International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 9
September 2017

PER Vs BER Performance and to Understand the Main Causes for Fading of Transmitted Signal over the Channel Path in IEEE 802.11a

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ABSTRACT

The IEEE 802.11 a is wireless LAN standard used for indoor communication which provides the data rate upto 54 Mbps.It uses OFDM technique in which subcarriers are orthogonal to each other. In this paper the performance of this standard is evaluated in WLAN environment under 3 different fading modes that is dispersive fading mode ,flat fading mode and no fading mode.The parameters which we measure are PER,BER and bit rate for mode 1,2,3,4.The main purpose of this paper is to understand and find out the main causes for fading of transmitted signal over the channel path.

Keywords:IEEE802.11a,SNR,PER,OFDM,PLCP

1 INTRODUCTION

The IEEE 801.11 series is used to specify the different wireless LAN standard. IEEE 802.11a is one of them.It is recently announced as interoperability standard called as Wi-Fi5.One big advantage of this standard is that it is not subject to interference from Bluetooth or any of the other2.4 GHz Frequency designer . The standard use OFDM technique instead of FDM technique as shown in fig 1. To transmit FDM signals there is need to have a large frequency guard-band between channels to prevent interference. The overall spectral efficiency so is very poor. But in OFDM with the dense orthogonal packing of the each sub carriers eliminates this guard band, and improves the spectral efficiency.[2]

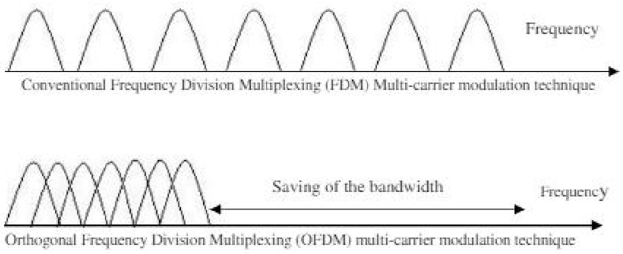

Fig 1:Overlapped Subcarriers of OFDM

This standard has 8 different transmission modes. Each mode corresponds to a particular data rate.Four types of modulation scheme.Three types of code rates as shown in table No.1 [1].

Table 1. IEEE 802.11a Rate–dependent parameter.

Data Rate Mbits/s	Modulation	Coding Rate R	Coded bits per subcarrier	Coded bits per OFDM symbol	Data bits per OFDM symbol
6	BPSK	1/2	1	48	24
9	BPSK	3/4	1	48	36
12	QPSK	1/2	2	96	48
18	QPSK	3/4	2	96	72
24	16-QAM	1/2	4	192	96
36	16-QAM	3/4	4	192	144
48	64-QAM	2/3	6	288	192
54	64-QAM	3/4	6	288	216

One OFDM symbol consist of 52 subcarriers.Out of which 48 are data subcarriers ,4 are pilots as shown in below fig.2

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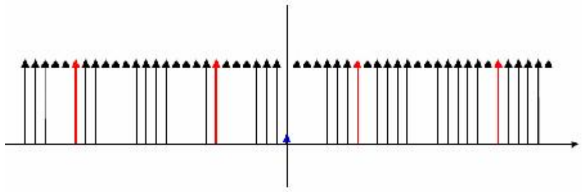

Fig 2 : 52 Subcarriers ,4 Pilots.

Table shows different parameters for 8 different mode as follows. For mode 1(BPSK,1/2 code rate, 6Mbps) data bit per subcarrier is 1 as modulation used is BPSK.Therefore coded bits per OFDM symbol are 48 bits . But the transmitted data bits after puncturing are 24 as the code rate is ½ .In puncturing ½ of the 48 bits are punctured/removed in which only 1 bit is sent instead of 2 bits.Thus time required to send 1 bit is less than time of 2 bits.Thus puncturing is used to increase the transmission of data rate.In mode 8 the 3/4th of the 288 bits i.e. 216 are sent.Instead of 6 bits per subcarrier 4 bits are sent (2 bits are punctured per subcarrier) increasing the transmission data rate.[3].Thus in this way the data bits per ofdm symbol is calculated in the table no.1 . In this standard at the transmitter section the IFFT is used to convert frequency subcarriers into time domain, the FFT block is used at the receiver section to obtain the signal back to frequency domain. In section 2 we will discuss about IFFT and FFT.The frame structure of IEEE 802.11a is studied in detail in section 3..In section 4 the results are presented .Finally the conclusion and future work are presented in the section 5.

2.IFFT and FFT

The OFDM transmitter and receiver use Inverse Fast Fourier Transform (IFFT) and Fast Fourier Transform (FFT),respectively.The IFFT/FFT algorithms are chosen due to their execution speed, flexibility and precision[4].

The FFT is given by:

$$X(k)=\sum_{n=1}^{N-1} x(n)e^{-j2\pi kn/N} \quad ,k=0,\dots,N-1$$

The IFFT is given by:

$$x(n)=\frac{1}{N}\sum_{n=1}^{N-1} X(k)e^{-j2\pi kn/N} \quad ,n=0,\dots,N-1$$

The Radix 2 ,64 point FFT is used and it is as shown in the below fig 3.

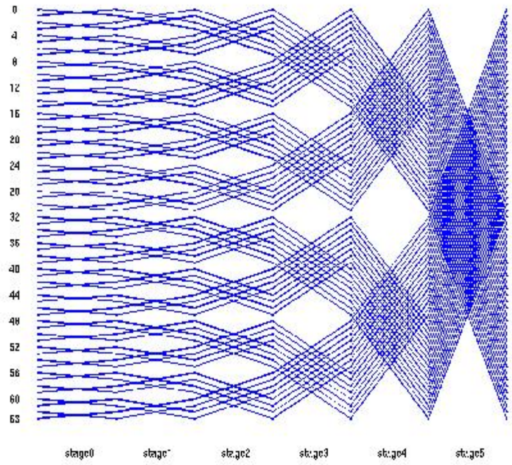

Fig 3 : Radix 2 64 point FFT (Butterfly diagram).

The subcarriers are mapped as follows in the 64 point IFFT as shown in fig 4.The coefficients 1 to 26 are mapped to the same numbered IFFT inputs.while the coefficients -26 to -1 are copied into IFFT inputs 38 to 63 .The rest of the inputs ,27 to 37 and 0(DC)input are set to zero. After performing an IFFT, the output is cyclically extended to the desired length[5].

Zero pad and selector blocks are used for this assignment. Zero pad appends zeros to the input signal and the selector block reorders the subcarriers and then IFFT is transmitted across the channel. Thus An inverse Fourier transform converts the frequency domain data set into samples of the corresponding time domain representation of this data.

At the receiver,an FFT block is used to process the received signal and brings it back into frequency domain.

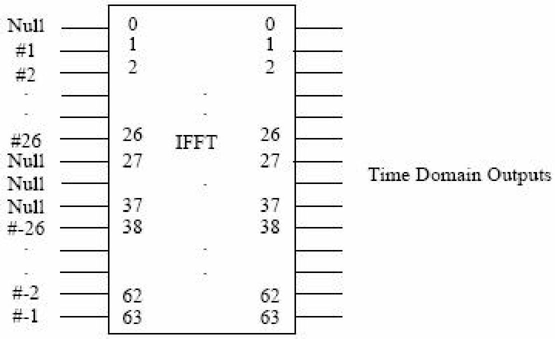

Fig 4 : IFFT Mapping .

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3. FRAME STRUCTURE 802.11A

802.11a WLAN frame consist of three parts viz. preamble,header and data.[6]

3.1 PREAMBLE

Preamble is about 12 symbol in length and referred as PLCP (Physical layer convergence protocol) preamble..PLCP preamble field composed of 10 repetitions of "short training sequence" and two repetitions' of "Long training sequence" preceded by a guard interval .

PLCP Preamble

12 Symbols

Fig.5 PLCP preamble consisting of 12 symbols

the protocol of physical layer and used in several data transmission network.It is used for synchronization purpose.

3.2 HEADER

Header part consist of 24 bits which is always BPSK modulated.The total 24 bits are as follows.

Rate 4bits	Reserved 1 bit	Length 12 bits	Parity 1bit	Tail 6 bits

Fig 6: Header part consisting of 24 bits

3.3 DATA

Data part carry MAC frames and CRC is appended for error checking purpose. [6]

The detail frame structure of IEEE 802.11 a is as follows.

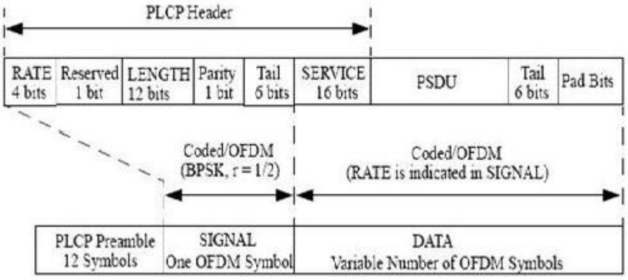

Fig 7:Frame Structure of IEEE 802.11a

5 SIMULATION ENVIRONMENT

5.1 COMMUNICATION CHANNEL PATH

The Multipath Channel consist of Multipath Rayleigh fading Channel followed by AWGN channel.Because in wireless communication the channel is often modeled by random attenuation (known as fading) of the transmitted signals followed by the Additive noise [7].

5.2 RESULTS

The model is run in Matlab simulink. To select fading mode and to set SNR Threshold the following blocks shown in fig 8 and 9 are used respectively.The performance of this standard is evaluated over Multipath Channel.

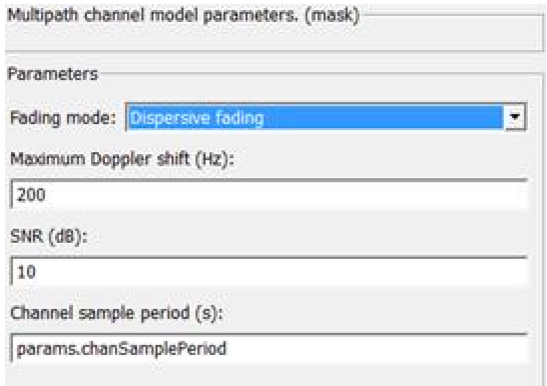

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Fig 8:Multipath Channel Model Parameters

To select the particular mode the SNR threshold is set in . following block.

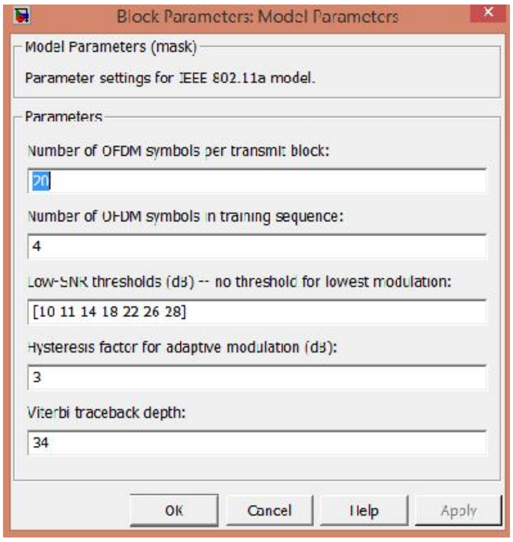

Fig 9:SNR Threshold setting

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The parameters to be measured (PER and BER) are taken in workspace. The programme is written in matlab and the results are obtained as follows for mode 1,2,3,4 in fig 10,11,12,13 respectively.

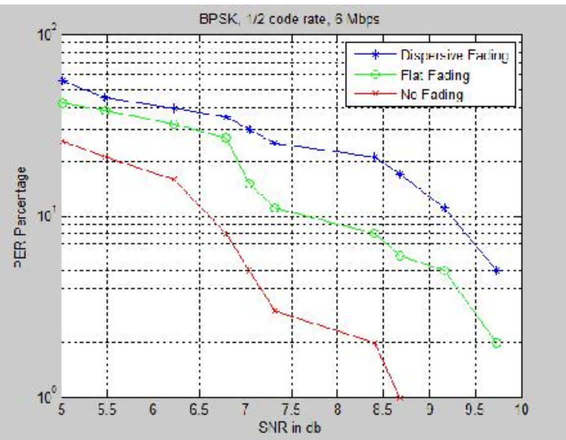

Fig 10: Mode 1

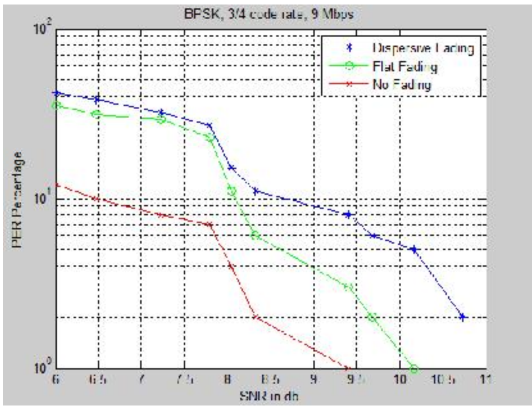

Fig 11:Mode 2

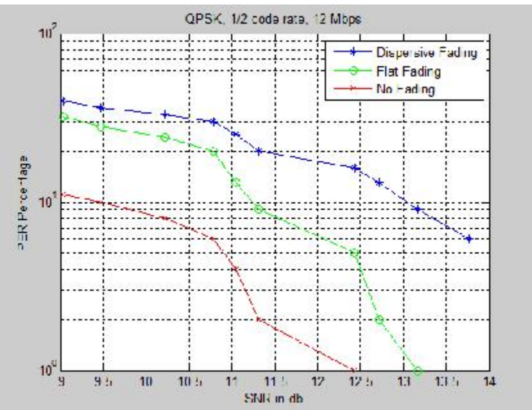

Fig 12:Mode 3

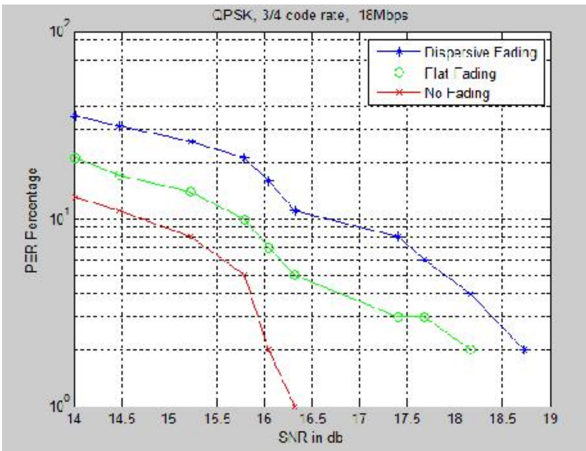

Fig 13:Mode 4

6 CONCLUSION

We can see that in mode 1,2,3,4 the PER decreases with increasing SNR..

From Figure 10 (BPSK,1/2code rate,6Mbps) it is clear that for the SNR of 6.23 dB, the PER is 39% in dispersive fading mode ,it is 32 %in flat fading mode and 16% in no fading mode (PHY mode).

Fading causes poor performance in a communication system because it can result in a loss of signal power without reducing the power of the noise .If the fading is more then there is severe drop in the channel signal-to-noise ratio and this may cause the temporary failure of the communication.

In all the PHY modes(In PHY mode 1,2,3,4), the multipath channel in dispersive fading mode has PER is more than in flat fading mode and no fading mode. The channel in the dispersive fading has a dispersed gain(scattered).Since the gain is scattered the strength of the transmitted is weakened heavily over the distance .In the dispersive fading the spectral characteristics of the transmitted signal are dispersed (scattered) and cannot be preserved. There is severe drop in the SNR of the multipath channel and hence in the PHY mode 1 the PER is 39% for the SNR 6.23dB.

In all the PHY modes, the channel in the flat fading mode has constant gain over the channel,the strength of the transmitted signal is weakened slowly over the distance.Spectral characteristics of the transmitted signal are preserved properly at the receiver side as compared to the dispersive fading mode.There is no sever drop in the SNR of the multipath channel hence the PER is 32 % in flat fading mode.(Less than dispersive and more than no fading mode) for the SNR 6.23dB.

There is no fluctuations in the gain of the channel in the no fading mode hence the strength and spectral characteristics of signal are well preserved as compared to dispersive and flat fadind mode. Hence the PER is 16% for the SNR 6.23dB.

Thus it can be seen that in each distinct PHY mode for the same value of SNR the PER is high in dispersive fading mode ,it is reducing in flat fading mode and highly reduced in no fading mode .

ACKNOWLEDGMENTS

I would like to thank Electronics and Telecommunication Engineering Department, Vishwakarma Institute of Information Technology,Pune,India for great support.

I am thankful to Prof. Radhika Punrandare for her guidance and for all valuable discussions and suggestions.

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