International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in

Vol.3., Issue.3, 2015

REVIEW ARTICLE

ISSN: 2321-7758

A REVIEW ON OFDM INTERFERENCE REDUCTION

GHULAM HASSAN JAGOO[1], Er. PUNEET JAIN[2]

[1]Post-graduation student, Department of ECE, AIET, Faridkot, India

[2]Assistant Professor,Department of ECE, AIET, Faridkot, India

Article Received: 29/04/2015 | Article Revised on:03/05/2015 | Article Accepted on:06/05/2015

GHULAM HASSAN JAGOO

ABSTRACT

As more and more people started using the communication equipment the demand for high data rates increased quickly. Orthogonal Frequency Division Multiplexing is one of the latest modulation technique used in order to combat the frequency selectively of the transmission channel, achieving high data rate without inter-symbol interference. OFDM is considered as the revolutionary, futuristic technology and acts as a key behind the LTE-4G cellular standard. Therefore it is crucial to understand the concept behind OFDM. In this paper it is given an overview of the basic principle on which this modulation scheme is based and different interference reduction techniques are mentioned with their effects on the OFDM system

Key Words—OFDM, Cognitive Radio, Guard carriers, Inter-symbol interference,inter-carrier cancellation.

I. INTRODUCTION

Spectrum is the most valuable resource in wireless system but not unlimited. Static spectrum allocation policies results in underutilization of the spectrum due to the fact that most of the permanently allocated spectrum is not utilized all the time hence results in spectrum holes in the time domain [1].In today's world, the demand for high speed wireless services growing exponentially but almost no spectrum is left for new services. There comes a new technology named Cognitive radio[2] which shows a new paradigm for efficiently utilize the spectrum in an intelligent manner. Cognitive radio tries to utilize the spectrum in opportunistic manner which basically works on the principle of detect-and –avoid (DAA). OFDM proved to be a suitable candidate for cognitive radios but high spectral sidelobes of OFDM have the tendency to interfere out –of-band as well as in band services. In today's world we are surrounded by many wireless services, so there is very high probability that two services have to share the same spectrum .The same congestion can be seen in ultra wideband (UWB) (3.1 – 10.6 GHZ), where primary services such as WiMax (3.5 GHZ) and IEEE802.11a (5 GHZ) has to share the same band with UWB systems. In order to coexist with already existing users called as primary user (PU),UWB systems should have the Cognitive Radio (CR)[2] capability to detect and create a notch on that portion of the spectrum which falls within the PU band.

The paper is organised as follow: In section II, we have literature survey. In section III basic principle is mentioned. In section IV operation is discussed and in section V conclusion is given.

II. LITRATURE SURVEY

It is well known that Chang proposed the original OFDM principles in 1966, and successfully achieved a patent in January of 1970. OFDM is a technique for transmitting data in parallel by using a large number of modulated sub-carriers. These sub-carriers divide the available bandwidth and are sufficiently separated in frequency so that they are orthogonal. The Orthogonality of the carriers means that each carrier has an integer number of cycles over a symbol period. In 1971, Weinstein and Ebert[3] proposed a modified OFDM system in which the discrete Fourier Transform (DFT) was applied to generate the orthogonal subcarriers waveforms instead of the banks of sinusoidal generators. Their scheme reduced the implementation complexity significantly, by making use of the inverse DFT (IDFT) modules and the digital-to-analog converters. In their proposed model, baseband signals were modulated by the IDFT in the transmitter and then demodulated by DFT in the receiver. Therefore, all the subcarriers were overlapped with others in the frequency domain, while the DFT modulation still assures their Orthogonality. Cyclic prefix (CP) or cyclic extension was first introduced by Peled and Ruiz in 1980 for OFDM systems. In their scheme, conventional null guard interval is substituted by cyclic extension for fully-loaded OFDM modulation. As a result, the Orthogonality among the subcarriers was guaranteed. With the trade-off of the transmitting energy efficiency, this new scheme can result in a phenomenal ISI (Inter Symbol Interference) reduction. Hence it has been adopted by the current IEEE standards. In 1980,Hirosaki introduced an equalization algorithm to suppress both inter symbol interference (ISI) and ICI[10] , which may have resulted from a channel distortion, synchronization error, or phase error. In the meantime, Hirosaki also applied QAM modulation, pilot tone, and trellis coding techniques in his high-speed OFDM system, which operated in voice-band spectrum. In 1985, Cimini introduced a pilot-based method to reduce the interference emanating from the multipath and co-channels. In the 1990s, OFDM systems have been exploited for high data rate communications. In the IEEE 802.11 standard, the carrier frequency can go up as high as 2.4 GHz or 5 GHz. Researchers tend to pursue OFDM operating at even much higher frequencies nowadays. For example, the IEEE 802.16 standard proposes yet higher carrier frequencies ranging from 10 GHz to 60 GHz. However, one of the main disadvantages of OFDM is its sensitivity against carrier frequency offset which causes inter carrier interference (ICI). The undesired ICI degrades the performance of the system. Number of authors has suggested different methods for ICI reduction. These methods are investigated and their performances are evaluated.

III. BASIC PRINCIPLE

The basic principle of OFDM is to split a high rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers because the symbol duration increases for the lower rate parallel subcarriers, the relative amount of dispersion in time caused by multipath delay spread is decreased[11].Orthogonal Frequency Division Multiplexing (OFDM) has grown to be the most popular communications systems in high speed communications in the last decade. In fact, it has been said by many industry leaders that OFDM technology is the future of wireless communications. Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier transmission technique, which divides the bandwidth into many carriers; each one is modulated by a low rate data stream. In term of multiple access technique, OFDM is similar to FDMA in that the multiple user access is achieved by subdividing the available bandwidth into multiple channels that are then allocated to users. However, OFDM uses the spectrum much more efficiently by spacing the channels much closer together. This is achieved by making all the carriers orthogonal to one another, preventing interference between the closely spaced carriers. Late 1997, Lucent and NTT submitted proposals to the IEEE for a high speed wireless standard for local area networks (LAN). Eventually, the two companies combined their proposals and it was accepted as a draft standard in 1998 and as a standard now known as IEEE802.11a standard, in 1999.

IV. THE OPERATION PRINCIPLE

OFDM is a combination of modulation and multiplexing. Multiplexing generally refers to independent signals, those produced by different sources[12]. In OFDM the question of multiplexing is applied to independent signals but these independent signals are a sub-set of the one main signal. In OFDM the signal itself is first split into independent channels, modulated by data and then re-multiplexed to create the OFDM carrier. If the FDM system above had been able to use a set of subcarriers that were orthogonal to each other, a higher level of spectral efficiency could have been achieved. The guard bands that were necessary to allow individual demodulation of subcarriers in an FDM system would no longer be necessary. The use of orthogonal subcarriers would allow the subcarriers spectra to overlap, thus increasing the spectral efficiency. As long as Orthogonality is maintained, it is still possible to recover the individual subcarriers signals despite their overlapping spectrums. It can be seen that almost half of the bandwidth is saved by overlapping the spectra. As more and more carriers are added, the bandwidth approaches (N+1)/N Bits per Hz. Larger number of carriers gives better spectral efficiency. The main concept in OFDM is Orthogonality of the sub-carriers. The "orthogonal" part of the OFDM name indicates that there is a precise mathematical relationship between the frequencies of the carriers in the system. It is possible to arrange the carriers in an OFDM Signal so that the sidebands of the individual carriers overlap and the signals can still be received without adjacent carrier's interference. In order to do this the carriers must be mathematically orthogonal. The Carriers are linearly independent (i.e. orthogonal) if the carrier spacing is a multiple of 1/Ts. Where, Ts is the symbol duration. The Orthogonality among the carriers can be maintained if the OFDM signal is defined by using Fourier transform procedures. The OFDM system transmits a large number of narrowband carriers, which are closely spaced. Note that at the central frequency of the each sub channel there is no crosstalk from other sub channels. In an OFDM system, the input bit stream is multiplexed into N symbol streams, each with symbol period Ts, and each symbol stream is used to modulate parallel, synchronous sub-carriers. The sub-carriers are spaced by 1/NTs in frequency, thus they are orthogonal over the interval (0, Ts). A typical discrete-time baseband OFDM transceiver system is shown in Figure First, a serial-to- parallel (S/P) converter groups the stream of input bits from the source encoder into groups of log2M bits, where M is the alphabet of size of the digital modulation scheme employed on each sub-carrier. A total of N such symbols, Xm, are created. Then, the N symbols are mapped to pins of an inverse fast Fourier transform (IFFT). These IFFT bins correspond to the orthogonal sub-carriers in the OFDM symbol. Therefore, the OFDM symbol can be expressed as

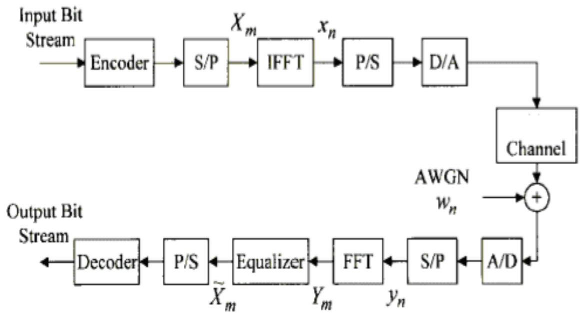
$$x(n) = 1/N \sum_{m=o}^{N-1} X_m e^{j2mn\pi/N}$$

$$0 \leq n \leq N-1$$

Where Xm are the baseband symbols on each sub-carrier. The digital-to-analog (D/A) converter then creates an analog time-domain signal which is transmitted through the channel. At the receiver, the signal is converted back to a discrete N point sequence y(n), corresponding to each sub-carrier. This discrete signal is demodulated using an N-point fast Fourier transform (FFT) operation at the receiver. The demodulated symbol stream is given by

$$Y(m) = \sum_{m=o}^{N-1} y(n)\, e^{-j2mn\pi}/N + W(m)$$

Where W (m) corresponds to the FFT of the samples of w (n), which is the Additive White Gaussian Noise (AWGN) introduced in the channel. The high speed data rates for OFDM are accomplished by the simultaneous transmission of data at a lower rate on each of the orthogonal sub-carriers. Because of the low data rate transmission, distortion in the received signal induced by multi-path delay in the channel is not as significant as compared to single-carrier high-data rate systems. For example, a narrowband signal sent at a high data rate through a multipath channel will experience greater negative effects of the multipath delay spread, because the symbols are much closer together. Multipath distortion can also cause inter-symbol interference (ISI) where adjacent symbols overlap with each other. This is prevented in OFDM by the insertion of a cyclic prefix between successive OFDM symbols. This cyclic prefix is discarded at the receiver to cancel out ISI. It is due to the robustness of OFDM to ISI and multipath distortion that it has been considered for various wireless applications and standards.OFDM is a recognized approach for implementing UWB systems[12]. It promises to deliver very high data rates up to 480 Mbps. MB-OFDM is highly flexible and a good candidate for cognitive radio CR.



OFDM transceiver system.

The easiest way of creating notch is turning off the OFDM tones. Various sidelobe suppression techniques have been given which are performed in time or frequency domain .Time domain windowing[4] ,adaptive symbol transition[5] are implemented in time domain. Both the technique result in reduced throughput due to the extension of symbol in the time domain. In frequency domain, tones nulling [6] can be used but this is not sufficient for interference suppression. Further suppression can be done by applying active interference cancellation(AIC)[7] which introduces aic –edge tones to nullify the side lobe interference. More techniques such as spectral precoding [8] subcarrier weighting (SW)[9] multiply data carriers with some weighting factor to reduce sidelobes.

V. CONCLUSION

In this paper we summarized the review of OFDM interference reduction .We mention various interference reduction techniques with their effect on the important parameters of OFDM. So to reduce the interference between subcarriers we have to kept different parameters in the mind before going ahead with the interference reduction.

REFERENCES

[1]. FCC “Spectrum policy task force report,” ET Docket NO. 02- 135, Nov.2002.

[2]. Simon Haykin, “Cognitive radio: brain –empowered wireless communication,” IEEE journal on selected areas in communication,vol.23, no.2,pp 201-220, Feb. 2005.

[3]. S.Weinstein&P.Ebert-Data transmission by frequency division multiplexing using Discrete Fourier Transform IEEE Trans.vol.19, issue:5pp.628-634 oct 1971.

[4]. T.Weiss, J.Hillenbrand. A. Krohn, and F.K. Jondral, “Mutual interference in OFDM-based spectrum pooling system, “in proc. IEEE Veh. Tech Conf. ,Milan , Italy, vo.4,pp. 1873-1877, May 2004

[5]. H.A. Mahmood andH.Arslan, “sidelobe suppression in OFDM –based spectrum sharing system using adaptive symbol transition .” IEEE Coummun, Lett., vol.12 ,no.2,pp.113-135,Feb.2008.

[6]. T.A. Weiss abdF.K,Jondral, “spectrum pooling an innovative strategy for the enhancement of spectrum efficiency.” IEEE Commune., Mag.,Radio commune .suppl.,pp8-14,Mar. 2004.

[7]. H. Yamaguchi, “Active interference cancellation technique for MB-OFDM cognitive radio,” in proc .Eur. Microw. Conf.,Amsterdam ,Netherland ,vol.2, pp.1105-1108, Oct. 2004.

[8]. C.D. Chung , “spectral precoding for rectangularly pulsed OFDM ,” IEEE Trans. Commune ., vol.56, pp. 1498-1510, Sep.2008.

[9]. I. Cosovic, S.Brandes,M.Schnell, “subcarrier weighting a method for sidelobe suppression in OFDM system ,”IEEE Commune . Lett., vol. 10, pp. 444-446, june 2006.

[10]. B.Hirosaki “An analysis of automatic equalizers for orthogonal multiplexed QAM system”, IEEE Trans. Vol.COM-28, pp.73-83 jan 1980.

[11]. Richard Van Nee Ramjee Prasad “OFDM for wireless multimedia communication”.

[12]. Hirohisa Yamaguchi “Active interference cancellation technique for MB-OFDM cognitive radio .IEEE journal 2004.