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Analysis of Paper Reduction Scheme in OFDM using DFT Technique

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ABSTRACT: Now a days, the demand for multimedia data services has grown up rapidly. One of the most promising multi-carrier system,Orthogonal Frequency Division Multiplexing (OFDM) is basis for all 4G wireless communication systems due to its large capacity to allow the number of subcarriers, high data rate and ubiquitous coverage with high mobility. OFDM is significantly affected by peak-to-average-power ratio (PAPR).The Discrete Fourier Transform (DFT) Spreading is one of the scheme to reduce the PAPR Problem in OFDM system. This paper presents the DFT spreading technique to reduce the PAPR problem. The PAPR reduction capability of this technique is demonstrated by presenting simulation results of PAPR.

KEYWORDS: Orthogonal frequency division multiplexing (OFDM), Peak to average power ratio (PAPR), Discrete Fourier Transform (DFT),single carrier frequency division multiple access(SC-FDMA)

I INTRODUCTION

Recently, the demand for multimedia data services has grown drastically which drive us in the age of 4th generation wireless communication system. This requirement of multimedia data service where user are in large numbers and with bounded spectrum, modern digital wireless communication system adopted technologies which are bandwidth efficient and robust to multipath channel environment known as multi-carrier communication system. In single carrier system, single carrier occupies the entire communication bandwidth but in multicarrier system the available communication bandwidth is divided by many sub-carriers. So that each sub-carrier has smaller bandwidth as compare to the bandwidth of the single carrier system. These tremendous features of multicarrier technique attract us to study Orthogonal Frequency Division Multiplexing (OFDM)[1]. OFDM forms basis for all 4G wireless communication systems due to its huge capacity in terms of number of subcarriers, high data rate in excess of 100 Mbps and ubiquitous coverage with high mobility. OFDM (Orthogonal Frequency Division Multiplexing) is a Multi-Carrier Modulation technique[2]. In OFDM a single high rate data-stream is divided into multiple low rate data-streams and is modulated using subcarriers which are orthogonal to each other ODFM is a good choice for high speed digital communications [3]. In this, the data to be transmitted is spread over a large number of orthogonal carriers, each being modulated at a low rate. The carriers can be made orthogonal by appropriately choosing the frequency spacing between them. OFDM is an advanced modulation technique which is suitable for high-speed data transmission due to its advantages in dealing with the multipath propagation problem, high data rate and bandwidth efficiency. But in OFDM there is a big problem, which is high peak to average power ratio (PAPR), due to which distortion is present in the transmitted signal. Several techniques are present in the literature to minimize the PAPR like Selected Mapping (SLM), Partial Transmit Sequence (PTS), Interleaving Technique, Tone Reservation (TR), Tone Injection (TI), Peak Windowing, Clipping and Filtering, DFT spreading [4-5]. In this paper we simulate the results using DFT spreading technique, which is also known as SC-FDMA.

II SYSTEM MODEL

In figure 1, suppose that DFT of the same size as IFFT is used as a (spreading) code. Then, the OFDMA system becomes equivalent to the Single Carrier FDMA (SC-FDMA) system because the DFT and IDFT operations virtually cancel each other. In this case, the transmit signal will have the same PAPR as in a single-carrier system [6].

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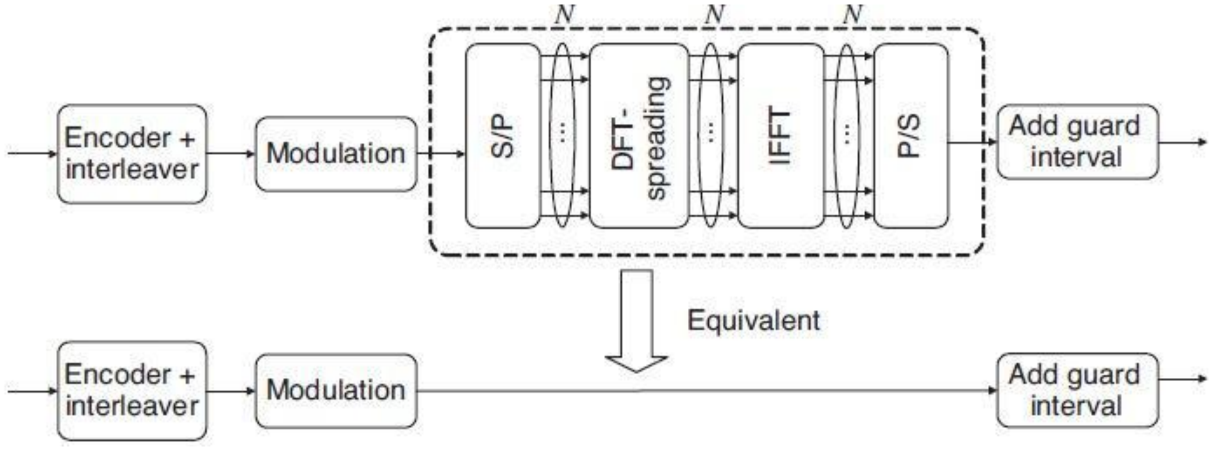

Fig1-Model of DFT technique

In DFT spreading, there are two different approaches of assigning subcarriers among users: DFDMA (Distributed FDMA) and LFDMA (Localized FDMA) [7].

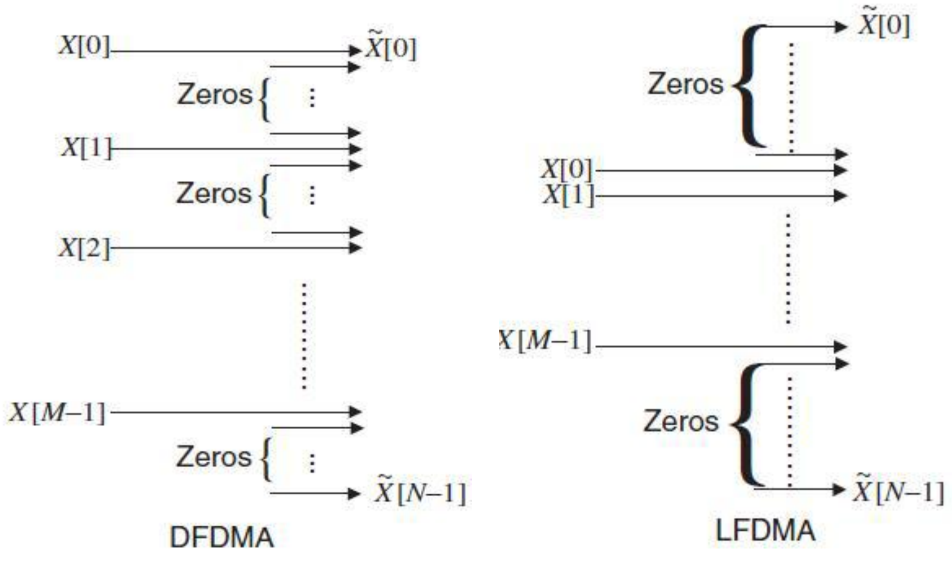

Fig 2-subcarrier mapping for uplink transmission in DFDMA and LFDMA systems.

Fig 2 Shows DFDMA distributes M DFT outputs over all N subcarriers with zeros filled in unused subcarriers i.e.(N-M), whereas LFDMA allocates DFT outputs to M consecutive subcarriers in N subcarrier. When DFDMA distributes DFT outputs with equidistance N/M = S, it is referred to as IFDMA (Interleaved FDMA) where S is called the bandwidth spreading factor.

III SYSTEM MODEL DESCRIPTION

In DFT-Spreading transmitter model we are using an FDMA mapping to address the subcarrier allocation method and DFT-Spreading code, then the equivalent system becomes single carrier frequency division multiple access (SC-FDMA), so to understand the repetition and frequency shift in the equivalent transmitter model we will go through the

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mathematical description [6], here the input data x(m) is the DFT-Spread to generate x(i) so equation is, Here the input data is DFT-spread to generate and then allocated as[8]

$$\tilde{X}[k] = \begin{cases} X\left[\frac{k}{s}\right] & k = s * m1 \\ 0 & else \end{cases} \tag{1.1}$$

The IFFT output sequence $\tilde{x}[n]$ with n=Ms + m for s=0, 1, 2…….. S-1 and m=0, 1, 2….. M-1 can be expressed as

$$\tilde{x}[n]=\frac{1}{N}\sum_{k=0}^{N=1}\tilde{X}[k]e^{j2\pi\frac{nk}{n}} \tag{1.2}$$

$$\tilde{x}[n]=\frac{1}{s}\ \frac{1}{M}\sum_{M1=0}^{M=1}\tilde{X}[m1]e^{j2\pi\frac{nm1}{M}} \tag{1.3}$$

$$\tilde{x}[n]=\frac{1}{s}\ \frac{1}{M}\sum_{M1=0}^{M=1}\tilde{X}[m1]e^{j2\pi\frac{ms+m1+m}{M}} \tag{1.4}$$

$$\tilde{x}[n]=\frac{1}{s}\ \sum_{M1=0}^{M=1}\tilde{X}[m1]e^{j2\pi\frac{m+m1}{M}} \tag{1.5}$$

$$\tilde{x}[n]=\frac{1}{s}\ X[m] \tag{1.6}$$

Which is the repetition of the original input signal X[m] scaled by 1/S in the time domain, in the IFDMA where subcarrier mapping starts with the rth subcarrier r = 0, 1, 2…………S-1, the DFT spread symbol can be expressed as

$$\tilde{X}[k]=\ \{X\left[\frac{k-r}{s}\right], k = s * m1 + \mathrm{r}$$

Where m=0,1,2,3...................M-1 (1.7)

Then the corresponding IFFT output sequence is given by [9]

$$\tilde{x}[n]=\tilde{x}[Ms+m] \tag{1.8}$$

$$\tilde{x}[n]=\frac{1}{N}\sum_{k=0}^{N=1}\tilde{X}[k]e^{j2\pi\frac{nk}{n}} \tag{1.9}$$

$$\tilde{x}[n]=\frac{1}{s}\ \frac{1}{M}\sum_{M1=0}^{M=1}\tilde{X}[m1]e^{j2\pi\frac{nm1}{M}+\frac{nr}{M}} \tag{1.10}$$

$$\tilde{x}[n]=\frac{1}{s}\ \frac{1}{M}\sum_{M1=0}^{M=1}\tilde{X}[m1]e^{j2\pi\frac{MS+m+m1}{M}} * \quad e^{j2\pi\frac{nr}{N}} \tag{1.11}$$

$$\tilde{x}[n]=\frac{1}{s}\ e^{j2\pi\frac{nr}{N}}\ \mathrm{X[m]} \tag{1.12}$$

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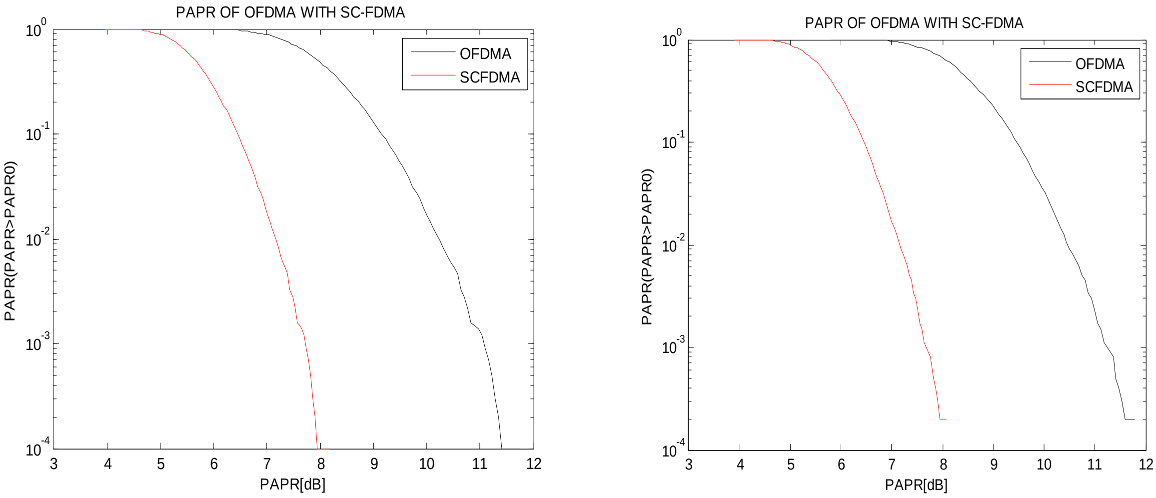
Compared with equation with (1.4) we can see that the frequency shift of subcarrier allocation starting point by r subcarrier results in the phase rotation of $e^{j2\pi\frac{nr}{N}}$ in IFDMA.

IV SIMULATION RESULTS

In the following simulation results, we compared SC-FDMA systems with OFDM and their performance in PAPR reduction. Figure shows the performance of PAPR with Different number of subcarriers. DFT-Spreading and in presence of different modulation techniques like BPSK,16QAM.

Table 1- PAPR values of OFDM and SC-FDMA with Different modulation technique

figure number	number of subcarrier	number of symbol	PAPR of OFDM in db		PAPR of SC-FDMA in db	
			BPSK	16QAM	BPSK	16QAM
3-(a)(b)	1024	128	11.5	12.5	7.9	8.2
4-(a)(b)	512	128	11.3	12.2	7.8	8.1
5-(a)(b)	256	128	10.8	11.5	7.8	8.0



(a) (b)

fig-3- PAPR with number of subcarrier 1024 (a) BPSK modulation (b) 16QAMmodulation

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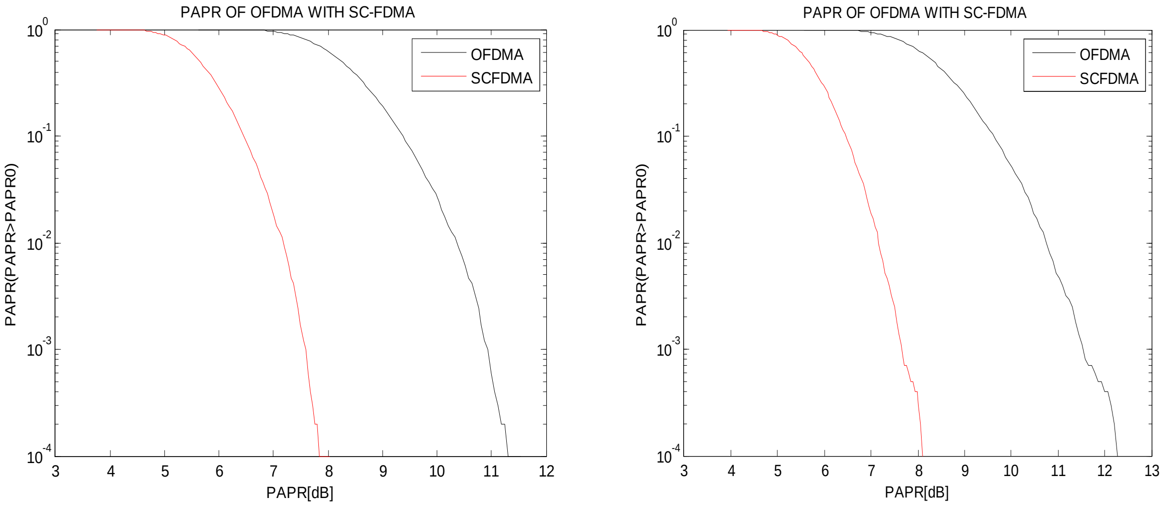
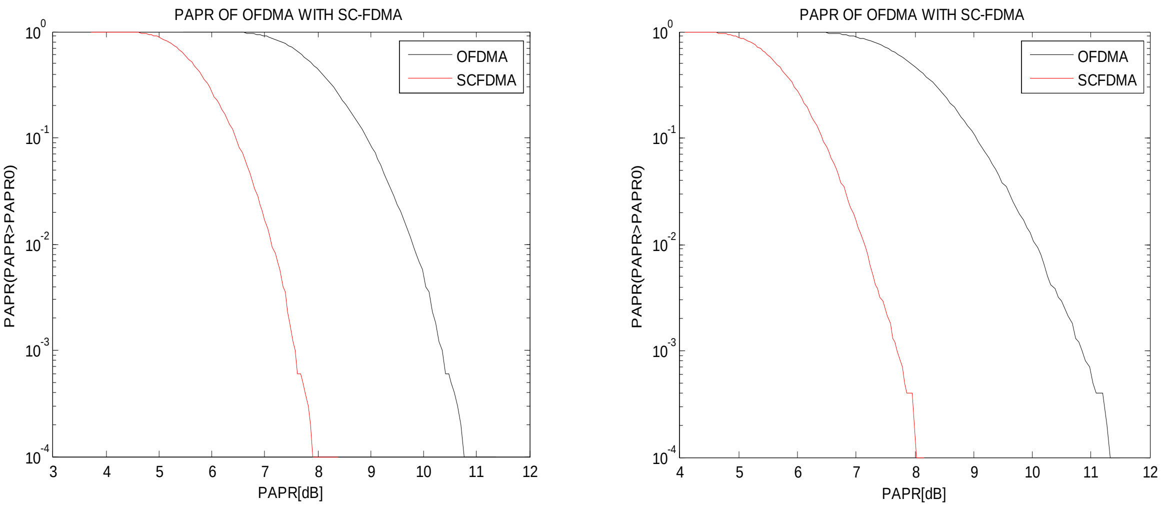


(a) (b)

fig 4- PAPR with number of subcarrier 512 (a) BPSK modulation (b) 16QAMmodulation



(a) (b)

fig-5 PAPR with number of subcarrier 256 (a) BPSK modulation (b) 16QAMmodulation

V CONCLUSION

In this paper we analyzed the performance of DFT spread OFDM method for reducing the PAPR in OFDM. The rapid development of OFDM system begins after the implementation of DFT technique. with reference to the simulation results we can say that if the values of subcarrier is decreases we get the reduced PAPR..Also from the table-1 we can conclude that with BPSK modulation we get reduced PAPR as compared with 16-QAM. By using this method we can easily transmit the signals with reduced PAPR. so this DFT technique we can applied for uplink transmission for 3GPP LTE system.

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