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# Difference between two Subcarrier Mapping Techniques IOFDMA and LOFDMA

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**Abstract: OFDMA is one of the promising candidates for wireless communication. In the subcarrier mapping, the two most important subcarrier mapping techniques namely Interleaved and Localized mapping techniques are being considered. OFDMA is a method that assigns different groups of subcarriers to different users. When an interleaved technique is implemented with OFDMA, it is known as interleaved OFDMA (I-OFDMA) and when localized technique is implemented with OFDMA, it is known as localized OFDMA (L-OFDMA).**

**Keywords: Bit error rate (BER), Peak-to-average power ratio, orthogonal frequency division multiplexing (OFDM), Interleaved orthogonal frequency division multiple access (I-OFDMA), Localized orthogonal frequency division multiple access (L-OFDMA).**

## 1. Introduction

Broadband Wireless Access (BWA) [1] is an appealing system for providing a flexible and easy deployment solution to high-speed communications. It appears as an alternative to wireline broadband access techniques such as copper line, co-axial cable, xDSL and cable modems. OFDMA is an OFDM-based multiple access scheme that is adopted in the downlink direction in both LTE and WiMax standards. Whereas OFDM assigns one block (in time) to one user, OFDMA is a method that assigns different group of subcarriers (in frequency) to different users. By doing this, more than one user can access the air interface at the same time. Several approaches to mapping transmission symbols to OFDMA subcarriers are under consideration. In the subcarrier mapping, the two most important subcarrier mapping techniques namely Interleaved and Localized mapping techniques are being considered. In this paper, we describe the basic concept of subcarrier allocation schemes i.e. interleaved scheme and localized scheme and performance analysis of localized OFDMA and interleaved OFDMA system via computer simulation Finally, concluded the difference between the two techniques.

## 2. Subcarrier Mapping Techniques

In this section, we specify the models of the system with two major subcarrier allocations, namely interleaved and localized.

### A. Interleaved Mapping

Interleaved subcarrier allocation scheme is an important case of distributed subcarrier allocation scheme [2]. To reduce the complexity of the mapping, subcarriers are clustered into slices (chunks) and all of the subcarriers in a slice are assigned together [3]. For example, 256 subcarriers grouped in 32 slices of 8 subcarriers per slice or 16 slices with 16 subcarriers per slice. Figure 1.1(a) indicates the subcarrier mapping in interleaved mode, where the subcarriers are mapped equidistant to each other. In this type of allocation, a user is assigned subcarriers that are uniformly distributed over a given band. For Interleaved signals, time symbols are simply a repetition of the original input symbols with a systematic phase rotation applied to each symbol in the time domain.

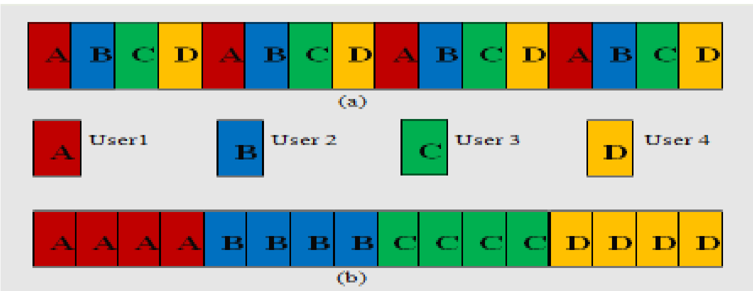


**Figure 1.1 (a) Interleaved Mapping (b) Localized Mapping**

### B. Localized Mapping

Figure 1.1(b) [4] indicates the concept of localized subcarrier mapping, where the subcarriers are mapped adjacent to each other. One distinct advantage of localized mapping over interleaved mapping is that localized mapping provides the feasibility of multiuser diversity, which leads to improved system capacity and/or performance. These subcarrier mapping techniques are applied on multiple access schemes i.e. OFDMA. In OFDMA, when interleaved and localized mapping is applied then the techniques are known as interleaved OFDMA (I-OFDMA) and localized OFDMA (L-OFDMA) respectively.

## 3. Simulation Results

In the simulation model, we have four numbers of users (Q) i.e. A, B, C, and D and we have 32 number of subcarriers per user that is N = 32. Thus, according to [3] total number of subcarriers is M = N.Q i.e. M = 128, that means the FFT size have to be equal to 128. Thus, in IOFDMA users are allocated like ABCDABCD….ABCD and in LOFDMA users are allocated like AAAABBBB...CCCC. The main parameters used for I-OFDMA an L- OFDMA are shown in the Table 1.1

**Table 1.1 Parameters used for simulation of I-OFDMA and L-OFDMA**

| Parameters | Values |
|---|---|
| FFT size, M | 128 |
| No. of Pilot Symbols | 4 |
| Modulation Techniques | QPSK, M-QAM,<br>where M = 8, 16, 32, 64, 128, 256 |
| Channel | Rayleigh fading |
| Channel Estimation | MMSE |
| No. of Channel Taps | 1 |

### BER Performance for I-OFDMA and L-OFDMA

We estimate the BER performances of the IOFDMA, LOFDMA via computer simulation and verified our results with the results given in [2] and [5]. To show BER performance of the IOFDMA and LOFDMA system, the data is generated randomly and then modulated by different modulation schemes as shown in the figures from 1.2 to 1.8 The results show that among the two mapping techniques, IOFDMA provides slightly better performance than LOFDMA as well as OFDM in the terms of BER. The different values of BER for are calculated using different modulation techniques QPSK, M-QAM (where M=8,16,32,64,128,256)

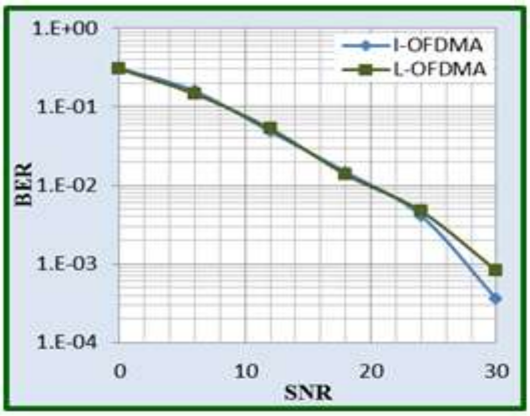


**Figure 1.2: BER performance of I-OFDMA and L-OFDMA systems using QPSK**

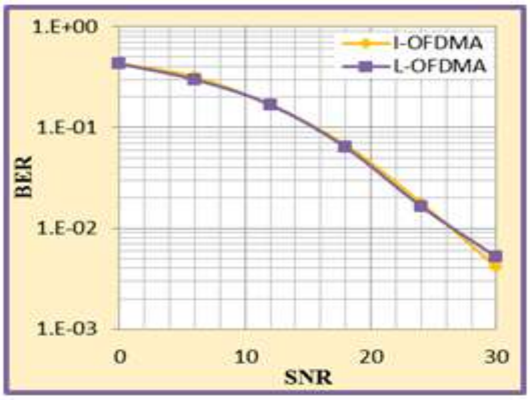


**Figure 1.3: BER performance of I-OFDMA and L-OFDMA systems using8-QAM**

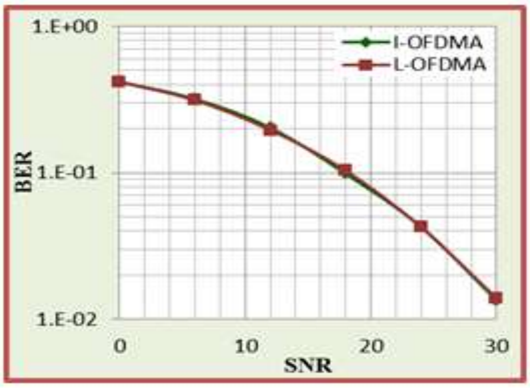


**Figure 1.4: BER performance of I-OFDMA and L-OFDMA systems using 16-QAM**

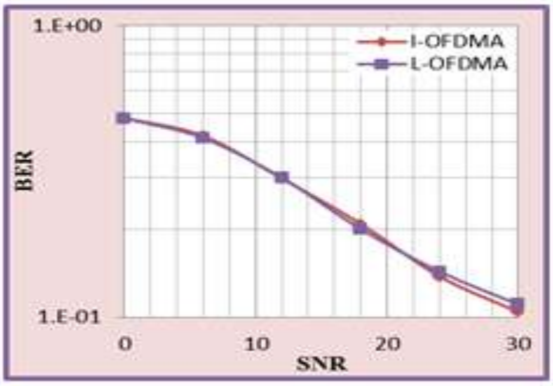


**Figure 1.5: BER performance of I-OFDMA and L-OFDMA systems using 32-QAM**

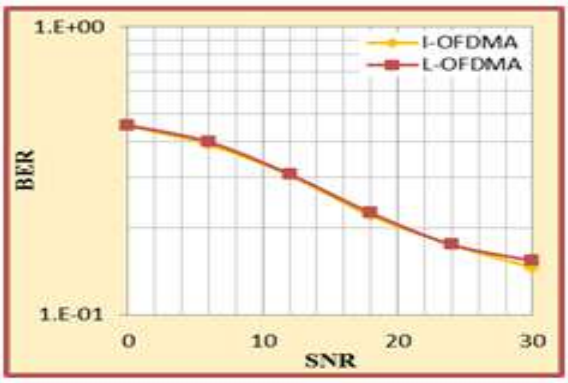


**Figure 1.6: BER performance of I-OFDMA and L-OFDMA systems using 64-QAM**

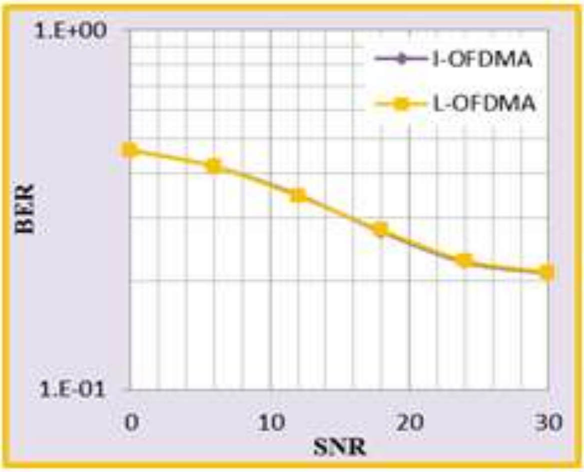


**Figure 1.7: BER performance of I-OFDMA and L-OFDMA systems using 128-QAM**

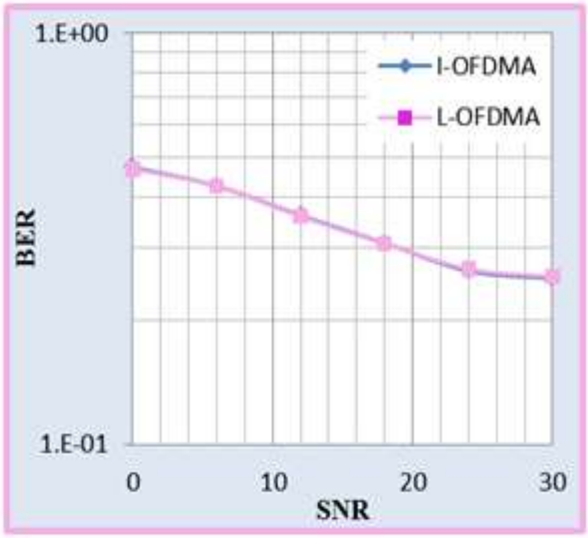


**Figure 1.8: BER performance of I-OFDM A and L-OFDMA systems using 256-QAM**

**Table 1.2: The different values of BER for different modulation technique at SNR 30dB**

| Modulation | I-OFDMA | L-OFDMA |
|---|---|---|
| **QPSK** | 0.000357 | 0.000821 |
| **8-QAM** | 0.004143 | 0.005167 |
| **16-QAM** | 0.013536 | 0.013929 |
| **32-QAM** | 0.104329 | 0.110786 |
| **64-QAM** | 0.14581 | 0.154083 |
| **128-QAM** | 0.210735 | 0.212265 |
| **256-QAM** | 0.253607 | 0.256054 |

**PAPR Performance for I-OFDMA and L-OFDMA**

As OFDM provides high PAPR therefore through the subcarrier mapping techniques we have tried to reduce that PAPR. We also verified our results with the results given in [6] and [7]. The PAPR performance of I-OFDMA and L-OFDMA are shown below in figure 1.9 It is observed that by using subcarrier mapping techniques, the PAPR of OFDM system is decreased. The values of PAPR are shown in table 1.3 as follows. It is clear that an improvement of 1 to 2 dB in PAPR is obtained when subcarrier mapping is used.

**Table 1.3: PAPR (dB) values of OFDM, I-OFDMA and L-OFDMA**

| OFDM | I-OFDMA | L-OFDMA |
|---|---|---|
| 12.4041 | 10.9344 | 11.3572 |

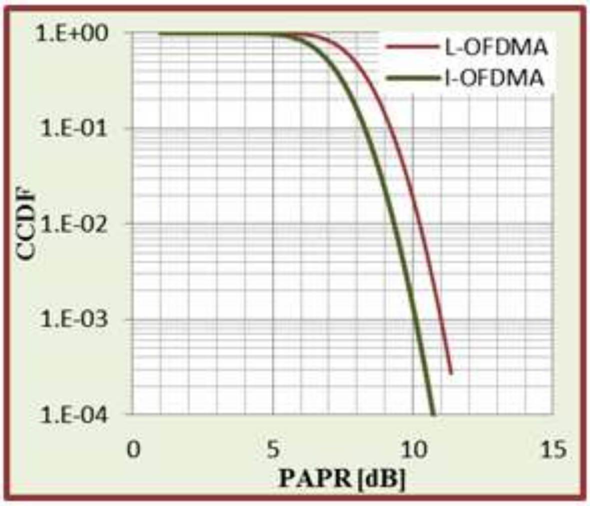


**Figure 1.9: PAPR performance of I- OFDMA and L-OFDMA system**

## Result/Discussion

The results show that among the two mapping techniques, IOFDMA provides slightly better performance than LOFDMA as well as OFDM in the terms of BER. The PAPR performance of I-OFDMA and L-OFDMA is less than OFDM.

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