

# Constraint Satisfaction Algorithm to Improve Energy Loss & Ber for Indoor Mobile Network

**Monika Rani, Mrs. Tulika Das**

CSE Deptt, PDMCEW MDU Rohtak, India.

Asst. Professor, CSE Deptt., PDMCEW MDU Rohtak, India.

[monika.kadian2611@gmail.com](mailto:monika.kadian2611@gmail.com)

[tulikagoel2004@gmail.com](mailto:tulikagoel2004@gmail.com)

**Abstract:** - When the network environment is defined then some physical properties of network are set such as propagation type, spectrum type etc. These properties control the network 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. This is an adhoc network that is limited to a small area such as a room or the building. The network is congested having a small range of communication for each node. 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. These propagation methods also affected from different network, environmental and communication parameters. To optimize the indoor communication network by setting up some channel specific constraints under different parameters. The work is about to perform the effective deployment in case of channel noise and disruption analysis. The presented work will be performed on three different models, they are: ray-leigh indoor propagation model, friis model, log distance shadowing model. The work is about to reduce the BER while performing the communication in indoor network under different distance and density constraints.

computing, and data synchronization such as for address bookrack calendars. Other pertinence could include home networking and home applications of the future such as smart gadgets, heating systems, and entertainment devices.

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

## I. INTRODUCTION

In the Indoor Propagation is a method for data communication that used short-range radio links to replace cables between computers and their connected units. 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.

Indoor Propagation is an open standard for wireless connectivity with supporters mostly from the PC and cell phone industries. Not exceptionally, its primary marker is for data and voice transfer between communication devices and PCs. Therefore, it is similar in purpose to the IrDA agreement, Indoor Propagation; this is a radio frequency (RF) technology utilizing the unauthorised 2.5 GHz industrial, scientific, and medical (ISM) band. Bulls'eye applications include PC and tangensial networking, unseen

## II. INDOOR MOBILE NETWORK

A radio reproduction model, also known as the Radio Wave Propagation Model or the Radio Frequency Propagation Model, is an factual mathematical formulation for the characterization of radio wave propagation as a function of frequency, distance and energy etc. 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. Typically, such gadgets use the minimum microwave bands usually 2.4 GHz. This model used for a much wider range. The Coverage Frequency is 900 MHz to 5.2 GHz.

The ITU indoor path loss model is perfectly depicted 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<sub>f</sub> == 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.

**III. RAY-LEIGH PROPAGATION MODEL**

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:

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

$$f_a(a) = 2a f_p(a^2) \dots \dots \dots (3)$$

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.<sup>[1][2]</sup> 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:<sup>[1]</sup>

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

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. FRIIS MODEL**

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<sub>r</sub>*, to output power of transmitting antenna, *P<sub>t</sub>*, is :

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

where *G<sub>t</sub>* and *G<sub>r</sub>* 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<sub>t</sub>*), when transmitted from another antenna (with gain *G<sub>r</sub>*), by a distance *R*, and operating at frequency *f* or wavelength *λ*.

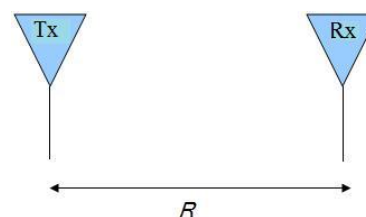


Figure 1. Transmit (Tx) and Receive (Rx) Antennas separated by *R*.

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:

$$P_R = \frac{P_T G_T G_R c^2}{(4\pi R f)^2} \dots\dots\dots(6)$$

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.

### V. 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

$PL_0$  = 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).

$\gamma$  = 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  $\sigma$  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.

### VI. BIT ERROR RATE (BER)

The Bit error rate and bit error probability The Bit Error Rate (BER) is a ~~Equation 21~~ for measuring the quality of radio links. It is defined as the ratio of the number of error bits to the total number of transferred bits

$$BER = \frac{N_{error}}{N_{total}} \dots\dots\dots(7)$$

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

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

$$C = B \log_2(1 + S/N) \dots\dots\dots(8)$$

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 :

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

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 :-

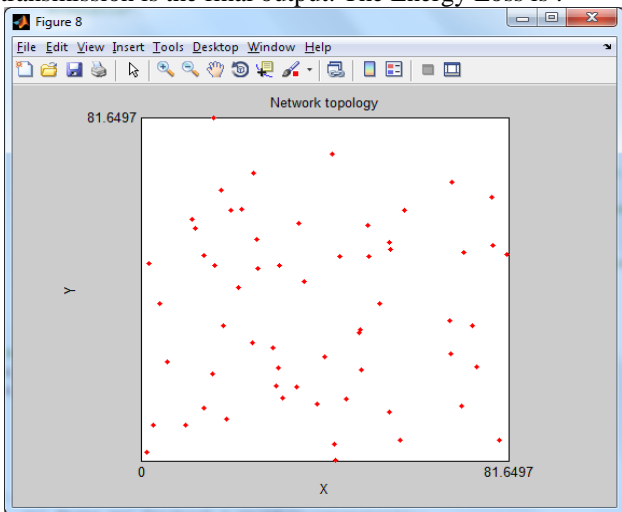


Fig 2: Network topology of 30 nodes

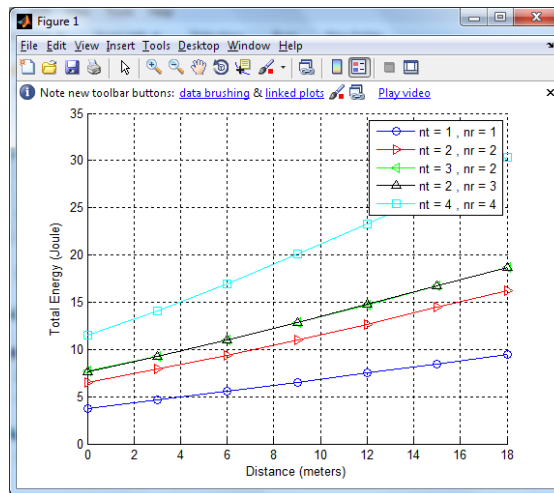


Fig 5: graph between energy of signal and distance of Friis model

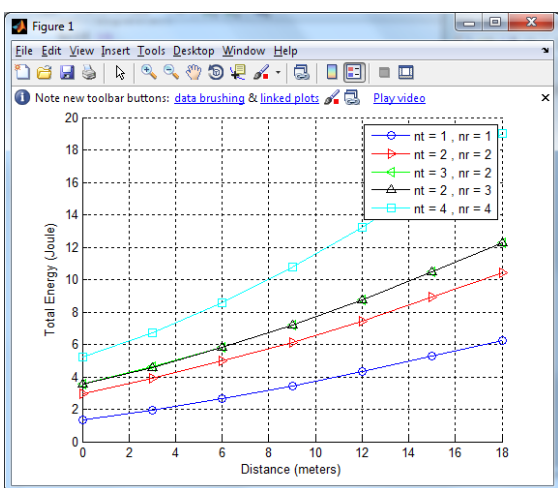


Fig 3: graph between energy of signal and distance of Rayleigh model

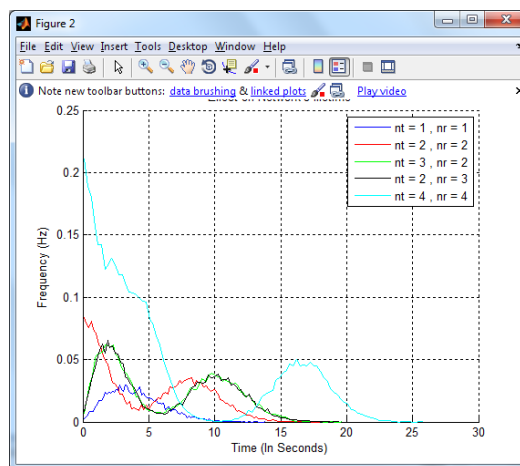


Fig 6: Graph between spectrum frequency and time of Friis model.

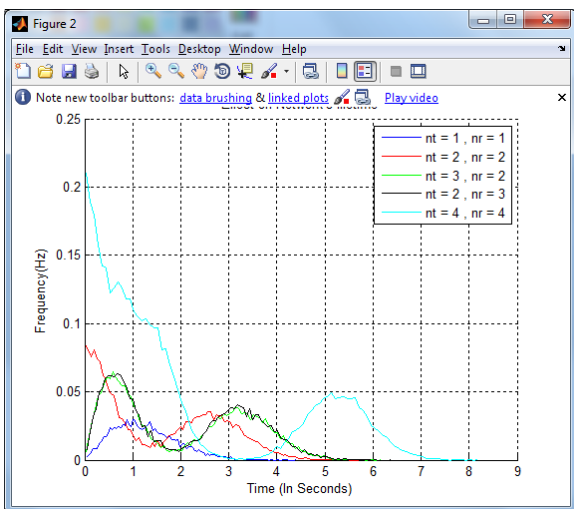


Fig 4: Graph between spectrum frequency and time of Rayleigh model.

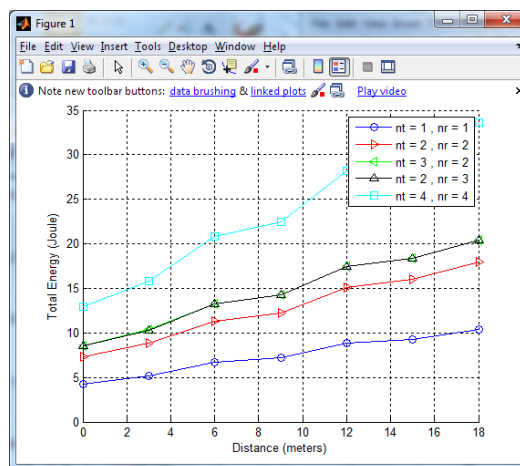


Fig 7: graph between energy of signal and distance of Log distance shadowing model

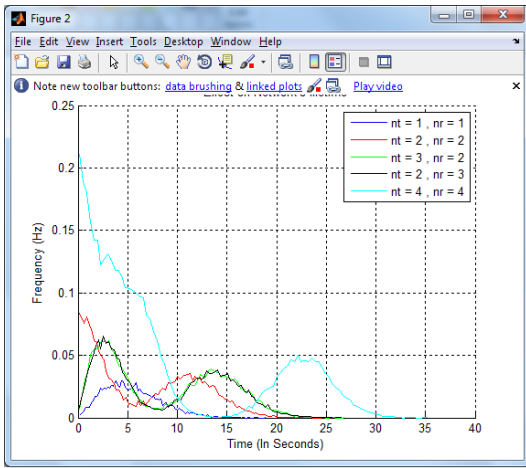


Fig 8: Graph between spectrum frequency and time of Log distance shadowing model.

**BER PERFORMANCE OF THREE DIFFERENT MODELS:**

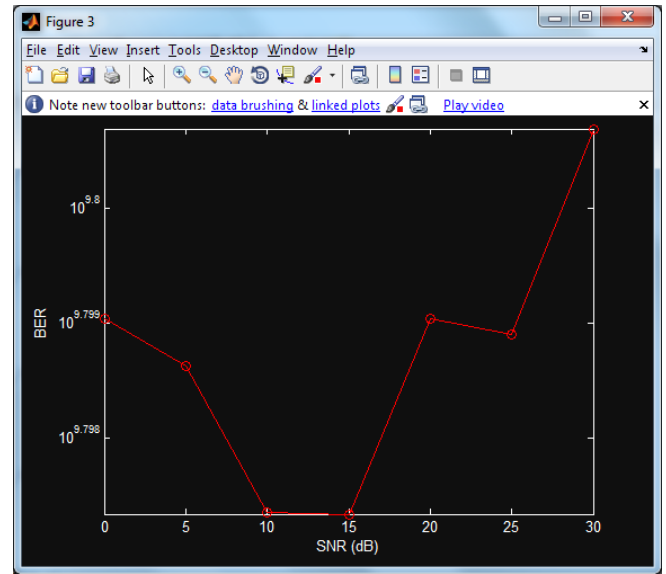


Fig 10: BER Performance Of Friis Propagation Model

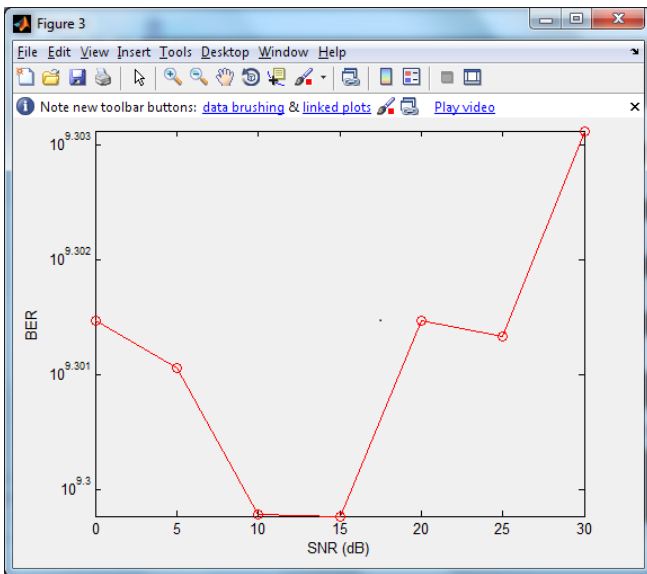


Fig 9: Ber Performance Of Rayleigh Model

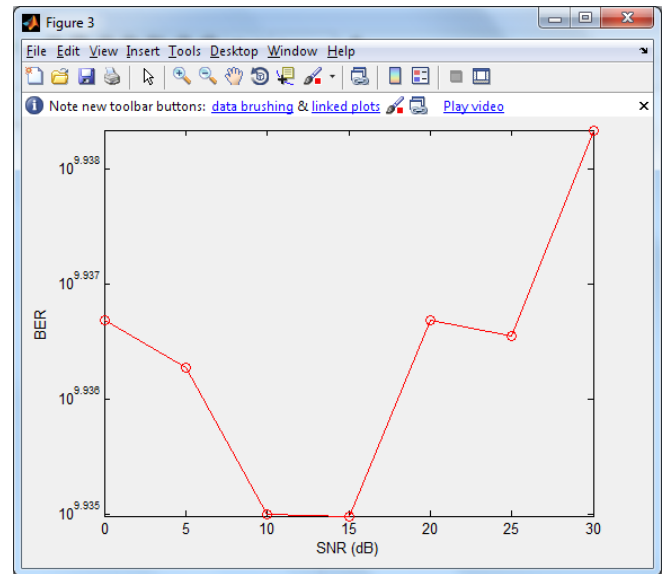


Fig 11: BER Performance Of Log Distance Propagation Model

**VIII. COMPARISON**

The output result of Rayleigh propagation energy loss is  $3.9972 * 10^{10}$  and the energy loss by the friis transmission model is  $1.2570 * 10^{10}$  and the total energy loss by the log distance shadowing model is  $1.7258 * 10^{10}$  which is lesser than the others parameters if we have taken.

**IX. CONCLUSION**

In this paper, a brief survey of basic solving techniques behind constraint programming has been studied. 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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