Implementation of Interleave Division Multiple Access (IDMA) for Wireless Communication

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ABSTRACT
Wireless has replaced wired networks in many homes, business and campuses. Wireless communication is, by any measure, the fastest growing segment of the communication industry. As such, it has captured the attention of the media and the imagination of the public. Cellular systems have experienced exponential growth over the last decade and currently billions of users are available worldwide. The exponential growth of cellular telephone use and wireless internet access has led to great optimism about wireless technology in general.

This paper presents the implementation of Interleave Division Multiple Access (IDMA) for wireless communication. Here, interleavers are the only means of user separation where different interleavers are assigned for different users. The performance is analyzed by the bit error rate and also this technique shows high performance can be maintained in multipath environments and also computational complexity is also reduced. A low-cost iterative chip-by-chip multiuser detection algorithm is also described with complexity independent of the user number and increasing linearly with the path number. simulations are performed for various scenarios and the results are analyzed and described.

Keywords
Interlerave Division Multiple Access(IDMA),Bit Error Rate(BER),Code Division Multiple Access(CDMA),Pilot Layer Aided Channel Estimation(PLACE).Tree Based Interleaver(TBI),Signal to Noise Ratio(SNR),

1. INTRODUCTION
The evolution of mobile system includes 1G, 2G, 3G and the next generation 4G till date. There is lot of improvement that have taken place at each switching of one generation to the other and also improvement in the data rate and quality of services have also improved. These various improvements in the 1G, 2G, 3G and 4Gsystems have led to the improved wireless communication systems which is presently indicative of the fastest growing demand of wireless communication.This paper presents an asynchronous interleave-division multiple access(IDMA) scheme for spread spectrum mobile communication system, in which users are distinguished by different chip –level interleavers instead of by different signatures as in a conventional CDMA system.

Wireless communication is the transfer of information between transmitter and the receiver points which are not connected by any of the electrical conductor. Wireless communication is the fastest growing segment of communication industry these days. The past decades have seen many changes and advances in physical layer wireless

communication theory and their implementation in wireless systems.

Multiple Access Techniques are the ways to access a single channel by multiple users that is how the same bandwidth channel is used by the different number of users. They provide multiple access to the channel. A channel refers to a system resource allocated to a given mobile user enabling the user to establish communication with the network (other users). Based on the type of channel, we can use a particular multiple access technique for communication.

The various types of channels and their corresponding multiple access techniques are as follows:

[FDMA - Frequency Division Multiple Access] –Users are separated by different frequency channels in this scheme.

Time-slot Within Frequency Bands [TDMA - Time Division Multiple Access] – Multiple users can transmit at the same frequency band at different times. Hence users are separated by different time slots in this scheme.

Distinct Codes [CDMA - Code Division Multiple Access] – Users may transmit at the same time using the same frequency band but using different codes so that we can decode to identify a particular user. Hence users are separated by different codes here.

Distinct Interleavers [IDMA - Interleave Division Multiple Access]- Users are separated by different interleavers here. Interleavers are the only means of user separation in this multiple access scheme. Hence complexity and memory requirement is reduced in this multiple access scheme because of using interleavers as the means of user separation.

For non-orthogonal MA technologies such as random waveform CDMA, although it mitigates inter cell interference and supports asynchronous transmission, the challenge is to combat intracellinterference. So, there is a new technique known as IDMA (Interleave Division Multiple Access) which seems to be the solution. Interleave-Division Multiple-Access

(IDMA) is a recently proposed multi-access scheme, in which users are distinguished by different interleaving patterns. Methodology includes implementation of IDMA using PLACE Technique and can be seen the IDMA is the most efficient technology for wireless communication because of reduced complexity, memory requirement and BER. However, cell-specific interleaving can also be used to randomize the inter-cell interference. Cell specific interleaving brings more robust performance than cell specific scrambling. The advantages of interleaving over scrambling seem very important for cell edge subscriber stations to receive broadcast services such as common signaling broadcasting.

The block diagram of IDMA scheme is shown in Figure1.1 for K users. The principle of iterative multi user detection (MUD) which is a promising technique for multiple access

problems (MAI) is also illustrated in the lower part of Figure1.1. The turbo processor involves elementary signal estimator block (ESEB) and a bank of K decoders (SDECs). The ESEB partially resolves MAI without considering FEC coding. The outputs of the ESEB are then passed to the SDECs for further refinement using the FEC coding constraint through de-interleaving block. The SDECs outputs are fed back to the ESEB to improve its estimates in the next iteration with proper user specific interleaving. This iterative procedure is repeated a preset number of times (or terminated if a certain stopping criterion is fulfilled). After the final iteration, the SDECs produce hard decisions on the information bits. The complexity involved (mainly for solving a size KxK correlation matrix) is O (K2) per user by the well-known iterative minimum mean square error (MMSE) technique in CDMA, while in IDMA, it is independent of user. This can be a major benefit when K is large.[7].

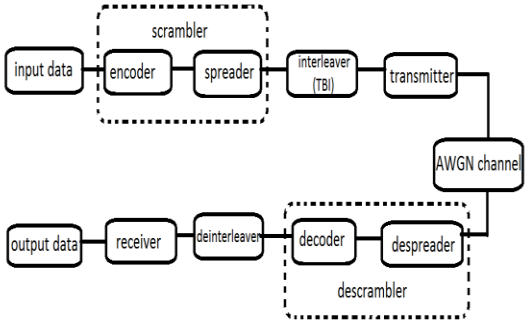

Figure 1.1 Block Diagram of IDMA

2. PLACE AND TBI

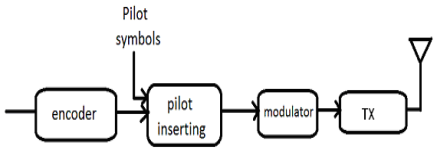

Figure 2.1: PLACE Transmitter

Figure 2.1 indicates the place transmitter.

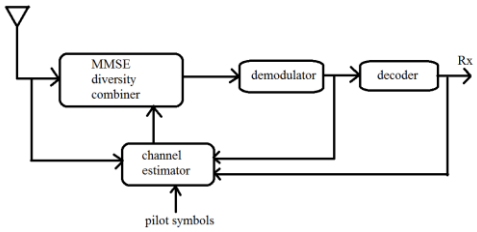

Figure 2.2: PLACE receiver

Figure 2.2 shows the PLACE Receiver structure.

PLACE is abbreviated as pilot layer added channel estimation. PLACE, pilot layer aided channel estimation is a channel estimation technique where, the main intention is to find the estimate h(i+1) of the channel co-efficient h based on the received data Y, and perfectly known pilot data matrix p_1 and the reinter leaved extrinsic information represented by the soft chip matrix X(i) which is obtained by previously decoded step. We can improve the channel estimate based on soft chip values and channel estimate can be improved iteration to iteration which leads to improvement in chip detection. Channel estimation is performed before dispreading.[5]

As shown in the above figure Pilot Layer Aided Channel Estimation receiver section is having a MMSE diversity combiner through which signals are combined and then demodulated using demodulator and then finally decoded to receive the signal. Using the pilot symbols the exact output is estimated using channel estimation.

There are basically many channel estimation techniques or concepts such as:

1. Training based channel estimation.
2. Semi blind channel estimation.
3. Blind channel estimation.
4. Pilot layer aided channel estimation.

Among these, Pilot Layer Aided Channel Estimation is preferred.

PLACE, pilot layer aided channel estimation is a channel estimation technique Which ismost efficient.Channel estimation is performed before dispreading. Here, channel estimation is based on the knowledge of the pilot layer and also the knowledge of soft chips. This technique also improves the power, significantly. PLACE structure is independent of the channel estimator type. Training sequence can be used as a pilot layer. Pilot sequence and chip-by-chip processing are able to track fast-fading frequency-selective channels. BER performance is also even improved. Sometimes performance of the channel estimates degrades when channel number of co-efficient to be estimated increases and the correlation of neighboring channel coefficients decreases due to fading. As shown in the above figure pilot layer aided channel estimation receiver section is having a MMSE diversity combiner through which signals are combined and then demodulated using demodulator and then finally decoded to receive the signal. Using the pilot symbols the exact output is estimated using channel estimation.

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Tree Based Interleaver (TBI is basically aimed to minimize the computational complexity and memory requirement that occur in power interleaver and random interleaver, respectively. The mechanism of Tree Based user-specific interleaver generation is based on two master interleavers, which are randomly selected. The algorithm for TBI is based on the selection of combination of two master interleavers. The odd number of users is taken upside while even number of users is taken downside. In this manner, a large number of users may be allocated with user specific interleavers with extremely less complexity. User specific interleaver is designed using a combination of these randomly selected master interleavers. Here Π1 and Π2 two master interleavers which are randomly selected. The interleaver Π1 is opted for

upper branch while Π2 is reserved for initiation for lower branch. Upper branch is selected in case of odd user count while lower branch is selected if user count is even. For the sake of understanding, from figure 3, for first user interleaver will be Π1 while for second user, the interleaver will be Π2. In case of third user it will be Π1 (Π1) and for fourth user, the interleaving sequence will be Π2 (Π1).

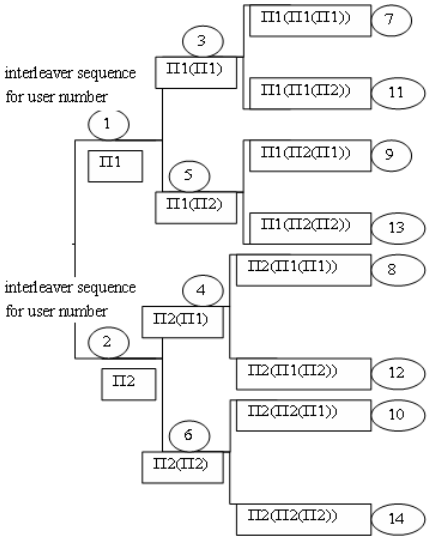

Figure 2.3: Tree Based Interleaver

The Memory requirement of Tree Based Interleaver is extremely low as compared to that of the Random Interleaver, while is slightly high if compared with master random interleaver. The IDMA scheme, inbuilt with random interleaver, imposes the problem of extra bandwidth consumption in the channel, along with high memory requirement at the transmitter and receiver ends. The result demonstrates that the memory required for storing the user-specific interleavers is user dependent for random interleavers in case of its deployment in IDMA scheme, while it is found to be at minimum level, in case of deployment of master random interleaver.[4]

For tree based interleaver, the requirement of memory is observed to be little bit high in comparison to that required in case of master random interleaver, however, it is extremely less when compared with requirement in case of random interleaver. Interleaving masks allocation for the Tree Based Interleaving scheme is mentioned. The simulation results conclude that the performance of tree based interleaver is very close to the desired ideal status of the results. However, the problem of computational complexity was raised with master random interleaver. Considering the computational complexity at the receiver end, the technique mentioned in TBI minimizes the computational requirement for master random interleaver

3. RESULT ANALYSIS

In this section we discuss the result analysis of the IDMA system. IDMA is most suitable for wireless communication because of its reduced complexity, low memory requirement and bandwidth efficiency.

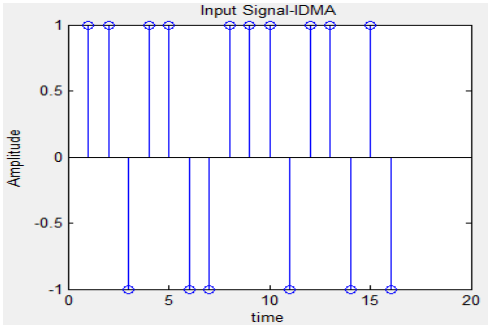

Figure 3.1: IDMA input signal

The figure 3.1 shows the input for the IDMA system

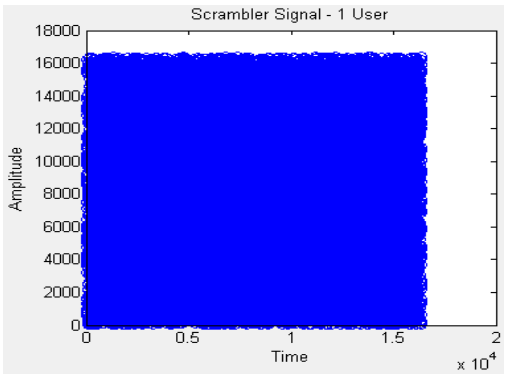

Figure 3.2: IDMA scrambled signal

The figure 3.2 shows the scrambled signal where encoding and spreading together called as scrambling is done.

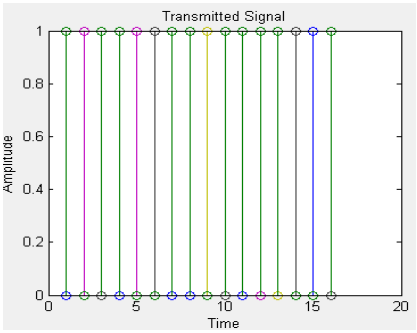

Figure 3.3:IDMA transmitted signal

The figure 3.3 indicates the transmitted signal of IDMA.

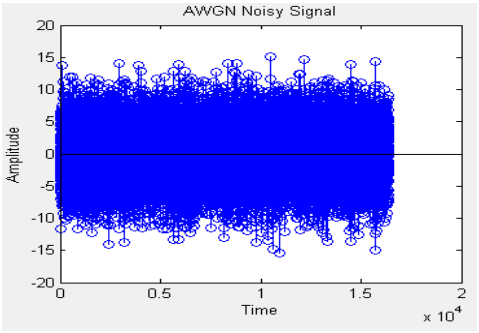

Figure 3.4:AWGN noisy signal

The figure 3.4 indicates the AWGN Additive White Gaussian Noise noisy signal where white noise is added.

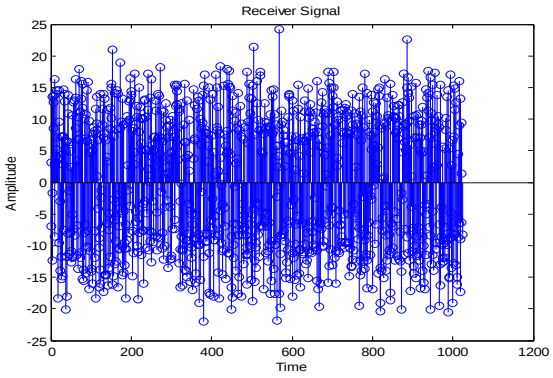

Figure 3.5:IDMA Receiver signal

The figure 3.5 indicates the IDMA receiver signal

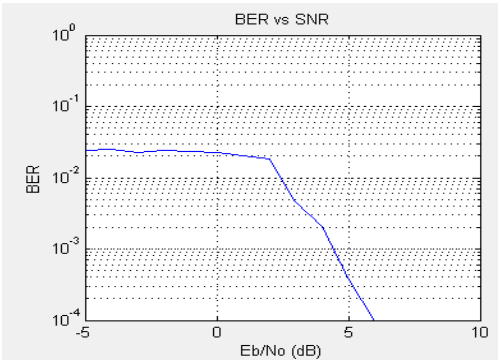

Figure 3.6:BER Plot for IDMA

The figure 3.6 indicates the BER performance of the IDMA systems which is good and suitable for wireless communication.

4. CONCLUSION

The novel concept of IDMA generates some fruitful results and also advantages of CDMA are maintained. As a consequence existing CDMA system are enhanced by IDMA. Hence we can see that IDMA is the most effective multiple access for wireless communication system since it overcomes the two important difficulties of CDMA that is MAI (multiple access interference) and ISI (inter-symbol interference) and we expect many more evolution of existing systems and better results for wireless communication systems. IDMA Performance is most suitable for wireless communication and it also reduces complexity and memory requirement can be reduced by using TBI.IDMA can mitigate interference among users to a maximum extent and provides high data rates without compromising the required quality of service. From the experimental results we can conclude that Bit Error Rate (BER) of IDMA system is reduced to a considerable amount. The research for the improvement in the IDMA is being carried out throughout the world for further improvement of data services.

5. REFERENCES

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