Performance Analysis of Different Modulation Techniques for OFDM System

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ABSTRACT
Orthogonal Frequency Division Multiplexing (OFDM) is a strong candidate for coming generation wireless system which ensures efficient utilization of the bandwidth by allowing overlap of carriers. OFDM is a combination of modulation and frequency division multiplexing as well as time division that is used in the transmission of signal. OFDM has lots of advantages like high spectral density, robustness to channel fading, ability to overcome many radio impairment factors such as effect of AWGN, multipath fading, impulse noise etc. when compared with the other transmission techniques like Frequency Division Multiple Access (FDMA), Code Division Multiple Access (CDMA) used in wireless, Due to this it finds wide range of applications in Digital Audio Broadcasting as well as Digital Video Broadcasting and Wireless LAN. Most of the wireless LAN standards such as IEEE 802.11g and IEEE 802.11a use the OFDM as the main multiplexing scheme for better utilization of bandwidth. In fact OFDMA is the backbone of 4G telecommunication system recently. In this paper the software simulation of OFDM system in a mobile radio channel using the MATLAB software design tools and SIMULINK model. From this simulation the performance of OFDM system in radio communication channel is evaluated.

Index Terms- *OFDM, BER, SNR, BPSK, QPSK, Transmitter, Receiver.*

I. INTRODUCTION
Wireless communication has been the talk of the town from the starting of this decade, may it be the auctioning of the 3G spectrum in various developing countries including India or the launch of wireless Internet services by different service providers. With the increasing traffic for the wireless communication the need for the more efficient use of the spectrum available holds the key. Along with that the 4G communication system are also peeping their head out in developed countries like USA and UK [1]. Obviously as the generation is advancing it is expected to have higher data rates, high spectral efficiency. Of course achieving this data rate requires careful selection of multicarrier modulation scheme available. Many multiple access techniques like FDMA, TDMA, CDMA, WCDMA, OFDMA, etc have come up. OFDM being the newest of the lot, what attracted us is to see the performance of this system in the mobile radio channel and how it is better than the other techniques [2]. In short, what appealed us is to find the advantage and disadvantage of this system so that the reason for its implementation in the wireless communication becomes clear [3-4]. The main objective of this paper is to study and investigate the effect of several radio channel impairment factors to the performance of OFDM system as well as to study and investigate the performance of OFDM in the mobile radio channel. To do this the best way is the simulation of the system which can be done easily with the help of software like MATLAB and SIMULINK. Also an application of the OFDM scheme can to be studied and implemented using simulation model. It is increasingly believed that OFDM results in an improved downlink multimedia services requires high data rates communications, but this condition is significantly limited by inter-symbol interference (ISI) due to the existence of the multiple paths. Multicarrier modulation techniques, including OFDM modulation are considered as the most promising technique to combat this problem [5]. OFDM technique is a multi-carrier transmission technique which is being recognized as an excellent method for high speed bi-directional wireless data communication. In wireless, satellite, and space communication systems, reducing error is critical. OFDM is a subset of FDM in which a single channel utilizes multiple sub-carriers on subsequent frequencies. Wireless medium is quite different from the counterpart using wires and provides several advantages, for example: mobility, better productivity, low cost, easy installation facility and scalability. On the other hand, there are some restrictions and disadvantages of various transmission channels in wireless medium between receiver and transmitter where transmitted signals arrive at receiver with different power and time delay due to the reflection, diffraction and scattering effects. Besides the BER (Bit Error Rate) value of the wireless medium is relatively high. These drawbacks sometimes introduce destructive effects on the wireless data transmission performance. As a result, error control is necessary in these applications. During digital data transmission and storage operations, performance criterion is commonly determined by BER which is simply: Number of error

bits / Number of total bits. Noise in transmission medium disturbs the signal and causes data corruptions. Relation between signal and noise is described with SNR (signal-to-noise ratio). Generally, SNR is explained with signal power / noise power and is inversely proportional with BER. It means, the less the BER result is the higher the SNR and the better communication quality.

II OFDM

Orthogonal Frequency Division Multiplexing (OFDM) is a transmission technique used for multicarrier system, it means the bandwidth is subdivided into too many carriers and each carrier is modulated by a slower data rate stream. OFDM is quite similar to FDMA in which multiple user access is achieved by subdividing the available spectrum into multiple no. of channels that are assigned to users. Although OFDM uses the bandwidth more efficiently by spacing all the channels together. The prime idea is that all queuing data in buffer are uniformly allocated on small subcarriers. OFDM efficiently squeezes multiple performances for 4G [6]. The world standard bodies such as IEEE and ETSI have selected the OFDM as their physical layer techniques for the next generation of wireless systems [7]. The growing demand for modulated carriers tightly together reducing the required bandwidth but keeping the modulated signals orthogonal so that they do not interfere with each other. OFDM that is highly efficient technique shows favorable properties such as robustness to channel fading and inter symbol interference (ISI) and is more immune to noise. OFDM system is capable of mitigating a frequency selective fading channel to a set of parallel flat fading channels, which relatively simple processes for channel equalization OFDM systems need have gained an equivalent attention with flat fading environment [8]. In, present the method of Channel estimation and Carrier frequency offset to design an OFDM receiver in flat fading environment. However, BER performance of OFDM system in flat fading channel using BPSK modulation technique is studied by [9]. So our motivation behind this paper is to study the performance of OFDM system using flat fading channel of AWGN channel & calculate bit error rate.

Multicarrier modulation technique saves almost half of bandwidth by overlapping shown in fig. 2. The realization of overlapping multicarrier technique reduces crosstalk between subcarriers, which means orthogonality between the different modulated carriers.

To eliminate interference the pulse-shaping filters can be used in the frequency domain from adjacent channels, it can also be used Intersymbol interference (ISI) to eliminate interference from adjacent symbols over the same channel caused by multi-path fading. Figure 1 shows the implementation of a pulse shaping filter on each generated symbol As the image shows that in the middle of the symbol period the maximum amplitude of the pulse-shaping filter is occurred.

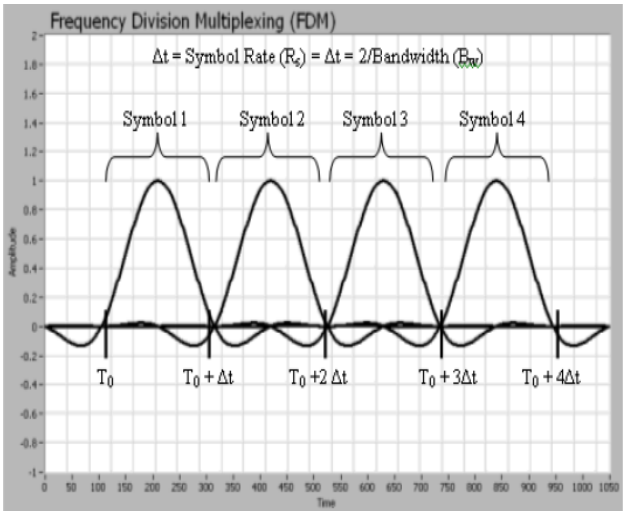

Figure 1: Implementation of a pulse shaping filter

The peak amplitude of each symbol corresponds directly to the zero-crossing point in the beginning and ending portions of the symbol period are attenuated. Inter symbol interference (ISI) can be reduced by providing a pseudo-guard interval while still limiting channel to a specified bandwidth.

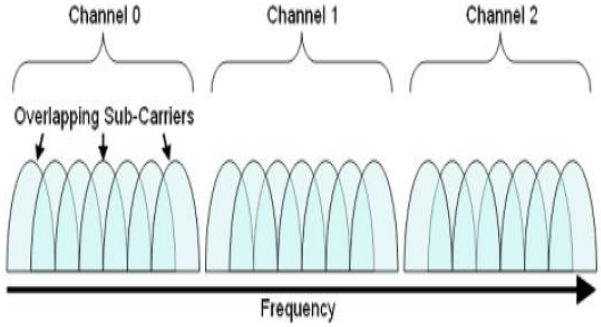

Figure 2: Frequency domain representation of OFDM

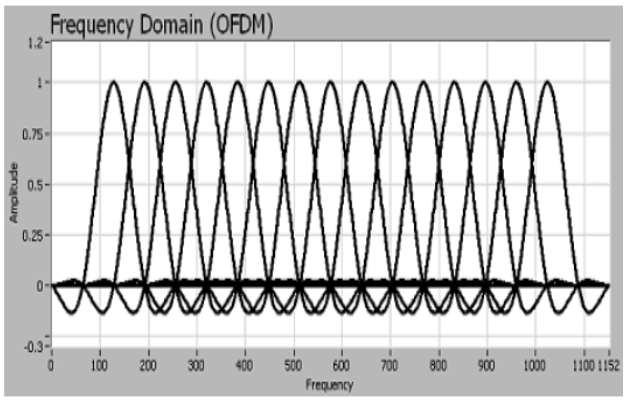

Figure 3: Frequency domain representation of OFDM

A transmission channel is divided into many smaller sub channels or subcarriers. The subcarrier frequencies and

spacing are chosen so they are orthogonal to one another. Their spectra won't interfere with one another, then, so no guard bands are required. Most broadband systems are subject to multipath transmission. Conventional solution to multipath is equalizer in the receiver but for high data rates equalizers are too complicated.

With OFDM there is a simple way of dealing with multipath which makes use of relatively simple DSP algorithms. OFDM solves the problem of multipath by transmitting the data in parallel with longer symbol period and by cyclic prefix to reduce Inter Symbol Interference [13-16].

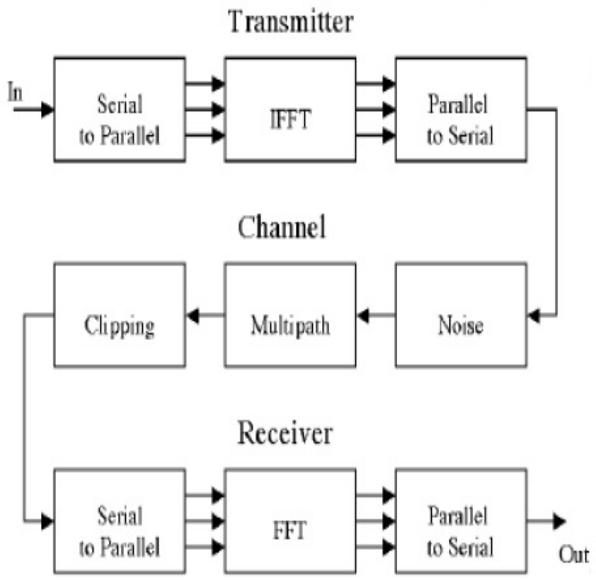

Figure 4: OFDM transceiver block diagram

In OFDM parallel data streams are used as inputs to an IFFT. IFFT output is sum of signal samples. IFFT does modulation and multiplexing in one step. Filtering and D/A of samples results in baseband signal as shown in Fig 4.

IV. SIMULATION & RESULT

In this paper we discuss the results obtained from the simulation using MATLAB and their analysis is presented. The simulation results were plotted in terms of performance of the OFDM system that is Bit Error Rat (BER) vs Signal to Noise ratio (SNR). Mainly the modulation techniques of BPSK, QPSK, 16-PSK and 64-PSK were used to see the tradeoff between system capacity and system robustness. The standard BER that was used to determine the minimum performance of the OFDM system is minimum BER for voice transmission system i.e. 10^{-3}. Analysis is done by observing the simulation result and tabulating the analysis result to make it more convenient to read [10-12].

The effect of Additive White Gaussian Noise (AWGN) channel to the performance of the OFDM system for four modulation techniques namely BPSK, QPSK, 16PSK and 64-PSK are shown in the figure 6. It can be observed from the figure 6 to achieve a BER of 10-3, the OFDM system using BPSK modulation needs at least a SNR of 11dB, the OFDM system using a QPSK modulation needs at least 14dB, the OFDM system using 16-PSK modulation needs at least SNR around 25dB and the OFDM system using 64-PSK modulation needs at least SNR around 36dB. It can also be analyzed that since OFDM technique is not intended to overcome the effect of AWGN, hence the performance of OFDM is similar to a BPSK, QPSK, 16PSK and 64-PSK standard single carrier digital transmission.

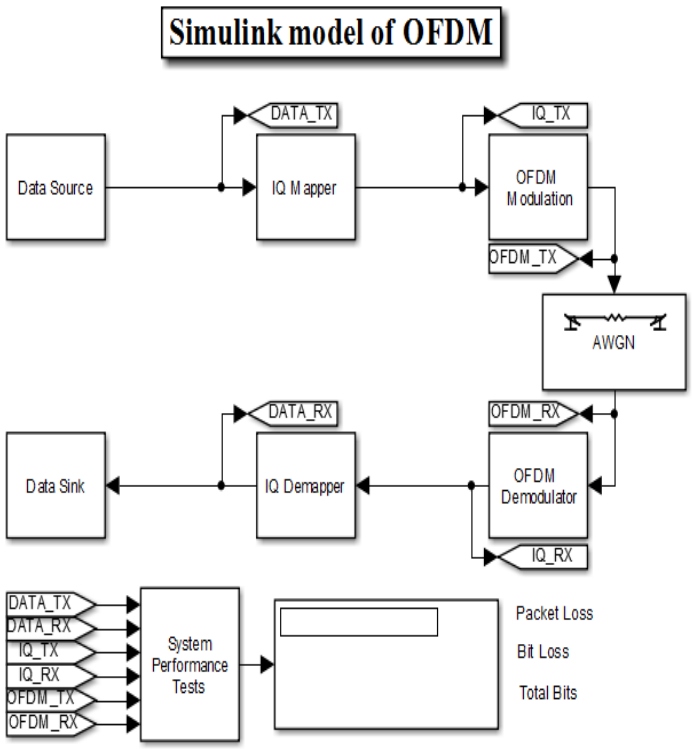

Figure 5: Simulink model for OFDM system

SIMULATION DATA IN OFDM USING VARIOUS MODULATIONS:

Table 1: BPSK Modulation

SNR	BER	No. of Error Bit	Total No. of Bits
0	0.189	36376	192192
1	0.161	31050	192192
2	0.134	25765	192192
5	0.057	11098	192192
7	0.023	4557	192192
10	0.002	523	192192
12	0.00019	37	192192
15	0	0	192192

Table 2: QPSK Modulation

SNR	BER	No. of Error Bit	Total No. of Bits
0	0.329	126554	384384

2	0.277	106623	384384
4	0.215	82916	384384
5	0.182	70007	384384
6	0.147	56691	384384
8	0.083	32190	384384
10	0.035	13466	384384
12	0.009	3761	384384

Table 3: 16-PSK Modulation

SNR	BER	No. of Error Bit	Total No. of Bits
0	0.428	329706	768768
2	0.408	313741	768768
4	0.382	293819	768768
6	0.350	269795	768768
8	0.314	241593	768768
10	0.274	210656	768768
12	0.229	176716	768768
14	0.181	139593	768768

Table 4: 64-PSK Modulation

SNR	BER	No. of Error Bit	Total No. of Bits
0	0.419	242111	577152
2	0.399	230376	577152
4	0.374	216417	577152
6	0.346	200252	577152
8	0.317	183362	577152
10	0.287	166155	577152
12	0.259	149692	577152
14	0.230	133104	577152
16	0.202	116587	577152
18	0.172	99777	577152

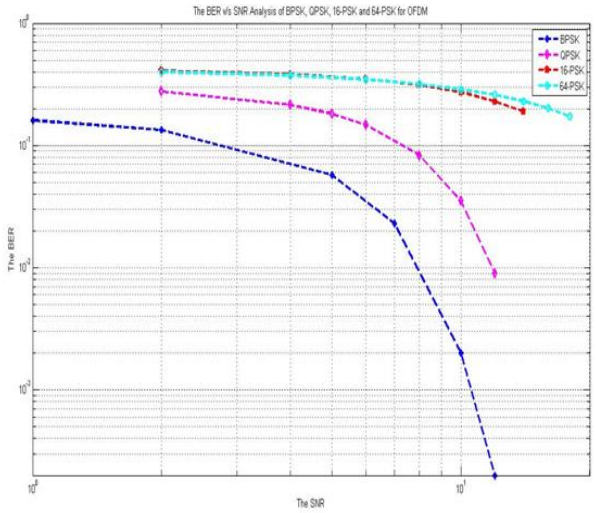

Figure 6: BER v/s SNR for OFDM in AWGN Channel

V. CONCLUSION

This paper was basically concentrated on OFDM and the study of its performance in the mobile radio channel. In our paper we used different modulation techniques like BPSK, QPSK, 16-PSK, 64-PSK etc to calculate bit error rate for OFDM system using simulink model as shown in figure 5. By using this simulink model we have calculated bit error rate for different modulation scheme as shown in table 1, 2, 3, 4. Finally it could be concluded that OFDM promises to be a suitable technique for data communication in a mobile radio channel and is going to play a major role in wireless communication in the present and the future.

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