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Performance optimization of a wireless multimedia transmission system based on the reduction of PAPR

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Abstract:

Communication systems have evolved in recent years, especially wireless systems, and more and more the need to use a large data transmission speed is needed. But existing technology are constraints to monitor progress of the necessary transmission speed; several methods and techniques have been developed to address this problem. Orthogonal frequency division multiplexing (OFDM) is an alternative due to its robustness against selective frequency fading and its resistance to inter-symbol interference (ISI).The latter (ISI) is a problem in high-speed data communication. The emission for long range wireless systems requires the use of power amplifiers, but the use of OFDM systems, among others, exhibits high amplitude peaks of the modulated signal envelope and therefore variations Important in instantaneous power. For OFDM systems, the Peak-to-Average Power Ratio (PAPR) parameter which has a direct influence on the power amplifier must be taken into consideration. PAPR reduction techniques include techniques for processing the signal prior to transmission. These methods are usually simple to implement. In this work, we talk about different methods of reducing PAPR.

***Keywords* — Multi-carrier systems, OFDM, clipping, PAPR, Tone reservation, selective mapping**

I. Introduction

Current communication systems have applications increasingly growing in terms of reliability, high-speed transmission, mobility, spectrum efficiency and energy efficiency. Generally they are used for the remote transmission and real-time voice, but also data as a text message, an email, an image or a video. Two methods are used for the transmission of data, the first type of series method known in which the various symbols are transmitted sequentially following each other **[1].** For this method, in a multipath environment, the performance of these systems are sometimes severely limited and require the use of complex equalization circuits to fight against inter-symbol interference (ISI). In this case the ability of equalization systems limit the bit rate. For the second method, known as the parallel system, the data will be transmitted with low bit rate, but a large number of carriers, unlike the first method,or the transmission is done on a single broadband carrier **[2]**. Since the 50s, parallel systems have been the subject of several studies.Most proposals equire the use of multiple modulations simultaneously at different frequencies. As the existing technology could not minimize the complexity of these systems, almost all the research for this type of transmission have been abandoned in favor of the simplest series systems.From the 80s, parallel systems are found increasingly in various applications through the development of digital signal processing technologies and recent advances in electronics and high-density integration technologies**[3]**. In these times, communication systems have several characteristics. One such feature is the data transfer rate, which varies and increases depending on the nature of the data and the application in general. One such application is represented by the standard for high speed internet access, ADSL ("Asymmetric Digital Subscriber Line").Several techniques and different technologies are used to achieve high speeds. An example of these techniques is the so-called OFDM multicarrier modulation. Like all other techniques, multicarrier modulation has advantages and disadvantages. The advantages relate mainly to the robustness of the signal with respect to the multi-path channel with fading and the optimum spectral size **[4]**. One of the disadvantages is represented by the amplitude amplitude fluctuations of the envelope of the modulated signal and therefore by large variations in instantaneous power.The Peak-to-Average Power Ratio (PAPR), which takes into account these power variations, is an indispensable parameter in the characterization of envelope modulations. On the communication chain there are non-linear elements such as power amplifiers (AP) whose operation depends directly on the modulated signal power, and the PAPR becoming sufficiently high, this will cause problems at the level of the AP) **[3]**.Different PAPR reduction techniques exist. Some techniques act on the amplifier to avoid saturation of the input signal and other techniques are based instead on a processing performed directly at the signal. In most of these techniques, the receiver must not be informed of the type of processing performed in transmission before amplification. These techniques include conventional clipping. This technique captures the input signal by reducing the PAPR, but the main disadvantage is represented by a strong degradation of the bit error rate (BER) **[5]**. The paper is organized as follows: in part two presents the different characteristics of an OFDM system, Part 3 focuses on the study of PAPR reduction systems, An overview on all the PAPR reduction systems is given, Part 4 is reserved for simulations and analyzes of the results, the conclusions are in part 5.

II. OFDM systems:

In this part, we focus on technical special multi carrier modulation, which is the multiplexing orthogonal frequency division (OFDM). This technique divides a broad frequency band into several sub-bands or sub-carriers, and the orthogonality that characterizes it authorizes some spectral overlap between the sub-carriers, thereby increasing the spectral efficiency of the system.

The division of the bandwidth into N subbands implies that the transmittance of each sub-band is almost flat, provided that N is large enough, hence the robustness of this modulation technique in the presence of frequency selective channels. We summarize the various steps of an OFDM transmission by the block diagram of Figure 1, with the cyclic prefix, and S / P and P / S representing the serial to parallel conversions and parallel to serial, respectively. However, the OFDM technique has the disadvantage of having a high sensitivity to frequency offsets and the presence of the peak power (PAPR) in the transmitted signal **[6]**.

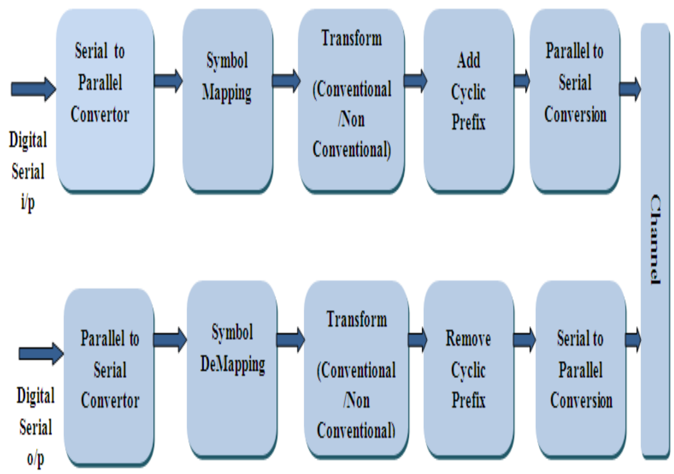

Figure 1: The blocks of an OFDM system.

II.1 Principle of multi-carrier modulation:

The basic idea of OFDM is to parallelize the transmission symbols to utilize most effectively the available bandwidth (Figure 2). The total available bandwidth is divided into N subcarriers, or subchannels uniform and orthogonal. The symbols of the constellation are inserted in each subcarrier. The frequency OFDM frame consists of these N subcarriers, after modulation by a bank of orthogonal filters to obtain a temporal OFDM frame. The duration of an OFDM symbol is $T = NT_S$ or T_S is the duration of a symbol on a subcarrier. OFDM is already part of many communications standards such as IEEE 802.11xg for wireless LANs **[7]**.Also there is the OFDM modulation in European broadcasting standards (DAB, Digital Audio Broadcasting) and broadcasting (T-DAB, Digital Video Broadcasting - Terrestrial), and HiperLAN 2 standard.

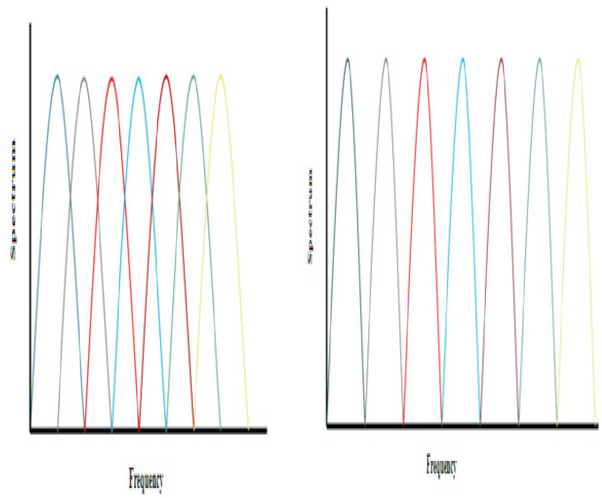

Figure 2 : OFDM spectrum and FDM spectrum

The spectral band allocated to the transmission is shared among the different sub-carriers, and thus each subcarrier can occupy a frequency band lower than the channel coherence bandwidth. Nevertheless, the orthogonality condition is no longer maintained at the receiver input, due to intersymbol interference (ISI) and inter-carrier interference (ICI), resulting from multipath transmission channel. The implementation of a guard interval between each transmitted OFDM symbol solves this problem with a small loss of energy transmission.OFDM allows simplification maximum equalization at the receiver, unlike a system in series with the equalizer quickly becomes very complex. Consequently, the OFDM is a good candidate for high bit rate transmissions, because equalization is very simple and cost in complexity of implementation are reduced **[8]**.

The modulation orthogonal subcarriers, is a technique that has very interesting properties for free in high-speed communications in environments rich spread of multi-path, so frequency selective.The OFDM is to multiplex a series of high-speed data MQAM symbols into a plurality of parallel subchannels lower rate **[4]**.This flow rate corresponds to a fraction of the original flow. The data symbols present in each of these sub-channels are modulated by subcarriers which are orthogonal to each other. The orthogonal subcarriers can be seen easily by studying the spectrum of an OFDM symbol. The OFDM signal is formed by multiplication, in the time domain, of a rectangular window function by a complex exponential. Frequency, this corresponds to the convolution of a sinc by Dirac pulses corresponding to the frequencies of the subcarriers **[9]**. It is important to note that the development presented above is valid only under two conditions. First, the length of the cyclic extension shall be larger than the largest major multi-path delay, otherwise there will be loss of orthogonality between carriers and decreased performance. Moreover, equalization will perform well only if the duration of the channel impulse response can be considered almost constant over the duration of the OFDM symbol. It is also important to note that the OFDM is a modulation technique whose performance is highly sensitive to frequency synchronization errors. Indeed, synchronization errors destroy the orthogonality of the subcarriers, which can result in greatly inferior performance or performance with perfect synchronization **[10]**.

II.2 Operation of the transmitter / receiver OFDM:

The OFDM transmitter parallelize a set of symbols series available equipped the N orthogonal subcarriers. And as mentioned above, OFDM is effective bandwidth because it allows duplication of subcarriers in addition to the orthogonality is preserved if the subcarriers are separated by a distance equal to Δf , $1/T$ such that T is The duration of an OFDM symbol. Then a serial / parallel converter comprises N whenever symbols from the QAM modulation, the transmitter therefore generates a continuous time signal composed of all the OFDM frames **[11]**.

The OFDM transmitter comprises converting the binary data into complex elements by the amplitude modulation in quadrature, the constellation data it fits on a regular grid, uniform and centered, while each carrier is modulated by the binary signal according to a modulation M-QAM constellation defined by, after the latter, the complex data will pass the frequency domain to time domain by the inverse Fourier transform, and the OFDM signal is generated. Once the signal is received, the inverse process is performed to recover the frequency-domain time domain signal, the OFDM signal undergoes the constellation to retrieve the complex data, after the Fourier transform it is possible to reduce the data from the parallel to Series and finally the input data are retrieved.

II.3 The advantages and limitations of OFDM:

OFDM is today a growing sucked, it is particularly suited for transmission channels with multipath. It then significantly reduces inter-symbol interference. As against it may become ineffective in these or multipath are strong, some frequencies so some subcarriers can then be greatly reduced. If in addition the receiver is fixed, as is the case for example for terrestrial television, the interference will extend making it impossible to use subchannels concerned .It must then use it with the error correction coding **[12]**.

II.3.1The advantages :

The benefits of OFDM are many. The first advantage is the gain in spectral efficiency compared to conventional modulation solutions of frequency multiplexing .This is because that in the OFDM, the subcarriers overlap while keeping a perfect orthogonality **[8]**. The OFDM also has the advantage of simplifying the channel equalization and therefore a simple decoding thanks to the use of the guard interval, at the cost of a slight decrease in the rate. In addition, the use of different Error-correcting coding systems associated with inter-frequency interleaving makes it possible to achieve the performance of an echo-free channel. Multi-carrier modulations and OFDM in particular are robust to impulsive noise since each subcarrier is affected by noise independent of other subcarriers.Unlike single-carrier modulations or noise can affect a number of transmitted symbols. Finally, it should be noted that the estimation of the channel in the OFDM context is facilitated by the sending of training sequences in the frequency domain. The identification of the channel coefficients is then done without inversion of systems of equations but at the cost of a degradation of the spectral efficiency **[13]**.

II.3.2 The limits:

OFDM has not only advantages, it also has disadvantages. The first and without doubt the most important is the high PAPR signals produced by OFDM. This has adverse effects on non-linear components such as the power amplifier. Indeed for high returns, the power amplifier must operate as close as possible to the saturation zone that is highly nonlinear. These non -linéarité are sources of interference and non-bands of degradation of bit error rate (BER). These effects are especially troublesome when the signals are at high PAPR **[10]**. The OFDM is also very vulnerable to offset problems and frequency synchronization. In the first case, the "frequency shift" generates interference between subcarriers that can destroy the orthogonality of the subcarriers .In the latter case, the synchronization errors induce a phase shift on the received symbols. compensation techniques that exist for single-carrier modulations are often ill-suited to multi-carrier modulations but new approaches are still being study**[9]**.

II.3.2. a Frequency offset:

The OFDM system has some major disadvantages such as its sensitivity to frequency shift. Studies have shown that multi-carrier systems are much more sensitive to frequency shifts than single-carrier systems. They have given a relationship that determines the degradation in terms of signal-to-noise ratio (SNR) **[6]**.

$$D \approx \frac{10}{\ln 10}\left(\frac{1}{3}\right)\left(\pi N \frac{\Delta f}{R}\right)^2 \frac{E_s}{N_0} \qquad (1)$$

Where Δf is the normalized frequency shift by the difference between the carriers $\Delta f = 1/T$, R is the symbol rate which is equal to $N = T_S$ and $E_S \neq N_0$ is the ratio between the energy per symbol and the noise spectral density. The sensitivity is even more important that the carriers are close. Furthermore, the sensitivity to synchronization errors affecting the orthogonality of the subcarriers and introduces phase shifts. We must therefore choose the length of the cyclic prefix **[4]**.

II.3.2. b Le PAPR :

One point that can be criticized in OFDM systems is the wide variation in the amplitude of the signal according to the symbols to be transmitted. While the addition of carriers is done consistently, the PAPR can be very important. OFDM signals have strong power variations characterized by the PAPR that generate distortions to the passage of nonlinear components **[11]**.

These distortions, mostly off-interference bands and an increase in the error rate are one of its major drawbacks that limit the performance of multi-carrier communications. In telecommunications equipment, most analog components have non-linear characteristics. The component that is causing major distortions is the power amplifier especially if one is looking to increase its energy efficiency and its output power **[14]**.

II.3.2.c l'ACPR :

The clipping used to reduce the PAPR has effects on the signal envelope. Besides the PAPR can be characterized OFDM systems by another factor, the ACPR (Adjacent Channel Power Ratio). The ACPR is the ratio between the signal power in the useful channel and the signal strength generated by the distortions in an adjacent channel. The clip has two consequences, the first being the PAPR reduction, the second is the degradation of the ACPR following the rise of the side lobes of the spectral density e power **[15]**.

III. The methods of reducing PAPR:

OFDM signals are subject to large variations in power, strong PAPR, which accentuates the problems related to the non-linearity of the power amplifier. Besides linearization which acts on the amplifier, a complementary way to address these problems is to reduce the PAPR which acts on the signal to be amplified. The PAPR reduction is to reduce the dynamics of the signal to be amplified to enable as close to amplification saturation zone where energy efficiency is better **[16]**. In this part, we discuss the various methods of reducing the PAPR, a disadvantage of OFDM systems caused by sharp fluctuations in amplitude of the signal. The PAPR parameter gives us an idea about the behavior of the signal $S(t)$, specifically the amplitude peaks and therefore power **[17]**.the latter has a direct influence on the power amplifier (PA). If we consider an observation window of the T signal $S(t)$, the PAPR is the ratio between the maximum power and the average power of signal $S(t)$ in the interval T. In the literature we find different definitions of PAPR. The expression of classical PAPR is given by **[18]**:

$$PAPR = \frac{P_{\max}}{P_{moy}} = \frac{\max_{t\in[0,T]} |S(t)|^2}{\frac{1}{T}\int_0^T |S(t)|^2\, dt} \qquad \textbf{(2)}$$

Every time we have a peak signal, the AP must use more energy to transmit. Now it is necessary to optimize the energy consumption especially in wireless transmissions. Power amplifiers are characterized by a saturation zone; you have to work as close as possible to this area. To optimize the use of power amplifiers or different power amplifiers are used with different areas of saturation ie that the treatment is done within the AP. The other method is to process the signal to approach the saturation zone. The PAPR reduction was the subject of several studies and several methods have been proposed **[19]**.

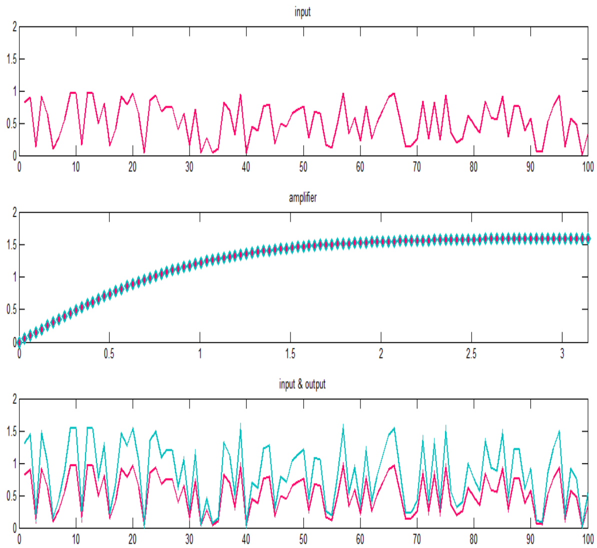

Figure 3: Spectrum of the signal before and after amplification

There are two types of PAPR reduction. The first acts directly on the power amplifier, the second processes the signal. The latter acts on the OFDM signal to be transmitted. In literature, we find various methods including those where the receiver must be informed of the type of treatment performed in transmission before amplification, such as the selective mapping (SLM) and other where the receiver does not receive Information of the issuer. A considerable number of PAPR reduction methods exists in the literature .They are classified into three categories: probabilistic methods, methods of coding, and adding signal methods **[20]**.

III.1 Effect of the power amplifier:

Most amplifiers used are non-linear, as linear amplifiers are very expensive. In this work, it was considered whether the amplifier is linear, or that the amplifier is not linear but works in its linear region **[21]**.

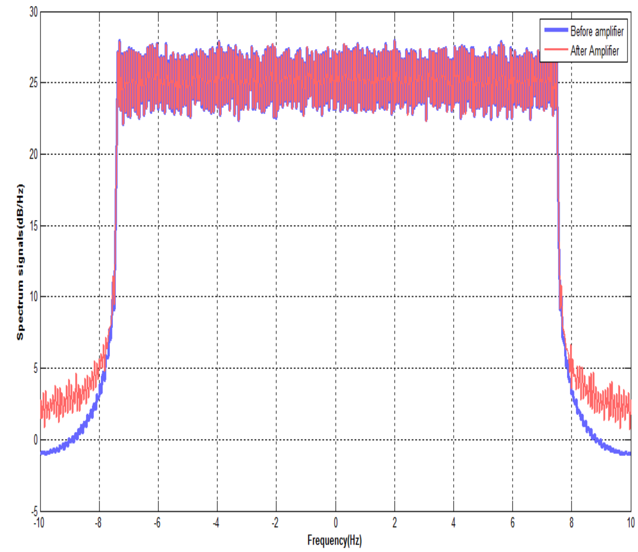

Figure 4: Effect of amplification of the signal power spectrum.

Since amplification will affect the signal, it has a direct effect on the constellation as we shown in Figure 5. Figure 4 illustrates the power spectrum response to the presence of a non-linear amplifier **[22]**.

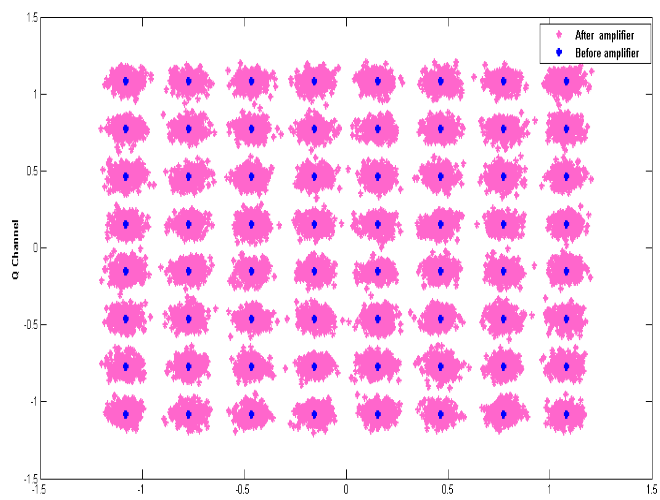

Figure 5: Effect of amplification of the constellation

Figure 6 shows the response of a linear amplifier and that of a non-linear amplifier. One can notice the linear range for the second amplifier. It was also reported the average amplitude of an OFDM signal. It is noted that this average value is close to the non-linear zone **[23]**.

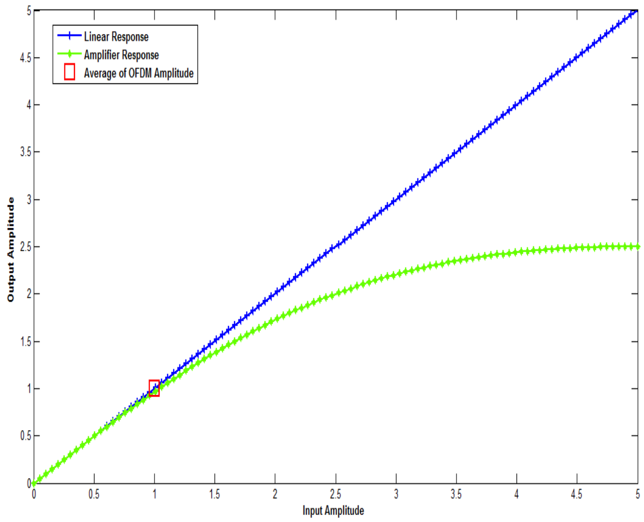

Figure 6 : Linear amplification vs non-linear amplification.

III.2 PAPR Reduction Methods:

This part aims to briefly introduce each of these three categories and the merit criteria of each method.

III.2.1 Probabilistic methods:

The family of probabilistic methods includes techniques such as Selective Mapping (SLM), the Partial Transmit Sequence (PTS), the Random Phasor etc.The idea at the base of these techniques is to make multiple copies of the initial OFDM symbol by modifying either the phase, the amplitude and position of sub-carriers and then select the copy of which the PAPR is the lowest **[24]**.

III.2.1. a Selective Mapping(SLM) :

The technique SLM Selective Mapping, is to phase rotations on several versions of the same signal before transmitting the version that has the lowest PAPR. This technique requires the repetition of the modulation process, including IFFT algorithm, as many times as there are versions **[17]**. The SLM has been the subject of much research and several variations are available including those called "blind" or no decoding information is transmitted to the receiver. The SLM is an effective technique for reducing the PAPR and conceptually very simple to understand From A other hand, it significantly increases the complexity of OFDM transmitter due to the use of multiple IFFT operations **[25]**.

III.2.1.b Partial Transmit Sequences (PTS):

The PTS technique is based on the same principle as the SLM, the authors who worked on the SLM also proposed PTS technique. The basic principle of the PTS is to truncate the train of N subcarriers into V blocks of N/V subcarriers. A subcarrier used in a block will be set to zero in all other. Once the formed block, the PTS applies phase rotation on each block as the SLM **[26]**.

III.2.2 Coding methods:

The family of encoding methods includes all techniques that use codes to reduce the PAPR. Reed Muller codes that generate Golay sequences constant PAPR, or the Grid shapping are examples of coding techniques. The idea behind these techniques is that by exploiting the redundancy introduced by a suitable choice of code, it is possible to avoid transmitting OFDM symbols with high PAPR **[27]**.

III.2.2.a The block codes:

More generally PAPR reduction Parle by code blocks and several methods of selection of words low PAPR have been proposed. There is for example the one based on Golay complementary sequences **[20]**. The PAPR reduction by block codes are two major drawbacks: the first is the PAPR calculating each sequence, which can become very long and almost impossible when the number of subcarriers becomes too great, the second coming Of the information word association - code word requiring matching tables for coding and decoding. Some authors proposed a simple implementation using methods of systematic coding. However, these methods do not provide a structured and systematic research of sequences with low PAPR. Moreover, the problem of error correction remains.

III.2.2.b The Reed Muller codes:

The PAPR reduction by Reed Muller codes are a continuation of complementary Golay codes. The goal is to insert an error correction code before the Inverse Fourier Transform (IFFT), correcting code generating complementary sequences. This code is based on those of Reed Muller and thus provides a coding gain but also the assurance of a constant 3 dB PAPR whatever the number of subcarriers N **[26]**.

It is important to note that the technical PAPR reduction by Reed Muller codes in addition to a fixed 3 dB PAPR whatever the number of subcarriers has a high capacity for error correction. This technique has two major disadvantages; the first is related to the fact that the technique is only applicable to digital phase modulation, which significantly reduces their scope. The second disadvantage is that the technique is not really applicable to a small number of subcarriers, that the coding rate is inversely proportional. Concretely, the codes are not profitable when the number of subcarriers increases **[28]**.

III.2.3 Methods of adding the signal:

The family as the name suggests, includes all methods including reducing the PAPR can be formulated as $PAPR(X + C^{papr}) < \text{PAPR(X)}$ or X refers to the OFDM signal in the time or frequency domain and C^{papr} the peak reduction signal in the time domain Or frequency required to reduce the initial PAPR. In the literature, there are examples like clipping and filtering, Tone Reservation, Tone Injection, Active Constellation Extension **[29]**.

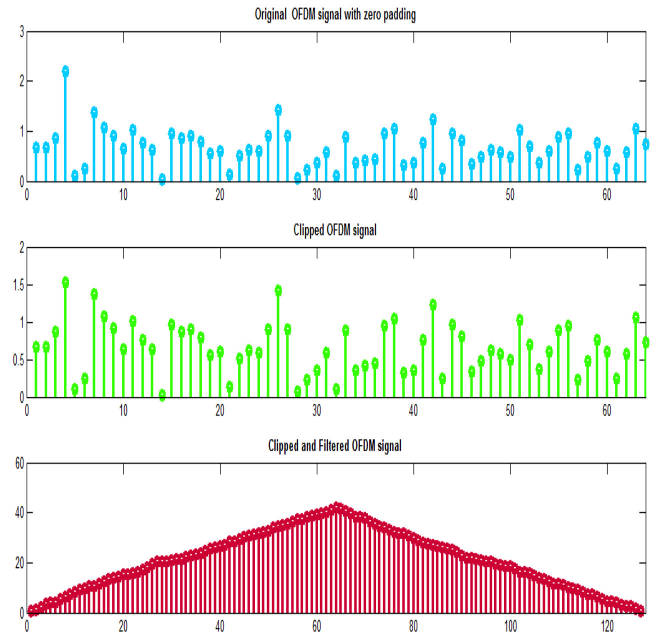

Figure 7: Spectrum of the OFDM symbol transmitted with clipping and filtering

III.2.3.a The clipping and filtering:

In a non-linear amplification context, the simplest way to remove the peaks is clipping the signal to be amplified. In this case, the signal amplitude is limited, but the phase remains unchanged, which has the effect of reducing the one hand the average power and then the maximum instantaneous power and thus the PAPR. Of course this will have drawbacks namely interference in the bands (degradation of the bit error rate) and out of band **[18]**. A filter is necessary to reduce interference off-tapes that must remain below the thresholds imposed by the standard mask. The major drawback of the technique of clipping and filtering is degradation due BER interference in the useful band .In associating with channel coding techniques; it is possible to reduce the degradation of the BER. Many other variations of the technique have been studied in the literature always looking for ways to reduce the effects of distortion generated. We particularly those that propose to amend the clipping function. These techniques like deep clipping the smoth clipping, clipping the reversal **[30]**.

III.2.3.b The Tone Reservation (TR):

In this technique, the basic idea is to reserve some subcarriers to be used for reducing the PAPR. It was initially proposed by J.Tellado, which showed more than the generation of peak reduction signal on the reserved subcarriers is a convex optimization problem **[23]**.In this vision, the sender and receiver agree on the number and position of sub-carriers that are reserved for the corrective signal responsible for reducing the PAPR, hence the name "Tone Reservation." However, other studies have proposed making the backward-compatible method (no change in the receiver) using the null subcarriers for PAPR reduction signal with coercion to meet the spectral mask. In all cases, the PAPR reduction will depend on the number of reserved subcarriers, their position and overall complexity **[24]**.

IV. Simulation and analysis of results:

As we have seen, the OFDM signals are subject to large variations in power, i.e high PAPR, which accentuates the problems related to the non-linearity of the power amplifier. Besides linearization which acts on the amplifier, a complementary way to address these problems is to reduce the PAPR which acts on the signal to be amplified. The PAPR reduction is to reduce the dynamics of the signal to be amplified to enable as close to amplification saturation zone where energy efficiency is better. A considerable number of PAPR reduction methods exist in the literature.

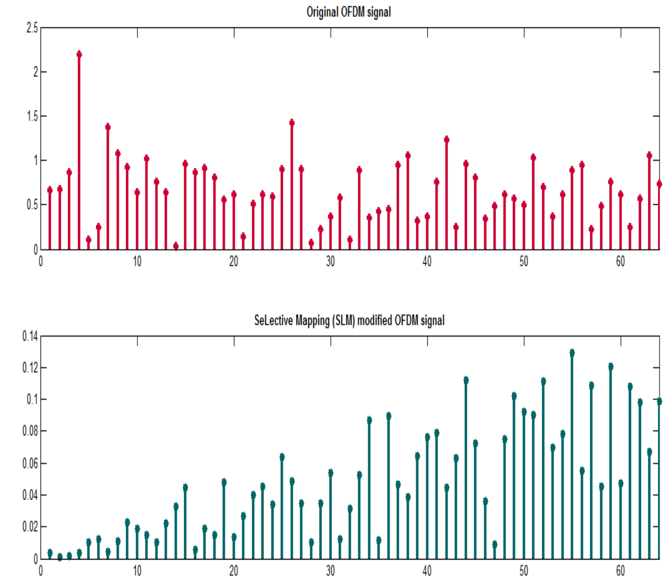

Figure 8: Reduced crest factor of a transmission channel of an OFDM signal.

Where S is the number of phase sequences, N is the number of subcarriers, and th is threshold. The qualities of OFDM enabled him to quickly establish itself as modulation for many standards in Telecommunications. Indeed, contrary to single carrier systems, the OFDM is made up from a sum of the modulated signals which may, if summed in consistency, causing strong amplitude levels.

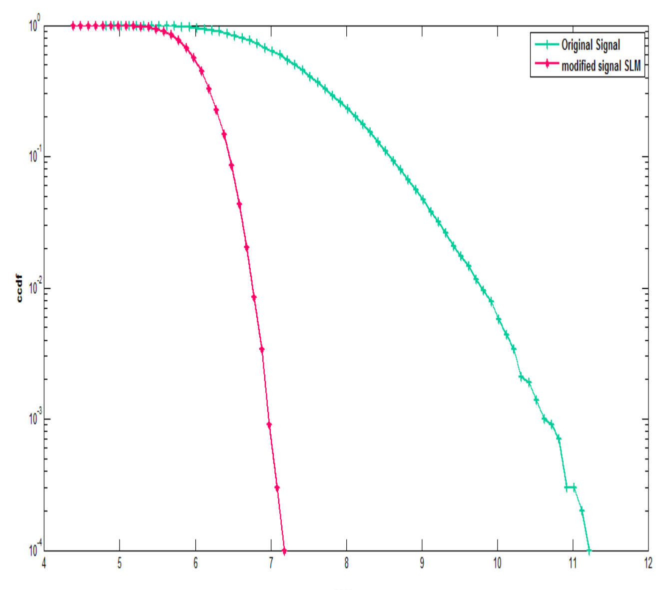

Figure 9: CCDF using Selective Mapping**,** N=64.

The output of the Fourier transform, the signal envelope then shows a dynamic which can compromise the linearity of the amplification. To quantify this effect, we study the level of PAPR (Peak-to-Average Power Ratio) of the OFDM signal, or the ratio of the highest peak of the envelope with the signal level. The evolution of this variable has been intensely studied and characterized in the literature since it is directly related to the quality of communication.

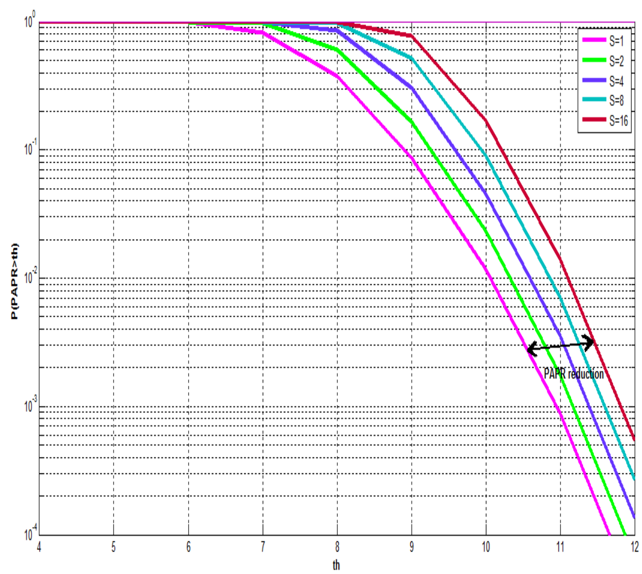

Figure 10: The PAPR reduction method with the SLM, for the various phases of sequences.

The PAPR reduction in OFDM systems is then a problem that concentrates a great interest. Many methods have been proposed in order to best limit the dynamics of the signals prior to amplification and the transmitter performs manipulations on the signal before its transposition of the transmission band.

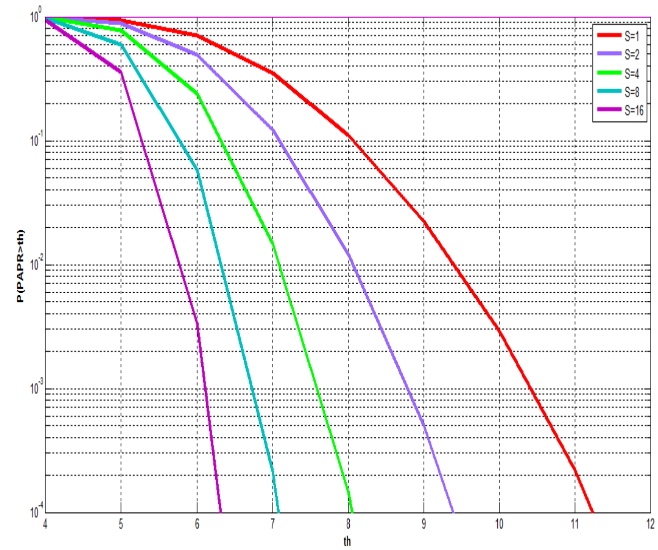

Figure 11: The PAPR reduction with the SLM method, where the number of subcarriers is 64 for the different phase sequence.

The problem addressed in this research is to reduce the peak power of average power ratio in an OFDM context. Unfortunately, one of the disadvantages of OFDM is the high PAPR signal that forces him to take a major setback not to saturate the transmission amplifier and then reduces power efficiency.

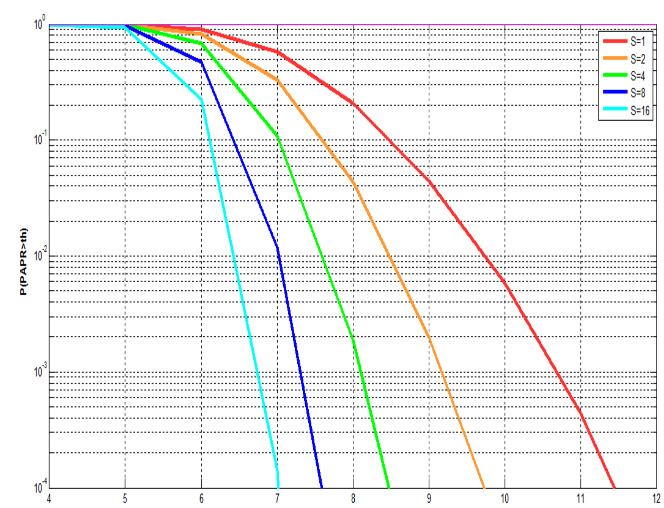

Figure 12: The PAPR reduction with the SLM method, where the number of subcarriers is 128 for the different phase sequence

We defined the concepts related to the problem of PAPR and thereafter, we will describe one of the attractive methods for the reduction of the latter method is the SLM (Selective Mapping). This method is known for its great performance in PAPR reduction but also its complexity, this purpose several approaches have been proposed to reduce this complexity. To contribute to this research topic PAPR, we will propose a new algorithm that supports the reduction of the PAPR of the OFDM signal is that from our perspective.

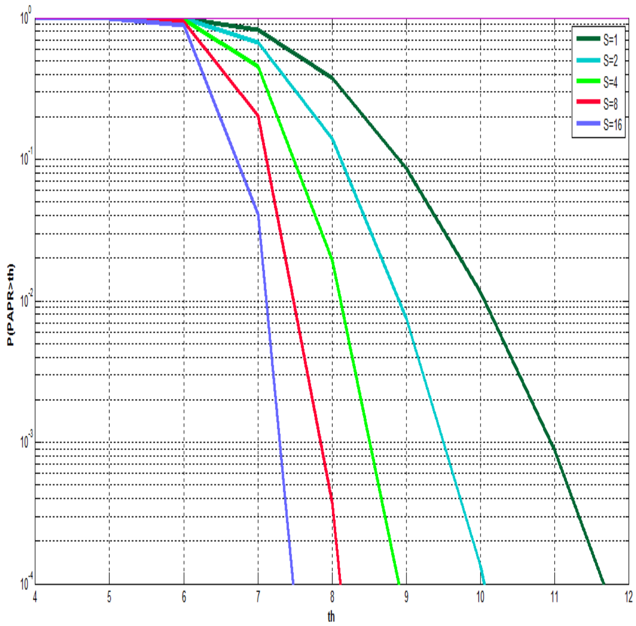

Figure 13: The PAPR reduction with the SLM method, where the number of subcarriers is 256 for the different phase sequence.

The PAPR parameter gives us an idea about the behavior of the signal, specifically the amplitude and thus power peaks. The latter has a direct influence on the power amplifier (PA). If we consider an observation window T signal $s(\mathrm{t})$, the PAPR is the ratio between the maximum power and the average power of the signal $s(\mathrm{t})$ of the interval T.

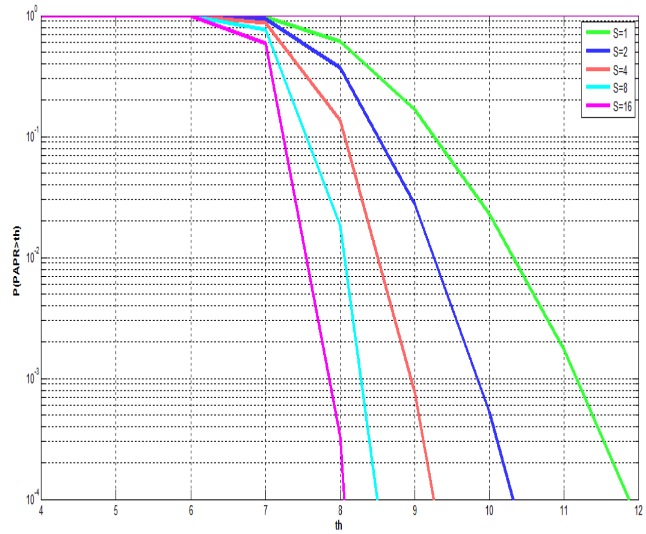

Figure 14: The PAPR reduction with the SLM method, where the number of subcarriers is 512 for the different phase sequence.

The distribution of PAPR provides probabilistic information on the OFDM system. It is often modeled by a complementary cumulative distribution function or complementary cumulative distribution function (CCDF). The CDF (Cumulative Distribution Function) is the cumulative probability that a parameter is less than a given value. In our case the parameter is the PAPR ie the probability of the PAPR to be calculated is less than a given value.

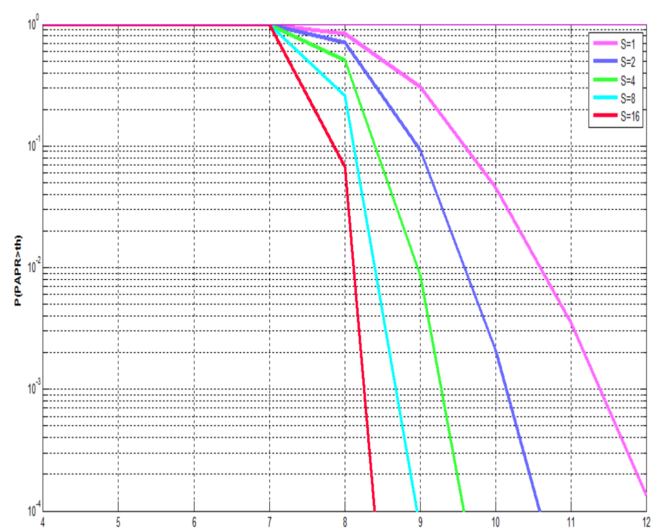

Figure 15: The PAPR reduction with the SLM method, where the number of sub-carriers is 1024 for the different phase sequence.

His knowledge is essential for the reduction of technical application upstream nonlinear transmission chain blocks. His modeling through a complementary cumulative distribution function for assessing the performance of PAPR reduction techniques in the evaluation of the probability that the PAPR exceeds a given threshold $PAPR_0$: $Prob(PAPR > PAPR_0)$.

Figures 11, 12, 13, 14 and 15 makes it possible to assess the likelihood of high levels of PAPR of an OFDM signal to discrete time baseband knowing the number of constituent sub-carriers. The theoretical equation is faced with the simulation results to confirm his good interpretation of the phenomenon. As suggests the theoretical result, the probability of high levels of PAPR increases rapidly with the number of subcarriers used. The greater the number of subcarriers and the greater the PAPR is high.

In simulation Note the number of subcarriers varies between 64, 256 and 1024, it is clear that the PAPR increases with the increase of subcarriers. As shown in the following figure, for 64 sub-carriers the PAPR of 9.3 dB, for 256 it is 10 dB for 1024 and finally subcarriers will bring PAPR 10.6 dB.

Table I: Reduced crest factor corresponding to different number of subcarriers

Peak to Average Power Ratio					
N	**64**	**128**	**256**	**512**	**1024**
S=1	**10.3**	**10.7**	**10.8**	**11.1**	**11.2**
S=2	**8.6**	**9.4**	**9.7**	**9.8**	**10.3**
S=4	**7.7**	**8.3**	**8.5**	**8.9**	**9.2**
S=8	**6.5**	**7.5**	**7.8**	**8.3**	**8.6**
S=16	**6.1**	**6.7**	**7.3**	**7.7**	**8.4**

V. Conclusion:

This paper deals with the high crest factor of the problem observed in PAPR OFDM multicarrier systems. A high PAPR leads to power amplifier saturation problems used before the show; it follows a distortion of the transmitted symbols and significantly degrading system performance. The Tone Reservation method called is a known method to reduce the PAPR. The Tone Reservation method is a widely studied and used for PAPR reduction in OFDM system. We also saw two metrics that can be used as optimization criterion, the level of the peak or PAPR and clipping power. Minimizing the level of the PAPR is performed with the LP linear programming method that requires the signals to be in real baseband, which is a major drawback. The energy minimization of clipping by setting the level of the PAPR, allows for better performance in terms of BER. But the complexity greatly increases especially when the number of carriers is large enough. It would be very interesting to work more on this aspect and try to reduce complexity.

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