

# Towards a Comprehensive Comparison of OFDM and CDMA techniques

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*Abstract:* - It is known that OFDM and CDMA modulation techniques are used in modern wireless communication networks as important modules of the relevant transmitters and receivers. There are several reports in the literature comparing these techniques in different conditions and simulation setups making quite difficult the overall cross-comparison. The goal of this paper is to analyze modelling and simulation requirements of these techniques and develop a unified MATLAB platform in order to make possible their comparison as modules of different communication systems. Some results of this educational oriented preliminary simulation system are herein presented concerning the BER performance of these algorithms involving different number of users.

*Key-Words:* - OFDM, CDMA, comparison of modulation techniques, MATLAB, BER Performance

## 1 Introduction

The field of wireless communications has witnessed revolutionary technology developments during last decades.

While previously there existed only 2G GSM, 2.5G (GPRS), 2.75G (EDGE) etc. based communication systems, which supported a data rate of around 10 Kbps and up to 384Kbps (downlink for EDGE), several radical wireless technologies have been developed in the last 15 years to enable broadband wireless access with rates in excess of 100 Mbps. These have subsequently led to the development of 3G and 4G wireless technologies such as HSDPA (High Speed Downlink Packet Access), LTE (Long Term Evolution) and WiMAX (Worldwide Interoperability for Microwave Access).

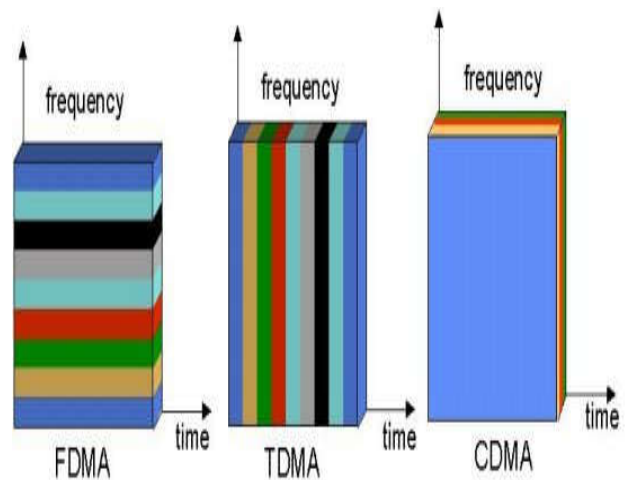
This has been made possible through breakthrough wireless technologies such as Code Division for Multiple Access (CDMA), Orthogonal Frequency Division Multiplexing (OFDM), Multiple Input Multiple Output (MIMO). These techniques form the basis of understanding the world of 3G/4G wireless communication systems as well as that of the newest 5G. [1-6]

The background of these technologies is that they are Multiple Access communication schemes. There are three common such technologies used by mobile communication networks for transmitting information. These are:

- Frequency Division Multiple Access (FDMA),
- Time Division Multiple Access (TDMA),

- Code Division Multiple Access (CDMA).

These three technologies can be represented graphically in figure 1 below:



**Fig.1** The basic Multiple Access Techniques for Wireless Communications

- FDMA puts each call on a separate frequency.
- TDMA assigns each call a certain portion of time on a designated frequency.
- CDMA gives a unique code to each call and spreads it over the available frequencies. [1-6]

### 1.1 Frequency Division Multiple Access (FDMA)

In FDMA, the available bandwidth is divided into a number of frequency non-overlapping subchannels,

















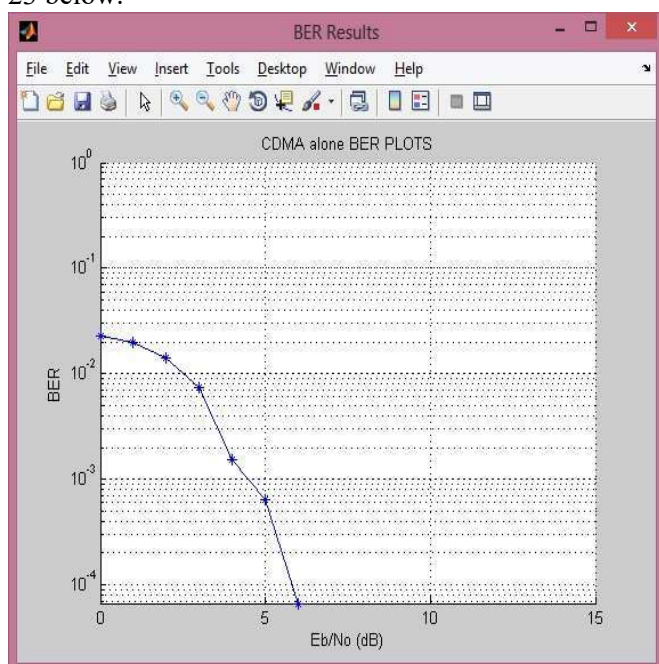








Having checked the main program (ofdm-dscdmaTestbed.m) and its results, it's time for the desired evaluation outcome of the OFDM-CDMA simulation/evaluation platform to be presented as a figure of Bit Error Performance, created during the simulation of ofdm-dscdmaTestbed.m with respect to  $E_b/N_0$ . At the beginning some problems came up and the GUI was not responding. After a long time of experimenting on it, in order to work, finally the desired results were accomplished as figures 22 and 23 below.

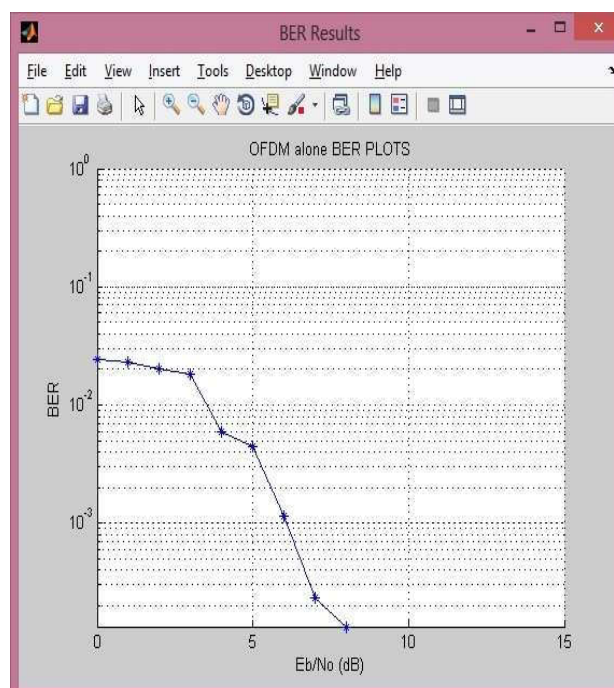


**Fig. 22** The CDMA BER plots per  $E_b/N_0$  (dB)

Careful inspection of Figures 21 and 22 shows that OFDM and CDMA achieve almost the same BER results but at higher level of energy per symbol to noise power spectral density, which is the definition of  $E_b/N_0$  (dB). Actually, when the signal bandwidth is well defined,  $E_b/N_0$  is also equal to the signal-to-noise ratio (SNR) in that bandwidth divided by the "gross" link spectral efficiency in (bit/s)/Hz, where the bits in this context again refer to user data bits, irrespective of error correction information and modulation type. [7]. Such a performance indicates that CDMA at the same level of  $E_b/N_0$  can achieve smaller BER than OFDM, a result valid, however, under the hypothesis of small number of users. More detailed graphs are needed to support such a conclusion for different setups and number of users.

## 5 Conclusions and Prospects

In this paper we have analyzed from an educational perspective the basic procedures of OFDM and CDMA systems and their relevant advantages and disadvantages. Based on this analysis we have



**Fig. 23** The OFDM BER plots per  $E_b/N_0$  (dB)

attempted to realize in MATLAB a relevant evaluation package to compare these techniques, for different parameters and implementations. Although at preliminary stage and having confronted several difficulties in building a unified GUI, this educational simulation system, even at this stage, can provide useful results that need to be extended, however.

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