IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 11, June 2016)

Multi- Carrier Code Division Multiple Access (MCCDMA): A Review

Prachi Agarwal
M. Tech. Scholar
agarwal.prachi922@gmail.com
Department of Electronics and Comm. Engg.
Shrinathji Institute of Technology & Engineering,
Nathdwara (India)

Dr. Mahesh Kumar Porwal
Professor
porwal5@yahoo.com
Department of Electronics and Comm. Engg.
Shrinathji Institute of Technology & Engineering,
Nathdwara (India)

Abstract –**Code-division multiple access (CDMA) schemes have been considered as attractive multiple access schemes in both second-generation (2G) and third-generation (3G) wireless systems. The evolution from 2G to 3G corresponds to adapting a new air interface i.e. change of focus from voice to multimedia. MC-CDMA scheme has become a promising access technique for 4G air interface. In this paper, we review about MC-CDMA model using Rake Receiver.**

Keywords –**2G, 3G, 4G, CDMA, MC-CDMA.**

I. Introduction

The interest for wireless communications administrations has developed gigantically. In spite of the fact that the arrangement of third generation cellular frameworks has been slower than was initially expected, scientists are now examining fourth generation cellular systems. These frameworks will transmit at much higher rates than the genuine 2G frameworks, and even 3G frameworks, in an ever packed frequency spectrum. The essential objective of next-generation wireless systems (4G) won't just be the acquaintance of new innovations with spread the requirement for higher data rates and new services, additionally the incorporation of existing advances in a typical stage. The strategy of multi-carrier transmission has recently been receiving wide interest, particularly for high data rate broadcast applications. The fundamental points of multi-carrier transmission are its forcefulness in frequency selective fading channels and specifically, the decreased signal processing complexity by equalization in the frequency domain.

Communication system has some limitation. Bandwidth and Noise limitation is part of the communication system. Bandwidth is simply a measure of frequency range. It is easy to see that the bandwidth we define here is closely related to the amount of data you can transmit within it, thus the more space in the frequency spectrum, the more information you can fit in at a given instance.

In a communications system lack of bandwidth means lack of throughput of intelligible data. So that Bandwidth limitation means restricting the quantity of information transmitted from sender to receiver each second. The results of which are the degradation in the quality of information arrives.

A limited amount of bandwidth is allocated for wireless services. A wireless model is mandatory to accommodate as many users as possible by effectively allocate the bandwidth. Thus, in the field of communications, the word multiple access could be well-defined as a way of allowing multiple users to concurrently distribute the finite bandwidth with smallest likely degradation in the performance of the system. There are a number of methods showing how the multiple accessing can be attained.

Requirement of MC-CDMA

Three major multiple access schemes exist:

- Frequency Division Multiple Access (FDMA)
- Time Division Multiple Access (TDMA)
- Code Division Multiple Access (CDMA)

The FDMA systems require a relatively simple algorithm and implementation compared to TDMA and CDMA [1], but there are several drawbacks. Firstly, due to the permanent assignment of FDMA channels, unused channels cannot be utilized by other customers, the consequence of which is the misuse of the communication resources. Secondly, nonlinearities in the power amplifier can cause signal spreading in the frequency domain, causing inter-channel interference (ICI) in other FDMA channels. Finally, the capacity of an FDMA system is limited by the number of channels available.
Compared to FDMA systems, TDMA systems offer more flexibility in the assignment of time slots whereby different numbers of time slots can be

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 11, June 2016)

allocated to different users depending on the service needed. In addition, because TDMA users can transmit signals only in their own time slots, the transmission of TDMA signal is non-contiguous and occurs in bursts, resulting in less battery power consumption. But, the TDMA signal needs a large synchronization overhead due to its non-continuous transmission. Inter-symbol interference (ISI), caused by multipath propagation, is also a serious glitch for TDMA, especially during high data rate transmissions.

The main advantage with CDMA is that the system capacity is limited only by the amount of interference; with a lower level of interference the system can support a higher number of users [1]. CDMA systems are also robust to narrow band jamming as the receiver signal can spread the jamming signal's energy over the entire bandwidth making it insignificant in comparison to the signal itself [2]. If the spreading sequence is perfectly orthogonal, it is possible to transmit multiple CDMA signals without introducing multiple access interference (MAI) during synchronous transmission [3].

Various types of CDMA such as direct-sequence CDMA (DS-CDMA) and wideband CDMA (W-CDMA), have been utilized and advanced in both 2G and 3G systems similar to CDMA One (IS-95), UMTS and CDMA2000 [4]. These techniques are considered to be single-carrier CDMA systems. Unfortunately when moving into the fourth generation of wireless communication systems (4G), in which data is transmitted at a rate as high as 1 Giga bits-per-second (bps) [5], single-carrier CDMA models are not appropriate.

Based on the combination of OFDM and DS-CDMA, a multicarrier code division multiple access (MC-CDMA) is proposed. Unlike DS-CDMA, which spreads the original data stream into the time domain, MC-CDMA spreads the original data stream into the frequency domain by initially converting the input data stream from serial to parallel then multiplying this stream by the spreading chips in different OFDM subcarriers, the result of which is MC-CDMA signal which takes on the advantages of both DS-CDMA and OFDM.

II. Overview of MC-CDMA

MC-CDMA, a digital modulation and multiple access scheme, is a combination of OFDM and CDMA which draws benefits from both. Such a combination is not unique and three different types of MC-CDMA can be distinguished, namely Multi-Carrier Direct Sequence Code Division Multiple Access (MC-DS-CDMA), Multi-Carrier Code Division Multiple Access (MC-CDMA) and Multi-Tone Code Division Multiple Access (MT-CDMA). MC-DS-CDMA spreads data symbols in the time domain. In this scheme, the same spreading code is used for all subcarriers as illustrated in Figure 1(a). In contrast, a data symbol in MC-CDMA is spread in the frequency domain, i.e. each chip of the spreading code corresponds to a subcarrier as illustrated in Figure 1(b). A fraction of the symbol, corresponding to a chip of the spreading code, is transferred through various subcarrier. Furthermore, symbols are modulated on many subcarriers to introduce frequency diversity instead of using only one carrier as in CDMA. Therefore, MC-CDMA is strong against deep frequency-selective fading compared to DS-CDMA. MT-CDMA spreads the data streams using a given spreading code in the time domain similar to MC-DS-CDMA. But the time domain spreading is performed after the IFFT stage as shown in Figure 1(c). This leads to the resulting spectrum of subcarriers no longer satisfying the orthogonality condition and the processing gain is increased within a given bandwidth. Therefore, MT-CDMA allows longer spreading codes leading to more users than MC-DS-CDMA, but suffers from Inter-Carrier Interference (ICI).

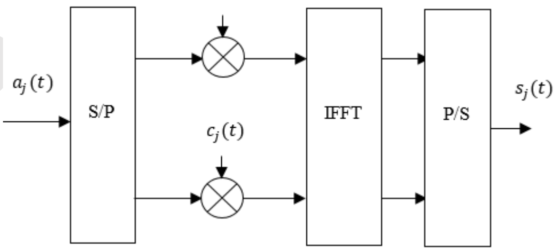

Figure 1 (a) MC-DS-CDMA

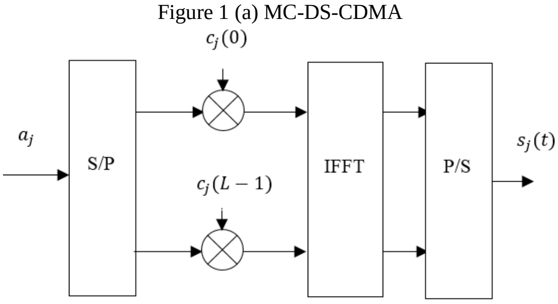

Figure 1 (b) MC–CDMA

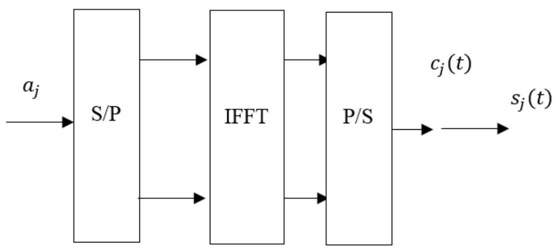

Figure 1 (c) MT–CDMA

Figure 1: MC-CDMA classification

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 11, June 2016)

III. MC-CDMA TRANSMITTER MODEL

Consider an MC-CDMA transmitter for the u^{th} user with N subcarriers modulated using M-QAM as shown in Figure 2.The M-QAM input data symbols have to be S/P.

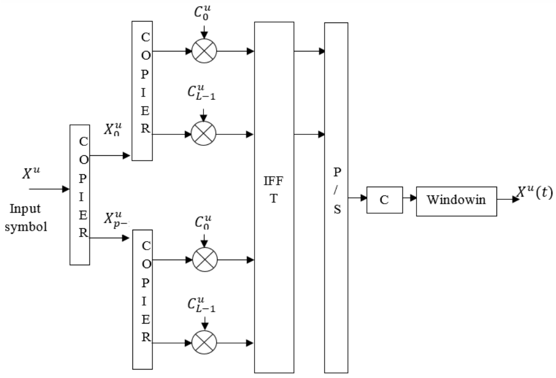

Figure 2: MC-CDMA transmitter

Converted to P parallel branches $X_0^u, X_1^u, \ldots . X_{p-1}^u$. The purpose of the S/P converter is to slow down the symbol rate in order to ensure frequency nonselective fading on the resulting subcarrier. Each branch is spread in the frequency domain with an orthogonal spreading code C^u of length L. The spread symbols are mapped onto PL = N subcarriers and an IFFT is performed to convert them to a time domain signal. The spreading data sequences are converted back to a serial data sequence. Then, a cyclic prefix is inserted between the symbols to combat the ISI and ICI caused by multipath fading. Finally, a windowing function $g(t - iT_s)$ is applied to the signal before DAC and up conversion for transmission.

IV. MC-CDMA RECEIVER MODEL

Consider the MC-CDMA receiver for the u^{th} user as shown in Figure 3.

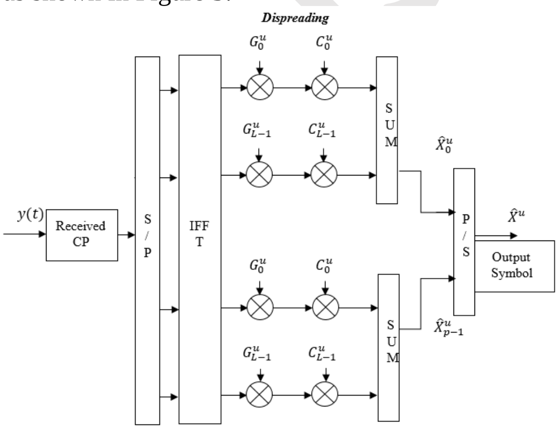

Figure 3: MC-CDMA receiver

The received signal is first down converted. Then, the cyclic prefix is removed and the remaining samples are S/P converted to N parallel branches. The FFT block performs demodulation in order to obtain the transmitted symbols with the amplitude and phase corrupted by the channel and the additive noise. The amplitude and phase corrupted signal subcarrier is equalized and despread using the desired u^{th} user spreading code to combine the received signal energy distributed in the frequency domain.

The equalization gain factor can be obtained using one of the well-known methods such as, Gain Combining (EGC), Maximum Ratio Combining (MRC), or Orthogonal Restoring Combining (ORC), sometimes called the Zero Forcing (ZF) method. The output data is then P/S converted to obtain the u^{th} user data stream.

V. RAKE RECEIVER

The rake receiver consists of multiple correlators, in which the receive signal is multiplied by time-shifted versions of a locally generated code sequence. The intention is to separate signals such that each finger only sees signals coming in over a single (resolvable) path. The spreading code is chosen to have a very small autocorrelation value for any nonzero time offset. This keeps away from crosstalk between fingers. In practice, the circumstances is less perfect. It is not the full periodic autocorrelation that determines the crosstalk between signals in different fingers, but rather two partial correlations, with contributions from two consecutive bits or symbols. It has been attempted to find sequences that have satisfactory partial correlation values, but the crosstalk due to partial (non-periodic) correlations remains substantially more difficult to reduce than the effects of periodic correlations.

The rake receiver is designed to optimally detect a DS-CDMA signal transmitted over a dispersive multipath channel. It is an extension of the concept of the matched filter.

In the matched filter receiver, the signal is correlated with a locally generated copy of the signal waveform. If, however, the signal is distorted by the channel, the receiver should correlate the incoming signal by a copy of the expected received signal, rather than by a copy of transmitted waveform. Thus the receiver should estimate the delay profile of channel, and adapt its locally generated copy according to this estimate.

In a multipath channel, delayed reflections interfere with the direct signal. However, a DS-CDMA signal suffering from multipath dispersion can be detected by a rake receiver. This receiver optimally combines signals received over multiple paths.

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 11, June 2016)

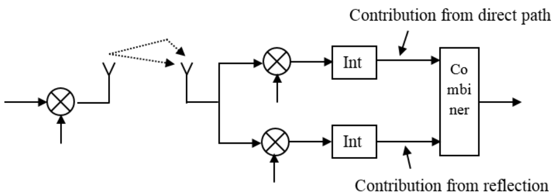

Figure 4: RAKE Receiver

Rake receiver gathers the energy received over the various delayed propagation paths. According to the maximum ratio combining principle, the SNR at the output is the sum of the SNRs in the individual branches, provided that,

- Only AWGN is present (no interference)
- Codes with a time offset are truly orthogonal

Signals arriving with the same excess propagation delay as the time offset in the receiver are retrieved accurately, because,

$$\sum_{n=1}^{N} c_1^2(nT_c + t_d) = \sum_{n=1}^{N} c_1^2(nT_c) = N \qquad (1)$$

This reception concept is repeated for every delayed path that is received with relevant power. Considering a single correlator branch, multipath self-interference from other paths is attenuated here, because one can choose codes such that,

$$\sum_{n=0}^{N} c_1(nT_c)c_1(nT_c + t_d) \cong 0 \qquad (2)$$

VI. LITERATURE REVIEW

In the year 2009 (Samreen Amir et al.) present a paper in which MC-CDMA-TCM is tested over wireless fading channel. The objective of this research is to perform an analytical study of the MC-CDMA-TCM system to achieve a theoretical BER curve. A conclusion is drawn on the basis of the outcomes of research which favours the system for better performance over Rayleigh fading channel but the increasing design complexity limits the system to use very high constellation orders [6].

In the year 2010 (S. Sivanesskumar et al.) present that Multi Carrier Code Division Multiple Access (MC-CDMA), a promising technology for the 4G communication systems is considered in this paper. The leading drawback of such model is the Multiple Access Interference (MAI) which is due to near-far effect, frequency offset, nonlinear power amplification and frequency-selective fading. The presentation of MC-CDMA under such situation is poor and optimal detection is one of the solutions with a high complexity tag attached. Use of global optimization for this type of detectors, particularly using a Global Search algorithm is considered in this paper. The Bit Error Rate (BER) performance analysis is performed for frequency fading channels with and without nonlinear distortion [7].

In the year 2010 (V.Jagan Naveen et al.) demonstrate the Doppler spread and Computes its effect on the bit error rate (BER) for multicarrier code division multiple access (MC-CDMA) and orthogonal frequency division multiplexing (OFDM). Also, they evaluate the channel capacity to quantify the potential of OFDM and MC-CDMA. They calculate the effect of Doppler spread with Doppler shift at various carrier frequencies. They also calculate the capacity of LTI, MC-CDMA OFDM, and RAYLEIGH channels [8].

In the year 2012 (B.Sarala1 et al.) aims at review of different PAPR reduction techniques with attendant technical issues as well as criteria for selection of PAPR reduction method. To reduce PAPR the constraints are low Bit Error Rate (BER) and low power consumption. Spectral bandwidth is improved by better spectral characteristics, and low complexity/cost [9].

In the year 2012 (Kattoush A. H. et al.) present a novel SLT-MC-CDMA transceiver design is presented based on the SLT-OFDM that is used as a basic building block in the design of MC-CDMA transceiver to maintain the orthogonality against the multipath frequency Selective Fading Channels (SFC). Simulation results are given to show the noteworthy increase in the execution of the proposed method. The Bit Error Rate (BER) of SLT-MC-CDMA scheme is compared with FFT-MC-CDMA and tested in Additive White Gaussian Noise (AWGN), Flat Fading and Selective Fading Channels (SFH). The simulation results confirmed that, the proposed system outperforms the reference one [10].

In the year 2012 (Mohammed Faisa et al.) demonstrated that in Rayleigh Fading Channels, because of multicarrier modulation, when one subcarrier reaches under deep fade, another subcarrier relic safe. So MC-CDMA can defeat multipath fading better than CDMA and signal can be received in low bit error rate (BER) [11].

In the year 2012 (Hema Kale et al.) targeted on study of different sub-carrier selection techniques for MC-CDMA system. It has been understood that suitable subcarrier selection technique can significantly improve BER performance, System capacity, Output performance, Speed and its output in higher spectrum efficiency as well as reduced power consumption at the mobile terminal. Generally it can carry out either by selecting the best subcarrier and transmitting the whole data of the user through that sub-carrier only or varying the number of sub-carriers allotted according to user requirement and transmitting user's data through the selected group of sub-carriers [12].

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 11, June 2016)

In the year 2013 (Karamjeet Singh et al.) demonstrates the MIMO-MC-CDMA system performance based on various techniques. As the MC-CDMA system plays a significant role in recent wireless communications, when the CDMA model combined with multiple antennas is a guaranteeing system, past advanced communications. On the other hand MIMO offers spatial diversity, which eliminate the fading [13].

In the year 2013 (Manjinder Singh et al.) presents the simulation of MC-CDMA system performance with MSK modulation over an AWGN channel and Rayleigh channel. It also represents the BER performance of the MC - CDMA system when it has users 2, 4, 16, 32 and 64 for both AWGN and Rayleigh channel. The SNR value between 0dB and 20dB the BER value showed an effect of AWGN and Rayleigh fading channel on the MC-CDMA system. Also the comparison of MC-CDMA BER performance over MSK modulation and BPSK modulation techniques show that minimum BER obtained with the MSK modulation technique for both AWGN and Rayleigh channel [14].

In the year 2013 (B. Sarala et al.) analyzes a new idea that is a combination of exponential compounding transform and clipping concept to obtain a new Modified Exponential Companding with Clipping Transform (MECCT) technique for MC-CDMA PAPR reduction. This method evaluates performance analysis of MC-CDMA while considering linear companding and exponential companding (nonlinear) with the Additive White Gaussian Noise (AWGN) channel and is simulated by utilizing the MATLAB. The simulation outcomes show that the proposed algorithm reduces the PAPR by 2.0 dB, and are able to improve Bit Error Rate (BER), reduced Power Spectral density (PSD), and improvement in spectral bandwidth [15].

In the year 2013 (Amandeep Singh et al.) presents a comparison of filters are described which are used to reduce the peak to average power ratio in the MC CDMA model. The maximum PAPR and pulse shaping filters are described and it is shown by computer simulation that the filtering scheme achieves the significant improvement in PAPR reduction in MC CDMA model. Its design complication is much lower in compared to the latest available methods. The benefit of filtering technique is that there is no need of extra IFFTs in implementations [16].

In the year 2013 (Noor Mohammed V. et al.) explore the effects of various spreading codes like WG, 3-term sequences and GMW on interference levels in the multicarrier code-division multiple access system. They calculate the performances of these codes in terms of interference cancellation in various subcarrier models. In the system, the data from the user is spreaded using a special code (sequence code). The spreaded data is transmitted using the orthogonal frequency division multiplexing i.e., the data is transmitted concurrently via various subcarriers. The orthogonality of this subcarriers further decreases the interference level. Simulation outcomes demonstrate that 3-term sequence performs better than other spreading sequences. Depends on the simulations, they propose that 3-term sequence can be used as the spreading code in higher order subcarrier systems for mitigating interference and achieving a better bit error rate (BER) performance [17].

In the year 2013 (Muhammad Zubair Farooquirt al.) addresses the issue of average transmit optical power reduction in multi-carrier code division multiple access (MC-CDMA)-based indoor optical wireless communications employing intensity modulation with direct detection. The problem is cured in a unique way by examining post- and pre-equalization based subcarrier selection for transmitting power reduction in downlink transmissions. Investigative terminologies are derived for upper bounds of the required fixed DC bias for both cases. The fixed DC bias is utilized to decrease the model complexity on one hand and to devise optimal subcarrier selection criteria on the other. Simulation outcomes depend on the proposed subcarrier selection reveal significant power reduction subject to the 10^{-4} bit error rate (BER) requirement for 10-Mbps 64-subcarrier MC-CDMA-based indoor optical wireless communication models. Besides, the BER performance obtained from pre-equalization is shown to be no higher than that obtained from post-equalization for the same transmit power [18].

In the year 2013 (B.vinodh kumar et al.) demonstrate the performance of WiMax in MC-CDMA (multi carrier code division multiple access) for RS encoder under various modulation methods. The model is tested in MATLAB simulation. The simulation outcomes displays the significant performance improvement in MC-CDMA over OFDM and the comparism is based on BER performance under various modulation scheme for Reed Solomon encoder. It is revealed that WiMax based MC-CDMA performance is much better than OFDM techniques [19].

In the year 2013 (Biru S. Bhanavase et al.) describes the various MAI reduction techniques for MC-CDMA system. MC-CDMA is the most

IJDACR
International Journal Of Digital Application & Contemporary Research
International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 11, June 2016)

promising technique for high bit rate and high capacity transmission in wireless communication. Multi-carrier code division multiple access (MC-CDMA) has been considered as a strong candidate for next generation wireless communication system due to its excellent performance in multi-path fading channel and simple receiver structure. During asynchronous transmission, multiple access interference (MAI) is a major challenge for MC-CDMA and significantly affects their performance [20].

In the year 2013 (Parvathy S Kumar et al.) recommended a turbo block code (TBC) technique for improving the performance of a multi-carrier code division multiple access (MC-CDMA) system in terms of bit error rate (BER). The goal of this experiment is to develop a coding scheme that generates low BER code-words. By applying a time domain TBC, designed utilizing powerful low density parity check (LDPC) code, the BER performance of the MC - CDMA system is improved and the same is proved through simulation. Two kinds of LDPC codes are, random LDPC codes and quasi cyclic (QC) LDPC codes are analyzed. These codes also have error correction capability along with high performance efficiency in terms of BER. In addition a decoding algorithm with moderate decoding complexity and with the feasible soft output generation is also proposed for each LDPC code [21].

In the year 2013 (Jaswinder Kaur et al.) present the reduction of PAPR in MC-CDMA using PTS, SLM and Hybrid techniques. According to the simulation results presented in this paper, using PTS technique, PAPR is decreased up to 2.9 dB as compared to the original PAPR of the signal for different number of users and iterations. By examining the plots of Complementary Cumulative Distribution Function (CCDF) versus probability (PAPR0), it has been shown that SLM technique lowers PAPR up to 2.2 dB and Hybrid method reduce PAPR upto1.5 dB than original PAPR of the signal [22].

In the year 2013 (Ali T. Shaheen) recommended a method to perform the N-Discrete Hartley Transform (N-DHT) mapper, which are similar to 4-Quadrature Amplitude Modulation, 16-QAM, 64-QAM, 256-QAM … etc. In spectral efficiency. The N-DHT mapper is chosen in the Multi Carrier Code Division Multiple Access (MC-CDMA) structure to serve as a data mapper instead of the conventional data mapping techniques like QPSK and QAM schemes. The proposed system is simulated using MATLAB and compared with conventional MC-CDMA for Additive White Gaussian Noise, flat, and multi-path selective fading channels. Simulation outcomes are provided to prove that the proposed system improves the BER performance and reduce the constellation energy as compared with the conventional system [23].

In the year 2013 (Parvathy S Kumar et al.) a coding scheme that reduces BER of MC-CDMA system. In this paper a time domain turbo block code (TBC) designed using powerful low density parity check (LDPC) code is used in the MC - CDMA system for improving the BER performance and the same is proved through simulation. This code also has error correction capability along with high performance efficiency in terms of BER [24].

In the year 2013 (Gagandeep Singh Dhaliwal et al.) present an employment and examination of MC-CDMA over different fading channel Rayleigh Fading, Rician Fading and Nakagami Fading Channel is shown. The performance is compared and analyzed with DS-CDMA (Direct Sequence Code Division Multiple Access) system in terms of BER curves and spectral efficiency curves for different fading channels [25].

In the year 2014 (Takemi Suzuki et al.) proposed the accurate MC-CDMA channel estimation method using Kalman filter with the colored driving source. The algorithm aim to achieve good performance from (i) a state equation composed of the channel gain and pilot signal, and (ii) an observation equation composed of the pilot signal, the channel gain, and the additive noise. The distinctive features of the proposed method are that (1) the channel estimation does not depend on the parameters of AR (auto-regressive) system, and (2) the maximum Doppler frequency is unknown, while conventional method utilizes AR parameters and known maximum Doppler frequency [26].

In the year 2014 (Ainiwan Abudoukeremu et al.)clarify the bit error rate (BER) performance of a new multicarrier code division multiple access (MC-CDMA) scheme without the multiple access interference (MAI) and inter carrier interference (ICI) over a very large delay spread channel, which can be characterized by a block coding technique using a set of sequences with a zero correlation zone (ZCZ code) and the minimum mean square error (MMSE) Rake receiver with a pilot-symbol-aided channel estimation to remove MAI and ICI, and to reduce the influence of the inter symbol interference (ISI), respectively. It is not necessary to use the frequency domain equalization technique which has been always applied in multicarrier communications. The length of delay chips is related to only block size and does not depend on the size of

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 11, June 2016)

the zero correlation zone and the number of users [27].

In the year 2015 (S. Kuzhaloli et al.) presented the comparison of the performance analysis of various equalization techniques involved in an Multiple Input Multiple Output (MIMO) Multi-carrier (MC) Code Division Multiple Access (CDMA) system. Multiple transmitting antennas and multiple receiving antennas are used by this system. Equalization techniques considered for comparison are Zero Forcing (ZF) and Zero Forcing with Successive Interference Cancellation (ZF-SIC). This comparison is simulated for a 2×2, 2×3 and 2×4 MIMO channel and simulation is done using MATLAB software. Bit Error rate is the estimation parameter taken into consideration for determining the efficient equalization technique for an MIMO MC-CDMA system [28].

In the year 2015 (Yanxin Yan et al.) proposed a novel frequency-domain oversampling (FDO) minimum mean square error (MMSE) receiver for the cyclic prefix (CP) MC-CDMA. Simulation results show that the proposed FDO based receiver for the CP MC-CDMA systems can outperform the traditional zero forcing (ZF) and MMSE equalizers in terms of BER performance for all the spreading factors (SF) [29].

In the year 2015 (Vinay Kumar Trivedi et al.) presented the performance analysis of full load & overload Multicarrier (MC)-CDMA transmission scheme over hybrid Satellite/Underwater Acoustic (UWA) channel. For full load case Walsh-Hadamard (WH) & Carrier Interferometry (CI) spread codes are employed, and for overload case Pseudo Orthogonal (PO)-CI code set in addition to CI codes are used. The analytic expressions for the code cross-correlation terms, and hence the Multiple Access Interference (MAI) terms are derived for overloaded MC-CDMA system, and compared with its fully loaded counterpart. Later it is shown that, the BER performance of overloaded system over UWA channel illustrates worse performance than over narrowband satellite channel due to higher code cross-correlation and large delay spread. Finally, from the simulation results, the BER performance of PO-CI spread (overloaded) MC-CDMA is observed to be slightly degraded than CI spread (full-load) MC-CDMA. Thus, a trade-off is established between the achievable system capacity and the error performance. Hence for the increased network capacity or better error performance, PO-CI/MC-CDMA or CI/MC-CDMA respectively, stems out to be the suitable candidates, for hybrid satellite/underwater acoustic communications [30].

VII. CONCLUSION

Multi-carrier code division multiple access (MC-CDMA) is an attractive choice for high speed wireless communication as it avoids the problem of inter symbol interference (ISI) and also exploits frequency diversity. In order to support multiple users with high speed data communications, the MC-CDMA technique is used to address these challenges.

REFERENCES

[1] T. S. Rappaport, Wireless communications: principles and practice, 2nd ed. Upper Saddle River, N.J.; London: Prentice Hall PTR, 2002.
[2] B. Sklar, Digital communications: fundamentals and applications, 2nd ed. Upper Saddle River, N.J.: Prentice-Hall PTR, 2001.
[3] S. Haykin and M. Mother, Modern Wireless Communications, international edition ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.
[4] H. Schulze and C. Lers, Theory and applications of OFDM and CDMA wideband wireless communications. Hoboken, NJ: Wiley, 2005.
[5] F. Adachi, D. Garg, S. Takaoka, and K. Takeda, "Broadband CDMA techniques," Wireless Communications, IEEE [see also IEEE Personal Communications], vol. 12, no. 2, pp. 8–18, Apr. 2005.
[6] Samreen Amir and Muhammad Asif, "Analytical Study of MC-CDMA-TCM over Multi-path Rayleigh Fading Channels", International Conference on Computer Engineering and Applications, 2009.
[7] S.Sivanesskumar, Dr (Mrs) R.Sukanesh, "Global search algorithm based multiuser detectors for mc-cdma system under clipping noise and rayleigh fading channels", Journal of Theoretical and Applied Information Technology.
[8] V.Jagan Naveen, K.Murali Krishna, K.RajaRajeswari, "Performance analysis of mc-cdma and ofdm in wireless rayleigh channel", International Journal of Advanced Science and Technology Vol. 25, December, 2010.
[9] B.Sarala1, D.S.Venkateswarulu, B.N.Bhandari "Overview of Mc Cdma Papr Reduction Techniques", International Journal of Distributed and Parallel Systems (IJDPS) Vol.3, No.2, March 2012.
[10] Kattoush A. H. , Qasaymeh M. M. , "Design and Simulation of MC-CDMA Transceiver via Slantlet Transform", I.J. Information Technology and Computer Science, 2012.
[11] Mohammed Faisa, Jia Uddin, Iqbal Hasan Haider, "Simulation Based Performance Analysis of MC-CDMA and CDMA over Rayleigh Fading Channel", (IJIDCS) International Journal on Internet and Distributed Computing Systems. Vol: 2 No: 1, 2012.
[12] Hema Kale, C.G. Dethe, M.M. Mushrif, "A Review of Sub-Carrier Selection Techniques Employed in MC-CDMA System for 4G Networks", International Journal of Scientific and Research Publications, Volume 2, Issue 4, April 2012.
[13] Karamjeet Singh, Rajvir Kaur, "Performance of MIMO Multi-Carrier CDMA with QPSK Modulation in Rayleigh Channel", IJAIEM, Volume 2, Issue 4, April 2013
[14] Manjinder Singh Karamjeet Kaur, "BER Performance of MC-CDMA Using Walsh Code with MSK

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 11, June 2016)

Modulation on AWGN and Rayleigh Channel", IJETT, Volume 4 Issue7- July 2013.

[15] B. Sarala, D. S. Venkateswarulu & B. N. Bhandari, "MC-CDMA PAPR Reduction using a Modified Exponential Companding Transform with Clipping", Global Journal of Researches in Engineering Electrical and Electronics Engineering, 2013.

[16] Amandeep Singh, Rajbir Kaur, "Performance Comparison Of Different Pulse Shaping Filters In PAPR Reduction In Multi Carrier Code Division Multiple Access Systems", IJIRS, 2013.

[17] Noor Mohammed V., P.S. Mallick, L. Nithyanandan, Aditya A. Kabra, "Analysis Of Interference Reduction In Mc-Cdma System Using Binary Spreading Sequences", Australian Journal of Basic and Applied Sciences, 7(8): 354-361, 2013.

[18] Muhammad Zubair Farooqui, Poompat Saengudomlert "Transmit power reduction through subcarrier selection for MC-CDMA-based indoor optical wireless communications with IM/DD", EURASIP Journal on Wireless Communications and Networking 2013.

[19] B.vinodh kumar, Arulpugazhendhi.M, A.Arul, "Performance Analysis of MC-CDMA Based Fixed Wimax Technology by RS Encoder for Different Modulation", Journal of Engineering Research and Applications, 2013.

[20] Biru S. Bhanavase, Bipeen B. Patil, V.R. Dahake, "An Overview of MAI Reduction Techniques for MC-CDMA System", (IJARECE) Volume 2, Issue 1, January 2013.

[21] Parvathy S Kumar, K. Rasadurai, N. Kumaratharan, "LDPC Coding for Performance Enhancement of MC-CDMA System", IJATCSE, 2013.

[22] Jaswinder Kaur, Komal Arora, "Performance analysis of PAPR reduction techinques for MC-CDMA system", International Journal of Scientific & Engineering Research, Volume 4, Issue 8, August-2013.

[23] Ali T. Shaheen, "Performance Improvement of Multi-User MC-CDMA System Using Discrete Hartley Transform Mapper", Eng. &Tech. Journal, Vol. 31,Part (A), No.9, 2013.

[24] Parvathy S Kumar , N. Kumaratharan, "Performance Enhancement of MC-CDMA System through Turbo Block Codes", Universal Journal of Communications and Network 1(2): 50-55, 2013.

[25] Gagandeep Singh Dhaliwal, Navpreet Kaur "BER based Performance Analysis of MC-CDMA over Multipath Channels". International Journal of Computer Applications, 2013.

[26] Takemi Suzuki, Takahiro Natori, Nari Tanabe, Toshihiro Furukawa, "Performance analysis of MC-CDMA channel estimation method using Kalman Filter", IEEE, International Symposium on Information Theory and its Applications (ISITA), Melbourne, pp. 507 – 510, 2014.

[27] Ainiwan Abudoukeremu, Jincheng Huang, Yuta Ida, Takahiro Matsumoto, Shinya Matsufuji, "On BER performance of block coding MC-ZCZ-CDMA", IEEE, International Symposium on Information Theory and its Applications (ISITA), Melbourne, pp. 516 – 520, 2014.

[28] S. Kuzhaloli, K. S. Shaji, "Comparison of equalization techniques for an MIMO MC-CDMA system", IEEE, International Conference on Circuit, Power and Computing Technologies (ICCPCT), Nagercoil, pp. 1-4, March 2015.

[29] Yanxin Yan, Maode Ma, "Novel Frequency-Domain Oversampling Receiver for CP MC-CDMA Systems", IEEE Communications Letters, Vol. 19, Issue4, pp. 661 – 664, April 2015.

[30] Vinay Kumar Trivedi, Akash Agarwal, Preetam Kumar, "Performance evaluation of MC-CDMA over hybrid satellite/underwater acoustic channel", IEEE, 10th International Conference on Information, Communications and Signal Processing (ICICS), Singapore, pp. 1-6, December 2015.

IJDACR