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Performance Analysis of MMSE Combining in Multi-carrier Spread Spectrum Systems over NLOS Channel

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Abstract: In this paper we explore the utilization of MMSEC for the detection of Multi-Carrier Code Division Multiple Access (MC-CDMA) signals. A diagnostic model is produced to estimate the ability of MC-CDMA framework with a huge number of subcarriers. This model is used and recreations for 8 and 16 subcarriers. Simulation results in a Rayleigh fading channel show very good performance.

I. INTRODUCTION

In a present scenario of wireless networks is not only for voice communication but also Data communications but due to the environment the signal is seriously degraded, high data rates & quality of Service is not achieved MC-CDMA employs the flexibility of OFDM & CDMA systems to maintain the high data rates in future wireless communications. Taking advantages of both techniques like multicarrier systems & reducing MAI over Frequency selective Fading Channel. OFDM, technology playing a crucial role in television broadcasting and radio [4], it combat the inter Symbol Interference and achieves high-speed data transmission over deep fading channels so it becomes a future generation standard for Wireless LAN. So OFDM is kind of efficient, Parallel Multicarrier transmission scheme. In OFDM initially data is converted from serial data stream to parallel data substreams. Using FFT data is modulated by different subcarriers which can be transmitted across multiple narrow bands and share the bandwidth effectively that progress high data rate transmission. CDMA is a spread spectrum technology where all users utilize the common bandwidth at a time, to avoid the interference between the users a unique PN code is assigned to each user which will maintain the Orthogonality between codes and mitigate the interference.

While the general state of the every individual subcarrier won't encounter noteworthy straight contortion after transmission, the flat fading that each subcarrier will encounter brings about a amplitude scaling. Unequal scaling at various subcarriers mutilates the Orthogonality between users. While the traditional detection strategies of Equal Gain Combining (EGC) and maximal Ratio Combining (MRC) might be adequate in an additive white Gaussian noise (AWGN) channel, these identification techniques don't straightforwardly address the issues of Orthogonality and of Interference cancelation [2]. Thus, these identification strategies don't execute too in interference restricted channels.

In this paper, we will apply Equalization to the identification of MC-CDMA signals. This is optimal in a mean-squared error sense as for both the commotion and the interference. In most fading channels, the assurance of the Equalization coefficients is performed adaptively. In this paper, we are concerned basically with the theoretical limits and not the implementation aspects how to track the channel variances [6]. In this manner, it is accepted that precise appraisals of the entire channel state data (i.e., the fading at the subcarriers) are accessible and that the equalization coefficients are picked appropriately. To overcome the additional complexity due to estimation of these quantities, low-complex MMSE equalization can be realized. With MMSE, the equalization coefficients are designed such that they perform optimally only in the most critical cases for which successful transmission should be guaranteed.

II. SYSTEM MODEL

The key difference between OFDM & MC-CDMA is, initially orthogonal subcarriers are experienced in OFDM however, in MC-CDMA Orthogonality between the spreading codes is maintained along with that, however in MC-CDMA, the same data symbol is modulated with different subcarriers. So this technique is more efficient for fading environment because if one path of subcarrier is corrupted by the environment we can easily recover the information from remaining symbols of subcarrier because a small portion of spreading code is damaged and that will encounter the ISI and further it will not influence on the BER. But in OFDM different data symbol transmission through different sub-carriers. Once the path of any subcarrier is damaged that will results loss of information and finally affects the reliability of the information and causes high BER [2]. In Multi-carrier spreading systems initially it is modulated with BPSK then data symbol is multiplied by Walsh Hadmard code (Orthogonal Code). Massive period of time is regenerate into little pulses by changing into parallel ways (Serial to Parallel Conversion). All the paths are replicated by same information that is modulated by sub carriers' exploitation FFT that reduces the system quality rather than using additional range of Oscillators. Then a Cyclic prefix is additional to the information symbols, a fraction of data symbols are taken and inserted at the start of the path. To mitigate the ISI (inter

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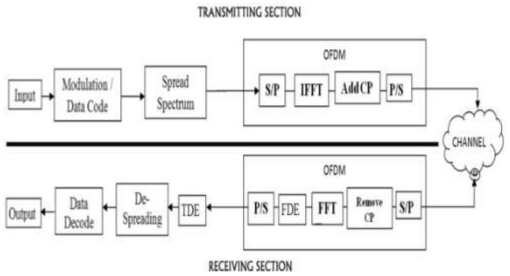
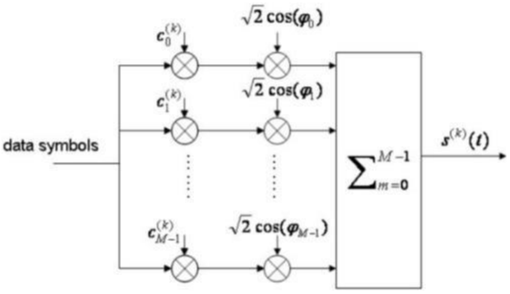
symbol interference) and ICI (Inter carrier Interference) caused by dispersions across the channel. And thus the delay unfold of the channel should be smaller than the cyclic prefix. Finally, the signals are sent to the desired attenuation environment and that we apply inverse transformation at the receiver.



2.1. Block diagram of MC-CDMA systems

III. TRANSMITTER MODEL

Initially, deliberate to Binary phase shift keying (BPSK) modulation and to the transmitter block theme shown in Fig. 3.1 the transmitted signal mentioned the nth user. Subsequently distended to QPSK, 16-QAM & 64-QAM modulations respectively



3.1. Transmitter Block Diagram

(t)= (3.1)

Transmitted signal referred as N^{th} user wherever Eb energy per bit, $b^{(N)}$ is the input symbol of the N^{th} user, m is subcarrier index, c_m is the m^{th} chip. g (t) may be a rectangular pulse wave form, with period [0, T]. A MC-CDMA system is accomplished, in apply, through inverse fast Fourier transform (IFFT) and FFT at the transmitter and receiver, respectively. When the sampling method, the signal results fully reminiscent of a MC-CDMA signal with rectangular pulses within the continuous time-domain. Considering that, exploiting the Orthogonality of the code, all the various users use an equivalent carriers, the entire transmitted signal leads to

(3.2)

3.1 Channel Model

Since we tend to thought-about the downlink, concentrating on the nth recipient, the information associated with numerous users analyzes an identical fading. because of the CDMA structure of the framework, each user gets data} of the other users and selects simply its own information through the spreading arrangement. we tend to accepted the drive reaction of the channel h (t) as time-invariant amid various. we tend to utilised a recurrence area direct model within which the exchange work, H (f), is given by

H (f) = (3.3)

, are amplitude & Phase coefficients of the model.

The Rayleigh fading Channel is mostly applied in cases once there is no LOS (Line of Sight) between the transmitter and thus the receiver. The channel jointly adds AWGN noise to the signal samples once it suffers from Rayleigh fading. Let the received signal "r" is given as:

$$r = s*h + n \quad (3.1.1)$$

Where; n is AWGN (Additive White Gaussian Noise) with zero mean & unit variance; h is that the Rayleigh fading response with zero mean & unit variance; s is that the transmitted signal. The transmitted symbols s is obtained from the received signal r by the strategy of equalization The likelihood of error in BPSK modulation over Rayleigh fading channel (with AWGN noise) is given as

= ½ (3.1.2)

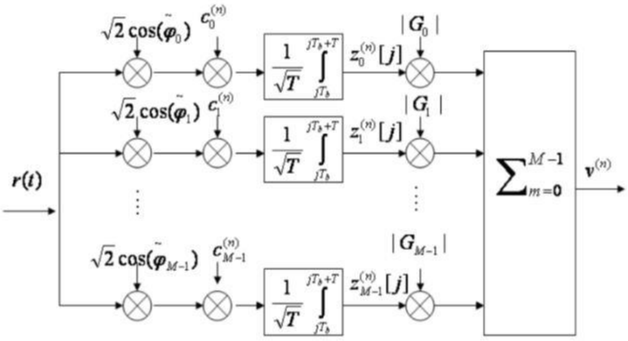
The theoretical BER for BPSK modulation scheme over an AWGN channel is given as:

− (3.1.3)

IV. RECEIVER MODEL

The signal is transmitted through the Rayleigh fading channel and received signal r (t)

r(t)= (4.1)



4.1. Receiver Block Diagram

The receiver structure is depicted in Fig4.1 Focusing, while not loss of all-inclusive statement, to the m^{th} sub-carriers of user n, the detector plays out the connection at the j^{th} instant (consummate synchronization and Phase tracking are expected) of the received information as

= (4.2)

The output decision variable $v^{(n)}[j]$ of the receiver is obtained by linearly combining the weights from each subcarrier as follows

$$= \qquad (4.3)$$

The utilization of equalization to the current received signal includes linearly combining the distinctive subcarrier diversity elements to extract the decision variable. Wherever the vector represents the optimum weight coefficients. These coefficients also can be viewed as associate amplitude equalization to catch up on the weakening at the subcarriers. Randomly selecting m = zero as the desired signal, the optimum selection of the equalization vector G in the mean-squared error sense are often determined to be

$$= \frac{\quad}{\quad} \qquad (4.4)$$

Where

Nu is that the number of active users and γ is that the mean SNR averaged over small-scale fading. Hence, additionally to the CSI, MMSE needs the data of the signal power, the noise power, and therefore the number of active users, so representing a lot of complicated linear technique to be enforced, particularly within the downlink, wherever the combination is typically performed at the mobile unit.

Wherever G_l indicates the complicated process channel gains and H_l is that the channel coefficients (operation * stands for complex conjugate) wherever l = 0, 1, 2…..M-1. The process gain is adequate to number of subcarriers.

V. SIMULATION RESULTS

The MC-CDMA system described in section 2 is implemented using MATLAB 7.9 with various parameters listed in below Table 1. The BER curves and efficiency curves are achieved from the simulations.

Table 5.1: Simulation parameters of MC-CDMA system

S. No	Content	Parameters
1.	Channel Type	Rayleigh Fading Channel, with 4 taps
2.	Spreading Codes	Walsh –Hadmard Codes
3.	Modulation	BPSK, QPSK, 16-QAM.
4.	Cyclic Prefix Length	5
5.	Equalization	MRC, EGC, MMSEC
6.	No of Processing Gains	8,64
7.	No of Sub carriers	8,64
8.	FFT Modulation	16-Point
	No of Users	8

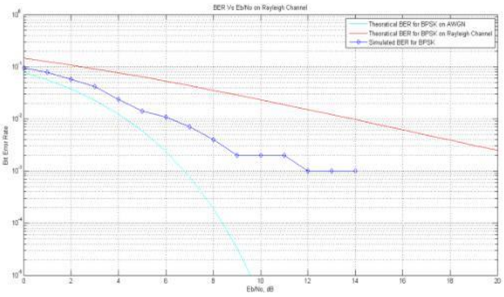


Figure 5.1 BER Analysis of BPSK for MC-CDMA systems over Rayleigh Fading channel

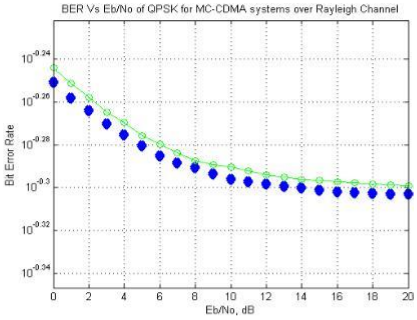


Figure 5.2 BER Analysis of QPSK for MC-CDMA systems NLOS channel in Multi-user environment

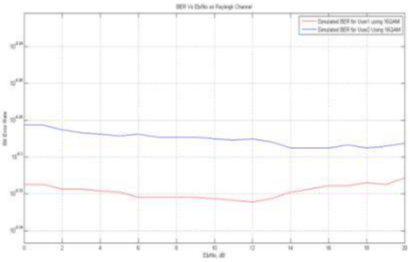


Figure 5.3 Bit Error Rate Analysis of 16-QAM for MC-CDMA systems across NLOS channel in Multi-user environment

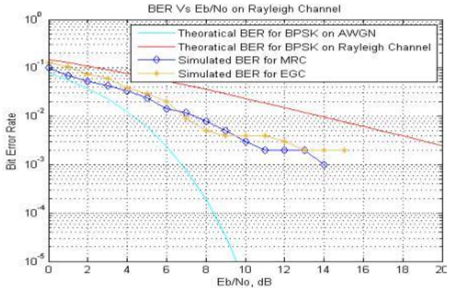


Figure 5.4 Bit Error Rate Analysis of MRC & EGC for MC-CDMA systems across AWGN & Rayleigh Fading channel in Multi-user environment

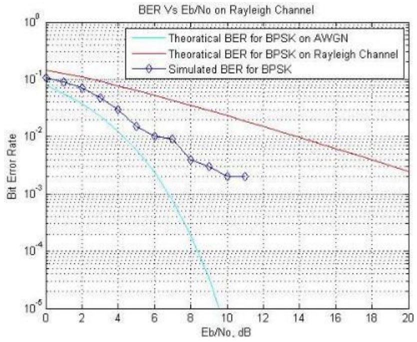


Figure 5.5 Bit Error Rate Analysis of MMSEC for MC-CDMA systems across AWGN & Rayleigh Fading channel in Multi-user environment

VI. CONCLUSIONS

In this paper, performance analysis of MC-CDMA is done for wireless environments by implementing MC-CDMA system model in multipath fading channels. Lower BER & High spectral potency is achieved in MC-CDMA system exploitation BPSK Modulation except for higher modulations like QPSK & 16-QAM higher BER is progressed because of multiuser setting as shown within the figures 5.2 & 5.3.to achieve the high performance in higher modulation schemes, Channel Estimations & Equalizations are Essential in multiuser & Serious fading environment. As no of users are utilizing the channel at the same time the Orthogonality of code varies that causes MAI Multi-access Interference). During this paper, the applying of MMSEC was applied to the detection method of MC-CDMA. In distinction to traditional diversity combining techniques, this detection technique directly addresses the consequences of the interference on the BER. Output performs single narrowband transmissions in an exceedingly Rayleigh fading channel.

VII.FUTURE SCOPE

In serious fading environment the estimation of signal power, noise power & Channel state data is too complicated, to beat the extra complexness due to estimation of those quantities, a low-complex suboptimum MMSE equalization is reliable

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