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# Equalization & Channel Estimation of Block & Comb Type Codes

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***Abstract**-Multi-carrier code division multiple access is an attractive choice for high speed wireless communication as it mitigates the problem of inter symbol interference and also exploits frequency diversity. The work described in this paper is my effort in this direction. In this paper working of Transmitter and Receiver model of MCCDMA system is presented. We evaluated interference and bit error rate for multicarrier code division multiple access wireless communication system. In this thesis my concern is find out the effect of interference in MC-CDMA system. We find out the effect of number of users and signal power on different parameters for MC-CDMA system. Simulations are given to support the system and receiver design. All the simulation is carried out on MATLAB tool.*

***Key words: BER, ICI, ISI, FFT etc.***

## I. Introduction

Multicarrier CDMA communication is a combination of the multicarrier modulation scheme and the CDMA concepts. The basic idea to use multicarrier transmission in a CDMA system is to extend the symbol duration so that a frequency selective fading channel is divided into a number of narrow band flat fading channels, and the complex time domain equalization can therefore be replaced with a relatively simple frequency domain combining. Normally an inverse Fast Fourier Transform (FFT) block is used in the transmitter to modulate user data onto the subcarriers, and an FFT block is used in the receiver to demodulate the data so as to achieve fast computation [1].

Frequency domain diversity can be easily achieved in multicarrier CDMA systems by [3] means of frequency diversity combining schemes. Fast implementation and simple receiver design are especially important in wideband applications, where the data rate and consequently the processing burden are very high. However, sinusoid waveforms which are used as the subcarriers in the conventional multicarrier CDMA are not well localized in the time domain. Thus, time diversity within one chip duration is difficult to achieve. Therefore, in practice a cyclic prefix is inserted between consecutive symbols to eliminate residual Inter Symbol Interference (ISI) due to multipath [4]. The length of the cyclic prefix is equal to or longer than the maximum channel delay spread. This method needs transmitting extra cyclic prefix, which introduces overhead and thus decreases bandwidth efficiency and data rate. A few blind methods have been proposed to eliminate such guard intervals for single user OFDM systems and MC-CDMA systems. In the approach an overlapped pulse-shaping filter is used to change the transmitted signal from stationary to cycle stationary so that a second order method can be derived [2]. Although the mention or realize it, the basic idea behind this approach is introducing some kind of time localization, which can be achieved naturally in our wavelet packet based system discussed later. The works of use subspace based methods in the detection, therefore requiring much higher computational complexity. This is contrary to the basic philosophy of MC-CDMA which is developed to reduce computational complexity. All the above works investigate system performances under time-invariant channel conditions. A number of works have been performed on the channel estimation and detection of MC-CDMA systems with time-varying channels.

## II. MC-CDMA

The combination of multicarrier transmission and CDMA can be achieved in different ways. Consequently, the multiplexing CDMA designs fall in two categories [3]

### Frequency Domain Spreading

MC-CDMA combines the multicarrier transmission with the frequency domain spreading, i.e., the original data stream from a user is spread with this user's specific spreading code in the frequency domain but not in the time domain. In other words, each symbol is transmitted simultaneously in a number of subcarriers, but multiplied by corresponding chips of the spreading code for every subcarrier . Fig.1 and Fig.2 give the transmitter and receiver structures of an MC-CDMA. It can be seen that the data rate for each subcarrier is only 1/N as that of a single carrier DS-CDMA system. This means that the chip duration is N times longer. Therefore, the channel delay spread is comparatively shorter. If it is much shorter than the extended chip duration, the original frequency selective fading channel is divided into a number of flat fading channels. Thus, the complicated time domain equalization can be replaced by a simple gain combining in the frequency domain.

 

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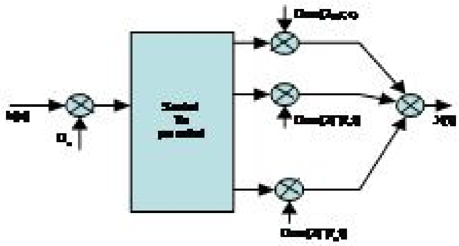

Fig. 1 MC-CDMA Transmitter

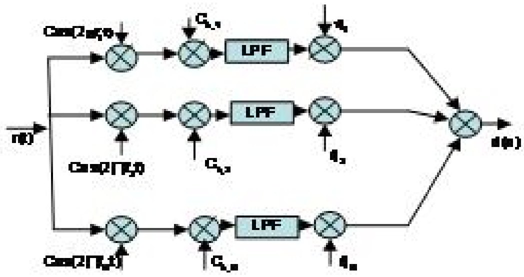


Fig. 2 MC-CDMA Receiver

## Time Domain Spreading

Another way of combining multicarrier modulation with CDMA is the MC-DS-CDMA scheme that spreads the original user data stream in the time domain. As shown in Fig.3, the user data stream is first serial to parallel converted into $N_c$ (the number of subcarriers) sub streams, each of which is time-spread and transmitted in an individual subcarrier. In other words, a block of $N_c$ symbols are transmitted simultaneously. The value of $N_c$ can be chosen according to the system design requirement. However, it is commonly assumed to be equal to the length of spreading code N which will also make the comparison with MC-DS-CDMA easier .All the symbols are spread in the time domain using the same spreading code for a particular user. It is clear that this scheme achieves time domain diversity but no frequency domain diversity for each individual data symbols. The sub carriers satisfy the same orthogonality condition as that of MC-DS-CDMA. This scheme is suitable for uplink transmission since it is easy for the establishment of quasi-synchronization between different users. Fig.4 gives the basic structure of the receiver of the MC-DS-CDMA system where each branch equals to a single CDMA signal detector.

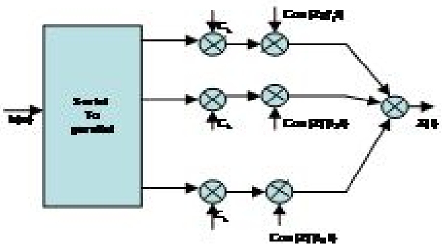

Fig 3 MC-DS-CDMA Transmitter

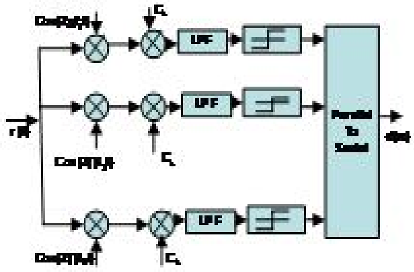

Fig 4 MC-DS-CDMA Receiver

 

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Another time domain spreading multicarrier CDMA scheme called MT-CDMA scheme uses much longer spreading codes so that the bandwidth for each subcarrier signal is about the same as the original DS-CDMA signal. The signals for different subcarriers overlap heavily and do not satisfy orthogonality condition, but longer spreading codes help to eliminate the multi-user interference .

## III. SIMULATION RESULT

We first simulate and analyze the effect of Numbers of user on following Communication Parameter

- Number of sub-carrier
- Signal power
- Signal to interference ratio
- Inter Carrier Interference

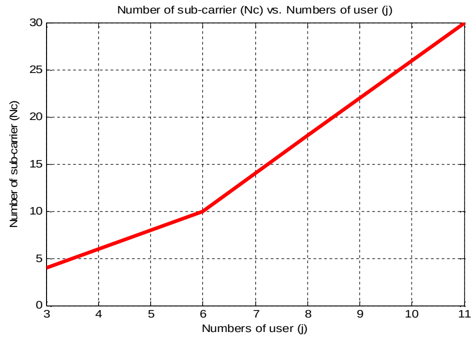


Fig 5 Number of sub-carrier vs. Numbers of user

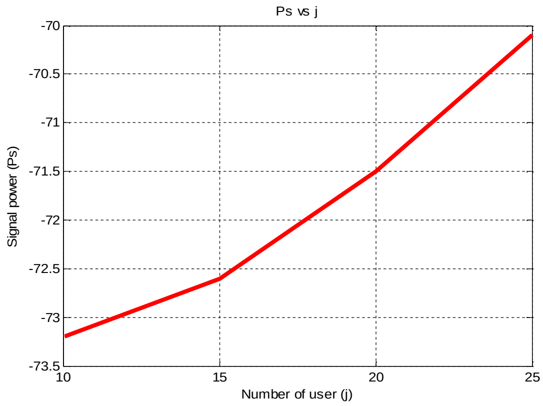


Fig 6 Signal power vs. Numbers of user

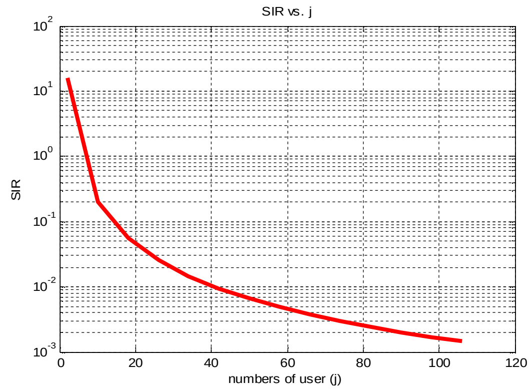


Fig 7 Numbers of user vs. the S/I ratio

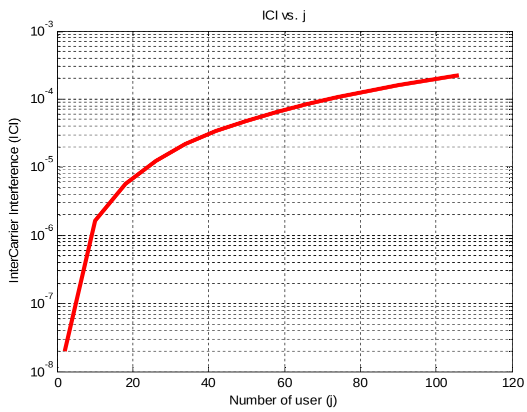


Fig 8 Number of user vs. ICI

 

Now we simulate and analyze the effect of Signal Power on following Communication Parameter

- Signal to interference ratio
- Bit error rate

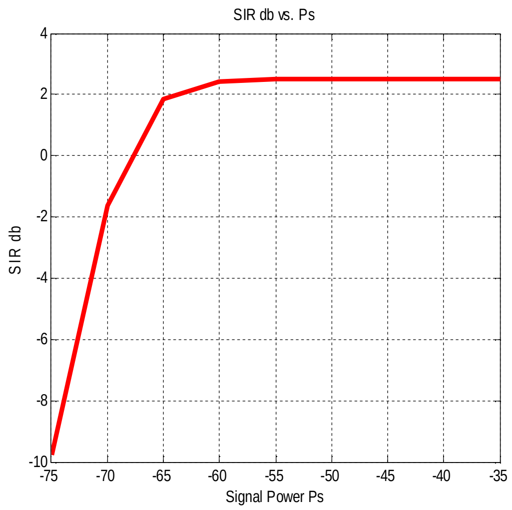


Fig 9 Signal power vs. signal to interference ratio

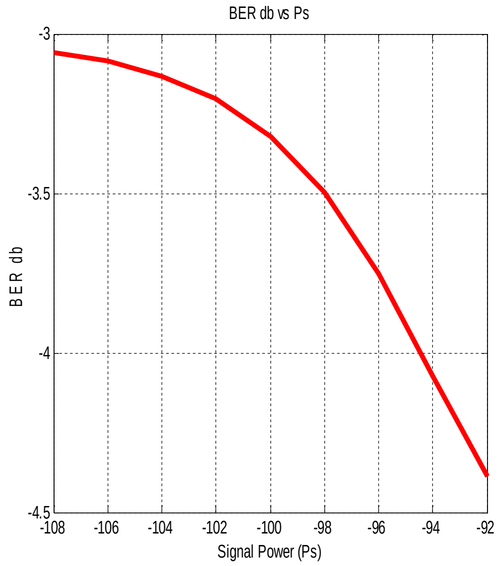


Fig 10 Signal power vs. BER

## IV. CONCLUSION

This paper analyse the effect of number of users and signal power on different parameters for MC-CDMA system. We basically focused on Interference, signal power and Bit error rate analysis for the MC-CDMA system in Mobile environment. We use MATLAB simulation toolbox for the analysis of different parameter effect on the performance of electronic wireless communication used in future generation wireless communication system. After analysing the result from the simulated plots we concluded some facts such as if we increase the numbers of user then number of sub-carrier will be increase, signal power will increase, the inter carrier interference will be increase but the signal to interference ratio will decrease. If we increase the signal power then signal to interference ratio will be increase and bit error rate will be decrease.

## V. REFERENCES

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