Volume 4, Issue 5, May 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Survey on the Impairments of an OFDM System

Sandeep Kaur*, Er. Pradeep Sharma
Department of Electronics and Communication Engineering
RBIEBT Institute of Engineering & Technology
Chandigarh Punjab India

Abstract— Orthogonal Frequency Division Multiplexing (OFDM) is becoming the chosen modulation technique for wide band digital communication. In this paper concentration is on the main problems found in high speed communications that are Inter symbol interference (ISI) and Inter carrier interference (ICI). The ISI is produced in the system due to the multi propagation effects and band limited channel. ICI is produced in the channel due to Doppler spreading of signals and non linear distortions due to power amplifiers. Due to these types distortions the bit error rate of the OFDM system increases and the system performance reduces. In this paper survey on analysis of BER performance of OFDM system by channel estimation is done.

Keywords— OFDM, BER, ISI, ICI, SNR.

I. INTRODUCTION

Wireless communication systems have been developed with new technologies in various spheres of life. Wimax (world wide interoperability for microwave access) is one example of these types of new systems, with mobile Wimax (IEEE802.16e) and fixed Wimax (IEEE802.16-2004 standard) technologies being rolled out world-wide [1]. The demand for high data rate transmission increases rapidly. To meet this demand some straight forward possibilities include reducing the symbol duration or using the higher order modulation techniques can be used [2]. OFDM is one of the key broad band technology developed in both fixed and mobile Wimax systems. OFDM is the modulation technique used in many new broadband communication schemes including digital television, digital audio broadcasting, ADSL and wireless LAN's. It also provides reliable and efficient data transmission over a radio channel, even in multipath environments [3]. The problem in most wireless systems is the presence of multipath channel due to which the transmitted signal reflects off several objectives and a result multiple delayed versions of the transmitted signal arrive at the receiver which causes the received signal to be distorted.

To increase the data rate for an OFDM system, the number of subcarrier per symbol should be increased. As the no. of sub carrier increases, the frequency spacing between the subcarriers in the symbol reduces; this makes the OFDM system more sensitive to inter carrier interference (ICI). In OFDM system due to high variations in the signal transmission, peak to average power ratio increases and the transmitted signal starts operating in the non linear region of high power amplifier. Due to which non linear distortions induces. These non linear distortions lead to Inter carrier interference (ICI). On the other hand the relative speed between the transmitter and the receiver in a wireless system introduces Doppler Shift in the frequency received. This destroys the orthogonality of sub carriers and contributes to ICI. These types of causes create problems in practical system and should be given pre considerations in the design of broadband communication system.

II. TERMS USED IN OFDM SYSTEM

BER-: The bit error rate probability Pe is the expectation value of BER. The BER can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors. The mathematical representation of BER is given as-:

$$\mathrm{BER} = \frac{1}{2}\,\mathrm{erfc}\left(\sqrt{E_b/N_0}\right)$$

Where Eb is the energy per bit of the transmitted signal No is the noise present in the system.

In communication system, the receiver side BER may be affected by transmission channel noise, interference, distortion, bit synchronisation problems, attenuation, wireless multipath fading etc. The BER may be improved by choosing strong signal strength, by choosing slow and robust modulation scheme or line coding scheme and by applying channel coding schemes such as redundant forward error correction codes. The transmission BER is number of detected bits that are incorrect before error correction divided by total no of transferred bits. The information BER is affected by the strength of forward error correction code.

Factors affecting the system performance-: Fading, inter-symbol interference, inter-channel interference, channel, IFFT-FFT length are the factors that affect the system performance of OFDM system. Fading can be caused due to multipath propagation or due to shadowing. ISI can be caused due to multipath propagation and band-limited channel. ICI can be caused due to Doppler spreading. Channel may be affected by co-channel and adjacent channel interference. IFFT-FFT

length causes the inter-channel interference. ISI and ICI are the two main factors that can increases the BER in the OFDM system. For reducing the BER in system the channel is to be estimated by reducing these ISI and ICI.

A. *Inter-symbol Interference (ISI)* -: Inter-symbol interference is a form of distortion of signal in which one symbol interferes with the subsequent symbols. ISI can be caused due to multipath propagation effects of signal and band-limited channels.

   Multipath propagation -: multipath propagation is effect in which a wireless signal from a transmitter reaches the receiver via many different paths, which is caused by reflection, refraction and atmospheric effects such as atmospheric ducting and ionosphere reflection.

   Band limited channels-: Passing a signal through such a channel results in the removal of frequency components above this cut off frequency, in addition the amplitude of below the cut off frequency may also be attenuated by the channel.

B. *Inter carrier interference (ICI***)**-: For increasing the data rate in the OFDM system, the no. of sub carrier per OFDM symbol should be increased. By increasing the no. of sub carrier in the system the frequency spacing between the subcarrier is reduced. Due to which the ICI can be produced in the OFDM system. ICI can be caused by Doppler spreading and non- linear distortions due to high power amplifier.

   Doppler spreading-: The relative speed b/w transmitter and receiver in wireless system introduces spreading in the frequency b/w transmitter and receiver. This is the Doppler spreading, which destroys the sub carrier's orthogonality and contribute to ICI [1].

   Non linear distortions-: Due to high variations of signal transmitted, peak to average power ratio is typically large making operation over linear power amplifier is difficult. Then some part of signal is transmitted operate in the non linear region of power amplifier, due to which non linear distortions are introduced in the system resulting ICI [1].

There are different types of methods that are used to reduce these types of interferences. Cyclic prefix and zero padding type of methods are used to reduce the effect of inter symbol interference in the OFDM system for reducing the BER of system. For reducing the inter carrier interference different algorithm can be used to estimate the channel that are MLE, MSE and LSE type of estimator can be used to estimate the channel. In this way there are different types of methods algorithm are implemented for reducing the BER of system and improves the performance of the OFDM system.

III. RELATED WORK

There are number of works having been considered for the channel estimation to reduce the BER & increase the performance of the OFDM system. The M-QAM based system with best relay selection cooperative has BER better than the regular cooperative diversity techniques. But in this environment the transmitted signal reflects off several objectives and a result multiple delayed versions of the signal arrive at the receiver which causes the received signal to be distorted [4]. Then by varying different parameters the BER can be calculated, but in this the FFT/IFFT length was 1024 points and SNR was 60db with 64 QAM for max SNR and min BER values, after this there is no effect of varying the SNR value[5]. Then OFDM system with 64 subcarrier is simulated which has advantage of less processing time requirement and complexity. The spectral efficiency can be increased by increasing the number of sub carriers. The problem of peak to average power ratio can be reduced by using power amplifier but the non-linear distortions produced in the channel and leads to ICI [6].

Then the estimation in the frequency shift in the OFDM systems is considered. A maximum likelihood estimator (MLE) is proposed in which the acquisition range is determined to +0.5 or -0.5 of the carrier spacing. But the estimation gets worse since the number of symbols over which the average estimate is computed become smaller [7]. After that an estimation using a null symbol is introduced [8]. When a null (empty) symbol is transmitted to help the receiver to find the start of symbol by detecting the power drop. The disadvantage of this scheme is extra overhead introduced by transmitted null symbols. A trial and error scheme has been proposed but this scheme has two disadvantages. First the frequency offset is increased; second the overhead is high due to long search process until the freq. offset is found [9].

As mentioned above the subcarrier orthogonality can be destroyed by Doppler shift as a result of mobility of mobile stations. A few algorithms have been proposed for Doppler shift estimation but the algorithm can only be applied to signals on pilot subcarriers. Therefore for accurate estimation large number of OFDM symbols are required [10]. In [1] an algorithm is proposed for Doppler shift estimation based on autocorrelation of time domain channel. This result in higher complexity at receiver. In this paper, analytical approach is make to quantify the effects of channel impairments such as Doppler shift and High Power Amplifier (HPA) distortion on BER performance of OFDM systems.

IV. CONCLUSIONS

A theoretical analysis shows that the BER is increased in the system due to different impairments which reduces the performance of an OFDM system. In this paper theoretical analysis for ISI and ICI impairments can be done. The ISI can be caused by multipath propagation and band limited channel and ICI can be caused by Doppler spreading and non linear distortions of high power amplifier. The analysis in this paper presents the quantification of ICI and ISI in OFDM system based on these two impairments [1]. Based on some observations some conclusion can be drawn-: OFDM system is sensitive to ICI this sensitivity is increased with increase the number of subcarriers. OFDM system is sensitive to ISI this is increased by increasing the number of symbols and due to less frequency spacing. Amplifier distortion is one cause due to amplifier characteristics. Doppler shift is caused due to the speed of Mobile Station (MS). These issues should be given for consideration in the design of a broadband system.

REFERENCES

[1] Ahmed, H.A. Sulyman, A.I. and Hassanin, H.S. (2009) "*BER Performance of OFDM system with channel Impairments*," The 9th IEEE International Workshop on Wireless Local Networks (WLN 2009), October 2009 20-23.

[2] Yang, S.C. voltz, P.J. Cassara, F.A. (2001) "*on channel estimation and detection of multicarrier signals in fast and selective Rayleigh channel*," IEEE transaction on communication, vol. 49, No. 8, AUGUST 2001.

[3] Roy, T.K. (2012) "*Comparative BER performance analysis of OFDM system using M-PSK and M-QAM modulation schemes over AWGN channel*," Department of electronics and telecommunication Engineering, Rajasthan university of engineering & Technology, vol. 1, issue-4, August 2012.

[4] Vyas, P. Bohra, S. and Parihar, N. (2013)"*A comparison study for BER Performance in OFDM systems based on using M-QAM with detection techniques*," International Journal of Advanced Technology & Engineering Research, vol.3, issue 2, March 2013.

[5] Mohamed, M.A. Samarah, A.S. FathAllah, M.I.(2012) "*Study of Performance Effects on OFDM Systems*," International journal of computer science, May 2012, vol. 9, Issue 3,No. 2.

[6] Ghorpade, S.S. Sank pal, S.V.(2013) "*Behaviour of OFDM system using matlab simulation*," International journal of advanced computer research, vol.3, No. 2, Issue 10, June 2013.

[7] Moose, P. (1994) "*A technique for orthogonal frequency division multiplexing frequency offset correction*," IEEE Trans. Communication., vol. 42, no. 10, pp. 2908 - 2914, Oct. 1994.

[8] Ngami, H. Nagashima, T. (1995) "*A frequency and timing period acquisition technique for OFDM systems*," IEEE-Personal, Indoor and Mobile Radio Communications, pp. 1010 - 1015, Sep.1995.

[9] Classen, F. Mery, H. "*Synchronization algorithms for an OFDM system for mobile communication*," ITG-Fachtagung, pp. 105 - 113, Oct. 1994.

[10] Schober, H. Jondral, F. (2002) "*Velocity Estimation for based Wireless Communication Systems*," IEEE VTC'02, pp. 715 - 718, Sep. 2002.

