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The Effect of Bit Error Rate on Hiperlan/2 Using 16 Qam, 64 Qam And 256 Qam

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ABSTRACT

With today rise in the demand for mobile communication services, tomorrow generations of mobile systems are expected to provide very high data rate transmissions as well as improved quality of service to users within commercial feasibility so as to avoid poor reception which the users are experiencing nowadays. This paper shows the effects of Bit error rate on hiperlan2 using 256 QAM modulation techniques.The developed model was simulated using MATLAB application package. OFDM-256QAM modulation format was employed to provide the parallel transmission and the received signal was compared withthe transmitted signal to analyse the bit error rate performance of the OFDM system.It was discovered that If the medium between the transmitter and receiver is good and the signal to noise ratio is high, then the bit error rate will be very small - possibly insignificant and having no noticeable effect on the overall system.The increase in bit error rate indicates performance degradation.

Keywords*: OFDM, BER, SNR, MATLAB, Eb/No. QAM, HIPERLAN/2*

1. INTRODUCTION

One of the developments that modern digital communications systems has brought to radio engineering is the need for end-to-end performance measurements. The measure of that performance is usually bit-error rate (BER), which quantifies the reliability of the entire radio system from “bits in” to “bits out,” including the electronics, antennas and signal path in between.

Designing the first version of the standard named HiperLAN/1, started 1991, when designing 802.11 was by now going on. The aim of the HiperLAN was the high data rate, higher than 802.11. The standard was accepted in 1996. The functional specification is EN300652, the rest is in ETS300836. The standard covers the Physical layer and the Media Access Control part of the Data link layer like 802.11. There is a new sub layer named Channel Access and Control sub layer (CAC). This sub layer deals with the access requests to the channels. The achievement of the demand is dependent on the usage of the channel and the precedence of the request. CAC layer provides hierarchical independence with Elimination-Yield Non-Pre-emptive Multiple Access mechanism (EY-NPMA). EY-NPMA codes precedence choices and other functions into one variable length radio pulse preceding the packet data. EY-NPMA enables the network to function with few collisions even though there would be a large number of users. Multimedia applications work in HiperLAN because of EY-NPMA precedence mechanism. MAC layer defines protocols for routing, security and power saving and provides naturally data transfer to the upper layers. On the physical layer FSK and GMSK modulations are used in HiperLAN/1. HiperLAN/2 functional specification was achieved February 2000. Version 2 is designed as a fast wireless connection for many types of networks. Those are UMTS back bone network, ATM and IP networks. Also it works as a network at home similar to HiperLAN/1. HiperLAN/2 uses the 5 GHz band and up to 54 Mbit/s data rate[1]. The physical layer of HiperLAN/2 is very similar to IEEE 802.11a wireless local area networks. However, the media access control (the multiple access protocol) is Dynamic TDMA in HiperLAN/2, while CSMA/CA is used in 802.11a. Basic services in HiperLAN/2 are data, sound, and video transmission. The accenting is in the quality of these services (QoS). The standard covers Physical, Data Link Control and Convergence layers. Convergence layer takes care of service dependent functionality between DLC and Network layer (OSI 3) [2].

2. RELATED WORK

A commonly used method to estimate the quality of a wireless link is to compute the BER using pilot symbols. Pilot symbols represent a predefined sequence of symbols, which are known at the transmitter and the receiver side. Therefore, the BER can be computed from these pilot symbols. For example, HiperLAN/2 as well as third generation telephony uses pilot symbols [2]. This approach has two disadvantages. First, the transmission of the pilot symbols introduces overhead. Second, the BER is only computed over a small amount of the total bits that are transmitted [3].

2.1 Bit Error Rate (BER)

Bit error rate is a key parameter that is used in assessing systems that transmit digital data from one location to another. BER is applicable to radio data links, Ethernet, as well as fibre optic data systems. When data is transmitted over a data link, here is a possibility of errors being introduced into the system. If this is so, the integrity of the system may be compromised. As a result, it is necessary to assess the performance of the system, and BER provides an ideal way in which this can be achieved. BER assesses the full end to endperformance of a system including the transmitter, receiver and the medium between the two.

BER is defined as the ratio of the number of wrong bits over the number of total bits.In simple form,

$$\text{BER} = \frac{\text{number of wrong bit}}{\text{Total number of bit}} \qquad \text{Eqn.1}$$

Using a Matlab simulation model for HIPERLAN/2 with ½ and ¾ code rates the BER performance for different modulation schemes is compared. It can be easily seen that the BER curves for all modulations with ½ code rates are less degraded as compared to that with ¾ code rate. Also the SNR is improved for ½ code rate that for ¾ code rate [4]

2.2. Factors affecting Bit error rate, BER

Interference: The interference levels are set by external factors which are present in a system and these levels cannot be changed by the main system design. Whether it may be possible to set the system-bandwidth. If we reduce the bandwidth, then the level of interference will be reduced by good amount.

Reduce bandwidth: Another way that can be adopted to diminish the BER (bit error rate) is to reduce the bandwidth.

Increase transmitter power: If the power level of the system is boosted, then the power per bit is improved. It would be balanced against interference levels factors. BER(Bit error rate) is a parameter which provides us an exceptional clue for the performance of a data link. Number of errors is one of the main parameters in any data link, But the BER(bit error rate) is a key parameter. One should have knowledge of the BER so that it gives information on other features like bandwidth and power.

3. SIMULATION MODEL

The study of bit error rate effect on hiper LAN/2 was done by modifying an existing model in Simulink (Matlab 7.12.0). This model was designed to show the effect of bit error rate on hiper LAN/2 using 64-QAM and 256-QAM modulation techniques with high power amplifier (HPA). Fig.1 and Fig.2 represent the whole system model for the proposed design. The Rapps model[5] and Linear Model of Travelling wave Tube was selected as HPA model in the system and it is connected after the OFDM transmitter. HPA's are used to amplify the power of the signal before sending it on the channel. This block of HIPERLAN/2 with RAPP'S amplifier and LINEAR amplifier are shown in Fig.1 and fig.2 respectively. The input data (random binary data) were mapped unto 64-QAM and 256-QAM constellation. The network is generated using the data of OFDM transmitter and receiver[6-8]. Each subcarrier was assigned a particular number of bits and the subcarriers were transmitted in parallel. The received bits were compared with the transmitted bits in order to calculate the BER [9-10]

The following parameters and system configurations were used:

Modulation: 64, 256 QAM
Data rate: 54Mbps and 72Mbps
FFT size: 64
Number of subcarriers: 32, 64 and 128
OFDM Frame size: 80
Guard interval type: Cyclic prefix
Number of paths: 2
Path delay vector: [0.1 6.2]
Distance: 2km
Carrier frequency: 900MHz
Amplifier Model: Rapp's Model, Linear Model.
Linear Model:0-20db

Table 1: Table of mode dependent physical layer parameters of HIPER LAN/2 [4]

MODULATION	CODING RATE	BITS PER SYMBOL	NORMAL BIT RATES(Mbps)
BPSK	½	1	6
BPSK	¾		9
QPSK	½	1	12
QPSK	¾	2	18
16 QAM	9/16		27
16 QAM	¾	4	36
64 QAM	¾	6	54
256 QAM	¾	8	72

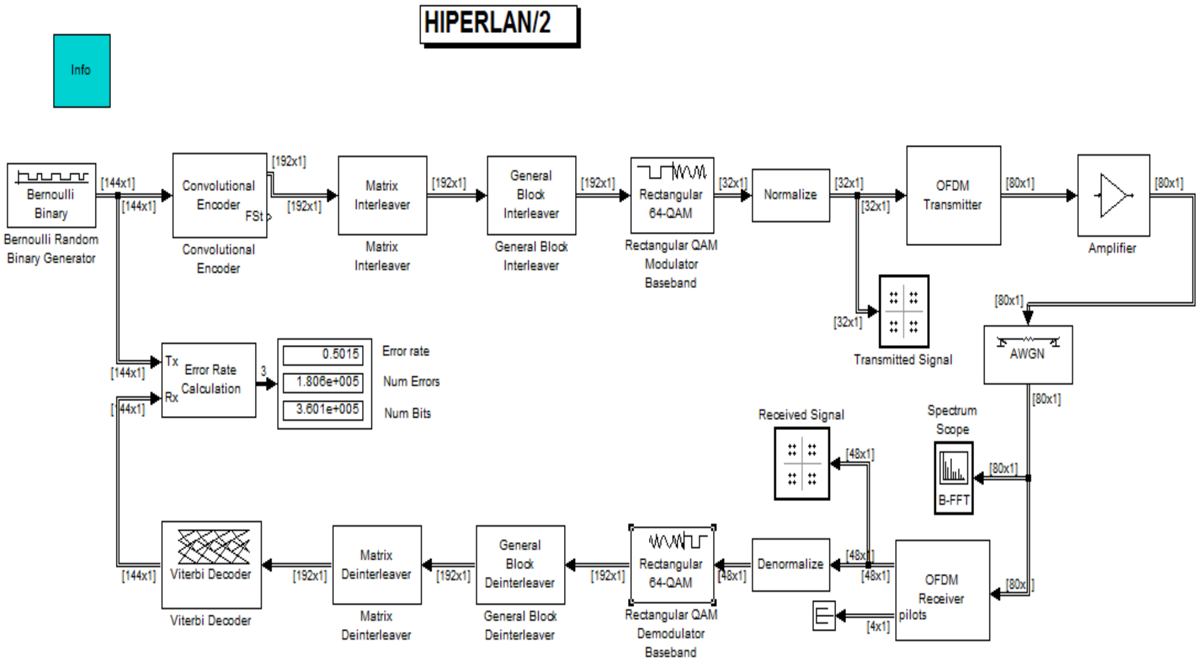


Fig.1: Modified Block Diagram for 64-QAM with HPA (Matlab.7.5)

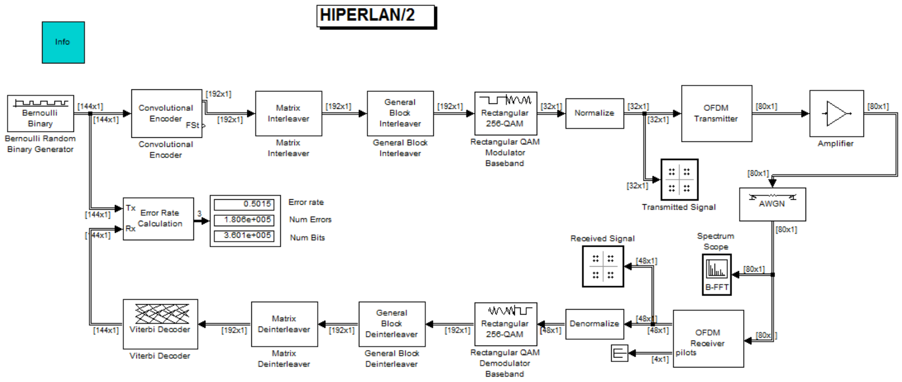


Fig.2: Simulation Block Diagram for 256-QAM with HPA (Matlab.7.5)

The simulation was carried out by varying the number of subcarriers and mobile speed parameters and their BER performances at Eb/No of 0 to 20dB were obtained.

Addition of extra zero bits in the OFDM symbol is used to avoid aliasing. Cyclic prefixing can be implemented by adding the last few bits of a symbol at the beginning of the symbol and is used for both timing and frequency synchronization . On the receiver side, most of the functions are just the opposite of the equivalent transmitter blocks. The time domain signal is converted into the frequency domain by the FFT and symbols are extracted by a demodulator. Removal of pilot carriers, frame synchronization and elimination of cyclic prefixes are performed beforehand in the receiver block. After de-normalisation, frames are passed through a de-interleaving process. Viterbi algorithm is used to decode convolution ally encoded input data. With the Viterbi algorithm, the zero-valued dummy bit has no effect on the outcome of the decoder. Finally the received data bits are compared to the transmitted bits by a bit error calculator.

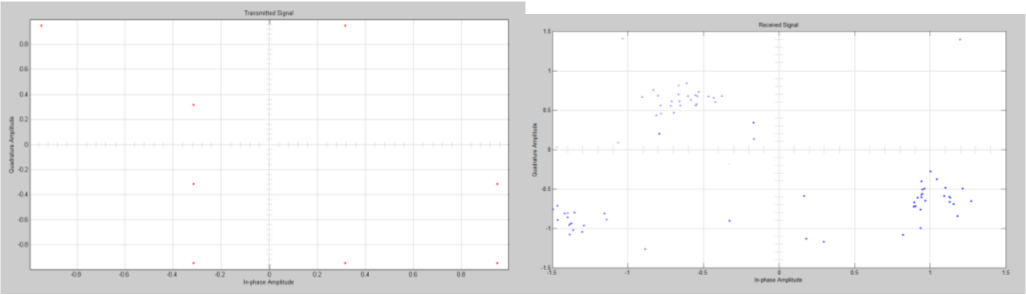
The following steps were taken to analyse the Hiper Lan/2 model alongside various QAM outcomes:

- Variation of different QAM modulation schemes such as 64 and 256.
- Variation of simulation time to determine its effects on the simulation results.
- Variation of signal to noise ratio to determine its effects on simulation results.
- Introducing amplifier to the model to see its effect on the simulation result.
- Variation of different model of the high power amplifier and compare it result with when it was not introduced.

4. RESULTS AND DISCUSSION

The main purpose of the simulation was to design a base-band HIPERLAN/2 model and observe its behaviour under different channel conditions. The aim of doing this simulation is to measure the performance of 64, 256-OFDM with BER and SNR calculations, under 64-QAM and 256-QAM modulation techniques. According to the standard, the highest data rate is 54 Mbit/s, which should be obtained using 64-QAM and a coding rate of 3/4 achieved using a puncturing rate of 2/3. However, 256-QAM was introduced into the simulation with a coding rate of ¾ using a puncturing rate of 3/4 to obtain a higher data rate of 72Mbit/s.Math lab/Simulink modelling demonstrated that 64 QAM mode with coding rate ¾, a data rate of 54 Mbit/s is achieved with 15db SNR improvement compared to 256 QAM coding rate ¾ (with puncturing) as required for the maximum 72Mbit/s.

The advantage of using QAM is that it is a higher order form of modulation and as a result it is able to carry more bits of information per symbol. By selecting a higher order format of QAM, the data rate of a link can be increased



(a)Transmitted Signal **(b) Received Signal**

Fig.3: Simulation result of HIPER LAN/2 with Rapp Amplifier

Fig 3(a) and (b) shows the transmitted and received signals and (c) shows the spectrum plot of HIPER LAN/2 with Rapp model of HPA. After including amplifier in an effect of nonlinearity can be seen on the received constellation points. The received signal is more scattering.

The Bit Error Rate Calculation block gave varying results as the value of the SNR were varied from 1dB to 20 dB which was shown in Table 2.

- The first value obtained for SNR of 1dB gave a high error rate of 0.4985, 0.4991 and 0.5011 for 16 QAM, 64 QAM and 256 QAM respectively.
- As the value of the SNR increases from 1dB to 15 dB, there was a significant reduction in the rate at which error was occurring in the calculation. The number of errors was significantly low.
- When the SNR was further increased to 16dB down to 20 dB for 16QAM the bit error rate was zero which implies that no errors occur in the transmission.

Table 2: Simulation values of 16 QAM, 64 QAM & 256 QAM against SNR.

S/N	Simulation Time	SNR	16 BER QAM	64 BER QAM	256 BER QAM
1	0.01	1	0.4985	0.4991	0.5011
2	0.01	2	0.4963	0.5009	0.5012
3	0.01	3	0.4925	0.5002	0.5014
4	0.01	4	0.4838	0.5001	0.5005
5	0.01	5	0.4702	0.4997	0.5009
6	0.01	6	0.438	0.4994	0.5009
7	0.01	7	0.3808	0.5018	0.5012
8	0.01	8	0.2741	0.5017	0.5007
9	0.01	9	0.1534	0.5008	0.5002
10	0.01	10	0.05621	0.5008	0.5001
11	0.01	11	0.01437	0.4994	0.5002
12	0.01	12	0.02674	0.5013	0.5004
13	0.01	13	0.000267	0.4999	0.5002
14	0.01	14	2.22E-05	0.5005	0.5002
15	0.01	15	2.78E-06	0.5009	0.5003
16	0.01	16	0	0.5006	0.5001
17	0.01	17	0	0.5004	0.5
18	0.01	18	0	0.5004	0.5001
19	0.01	19	0	0.5004	0.5001
20	0.01	20	0	0.5004	0.5001

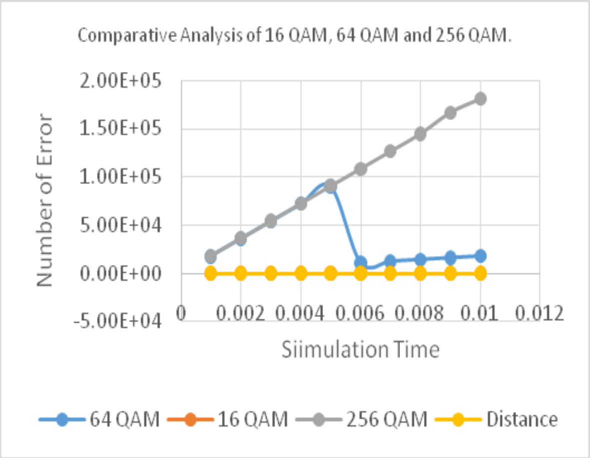


Fig.4 Comparative Analysis of 16 QAM,. 64QAM and 256 QAM.

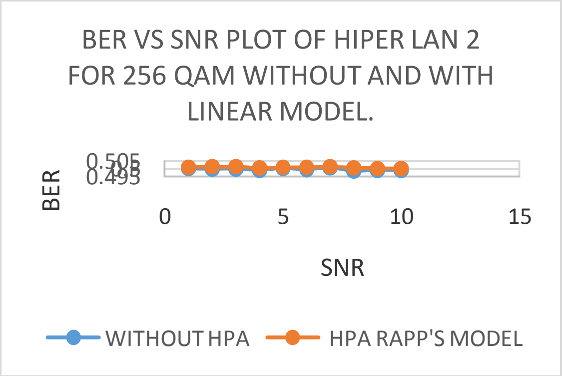


Fig.5. Ber Vs Snr Plot Of Hiper Lan2 For 256 Qam Without And With Linear Model

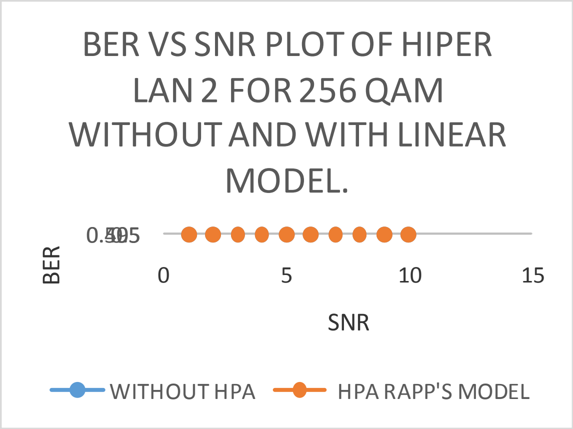


Fig.6. Ber Vs Snr Plot Of Hiper Lan2 For 256 Qam Without And With Linear Model.

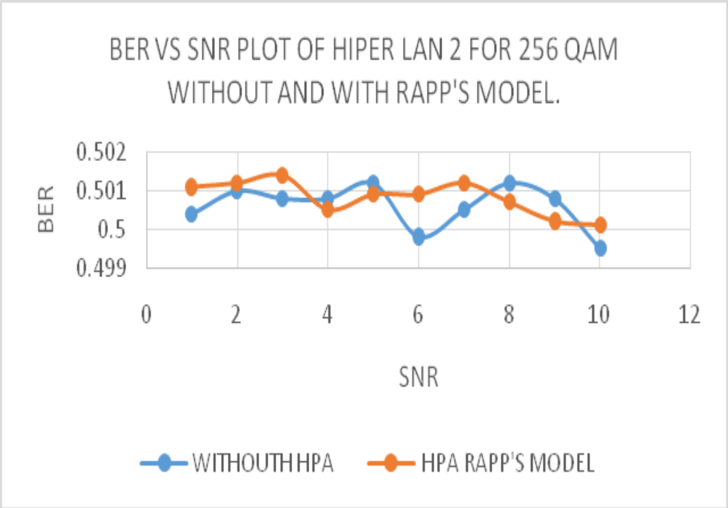


Fig7. Ber Vs Snr Plot Of Hiper Lan 2 For 256 Qam Withouth And With Rapp's Model.

Fig.4 shows simulation time vs Bit Error Rate for 16-QAM, 64-QAM and 256-QAM. As can be seen from the graphof 64-QAM, it increases and then decreasesat 0.05 as the simulation time increases over a constant distance. While for 256-QAM the graph increases as the simulation time increases over a constant distance.

Fig.5 shows BER vs SNR plot of Hiper/Lan 2 for 16-QAM, 64-QAM and 256-QAM.The BER for 32, 64 and 128 subcarriers were observed.

Furthermore for 16dB down to 20dB for 64QAM and 256QAM the bit error rate was constant which implies that at higher SNR the BER will be constant.

- ❖ Bandwidth calculation for 256 QAM is 72 Mb/s.
- ❖ The simulation results obtained show that for certain Eb/No and QAM, the more the number of SNR increases, the more the BER also increases.
- ❖ The spectrum is much wider after the signal passes through nonlinear amplifier.
- ❖ Figure 4.3 shows that the curve for HIPERLAN/2 with Rapp's model is much more degraded than the curve without model.
- ❖ Figure 4.4 shows that the curve after passing through the amplifier is much more degraded than the curve without amplifier.

5. CONCLUSION

In this paper, It was discovered that If the medium between the transmitter and receiver is good and the signal to noise ratio is high, then the bit error rate will be very small - possibly insignificant and having no noticeable effect on the overall system. However if noise can be detected, then there is chance that the bit error rate will need to be considered.Lower order modulation schemes can be used, but this is at the expense of data throughput. Higher modulation schemes can be used, but this is at the expense of noise.The results obtained in this work will serve as a useful reference for mobile wireless communication systems' designers and researchers working on HIPER LAN2 for high data rate transmissions. The increase in bit error rate indicates performance degradation.

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