PERFORMANCE OF QUASI CONSTANT ENVELOPE OFDM WITH SIGNAL COMPARISON OF QPSK, 16QAM AND 64QAM

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ABSTRACT

The is a technology in broadband wireless access, which employs OFDM (Orthogonal Frequency Division Multiplexing) as an alternative transmission to enable high speed data in communication system. This research aim is to analyze the performance system of the OFDM-Based QUASI, which used the cyclic prefix. The model was designed   in four schemes of simulation method, the BPSK (Binary Phase Shift Keying, QPSK (Quadrature Phase Shift Keying), 16 QAM (Quadrature Amplitude Modulation) and 64 QAM. Each scheme was investigated BER (Bit Error Rate) on AWGN (Additive White Gaussian Noise) channel and multipath Rayleigh fading channel, which had applied the cyclic prefix. By simulation of the cyclic prefix was produced the modulation measurement of the BPSK, QPSK, 16 and 64 QAM. The performance result of Eb/No   15 dB was obtained the BER of BPSK and QPSK of 1.11E-11, the BER of 16 QAM and 64 QAM of 8.69E-06 and 0.00333 respectively. Those results indicated much smaller BER value than EbNo 0 dB which BPSK and QPSK of 1 BER, 1.5 and 1.75 BER for 16 QAM and 64 QAM respectively. In conclusion, a higher value of EbNo, hence the BER value would be lower.

Keywords: BER measurement, cyclic prefix, OFDM, QUASI

1. INTRODUCTION
2.

Advances in broadband mobile communication provide information access that easy, cheap and reliable, both in the presentation of high-speed data and multimedia accesses. Those features can be provided by QUASI technology. The QUASI standard of 802.16 is one of the BWA (Broadband Wireless Access) issued by the IEEE (Institute of Electrical   and Electronics Engineering), which has developed with variants that have advantages in certain circumstances [1]. Particularly 802.16e standard supports portable and mobile applications, which adopts OFDM technique [2]. The OFDM as multicarrier modulation can overcome the problems of various kinds of propagation (multipath), including NLOS (Non Line Of Sight)

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conditions between the bases station to the user. The OFDM can also overcome the problem of delay spread and the ISI (Inter Symbol Interference).

The physical layer, a Media Access Control layer (MAC) and the application layer in the network system based on mobile QUASI IEEE 802.16e was a very important rule to be consideration for simulation models design [3]. Sharef et al [4] studied the
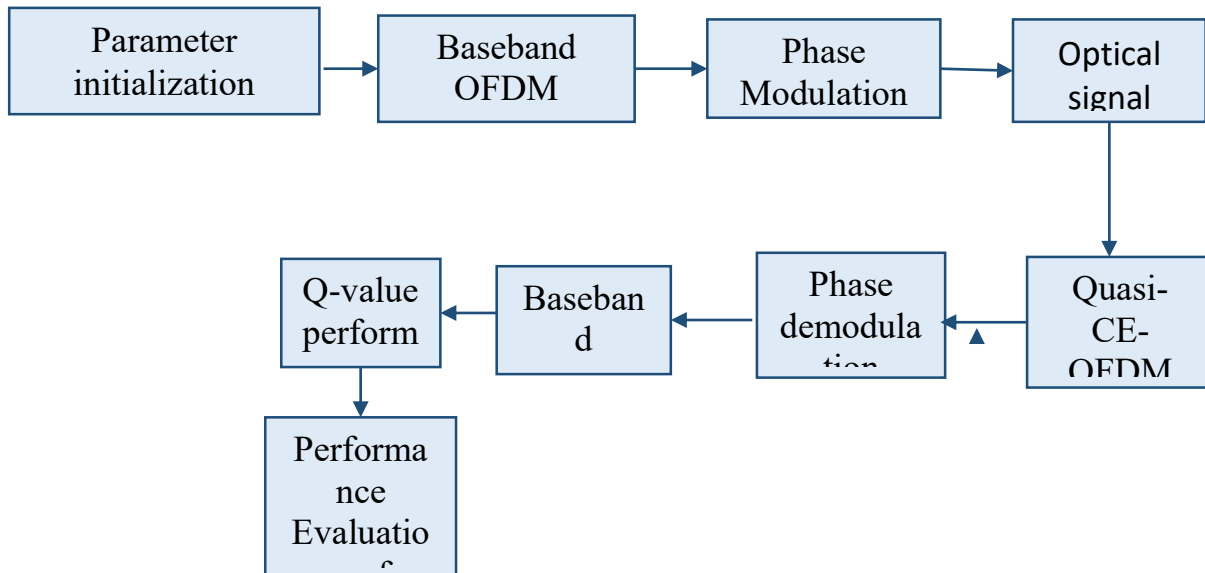

Figure 1: Block diagram of OFDM scheme

Physical layer performance of QUASI IEEE 802.16e that refer to channel model of ITU (International Telecommunication Union). They investigated the effect of multipath fading and Doppler shift using the cyclic prefix. The cyclic prefix is a data duplicate in the OFDM symbol before transmitting to minimize inter symbol interference and inter channel interference [5]. The length of cyclic prefix might influence in the OFDMA system performance [4].

A cyclic prefix reduces the effects of ISI and delay spread, which is caused by increas- ing of the symbol duration in the parallel sub-channels in the OFDM system. In other hand, the OFDM symbol is cyclically extended by the guard time to avoid inter carrier interference and let the receiver to take multipath energy in efficient manner. The modulation schemes such as BPSK, QPSK and QAM are used to modulate the signal of an OFDM. A transmission of a data link is involved the potentially errors. Then, a BER and probability error can be used to evaluate performance of the OFDM-based QUASI system. Meanwhile, the improving of performance of the OFDM-based QUASI system has still challenged [6]. Therefore, this paper aim is to simulate the OFDM- based QUASI system performance, which analyzed the BER in AWGN channel and Rayleigh fading channel. That was investigated the performance of the OFDM system using cyclic prefix with modulation of BPSK, QPSK, 16 QAM and 64 QAM.

3. METHODOLOGY
4.

The proposed model in this paper used the modulation and demodulation techniques to investigate the performance of OFDM-based QUASI system. According those mod- ulation techniques, the parameters of performance system that would be investigated as: Bit Error Rate (BER); Signal against Eb/No and Probability error (Pe). The simulation design in this proposed model was used the cyclic prefix guard interval. A block diagram of the OFDM scheme of simulation model is shown in Fig. 1. The performance of OFDM Scheme was simulated using Matlab software.

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It can be seen in Fig. 1, the simulation design of OFDM-Based QUASI scheme consist of three main sub-systems: transmitter, channel and receiver. In this model, the trans- mitter and receiver stations were assumed perfect synchronization, to investigate the performance of the QUASI OFDM modulation. The cyclic prefix length was assumed longer than the maximum spread delay to avoid the influence of ISI. The simulation was done by looking at the results of the BER versus EbNo in AWGN and Rayleigh fading channels. All experiments were performed to the level of modulation BPSK, QPSK, 16 QAM and 64 QAM.

The Pe is the assumption that the error rate occurs in the system due to noise and fading effect in the channel and also for cable losses at the transmitter and receiver. The Pe for M-ary PSK was calculated using the following Equation [7]:

$$Pe \simeq erfc\left(\sqrt{\frac{E_b}{N_0}}\, sin\frac{\pi}{M}\right) \qquad (1)$$

The _Pe_ for M-ary QAM was calculated using the following Equation [6]:

$$Pe \simeq 2\left(1 - \frac{1}{M}\right)erfc\left(\sqrt{\frac{3E_s}{2(M-1)\,N_0}}\right) \qquad (2)$$

3. RESULT AND DISCUSSION

The simulation of model added the cyclic prefix and 2000 samples of simulation run- ning, which 256 subcarrier. Constellation signal was BPSK, QPSK, 16 QAM and 64 QAM that used the model channel of AWGN and Rayleigh Fading. Regarding simulation result, the performance of QUASI OFDM with BPSK and QPSK modulation were a lot better than the 16 QAM and 64 QAM in term of the comparison between values of EbNo (dB) and BER.

Table 1: The measurement of BER results for model of the OFDM-QUASI system

Value of Eb/No (dB)	MODULATION			
	BER	BER	BER	BER
	BPSK	QPSK	16 QAM	64 QAM
0	0.07865	0.07865	0.141	0.1998
1	0.05837	0.05837	0.1212	0.1801
2	0.04094	0.04094	0.1019	0.1611
3	0.02682	0.02682	0.08341	0.143
4	0.01616	0.01616	0.06594	0.1259
5	0.008794	0.008794	0.04995	0.1096
6	0.004227	0.004227	0.03593	0.09392
7	0.001745	0.001745	0.02426	0.07886
8	0.0005981	0.000598	0.01517	0.06445
9	0.0001631	0.000163	0.00864	0.05088
10	3.36E-05	3.36E-02	0.00439	0.03848
11	4.91E-06	4.91E-06	0.00194	0.02763
12	4.71E-07	4.71E-07	0.0007225	0.01862

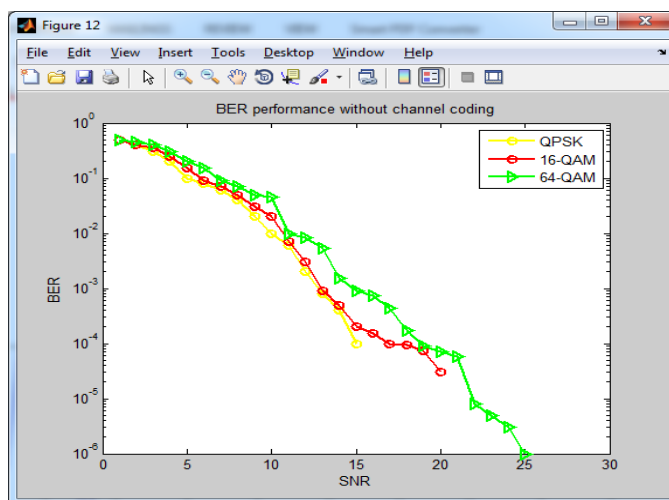| 13	2.68E-08	2.68E-08	0.0002182	0.01161
14	8.06E-10	8.06E-10	5.10E-05	0.006591
15	1.11E-11	1.11E-11	8.69E-06	0.003335

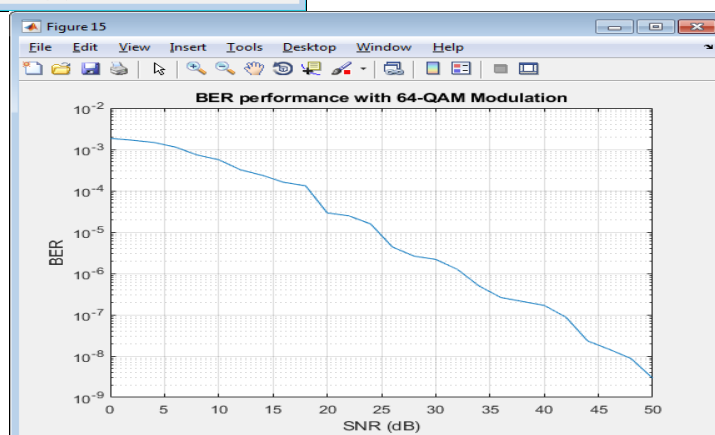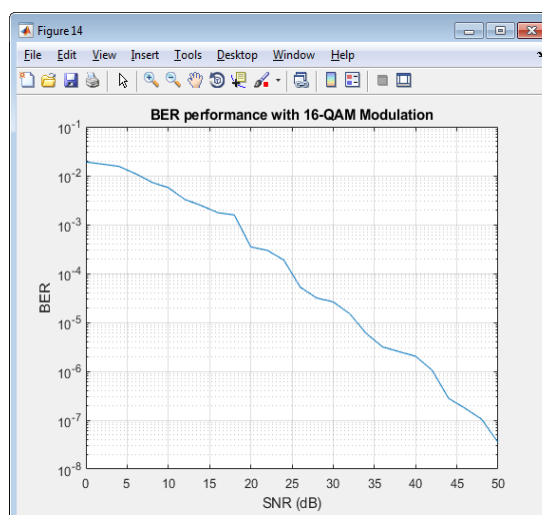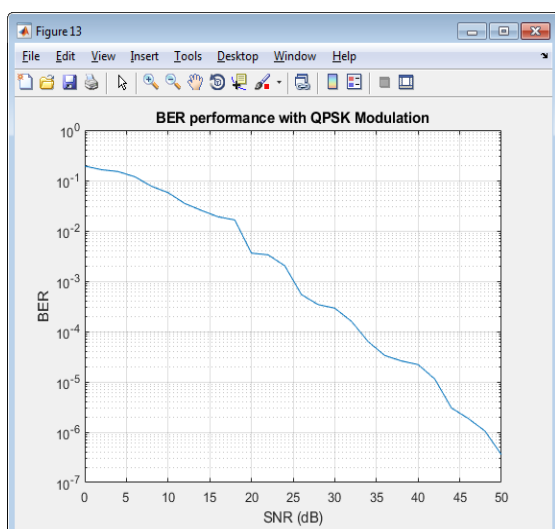**Figure 2: The performance of OFDM in terms of BER and SNR.**

Figure 3: Performance in BER vs SNR in QAM &QPSK

It can be seen in Table 1, the influences of EbNo in the AWGN channel and Rayleigh fading channel to values of BER. The EbNo value of 0 dB was obtained the BER of BPSK and

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QPSK of 0.07865, the BER of 0.141 to 16 QAM and the BER of 0.1998 for 64 QAM. The EbNo 10 dB was obtained the values of 3.363e-005 BER for BPSK and QPSK, BER of 0.00439 to 16 QAM and BER of 0.03848 to 64 QAM. Therefore, the higher provision of the EbNo values affected the smaller noise generated. As the result, the performance of the system would be better.

The simulation results to investigate the effects of CP using adaptive modulation techniques and compared the performance of OFDM in terms of BER and Eb/No (dB) that can be seen on Figure 2(A). Besides, the BER theoretical value with respect to the adaptive modulation technique to estimate the theoretical value of Eb/No(dB) with 256 subcarriers that can be seen on Figure 2 (B).

Table 2: The result of Probability of error (Pe) for OFDM modulation scheme

Value of Eb/No (dB)	MODULATION			
	Pe	*Pe*	*Pe*	*Pe*
	BPSK	QPSK	16 QAM	64 QAM
0	1	1	1.5	1.75
1	0.1797	0.3428	0.9821	1.446
2	0.05778	0.1797	0.7906	1.326
3	0.02014	0.1003	0.6579	1.235
4	0.00729	0.05778	0.5566	1.159
5	0.0027	0.03389	0.476	1.095
6	0.0003857	0.02014	0.41	1.038
7	0.0003857	0.01207	0.3551	0.9865
8	0.0001478	0.00729	0.3089	0.9399
9	5.70E-05	0.004427	0.2696	0.8972
10	2.21E-05	2.70E-03	0.2359	0.8578
11	8.598E=06	1.65E-03	0.207	0.8211
12	3.36E-06	1.02E-03	0.182	0.787
13	1.32E-06	6.25E-04	0.1603	0.755
14	5.17E-07	3.86E-04	0.1414	0.7249
15	2.04E-07	2.39E-04	0.1249	0.6965
16	8.83E-08	1.48E-04	0.1105	0.6698
17	3.17E-08	9.17E-05	0.09779	0.6445
18	1.26E-08	5.70E-05	0.08667	0.6204
19	4.97E-09	3.55E-05	0.07688	0.5976
20	1.97E-09	2.21E-05	0.06825	0.5759

The simulation result of Pe is depicted in Table 2. It can be seen in Table 2, the Pe of QUASI OFDM using BPSK modulation was much better than QPSK modulation. That was seen from the rapid decline in the value of Pe upon increasing of EbNo. The Pe values for 16 QAM was smaller than the Pe values for 64 QAM. The effect of EBNo 0 (dB) on the Pe value for BPSK and QPSK was 1, 16 QAM of 1.5 Pe value and 64 QAM of 1.75 of Pe value. The EbNo 5 dB was

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obtained Pe value of 0.0027 and 0.03389 for QPSK and BPSK respectively. Whilst, the Pe value of 16 QAM and 64 QAM were 0.476 and 1.095 respectively.The simulation result of the probability of error versus Eb/No (dB) was obtained using Matlab software that depicted on Figure 3.

Constellation of four digital modulation signals was shown the probability of error for EbNo of BPSK modulation rapidly decreasing by increasing of EbNo values. This mod- ulation technique is suitable for long distance transmission. While, QPSK modulation was reliable comparing to 16 QAM and 64 QAM. The QPSK modulation was reliable with the ability to carry twice of the data rate than the BPSK. Modulation of 16 QAM and 64 QAM was less reliable than the BPSK and QPSK modulations. However, the modulation of 16 and 64 QAM were efficient to applying in the frequency spectrum, and were suitable for transmission that closes to the BTS. The 64 QAM was also requiring higher bandwidth and better data rate than others.
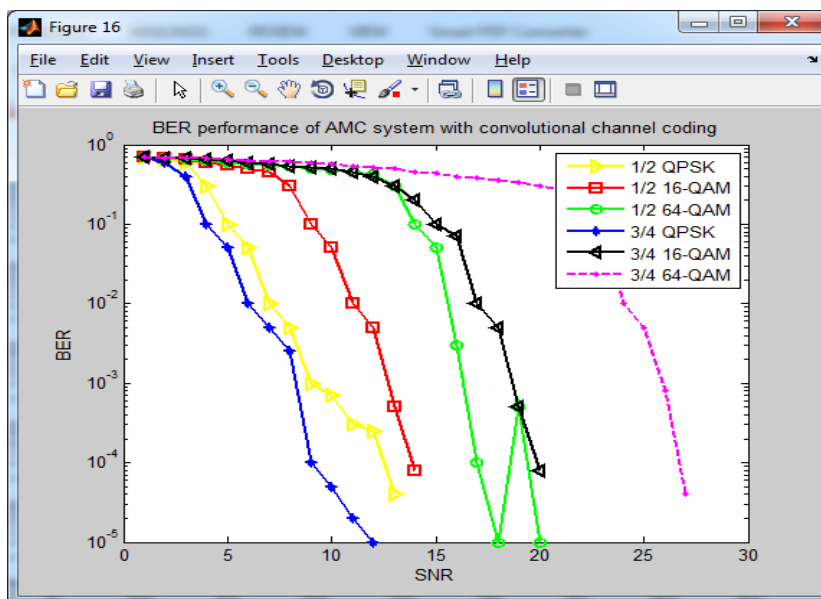

Figure 4: BER performance of AMC system with Convolutional channel coding.

4. CONCLUSION

This paper was proposed to investigate the performance of OFDM-Based QUASI sys- tem using cyclic prefix implemented in the BPSK, QPSK, 16 QAM and 64 QAM modula- tions schemes. The schemes of simulation model were performed by Matlab software. The simulation model showed that the performance of BPSK and QPSK modulations were better than the 16 QAM and 64 QAM modulations. The probability of error (Pe) at EbNo 0 dB was obtained Pe value of 1 for BPSK and QPSK. The Pe value of 16 QAM and 64 QAM were 1.5 and 1.75 respectively. The greater of EbNo value, hence Pe value would be smaller. The BPSK is better for long distance transmission due to small the error probability (Pe). While, the 64 QAM has a high data rate, that is suitable for close transmission to the BTS (Base Transceiver Station). In conclusion, the cyclic prefix has advantage to minimize Inter Symbol Interference (ISI) that generated the smaller BER, which it can improve the performance of the OFDM-based QUASI system.

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