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Research Article

IDMA-Based Improved Multi-User OFDM System For Next Generation WLAN

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ABSTRACT

The demand for mobile broadband not only enhanced the current communication applications, but also generated new services which are highly reliant on this connection. Since wireless applications are on the rise in the future systems, new technologies that can offer high capacity and QoS have to be incorporated. It is predicted that the future communication networks will face issues in managing large and diverse data traffic and a large number of users so that new sophisticated multiple access (MA) schemes will be needed. Since the focus of research is gradually moving to the development of even more effective MA schemes, it is important to compare various options to select the most suitable one. Thus the main purpose of the paper is to gave a compressive overview of most popular or the newest MA schemes.

Keywords: IDMA, OFDMA, WLAN, GSM.

1. Introduction:

Wireless communication technology has greatly enhanced the society today in so many ways. Twenty years ago, only high-tech laptops had "WLAN for wireless broadband Internet connection". Today, however, WLAN connectivity is an integrated aspect in most of the modern communication devices because of the increasing consumer demand. This has led to new applications such as multimedia streaming, video on demand and many others. As a result, a new research domain of 'wireless broadband access everywhere' has been developed. The mobile environment now supports services such as internet browsing and video streaming which is a success of wireless broadband through WLAN.

The current second-generation cellular technologies like GSM are mainly suitable for voice channels and are not suitable for data networks. Although there are some enhancements in data transfer technologies such as UMTS and HSDPA, they are not sufficient to satisfy the need for higher data rates and the QoS required for future applications.

Future systems are developed with the objective of attaining high capacity. It has been found out that IDMA systems have higher information transfer capability compared to OFDM systems [1, 2]. There are two main issues with wireless communication systems: interference between symbols (ISIA) and multiple-use interference (MAI). Although there are many methods like time-domain equalization that have been suggested to overcome these problems, they are usually expensive. OFDM however, combats ISI by transforming the frequency selective channel into parallel flat fading channels. IDMA also has advantages [3], especially in terms of low MAI by means of an iterative procedure that includes elementary signal estimation and decoding. In the following section, both technologies will be explained in detail.

2. Literature Review:

In this paper, Chulhee Jang put forward an IDMA system with relays. The system model is described and then the detection algorithm at the destination is described, which is based on the chip- chip detection method. The proposed system does not add any load on the mobile devices and the only operations required are simple forwarding. In this study, they describe an IDMA system with relays using the chip-by-chip detection

algorithm. The system is designed for mobile devices and therefore it needs only the most basic relays. The results indicate that this system operates as multiple access scheme and it is capable of delivering diversity gains [1].
Tao Yang also proposed a new linear programming method to find the best rate profile for the scheme. The numerical results show that when simple repetition coding is employed and the rate is optimally assigned, the scheme works about 5dB away from the capacity for a large number of users over a broad range of SNRs. The proposed rate allocation scheme is compared with other power allocation methods for IDMA and it is observed that the proposed scheme has moderate spectral efficiency but has similar performance as the other methods, thus reducing the requirement of complex power amplifiers.[2].
"Bin Zhang extended the DD-IDMA relay scheme to the MIMO relay networks with spatial multiplexing". For the system, they suggested a symbol-by-symbol iterative detection technique at the destination. The evaluation of the MIMO relay system was done through simulation and the results depicted that the diversity advantage "increases with the increase in the number of relays". This work uses a simple repetition code for ease of implementation but the application of other complex channel codes in addition to the repetition code could enhance the performance of the system [3].

In the paper, Xiaoxiang Wang (2010) described the causes of the outage probability and the selection of the partner in the cooperative networks in the study, the outage benefit matrix was converted into a symmetric form using IDMA superposition modulation and the Hungary and WLF algorithms were used to derive both the centralized optimal and distributed sub-optimal partner selection strategies for the SM-CMA-CN. The simulation results also show that these proposed partner selection strategies are useful in decreasing the average outage probability of the network. However, Authors' knowledge, the outage performance and the selection of the partner strategy of the ISM cooperative network that has been recently proposed have not been studied in the previous work. Therefore, in this paper, the distributed and the centralized partner selection strategies are proposed to fulfill the need of the superposition modulation system. In addition, the study establishes that the most effective strategy is the centralized strategy. [4].

In 2011, Xing-Zhong Xiong put forward an efficient uplink and downlink cooperative transmission and reception scheme for IDMA systems based on the TR method called TDR-IDMA because this transceiver system adopts the TDD modeTime-reversed variants of the channel impulse responses, or TDR-IDMA systems, estimated from the uplink, are utilized to precode the received signal before it is processed by the primary signal estimator at the base station receiver. Due to the weak correlation between the multi-path signals from different users, the SINR at the beginning of turbo-like detection in TDR-IDMA can be significantly enhanced. From the analysis of signal detection, it is found that TDR-IDMA systems provide better improvements than the conventional IDMA systems, much fewer iterations are required for TDR-IDMA systems. Therefore, the proposed scheme has the capability to reduce the MUD computational complexity for the uplink, which is one of the main challenges in IDMA systems [5].
In a later part of 2013, Jian Dang proposed a new kind of OFDM-IDMA that is referred to as grouped OFDM-IDMA or G-OFDM-IDMA. The user grouping problem is described as the integer linear programming problem and then the approximate solution with the lower bound is provided. The issues of optimization are discussed and the level of difficulty is defined. In order to assess G-OFDM-IDMA, simulation was carried out under the following system scenarios as explained below. Therefore, it was reasonable to assume that substitution of OFDM-IDMA by G-OFDM-IDMA and the configuration of the suboptimal grouping solution would result in the saving of up to 80% of the complexity [6].

Olutayo O. Oyerinde (2014) suggested two estimated channel approaches for OFDM-IDMA systems based on the soft data received from the decoder. The first approach involves forecasting and measuring the channel's characteristics in both the frequency and temporal domains. Using the regularized noise power estimate-based variable forgetting factor recursive least square (ℓ1-NPEVFF-RLS) for the CIR estimator, the second method is a time domain iterative channel estimation technique. The results of the simulation demonstrate that, despite requiring more computing power, the suggested channel estimators outperform other approaches mentioned in the literature in terms of performance. When the two suggested approaches' computational complexity is compared, it is evident that the CIR estimator based on ℏ1-NPEVFF-RLS has a somewhat lower complexity than the combined effort of the ℓ1-VSSNLMS-based and ISLMMSE-based CTF estimator[7].
In his work (2015) W. Belaoura proposed an interleaver based on a new idea concerning the permutation control keys that are defined with the help of elliptic curve cryptography. The degree of randomness that one sees in the interleaved sequence is very easily accomplished if you have several rounds and a different subkey for each round. In addition to the comparatively high degree of data security, the numerical simulation results obtained also indicate that the structure containing the proposed interleaver can be implemented to attain the practical BER performance. The reduction of the multipath fading and the multiuser interference was also demonstrated using this new scheme [8].
The low-complexity quantum-assisted multiple users soft-input soft-output sensors (QMUD) were proposed in the paper of Panagiotis Botsini in 2015 which can be readily incorporated into the today's advanced iterative receivers. This design has been generated from extrinsic information transfer charts. QMUDs were integrated

into MC-IDMA and the performance of the QMUDs was investigated while changing the channel code rate and spreading factor within the total bandwidth constraint. With regards to the functionality of the said QMUDs, the participants were able to testify to the functionality of only one of them, at a zero percent functionality. As earlier noted, it is said that after the three interactions with the decoders, the C-MAP MUD can be minimized to about 5 dB while the complexity of the latter is only half of the former [9].

"Yang Hu et al. (2018) suggested a low cost CSDMA in which instead of the user specific interleaving that is used in the IDMA, a user specific shift is used. They also presented a linear MMSE message passing detection algorithm for CSDMA using a low complexity Gaussian approximation. This work has provided evidence that CSDMA can perform nearly as well as the original IDMA in LDPC or turbo coded schemes and the implementation is very easy. Two low-cost implementation methods are also introduced in this paper, namely the user-specific shifting at the transmitter side and the GA-LMMSE at the receiver side. Some of the software used in this study are available at the following site: Therefore, it could be summarized that WWW. ee. cityu. edu. hk/%7Eliping/Research/Simulationpackage/ "[10].

D. Sony et al introduced the IDMA systems in the paper of 2021 and also described the simulation of the systems using MATLAB other than the comparison with the CDMA systems. This paper also confirms that engineers and scientists employ MATLAB for data manipulation, algorithm development, model creation, and application creation. For instance, CDMA used in 4G has multiple access communication capability though the quality of the Efficiency decreases as a number of users. Thus, in order to counter the said demerits of CDMA a new and improved version of CDMA is called IDMA and at present it is under discussion in the international forum of 5G communication systemIDMA is a multiuser approach that divides users based on distinct interleaver sequences. [11].

3. OFDM-IDMA:

The OFDM-IDMA protocol was initially set forth in [22][23]. Although inverse FFT activity occurs at the transmitter side and FFT activity occurs at the reception each other the concept of the OFDM-IDMA system is nearly identical to the one shown in the first figure. Because of their frequency selectivity, these procedures convert the ISI channel's time-domain convolution effect into a frequency-domain fluctuation effect. The primary benefit of OFDM-IDMA is its ease of integration with MUD and its ability to maintain user complexity independent of channel length and user count. This approach is more appropriate because the complexity is significantly smaller than in other scenarios.

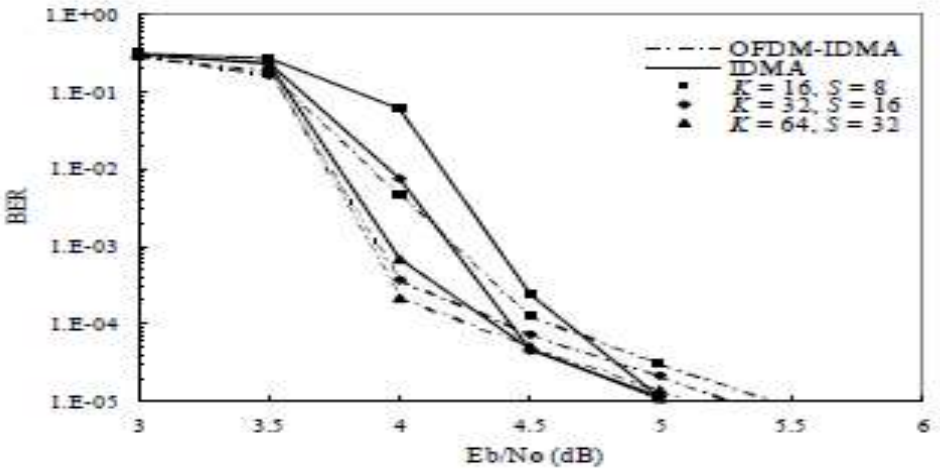

Fig 1: "IDMA and OFDM-IDMA systems' respective performances across ISI channels are compared. KR = 2 is the system throughput".

Figure 1 shows the reliability comparison of an OFDM-IDMA system over an ISI channel vs a single-carrier IDMA system with frequency domain identification, assuming uncorrelated Rayleigh fading of the sub-carriers. With a system throughput of KR = 2 bits/symbol, both systems use an assess-1/2 convolutional code, a length-S repetition code, and QPSK for the users. Additionally, the figure shows that both systems work almost equally well. However, by increasing K (and S proportionally), the OFDM-IDMA system's performance can be somewhat enhanced since a longer spreading length S offers greater compensation of frequency selectiveness among sub-carriers. Further, multi-user gains can be obtained via OFDM-IDMA systems even in circumstances in which there is a near-far effect. An OFDM-IDMA system in Figure 2. In addition to Rayleigh fading, Figure 2 depicts an OFDM-IDMA system in a single-cell fading channel with path loss and lognormal fading. With a constant system throughput of three bits per symbol, each user uses an 8-repetition code, a rate-1/2 convolutional code, and QPSK modulation to produce 24 coded streams. The performance is compared

with that of a single-user BICM-ID method with the same throughput when K < 24, which is comparable to that of the OFDM-IDMA system when K = 1. Each user is allotted numerous code streams based on SCM. The block length for each user is shortened when K is increased, making the multi-user BICM-ID system with OFDMA marginally inferior than the single-user alternative.

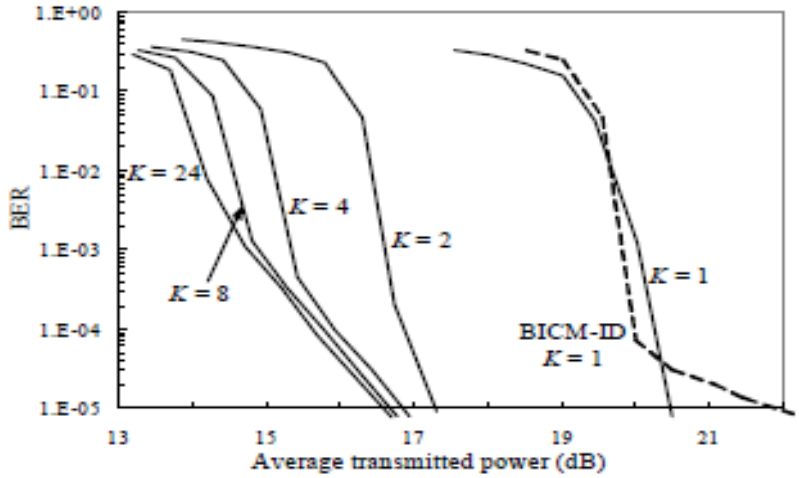

Fig. 2: "The simulation assesses the OFDM-IDMA system in an ISI channel that has path loss, lognormal fading and Rayleigh fading. The throughput is set at KR = 3. The transmitters are aware of the path loss and the lognormal fading but are not aware of the Rayleigh fading."

3. Conclusion:

In this review, we have described the impact of "a combined IDMA-OFDMA system on the BER performance in terms of the variation of SNR during the wireless transmission through various modulation schemes. In our work, we decreased the ISI by using the cyclic prefixing method in OFDM and used the iterative detection with IDMA."

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