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Statistical Analysis and Performance Comparison in an Indoor Wireless Scenario

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***Abstract*—Wireless Sensor Network is one of the active research topic and gives contribution to the field of Science and Technology. Wireless Communication gives many potential applications. Network is formed by collection of sensor nodes which entirely perform Communication. Some of the indoor applications of wireless Communication are Home, Factory, telemedicine sensor for Health care. These indoor applications require less resources and utilized channel efficiently. Indoor Communication formation in real scenario is difficult task. Wireless Sensor Network acts like bridge; it is used to connect Physical and Virtual worlds. So it can be visualized in Simulator and performance Parameter are characterized. In this paper mainly develop Indoor Network Topology and model Wireless channel which contain Multiple input and multiple output and Fading Statistics are applied. Paper focused about Simulation scenario for Different height combinations and Parameter like Average Covariance, SNR and Throughput are calculated.**

***Keywords*—Wireless Network, Channel Modeling, MIMO Channel, Small Scale Fading, Network simulator.**

I. INTRODUCTION

The growing demands of Wireless Sensor Networks have attracted a great deal of research attention due to their wide range of potential applications. The transition of century from the 20th to 21st observed the emergence of less-cost, less-power, and tiny size electronics, enabling attractive solutions for numerous new application areas to be created as well as facilitating several existing ones to improved. One such example is the development of Wireless Sensor Network (WSN).Wireless sensor network is one of the latest trend and emerging technology which provides a wider range of applications like temperature, water level, monitoring pressure, health care etc. Generally, this network is a collection of small sensors. Sensor which perform operation as sense, process and communicate the data, based on the specified application. Some of the application are Indoor based, these are characterized by using Propagation model. General Indoor application are Factory, telemedicine Hospital , Home, Office etc. Signal Propagation in Indoor are affected by multipath fading. Fading are characterized as Small scale and large scale fading. The Fading statistics determine amount of Cooperation between nodes [10] and required to achieve SNR and Throughput value.The Pico

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Radio project was proposed in the year of 2000 by Berkeley Wireless Research Centre (BWRC) which focuses development of low-power sensor devices. Power consumption is so small that they can power themselves from energy sources of the operating environment, such as vibrational or solar energy. In the year of 2005, the MIT μAMPS (micro-Adaptive Multi-domain Power-aware Sensors) project focuses on low power software and hardware components for sensor nodes, which includes the use of microcontrollers which is capable of scaling dynamic voltage and techniques to restructure data processing method to reduce power requirements at the software level [1].

Basic Propagation Mechanism

The mechanism behind propagation is generally attributed to diffraction, scattering and reflection. Most communication system operates in urban areas where there is no line of sight path between transmitter and receiver.The transmitted signal generally reaches the receiver through different paths and may experience propagation mechanisms such as transmission, reflection, scattering, and diffraction along these paths. One of the major influences the wireless channel has on the Receive signal is an attenuation relative to the Transmission signal. The Receiver power is influenced by a deterministic attenuation factor and random fluctuations, termed fading. More specifically, the Rx power is influenced by a product of three factors; pathloss, large-scale fading and small-scale fading[2].

Pathloss

Pathloss is the attenuation of the average Rx power that increases with distance. Conventionally, pathloss is modeled as increasing with a power law in distance [3] Alternatively, pathloss can be expressed as an average path power gain, Gavg(d), that has a power law decay in distance,

$$\mathbf{G\,avg(dx) = G0.q}$$

where dx is the Transmitter-Receiver distance, $q = d^{-n}$ at the reference distance d0 (usually assumed 1 m) and n is called the propagation exponent.

Large-scale fading

Large-scale fading is defined as random variations of locally averaged Receiver power, as the receiver travels a distance typically on the order of a few hundred wavelengths while maintaining approximately the same distance to transmitter. Fading is observed when Interacting Objects (IOs), such as buildings or terrain, block the Line-Of-Sight (LOS) or other dominant multipath components. [4].

Small-scale fading

Multiple copies of the Transmitter signal arrive at the receiver with different attenuations and time-delay of arrival. These copies are often termed Multi-Path Components (MPCs), and their superposition gives the Receive signal. Small-scale fading refers to random fluctuation of the Rx signal caused by an interference pattern of these MPCs. The pattern may change in space due to motion of the receiver or in time due to motion of the transmitter or scattered. Time variant Channel impulse response is written as

$$(t,\tau)^1 = \sum_{l=1}^{L} \alpha l(t)\ r$$

where r= $\delta(t-\tau l)$ and $\delta(\cdot)$ is the delta Dirac function, L is the number of MPCs.

Measurement Setup and Processing:

Indoor Propagation is characterized based on statistical data. These statistical data are used to form accurate Channel Modeling which is analyzed by using Simulation model[8]. Simulator provide experimental result in a well defined fashion and reproduce experiment with different network type, network parameters, traffic module and routing protocols. Wireless Sensor Network are simulated using Network Simulator tool. Flow chart for the Indoor Scenario Creation in Network Simulator tool.

Implementation

Step1-For a Given node deployment in small scale area, nodes are separated by some distance. Random Uniform Distribution are generated which is denoted as m. Compare m value with mixture weight α. If mixture weight value greater than m then Calculate K_{Rice} value for Normal Distribution. Otherwise K_{Rice} value should be taken as zero[9]. The parameter μ_{dB}, σ_{dB}, α are taken from Table 5.1.

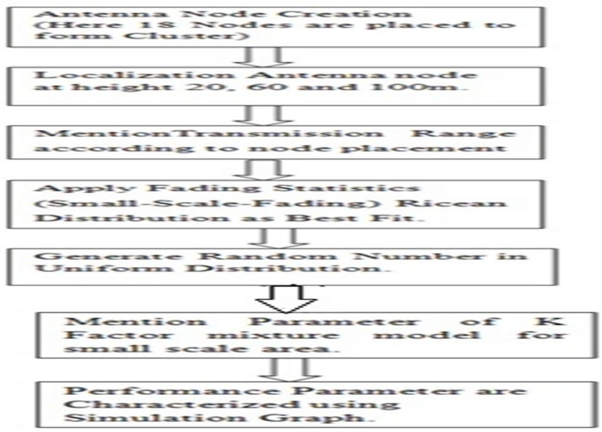


Figure 4.1 Shows Flow chart for Indoor scenario Creation in Network Simulator

TABLE V(1) REPRESENTS K FACTOR MIXTURE MODEL PARAMETER.SAME WALL MEASUREMENT

Antenna	μ_{dB}				σ_{dB}	α	
Tx20Rx20	1.23	-9.52	20.64	-8.17	3.84	-0.05	1.05
Tx60Rx60	-0.84	5.80	-14.6	14.68	3.61	-0.06	1.04
Tx100Rx100	-0.43	3.57	-10.09	10.66	4.80	-0.04	0.98

Opposite Wall Measurement

Antenna	μ_{dB}				σ_{dB}	α	
Tx20Rx20	0.79	-6.41	12.06	-1.58	3.75	-0.13	1.25
Tx60Rx60	-1.72	18.62	-67.55	81.64	4.47	-0.11	1.12
Tx100Rx100	-1.40	15.13	-54.8	66.72	4.14	-0.02	0.85

Step 2- Generate Sequence for S_{SSF}, Small scale fading values of correlated Ricean Random variable that represent spatial samples.

Step 3- Generate Sequence $S_{LSF,}$ Correlated lognormal random variable is representing Large Scale Fading for the samples of the measurement runs. The lognormal amplitude sequence is S_{LSF} given by $S_{LSF}=10^{\sigma LSF/20}$

Step 4- Integrate effect of Small Scale Fading and Large Scale Fading simultaneously to form Third variable called as S, which is the composite of SSF and LSF expressed as, $S=S_{LSF} \cdot S_{SSF}$

Step 5- Multiply S sequence with the distance dependent path gain, then total path gain S_{tot} expressed as

$S_{tot}=S \cdot Go(d)\ 10^{\frac{Go(d)}{20}}$

Go(d)=

Using S_{tot} value Average Covariance are Calculated.

Covariance=1- (S_{tot}/1000)

1000 value is considered because 1000 packets are sending from nodes.

Based on the value of Covariance Cumulative Probability value is calculated for different antenna height

Cumulative-Probability=Covariance*2

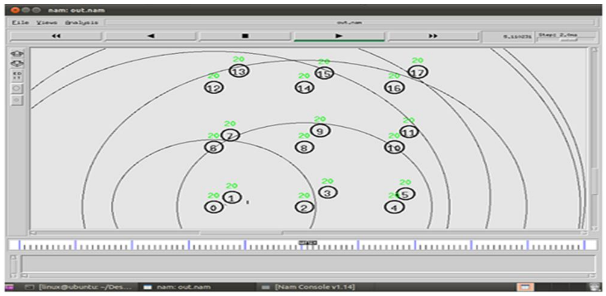
This Statistical Model are used to investigate SNR and Throughput.SNR is calculated as

SNR=Covariance*2-10

Throughput can be represented as Throughput=S_{tot}*1.0/1000

II. SIMULATION RESULT

Network Console window Executes NAM Visualization Window, which help for Visualizing node placement and packet transmission and queue type. Packet Transmission in NAM Window are visualized as shown Simulation is carried out at Equal Antenna Height, which means that Source and Sink Node are placed at Equal Height. All the parameters used in the Simulation are Distance Dependent



Cumulative Probability

Table 6.1 shows Cumulative Probability values for Different antenna height Configuration

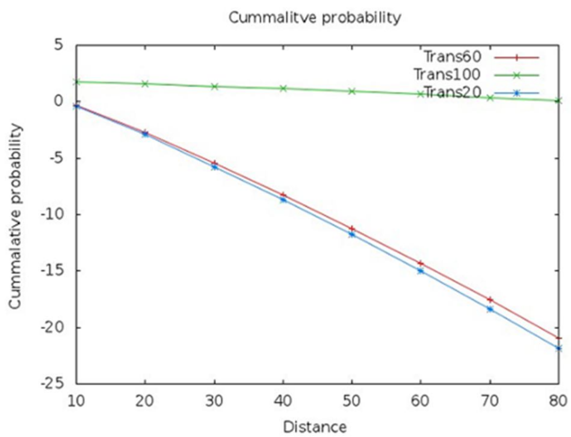


TABLE VI(1). CUMULATIVE PROBABILITY

Distance Between Nodes	TX20RX20	TX60RX60	TX100RX100
10	-0.42	-0.32	1.79
20	-2.85	-2.67	1.61
30	-5.77	-5.47	1.37
40	-8.66	-8.27	1.15
50	-11.75	-11.22	0.91
60	-14.93	-14.29	0.66
70	-18.34	-17.57	0.39
80	-21.80	-20.90	0.12

In this GNU Graph Representation, Cumulative Probability value Increases as Antenna Height Increases. For Maximum Antenna Height, Cumulative Probability is Positive value and Separation of node increases Cumulative Probability slowly as decreases.

Average Covariance

For Increasing Antenna Height, Average Covariance Value increases. But value is negative in TX20RX20 and TX60RX60 Antenna Height. For TX100RX100 Average Covariance value is positive but it decreases as distance between node increases. Average Signal to Noise Ratio Decreases as distance Between nodes increases. As antenna height increases, SNR value is less negative

TABLE VI(2) SHOWS AVERAGE COVARIANCE VALUES FOR DIFFERENT ANTENNA HEIGHT CONFIGURATION

Distance Between Nodes	TX20RX20	TX60RX60	TX100RX100
10	-0.21	-0.16	0.89
20	-1.42	-1.33	0.80
30	-2.88	-2.73	0.68
40	-4.34	-4.13	0.57
50	-5.87	-5.61	0.45
60	-7.46	-7.14	0.33
70	-9.17	-8.78	0.19
80	-10.94	-10.45	0.06

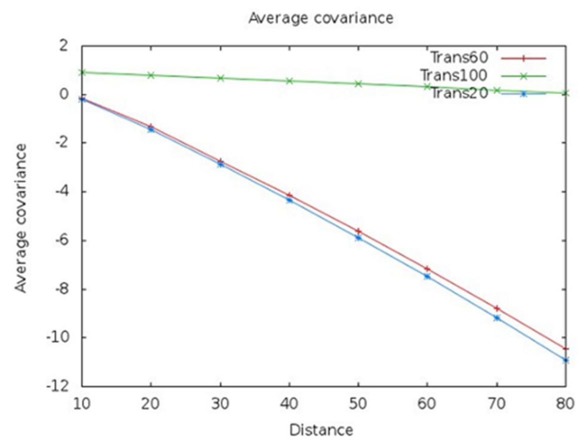


Figure 6.3 shows Average Covariance GNU Plot

Throughput

TABLE VI(4) SHOWS THROUGHPUT VALUES FOR DIFFERENT ANTENNA HEIGHT CONFIGURATION.

Distance Between Nodes	TX20RX20	TX60RX60	TX100RX100
10	1.21	1.16	0.10
20	2.42	2.33	0.19
30	3.88	3.73	0.31
40	5.34	5.13	0.42
50	6.87	6.61	0.54
60	8.46	8.14	0.66
70	10.17	9.78	0.80
80	11.90	11.45	0.93

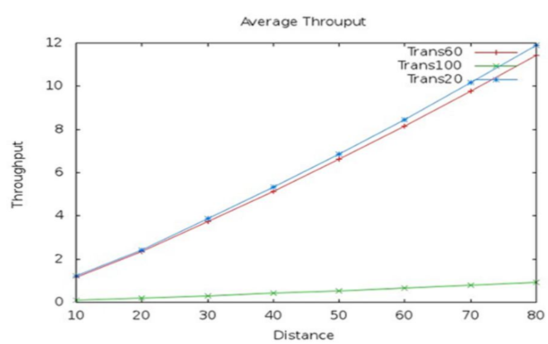


Fig 6.5 Shows Throughput GNU Plot

III. Conclusion

In this Paper Indoor propagation Measurements are carried out in a Network Simulator, Which Characterize the Wireless propagation channel for a set of Sensor Nodes are deployed in the Simulator Scenario. Three Different Antenna Height of Sensor nodes are used for measurement of the Performance parameters. Paper Concludes that Distance Between nodes and Antenna node Height affect performance parameter of wireless communication. As Distance Between Nodes increases, Cumulative Probability, Average Covariance and SNR Value Decreases. Throughput Value Increases. These parameter results helpful for determining data rate, outage probability and latency of sensor network. The Simulation outcome gives intercommunicating sensor nodes in Indoor scenario with Distance dependent Fading. Entirely Simulation work gives Contribution to the Research field of Wireless Sensor Network.

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