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Efficient OFCDM Techniques In 4G

Supriya D. Kubade*, Dr.Mr. Santosh Chede **,Pravin R.Lakhe***
* (M.Tech Student, SDCOE,Wardha,India
Email: supykubade@gmail.com)
** (Principal Of OMCOE, Wardha,India
Email: santoshchede@radiffmail.com)
*** (Asst.Professor SDCOE, Wardha,India
Email: pravinlakhe@radiffmail.com)

ABSTRACT
Future 4G systems require transmission of richer multimedia services which inevitably implies an increase in data rate. Combination of (OFDM) orthogonal frequency division multiplexing technique with two dimensional scattering code forms (OFCDM) orthogonal frequency code division multiplexing technique which shown promising result in achieving a high data rate while simultaneously combating multipath fading. The present OFCDM systems employ 1 dimensional orthogonal variable spreading factor (OVSF) codes and 2D OVSF codes to achieve the required 2D spreading in code multiplexed channels. In future we will design multi D-OVSF code which provides high data speed at down link and more reduction of bit error rate (BER) than existing OFCDM system.
***Keywords* -** OFDM, OFCDM, 1D AND 2D OVSF Code

I. INTRODUCTION

4-generation systems will support multimedia services like high-speed internet access & broadcast services from information sites. Data traffic in the downlink is expected to be much more than that in the uplink because number of substation at downlink frequency is more than the uplink frequency. Therefore, high data rates are especially necessary for 4G in the downlink.The main purpose of the 4th generation (4G) mobile communication is provide high rate data serves 100Mbps, especially in the downlink over wide coverage. Various wireless access schemes have been proposed for the broadband downlink transmission in 4G systems. Single carrier CDMA is not suitable over a broadband channel, due to too much multipath interference (MPI) on the other hand, although orthogonal frequency division multiplexing (OFDM) is robust to MPI, it does not have coherent frequency diversity. Moreover, in mobile cellular systems, OFDM suffers from adjacent cell interference unless the same sub-carriers are not used among adjacent cells. Thus, orthogonal frequency code division multiplexing (OFCDM) system has been design for the high speed data transmission in down link in future 4G networks.

II. OVERALL ANALYSIS REPORTED WORK

The satellite transponder can be accessed by many earth stations from different locations on the earth at same time instant called as multiple access technique. FDMA is a first generation (1G) used 30 KHz for each user. TDMA is a (2G) used same 30 KHz channels, but with three users sharing them (3 slots). WCDMA is a 3G wireless network 1st lunch by NTT DOCOMO, Japan. It provide multimedia services with data rate of 2Mb/s with band width of 5MHz.HSDPA has been introduced in the WCDMA System by using advanced techniques, such as adaptive modulation and coding and hybrid automatic repeat request (ARQ), and the data rate can be increased to 14 Mb/s. Data rate requirement increases dramatically due to demand for high-speed multimedia services. Future 4G mobile communication systems are designed to fill this big gap. A new wireless access technique using 50–100 MHz bandwidth is needed for wireless transmission in the downlink of 4G systems. Various wireless access schemes have been proposed for the broadband downlink transmission in 4G systems. OFDM is attractive for high-speed wireless communication; it does not have coherent frequency diversity. Moreover, in mobile cellular systems, OFDM suffers from adjacent cell interference unless the same subcarriers are not used among adjacent cells .OFCDM system has been proposed for the downlink transmission in future 4G networks.

III. OFDM

Modulation is a mapping of the information a change in the carrier phase, frequency or amplitude or combination. Multiplexing is a method of sharing a bandwidth withother,independent data channels. OFDM is a combination of modulation and multiplexing. In OFDM independent signal are a subset of one main signal put on sub channel after serial to parallel conversion of bit of stream. In OFDM the signal is first split into independent channel, modulated by data and the multiplexed to create the OFDM carrier. OFDM is a special case of frequency division multiplexing (FDM).As an analogy ,a FDM channel is like water flow out of faucet, in contrast the OFDM signal is like shower .In a faucet all water come in one big stream and cannot be sub-divided. OFDM shower is made of lot of little streams .Figure 1 shows the OFDM spectrum consist of different sub channel carry different symbols.Another way to see this, one hire a big truck or four smaller trucks, both methods carry the exact same amount of data .But in case of accident, one ¼ of data on the of OFDM trucking will suffer. These 4 smaller trucks when seen as signal are called as sub carrier in an OFDM system and they must be orthogonal for this idea to work. The independent sub channel can be multiplexed by frequency division multiplexing. The idea is key to understanding OFDM .The orthogonality allows simultaneous transmission on a lot of sub carriers in tight frequency space without interference from each other. An OFDM signal offers an advantage in a channel that has a frequency selective fading response .When we lay an OFDM signal spectrum against the frequency selective response of the channel, only few sub carriers are affected ,all the others are perfectly ok .Instead of the whole symbol being knocked out ,we lose just a small subset of the (1/N) bits. The OFDM block diagram is shown in the figure 2. The complex data converted into a parallel data stream. Data symbols are coherently modulated on N-1 subcarriers by an Inverse Fast Fourier Transform (IFFT). An IFFT exists used to convert the frequency domain into time domain waveforms denoted as s (n).At the transmitter, the last portion of OFDM symbols is added the beginning of OFDM symbols. This is known as cyclic prefix, is used to eliminate the interference such as ISI and ICI. It also converts linear convolution into circular convolution. The parallel data is converted into serial converter and the data vector is serially transmitted over the channel. After digital to analog conversion the signals pass through the channel that will have the effects of additive noise and multi path fading. OFDM can overcome these adversaries very easily. Next to the receiver, afterwards analog to digital alteration, the serial data is converted back to parallel. An efficient channel estimation using cyclic prefix is performed. Then the CP is removed. The signal is demodulated with fast Fourier Transform (FFT) and converted back into frequency domain. That output symbols are demultiplexed into N data symbols. At receiver section, an N-tap FFT is employed .The retrieve of data symbols are demultiplexed and restore in the serial order. The OFDM symbol might naturally be received through a bank of matched filters. Another demodulation is used in practice. Typically implemented with an FFT for faster operation and efficient implementation, actually realizes a sampled matched-filter receiver. Two adversaries arise at what time the signal remains communicated over a dispersive channel. That is the channel dispersion terminates the orthogonality among sub-carriers and causes Inter-carrier Interference (ICI). Now adding, a system could transmit several OFDM symbols in a series consequently that a dispersive channel causes Inter-Symbol Interference (ISI) among consecutive OFDM symbols would evade ISI in a dispersive surroundings but it does not evade the loss of the sub-carrier orthogonality. Therefore, OFDM schemes become quite sensitive to frequency offsets, and these calls for enhanced and efficient synchronization schemes .This problem can be solved more effectively with the introduction of a Cyclic Prefix (CP), it is a facsimile of the few preceding bits added by way of a preamble to the OFDM symbols. The CP helps in maintaining and preserving the orthogonality of the sub-carriers and also avoiding ISI between consecutive OFDM symbols, which promote the usage of OFDM in wireless systems in high data rate transmission systems such as WiMAX. The cyclic extension lead of the OFDM symbol is injected as a guard period between successive OFDM signals. The signal then passes through the channel. Addition the

CP, orthogonality is conserved through the transmission if the transmitter and receiver are synchronized suitably. Alternative advantage of by a CP is that it performances as a guard space between next to OFDM frames, thus the problem with inter-frame interference vanishes.

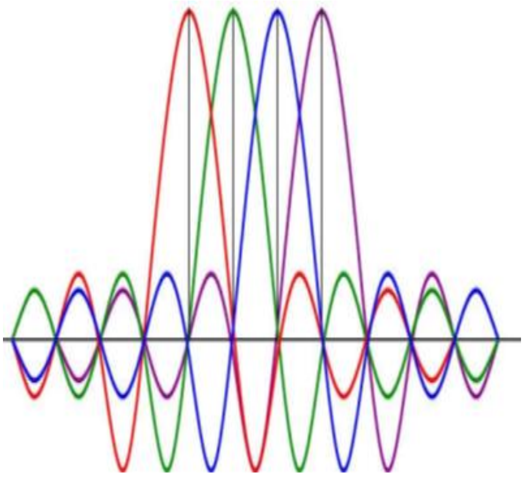

Fig.1 OFDM spectrum

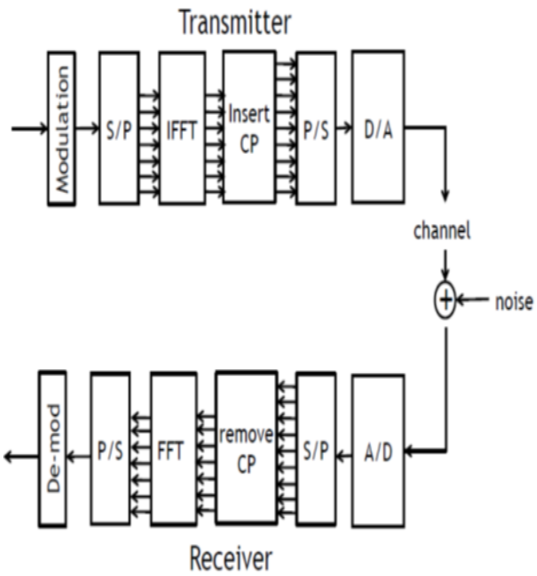

Fig.2 OFDM system block diagram

IV. OFCDM

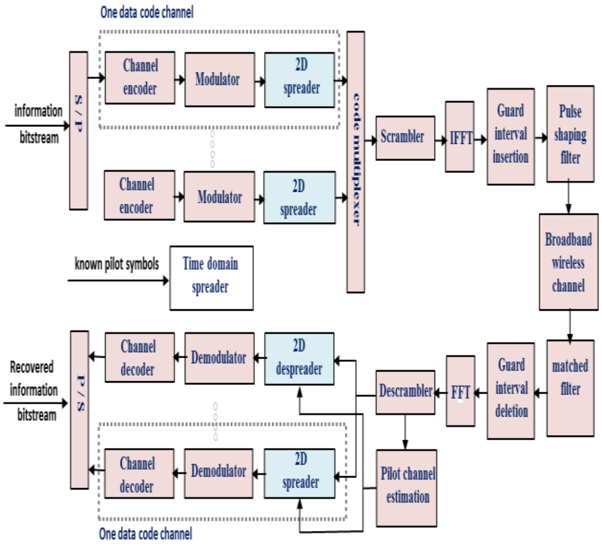

Fig.3 OFCDM system block diagram

The combination OFDM and CDMA techniques can be called variable spreading factor-orthogonal frequency code division multiplexing (VSF-OFCDM). The variable spreading is a very attractive feature. The spreading factor can be set in two dimensions to get transmitted data more resistant to fading in the transmission channel. Data spreading in VSF-OFCDM system can to be done in two dimensions - in the frequency domain and in the time domain. This is the main difference between the OFDM and the CDMA approach

V. TWO DIMENSIONAL SPREADING FACTOR

$$SF = SFtime \times Sffreq$$

SF time is spreading factor in the time domain and SFfreq is spreading factor in frequency domain. The variable spreading means that we can change the spreading factor according actual transmission channel conditions to get lower bit error rate (BER).Frequency diversity gain can be achieved through frequency domain dispreading due to the different fading experienced by subcarriers in a broadband channel. Furthermore, with the introduction of time domain spreading, the system can provide flexible transmission rates. The time and frequency domain spreading factors SFtime and SFfreq can be changed flexibly to provide variable spreading factor (VSF) in order for the system to work in different cell environments and channel conditions. It provides robustness against frequency-selective fading.It provides high data transmission rates. It provides frequency diversity gain. It provides different transmission rates. Various service rates by assigning different numbers of code channels to a single user. OFCDM provides not only all advantages of OFDM, but also additional benefits by means of 2D spreading .Figure 3 show the OFCDM system. Figure.4 Scheme of 2D spreading in OVS-OFCDM

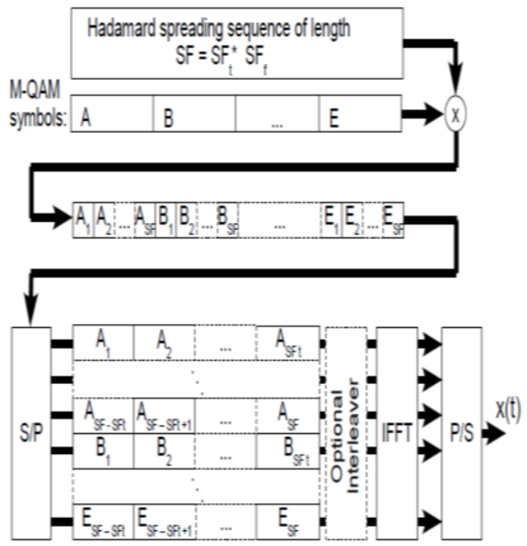

Fig.4 Scheme of 2D spreading in OVS-OFCDM

Combining OFDM with two-dimensional spreading (time and frequency domain spreading), an orthogonal frequency-and code-division multiplexing (OFCDM) system has been proposed for the downlink transmission in future 4G networks. Figure 4 shows the scheme of 2D spreading in OVS-OFCDM. Based on OFDM, OFCDM provides not only all advantages of OFDM, but also additional benefits by means of 2D spreading. The time and frequency domain spreading factors NT and NF can be changed flexibly to provide variable spreading factor (VSF) in order for the system to work in different cell environments and channel conditions. By using OFCDM and a bandwidth of 100 MHz, a data transmission rate of 100 Mb/s in the downlink has been achieved without the use of multiple-input multiple-output (MIMO) in outdoor environments at a moving speed of 20 km/h. Thus, OFCDM has proven to be a promising candidate for downlink access in future 4G mobile networks. Channel processor then modulates interleaves and carries out 2D spreading on the data bits. As shown in figure 5, the symbol is first spread by a time domain spreading code with spreading factor (SF) = N (here NT = 4). This time spread signal is then duplicated on frequency interleaved subcarriers to prevent burst errors. The number of duplicate copies is same as the frequency domain SF = NF (here NF = 2). The signal obtained after duplication is then multiplied with the frequency domain spreading code.

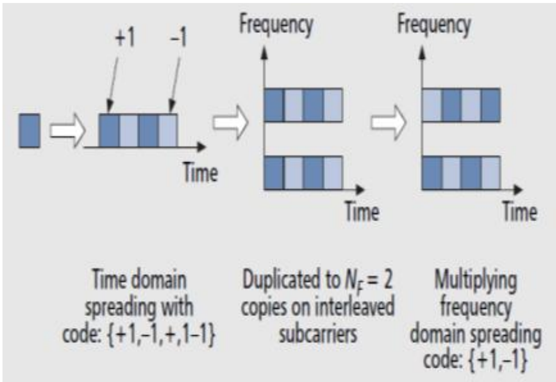

Figure.5 2D spreading with 1D OVSF Code

Similarly, 2D spreading is carried out for each symbol. If there are NC subcarriers being used then at any time instant, K = NC/NF symbols can be transmitted at a time on one code channel. This scheme is replicated for all code channels which are assigned individual time and frequency spreading codes to maintain the orthogonality among each other. The processed data is then multiplexed at the code multiplexer. In addition to information bits, pilot symbols are also multiplexed for channel estimation. Pilot symbols may be time, frequency or code multiplexed. Code multiplexed scheme provides more flexibility in design.

VI. 2D SPREADING USING 2D OVSF CODES

Code multiplexing and 2D spreading in the OFCDM system is achieved by using 1D OVSF codes. Figure 6 and 7 shows the codes tree of 1D and 2D OVSF codes. The construction of 2D OVSF codes is based on a recursive algorithm 2D OVSF codes use a seed matrix which represents its first layer. In addition, it uses two 2 × 2 orthogonal matrices to obtain the second layer. This process is repeated recursively to obtain codes with the required length. The ith layer of 2D OVSF codes consist of 2i codes of 2i × 2i dimension each. Compares the performance of the OFCDM system using 1D OVSF codes against OFCDM system using 2D OVSF codes for achieving 2D spreading. The results are obtained by keeping a fixed SF = NT × NF, where NT = 8, NF = 4. One code channel is assigned for pilot data while the rest (NT − 1) × NF channels are fully loaded with information bits. The OFCDM – 2D – OVSF scheme has a higher throughput in comparison to OFCDM – 1D OVSF scheme. System gives improved results with respect to the OFCDM system employing 1D OVSF codes. It is preferred to assign codes with greater code distances among adjacent code channels. The non-sequential code assignment scheme and 2D OVSF codes based 2D de-spreading have significantly reduced MCI in systems using BPSK and QPSK modulation schemes. However, it is observed in higher modulation schemes, such as M-ary QAM that the techniques are not sufficient. Hence, it is essential to further reduce MCI.

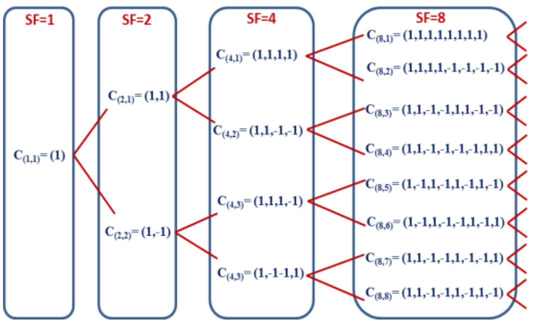

Fig.6 1D OVSF Codes Tree

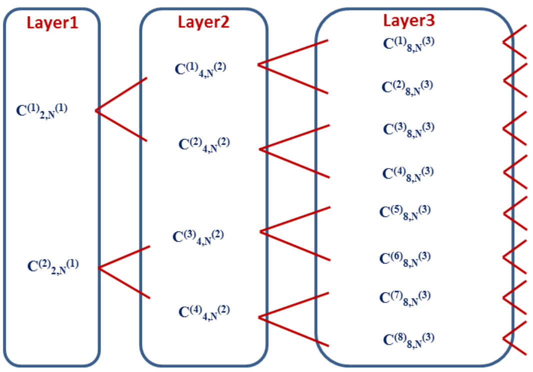

Fig.7 2D OVSF Codes Tree

VII. CONCLUSION

In this paper we study the multiple access technique used in 4G for high speed downlink data transmission. Code multiplexing and 2D spreading in the OFCDM system is achieved by using 1D OVSF codes. The OFCDM – 2D – OVSF scheme has a higher throughput in comparison to OFCDM – 1D OVSF scheme. System gives improved results with respect to the OFCDM system employing 1D OVSF codes. In future we will study on the multiple symbol technique for efficient OFCDM system and compare the result with conventional techniques.

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