Synchronization of OFDM to Overcome High Data Rate Problems

Nirali Patel
Department of Electronics & Communication,
Marwadi Education Foundation Group of Institutions, Rajkot, India
nirali.ec.patel@gmail.com

***Abstract* — Transfer the information data without wire is more challenges for us. Not only for communication purpose but also research point of view is quite difficult. Transfer the multimedia data is fast as possible without any degradation of quality performance. Now a day wireless communication is more essential to use as well as manufacturing. User requires more quality when they work with multimedia data. And device which related to transfer these types of data is requiring more capacity and give us high quality of multimedia data. OFDM (orthogonal frequency division multiplexing) is a modulation technique that achieves high data rates and increase band width efficiency and use to multipath environment. OFDM have ICI which create noise. So that studies about OFDM technique and its block and analysis of that transmitter model first. Then study and analysis of receiver side block that support the high data rate and its performance quality also increase. The aim of this paper is to survey and compare earlier methods for Data-aided in receiver side synchronization of OFDM System and support multi bit communication.**

***Terms* — Orthogonal Frequency Division Multiplexing (OFDM), Inter Symbol Interference (ISI), Inter Channel Interference (ICI).multi gigabit.**

I. Introduction

Basic concept high speed communication using a large number of corresponding narrowband subcarriers like parallel communication instead of a single wide-band carrier to transport information OFDM is a multi-carrier transmission technique, which divides the accessible spectrum into many Subcarriers. A rectangular pulse is used as a sub carrier for transmission. each one being modulated by a low Data rate stream it uses serial to parallel conversation scheme as shown in figure The employment of discrete Fourier transform to replace the banks of sinusoidal generator and the demodulation significantly reduces the implementation complexity of OFDM modems At Receiver Side. The Orthogonal Frequency Division Multiplexing (OFDM) is very important broadcast technique that belongs to the category of multicarrier modulation techniques. It solves the problems like ISI and ICI encountered by the conventional single carrier transmission techniques for high data rate transmission or multigiga bit communication. In addition to this it provides higher bandwidth efficiency as compared to conventional multicarrier modulation techniques. Similar to conventional multicarrier modulation techniques, here the single high data rate stream is divided into several low data rate streams and modulated over different subcarriers. The only difference is the orthogonality of the subcarriers. The word orthogonal indicates that there exists a precise mathematical relationship (i.e. independence) between the frequencies of the subcarriers used in OFDM system. The subcarrier frequencies are selected in such a way that they are orthogonal to each other show figure1. Due to orthogonality property of subcarriers they can overlap each other in the frequency domain without interfering with each other and thus resulting in the higher spectrum utilization or greater spectrum efficiency, and also the data can be recovered on the receiver side without any Inter Channel Interference (ICI). The spectra of overall OFDM signal with multiple subcarriers. The individual subcarrier spectrum is sinc (i.e. $\sin(x)/x$) in shape and the overall spectrum of the OFDM signal consists of sinc pulses arranged in such a way that the side-lobes of the individual subcarriers overlap each other whereas at the peaks of the main lobes all other subcarriers are zero resulting in the zero ICI and high spectral efficiency. In an OFDM system, the total available bandwidth B Hz is divided into N subcarriers. These N subcarriers are spaced in frequency domain with the frequency spacing of $f = B/N$. The binary data is first mapped into digital symbols using digital modulation like QAM, QPSK etc., and then is modulated to subcarriers. The OFDM signal is the sum of these individually modulated subcarriers.

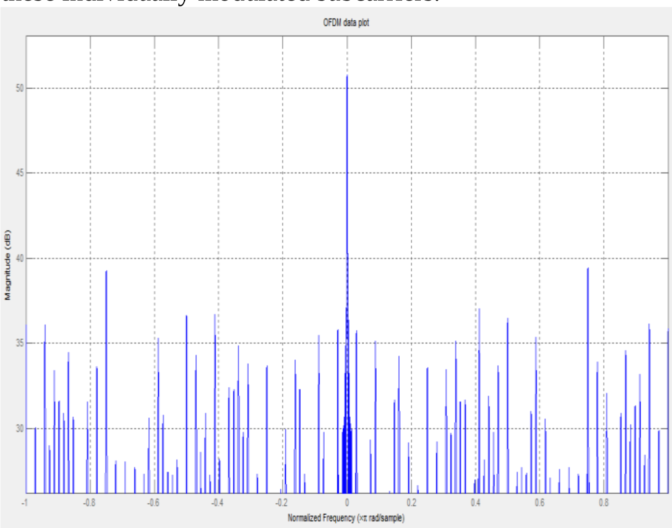

Figure.1.OFDM PLOT

II. PROBLEM STATEMENT

Inter Symbol Interference (ISI) is the major problem caused by high data rate transmission using conventional transmission techniques. It is a form of signal distortion in which previous symbol interferes with subsequent symbols causing the distortion of subsequent symbols. Multipath propagation of wireless signal and band limited channels are the two factors causing ISI [5] [3].Therefore, in this paper we will categorize the problem of ISI as multipath propagation problem and band limited channel problem. Multipath propagation problem: This problem arises when the channel being used for transmission of data is wireless channel. The signal reaches the receiver end propagating through different paths. This phenomenon is called as multipath propagation of wireless signal. The time taken by the signal to reach the receiver end from the transmitter end is directly proportional to the path length between the transmitter and the receiver end. Therefore due to different path lengths for multipath propagation the delay time of the received signal at the receiver end varies. the different delay times for the received signals due to multipath propagation of a signal through wireless channel. In the Plot, the upper part of the figure shows two different narrow pulses being transmitted by transmitter at different time instants. The received signal consists of the desired line of sight (LOS) pulses plus the multiple delayed secondary pulses due to multipath propagation of the primary pulses. Depending upon the pathway length, the delayed pulse may arrive at the receiver at the same time as the second main pulse. This peak is shown in Plots. This delayed pulse will act as a form of noise to the second primary pulse. This will make the recovery of the bit information more difficult and will therefore increase the bit error rate of the system [5]. This type of distortion or interfering is known as the Inter Symbol Interference (ISI). As the bit rate is increased the transmission time for individual pulses decreases. Therefore the transmission pulses in the time domain become narrow and the effect of channel delay spread increases. Therefore the distortion of the signal due to ISI increases with the increase in the bit rate of the system. Band limited channel problem: Band limited channel is the channel whose frequency response is zero above and below certain cut-off frequencies. It is present in both the wireless and cable channel communication systems. When the signal is passed through such a channel the frequency components above the cut-off frequencies are completely removed. Since the high frequency components present in the signal causes the sharp transitions in the time domain signal; therefore the removal of higher frequency components due to band limited channel results in slow transitions in time domain therefore making the time domain pulse spread. This distortion due to pulse spreading is referred as Inter Symbol Interference (ISI).

III. SYNCHRONIZATION METHODS

SYNCHRONIZATION: In OFDM systems, the main synchronization parameters to be estimated are a sync flag indicating the presence of the signal (especially for burst-mode transmission), the starting time of the FFT window (timing synchronization), the frequency offset due to the inaccuracies of the transmitter and receiver oscillators, and the Doppler shift of the mobile channel, as well as the channel estimates if coherent reception is adopted[7]-[9]. The sync flag can be generated by automatic gain control (e.g., ramp-up indication via power measurement and threshold decision) or using a training symbol (which can also be used for timing synchronization and possibly frequency synchronization). For the latter case, the same metric used for timing synchronization may be used together with the threshold decision, in order to generate the sync flag. After detecting the presence of the signal, the other sync parameters are estimated.

[1] Schmidl's method

Two timing symbols are placed at the beginning of each frame as preface. Here, the sequence used to make the timing sequence should be select on base of having a low peak-to-average power ratio so that there is little distortion in the transmitter amplifier to detect the frame, the conjugate of a sample from the first half is multiplied by the equivalent sample from the second half, and then at the start of the frame, the products of each of these pairs of samples will have approximately the same phase and the magnitude of the sum will be peaked [4].

$$CP=[A, A] \tag{1}$$

The *timing metric* of this estimator is given by following Equation

$$p(d)=\sum_{m=1}^{l-1}(r_d \cdot r_{d+m}) \tag{2}$$

$$R(d)=\sum_{m=1}|r_{d+m}|^2 \tag{3}$$

$$m(d)=\frac{|p(d)|^2}{(R(d))^2} \tag{4}$$

[2] Minn's method

Based on Schmidl method, Minn method modified the training sequence's pattern and timing metric's definition and designed the first training symbol having four parts with following patterns

$$CP=[A, A,-A,-A] \tag{5}$$

where A represents samples of length $L = N / 4$ generated by $N/4$ point IFFT of N length modulated data of a sequence. The *timing symbol* used in the evaluation of the technique is given by Equation 6

$$p(d)=\sum_{k=0}^{1}\sum_{m=0}^{L-1}(r_{d+2Lk+m}\cdot r_{d+2Lk+m+L}) \tag{6}$$

$$R(d)=\sum_{k=0}^{1}\sum_{m=0}^{L-1}|r_{d+2kL+m+L}|^2 \tag{7}$$

Here r is the received signal, and d is a time matrix equivalent to the first sample in a sliding window of 4L samples. Figure4 show the magnitude response using two parameter P(d) and R(d).

[3] Park's method

Minn's method reduces the timing metric found in Schmidl's method but the MSE is still large particularly in ISI channels. This is resulted from the timing metric values around the correct timing point in Minn's method are almost the same. Park method proposed to increase the difference between the peak timing metric with respect to other metric values. The proposed method entails modifying the training sequence's pattern and timing metric's definition to maximize the different pairs of product between them [4]-[6].

$$CP=[A,B, A^*, B^*] \tag{8}$$

The first training symbol having four parts with the following patterns:

$$p(d)=\sum_{k=0}^{\frac{N}{2}}(r_{d-k} \cdot r_{d+k}) \tag{9}$$

$$R(d)=\sum_{m=1}^{N/2}|r_{d+m}|^2 \tag{10}$$

Where A represents samples of length $L = N / 4$ generated by FFT of a PN sequence. *B* is designed to be symmetric with *A.*

*A** and *B ** are conjugate of *A* and *B* respectively. Figure show the magnitude response using two parameter P(d) and R(d).

IV. Simulation Results

In this section, the proposed algorithm shows the estimation Performances for OFDM signals in P & R Parameter. The simulations were performed for the base-band model of signals. Data symbols are modulated with each carrier. The estimation performances with varying parameters of System Channels in shifted data are shown below. Correct estimation probability in the graph indicates figure 4 and figure 5. the proposed algorithm exactly estimating each parameter. From the result, P & R is recognized with 100% probability.

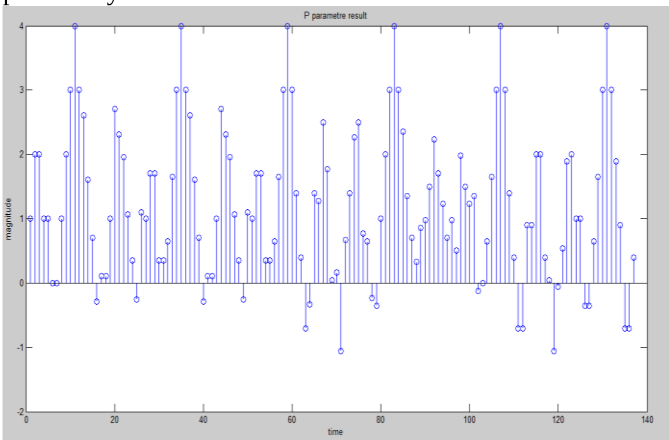

Figure 2:P parameter

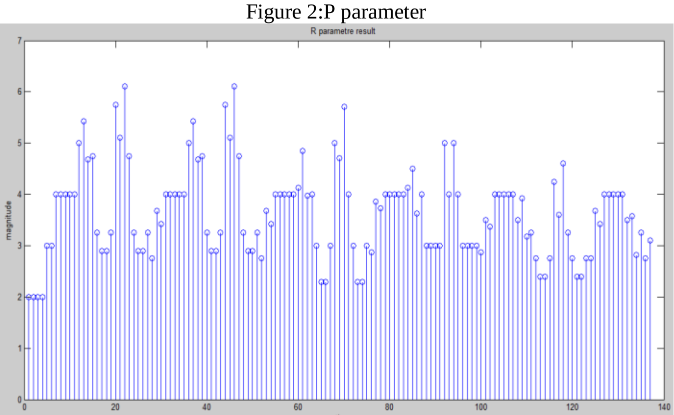

Figure 3: R Parameter

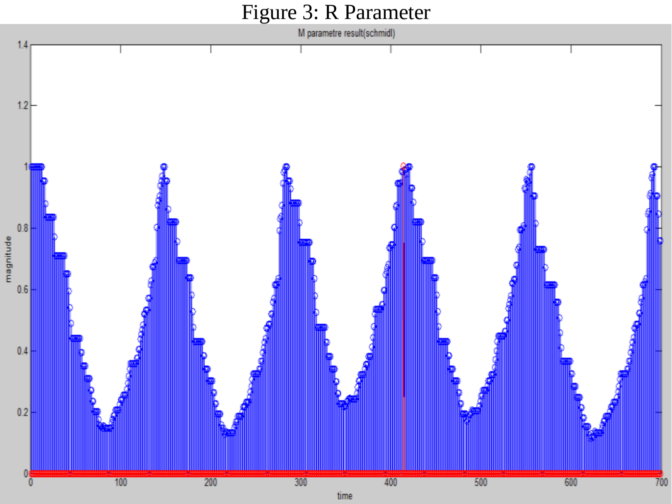

Figure.4. M parameter of Schmidl's method

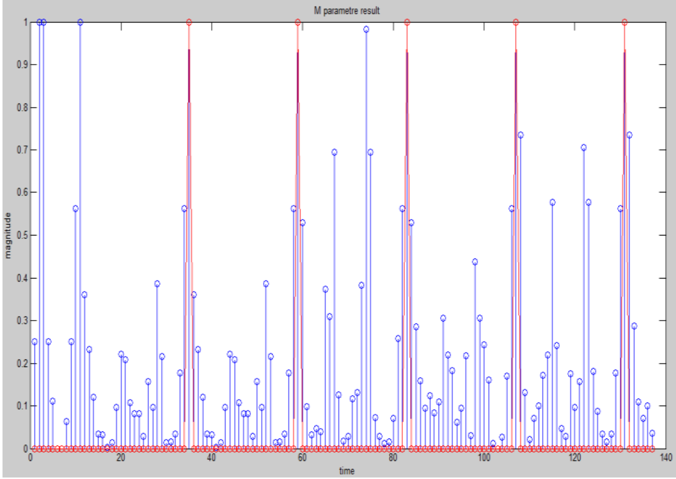

Figure 5. M Parameter of minn's method

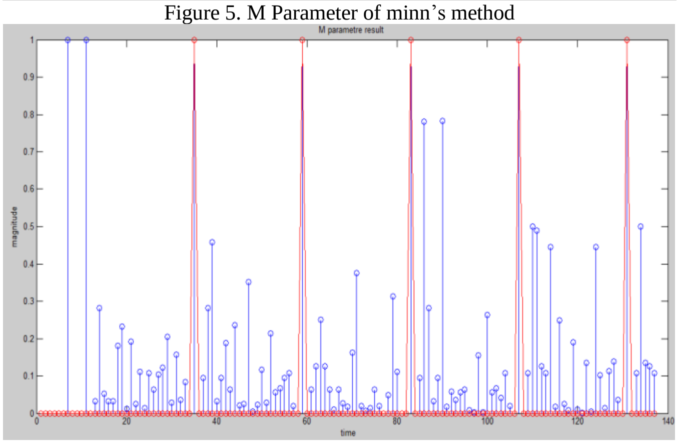

Figure 6. M Parameter of Park's method

V. ADVANTAGES OF TECHNIQUES

[1]Multi-path Delay Spread Tolerance

The increase in the symbol time of the OFDM symbol by N times (N being the number of sub-carriers), leads to a corresponding increase in the effectiveness of OFDM.

[2]Effectiveness against Channel Distortion

A typical example would be the twister-pair used in telephone lines. These transmission lines are used to handle voice calls and have a poor frequency response when it comes to high frequency transmission. In systems that use single-carrier transmission, an equalizer might be required to mitigate the effect of channel distortion In OFDM systems on the other hand, since the bandwidth of each sub-carrier is very small, the amplitude[8] response over this narrow bandwidth will be basically flat (of course, one can safely assume that the phase response will be linear over this narrow bandwidth). Even in the case of extreme amplitude distortion, an equalizer of very Simple structure will be enough to correct the distortion in each sub-carrier.

[3]Throughput Maximization & Latency minimization [9]

The capacity of transmitting data packet per second will increase and times from transmitter to receiver for one packet will decrease the symbol duration of the OFDM Symbol, it can be possible to change and according to Symbol duration latency and through put will vary.

VI. STANDARD COMPARISON

[1]IEEE 802.11a

An 802.11a network, which broadcasts on the 5GHz frequency band, supports 12 simultaneous channels (in North American). Maximum data rate 12*54=648 Mbps[6].

[2]IEEE 802.11b

A 802.11b network supports three non-overlapping channels (worldwide), each with a peak data rate of 11 Mbps. Maximum data rate 3*11=33 Mbps[5].

[3]IEEE 802.11g

An 802.11g installation supports three channels, each with a peak rate of 54 Mbps. Maximum data rate 3*54=162 Mbps[5].

CONCLUSION

In this paper we summarized the high data rate problems with the conventional transmission techniques. Then we presented the use of OFDM in solving the high data rate problems by three schmidl, minn & park transmission techniques. OFDM solves the problem of ISI due to high data rates. Park method is give to high peak value and less side peak. High peaks value show that synchronization of OFDM symbol is perfect. That high peak provide where exactly frame was start. It also provides other advantages like high spectral efficiency, low ICI. Some of the major applications of OFDM include digital audio broadcasting, digital video broadcasting, local area networks etc. Despite of all these advantages and applications the ISI is one major disadvantage of OFDM that is somewhat restricting its use on larger scale. This disadvantage needs to be addressed properly to allow further widespread use of OFDM.

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