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VARIABLE RATE SPREADING SCHEME FOR MCCDMA SYSTEM OVER LONGER DELAY CHANNELS

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ABSTRACT

Multi Carrier Code Division Multiple Access (MC-CDMA) system considered to be a key enabler for both 4G and future 5G air interface to achieve ultimate goal of spectrum efficiency with good QoS. During resource sharing interference is greatly reduced with spreading gain which incorporates orthogonality. The multiple access interference cause by multipath channel environment is largely depends on correlation among spreading codes. The statistical analyzes have already proved that changes made in spreading gain will cause trade off effect over variable rate transmission. Here in this paper by considering spreading gain over user rate spreading diversity and phase characteristics of spreading code is changed in MCCDMA system. Finally we proved that the proposed transceiver type will give better metrics over longer delay channels. Both robustness over variable rate and its efficiency over successive and parallel interference cancellation has been analyzed and verified through simulations.

Key Words: *MCCDMA, spreading code, correlation, multiple access interference (MAI)*

1. INTRODUCTION

Among all other multicarrier modulation techniques multicarrier code division multiple access getting much popular since it incorporates merits from both Orthogonal Frequency Division Multiplexing (OFDM) and Code Division Multiple Access (CDMA). It has a potential to drive next generation wireless standards due to its robustness over longer delay channel [1]. The spreading nature of MCCDMA system can successfully mitigate the delay spread problem [2] and exploits the diversity in the transmission leads better spectral efficiency. Though it has many advantages over all other wireless standards multiple access interference is major challenge for MCCDMA system and it affects overall performance metrics during asynchronous transmission [3]. In many previous works have already described this problem and some methodologies are also elaborated to suppress this kind of interference. Frequency hopping technique or polarization techniques are commonly used to reduce the MAI effect. In [4] adaptive frequency hopping is carried out and patterns are adaptively modified based on channel fading levels. In tapped delay lines (TDL) are used to accomplish frequency hopping for performance enhancement. In [5-6] polarization diversity techniques are accumulated at the base station for MAI mitigation.

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Existing solutions for MAI problems of MC-CDMA comes with maximum complexity and complex computations and has many limitations during real time hardware implementation. So varying spreading gain is an optimize solution to the problems for OFDM and CDMA systems for time varying channel. This research provides a solution in this by presenting new form of spreading method for an efficient MCCDMA transceiver with relative low complexity and the ultimate goal of this work is to prove it using extensive simulation results.

In variable spreading gain both inter symbol interference (lSI) and MAI can be suppressed over multipath channel with potential benefits of low complexity. It has been reported in [7], [8], that moderate spreading gain offers better performance fixed gain.

During sub carrier mapping multiple low data rate streams are transmitted over parallel subcarriers which are placed at integer multiples of frequency after spreading process. The orthogonal phenomenon is driven by spreading codes among them and this permits the transmission of subcarriers in narrow frequency space as like OFDM system and other Multi-Carrier Modulation techniques.

2. MCCDMA System Model

The actual system description is done with total available sub carrier over variable rate spreading among M user as shown in Figure 1. Here users are grouped into M regions based on their different rates. This process is considered to be pre processing to simply the spreading process and weightage assignments for spreading code length as in Eqn [1]. The user from each group is categorizing the weightage matrix. Normally the system is considered to transmit data at rate which is defined and well bounded within the constraints given.

Data packets (u1,u2…uM) from each user of the one listed group is multiplied with weighted spreading code Sk (Sk (0), Sk (1), Sk(2), ... ,Sk(|WhitageM|-1)).

$$Xk(i)=Uk.Sk(M) \qquad (1)$$

The spreaded sequence is obtained through linear product and modeled as an independent and identically distributed (i.i.d.) random values as shown in Eqn [2] taking values with equal probability for retaining maximum entropy value.

$$Sk(M:gm€M)=\sum e^{j\beta} \qquad (2)$$

Where β is related to user rate of each groups.

2.1 Basic modules

The design module consists of: random data acquired from several users followed by pass band modulation (QPSK, 16-QAM) with frame length 8 times as that of delay insertion carried for ISI interference and it offers significant simplicity at the receiver side. And then generation of the speading code as per the weighted matrix according to the specifications has given in previous section. Both Flexibility and orthoganality are considered according to the Qos level required for that transmission and optimum diversity for given user rate. The ultimate goal is to mitigate the multiple access interference problem over time varying channels offers optimal coding gain which is within the range of the speed constrains.

Additionally to compact the multiple access interference (MAI) during multiple access schemes with variable puncture rate forward error correction (FEC) code since optimal error level for given user over data

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rate requirements is varying form one user to another. The transmitter characteristics are well defined with optimized spreading and channel codes used. And channel allocation or sub carrier mapping is carried out through IFFT transform. The conventional radix factorizations of FFT transform are not sufficient to balance the user rate requirements. The composite method of radix-2^K can be used as a potential alternative to high radix (radix-8, 16) for getting accurate merits of this system in digital implementations.

At the receiver side, data retrieval is carried with simplified composite codes and error correction methods. The interference cancellation with orthogonal subcarriers is achieved through single tap or parallel taps to provide tradeoff between design complexities over Qos requirements.

1.2 Correlation property

As like all other Direct Sequence spread spectrum type here also the code sequence are binary sequences. The duration of chip time (t) is fixed for all types of user rate. Here there is no limitations on the length of the spreading codes but it is well constrained by number of groups categorized .Behaviour of all the modules in the demonstrator and includes a realistic MIMO channel model. It has been stated earlier that weightaed code sequence may be sensitive to phase noise and proper synchronization method have to incorporate for better performance with slight complexity overhead.

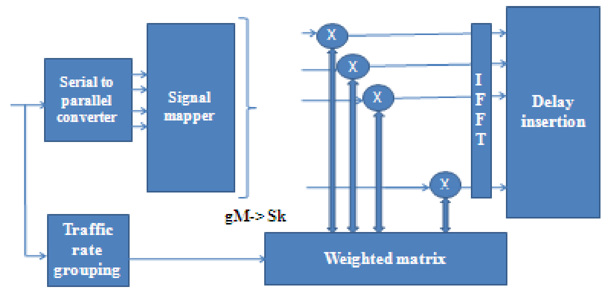

Figure 1. Transmitter architecture

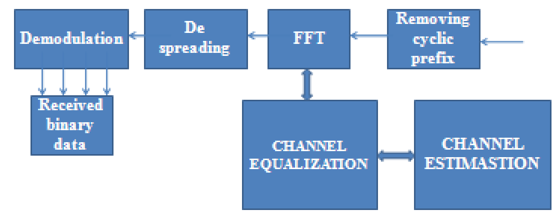

Figure 2. Receiver architecture

1.3 MC CDMA system model parameters

Here to incorporate only the delay spread impact at the receiver side it is assumed to be perfectly synchronized with transmitter minimum mean square error (MMSE) based equalization is used to get to know best possible performance metrics from MC-CDMA system.

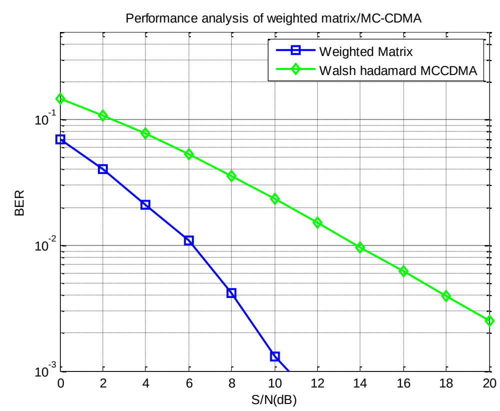

Figure 3. MAI interference over weighted matrix code

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To analyze the system performance over multiple access interference (MAl) each user is allowed to experience certain degree of correlation from other user within a group. The proposed weighted driven spreading method outperforms hadamard transform under moderate MAI interference among users as shown in Figure 3.

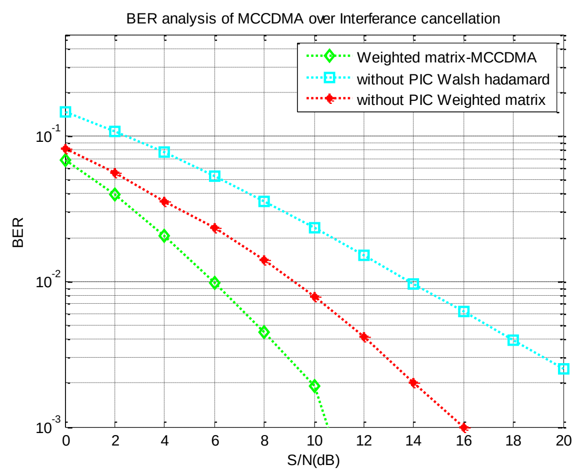

Figure 4. BER reduction with interference cancellation

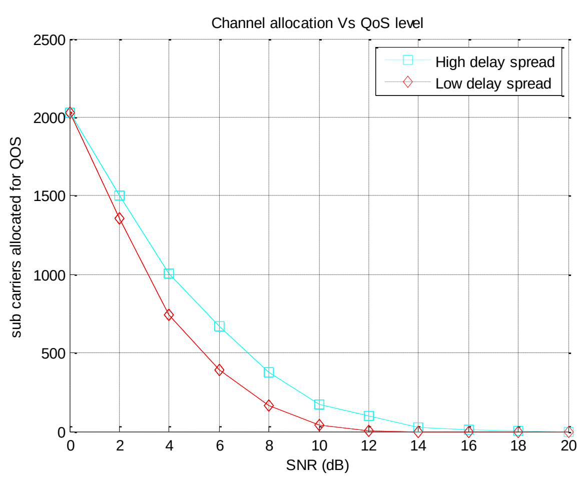

Figure 5. Qos driven carrier mapping analyzes

3. PERFORMANCE RESULTS

The simulation of adoptive rate transmission over longer delay channels with higher order modulation is carried out without using any error correction mechanism. The advantages of applying interference cancellation are quite virtual with weighted driven method as shown in Figure 4. For longer delay channel we were used ITU vehicular channel models with high delay spread. Generation of channel coefficients is restricted with smaller Doppler frequencies since purpose of the work is to prove the robustness over delay spread. First we analyze the metrics of weighted driven spreading codes and then its impact over PIC and SIC methods are evaluated. And finally efficiency of resource allocation over variable rate transmission is shown in Figure 5.

4. CONCLUSION

In this paper, a novel low-complexity spreading codes for MCCDMA is replaced with weighted driven spreading codes with zero correlation property. It is based on the use of a input user rate and on the QoS related to the particular transmission as shown in Fig 1.5. For compatibility purpose, typical MCCDMA system is analyzed with interference cancellation choices for next generation wireless standards. Analytical and simulation results of the system are demonstrating significant BER reduction.

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