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An Overview of CDMA Techniques for Mobile Communications

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Abstract: According to the classification based on the modulation method used to obtain the spread spectrum signal, a study of the CDMA (Code Division Multiple Access) for all current techniques is presented in this study. The first technique is DS-CDMA (Direct Sequence-Code Division Multiple Access) which is used for many commercial communication systems (almost all 3G mobile cellular systems as prime multiple access air-link architecture) and measurement instruments. This type is illustrated from the both transmitter and receiver, DS-CDMA is then compared with the two types of multiple access (time and frequency division) because it is the 1st type of code division multiple access. Next, the 2nd type of CDMA techniques: FH-CDMA (Frequency Hopping-Code Division Multiple Access) all the basic concepts of the modulator and the receiver are clarified then a comparison with DS-CDMA is done with an expectations for FH-CDMA in the future according to the advancement in micro-electronics technologies. TH-CDMA (Time Hopping-Code Division Multiple Access) represents the 3rd technique of code division multiple access, it is transmitter and receiver are analyzed and shown that TH-CDMA uses the whole wideband spectrum for short periods instead of parts of the spectrum all of the time. All currently researchers are exploiting new modulation, diversity and coding techniques to overcome the limited natural wireless resources: frequency and power where this represents the hybrid CDMA (forth technique) which is discussed with all necessary equations.

Key words: CDMA, DS-CDMA, FH-CDMA, TH-CDMA, hybrid CDMA, MC-CDMA, MC-DS-CDMA, TD-SCDMA, features, advantages, disadvantages

INTRODUCTION

Spread spectrum and CDMA are up-to-date technologies widely used in operational radar, navigation and telecommunication systems and playing a dominant role in the philosophy of the forthcoming generations of systems and networks (Valery, 2005). Code Division Multiple Access (CDMA) is a multiple access technique where different users share the same physical medium that is the same frequency band at the same time. The main ingredient of CDMA is the spread spectrum technique which uses high rate signature pulses to enhance the signal bandwidth far beyond what is necessary for a given data rate (Schulze and Luders, 2005).

In a CDMA system, the different users can be identified and hopefully, separated at the receiver by means of their characteristic individual signature pulses (sometimes called the signature waveforms) that is by their individual codes (Schulze and Luders, 2005).

CLASSIFICATIONS OF CDMA SCHEMES

CDMA can be classified according to the modulation method used to obtain the spread spectrum signal into four major techniques (Hanzo *et al*., 2003): DS-CDMA, FH-CDMA, TH-CDMA and hybrid CDMA.

DS-CDMA

Introduction to DS-CDMA: Now-a-days, DS modulation has been used for many commercial communication systems (almost all 3G mobile cellular systems use DS-CDMA as their prime multiple access air-link architecture) and measurement instruments. It is reasonable to expect that DS modulation will continue to be a familiar form of spreading modulation scheme in the years to come due to its unique and desirable features. Characteristic of DS spreading modulation is just exactly that modulation of a carrier by a code sequence (Abu-Rgheff, 2007). The use of DS-CDMA can effectively

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enhance overall bandwidth efficiency compared with traditional multiple access schemes such as FDMA (Frequency Division Multiple Access) and TDMA (Time Division Multiple Access). Spectrum is extremely expensive; it has to be purchased from various governmental licensing authorities at auction and sometimes those auctions have involved billions of US dollars (or equivalent monetary value in other currencies). It represents a considerable investment by a service carrier. Therefore, the bandwidth efficiency of a communication technology will be a primary concern for any network operator. The right selection of a suitable multiple access scheme to provide multi-user services is of ultimate importance. DSCDMA-based mobile cellular carries more calls than TDMA-based technologies. Generally speaking, CDMA will carry between 2 and 3 times as many calls simultaneously as TDMA in the same amount of bandwidth. The another major advantage of CDMA is its capability for dynamic allocation of bandwidth. To understand this, it is important to realize that in this context in CDMA, bandwidth refers to the ability of any user to get data from one end to the other. It does not refer to the amount of spectrum used by the user because in CDMA every terminal uses the entire spectrum of its carrier whenever it is transmitting or receiving. On the other hand, TDMA works by taking a channel with a fixed bandwidth and dividing it into several time slots. Any given mobile terminal is then given the ability to use one or more of the slots on an ongoing basis if it is in a call (Abu-Rgheff, 2007).

DS-CDMA's system model: The block diagram of simple asynchronous DS-CDMA modem in a noiseless channel is shown in Fig. 1. This system supports K users each transmitting its own information. The users are identified by k = 1, 2, 3, ..., K. This modulation scheme is used in

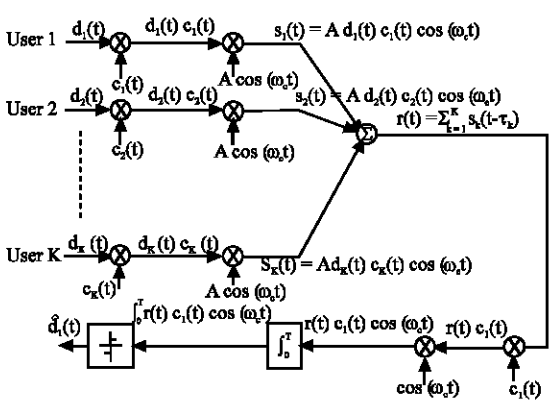

Fig. 1: Block diagram of a simple asychronous DS-CDMA system

Binary Phase Shift Keying (BPSK). Each user' s data signal is denoted by $d_k(t)$ and each user is assigned a unique pseudo-random code also known as a spreading code denoted by $C_k(t)$.

There are two classes of spreading codes in general, binary and complex. For simplicity, the following discussion considers only binary codes. Each spreading code consists of Q pulses, commonly known as chips (Hanzo *et al*., 2003). Here, the wanted signal is the signal of user k = 1 and all the other (K-1) signals are considered to be interfering signals. At the DS-CDMA transmitter of user k is 1st multiplied by the spreading code $c_k(t)$. This causes the spectrum of the information signal to be spread across the allocated bandwidth. Next, the signal is modulated onto its carrier before it is transmitted. The transmitted signal is given by:

$$S_k(t) = A\, d_k(t)\, c_k(t) \cos(w_c t) \quad (1)$$

where, w_c is the carrier frequency in rad sec^{-1} and A is the amplitude of the carrier signal (Hanzo *et al*., 2003). At the DS-CDMA receiver, the composite of all the K user signal is received, consisting of the transmitted signal from user 1 and the other (K-1) interfering signals. Ignoring the noise, the received signal is given by:

$$r(t) = \sum_{k=1}^{k} S_k(t - \tau_k) \quad (2)$$

where, T_k is the propagation delay from the transmitter to the receiver of the kth user.

FH-CDMA

Introduction to FH-CDMA: After having discussed the issues on DS-CDMA techniques, let's look at Frequency-hopping (FH) CDMA. Compared to the DS-CDMA technique, the FH-CDMA technique is a relatively less widely used CDMA scheme in real applications. The reason for its less wide acceptance is owing to several factors. First, the FH technique requires a very accurate reference clock in the whole wireless system which uses the FH-CDMA technique for user separation. This accurate network-wide reference clock is very costly to implement using currently available digital technology (Abu-Rgheff, 2007).

Maybe in the future, the situation will be different with the advancement in micro-electronics technologies. Second, the hardware to implement an FH-CDMA is still much too complex compared to DS-CDMA under the same maximum data transmission rate constraint. Therefore, system designers still prefer DS-CDMA to FH-CDMA for most commercial wireless applications

(Abu-Rgheff, 2007). In Frequency Hopping CDMA (FHCDMA), the transmission bandwidth is divided into frequency sub-bands where the bandwidth of each sub-band is equal to the bandwidth of the information signal (Abu-Rgheff, 2007). A pseudo-random code is then used to select the sub-band in which the information signal is transmitted and this sub-band changes periodically according to the code. There are two sub-categories of FH-CDMA: Fast frequency hopping where one complete or a fraction of the data symbol is transmitted within the duration between carrier hops. Consequently for a binary system, the frequency hopping rate may exceed the data bit rate (Hsiao-Hwa, 2007). Slow frequency hopping system, >1 symbol is transmitted in the interim time between frequency hops (Hsiao-Hwa, 2007). Figure 2 shows how the carrier frequency hops with time. Let time duration between hops be T_h and data bit duration be denoted by T_b then (Hsiao-Hwa, 2007):

$$T_h \leq T_b \text{ for fast hopping} \quad (3)$$

$$T_h > T_b \text{ for slow hopping} \quad (4)$$

FH-CDMA's system model: In frequency hopping usually each carrier frequency is selected from a set of frequencies which are spaced approximately, the width of the data modulation bandwidth apart. The spreading code in an FH system does not directly modulate the data modulated carrier but is instead used to control the appearance sequence of carrier frequencies because the transmitted signal appears as a data-modulated carrier which is hopping from one frequency to another. In the receiver side, the frequency hopping is removed by mixing (down-converting) with a local oscillator signal that is hopping synchronously (which is the most difficult part of the FH system implementation) with the received signal (Abu-Rgheff, 2007).

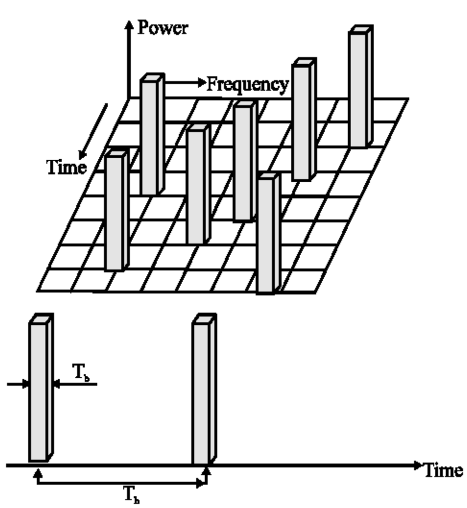

Fig. 2: Carrier frequency hopping from one frequency to an other

Usually, an FH system must have a code generator and a synthesizer which is capable of generating the corresponding frequencies according to the code generator. As stated earlier, the difficult part of developing an FH system is to design a fast-settling synthesizer with a sufficiently large number of carrier frequencies. Theoretically speaking, the output instantaneous frequency the synthesizer generates must be a single frequency. This is one of the reasons why an FH system is very difficult and costly to implement. In particular, the synthesizer in a fast-hopping, FH system has to work by switching from one frequency to another in a very fast and stable way, especially when the data rate is very high. However, a practical system may produce an output spectrum which can be a composite of the desired frequency, sidebands generated by hopping, as well as some other spurious frequencies generated as by-products. Figure 3 shows a conceptual block diagram of an FH transmitter. The receiver of the FH system is given in Fig. 4 (Abu-Rgheff, 2007; Hsiao-Hwa, 2007). The FH-CDMA transmitter shown in Fig. 3, consists of the following basic blocks, a data modulator, a mixer (denoted simply by a multiplier), an FH pattern code generator, a synthesizer and an antenna. The data modulator will perform the digital modulation between the user data m(t) and the main carrier signal. The synthesizer will work according to the hopping sequences generated by the code generator (Abu-Rgheff, 2007; Hsiao-Hwa, 2007). Usually, the code generator can produce a great number of different patterns each of which will be used by the synthesizer to generate a particular carrier which will be multiplied with the data modulated signal in the mixer to produce an up-converted transmitting signal from the antenna. Therefore, the carrier frequency of the transmission signal is under the control of the code generator which can also control the FH rate from one frequency to another. The hopping rate is a very

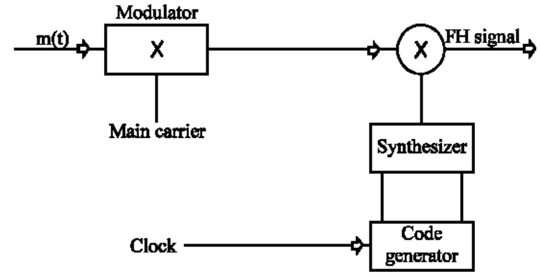

Fig. 3: Basic FH modulator

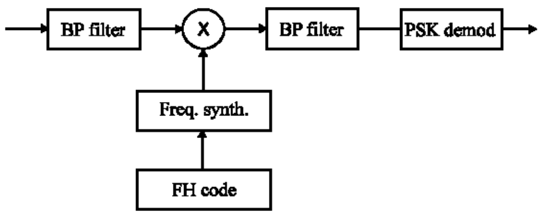

Fig. 4: Basic FH receiver

important parameter in an FH-CDMA system which will determine if it is a fast-hopping or a slow-hopping FH system (Abu-Rgheff, 2007). At the FH-CDMA receiver as shown in Fig. 4, the received signal should first go through a band pass filter which will be used to reject the image of the carrier frequency produced in the mixer. For the same purpose, the code generator will produce a replica of the sequence used by the transmitter and will yield an FH pattern which should be exactly the same as that used in the transmitter in the output of the synthesizer.

The locally generated FH pattern will be mixed with the received signal to produce a narrowband data-modulated signal with a fixed carrier frequency which should be equal to the intermediate frequency (IF) ω_I. The output IF signal will be demodulated by a PSK demodulator to recover the transmitted data information. Ideally, the spectrum generated from an FH system should be perfectly rectangular with spectral lines distributed evenly in every predetermined frequency channel. The transmitter should also be designed to send the same amount of power in each frequency. Otherwise, the detection efficiency on different frequencies will be different causing decision errors at a receiver. As shown in Fig. 4, the received frequency-hopping signal is mixed with a locally generated replica which is offset by a fixed amount (which is equal to a carrier frequency suitable for the reception process at the receiver, ω_I) such that the output from the mixer in the receiver will produce a constant difference frequency or ω_I if transmitter and receiver code sequences are synchronous (Abu-Rgheff, 2007). Signal that is not a replica of the local reference is spread by multiplication with the local reference and is never restored into its original narrowband waveform. The bandwidth of an undesired signal after multiplication with the local reference is approximately equal to the bandwidth before dispreading.

TH-CDMA

Introduction to TH-CDMA: The 3rd CDMA technique, TH-CDMA is found to be much less widely used than the previous two mainly due to its implementation difficulties and hardware cost associated with its transmitter which should provide an extremely high dynamic range and very high switching speed (Abu-Rgheff, 2007). The TH technique in fact, works in a very similar way as a digital modulation scheme called Pulse Position Modulation (PPM). The TH-SS (Time Hopping Spread Spectrum) technologies are not as popular as the other two spread spectrum techniques, i.e., the DS-SS (Direct Sequence Spread Spectrum) and FH-SS (Frequency Hopping Spread Spectrum) techniques. The main reason is implementation difficulties, especially for the pulse generator which is the core of a TH-SS system and should be able to produce a train of very narrow impulses with its width being at an order of nano sec. The pulse generator should also provide very good timing accuracy such that the PPM can be effectively applied to code different SS sequences for multiple access. The TH-SS technique seldom works independently in an SS system (except for the case of an Ultra-wideband (UWB) system, a technology developed based on the TH technique). Instead, it works with some other SS modulation schemes in particular the FH technique which has been discussed in the previous study to result in a time-frequency hopping SS scheme.

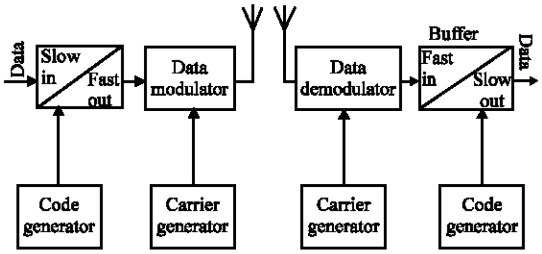

Fig. 5: Block diagram of a TH-CDMA transmitter and receiver

TH-CDMA's system model: In the TH-CDMA system, a pseudo-noise sequence defines the transmission moments, rather than the transmission frequency as FH does. The data signal in time-hopping CDMA is transmitted in rapid bursts at time intervals determined by the code assigned to the user. The time axis is divided into frames and each frame is divided into M, time slots. During each frame, the user will transmit in one of the M time slot which of the M time slots is transmitted depends on the code signal assigned to the user. Since, a user transmits all of its data in one instead of M, time slots, the frequency it needs for its transmission has increased by a factor M.A. block diagram of a TH-CDMA system is shown in Fig. 5.

Figure 6 shows the time-frequency plot of the TH-CDMA system which clarified that TH-CDMA uses the whole wideband spectrum for short periods instead of parts of the spectrum all of the time (Abu-Rgheff, 2007).

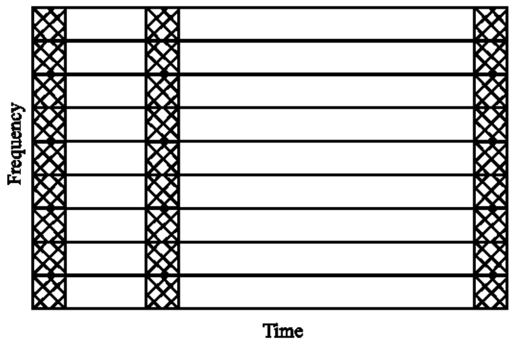

Fig. 6: Time frequecny plot of the TH-CDMA

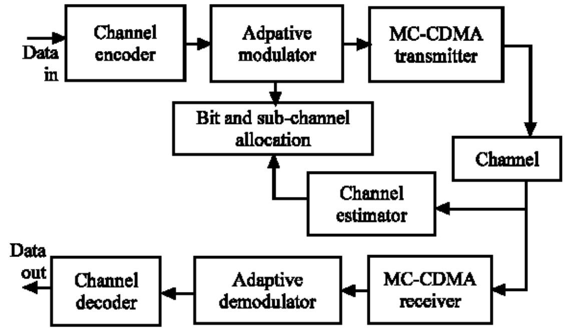

Fig. 7: MC-CDMA system

Hybrid CDMA: The increasing demand for high data rate transmission for newly evolving wireless communications systems (3G, beyond 3G and 4) has challenged the researchers to exploit new modulation, diversity and coding techniques to overcome the limited natural wireless resources: frequency and power (Elnoubi and Hashem, 2008). There are many different types of hybrid CDMA schemes which can be formed by various combinations of DS, FH and TH, together with Multi-carrier (MC) and Multi-tone (MT) techniques (Abu-Rgheff, 2007).

MC-CDMA (Multi Carrier-Code Division Multiple Access): A multi-carrier communication system is projected as a dominant contender to the next generation wireless communication systems (Kumar and Chellappan, 2009). The conventional Code-division Multiple-access (CDMA) technique used in third generation system faces serious limitations by channel dispersion causing Inter Symbol Interference (ISI) and it requires advanced signal processing algorithms to contain it. The MC-CDMA employing multiple stream of data channel can combat channel dispersion hence, ISI thereby increasing system capability to accommodate a higher number of users and its data rate requirements.

The efficiency in the multiple access techniques becomes an important issue as the demand for high data rate to support Internet applications continue to grow up. Many application demands more bandwidth either in forward channel or in reverse channel and popular applications like web browsing are bias towards downlink. Allocating equal resource in both uplink and downlink becomes bottleneck for the system as uplink remains underutilized while downlink gets strained (Kumar and Chellappan, 2009).

The MC-CDMA employing Time Division Duplexing (TDD) techniques can easily support this asymmetric traffic by dynamically varying the number of slots in uplink and downlink. Further, the MC-CDMA shows higher efficiency by adopting adaptive modulation techniques like M-ary Quadrature Amplitude Modulation (M-QAM). By dynamically allocating subcarriers and adaptive slot management the system can meet the large dynamic resource requirements of a real-time multimedia application in internet.

The CDMA based systems are inherently interference limited. The presence of every other user affects the SNR and hence, data supported on a particular channel. The channel state information can be estimated periodically by with the help of a pilot carrier and based on the estimated value, the order of modulation M is decided thus, optimizing the system capacity. Based on the call arrival and traffic present in a slot, the next slot can be declared either uplink or downlink (Kumar and Chellappan, 2009). The block diagram of MC-CDMA system employing adaptive modulation is shown in Fig. 7.

The channel capacity is estimated based on the SNR provided by the receiver. The requested data rate of an application is met by allocating number of subcarriers (Kumar and Chellappan, 2009). The adaptively modulated streams are then passed through the MC-CDMA transmitter block that further modulates it. The receiver performs the reverse operation to demodulate and decode the original information. The channel estimator estimates the quality of the channel from the pilot symbols transmitted periodically. The transmitter needs to inform the receiver the order of modulation to enable it to decode the signal.

The proposed algorithm tries to optimize the number of subcarrier and slot utilization for MC-CDMA employing TDD technique. Every cell can have its own slot allocation method based on the traffic load. The SNR depends mainly on the direction of traffic (uplink/downlink) in home and interfering cells. In multi-cell environment based on prevailing conditions many cases of interference pattern may arise. The system representation could be the generalization of two cell

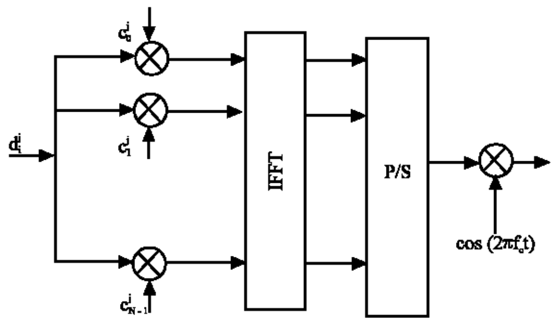

Fig. 8: MC-CDMA transmitter structure

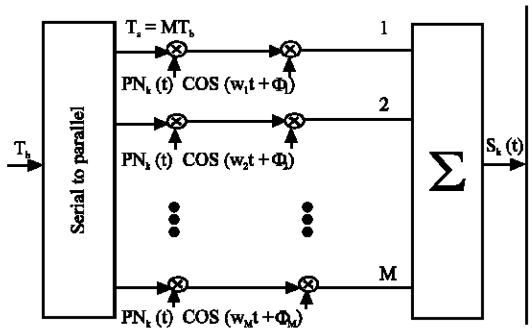

Fig. 9: Multi carrier DS-CDMA transmitter for M carriers

model for multi-cell. Further, the analysis presented here case scenario to evaluate system performance. The simulation carried out is extension of the two cell model to represent MC-CDMA in time duplex mode (Kumar and Chellappan, 2009). In MC-CDMA transmission, the input (M-QAM modulated) signals are spread by CDMA code and then passed it to the IFFT for further modulation (Fig. 8). The output of IFFT represents N low symbol rate parallel sub-channels. The parallel to serial converter is used to pass data serially to RF module. A reverse procedure is adopted at the receiver to decode the signal. The signal of an ith subcarrier can be denoted as:

$$S_i(t) - X_i(t)e^{j2\pi ft} \quad (5)$$

After performing transformation using N-Po int IFFT, the ith subcarrier signal is given by:

$$S(t) = \frac{1}{N}\sum_{i=0}^{N-1} X_i(t)e^{j2\pi ft} \quad (6)$$

where, N is the total number of sub-carrier. The received signal for the Kth user can be given by:

$$r_{k,i} = \zeta_{k,i}H_{k,i}S_{k,i} + N_i \quad (7)$$

Where:

$\xi_{k,i}$ = Channel gain
$H_{k,i}$ = Channel function
$S_{k,i}$ = Signal strength
N_i = Noise variance for ith sub-carrier (Kumar and Chellappan, 2009)

The capacity of a cellular CDMA system heavily depends on interfering noise power. For M users each cell-site receiver receives the desired signal having power P and (M-1) interfering signals each also of power P. Hence, the Signal-to-noise (interference power) Ratio (SNRi) of ith sub-carrier is given by:

$$SNR_i = \frac{P}{(M-1)P} = \frac{1}{M-1} \quad (8)$$

In digital communication, the commonly used parameter is energy to noise density ratio (E_b/N_o) which is obtained by dividing desired signal Power (P) by information bit Rate (R) and noise power ((M-1)P) by the total bandwidth (W) in the SNR. Thus:

$$E_b/N_o = \frac{P/R}{(M-1)P/W} = \frac{W/R}{M-1} \quad (9)$$

E_b/N_0 calculation in ignores background noise which results because of spurious interference and thermal noise. By incorporating background noise get modified as:

$$E_b/N_o = \frac{W/R}{(M-1)+\eta/P} \quad (10)$$

MC-DS-CDMA (Multi Carrier-Direct Sequence -Code Division Multiple Access): Recently, some new techniques for high data rate communications, based on a combination of multicarrier modulation and CDMA were proposed. The Multi Carrier (MC) or the Orthogonal Frequency Division Multiplexing (OFDM) is the candidate for the 4G systems due to its capability to mitigate multipath fading. Specifically, OFDM is implemented for Wimax IEEE 802.16d and OFDMA is implemented in IEEE802.16e. The MC-DS-CDMA is a combination of OFDM and CDMA whereby the OFDM system generated by Fast Fourier Transform (FFT) is coded by a CDMA code to provide the multiple access (Elnoubi and Hashem, 2008). The transmitter of the system is shown in Fig. 9 where the bit stream with bit duration T_b is serial-to-parallel converted into M parallel data streams. The new symbol duration on each stream is $T_S = MT_b$. The data symbols at each data stream are coded by the Pseudo Noise (PN) code with chip duration T_c, processing gain N.

Then the coded symbol of each data stream is multiplied by the sub-carrier. The system sub-carriers are generated by the Inverse Fast Fourier Transform (IFFT) and the Fast Fourier Transform (FFT) at the transmitter and receiver sides, respectively (Elnoubi and Hashem, 2008).

The bandwidth per sub-carrier is BW = 2/T_c. The total transmission bandwidth is assumed to be the pass-band null-to-null W_1 = 2/T_{c1} where, T_{c1} is the PN code chip duration for the equivalent single-carrier DS-CDMA system in the same channel. Assuming no overlapping between successive sub-carriers:

$$BW_1 = \frac{2}{T_{c1}} = \frac{2}{T_c}M \tag{11}$$

After some manipulations, we get: N = N1where, N1 is the processing gain in the single carrier DSCDMA system. If the transmitter consists of MT transmitting antennas, then the transmitted signal is expressed as a vector of length MT as follows:

$$S(t) = [S_1(t)\, S_2(t) \ldots S_{M_T}(t)]^T \tag{12}$$

where, the symbol T denotes the vector transpose. Assuming a number of K users in the system as well as perfect power control is employed; the transmitted signal of user k emitted from transmit antenna y is given by:

$$S_y^k(t) = \sum_{p=1}^{M} \sqrt{2P} b_{k,p}(t) a_k(t) \cos\left(\omega_p t + \phi_{k,p}\right) \tag{13}$$

Where:

p = [12...M]	=	The subcarrier number in the system
$b_{k,p}(t)$	=	The symbol stream on the pth data branch in the transmitter
P	=	The transmitted power per symbol
ω_p	=	The pth carrier frequency
$\phi_{k,p}$	=	Random phase for each sub-carrier, assumed to be uniformly distributed over [0, 2π)

$a_k(t)$ consists of a periodic train of chips $a_1, a_2, \ldots, a_N$ that takes the values ±1 which corresponds to the DS code assigned for each user. For simplicity, we assume that the bit and chip waveforms are rectangular. For the multiple receive antenna system, the received vector r is then given by:

$$r(t) = H \otimes s(t) + n(t) \tag{14}$$

Where:

x = Convolution sign

n(t) = AGWN vector in the channel defined by:

$$n(t) = [n_1(t)\, n_2(t) \ldots n_{M_R}(t)]^T \tag{15}$$

The received signal vector is then given by:

$$r(t) = [r_1(t)\, r_2(t) \ldots r_{M_R}(t)]^T \tag{16}$$

In MC-DS-CDMA each OFDM-block (after IFFT and cyclic prefix) is block-wise spreaded, i.e., the OFDM-block is spreaded into multiple OFDM blocks each multiplied with a different chip of the spreading code. A major feature of MC-DS-CDMA system is that each OFDM sub-carrier works like DS-CDMA. Specifically if there is only one sub-carrier then the MC-DS-CDMA reduces to a conventional DS-CDMA. The advantages of MC-DS-CDMA are higher frequency diversity, improved overall system performance when compared to other multi-carrier schemes and the major advantage is that each DS-CDMA signal (in each sub-carrier) of a user can be maintained orthogonal to that of all the other users when orthogonal spreading codes are used.

As a result, Multi-access Interference (MAI) is mostly avoided which may greatly boost performance over conventional DS-CDMA. MC-DS-CDMA offers several advantages specially over MC-CDMA schemes. MC-DS-CDMA systems have the desirable properties of exhibiting narrowband interference suppression and no Multi-user Interference (MUI). MC-DS-CDMA is also capable of mitigating the worst-case peak-to-average power fluctuation experienced in MC-CDMA systems due to time-spreading (Basilio *et al*., 2009).

On the other side, the capacity of MC-DS-CDMA system is limited by multipath fading and Multiple Access Interference so mitigating (MAI) can improve the overall capacity of the system. However, the search for the best set of codes contributing reduced MAI is still one of the severe requirements of future MCDS/CDMA systems (Nagarajan and Dananjayan, 2008, 2010; Nagaradjane *et al*., 2009).

Nevertheless, a major problem for MC-DS-CDMA (and in fact for all multi-carrier systems) is the loss of carrier frequency synchronization or the residual Carrier Frequency Offset (CFO) (Ng and Li, 2007; Li and Darwazeh, 2007).

TD-SCDMA (Time Division Synchronous Code Division Multiple Access): TD-SCDMA was proposed by the CHINA CWTS Group in 1998, approved as one of the 3G standards by ITU in 2000. TD-SCDMA is the only 3G mobile communication standard which is based on TDD-CDMA technology. Different from others, TDSCDMA has been specifically and primarily designed

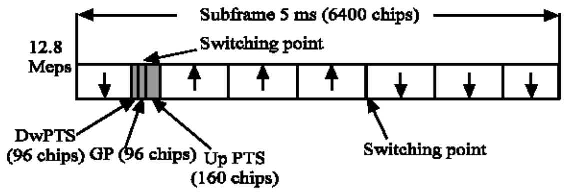

Fig. 10: TD-SCDMA subframe structure

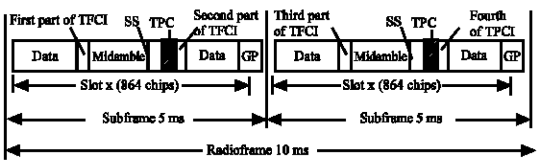

Fig. 11: SS segment

for TDD operation. While MANET nodes generally work on the same frequency and TDMA mode so, constructing MANET through TD-SCDMA air interface is an over whelming convergence scheme (Xu and Shen, 2008).

TD-SCDMA is a synchronous CDMA system. There are both synchronous transmission in the uplink and downlink. Uplink synchronization is made possible through BS monitoring of signals from terminals and transmission timing adjustment feedback. The subframe structure is shown in Fig. 10. Each frame is 10 ms long, and consists of two equal sub-frames. Each subframe contains seven common slots and three special slots: DwPTS, GP and UpPTS. DwPTS and UpPTS are used to exchange broadcasting messages and control signaling with BS. GP is main guard period for TDD operation, 96 chips duration. GP is important to compute the coverage of TD-SCDMA devices. When a node is powered on, it first needs to establish the downlink synchronization with BS. Only after the node has established the downlink synchronization, it shall start the uplink synchronization procedure.

For the maintenance of the uplink synchronization, the midamble field of each uplink burst can be used (Xu and Shen, 2008). In each uplink time slot the midamble for each node is different. The node B may estimate the timing by evaluating the channel pulse response of each node in the same time slot. Then in the next available downlink time slot, the node B will signal Synchronization Shift (SS) commands to enable the node to properly adjust its transmit timing. SS segment is shown in Fig. 11. The smallest step for the SS signaling is 1/8 chip period. The SS command is spread with the same Spreading Factor (SF) and spreading code as the data parts of the respective physical channel.

CONCLUSION

The overview of CDMA schemes, highlights the potential of increasing capacity in future cellular communications. This study describes all the possible CDMA techniques to date; the evolution of all the techniques, the differences in terms of system capacity, efficiency, power and frequency limitations and which of them has the best performance. Hybrid CDMA represents the open door to exploit new modulation, diversity and coding techniques. The most important addition to hybrid CDMA is the multi-carrier CDMA scheme which has two important different approaches; frequency-domain spreading as in Multi-carrier CDMA (MC-CDMA) systems and time-domain spreading as in MC-DS-CDMA systems.

MC-DS-CDMA systems (compared to MC-CDMA systems) have the desirable properties of exhibiting narrowband interference suppression and no Multi-user Interference (MUI). MC-DS-CDMA is also capable of mitigating the worst-case peak-to-average power fluctuation experienced in MC-CDMA systems due to time-spreading. Recent advancement in internet traffic such as multimedia streaming application is driving the demand for high speed data packet wireless services. In order to meet this demand and ameliorate the capacity of future generation wireless cellular network, several capacity improvement on MC-DS-CDMA technique have been proposed in the recent past as the best possible solutions to obtain high speed service.

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