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Performance Analysis of IEEE 802.11b Model for Various Wireless Communication Channels

Nilesh B. Kalani
Research Scholar, J. J. T. University,
Jhunjhunu , India

***Abstract* — In this paper, 802.11b simulation model for various wireless communication channels such as AWGN, Rayleigh and Rician fading channels is analyzed. In this model, as an input real time speech signal is being transmitted through the IEEE 802.11b model and then this speech signal is being processed based on various parameters such as different data rates, packet sizes, etc. This paper gives analysis of IEEE 802.11b model based on these parameters in terms of error performance expressed in the form of BER vs. Es/N0 graphs. The generated results are validated with the help of regression technique.**

Keywords— IEEE 802.11b, BER, Es/N0, MATLAB

I. INTRODUCTION

There is a huge amount of development found in last 2-3 decades in wireless technologies. A wireless LAN is a very flexible structure for data communications that can be useful instead of wired LAN for any geographical region. Wireless LAN is also useful for providing some extra coverage area between a wired backbone network and a mobile user carrying some wireless apparatus [2].

A major problem for use and implementation of wireless communication system is availability of multiple standards for wireless communication system. Currently, WLANs are mostly based on the IEEE 802.11 standard. More specific, most of the applications, products and research today, regarding wireless solutions, are making use of 802.11b, 802.11g and 802.11n protocols [2].

First wireless standard was created by IEEE in 1997. But, the main disadvantage of that standard was its lower speed of 2Mbps. So, for further improvements in it, it was named as 802.11. The first improved version of 802.11 was IEEE 802.11a, which was using frequency band of 5.7GHz with OFDM modulation scheme. The data rates varying from 6 to 54 Mbps were available in 802.11a. But after that one of the most popular IEEE 802.11 versions had been introduced and published in September 1999. Then after many other wireless standards such as IEEE 802.11 c/d/e/f have been published with some minor modifications. Also an extended version of IEEE 802.11b with higher data rates was being published and named as 802.11g.

Many research works have been done on the IEEE 802.11b standards for data rates of 1 Mbps & 2 Mbps for AWGN channel. In [4], analysis of IEEE 802.11b is done for Rayleigh fading channel for data rates of 1 Mbps and 2 Mbps. However, the simulation is done for 1 Mbps and 2 Mbps which includes only QPSK modulation scheme but in the simulation CCK modulation scheme for data rates of 5.5 Mbps and 11 Mbps is not included. Now, in [3], analysis of IEEE 802.11b is done for various data rates such as 1 Mbps, 2 Mbps, 5.5 Mbps and 11 Mbps, for Rician fading channel.

This paper consist analysis of IEEE 802.11b model is done on the basis of error performance with various data rates and wireless communication channels such as AWGN, Rayleigh and Rician fading channels.

This paper is organized as follows: - Section II discusses the theory of various wireless communication channels and modulation schemes; Section III consist Results; Section IV consists of discussion; Section V includes conclusion.

II. THEORY OF IEEE 802.11B MODEL WITH MATLAB SIMULINK & GUI IMPLEMENTATION

This section includes basic introduction regarding IEEE 802.11b standard and its MATLAB implementation of it is explained in below Fig. 1.

This IEEE 802.11b model formed under MATLAB platform in such a way that it gives complete analysis of this given model. Basic formation of IEEE 802.11b model is shown in Fig. 1.

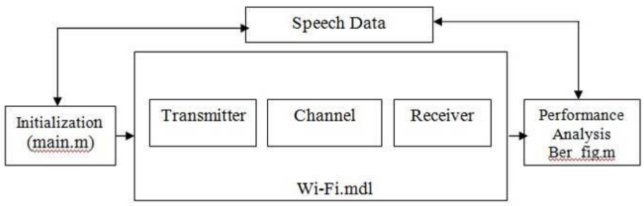

Fig. 1 Model to analyze IEEE 802.11b [1]

The speech signal is applied at the transmitter side of the model which is converted in to packets afterward for the further process. The data is applied to the Simulink file Wi-Fi.mdl that implements PHY of the IEEE 802.11b networks. To accomplish this real time processing on the speech signal through IEEE 802.11b model is accomplished by means of the MATLAB implementation of it as in [9]. Here, this IEEE 802.11 PHY model provides the analysis in the form of spectrum and error performance for the transmitted speech signal at the input of the said model. Along with that facility of the Graphical User Interfacing (GUI) is also provided as shown in below Fig. 2.

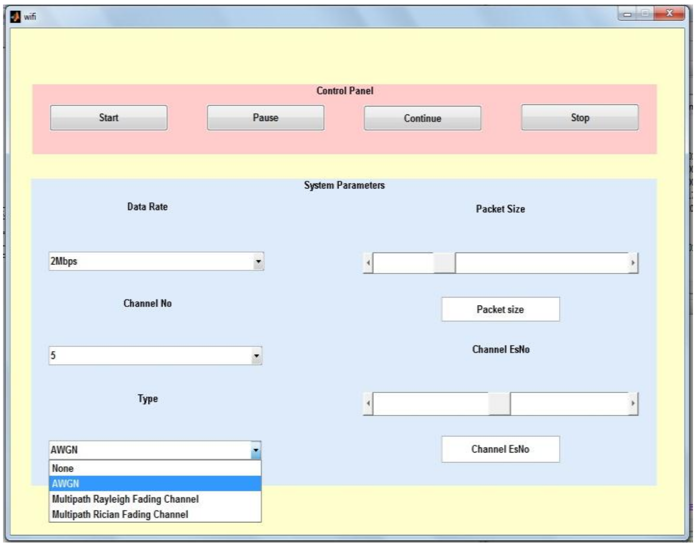

Fig. 2 GUI model for IEEE 802.11b

Now, GUI for 802.11b model with IEEE standards 802.11b is shown in above Fig. 2. Here, GUI model is formed in such a way that we can start, pause, stop and continue the process of the formation of results at any time. From this GUI model we can set the various system parameters such as Channel, Es/No, Packet Size, Channel Type, Channel No, Packet size and Data rates.

III. RESULTS

The various channel types categorized on the basis of signal transmitting environments are AWGN, Rayleigh and Rician. All these three channels have been considered in the present work for investing the effect of fixed parameters among 11 various channels, and the selected channel No. 6 by using long preamble with the packet size of 4095. The graphs have been plotted for parameters BER versus Es/N0 for determining the error performance of the increasing signal strength in the wireless communication.

In this work the results were generated for various transmission packet sizes of IEEE 80.211b which are channel number 512, 1024, 2048 and 4095. The results were generated for three different channels of communication as AWGN, Rayleigh and Rician with various packet sizes. Here, the results depicted for Rician channel, non-overlapping channel number 11.

Moreover, the analysis has been done for the different non-overlapping channels of IEEE 802.11b which are channel number 1, 6 and 11. The validated result depicted for the various communication channels with respect to all three non-overlapping channels.

The parameter Es/N0 is represented on X-axis and another parameter BER is represented on Y-axis. The effect of Es/N0 on the BER has been depicted in this graph for various data rates like 1Mbps, 2Mbps, 5.5Mbps and 11Mbps respectively. The results in this graph depicted for AWGN channel shown in Fig. 3.

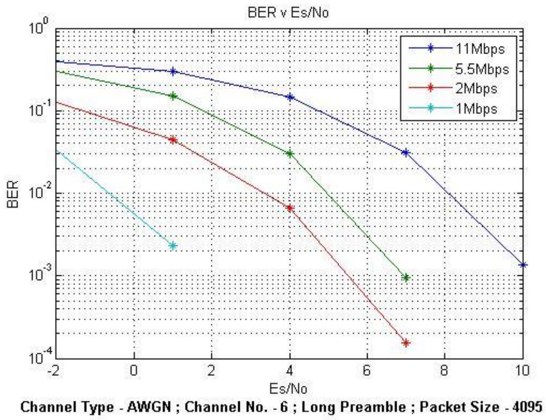

Fig.3 Plot of BER vs. Es/No for AWGN channel

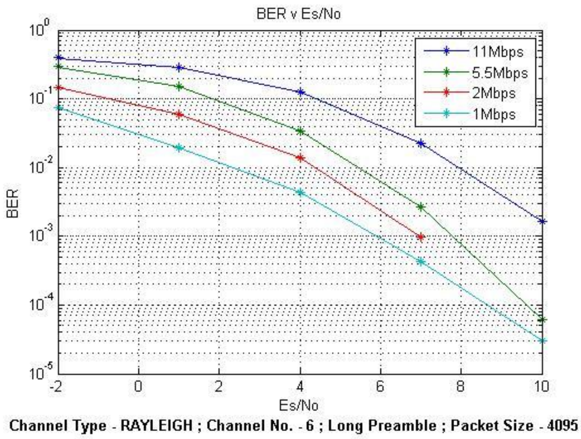

Fig. 4 Plot of BER vs. Es/No for RAYLEIGH fading channel

For the wireless channel Rayleigh, the effect of Es/N0 on the BER at data rates of 1Mbps, 2Mbps, 5.5Mbps and 11Mbps respectively, were investigated. Graph for the discussed specifications shown in Fig.4.

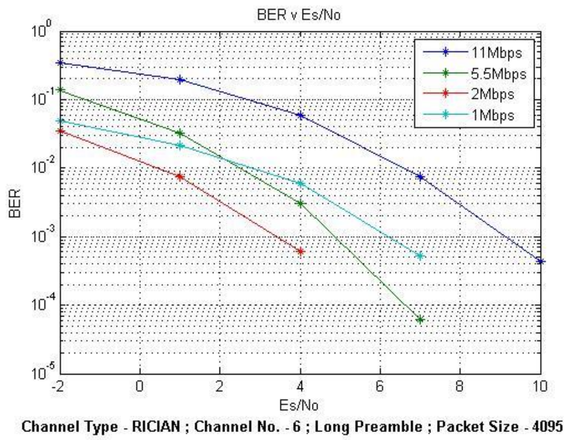

Fig.5 Plot of BER vs. Es/No for RICIAN fading channel

The graph depicted for the wireless channel Rician to represent the BER affected by variation in the parameter Es/N0 at data rates of 1Mbps, 2Mbps, 5.5Mbps and 11Mbps respectively. Graph for the discussed specifications shown in Fig. 5. The results of regression analysis are as depicted in the Table I.

Table I Validated Results for various data rates

Channel	Data Rate			
	1Mbps	*2Mbps*	*5.5Mbps*	*11Mbps*
AWGN	0.55	0.75	0.83	0.96
Rayleigh	0.70	0.80	0.84	0.95
Rician	0.88	0.77	0.86	0.98

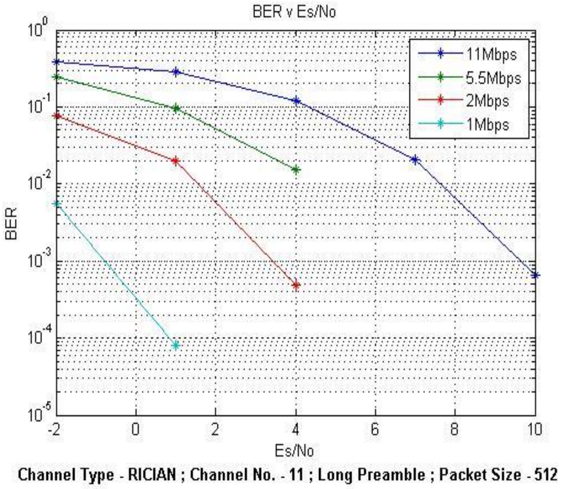

Fig. 6 Plot of BER vs. Es/No for packet size 512

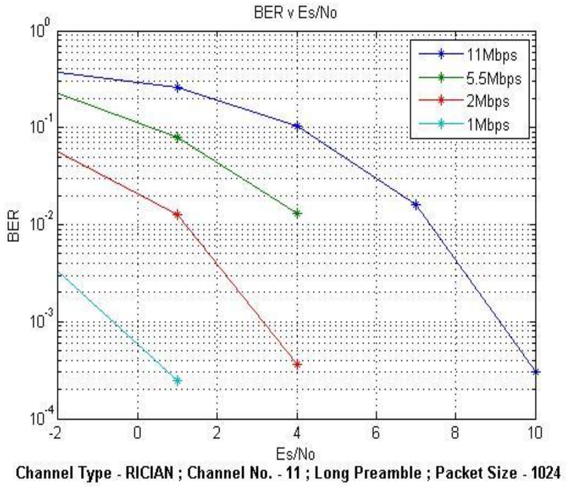

Fig. 7 Plot of BER vs. Es/No for packet size 1024

The graph depicted the BER performance for Rician communication channel and non-overlapping channel number 11 with packet size of 512 is shown in above Fig. 6. For the packet size of 1024 results depicted in this graph for the Rician channel for BER versus Es/N0 is shown in Fig. 7.

The effect of Es/N0 on the BER depicted for the packet size of 2048 for Rician channel is shown in below Fig. 8.

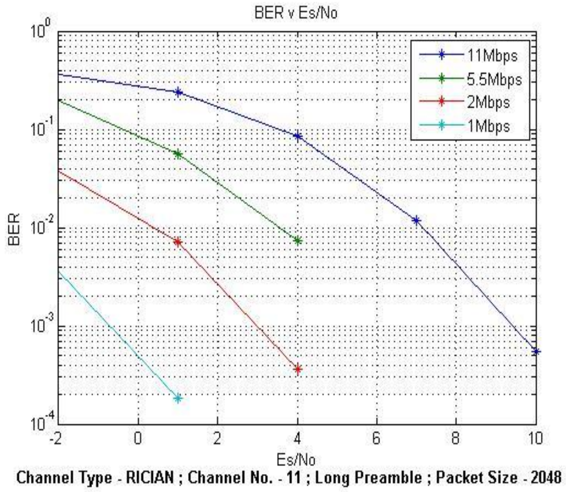

Fig. 8 Plot of BER vs. Es/No for packet size 2048

For the packet size 4095 the BER performance with respect to Es/N0 is depicted in Fig. 9.

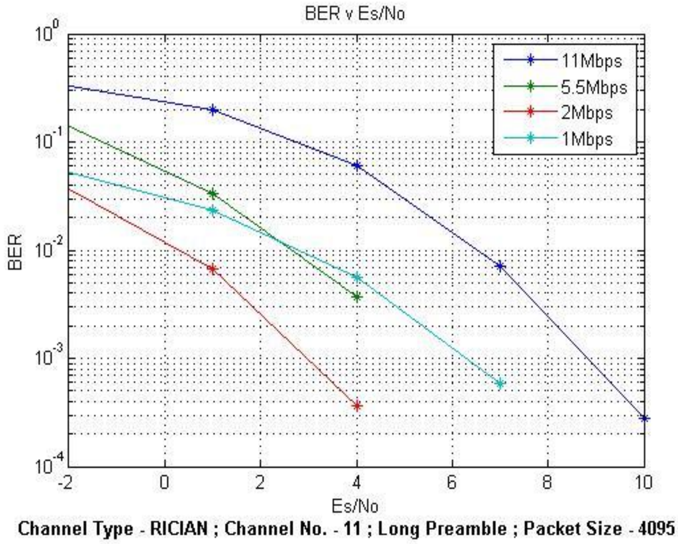

Fig. 9 Plot of BER vs. Es/No for packet size 4095

The validated results for the various packet sizes for non-overlapping channel number 11 depicted in Table II.

Table II Validated results for packet size

Packet Size	Non-overlapping channel No. 11			
	1Mbps	*2Mbps*	*5.5Mbps*	*11Mbps*
512	0.60	0.84	0.94	0.97
1024	0.59	0.82	0.93	0.98
2048	0.60	0.77	0.91	0.98
4095	0.90	0.77	0.87	0.98

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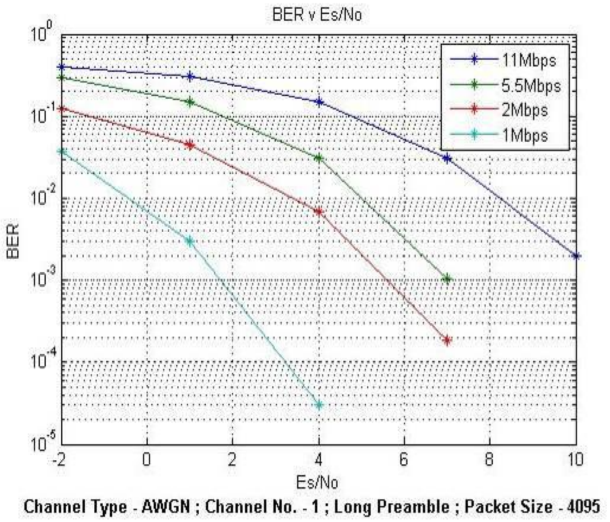

Fig. 10 Plot of BER vs. Es/No for various non-overlapping channel number-1

The graphs shown in Fig 10-12 depicted the performance of BER for various Es/N0 for the AWGN communication channel and various non-overlapping channels such as, channel no. 1, 6 and 11.

For the non-overlapping channel 6 with AWGN communication channel, the graph is depicted for BER versus Es/N0.

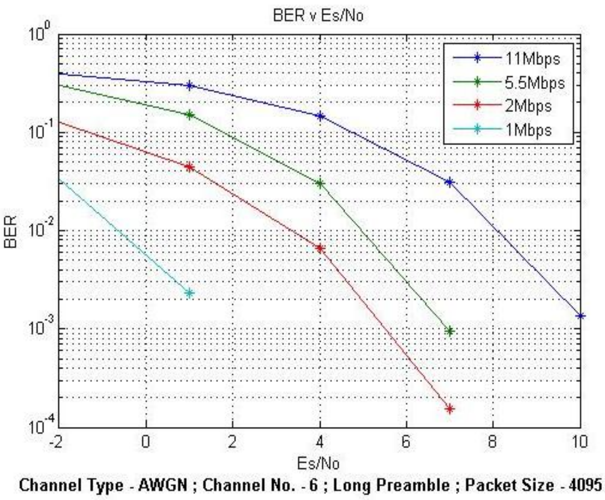

Fig. 11 Plot of BER vs. Es/No for various non-overlapping channel number-6

The AWGN communication performance depicted against the various Es/N0 for the non-overlapping channel 11.

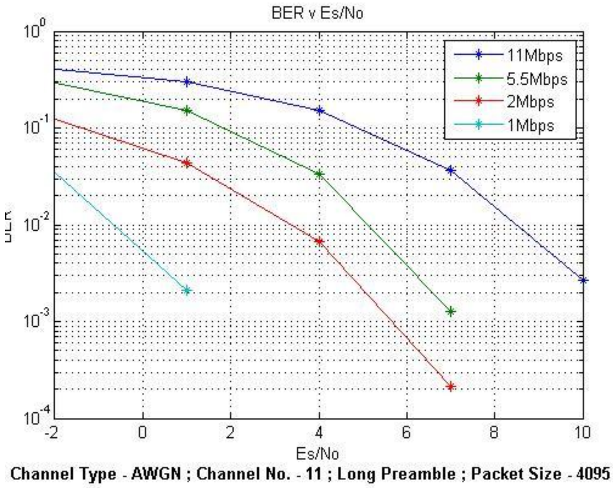

Fig. 12 Plot of BER vs. Es/No for various non-overlapping channel number-11

The validated results depicted for different communication channels for various non-overlapping channels of IEEE 802.11b model in Table III.

Table III Validating results of non-overlapping channels

Non-overlapping Channel No.	**Channel Type**		
	AWGN	***Rayleigh***	***Rician***
1	0.9646	0.9553	0.9857
6	0.9633	0.9505	0.9864
11	0.9664	0.9520	0.9856

IV. DISCUSSION

The parameter BER can be reduced by increasing Es/N0 for all the data rates but these graphs emphasize that the effect of increasing in Es/N0 can improve the error performance for the higher data rate like 11Mbps as compared to other data rates. This improvement has been found common for all three channels. These effects have been observed by validating result with the help of regression technique. The regression values for 11Mbps are 0.96, 0.95 and 0.98 for AWGN, Rayleigh and Rician respectively. The values of regression for AWGN, Rayleigh and Rician are 0.83, 0.84 and 0.86 respectively for data rate 5.5Mbps. For the data rate of 2Mbps, the regression values for AWGN, Rayleigh and Rician are 0.75, 0.80 and 0.77 respectively. The regression values for three channels AWGN, Rayleigh and Rician are 0.55, 0.70 and 0.88 respectively for 1Mbps data rate. It has been observed that regression values were highest for 11Mbps data rate, which emphasize that the increase in Es/N0 can improve the BER at higher data rate, whereas the regression values were found to be lowest for 1Mbps, which indicates that the increment in Es/N0 affects less at lower data rate for improving the BER.

The error performance can be improved for the packet size of higher packet size with increasing the Es/N0 parameter. The regression values for data rate 1Mbps are 0.60, 0.59, 0.60 and 0.90 for the packet size 512, 1024, 2048 and 4095 respectively. The 0.84, 0.82, 0.77 and 0.77 are the regression values found for the packet size of 512, 1024, 2048 and 4095 with data rate 2Mbps respectively. For the data rate of 5.5Mbps the regression values were 0.94, 0.93, 0.91 and 0.87 for the packet size of 512, 1024, 2048 and 4095 respectively. The regression results for the packet size of 512, 1024, 2048 and 4095 were 0.97, 0.98, 0.98 and 0.98 respectively for the data rate of 11Mbps.

The increasing value of Es/N0 is found to be more effective in improving the BER performance for the non-overlapping channel number 1 compare to other non-overlapping channel. The regression values for non-overlapping channel 1 were 0.9646, 0.9533 and 0.9857 for AWGN, Rayleigh and Rician respectively. For the non-overlapping channel number 6 the regression values were 0.9633, 0.9505 and 0.9864 respectively for AWGN, Rayleigh and Rician channels. The regression values were 0.9664, 0.9520 and 0.9856 for the AWGN, Rayleigh and Rician respectively for the non-overlapping channel number 11. Therefore, there is no significant difference on the performance of BER in terms of non-overlapping channel, in all the three categories, viz. AWGN, Rayleigh and Rician.

V. CONCLUSION

The performance of BER can be improved with the help of increasing the value of the Es/N0 under the transmission condition of higher data rate having larger packet size. In the present work, the transmitted signal was speech signal which could provide the real time error performance analysis. The more improvement can be achieved in terms of BER by increasing Es/N0 for the higher data rate transmission and also it is applicable if the packet size is larger, like 4095. The observed result emphasized that there is nearly equally effect of BER on all the three non-overlapping channels used for communication. Thus, in the real time environment, it is recommended to employ the Es/N0 increment for transmitting at higher data rates of larger packet size.

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