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Research Article

5G Technology: Core Module Realization Scheme for faster data rate

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ABSTRACT

OFDM is one of the most common multi-carrier modulation schemes implemented for a range of wireless standards. The key drawback of the OFDM method is its frequency offset sensitivity, which contributes to loss of orthogonality. In OFDM system, when the orthogonality is lost ICI occurs which decreases the System Output. The reason for occurrence of Inter Carrier Interference because of the arising carrier frequency offset from the doppler shift from lesser extent. Various methods of Inter Carrier Interference cancellation techniques idea has also been discussed. In this project, the ICI triple cancelation scheme was proposed to minimize inter-carrier interference in a quick time varying environments. In this process, at transmitter section the Inter Carrier Interference self-cancellation modulation is observed

and LTV model is modeled for time varying channel to perform ICI dual cancellation scheme and thus ICI self-cancellation demodulation is done at the end of the receiver.. The basic scheme is performed through channel estimation which works more efficient in fast varying systems The outputs obtained by this technique and by comparing MSE in various channel estimations demonstrates that the latest scheme is certainly better than the current scheme and increases the efficiency of the program.

key words: ICI, guard period, orthogonality, bit error rate, cyclic prefix, signal to noise ratio

I. Introduction

What is OFDM?

It is a type of multicarrier modulation where it consists of no. of a closely spaced modulated carrier and a previously modulated signal into another signal of higher frequency and bandwidth, where each signal can be modulated by a low-speed data stream that can be used to divide the available spectrum into multiple carrier

Working of OFDM

a. Receiver section and transmitter section are the two sections of the OFDM system.

b. The AWGN channel is primarily seen in OFDM device service.

c. By analyzing the segment of the receiver, the function of the OFDM is understood.

d. The time to retrieve the information from the carrier the corresponding dc is spread across the symbol..

c. Since carrier spacing is equivalent to the inverse of a symbol time, i.e. they can have a total number of symbol time cycles and their importance to the symbol period.

Frame structure of OFDM

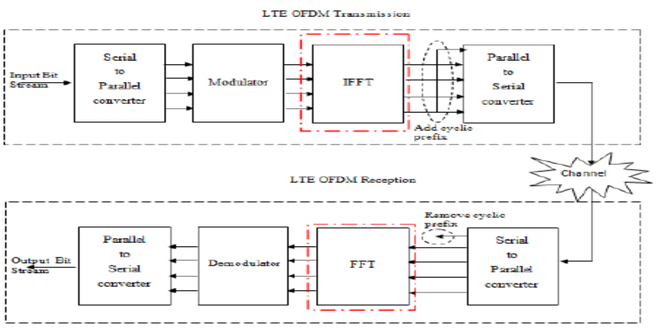

Fig : OFDM frame structure

Requirements of OFDM

Sending data and then receiving data systems should be linear, as any non-linearity of the network can cause interference between carriers. due to intermodulation distortion, this will result in unintended signals that could cause interference and reduce orthogonal transmission.

Data on OFDM

Each substream is a bit lower and spread farther besides time, which eliminates interference between Symbols and makes it much easier to correctly obtain each symbol. Where minimum data rate in each stream means that there is a lot of guard room for reflective interference.

Key features

a. Substreams are multi-carriers present in signal
b. Subcarriers are orthogonal to one another.
c. Guard intervals are applied to each symbol in order to minimize channel delay distribution and intersymbol interference.

Advantages

a. Immunity to selective fading
b. interference can be recovered quickly
c. Performance of the spectrum is more efficient
d. ISI Robust
e. Adaptable to narrow-band effects

Disadvantages

a. Strong peak to average ratio of power
b. Prone to offset and drift carrier
c. Requires multiple local oscillators

Applications of OFDM

a. Digital audio broadcasting
b. Asymmetric digital subscriber line
c. Hiperlan2

Problems in OFDM

a. Synchronization
b. Phase noise is added through local oscillator
c. Common phase error is due to a rotation of signal constellation
d. ICI: more hard to resolve due to the additive noise which is different for all carriers.
e. Peak to average power ratio.

Need of channel estimator

Channel State Information is used to provide the channel properties of the connection. But CSI is technically applicable when the channel is in a slow time variant but not applicable under fast time variable systems, such as the OFDM system. Channel estimators have also been implemented to increase the precision of the obtained signal. Usually radio channels which 0are also known as multi-path fading signals that cause inter-symbol interference to the received signal. The Inter Symbol Interference Several detection methods on the receiver side can be derived from the signal, while the channel estimator is used to provide channel pulse response information for detectors.

channel estimator

It plays an significant role in the OFDM system, which shall be used to increase the performance of orthogonal frequency division of multiple access systems by increasing device production in terms of bit error rate. Since the bit error Rate is increased, the carrier frequency gap reduces and thus the ICI decreases..To allow the estimation of the characteristics of the channel.LTE uses both time and frequency pilot symbols added. These pilot symbols can be used for measuring the channel at a given position within the subframe.

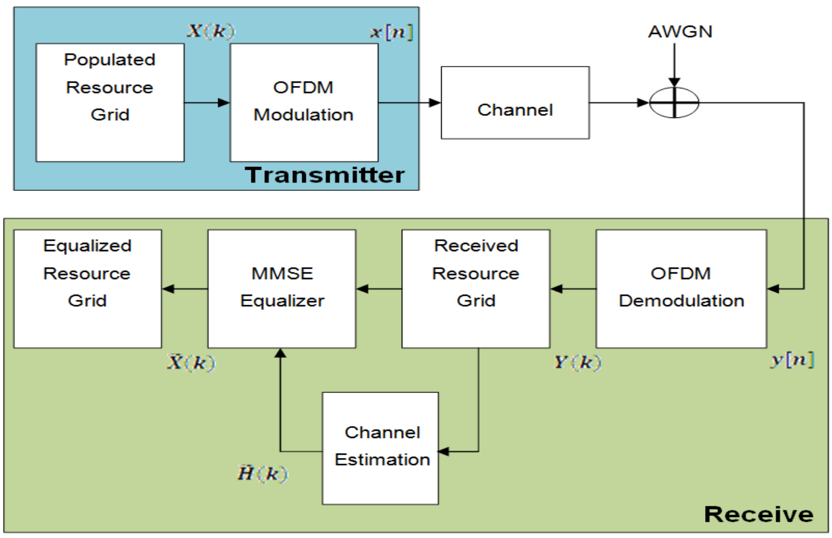

Fig: transmit and receive chains and the propagation channel model

Classification of channel estimators

1. Training based estimation: It could be achieved whether by block type pilots or by comb type pilots also with data signs. It is very important for changes to be made even in one orthogonal frequency division multiplexing unit.

2. Blind channel estimation: The calculation shall be performed by Analyzing the hard data information of the network and the basic features of the signals transmitted. This has no downtime loss and is suitable for slow-moving networks.

3. Semiblind channel estimation: This technique is a mixed combination of blind channel and training-based channel that uses pilot carriers and other natural constraints to perform channel estimation.

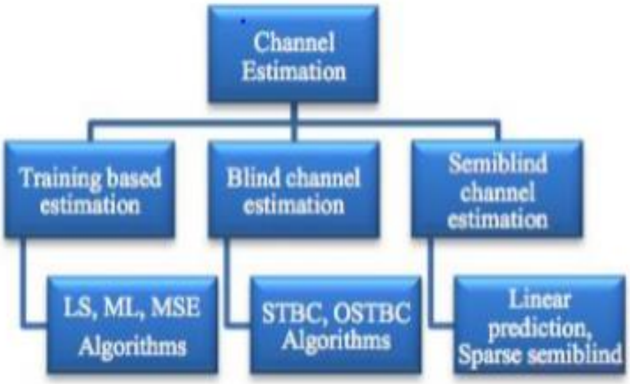

Fig : Classification of channel estimators

what are pilot symbols

It is defined as the complete OFDM symbol where the value of each subcarrier is defined at receiver and transmitter. The repetition of the symbol depends upon how fast the channel changes. These pilot symbols are used for channel estimation which can take place in 4-stages.

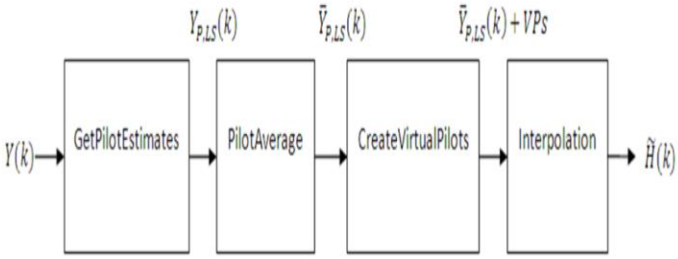

Fig : estimation of entire subframe using pilot symbols

II. Literature Survey

Sukhpal Singh , Harmanjot Singh [1] in the year 2015 has published a paper on OFDM concepts and applications. In this paper we will be dealing with introduction part of OFDM which includes the definition of the system, the system mode, block diagram , applications, advantages, disadvantages ant the types of OFDM system.

In the year 2017, Jagsir Singh and Jaswinder Singh [2] as given an overview on the problems that occur in OFDM system. This paper investigates the Significant problems of orthogonal frequency division multiplexing, such as high peak to average power ratio, inter-carrier interference, inter-symbol interference and the explanations for various problems.

T. Srinivas Reddy, J. Prabhakar, CH. Shekar [3] in the year 2019 as published an overview on the analysis and implementation of ICI in OFDM system. In this article the writer describes about the interference adder, efficiency of BER and CIR. The author concludes the paper by stating two different things primarily it deals with the attempt of self-cancellation schemes for ICI in OFDM systems and secondly implementation of interference adder by FPGA

In the year 2014, Rehman Zhang Lei, Naveed Ur and Muhammad Zahid Hammad [4] as published an paper on ICI self-cancellation scheme by reducing the frequency offset. The paper gives us a rundown on pilot symbols, frequency offset and various ICI cancelation systems, such as time domain windows, frequency domain windows, frame form pulse and frame windowing techniques, with their advantages and disadvantages. The paper focuses on the Inter carrier interference self-cancellation scheme with Inter carrier interference modulation and demodulation techniques. Various extended techniques, such as the extended Kalman filter and the ML system, are also given a brief overview of their BER efficiency.

Prof. T. S. Rappaport [5] in the year 2003 has published a paper which mainly deals with the comparison of three major techniques on Inter carrier interference cancellation that is Inter carrier interference self-cancellation scheme, Maximum Likelihood(ML), Extended Kalman filter Centered on the error rate of the bit, Bandwidth performance and computational complexity under different networks. The paper concludes that the ICI degrades the efficiency of the network by analyzing the Device output in terms of carrier interference ratio, bit error rate in the presence of frequency offset between the transmitter and the receiver. The author notes that under the higher frequency offset and modulation scheme the overall likelihood and the predicted Kalman filter function well than under the self-cancellation scheme by contrasting relaxation effects to different values. However the user should choose a form depending on the intent of the program. Self-cancellation, for example, does not need very complicated hardware or software to be implemented.

Ke Gong, Changyong Pan, Jun Wang, Shigang Tang and Zhixing Yang [6] has published a paper that describes the self-cancellation scheme in ICI with phase disturbance. The paper sets out the concept of phase noise in the OFDM system caused by the local oscillator due to the loss of orthogonality of the device. The key feature of the method, i.e. the symmetric conjugate with negative properties of inter carrier interference weighting, is used to test the efficiency of ICI self-cancellation, in which it was observed that the improvement of CIR is greater when the RMS phase noise is lower. The efficiency of the BER was also measured in the three separate networks. It has been found that the efficiency of BER in the adjacent data conjugate system is higher.

In 2014, S.E. D. Habib, Reem I. Sayed, Hisham M. Hamed, and Magdi Fikri[7] published a paper on the new Inter Carrier Interference self-cancellation scheme for Orthogonal Frequency Division Multiplexing systems Increased protection against CFO errors as demonstrated by BER and CIR.. The paper provides a full understanding of the different schemes involved in the ICI self-cancellation process, such as adjacent symbol repetition, symmetric symbol repetition (SSR), adjacent conjugate symbol repetition, symmetric conjugate symbol repetition, conjugate cancelation process. and the author has proposed two other schemes that is Conjugate Phase Additive Single Carrier transmission and Conjugate Phase Additive Single Carrier transmission where this The two schemes are based on the replication of the symbols on the sender side and the conjugate multiplying Of the symbols on the data FFT receiver node outputs. However, proposed two schemes have strong BER and CIR efficiency even with high CFO errors compared to other schemes.

In the year 2001, Yuping Zhao and Sven-Gustav Häggman [8]in the paper the author has proposed the first main scheme of Inter Carrier Interference self-cancellation i.e. ASR which works in two simple steps i.e. On the Transmitter hand, one data symbol is being modulated on the Collection of nearby sub-carriers with a weighting parameter set on the receiver side by sequentially integrating the transmitted pulses on those subcarriers with the suggested factors, The residual Inter Carrier Interference found in the signals emitted could then can be reduced further. The proposed method gives us the significant CIR performance and also works under Multi-path Radio Channel including Doppler Frequency Spread State of the same bandwidth and low frequency differences. As proposed procedure does not need any channel equalization, it is thus simple to enforce without increasing device complexity.

In 2018, Jiongyao YE*, Hengxiao WANG, Weina YUAN, Nan WANG and Rui XU[9] received an overview of the latest cancelation scheme of ICI i.e. ICI Triple cancelation scheme for orthogonal frequency division multiplexing systems in a quick time-shifting environment that gives us a brief overview. of Combining dual separate techniques, such as Inter Carrier Interference Self-Cancelation Modulation and Demodulation Module dependent on differential coding and differential decoding (method-1) and inter carrier interference Self-Cancelation Modulation and Demodulation system based on adjacent data conversion and data subtraction (method-2). Various analyzes were carried out on the methods used mostly by channel estimators, such as the least square to measure the efficiency of the SNR system. It has been observed that noise is generated by the cause of differential coding and differential decoding in which it enhances signal noise interference and reduce the efficiency of the scheme in a low Signal Noise Ratio environment, while increasing the spectral effectiveness of the self - cancellation scheme and enhancing efficiency in a high Signal to Noise Ratio environment. Method-1 can therefore be implemented if the system's spectral tools are adequate and the Signal to Noise Ratio is comparatively low and Method-2 can be adopted if the spectral resources of the system are adequate and the different limitations of the different methods of the Inter Carrier Interference self-cancellation scheme are discussed.

In 2015, Upena Dalal, Shilpi Gupta and Vishnu Narayan Mishra[10] outlined the reports of the Inter Carrier Interference self-cancellation mechanism in Fast Fourier transformation OFDM and Direct Cosine Transform OFDM Systems. In this paper, the researchers carried out an individual examination of a Inter Carrier Interference self-cancellation scheme in Fast Fourier Transform OFDM and direct cosine transformation OFDM framework and a modern technique for Inter Carrier Interference self-cancellation system is introduced In terms of raising the effect of the frequency offsetting. This new scheme improves CIR compared to the current self-cancellation scheme in the Fast Fourier Transform OFDM while in the Direct Cosine Transform OFDM Schemes the performance of the DCT-Orthogonal frequency division multiplexing method is poor in the factors of carrier interference ratio at the significantly lower subcarrier index, while at the higher subcarrier index.

In 2014, Kyung-Hwa Kim and BangwonSeo[11] identified the Inter Carrier Interference self-cancellation system in the Orthogonal Frequency Division Multiplexing system for reducing the ICI produced by PHN and RFO. The suggested scheme consists of a modern Inter Carrier Interference cancellation tracing for a broadcast signal, which is converted into a real signal. The proposed ISC scheme is used to account for the phase offset induced by PHN and RFO, with the use of primary property of the emitted signal, PHN and RFO were calculated and compensated by the receiver. The ICI induced by phase noise and residual frequency offset can therefore significantly suppressed and hence the proposed scheme has higher Carrier Interference Ratio and better Bit Error Rate efficiency compared to traditional symmetric Inter Symbol Cancellation scheme.

Rakshit Govil [12] in the year 2018 has explained the Various forms in channel estimation methods utilized the MIMO-OFDM method for successful communication. Processing of CSI correctly and synchronization between receiver and transmitter is a key challenge for the MIMO-OFDM network. To address this obstacle, the author explains the different types of channel estimators, for eg, training-based, blind channel, semi-blind channel-based algorithms, and the output of each estimator. Numerous optimization methods, such as particle swarm optimization, evolutionary programming is also tested to optimize LS & MMSE algorithms.

Patteti Krishna [13] in the year 2019 as measured for the performance of BER in the FBMC-system and OFDM-system where FBMC coding is used for PSACE where the complexity is not considered. The author also indicated that the channel estimators frame and give a strong inspiration driving constrainment for the medium SNR.

C. Yu , Y. Lee , S. Y. Kim , G. I. Jee and S. Yoon [14] in the year 2013 Suggested a carrier frequency offset estimation method, which basically conducts the envelope equalizing process to transform the offset measurement issue to the carrier estimation problem, and then Calculates a total and decimal portions of the Carrier Frequency Offset using the signal periodogram obtained. The author concluded that the suggested scheme with greater frequency offset acquiring chance efficiency than the conventional scheme for a wider range of FFOs.

Puri Anuj, Mustafa Ergen, , Ahmad Bahai and SinemColeri [15] in the year 2002 a research has been done on channel estimates in the OFDM program based on a pilot arrangement was carried out. Pilot frequency channel estimation is focused on LS and LMS, whereas channel interpolation is performed by utilizing various interpolation techniques such as linear , second order domain etc. The author listed a detailed study of a block-type and a comb-type pilot-based channel estimation The channel estimation is specified on the basis of a block pilot arrangement with or without a decision equalizer.

Aswani Lalitha, G.Harinatha Reddy [16] in the year 2019 the authors have done survey and summarized the major limitations of the techniques of channel estimation.

III. Methodology

Inter Carrier Interference Triple Cancellation Scheme

Working principle

In the Inter Carrier Interference Triple Cancellation Procedure, the ICI channel matrix determined from the previous OFDM symbol is used to perform the pre-cancellation Inter Carrier Interference at first. The first Orthogonal frequency division multiplexing symbol can be obtained from the first transmitted header of ICI channel matrix. Cox and Schmidl suggest series for the calculation of time and frequency variations, and "0" data is sent to unusual sub-carriers, and the PN series are sent to other sub-carriers.Thereafter, the Inter Carrier Interference channel matrix is re-assessed At the point, using the signal obtained after Inter Carrier Interference's pre-cancellation for termination of Inter carrier Interference .

Frame structure of ICI triple cancelation scheme

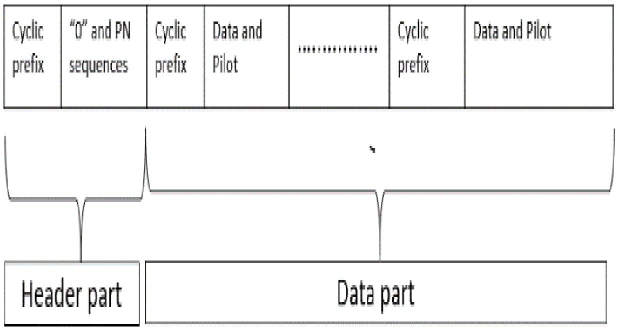

Fig : block diagram of ICI triple cancellation

Design of the framework

Let, the Subcarriers be represented by number N and the intersymbol interference will be eliminated by adding the cyclic prefix, so expressed as

Y=hx+w

Where;

x=$[x_0, x_1, x_2 \ldots\ldots x_n]^T$

y=$[y_0, y_1, y_2 \ldots\ldots y_n]^T$

w: AWGN in the time domain

h: channel matrix in time domain of dimensions N*N is defined by

h(n,l):l tap channel response at n sampling point ranges: 0 ≤ n ≤N-1, 0, 0 ≤ l ≤ L-1

When the FFT is applied to the equation(3.1), the relationship in frequency domain input-output for is defined by:

Y=Fy=$FhF^hX + Fw$ = HX+W

Where:

F: Fast Fourier Transfom matrix

F^h: Inverse Fast Fourier Transform matrix

$()^h$: Hemet conjugate transpose of the matrix of F is defined by

$$F(n,m) = \frac{1}{\sqrt{N}} e^{\frac{-j2\pi nm}{N}}$$

The situation developed when the channel is not time-differentiated is specified

h(0,l)=h(1,l) = ………. = h(N-1,l)

Nevertheless, the latter condition cannot be calculated by high-speed motion where the channel is time-variable. For such case, the frequency domain matrix(H) is an essentially banded matrix resulting in an ICI matrix.

It can be decomposed into two parts i.e. a channel matrix without Inter Carrier Interference consisting of a diagonal element of H and a channel matrix composed of an off-diagonal element of H without loss of orthogonality;

$$Y_n = H_n^{ave} H_n + H_n^{ICI} X_n + W_n$$

Analysis of ICI triple cancellation

The Inter Carrier Interference valued by the header followed by:

$$\widehat{H_n^{ICI,pre}} = c\hat{A}_{n-1,p}$$

Where C is Fb_pF^H where its \$(m,n) can be given by:

After ICI pre-cancellation, the signal obtained is defined as:

$$Y_n^{\prime ICI,pre} = Y'_n - \widehat{H_n^{\prime ICI,pre}}\widehat{X'_n}$$

$$= H_n^{ave} X'_n - CA_{n-1,p} X'_n - C\widehat{A_{n-1,p}}\widehat{X_n} + W_n + E_n X'_n$$

Where channel matrix without ICIH_n^{avg}=∅$\widehat{H}_n^{ls}$

Where $\widehat{H}_n^{ls}$represented as Frequency Channel Response Matrix at Pilot Place, which is accessed by using the transmitted pilot via the least square method. It is given by:

$$\widehat{H}_n^{ls} = \frac{Y_n^{ICI,pre}(p_k)}{X_n(p_k)}$$

Using an arbitrary ICI-free channel matrix of three adjacent orthogonal frequency division multiplexing symbols, the channel envelope of the conjugate symbols will be extracted as follows:

$$\hat{A}_{n,p} = \frac{\widehat{H}_n^{ave} - \widehat{H}_{n-1}^{ave}}{N + N_g}$$

$$\hat{A}_{n,f} = \frac{\widehat{H}_n^{ave} - \widehat{H}_{n-1}^{ave}}{N + N_g}$$

Where Ng is the CP duration. After the Inter Carrier Interference pre-cancellation, the Inter Carrier Interference re-cancellation matrix can be expressed as:

$$\widehat{H}_n^{ICI,pos} = C_p\hat{A}_{n,p} + C_f\hat{A}_{n,f}$$

In order to achieve correct pre-demodulation at the receiver, the received signal can be interpreted as a dual ICI cancellation.:

$$Y_n^{\prime ICI,pos} = Y'_n - \widehat{H_n^{\prime ICI,pre}}\widehat{X'_n}$$

$$=H_n^{ave} X'_n - \left(H_n^{ICI} - \widehat{H}_n^{ICI,pos}\right) X'_n + W_n + E_n X'_n$$

The obtained signal $\hat{X}_n^{ICI}$is provided by equalization with $Y_n'^{ICI,pos}$

The receiver performs Inter Carrier Interference self-cancellation demodulation of received signal and takes difference of data from the consecutive subcarriers to further reduce the Inter Carrier Interference, which is interpreted by:

$$\hat{X}_m^{"} = \frac{1}{2}[\hat{X}_m^{ICI} - \hat{X}_{m+1}^{ICI}]$$

$$=\sum_{n=0,2,4..}^{N-2} X_n[-s(n-m-m1) + 2S(n-m) - S(n-m+1)] + W_m - W_{m+1}$$

After ICI self-cancellation demodulation, the ICI coefficient can be expressed as:

$$S(n-m) = -S(n-m-1) + 2S(n-m) - S(n-m+1)$$

Observations

1. Of the three Inter Carrier Interference parameters, it has been shown that |s(n-m)| has higher value and |s"(n-m)| has lower value. Thus, pulses are conducted as Inter Carrier Interference self-cancelation modulation and Inter Carrier Interference self-cancellation demodulation in the orthogonal frequency division multiplexing system for better suppression of ICI.
2. Inter Carrier interference self-cancellation modulation by means of a differential encoding on the transmitter, the signals will then be carried out by start receiving decision and forward suggestions in order to understand the differential encoding of the receiver by

Dec(): The decision to receive the data from the receiver.

X^n: output after the Inter Carrier Interference triple cancellation.

3. noise for every subcarrier is overlaid by differential coding and decoding, where it enhances the Noise on the signal of the channel and capacity of network is decreased
4. The Inter carrier interference self-cancellation method can choose a specific type, so that the Inter Carrier Interference triple cancelation scheme involves two techniques;

a. Method-1: Inter Carrier Interfere self-cancellation modulation and demodulation of the differential coding and differential decoding units.

b.Method-2: the Inter Carrier Interference Self-Cancelation Modulation and Demodulation Module, which adopts adjacent data-conversion and data-subtraction

Analysis on the performance of bit error rate

1. Bit error ratio : it means the number of error bits per unit time.
2. Bit error performance analysis can be done three ways

I . BPSK modulation: This is the simplest type of phase shift keying. In this process, the carrier phase is regulated by the individual data bits.

Ii. Through AWGN channel: The Signal to Noise Ratio is varied to display on bit error rate. The BER theoretically is given by Q(sqrt(2*SNR)) is also seen for accuracy of plotted simulation line.

iii. Through RAYLEIGH channel: The Bit error Rate with Rayleigh fading channel which is of specified form y= zx+n.

3.The effective bit energy to noise ratio :

$$\frac{|Z|^2 * \mathrm{Eb}}{No}$$

Effect of frequency offset on BER

1. BER reduction is caused by the presence of CFO and CPN is analyzed analytically.
2. From the data, we can note that, in orders of magnitude, the values of the FO and the line width of the carrier that are provided for OFDM are smaller than for single carrier systems with the same bit rate.

IV. Simulation and results

MSE performance of different channel estimations

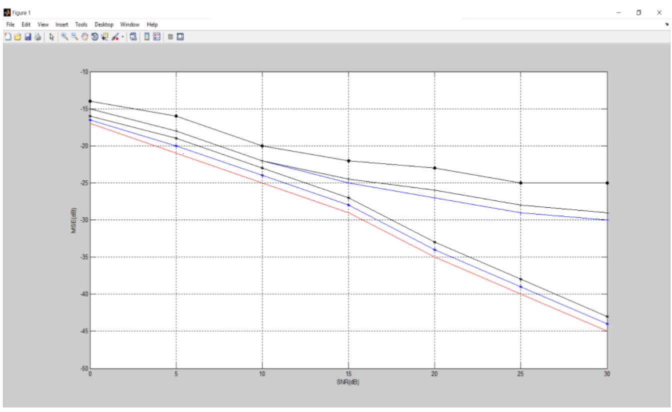

Fig: MSE performance of different channel estimations

From the above Fig the performance of MSE such as least squares estimation, BPD channel estimation and ideal channel knowledge at basic two methods of ICI triple cancellation where each color depicts each channel estimator such as Red-ideal channel knowledge, Blue-BPD channel estimator, Black-least square estimation. The MSE is calculated with input snr, L, Nr-Blocks. The x-label represents SNR in decibel(dB) and the Y-label represents MSE in decibel(dB). The various performances are observed under various multiple inputs and thus multiple outputs are obtained .

MSE performance of proposed CTSD method

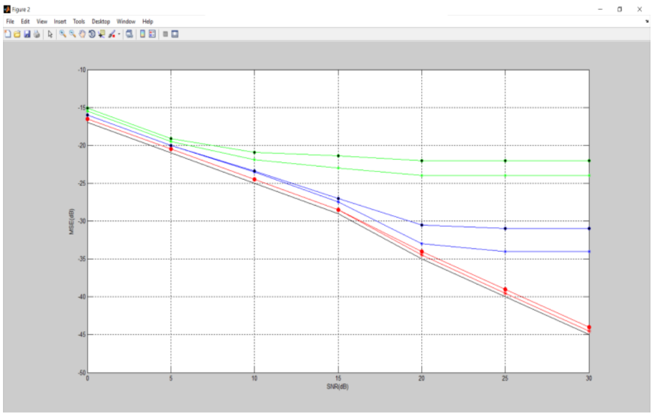

Fig : MSE performance of proposed CTSD method

The proposed CTSD method is described as Inter Carrier Interference self-cancellation modulation and demodulation module using differential coding and differential decoding, adjacent data-conversion and adjacent data-subtraction schemes the channel estimations are done where each color represents various MSE for two various methods as represented in diagram 4.2. The performance is observed in both the cases theoretically and practically and it is observed that proposed CTSD method is good in practically condition.

MSE performance in CTSD method

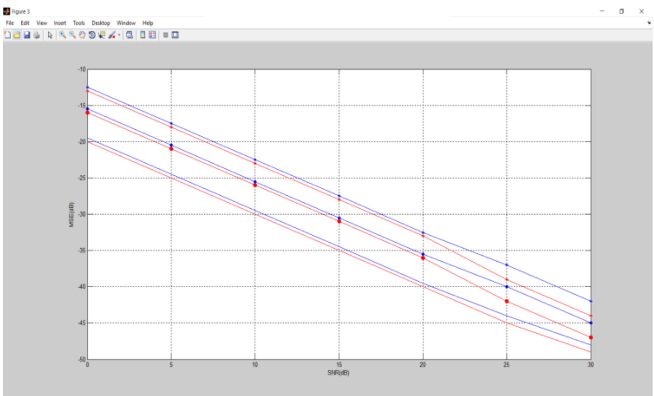

Fig : MSE performance of different CTSD method

The Fig represents the MSE value comparison both theoretically and practically under the three situations i.e. ideal channel where it is described when the system has no noise phase difference and the interference doesn't occur. Inter Carrier Interference self-cancellation modulation and demodulation differential coding and decoding improves the performance of the system. Inter Carrier Interference on modulation and demodulation with adjacent data-conversion and data-subtraction performs better as compared with single cancellation scheme but possess low spectral efficiency. The three various graphs depicts the ideal single cancellation scheme, modulation and demodulation differential coding and decoding and adjacent data-conversion and data-subtraction. The red line represents its theoretical value and blue line depicts the practical value. If observed from the graph it is clear that the performance of the differential coding and decoding applied in practical condition is more efficient.

Comparison of MSE

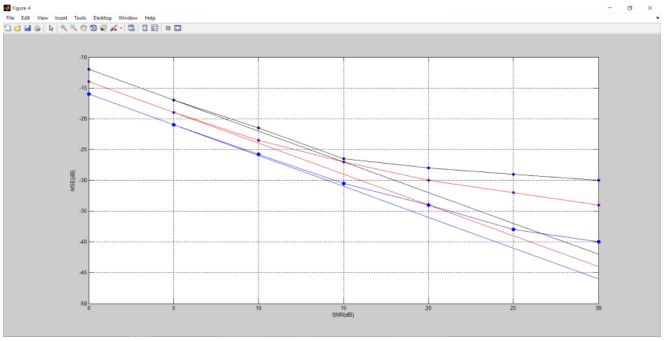

Fig : MSE performance at different channel estimator

The above Fig represents the comparison of MSE under three different channel estimators i.e. least squares estimation, BPD channel estimation and ideal channel knowledge. The most significant error is calculated under various CIR samples. The performance of MSE is observed for the OFDM system to perform efficiently. The MSE in different channel estimators is calculated and thus concluded that the least square method is has significant MSE and it can improve the performance and hence the ICI of the OFDM system can be reduced.

Performance of BER in MIMO OFDM and MIMO FBMC system

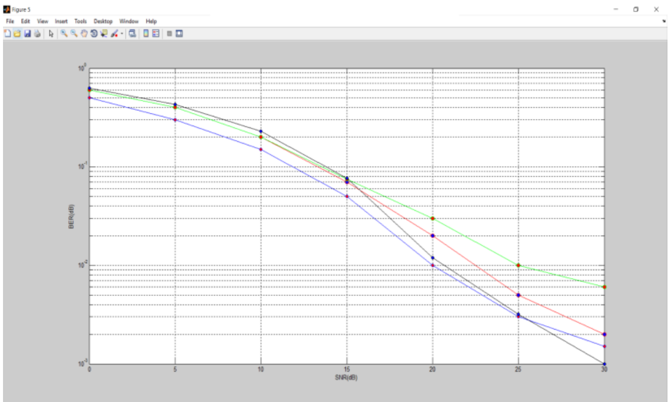

Fig : BER performance comparison between un-coded MIMO OFDM and MIMO FBMC systems

From the above Fig represents the comparison of BER in MIMO FBMC and OFDM systems and it is been observed that BER is less in MIMO FBMC system as compared with MIMO OFDM. Thus in varying communication technology we can use FBMC system which doesn't induce more inter carrier interference as produced in OFDM system.

Output for channel estimation techniques

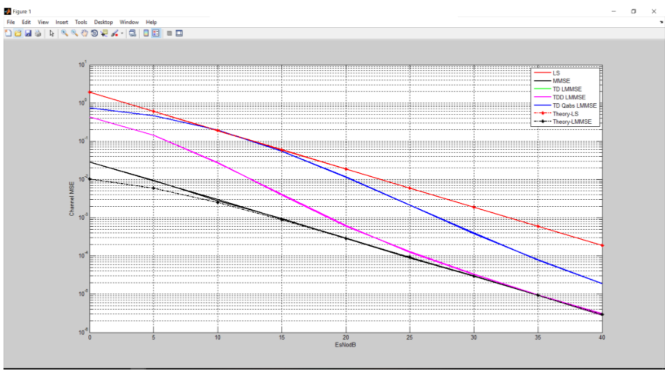

Fig : channel estimation techniques

From the above Figure Fig 4.6 the outputs for various channel estimators as been represented with E_s/N_o (dB) on X-axis and channel MSE on Y- axis which include least square method , most mean square error method , least most mean square error method theoretically least square , theoretically least mean square error etc are represented with various color.

Comparison of terms in ICI cancellation scheme

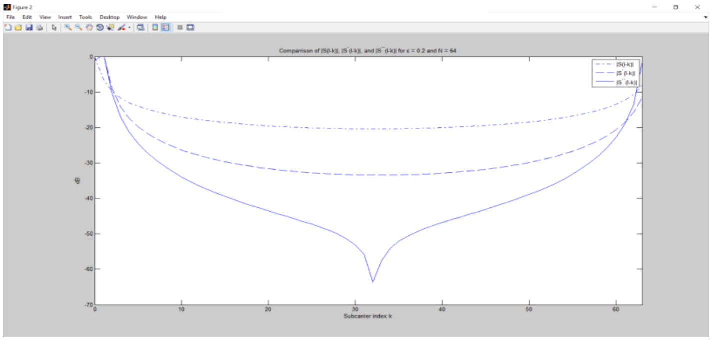

Fig: comparison of ICI terms

From the above Fig comparison of ICI terms with $\epsilon=0.2$ and N=24 on log scale. It is observed that $|S'(l-k)|$ is less than $|S(l-k)|$ for all the values l-k values. Thus, the components of Inter Carrier Interference are much smaller and the total number of interference signal is halved because only the even sub-carriers are summed up. The above can be represented with the equations represented in appendix-II.

BER performance under BPSK modulation

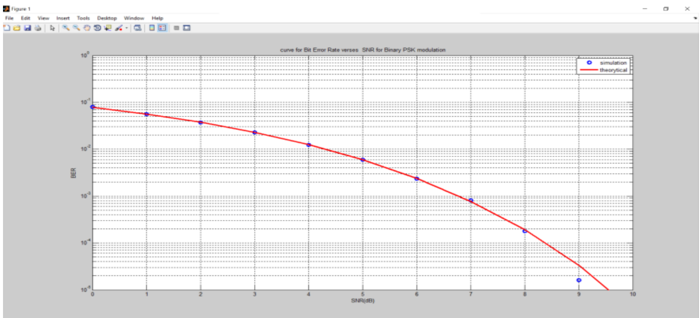

Fig BER in BPSK modulation

From the above Fig the performance of BER in BPSK modulation is observed where the blue represents the practical and red represents the theoretical. The analysis is done by using formulae . This BPSK baseband is generated through Monte Carlo method

BER in AWGN channel

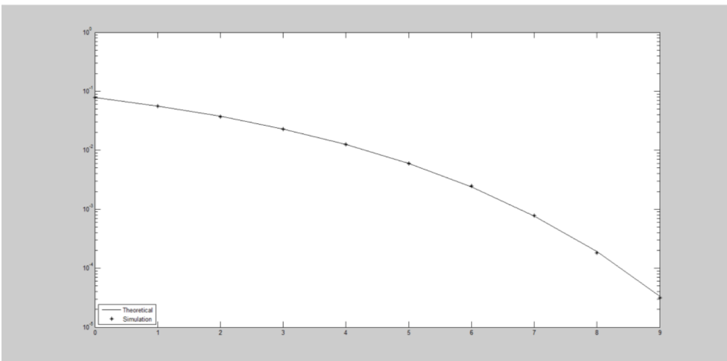

Fig : Ber in Awgn Channel

From the above Fig it can be realized that BER over AWGN channel is stimulated and the effect of noise is indicated by adding up gaussian random samples to each signal. Thus to show the effect of SNR on BER, SNR is varied and for the accuracy the theoretical value is also calculated.

BER in Rayleigh channel

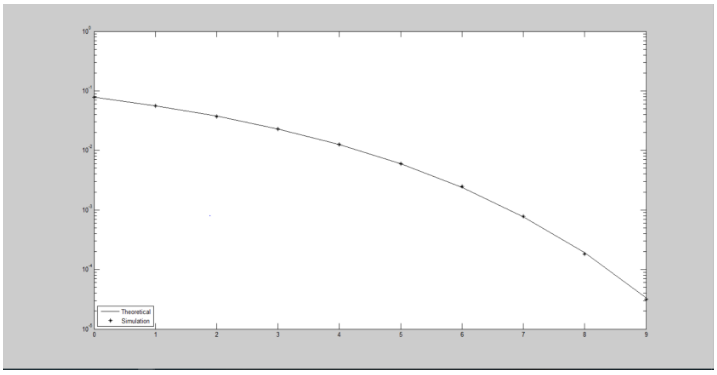

Fig : Ber in Rayleigh

From the above Fig where the points represent the theoretical values and the line represents the practical value. When the above Figured in compared with AWGN there is degradation of 25 dB due to multipath but this causes drawback for reliable wireless link and advantage for improving the performance

Sensitivity of Bit error rate

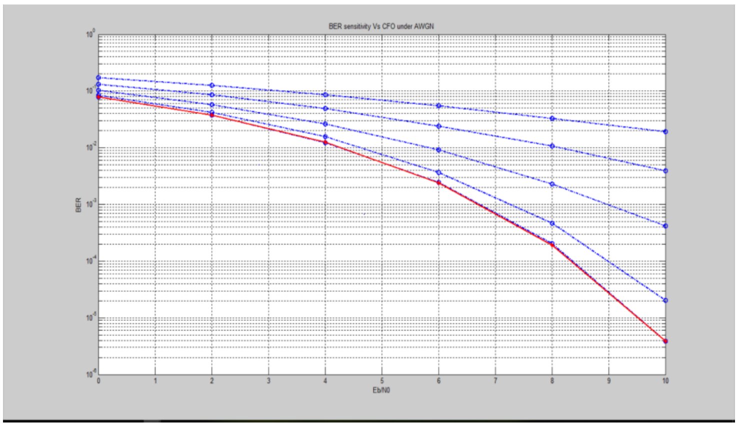

Fig: Ber Vs Frequency Offset

From the Fig it is clear that the degradation of the bit error rate caused by the presence of carrier frequency offset and carrier phase noise is evaluated and thus it is shown that for a given BER degradation, the values of the frequency offset of OFDM are orders of magnitude smaller than for single carrier systems carrying the same bit ratio. not much suitable for the cancellation. Later, ICI triple cancel scheme is proposed where various channel estimation schemes have been introduced to reduce BER.

The research done above has two directions:

a) to reduce the BER by using most efficient method
b) to reduce the doppler shift

V. Conclusion

OFDM systems produce ICI at fast speed mobile environments caused by doppler changes, which is primarily caused by carrier frequency offset. To decrease CFO in Orthogonal Frequency Division Multiplexing system the bit error rate should be reduced. Thus, different techniques have been introduced but due to various drawbacks they were

VI. Future Scope

The Future complexity of the mission can be extended to increase the BER and thus increase the efficiency of the system. Orthogonality can be maintained if the carrier frequency offset is maintained. Thus techniques can be introduced to maintain the frequency offset and ICI can be cancelled in more efficient way and for more efficiency in the communication system the FBMC systems can be designed which has less errors and can be designed easily.

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