Performance Comparision of OFDM Synchronization Techniques

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Abstract*- In the recent years there occurs a rapid growth in wireless communication which increased the need of high speed data transmission.The future wireless systems are expected to support a wide range of services which includes video, data and voice. Orthogonal Frequency Division Multiplexing (OFDM) is a promising candidate for achieving high data rates in mobile environment because of its multicarrier modulation technique and ability to convert a frequency selective fading channel into several nearly flat fading channels. In this project, Performance Comparison of OFDM synchronization technique is considered. Timing offset, Carrier frequency offset and Phase offset are considered. Symbol synchronization is done with the help of Training Sequence which is deviated from conventional cyclic prefix based synchronization. Cyclic Prefix of the OFDM symbol has been used in Carrier frequency offset estimate based on Maximum Likelihood Estimate (MLE).Phase offset estimation was also carried out with the help of training sequences. These estimated offsets were used to make corrections in the received signals to achieve better signal power to noise power ratio at the input of the detector.

I. INTRODUCTION

The evolution of wireless technologies had grown up remarkably since 1897 .Orthogonal frequency division multiplexing (OFDM) is the most popular Communication system which evolved as the future.

The differences occurring between OFDM and FDM are shown below in fig 1 the fig 2 below shows OFDM transceiver which converts digital data and maps it's to subcarrier amplitude and phase. It transforms spectral representation of data to space domain

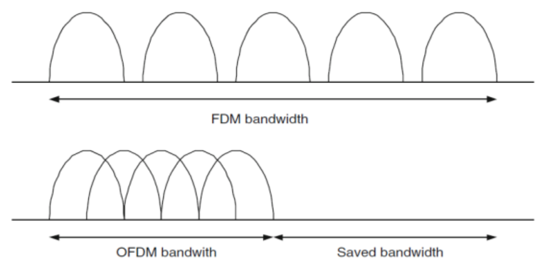

Figure 1.1 Frequency spectrums of FDM signal and OFDM signal

The Inverse Fast Fourier Transform (IFFT) can be used to perform the above operations but it is much more computationally inefficiency. The OFDM signal is transmitted by mixing up required frequency. In the receiver side the reverse of mixing the RF signal to base band for processing is used and then FFT is used to analyze the signal in the frequency domain.

Now consider Orthogonal Frequency Division Multiplexing (OFDM) system which is illustrated in figure 1.4.The input data bits are initially mapped using the modulation QPSK in which the bits are grouped as symbols and then Inverse Fast Fourier transform is taken. After that the training sequences and cyclic prefix are inserted which are again passed through the AWGN and Fading channel. Using synchronization, the OFDM symbols are mapped to the original position. After removing of cyclic prefix, training sequences and FFT is taken. After that symbols are decoded into bits.

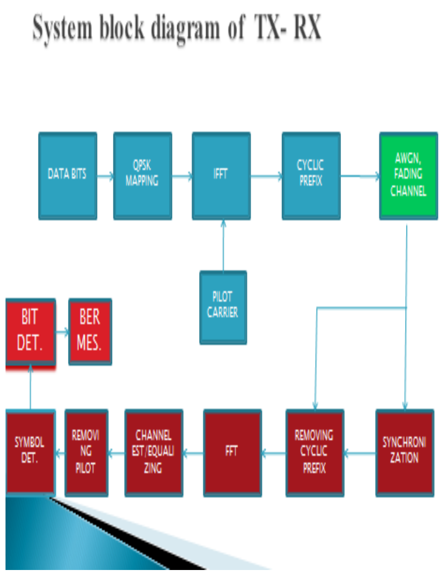

Figure 1.4 Block diagram of OFDM System with Synchronization

Certain issues associated with the receiver sub-system are

High sensitive time synchronization

Frequency offset synchronization and frequency-selective fading channels.

II. RELATED WORKS:

The various previous works related to this work is stated below:

- ➢ In [1], the authors discussed about synchronization using training sequences. Estimation of timing offset, frequency offset are done in this report.
- ➢ In [2], symbol detection using one training sequence for two symbols. The algorithm use Cram´er–Raolower bound for frequency offset .
- ➢ In [3], describes about Maximum Likelihood Estimation (MLE) of symbol and carrier frequency offset with the help of Cyclic prefix .

In [4], describes optimal ML estimator of time and frequency offset using window. The correlation residing in cyclic prefix samples and useful data samples

III. PROPOSED WORK

The aim of this work is to study the receiver synchronization algorithm of OFDM systems which is shown in figure 1.4 by simulating a transceiver. With the help of design specification chosen, the algorithm in [1] was carried out with the help of MATLAB simulation considering the effects of multipath channel impairments, Carrier Frequency Offset (CFO) and synchronization of OFDM symbol.

The techniques involved in synchronization of OFDM receiver over time, carrier frequency and phase offsets are described. The simulation specifications and observed results are also disused in this paper.

The block diagram of OFDM system shown in figure has been carried out with the following design specifications with anomalies described in the earlier chapters like Time offset, Carrier Frequency offset and phase offset.

IV. DESIGN SPECIFICATIONS

In this work, the simulation parameters have taken as stated in [1]. This used 256 point fast Fourier transform (FFT) with 240 active subcarriers, 15 guard subcarriers, 14 cyclic prefix, sample frequency of 1.6MHz, subcarriers spacing of 6.25kHz, number of OFDM symbols per time slot is 4, training sequences of 128.

V. SIMULATION OF OFDM SYSTEM IN AWGN CHANNEL

In the first step simulation was carried out to estimate the effect of AWGN channel on bit error rate (BER) performance over signal power to noise power ratio (SNR). The simulated result is plotted in figure 4.1, and it is observed that OFDM system requires minimum of 11dB SNR to yield BER of 10^{-4}.

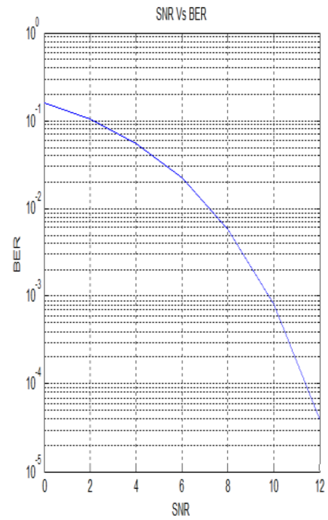

Fig 3.1 SNR vs. BER curve for AWGN channel

VI. SIMULATION OF OFDM SYSTEM IN RAYLEIGH CHANNEL

The simulation of OFDM system is carried out with the help of following design specification in Rayleigh multipath channel.

pling Time	0.1ns
lays in ns	781 156 2344
ins in dB	-3 -6
pread	2344ns
r shift	0
type	ıcy selective & ding

Table 3.2 Design specification

VII. SYMBOL SYNCHRONIZATION OF OFDM SYSTEM

Awell-known drawback of OFDM is that it requires accurate symbol synchronization because the OFDM signal is demodulated based on symbol structure and the arriving time of the received signal isunknown. Wrong symbol synchronization would cause the inter-symbol interference (ISI), and then bring up an increase of bit error rate (BER), so it is essential to achieve accurate and fast symbol synchronization for OFDM system.

The following graph shows that when offset = 125 and estimated timing is 1084, the OFDM system gets synchronized to the estimated timing.

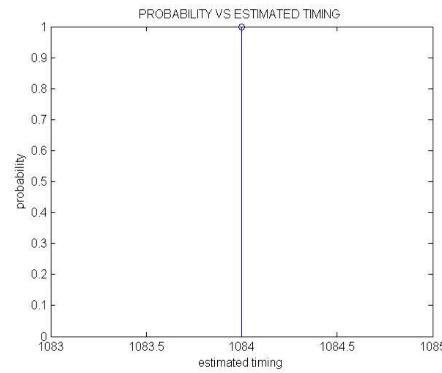

Figure 3.2 Probability occurrence of estimated timing

VIII. OBSERVATIONS

- From the simulation it has been inferred that after an SNR value greater than 0 dB OFDM system is properly synchronized.
- For different value of offsets, simulation is confirms that the system gets exactly synchronized for positive SNR.

IX. CARRIER FREQUENCY OFFSET ESTIMATION:

As we saw in the earlier chapters CFO is due to the mismatch of the RF oscillator in the transmitter and receiver side of the OFDM system.

In the figure 4.3 as SNR value increases, MSE of estimated CFO decreases under Rayleigh channel.

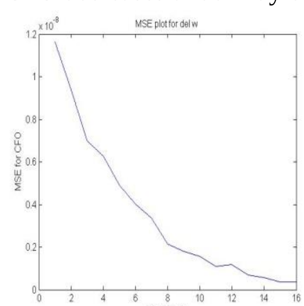

Figure 4.3 SNR Vs MSE for Δω=0.0019

The following table gives estimated offset for SNR=20 dB.

Frequency offset	**Estimated offset(AWGN channel)**	**Estimated offset (Rayleigh channel)**
0.0019	0.0019	0.0014
0.0029	0.0029	0.0027
0.0039	0.0039	0.0040
0.0049	0.0049	0.0047
0.0059	0.0049	0.0055
0.0069	0.0069	0.0067
0.0079	0.0079	0.0083
0.0089	0.0089	0.0084

It is observed that the offset is possible to estimate exactly while the channel is AWGN. If the noise increases or channel becomes highly faded, the error in the estimate becomes larger beyond the values shown in the table 4.3.

X. CONCLUSION

Thus in this project OFDM system is simulated based on the selected specifications and receiver algorithm was verified with the help of MATLAB by considering the receiver design anomalies like timing offset, Carrier Frequency Offset, phase offset. Timing synchronization is done with the help of training sequences inserted between the OFDM symbols. Carrier frequency offset is cancelled by means Maximum Likelihood Estimate (MLE) and Phase offset is estimated and corrected with the help of training sequence

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