International Journal of Technical Research and Applications e-ISSN: 2320-8163,
www.ijtra.com Volume 8, Issue 2 (MARCH-APRIL 2020), PP. 39-44

CLIPPING BASED PAPR REDUCTION METHOD FOR LTE OFDMA SYSTEMS

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***Abstract*— The 3GPP LTE standards and mainly concentrates on the LTE 8 OFDM PHY layer. A MATLAB model based on LTE 8 PHY baseband is built for simulation and performance evaluation. All mandatory blocks in the 802.11aOFDM-PHY specification are included: Randomization, FEC, adaptive modulation, and IFFT/FFT. An additive random Gaussian channel is implemented and Peak to Average Power ratio is reduced using clipping and filtering and commanding model at the transmitter end and it is quantified using CCDF analysis.**

***Index Terms*— OFDMA, Advanced Research Projects Agency, MATLAB, LTE, Orthogonality.**

I. INTRODUCTION

A computer network is an interconnected collection of independent computers which aids communication in numerous ways. Apart from providing good communication medium, Sharing of available resources, improved reliability of service and cost-effectiveness are some of the advantages of computer networking. A computer network allows computers to communicate with many other and to share resources and information. The Advanced Research Projects Agency (ARPA) funded the design of the Advanced Research Projects Agency Network" (ARPANET) for the United States Department of Defense. It was the _rest operational computer network in the world. Development of the network began in 1969, based on designs starting in the 1960s.

II. PROPOSED METHOD

A. 3GPP LONG-TERM EVOLUTION

The Third-Generation Partnership Project (3GPP) is an international standardization body working on the specification of the 3G Universal Terrestrial Radio Access Network (UTRAN) and on the Global System for Mobile communications (GSM). The latest specification that is being studied and developed in 3GPP is an evolved 3G radio access, widely known as the Long-Term Evolution (LTE) or Evolved UTRAN (E-UTRAN), as well as an evolved packet access core network in the System Architecture Evolution (SAE). The initial requirements for LTE were set out in early 2005. The initial objective of 3GPP [29] was to produce global specifications for a 3G mobile system evolving from the existing GSM core network. This includes the Wideband CDMA (WCDMA) based UTRA Frequency Division Duplex (FDD) mode and the Time Division Code Division Multiple Access (TD-CDMA) based UTRA Time Division Duplex (TDD) mode. There are some key features of LTE release 8 that has been mentioned in an explicit way so that we can understand that our current LTE has been utilizing it because of so many features that makes it distinct from others.

III. PROBLEM IDENTIFICATION & ISSUES

A. ORTHOGONALITY

OFDM is simply defined as a form of multi-carrier modulation where the carrier spacing is carefully selected so that each sub carrier is orthogonal to the other sub carriers. Two signals are orthogonal if their dot product is zero. That is, if you take two signals multiply them together and if their integral over an interval is zero, then two signals are orthogonal in that interval. Orthogonally can be achieved by carefully selecting carrier spacing, such as letting the carrier spacing be equal to the reciprocal of the useful symbol period. As the sub carriers are orthogonal, the spectrum of each carrier has a null at the center frequency of each of the other carriers in the system. This results in no interference between the carriers, allowing them to be spaced as close as theoretically possible. Mathematically, suppose we have a set of signals ψ then

$$\int_a^{a+T} \psi_p * \psi_q^*(t) = \begin{cases} k & for\ p = q \\ 0 & for\ p \neq q \end{cases} \quad (1)$$

The signals are orthogonal if the integral value is zero over the interval [a a+T], where T is the symbol period. Since the carriers are orthogonal to each other the nulls of one carrier coincides with the peak of another sub carrier. As a result it is possible to extract the sub carrier of interest.

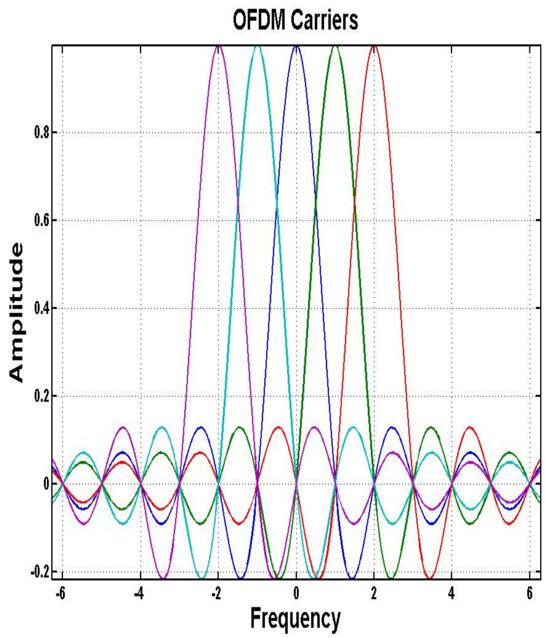

Fig. 1 OFDM Carriers in Frequency domain

OFDM transmits a large number of narrowband sub channels. The frequency range between carriers is carefully chosen in order to make them orthogonal each another. In fact, the carriers are separated by an interval of 1/T, where T represents the duration of an OFDM symbol. The frequency spectrum of an OFDM transmission is illustrated in figure 3.1. The figure indicates the spectrum of carriers significantly over laps over the other carrier. This is contrary to the traditional FDM technique in which a guard band is provided between each carrier.

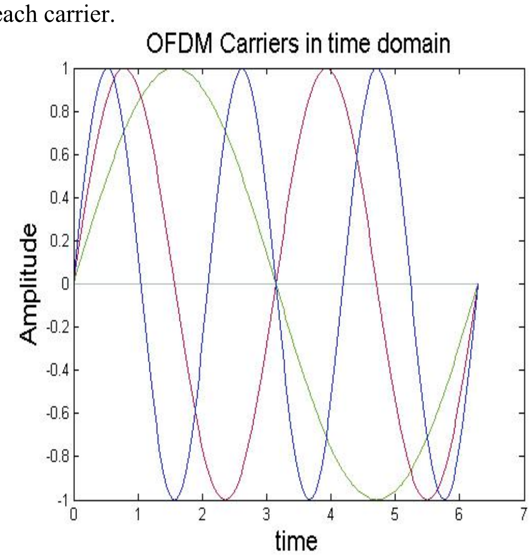

Fig. 2 OFDM carriers in time domain

Each sinc of the frequency spectrum in the figure 3.2 corresponds to a sinusoidal carrier modulated by a rectangular waveform representing the information symbol. One could easily notice that the frequency spectrum of one carrier exhibits zero-crossing at central frequencies corresponding to all other carriers. At these frequencies, the inter-carrier interference is eliminated, although the individual spectra of subcarriers overlap. It is well known that orthogonal signals can be separated at the receiver by correlation techniques. The receiver acts as a bank of demodulators, translating each carrier down to baseband, the resulting signal then being integrated over a symbol period to recover the data. If the other carriers beat down to frequencies which, in the time domain means an integer number of cycles per symbol period (T), then the integration process results in a zero contribution from all these carriers

IV. SIMULATION RESULT

A. MATHEMATICAL DEFINITION

The theoretical BER for BPSK or QPSK using AWGN channel in shown in terms of equations summarized below as well as supporting figures 6.1 and 6.2 for them below:

$$R_b = \frac{1}{2}\, erfc\left(1 - \sqrt{\frac{\frac{E_b}{N_o}}{\frac{E_b}{N_o}+1}}\right) \quad (2)$$

Where, N_o is spectral noise density and is E_b is the energy per bit.

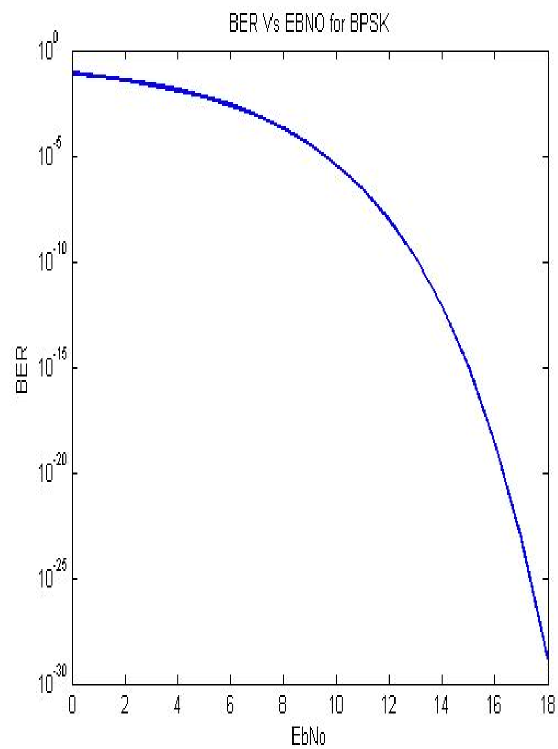

Fig. 3 BER vs EbNo for BPSK

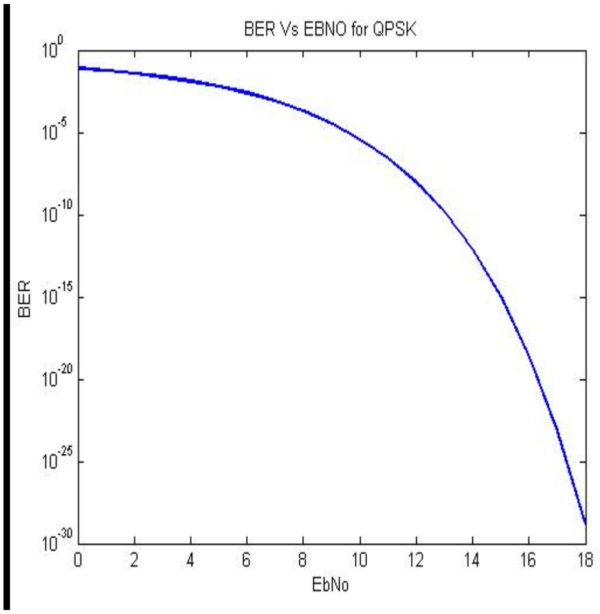

Fig. 4 BER vs EbNo for QPSK

The theoretical BER for BPSK or QPSK using Rayleigh fading channel

$$P_b = \frac{1}{2} erfc\left(1 - \sqrt{\frac{\frac{E_b}{N_o}}{\frac{E_b}{N_o}+1}}\right) \quad (3)$$

where, N_o is spectral noise density and E_o is energy per bit

The theoretical BER for QAM using Gaussian fading channel in terms of its equation and figure 6.3 is as given below:

$$P_b = \frac{3}{8} erfc\left(\sqrt{\frac{E_s}{10 * N_o}}\right) \quad (4)$$

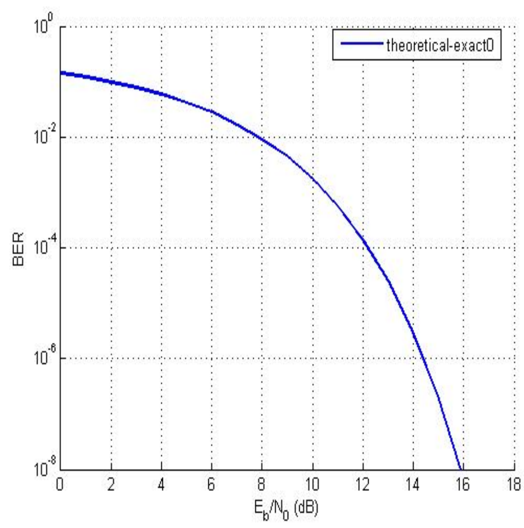

Fig. 5 BER for 16 QAM

Where, N_o is spectral noise density and E_s is energy per bit. The peak-to-average power ratio of OFDM, PAPR{s(t), τ} is given in equation (6.4) where, s(t) is the signal and τ is the time interval. A clipping and filtering method in its basic form is based on simple time domain signal limitation. Clipped signal $s_c(t)$ can be expressed by following relationship:

$$s_c(t) = \begin{cases} A e^{j\varphi(t)} & , \quad |s(t)| > A \\ s(t) & , \quad |s(t)| \le A \end{cases} \quad (5)$$

Where A is the clipping level & $\varphi(t)$ is the phase of original signal s(t).TEST and Measurement

To determine the dc gain improvement provide by the introduce structure. We have realized two stages Op-Amp in 180 nm CMOS technology. In the figures 5 we have simulate it to calculate the transient response, fig-6 shows DC gain, fig-7 phase and fig 8 shows gain margin and phase margin in table 3 we simulate the proposed Op-Amp at 180 nm and measure the performance. By the proposed structure we got excellent result of dc gain and Slew rate. If it is less than the simulated one (not totally realistic, because technology dispersion are not taken into account) dc gain and GBW shows increase DC gain decrease GBW frequency .then I say that yet increase bandwidth of op-amp then balance DC Gain , good being to amplifier. If increase frequency then these amplifier work at oscillator .so we have to balance condition in both. We do not have yet the simulation result for the Op-Amp realized at 180 nm with 1.8 V VDD.

V. PAPR REDUCTION

Simulation results of PAPR using different iterative clipping and filtering levels for QAM technique is given below in the figure. The complementary cumulative distribution function (CCDF) of the PAPR for the transmitted signal is plotted in Figure 6.4.Here only clipping and filtering technique is used and then it is observed that PAPR is reduced to 0.1 at value of 6.6dBs.

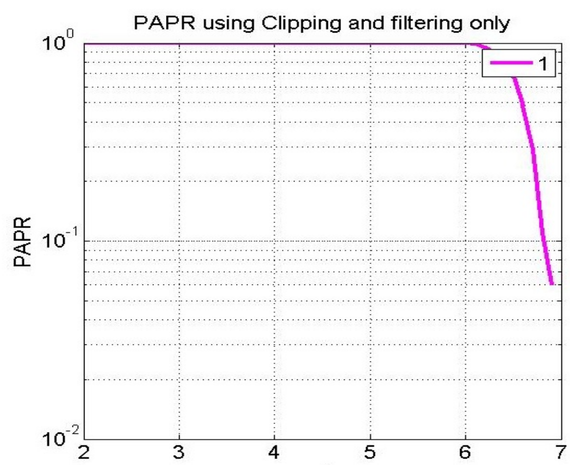

Fig.6 PAPR reduction using 16 QAM Technique and clipping and filter only

Here in the figure 6.4 results are shown for the Companding technique A law and μ law and observations in the figure reveals a reduction of PAPR to 0.01 for A law at 6.6dBs and 0.01 for μ law at 6.5dBs.

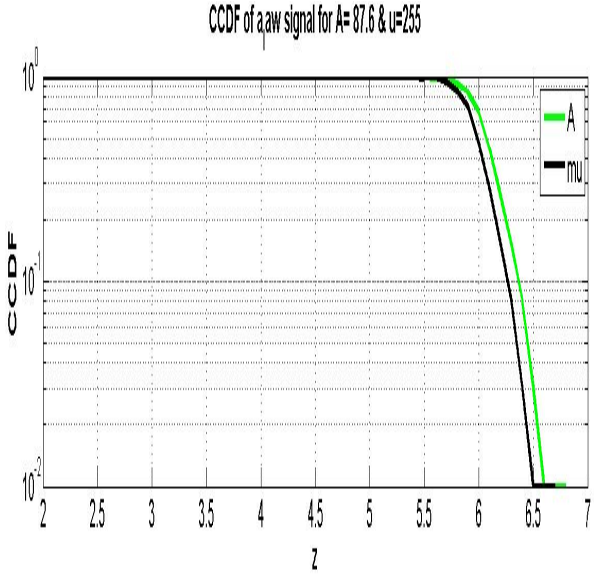

Fig. 7 PAPR reduction using 16 QAM Technique and Companding method

Now after the Companding techniques are discussed the approach must discuss the improvement which is shown in figure 6.6. The results are discussed for the iterative clipping and filtering techniques over reduced clipping ratios. The results shown so far gives best output when worked out at an iteration approach of 3 or 4. At this stage the CCDF graph shows the best results. The PAPR value is reduced to $10^{-1.9}$ at value of 4.9dBs in the 4th iteration, which is the best output so far.

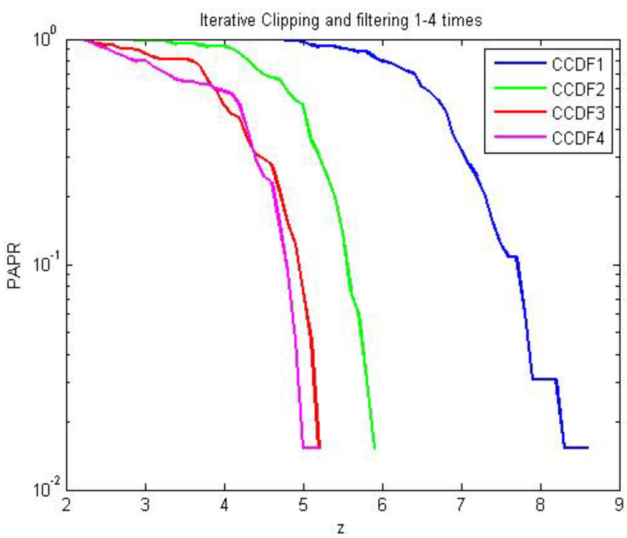

Fig. 8 PAPR using iterative clipping and filtering

It is also important to look into the constellation diagram of 16 QAM techniques which has been used for the present work both at the transmitter and receiver end. The work presents a simple constellation diagram as per results in the MATLAB software. Figure 6.6 and 6.7 shows the results of the CCDF and constellation diagram respectively for clip and filter technique employed at transmitter.

In the Simulation table 6.1 results of authors were shown, however the work done by the authors can be discussed now as a part of it. S.H. Han, J.H. Lee has discussed strongly about PAPR reduction using oversampling L=4 and QPSK modulation technique and his results are shown as follows in the figure [23]. He has also implemented the SLM technique for oversampled data. Their model remains the same for the case with OFDM signal of 256 and 1024 subcarrier signal. The figure 6.8 discusses results. Similarly figure 6.9 shows results of J Armstrong and the Table 6.2 summaries their achievements in terms of their results.

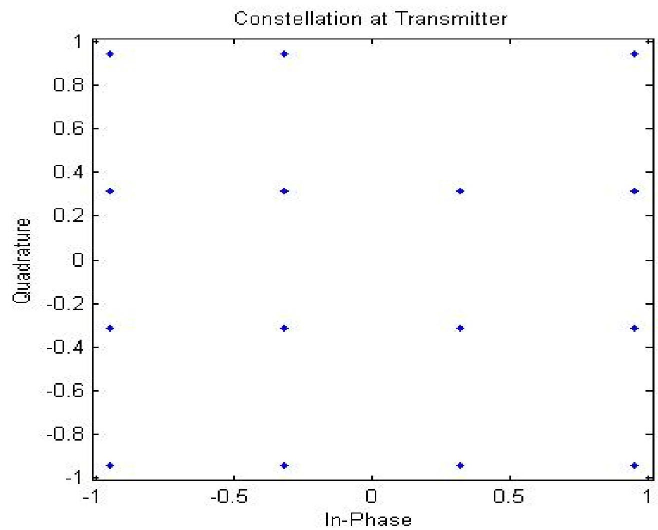

Fig. 9 Constellation diagram at Transmitter

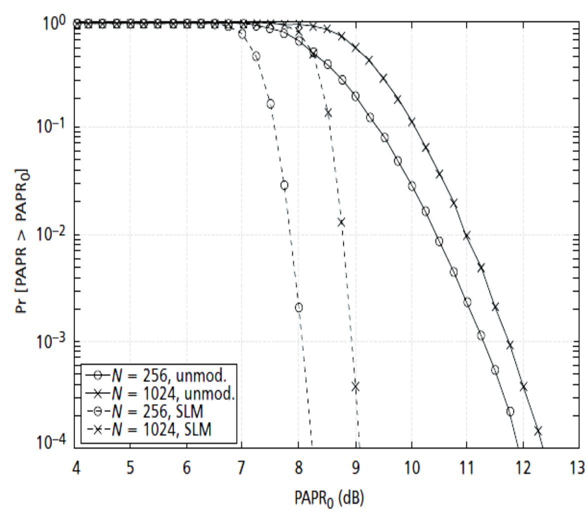

Fig. 10 CCDF results of S.H. Han and J.H. Lee

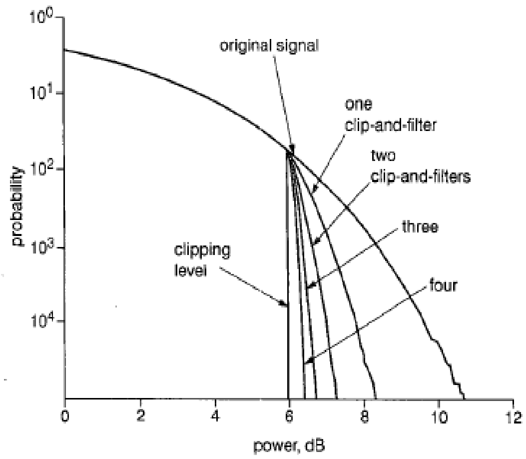

Fig. 11 PAPR of iterative clipping and filtering by J. Armstrong

The results of the author above shows similar behavior to the one described in the proposed work. But there is improvement of PAPR which is significant when compared with the proposed technique i.e. iterative clipping and filtering. The work is also done on Companding technique and the results are far better than the results of the previous authors. A small table of the proposed work for both the techniques can be summarized here in table 6.2.

Table 6.2: Parameters of the proposed techniques

Parameters	Work done by Armstrong[20]	Work done by S. H. Han [28]	Thesis work
FFT Size	128	2,561,024	128,256
Sampling frequency	-	-	1MHz
Modulation	4-QAM	4-QAM	4-16QAM
Companding Factor	Not used	Not used	87.6,255
Companding Type	Not used	Not used	A law ,μ law
Clipping Technique	Clipping and Filtering	Not used	Iterative clipping and filtering
Iteration	4-Jan	-	4-Jan
Oversampling	4-Jan	4-Jan	4-Jan
PAPR Achieved in Work	4-5dBs	4-5dBs	6-8dBs

VI. CONCULATION

This chapter discusses the overall scenario of the thesis and presents the future work which can be taken in the near future for further developments. OFDM is a promising technique for wireless communication systems although it has some drawbacks which are given below:

- High PAPR
- Frequency offset

High PAPR is one of the major problems of OFDM system. There are several techniques to reduce the PAPR in OFDM transmission system. All PAPR reduction techniques have some advantages and disadvantages. These PAPR reduction techniques should be chosen carefully for getting the desirable minimum PAPR. All PAPR reduction techniques are based on particular situation of system. This section describes and summarizes several techniques of PAPR and proposes repeated clipping and frequency domain filtering technique which is the best solution for PAPR. If considered the peak to average power ratio problem which becomes hindrance for higher number of subcarriers it is very important from the technical context that complementary cumulative distribution function is a better way to deal with the problem in a graphical format. The situation has enlarged in the thesis and is based on the modulation technique which is used in 3GPP systems for a particular bandwidth. Another significant improvement that has been observed is the 6-7dBs reduction which is observed in our results.

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