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ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING FOR FUTURE COMMUNICATION

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ABSTRACT

OFDM (Orthogonal Frequency Division Multiplexing) is a form of signal waveform consisting of a number of closely spaced modulated carriers which are resilient to selective fading, interference and provide high degree of spectral efficiency. OFDM requires linear transmitting and receiving antenna as any non-linearity will result in inter-modulation distortion thereby impairing the orthogonally of transmission. OFDM is applicable for the high data applications including Wi-Fi, cellular telecommunication, digital audio broadcasting.

KEYWORDS: Cellular Telecommunication, Digital Audio Broadcasting, Orthogonal Frequency Division Multiplexing, Wi-Fi.

INTRODUCTION & LITERATURE SURVEY

OFDM (Orthogonal Frequency Division Multiplexing) is a form of multicarrier modulation in which the sidebands are orthogonal to each other and thus can be received without interference. OFDM provides resilience to selective fading and interference, high spectral efficiency with the disadvantages of high peak to average power ratio and sensitive to carrier offset and drift. OFDM is used in wide bandwidth, high data rate wireless systems including Wi-Fi, cellular telecommunication, digital audio broadcasting.

In paper [1], the performance of OFDM system in mobile wireless channels can be enhanced by introducing adaptive loading schemes wherein an assumption of perfect channel estimation is considered to achieve gain over non-adaptive loading scheme for typical channels. The effect of channel mismatch due to Doppler spread is studied as well. The results show that adaptive loading can preserve most of its gain even with imperfect channel information. Though the performance is improved by using adaptive loading scheme, it still didn't establish much about achieving a higher bit rate for wireless multimedia service which is elaborated in paper [2]. In paper [2], Orthogonal frequency-division multiplexing (OFDM) modulation is a promising technique for achieving the high bit rates required for a wireless multimedia service but to further improve the performance of OFDMA systems is by using coherent phase shift keying

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(PSK) to investigate its robust channel estimation which can significantly improve the performance of OFDMA systems in a rapid dispersive fading channel. The only drawback of this scheme is that it did not cover the problems in multiuser diversity which is addressed in paper [3]. In paper [3], three problems in multiuser diversity for OFDMA systems are addressed. First, a way was proposed to significantly reduce the amount of channel state information (CSI) feedback without sacrificing performance too much, second to increase the cell throughput and fairness and thirdly, the issue of fairness and quality-of-service (QoS) in opportunistic systems are dealt with. Extensive simulation results are presented to evaluate the performance of the proposed schemes and it is seen that the modified PF scheduler was able to give users different QoS, based on their requirements, while still exploiting multiuser diversity. Though the problems in multiuser diversity are addressed in paper [3], it didn't consider the imperfect channel knowledge case of an adaptive multiuser. In paper [4], the performance of an adaptive multi-user OFDM system with imperfect channel knowledge at the transmitter is investigated, where the ergodic capacity is taken as performance criterion to compare its performance with the performance achieved with the use of diversity. Therefore different models of imperfect channel knowledge are introduced and it is shown that by means of ergodic capacity, adaptive subcarrier allocation with imperfect channel knowledge is better than the use of diversity. Paper [4] did not address the topic of beam forming in cellular communication which is covered in paper [5]. In paper [5], for the downlink of cellular communication network based on MIMO-OFDMA transmission technique, a self-organized beamforming approach with opportunistic scheduling algorithms is combined so that different beams are formed and grouped together. An adaptive use of beams is also perused. The topic paper [5] did not address is the flexibility and efficiency of data service in wireless communication which proposed in paper [6]. In paper [6], in the future wireless communication systems, MIMO and OFDMA are a promising solution for flexible and spectral efficient data services although an adaptive Resource Allocation(RA) in multi-user MIMO-OFDMA systems is very complex and optimal RA to maximize the sum rate is also very complex for practical application therefore, a model of suboptimal strategy is proposed wherein maximization of the sum rate is investigated and are shown to present better performance-complexity and performance-fairness as well as achieve almost the same sum rate obtained through an exhaustive search.

From paper [7], the problem of jointly optimizing. Minimizing the total power consumption along with quality of service requirement and transmit and receive processing matrices is the main objective. The quality of service (QoS) of each user is assumed to be the sum of the mean square errors over all subcarriers rather than on the sum of the achievable rate. Next, employing a nonlinear THP precoder operating at user level at the transmitter, transceiver design is carried out, Lastly, by combining with the THP precoding technique, choice of the user partitioning strategy is motivated which allows us to completely remove the multiuser interference. Here, there is a problem in the precoder design and the joint subcarrier allocation has not been looked into. From article [8], an efficient algorithm for the joint subcarrier allocation and precoder design problem is proposed. It is aimed at maximizing the sum rate of OFDMA wireless communication system. When the no. of subcarriers is small, using some powerful optimization solvers such as CPLEX, MOSEK or GUROBI, the MI-SOCP can be solved optimally in acceptable time or else, resulting MI-SOCP

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can be easily reduced to SOCP by allowing the binary variables to take any value on the interval [0, 1]. Here, Joint multi-carrier index keying and performance of MCIKOFDMA system is not being discussed. From paper [9], Firstly, the BER expression of a joint multi-carrier index keying and OFDM (MCIK-OFDM) that is based on any number of active sub-carriers is being generalized. Secondly, the performance of the MCIKOFDM system which has a tight upper bound on the BER in the presence of imperfect and perfect detection of active indices is analysed. In this article, spectral precoding and the corresponding spectral precoders for desirable spectral property are not developed.

In [10], selection of precoder on the mirror subcarrier induces variations in the quality of the signal thereby causing outage. Now this problem is overcome in [11], where digital precoding is done in the frequency domain and is different for each subcarrier. An algorithm has also been proposed to jointly optimize the wideband analog beamformers, per- subcarrier digital precoders and to minimize the loss caused by allocating multiple users to different subcarriers with a limited number of radio frequency chain. In [11], a frequency-selective hybrid precoding system with the RF precoders has been considered. But exhaustive search over the RF codebook is still required as the derived solution provides hybrid precoding design problems and also the algorithms proposed have low complexity. This problem is overcome in [12], by combining OFDM-IM and MIMO transmission techniques where a low complexity transceiver structure of the MIMO-OFDM-IM scheme is developed having a better error performance as compared to classical OFDM system. In [12], the implementation and error performance analysis of the MIMO-OFDMIM scheme for different type of detectors has been dealt with, where MIMO-OFDM-IM is found to be a strong alternative to classical MIMO-OFDM due to its improved BER performance and flexible system design. However, exhaustive search on this paper has been covered in [13], where a low-complexity detection scheme for MCIK-OFDM with diffused power (TWDP) fading channel has been used. The obtained results provide a new insight into the performance of MCIK-OFDM. In [13], a low-complexity detection scheme for MCIK-OFDM has been used to obtain a simple approximate expression for the pairwise error probability (PEP) that enables the performance analysis of MCIKOFDM. However, in [14], proposal of a precoding method that has a large capacity gain over that of no small-cell precoding for all subcarriers has been made. Thus, the precoding method proposed in [14] has not been proposed in [13]. In [14],the problems of orthogonal frequency-division multiple access (OFDMA) demodulation like the intercarrier interference (ICI) and interblock interference (IBI) have been discussed but the effects on small-cell uplink capacity mitigation have not been well discussed in this paper .This problem is overcome in [15],where a low-interference NC-OFDM scheme by addition of an improved smooth signal in the time domain has been used for reducing the interference of NC-OFDM and avoiding complex signal recovery at the receiver. In [15], a low-interference NC-OFDM scheme by addition of an improved smooth signal in the time domain has been proposed for reducing the interference of NC-OFDM and avoiding complex signal recovery at the receiver. Meanwhile, in [16] subcarrier allocation and precoder design problem have been studied to maximize the energy efficiency (EE) of the system. Thus, in [16] an algorithm to find the maximal EE has been concluded which has not been proposed in [15]. In [16], the time-sharing concept of subcarrier allocation maximizes energy efficiency (EE) of the system but fails to solve the problem for any value of transmit power. Thus, the proposed subcarrier allocation results in a discontinuous and quasi-

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concave EE function. Meanwhile, in [17] a unitary precoder is proposed to suppress the out-of-subband (OOSB) spectral leakage and reduce the peak-to-average-power-ratio (PAPR) for DFT-based orthogonal frequency division multiple access uplink signal. Thus, [17] produces an iterative decoding algorithm to improve the system performance on bit-error-rate (BER) which has been neglected in [16]. In [17], a unitary precoder is proposed to suppress the out-of-subband (OOSB) spectral leakage and reduce the peak-to-average-power-ratio (PAPR) for DFT-based orthogonal frequency division multiple access uplink signal followed by an iterative decoding algorithm to improve the system performance on bit-error-rate (BER).Meanwhile [18] deals with generalized discrete Fourier transform-spread-orthogonal frequency division multiplexing (G-DFT-s-OFDM) waveforms that produces flexibility, spectral containment, and low peak-to-average power ratio. Thus, possibility of tracking of varying propagation conditions has been concluded in [18], which has not been done in [17]. In [18], generalized discrete Fourier transform-spread-orthogonal frequency division multiplexing (G-DFT-s-OFDM) waveforms that produces flexibility, spectral containment, and low peak-to-average power ratio has been dealt with thereby enabling the tracking of varying propagation conditions.

System Model with brief Theory

Orthogonal Frequency Division Multiplexing (OFDM) provides a solution of efficient bandwidth and reduction in ISI causing multipath fading. OFDM divides high rate data stream using FFT. OFDM is also used in wireless communication system (WiMAX, LTE etc.). Thus, OFDM is a multiplexing scheme that divides data stream into narrowband data channel to make the bandwidth available. The functional block diagram of OFDM system is shown below:

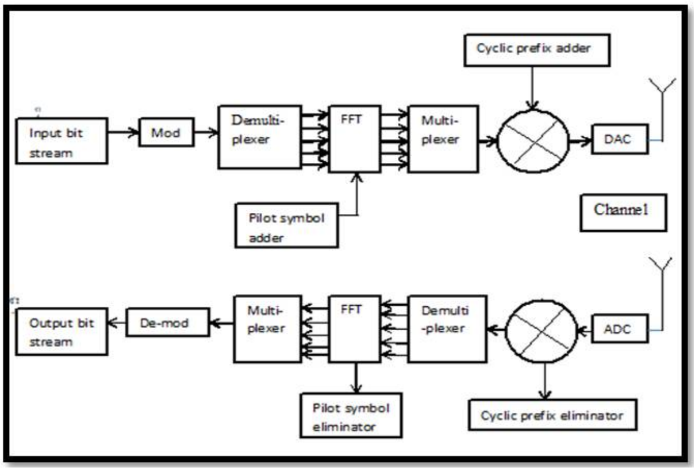

Figure 1.Block Diagram of OFDM System

Data bits stream are transmitted by converting them from serial to parallel such that each subcarrier is modulated with the help of phase or amplitude modulation. This process is called symbol mapping. Then, all the modulated signal is carried by OFDM carrier Volume 2, No. 1, June 2014 EMITTER International Journal of Engineering Technology, ISSN:2355-391X using IFFT module to create complex signal that includes all subcarrier. Data parallel stream is then converted to serial stream as well as real and imaginer signal respectively are processed on Digital to Analog Converter (DAC). Both analog signals is multiplied by the radio frequency with a phase shift of 90° and summing them both. This signal is then transmitted over antenna. Figure 1 shows the diagram of OFDM system. At the receiver end, real and imaginer signal are received separately and processed by low pass filter to eliminate mirrored frequencies. Then, the quantization is done by Analog to Digital Converter (ADC) block and the signal is evaluated by Fast Fourier Transform (FFT) module. Demodulation of the data symbols are done by symbol mapping block according to the modulation used. To recover the original data, Parallel data stream is converted into serial data.

PROPOSITION

OFDM technique has already been used in numerous communication standards in an efficient fashion. However, reduction of PAPR along with BER is one of the big challenge for research community. To overcome this a new proposition can be made on their encoding and decoding structures. Instead of using traditional convolutional code a pre coder based Low Density Parity Check Code (LDPC) can be used for achieving better system performances. It may also make the system robust.

CONCLUSION AND FUTURE SCOPE

Precoding is a technique that exploits transmit diversity by weighting the information stream resulting in a narrow band channel achieved through OFDM. Processing required for the signal format was relatively high for OFDM based systems but with advancement in technology, OFDM experienced few problems in terms of processing required as no development for sum rate maximization in mm wave OFDM has been cited so far. So a fully digital precoder and subcarrier allocation can be considered to overcome this loop hole. In this regard LDPC code can also be incorporated to make the system robust and efficient.

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