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Performance Evolutionary in AWGN Channel for 802.11a High Speed Network

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Abstract*—FDMA, TDMA and CDMA are the well known multiplexing techniques used in wireless communication systems. While working with the wireless systems using these techniques various problems encountered are (1) multi-path fading (2) time dispersion which lead to intersymbol interference (ISI) (3) lower bit rate capacity (4) requirement of larger transmit power for high bit rate and (5) less spectral efficiency. With the investigation of 802.11a standard provides better solution for the above mentioned problems. In 802.11a standard of multicarrier transmission, a single data stream is transmitted over a number of lower rate subcarriers to provide high data rates. 802.11a wireless standard provides a specification for distributing the data over a large number of carriers that are spaced apart at precise frequencies. This spacing provides the "orthogonality", which prevents the demodulator from seeing frequencies other than their own. 802.11a wireless standard design includes simulation of wireless communication system was done with different modulation techniques such as BPSK, QPSK, 8PSK, 16PSK, QAM using MATLAB. From the simulation results, it is observed that the BPSK allows the BER and signal to noise ratio (SNR) to be improved in a noisy channel at the cost of maximum data transmission capacity. As we investigate different modulation techniques allows higher transmission capacity, but at the cost of slight increase in the probability of error. From the results, the use of 802.11a wireless standard with QPSK is beneficial for short distance transmission link, whereas for long distance transmission link OFDM with BPSK will be preferable.

***Keywords*—communication transmission technology, OFDM, computer simulation, bpsk, Matlab**

I. INTRODUCTION

Orthogonal frequency division multiplexing is a multicarrier transmission system in parallel. This parallel transmission system greatly expands the pulse-length and increases the performance of anti-multipath fading. Its biggest feature is the high data transfer rate, with a strong anti-inter-symbol interference and channel selective fading capacity. In the 20th fifties the concept of OFDM has been proposed. At first it is used for high-speed MODEM, digital mobile communications and wide-band data transmission on wireless FM channel. With the development of IEEE802.IIa protocol, BRAN (Broadband Radio Access Network) and multimedia technology, the current OFDM technology has been widely used in asymmetric digital subscriber loop (ADSL), ETSI standard Digital Audio Broadcasting (DAB), Digital Video broadcasting (DVB), high-definition television (HDTV), wireless local area network (WLAN) and so on[2].

II. BASIC PRINCIPLE OF OFDM

OFDM is a special multi-carrier transmission technology in which high-speed serial data are converted into N channel parallel data and certain frequency sub-carriers are band is divided into N orthogonal sub- throughout the symbol period to ensure the receiving end recover the signal without distortion is overlapped [3]. The OFDM signal spectrum is shown in Figure 1.

In OFDM system, set the symbol period of serial code ts, 'rate rs = 1/ ts . N-serial-symbol is converted into paralle The length of the parallel code is T = Nts, and rate is Rs=1/T=l/Nts, =rs/N. Each sub-carrier is modulated by the N-parallel code respectively:l code.

$$f_n = f_0 + n\Delta f \quad n = 0,1,2,\cdots, N-1 \qquad (1)$$

$$\Delta f = 1/T_s = 1/Nt_s \qquad (2)$$

Equation (2) is sub-carrier interval which is one of the important design parameters in OFDM system. When fo»1/T, each sub-carrier is orthogonal, that is,

$$\frac{1}{T_s}\int_0^{T_s}\sin(2\pi f_k t + \varphi_k)\sin(2\pi f_j t + \varphi_j)dt = 0$$

$$f_k - f_j = m/T_s \quad (m = 1,2,\ldots) \qquad (3)$$

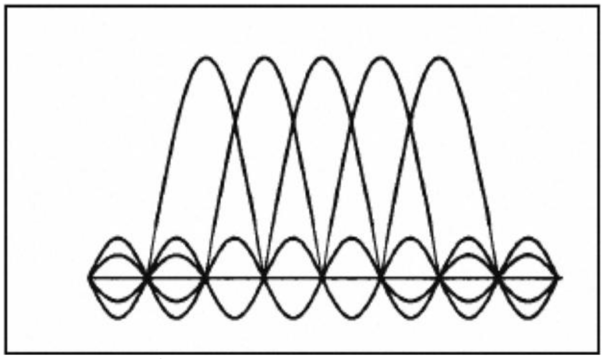


Fig.1 Orthogonal frequency division multiplexing signal spectrum

The N-parallel branch of the sub-carrier signals are added together and the actual transmit signals of OFDM is get.

$$D(t) = \sum_{n=0}^{N-1} d(n)\cos(2\pi f_n t) \quad (4)$$

$$\hat{d}(k) = \int_0^{T_s} D(t)\cdot 2\cos\omega_k t dt = \int_0^{T_s} \sum_{n=0}^{N-1} d(n) 2\cos(\omega_n t)^2 dt = d(k) \quad (5)$$

The hardware system used in OFDM signal generation and demodulation is complex. The use of discrete Fourier transform can simplify the structure of system. The modulation and demodulation of OFDM system can be realized by the IFFT and FFT. For the inter-symbol interference caused by the delay spread can be eliminated by adding the guard interval and its length must be generally larger than the largest delay spread in the wireless channel. In addition, because multipath interference can also cause inter-channel interference, cyclic prefix is added in the front of the OFDM symbol to eliminate inter-channel interference. Multi-ary digital modulation is adopted to improve frequency spectrum utilization in each branch. The modulation method of each carrier in OFDM may be different and each carrier can adopt different modulation methods, such as BPSK, QPSK, 8PSK, 16QAM, 64QAM, etc. according to the channel conditions to get the best balance between frequency spectrum utilization and bit error rate [4]. In the OFDM modulation method, firstly the serial input data do, d 1 ..., d (N-l) are converted into parallel data, then symbol is mapped. BPSK,

QPSK, 16PSK, 16QAM and 64QAM can be used as modulation method to obtain the frequency-domain data. After IFFT modulation is equivalent to be modulate with orthogonal sub-carrier fO, fl , ... , fN-I to complete the orthogonal frequency division multiplexing. After the cyclic prefix adding, parallel to serial conversion and D/ A conversion have run, the data are modulated to a high-frequency carrier to send. If it is base-band transmission, carrier modulation isn't needed. At the receiving end the converse operation is performed. After FFT transformation the time-domain data is transformed into frequency-domain data, and the OFDM signal demodulation is completed. OFDM baseband system schematic diagram is shown in Fig. 2.

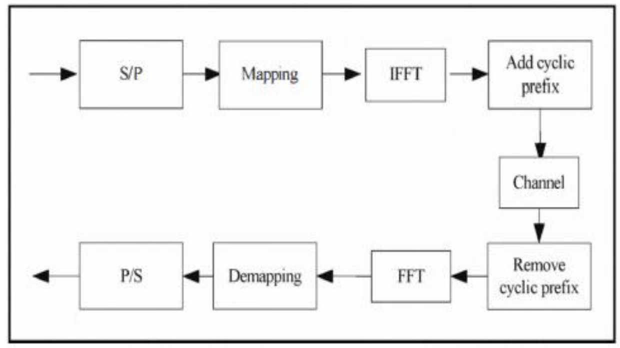


Fig.2 Base-band OFDM system diagram

III. OFDM SYSTEM SIMULATION

MATLAB is a high-level computing language and interactive environment used for algorithm development, data visualization, data analysis and numerical calculation. In this paper, Simulink in MATLAB is used to create a simulation model. According to base-band OFDM system diagram, on the base-band system, the source output signal is prior to channel coding in which R-S cyclic codes is used. The redundant data is introduced to improve system reliability. QPSK modulation is adopted in the mapping part. The specific simulation model in OFDM sending part is shown in Figure 3.

In figure3 Bernoulli Binary is used to generate a binary sequence whose rate is I Mb/s and R-S Encoder is used to encode binary data. (15, 11) R-S coding and QPSK Mapping are used to achieve constellation mapping in which subcarrier number is 30. OFDM Baseband modulator is used to implement OFDM modulation and the parallel to serial convert, zero-padding, and IFFT transform is included in the process. ADD CP is used to insert cyclic prefix (cyclic prefix CP = 26). Rayleigh fading channel and Gaussian white noise channel are adopted in the simulation.

The data modulated by OFDM are transmitted through Rayleigh multipath fading channel and Gaussian white noise channel and then come into the receiving end to demodulate. The part of OFDM receiver in the simulation model is shown in Fig. 4.

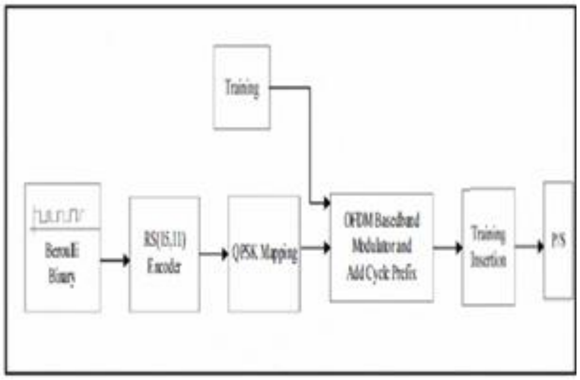


Fig. 3 Simulation Model of OFDM sending part

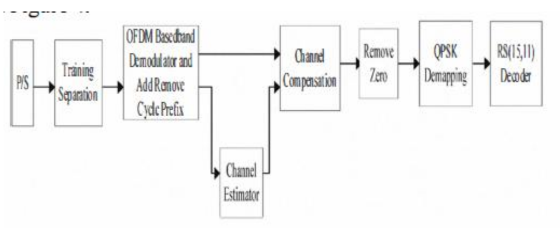


Fig. 4 Simulation model of receiver part

In fig. 4, the S/P for the serial to parallel conversion, Training Separation is used to remove training sequence added on the sending end and OFDM Baseband Demodulator is used to remove the cyclic prefix inserted on the sending end to carry out FFT transform and parallel to serial conversion. Remove Zero is used to remove zero value data. QPSK de-mapping is used to achieve the inverse.

III. MATLAB SIMULINK WITH RESULT

A. *OFDM system layout:*

The OFDM simulation result is shown in fig 5 for 16 PSK. In this OFDM Simulation we use different modulation schemes such as: 16PSK, QAM. By using these modulation schemes the constellation diagram and their OFDM frame structure as shown below:

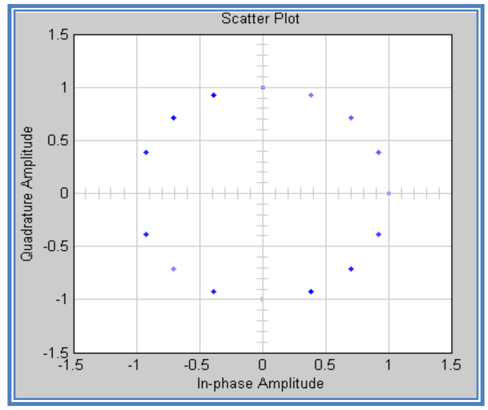
B. SCATTER PLOTS:

1) Without channel

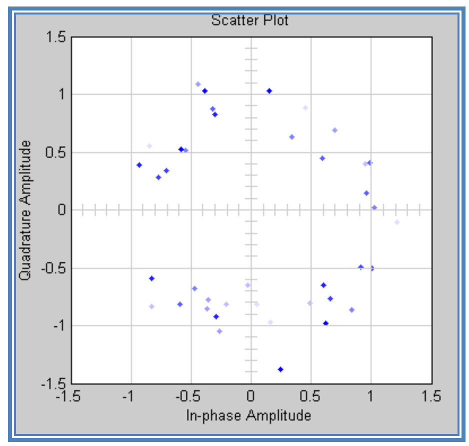
2) With AWGN channel

3) With AWGN and multipath channel

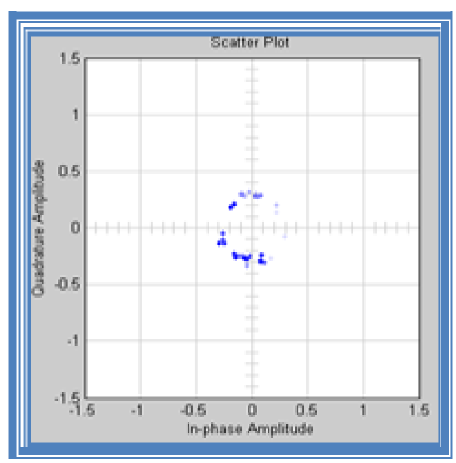
16-PSK



Without channel



AWGN channel



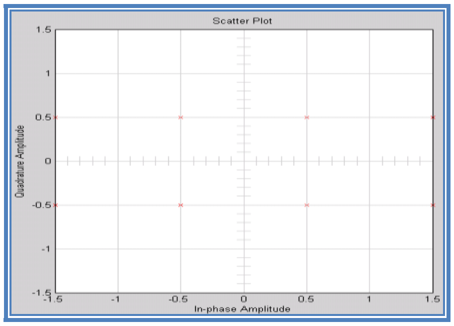
AWGN and MULTIPATH channel

Fig. 5 OFDM frame with 16PSK

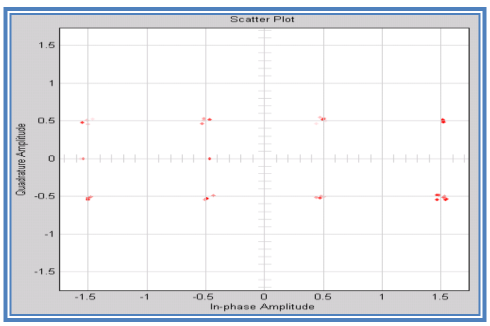
Similarly we use "QAM modulator baseband" and AWGN channel with and without multipath" simulation block.

C. SCATTER PLOTS:

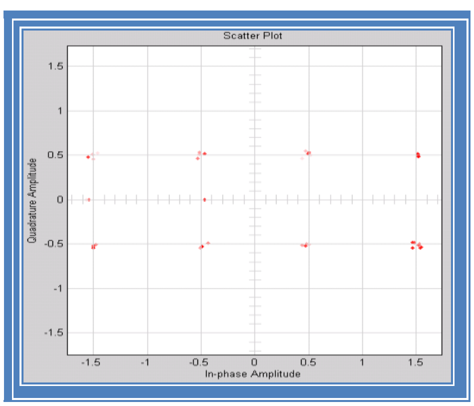
1) Without channel 2) With AWGN channel 3) With AWGN and multipath channel



Without Channel



AWGN channel



AWGN with Multipath channel

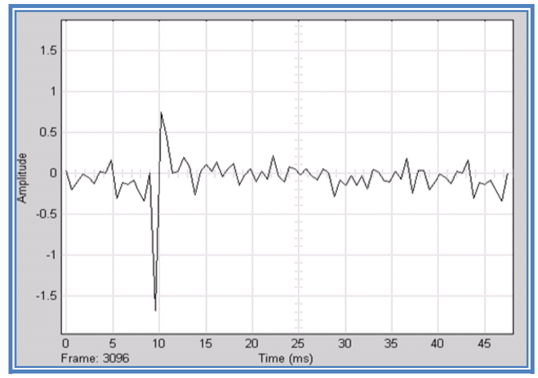
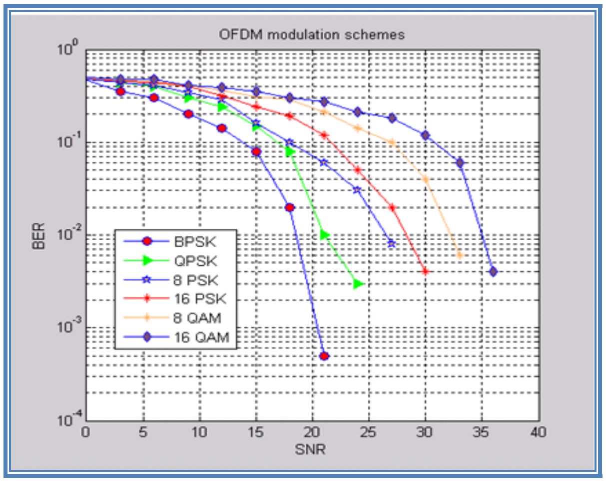


Fig. 6. OFDM frame with QAM

4.5 BER PERFORMANCE

The PSK-based digital modulation scheme (BPSK, QPSK etc.) that gives the best BER performance in a multipath fading environment using computer simulation. Essentially, ideal and worst case communication channel models were studied and simulation programs were written to simulate the performance obtain. the BER performance for each PSK-based transmission scheme under various conditions and to identify which modulation scheme gives best BER performance. The comparison study showed that BER for BPSK, QPSK, MPSK and QAM are similar and they give the lowest BER under multipath fading. While these modulation schemes shows high robustness under multipath fading channel, a modulation scheme that can increase transmission rate while keeping high frequency utilization efficiency should the directions of future modulation schemes.

SNR performance of OFDM is similar to a standard single carrier digital transmission. This is to be expected, as the transmitted signal is similar to a standard Frequency Division Multiplexing (FDM) system. Figure 4.46 shows the results from the simulations. The results show that using QPSK the transmission can tolerate a SNR of >18-25 dB. However, using BPSK allows the BER to be improved in a noisy channel, at the expense of transmission data capacity. Using BPSK the OFDM transmission can tolerate a SNR of >18-23 dB. In a low noise link, using 16PSK can increase the capacity. If the SNR is >25 dB 16PSK can be used, doubling the data capacity compared with QPSK. If SNR is >28 dB QAM can be used for data capacity. Graph shows the comparisons of BER Vs SNR graph with different modulation schemes with AWGN channel



BER verse SNR for OFDM using BSPK, QPSK, 8PSK, 16PSK and QAM

Eb/N0 (the energy per bit to noise power spectral density ratio) is an important parameter in digital communication or data transmission. It is a normalized signal-to-noise ratio (SNR) measure, also known as the "SNR per bit". It is especially useful when comparing the bit error rate (BER) performance of different digital modulation schemes without taking bandwidth into account. The graph compares the bit-error rates of BPSK, QPSK, 8-PSK, 16-PSK and QAM. It is seen that higher-order modulations exhibit higher error-rates; in exchange however they deliver a higher raw data-rate. Fig.4.47 shows the comparisons of BER Vs Eb/No graph with different modulation schemes with AWGN channel and 64 carriers.

IV. CONCLUSION

In simulation bit error rate and frame error rate in OFOM system are within the allowable range, which shows that computer simulation has achieved the expected results. The simulation results show that OFOM has a strong anti multipath interference capability in a high-speed data transfer conditions and has high spectral efficiency. The inserting of training sequence can improve the system performance.

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