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A PERFORMANCE COMPARISON AND PAPR ANALYSIS OF PRE-CODED WEIGHTED CYCLIC PREFIX OFDM

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ABSTRACT:

In this paper, we present a weighted cyclic prefix orthogonal frequency-division multiplexing (WCP-OFDM) transceiver as a generalization of traditional cyclic prefix (CP)-OFDM. In time-variant channels, this multicarrier transmission scheme may mitigate inter-channel interference (ICI) thanks to the use of non-rectangular pulse shapes. A precoding step may be required in order to reduce the peak-to-average power ratio (PAPR) at the transmitter output. For instance, a discrete Fourier transform (DFT) precoder leads to a single carrier transmission scheme with frequency domain equalization. We analyze the consequences of such a precoding, in terms of performances,in the context of a time-frequency selective channel.

I. INTRODUCTION

Mobile radio applications in terrestrial environment usually imply multipath propagation and motion induced the Doppler spread. However, Doppler spread introduced by time variant channels breaks the orthogonality between sub channels causing inter channel interference [1, P 735]. cyclic prefix orthogonal frequency division multiplexing (CP-OFDM) diagonalizes multipath invariant channels if a guard interval is longer than the channel impulse response.it relies on how complexity implementation using fast fourier transform (FFT) algorithm and it allows perfect reconstruction of the transmitted signal thanks to the single tap per sub channel equalizer. Filter bank based multicarrier modulations (FBMC) represent a more general transmission scheme. This technique allows the design of various pulse shape filters, as compliant as possible with multipath time variant channel. Despite attractive performances, FBMC systems are rarely recommended in standardized applications because of their computational complexity. Indeed, they require the use of polyphase matrix filtering whose complexity increases with the length of the prototype filters [3].

In this work, we focus on short prototype filters that ensure a low-complexity implementation. Thus, we consider here the case of filters with the same length as rectangular pulses used in CP-OFDM. The difference with CP-OFDM is that the pulses do not need to be rectangular. Such a generalization of CP-OFDM is referred to as weighted cyclic prefix (WCP)-OFDM. The major problem of Orthogonal Frequency Division Multiplexing (OFDM) is its High Peak-to-Average Power Ratio (PAPR). The High PAPR increases the complexity of Analogue to Digital (A/D) and Digital to Analogue (D/A) converters and also reduces the efficiency of Radio Frequency High

IJMTARC – VOLUME – VI – ISSUE – 24, OCT-DEC, 2018

ISSN: 2320-1363

Power Amplifier (RF HPA). we present here Discrete Fourier Transform (DFT) pre coder. In this study, we compare the PAPR of CP-OFDM with a time-frequency optimized WCP-OFDM. We also define a DFT-precoding block which leads to a single carrier (SC) block transmission scheme with frequency domain equalization. We compare the performances of both systems with LDPC channel coding and assuming a time-frequency selective channel.

2. SYSTEM MODEL

MC-CDMA system has been proposed for a variety of topologies. The configuration used in this paper is similar to the design in [15]. Let *N* be the number of sub-carriers, *L* be the spreading factor of frequency domain, and *M* be the number of parallel input data symbol per an MC-CDMA symbol. The modulated signals of each user are fed into serial to parallel converter. The parallel signals are copied into *L* parallel sub-carriers. First, as the number of sub-carriers is *N*, the same as the length of spreading code, a data symbol d_k is copied to *N* parallel taps. Each copy is multiplied by a single chip of the spreading sequence, $c_{k,n}$, $k = 0, 1, \ldots, K$,and *n*=0, ..., *N*-1, which is a chip of the *k*th user's spreading code at the *n*th sub-carrier. The *k*th user's frequency-domain spread spectrum X_k , is given by

$$X_k = d_k c_k \quad (1)$$

where $X_k = [X_{k,0}, X_{k,1}, \ldots X_{k,N-1}]^T$ and $c_k = [c_{k,0}, c_{k,1}, \ldots, c_{k,N-1}]^T$. $X_{k,n}$ and $c_{k,n}$ denote the *k*th user's spread data and chip of the spreading code, respectively, at the *n*th sub-carrier. Each user's channel is modeled as an independent flat fading channel $H_k = diag\{[H_{k,0}, H_{k,1}, \ldots, H_{k,N-1}]\}$, where $H_{k,n}$ is a frequency domain channel response at the *n*-th sub-carrier for the *k*-th user. The received signal also experiences additive white Gaussian noise of zero mean and variance [9].

These signals are converted into time domain using inverse fast Fourier transform of size $N = V \times L$. MC-CDMA signals $x(t)$ can be written as

$$x(t) = \sum_{n=0}^{N-1} \sum_{i=0}^{N_d-1} \sum_{k=0}^{K=1} d_{k,n}(t - iT_s) c_{k,n} e^{j2\pi nt/T_s} \quad (2)$$

where N_d is the number of symbols in a frame and T_s is inserted between symbols to eliminate the ISI caused by multipath fading

2.1 PROPAGATION CHARACTERISTICS OF MOBILE RADIO CHANNELS:

In an ideal radio channel, the received signal would consist of only a single directpath signal, which would be a perfect reconstruction of the transmitted signal. However in a real channel, the signal is modified during transmission in the channel.

It is known that the performance of any wireless system's performance is affected by the medium of propagation, namely the characteristics of the *channel*. In telecommunications in general, a channel is a separate path through which signals can flow. In the ideal situation, a direct line of

ISSN: 2320-1363

sight between the transmitter and receiver is desired. But alas, it is not a perfect world; hence it is imperative to understand what goes on in the channel so that the original signal can be reconstructed with the least number of errors.

The received signal consists of a combination of attenuated, reflected, refracted, and diffracted replicas of the transmitted signal. On top of all this, the channel adds noise to the signal and can cause a shift in the carrier frequency if the transmitter, or receiver is moving (Doppler effect). Understanding of these effects on the signal is important because the performance of a radio system is dependent on the radio channel characteristics.

3. PROPOSED SYSTEM

One of the most important properties of OFDM transmissions is the robustnessagainst multipath delay spread. This is achieved by having a long symbol period, which minimizes the ISI. The level of robustness, can infact is increased even more by the addition of a procoded b/w transmitted sym's. The procoded allows time for multipath sig's from the pervious symbol to die away before the information from the current symbol is gathered.

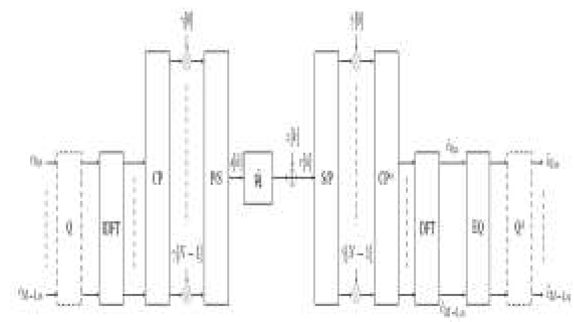

Fig. 1: Efficient implementation of a precoded WCP-OFDM transmultiplexer.

The most effective procoded to use is a cyclic extension of the symbol. If a mirror in time, of the end of the symbol waveform is put at the start of the symbol as the procoded, this effectively extends the length of the symbol, while maintaining the orthogonally of the waveform. Using this cyclic extended symbol the samples required for performing the FFT (to decode the sym), can be taken anywhere over the length of the sym. This provides multipath immunity as well as sym time synchronization tolerance.

As long as the multipath delay echos stay within the procoded duration, there is strictly no limitation regarding the signal level of the echos: they may even exceed the signal level of the shorter path! The signal energy from all paths just adds at the input to the receiver, and since the FFT is energy conservative, the whole available power feeds the decoder.

If the delay spread is longer then the guard interval then they begins to cause ISI.

ISSN: 2320-1363

However, provided the echo's are sufficiently small they do not cause significant problems. This is true most of the time as multipath echo's delayed longer than the procoded will have been reflected of very distant objects. Other variations of procodeds are possible. One possible variation is to have half the procoded a cyclic extension of the symbol, as above, and the other half a zero amplitude signal. This will result in a signal as shown in **Fig 3.6.**

Using this method the symbols can be easily identified. This possibly allows for symbol timing to be recovered from the signal, simply by applying envelop detection. The disadvantage of using this procoded method is that the zero period does not give any multipath tolerance, thus the effective active procoded is halved in length. It is interesting to note that this procoded method has not been mentioned in any of the research papers read, and it is still not clear whether symbol timing needs to be recovered using this method.

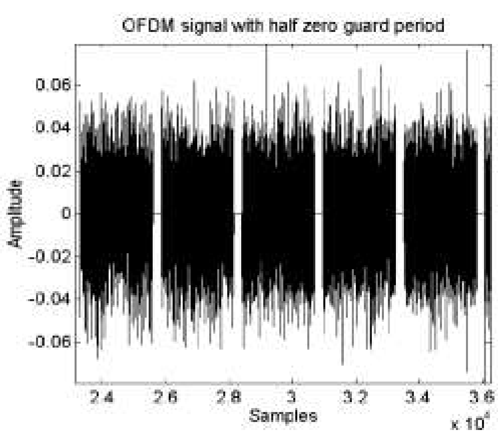

Fig.2 Section of an OFDM signal showing 5 symbols, using a pre-coded points which is half a cyclic extension of the symbol, and half a zero amplitude signal.

4. CONCLUSION

Weighted cyclic prefix OFDM systems generalize traditional CP-OFDM, allowing the use of non-rectangular filters. Even if time-frequency localized pulses yield interesting BER performances in time-frequency selective channels, they also introduce a greater PAPR than rectangular pulses, increasing with the oversampling factor. In order to mitigate the PAPR, a DFT-precoding may be used, leading to a single carrier block transmission schemeWe have shown, through simulation, that best (LDPC coded) BER performance results are achieved by a multicarrier scheme, using TFL pulse, assuming a realistic time-frequency selective channel

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