

A novel technique for improved performance in wireless communications

Taiseem Ahmed¹, Himanshu Saini²

^{1,2}School of ICT, Gautam Buddha University, U.P., India

Abstract: A limited amount of bandwidth is allocated for wireless services. A wireless system is required to accommodate as many users as possible by effectively sharing the limited bandwidth. Therefore, in the field of communications, the term multiple access could be defined as a means of allowing multiple users to simultaneously share the finite bandwidth with least possible degradation in the performance in the system. Fourth Generation is the next generation of wireless network multiple access technique OFDM /OFDMA network in future.4G is intended to provide high speed, high capacity; low cost per bit, IP based services.4G is all about an integrated, global network that's based on an open system approach. In this paper, we present an overall vision of the performance analysis of wireless communication system by using multiple access OFDM scheme. We will compare different multiple access strategies, OFDMA, and performance analysis of conflict free multiple access method OFDM in terms of performance relation between BER and SNR in wiMAX technology.

Keywords: BER, CDMA, OFDM, 4G, Performance.

I. INTRODUCTION

Wireless broadband access is estimated to have range of 50 Km, in that one of the technology is known as wiMAX technology. Wireless communication has become increasingly important not only for professional applications but also for many fields in our daily routine and in consumer electronics [1]. Many of communication systems make use of one of two sophisticated techniques that are known as orthogonal frequency division multiplexing (OFDM) and code division multiple access (CDMA). The first, OFDM, is a digital multicarrier transmission technique that distributes the digitally encoded symbols over several subcarrier frequencies in order to reduce the symbol clock rate to achieve robustness against long echoes in a multipath radio channel [2,3]. Even though the spectra of the individual subcarriers overlap, the information can be completely recovered without any interference from other subcarriers. This may be surprising, but from a mathematical point of view, this is a consequence of the orthogonality of the base functions of the Fourier series. The second, CDMA, is a multiple access scheme where several users share the same physical medium, that is, the same frequency band at the same time[4]. In an ideal case, the signals of the individual users are orthogonal and the information can be recovered without interference from other users. Even though this is only approximately the case, the concept of orthogonality is quite important to understand why CDMA works. It is due to the fact that pseudorandom sequences are approximately orthogonal to each other or, in other words, they show good correlation properties. CDMA is based on spread spectrum, that is, the spectral band is spread by multiplying the signal with such a pseudorandom sequence. One advantage of the enhancement of the bandwidth is that the receiver can take benefit from the multipath properties of the mobile radio channel. OFDM transmission is used in several digital audio and video broadcasting systems [5].

II. MULTIPLE ACCESS TECHNIQUES

Multiple access is a signal transmission situation in which two or more users wish to simultaneously communicate with each other using the same propagation channel [6]. This is precisely the uplink transmission situation in a wireless communication system. There are following five basic schemes[7]

- A. Frequency Division Multiple Access (FDMA)
- B. Time Division Multiple Access (TDMA)
- C. Code Division Multiple Access (CDMA)
- D. Space Division Multiple Access (SDMA)
- E. Orthogonal Frequency Division Multiple Access (OFDMA)

A. FREQUENCY DIVISION MULTIPLE ACCESS (FDMA)

FDMA is one of the earliest multiple-access techniques for cellular systems when continuous transmission is required for analog services. In this technique the bandwidth is divided into a number of channels and distributed among users with a finite portion of bandwidth. The channels are assigned only when demanded by the users. Therefore, when a channel is not in use it becomes a wasted resource. FDMA channels have narrow bandwidth (30KHz) and therefore they are usually implemented in narrowband systems. Since the user has his portion of the bandwidth all the time, FDMA does not require synchronization or timing control, which makes it algorithmically simple. Even though no two users use the same frequency band at the same time, guard bands are introduced between frequency bands to minimize adjacent channel interference. Guard bands are unused frequency slots that separate neighboring channels. This leads to a waste of bandwidth. When continuous transmission is not required, bandwidth goes wasted since it is not being utilized for a portion of the time. In wireless communications, FDMA achieves simultaneous transmission and reception by using Frequency Division Duplexing(FDD). In order for both the transmitter and the receiver to operate at the same time, FDD requires duplexers. The requirement of duplexers in the FDMA system makes it expensive.

B. Time Division Multiple Access (TDMA)

In digital systems, continuous transmission is not required because users do not use the allotted bandwidth all the time. In such systems, TDMA is a complimentary access technique to FDMA. Global Systems for Mobile communications (GSM) uses the TDMA technique. In TDMA, the entire bandwidth is available to the user but only for a finite period of time. In most cases the available bandwidth is divided into fewer channels compared to FDMA and the users are allotted time slots during which they have the entire channel bandwidth at their disposal. TDMA requires careful time synchronization since users share the bandwidth in the frequency domain. Since the number of channels are less, inter channel interference is almost negligible, hence the guard time between the channels is considerably smaller. Guard time is a spacing in time between the TDMA bursts. In cellular communications, when a user moves from one cell to another there is a chance that user could experience a call loss if there are no free time slots available. TDMA uses different time slots for transmission and reception. This type of duplexing is referred to as Time Division Duplexing (TDD). TDD does not require duplexers.

C. Code Division Multiple Access (CDMA)

In CDMA, all the users occupy the same bandwidth, however they are all assigned separate codes, CDMA systems utilize a spread spectrum technique in which a spreading signal, which is uncorrelated to the signal and has a large bandwidth, is used to spread the narrow band message signal[8]. Direct Sequence Spread Spectrum (DS-SS) is most commonly used for CDMA. In DS-SS, the message signal is multiplied by a Pseudo Random Noise Code (PN code), which has noise-like properties. Each user has his own codeword which is orthogonal to the codes of other users. In order to detect the user, the receiver is required to know the codeword used by the transmitter. Unlike TDMA, CDMA does not require time synchronization between the users. A CDMA system experiences a problem called self-jamming which arises when the spreading codes used for different users are not exactly orthogonal. While dispreading, this leads to a significant contribution from other users to the receiver decision statistic. If the power of the multiple users in a CDMA system is unequal, then the user with the strongest signal power will be demodulated at the receiver. The strength of the received signal raises the noise floor for the weaker signals at the demodulators. This reduces the probability that weaker signals will be received. This problem, known as the near-far problem can be taken care of by using power control. This ensures that all the signals within the coverage of the base station arrive with same power at the receiver.

D. Space Division Multiple Access (SDMA)

SDMA utilizes the spatial separation of the users in order to optimize the use of the frequency spectrum. A primitive form of SDMA is when the same frequency is re-used in different cells in a cellular wireless network. However for limited co-channel interference it is required that the cells be sufficiently separated. This limits the number of cells a region can be divided into and hence limits the frequency re-use factor. A more advanced approach can further increase the capacity of the network. This technique would enable frequency re-use within the cell. It uses a Smart Antenna technique that employs antenna arrays backed by some intelligent signal processing to steer the antenna pattern in the direction of the desired user and places nulls in the direction of the interfering signals. Since these arrays can produce narrow spot beams, the frequency can be re-used within the cell as long as the spatial separation between the users is sufficient. Therefore it becomes imperative to use other multiple access techniques in conjunction with SDMA. When different areas are covered by the antenna beam, frequency can be re-used, in which case TDMA or CDMA is employed, for different frequencies FDMA can be used[9].

E. Orthogonal Frequency Division Multiple Access (OFDMA)

OFDM is a digital modulation technology in which in one time symbol waveform, thousands of orthogonal waves are multiplexed. This is good for high bandwidth digital data transition.

W-OFDM

W-OFDM enables data to be encoded on multiple high speed radio frequencies concurrently. This allows for greater security, increased amounts of data being sent, and the industry’s most efficient use of bandwidth. W-OFDM enables the implementation of low power multipoint RF networks that minimize interference with adjacent networks. This enables independent channels to operate within the same band allowing multipoint networks and point-to-point backbone systems to be overlaid in the same frequency band.

MC-CDMA

MC-CDMA is actually OFDM with a CDMA overlay. Similar to single-carrier CDMA systems, the users are multiplexed with orthogonal codes to distinguish users in(multi-carrier) .MC-CDMA. However in MC-CDMA, each user can be allocated several codes, where the data is spread in time or frequency.

LAS-CDMA

Link Air Communications is developer of LAS CDMA(Large Area Synchronized Code Division Multiple Access) a patented 4G wireless technology. LAS-CDMA enables high speed data and increases voice capacity and latest innovative solution, CDD, merges the highly spectral efficient LAS CDMA technology with the superior data transmission characteristics of TDD. This resulting combination makes CDD the most spectrally efficient, high-capacity duplexing system available today.

III. ANALYTICAL PERFORMANCE

In this section, we analyzed the performance of an optimum receiver for K users (maximum capacity) in AWGN and Rayleigh fading channels[10]. The single user case is a special case of the K user case. For a Rayleigh fading channel, we will try to define an upper bound for the bit error rate (BER) in Table 1.We will find out system spectral efficiency and system capacity. We have taken a wiMAX model and consider performance between SNR and BER at the bandwidth of 3.2 MHz as shown in Figure 1.Performance for bandwidth 3.2 MHz. We have taken simulation stop time 0.2 sec and number of OFDM symbols per burst=2, cycle prefix factor G= 1/8, low SNR threshold for rate control 4 10 12 19 22 28 db. We have used AWGN channel in wiMAX physical layer model using MATLAB.

SNR	BER
0	0.3779
1	0.2395
2	0.09543
3	0.0199
4	0.002861
5	0.0002878

Table 1

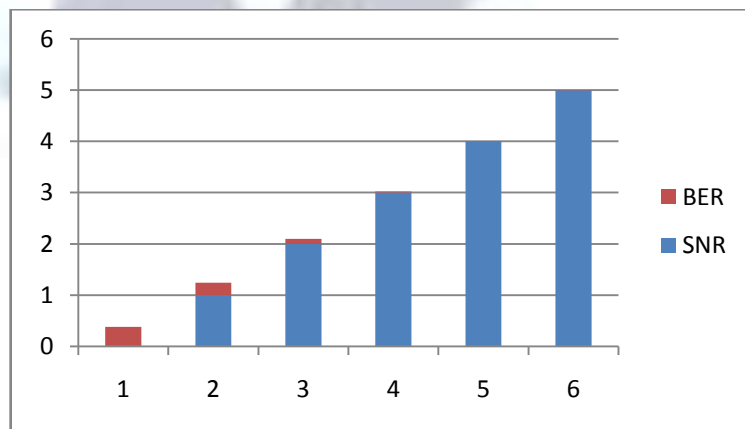


Figure 1

First start by setting parameters needed for the simulation. This graph shows maximum bit transmission when SNR is high, BER will be less and bit transmission rate will be effective at 3.2 MHz bandwidth.

CONCLUSIONS

Different multiple access techniques were presented. These include FDMA, TDMA, CDMA, OFDMA. Multiple access techniques solved many of the problems such as channel capacity and security that face the users sharing a channel. OFDM is used in many applications solution to multipath, good digital signal processing algorithms. We will compare multiple access techniques and OFDMA for performance improvement analysis of wireless communication system. Thus we have analyzed performance improvement of wireless communication system by using multiple access OFDMA techniques and shown maximum bit transmission when SNR is high, BER will be less and bit transmission rate will be effective at 3.2 MHz bandwidth.

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