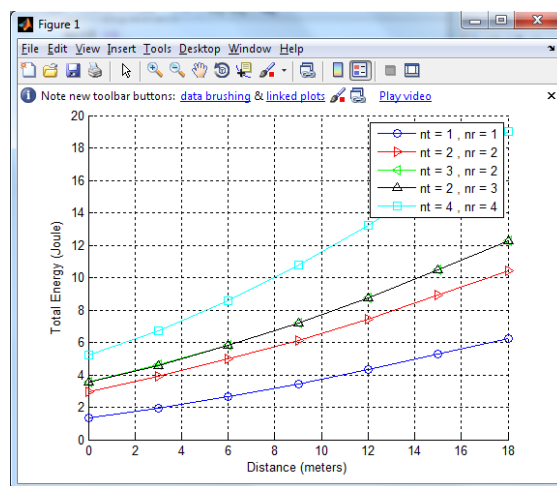


Fig 2: graph between energy of signal and distance of Rayleigh model

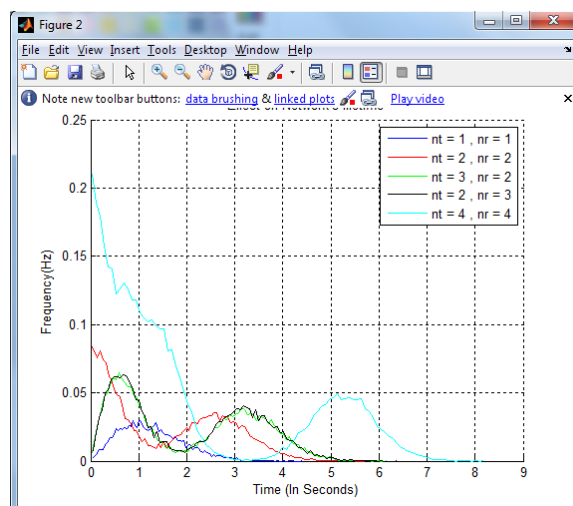


Fig 3: Graph between spectrum frequency and time of Rayleigh model.

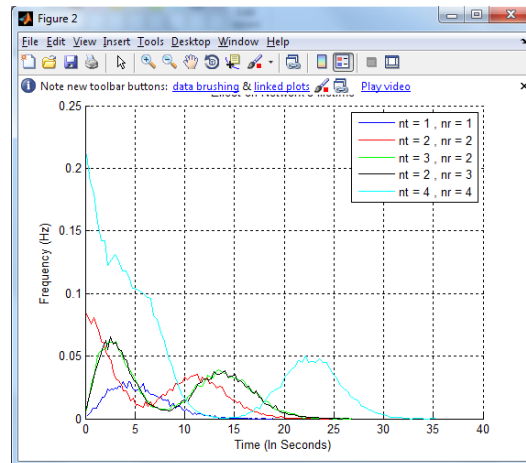


Fig 4: Graph between spectrum frequency and time of Log distance shadowing model.

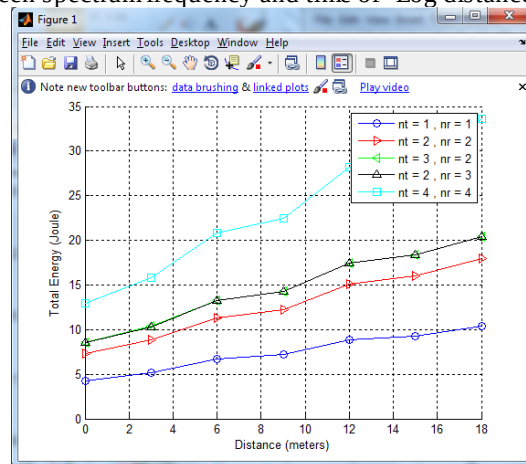


Fig 5: graph between energy of signal and distance of Log distance shadowing model

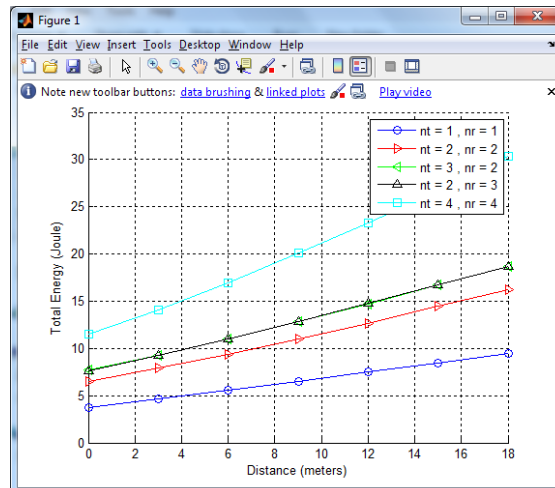


Fig 6: graph between energy of signal and distance of friis model

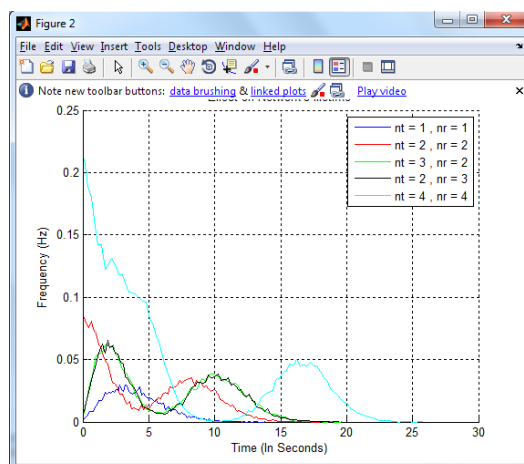


Fig7: Graph between spectrum frequency and time of Friis model.

BER PERFORMANCE OF THREE DIFFERENT MODELS:

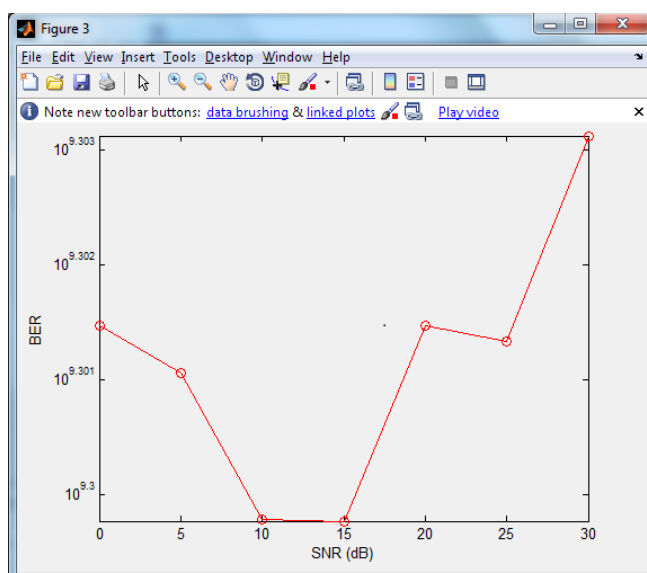


Fig 9: Ber Performance Of Rayleigh Model

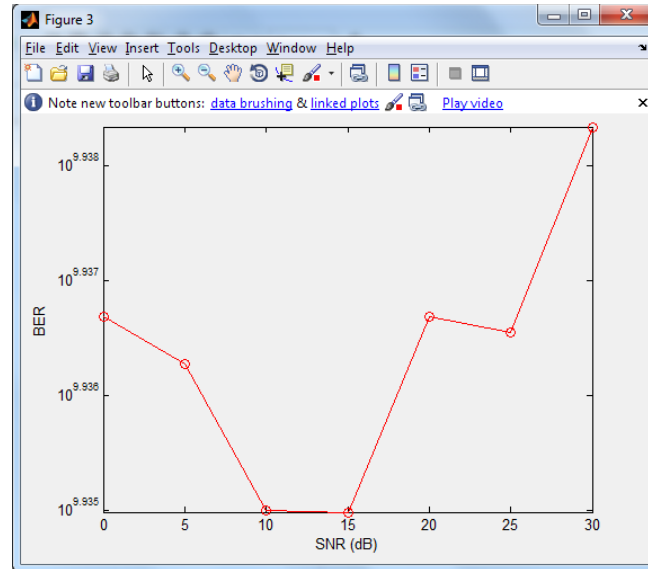


Fig 10: BER Performance Of Log Distance Propagation Model

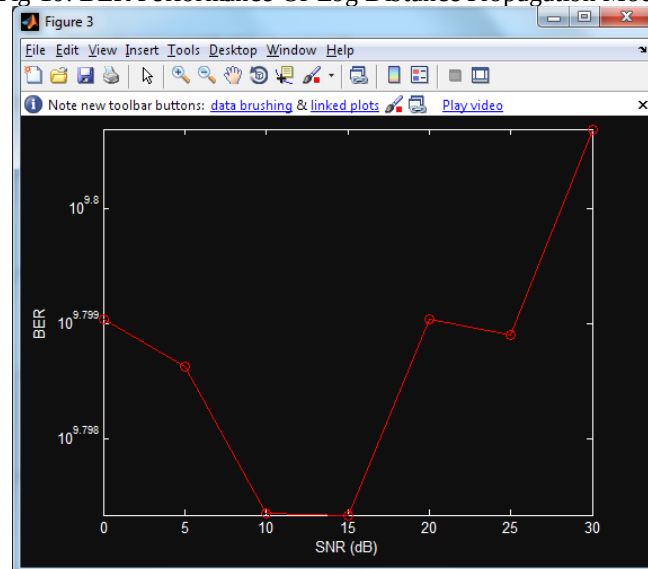


Fig 10 BER Performance Of Friis Propagation Model

VIII. COMPARISON

The output result of Rayleigh propagation energy loss is $3.9978 * 10^{10}$ and the energy loss by the friis transmission model is $1.2572 * 10^{10}$ and the total energy loss by the log distance shadowing model is $1.7262 * 10^{10}$ which is lesser than the others parameters if we have taken.

IX. CONCLUSION

This paper presented a brief survey of basic solving techniques based on constraint programming . An overview of the main technique of solving constraint optimization problem i.e. branch and bound algorithm has been used. There are various wireless indoor propagation models used for channel communication using the constraint satisfaction algorithm. Besides, many radio propagation simulators provide only the mean power prediction, but it has been shown that fading has also an important impact on the system performance. Hence, the fading information was extracted based on the Ray-Leigh model, Friis Model and Log distance shadowing Model and then an accurate prediction of the Energy loss was achieved. The prediction of the Energy loss has been tackled for three parameters: distance, density, energy. As is known, the BER depends not only on the mean power, but also on the fading severity. The Friis model is the best one to signal strength and energy loss.

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