



MINIMIZATION OF MAI AND ISI DISTORTION EFFECT IN WIRELESS SYSTEM BY OFDMA-IDMA TRANSMISSION APPROACH IN NOISY CHANNELS

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ABSTRACT: Along with providing existing communication application in a mobile fashion many new services have become available which explicitly require mobile broadband access. The increase in demands on wireless applications, future systems have to structure new technologies that support high capacity and QoS. In this paper we determine the effect of a combined IDMA-OFDMA system on performance of bit error rate (BER) with respect to change in SNR during wireless transmission for different modulation schemes. We have minimized ISI by the cyclic prefixing technique in OFDM [4], by iterative detection with IDMA [5]. OFDM-IDMA has advantages of low-cost receiver, diversity against fading and flexible rate adaptation.

Keywords: OFDMA, IDMA, quality of service, WLAN, 2G/3G cellular communication

I. INTRODUCTION

Development in wireless communication has changed modern world. Two decades before only high-tech notebooks had connectivity capability with Wireless Local Area Networks (WLAN), for wireless broadband internet access. But now WLAN connectivity is common to many modern communication devices due to increasing consumer demand. This growth has offered new application like multimedia streaming and video-on-demand. This development has created a innovative research field for “wireless broadband access everywhere”. Mobile environment also providing services of internet surfing or watching a video stream it indicates the success of wireless broadband by means of WLAN.

Current 2G cellular technologies like (GSM) are designed for voice-centric network but they work poorly for data-based applications. The 3G cellular technology like UMTS and HSDPA are better suited for data-centric based network transmission. But these standards are not able to provide the demand of high data rates and high expectations of quality of service (QoS) for future prospects

Future systems are designed in respect of fields that gives high capacity. It has been found that [1, 2] interleave division multiple access (IDMA) systems provides capacity of higher information transfer over orthogonal frequency division multiplexing (OFDM). Two major disabilities multiple access interference(MAI) and inter-symbol interference (ISI) are present in wireless communication systems that can degrade transmission performance. Many proposed techniques like time domain equalization are available but they are very costly, OFDM can fight with ISI very efficiently with methodology of conversion by using the frequency selective channel into parallel flat fading channels. The benefits of IDMA [3] are over minimizing MAI by iterative process of combining elementary signal and decoding. In next section we will discuss about both technologies in details and final we will determine the effect of an IDMA-OFDMA system on performance of bit error rate (BER) with respect to change in SNR

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II. IDMA AND CHANNEL INTERSYMBOL

Inter Symbol Random interleaving facilitates detection in ISI channels [11] and minimizing MAI both. The workings of IDMA Technology in wireless communication are discussed below

1BASICIDMASYSTEM

For an IDMA system in presence of ISI channel, the modified model of a received signal is given by equation (1):

$$r = \sum_{k=1}^K \sqrt{P_k} h_k \otimes X_k + z(1)$$

r: received signal vector,

$h_k: \{h_{k,0}, \dots, h_{k,L-1}\}$ a fading coefficients vector for user k,

x_k : the transmitted signal vector for user k,

z: sample vector of AWGN noise and

\otimes : represents convolution operation.

Let us consider the transmitter for user k, at start the information encoded by ENC_k (encoder) see figure 1 and then passed by an interleaver π_k into a chip sequence $\{x_k(j)\}$. In some cases a power control factor $\sqrt{p_k}$ is also used. The conventional spreading operation in CDMA is used but it is not necessary because user separation is also performed by user-specific interleavers $\{\pi_k\}$.

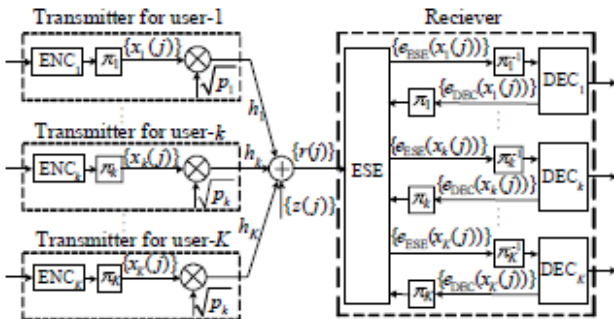


Fig1: The system model of an IDMA multiple access scheme

Focusing the k^{th} user the equation (1) is written as:

$$r(j) = \sqrt{p_k} h_k x_k(j) + \xi_k(j)$$

where $\xi_k(j)$ is the noise-plus-interference component in $r(j)$ with respect to $x_k(j)$. Although the above detection technique is rather simple and straightforward, it works very well, usually converging to satisfactory results within several iterations.

III. OFDMA TRANSMISSION SYSTEM

In OFDMA the transmitted signal is taken as sum of equal bandwidth but independent N_c sub-symbols having frequency separation $1/T_s$, (T_s : OFDMA symbol time duration). Since all K sub carriers are used to carry data for one user. In case of multiple users want to transmit using OFDM, they have to take their turns in time [4]. The OFDMA transmission system of OFDMA is shown in Figure. 2.

Here one sub-carrier is assigned per user and additive white Gaussian noise (AWGN) is acting as source of disturbance, the n^{th} of encoded bits is mapped into the complex valued OFDMA vector [5] of QPSK constellation points, and thereafter single multi carrier symbol in the continuous time representation is given as:

$$X_K(n) = 1/\sqrt{N_c} \sum_{k=0}^{N_c} d_k(n) e^{j2\pi kn/N_c}$$

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Where m is a symbol index and $X_k(m)$ is the QPSK value of k^{th} user with $K= 0, 1, \dots, K- 1$, at the receiver, here the all users channels to the base station are constant for every OFDMA symbol. The demodulated receive signal is written below:

$$\hat{d}_k = 1 / \sqrt{N_c} \sum_{k=0}^{N_c} d_k(m) e^{-j 2\pi km / N_c}$$

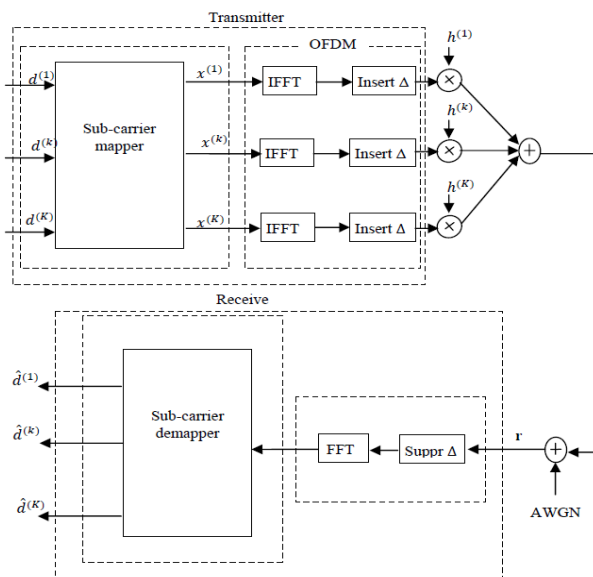


Fig 2: The transmitter and receiver structure of an OFDMA system, where Δ denote the cyclic prefix

IV. OFDMA IDMA

Multiple-access interference (MAI) and inter-symbol interference (ISI) cause degrading quality in wireless communication. Conventional methods are very costly and recently it has been shown that interference can be minimized by an orthogonal frequency division multiplexing interleaved-division multiple-access (OFDM-IDMA) scheme [6–8]. In this paper we have minimize ISI by the cyclic prefixing technique in OFDM [9], by iterative detection with IDMA [10]. Compared with conventional multi-carrier schemes, OFDM-IDMA has several noticeable advantages such as low-cost receiver, diversity against fading and flexible rate adaptation.

The results consist of the analysis and design for OFDM-IDMA. We show that OFDM-IDMA schemes can achieve significant performance improvement over orthogonal schemes. This provides a motivation for optimising the performance of OFDM-IDMA systems according to theoretical prediction.

V. RESULTS AND DISCUSSION

We have used Matlab10 based platform for writing algorithm. We have written script file for wireless transmission in AWGN noise at different SNR

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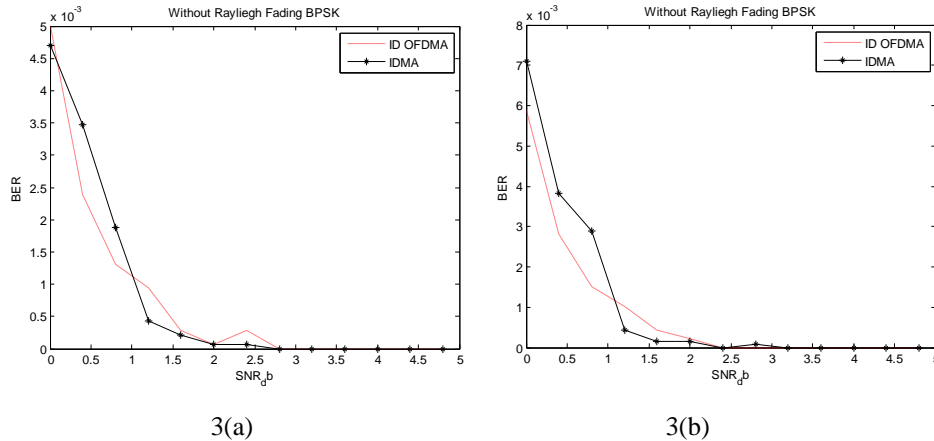


Fig 3: BER vs SNR plot for BPSK modulation using IDMA(solid) & IDMA-OFDMA(dash) transmission.

We applied first IDMA on our message signal and checked BER at SNR values varying from 0 to 5. Figure 3 (a & b) are BER vs SNR plot for BPSK modulation solid line for IDMA and dashed line for IDMA-OFDMA transmission. We can see that the BER for OFDMA-IDMA transmission is lower than IDMA. 3(a) and 3(b) are results obtained for two different random messages.

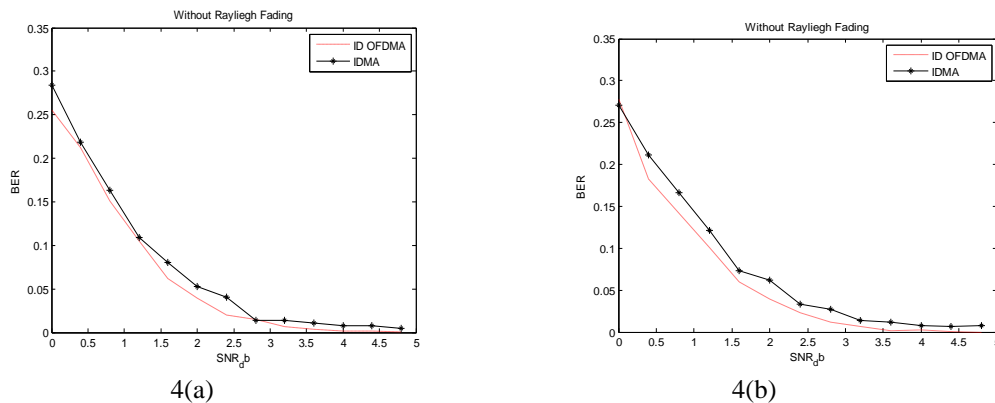


Fig 4: BER vs SNR plot for QPSK modulation using IDMA (solid) & IDMA-OFDMA(dash) transmission.

Similar algorithm is applied for QPSK modulation. Figure 4(a & b) are obtained again for two different random signals and we can again see that The BER for OFDMA-IDMA (dashed) is obtained lower than IDMA only(solid).

Prior to interleaving we have applied conventional coding. For BPSK the polynomial structure used is (5, [23, 35, 32, 31]) for generating polynomial and for QPSK it is ([5 4], [23 35 32 31; 17 14 5 13]) about 1384 binary message signals are generated different time for testing the algorithm.

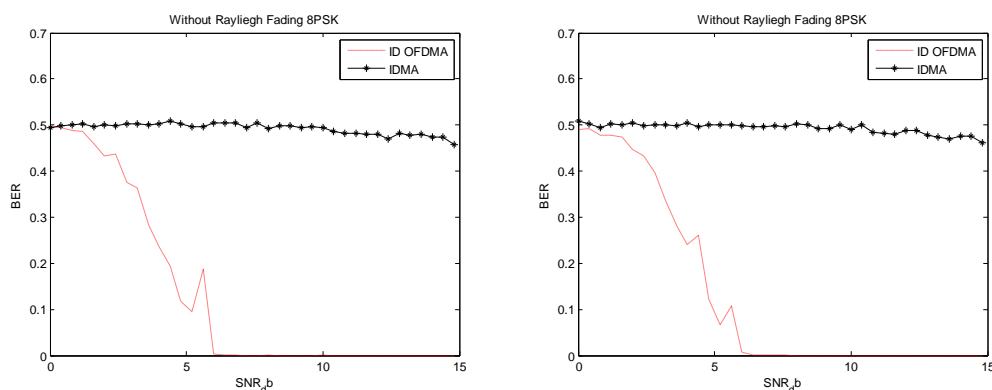
Similar algorithm is applied for 8PSK modulation. Figure 5 (a & b) are obtained again for two different random signals and we can see that The BER for OFDMA-IDMA (dashed) is obtained lower than IDMA only (solid).

We have considered three case for each case the maximum value of BER obtained is given in table 1.

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5(a)

5(b)

Figure 5: BER vs SNR plot for 8PSK modulation using IDMA(solid) & IDMA-OFDMA(dash) transmission.

	BPSK		QPSK		8PSK	
	Data1	Data2	Data1	Data2	Data1	Data2
BER IDMA	7×10^{-3}	4.8×10^{-3}	0.25	0.3	0.5	0.5
BER OFDM IDMA	5.6×10^{-3}	4.7×10^{-3}	0.25	0.25	0.501	0.501

Table 1 Maximum BER obtained for different modulation using IDMA and IDMA-OFDMA transmission.

Table 1 represents that BER is minimum in case of BPSK and as the M-array number is increased BER is increasing

VI. CONCLUSION

We have designed an IDMA-OFDMA system to check its performance and robustness against the AWGN noise. Three different schemes are used for modulation known as BPSK; QPSK and 8PSK the BER values are calculated by using Matlab based simulation algorithm. It has been found that for different random generation of binary signals we get lower BER in the case of OFDMA –IDMA system. Hence IDMA system alone can perform good performance against multiuser access interference but along with OFDMA IDMA we can combat with ISI and get reduced bit error rate. At higher SNR performance of both IDMA and IDMA-OFDMA become equivalent but at lower SNR OFDMA-IDMA helps in lower the BER. For different modulation the lowest BER is obtained for BPSK in the range of 5×10^{-3} to 7×10^{-3} hence the performance is best for BPSK. But in the case of 8PSK our IDMA-OFDMA outperforms to IDMA .

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