2.1 HISTORY OF WIRELESS COMMUNICATION:

Wireless communication has created a revolution in the world. This field is experiencing the fastest growth period in history. In the last two decades due to wireless communication the whole world is made available in a space to fit in anybody’s pocket. This began with the first demonstration of Marconi in 1897 of keeping continuous contact with the sailing ships in the English Channel by using radio. Many advanced technologies have been adopted in wireless communication field to meet the continuously increased demand of users with an evidence of significant growth of services and applications on mobile and wireless access networks. Various other factors also contributed for this extra-ordinary growth in wireless communication. These factors are improvements in RF circuit fabrication, advance large scale circuit integration and other miniaturization technologies. These influenced the cost, size and reliability of the portable radio equipment. The cost became affordable and simultaneously the size got reduced making it easy and comfortable for handling.

The mobile telephone system was first started in 1940 which improved over the years. It was a very primitive system known as MTS (Mobile Telephone System). On the basis of this Bell Laboratories developed a new mobile telecommunication system known as cellular radio system in 1970’s. The first generation (1G) Radio system used analog technology to transmit voice signals i.e. speech transmission services of
1G in 1980. In 1987 Telecom was then known as Telstra, Australia utilized the 1G analog system for its cellular mobile phone network. The basic structural requirement of wireless communication was defined which included Cellular Architecture, Multiplexing, Mobility in the domain and uninterrupted intercommunication.[8]

The 2G system was built after 1980 and based on Digital Signal Processing Techniques. The Global System for Mobile Communications (GSM) is the most successful system of 2G. The 2G system was developed for voice transmission with more mobility however it couldn’t support the future demand of services for higher data rate and more bandwidth, such as multimedia, massive file transfer and streaming video.

The 3G wireless system provided the users with high data rate, wireless access of 2Mb/s for fixed users, 384Kb/s for low mobility users and 144Kb/s for high mobility users.[9] 3G developed rapidly in the 1990’s and is still developing today. The three main standards for 3G are Wideband Code Division Multiple Access (WCDMA), Time Division Synchronous CDMA (TD-SCDMA) and CDMA2000.[10, 11] A comparative analysis of 1G to 4G is shown in table 2.1 However there are several limitations with 3G. The major difficulty is continuously providing high data rate transmission to meet multimedia services requirement due to excessive interference between services. Therefore, the future wireless communication system is developing trend that can higher the data rate extended coverage and be more reliable transmission as demanded on broadband wireless communications.
2.1.1 Evolution of 4G:

While the 3G wireless communication system is beginning to be widely deployed around the world currently as a main standardization of high speed data communication, research on the 4G system are emerging and becoming more attractive. 4G is the next generation of wireless communication network that will replace the current core cellular networks in the future. The objectives of 4G are high speed, large capacity, low cost and effective bandwidth usage. It has received a great amount of attention from both research communities and industry vendors in the field of telecommunications. [12] 4G wireless communication is to provide higher data rate and more reliable services including video, audio, data and voice signals with worldwide compatibility. [13, 14]

Mobile WiMAX and Long term evolution (LTE) have been on the market since 2006 and 2009 respectively, and are often branded as 4G. The current versions of these technologies did not fulfill the original ITU-R (International Telecommunication Union-Radio communication sector) requirements of data rates approximately up to 1G bit/s for stationary condition and 100 Mbps for a moving condition in 4G system.
Table 2.1: Comparison of 1G, 2G, 3G & 4G

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>1G</th>
<th>2G</th>
<th>3G</th>
<th>4G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Analog</td>
<td>Digital Circuit Switched</td>
<td>Digital Packet Switched</td>
<td>Digital Broadband</td>
</tr>
<tr>
<td>Data Rate</td>
<td>9.6Kbps to 15 Kbps</td>
<td>9.6 Kbps to 115 Kbps</td>
<td>2 Mbps</td>
<td>20 to 40 Mbps</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 Mbps to 1 Gbps</td>
</tr>
<tr>
<td>Year</td>
<td>70's to 80's</td>
<td>90's to 2000</td>
<td>2001-2005</td>
<td>2006+</td>
</tr>
<tr>
<td>Multiple Access</td>
<td>FDMA</td>
<td>TDMA/CDMA</td>
<td>CDMA</td>
<td>OFDMA</td>
</tr>
<tr>
<td>Frequency</td>
<td>800 MHz</td>
<td>800 MHz or 1.9 GHz</td>
<td>2GHz</td>
<td>In Development</td>
</tr>
<tr>
<td>Primary Countries</td>
<td>World Wide</td>
<td>Europe, USA</td>
<td>Europe, Japan , USA</td>
<td>In Development</td>
</tr>
<tr>
<td>Channel Spacing</td>
<td>30 KHz</td>
<td>200 KHz</td>
<td>5 MHz</td>
<td>In Development</td>
</tr>
<tr>
<td>Features</td>
<td>Wireless Telephone Technology</td>
<td>Digital data services, such as SMS and email</td>
<td>Increase in the speed of internet browsing, picture and video messaging, and handled GPS use</td>
<td>Fully IP-based system, much like modern computer networks</td>
</tr>
</tbody>
</table>
2.1.2 Modulation Techniques for 4G:

4G systems are designed to support the high data rate transmission and a less bandwidth. As the bandwidth is increased, Inter symbol interference (ISI) becomes problematic and complex equalizers are required to compensate the channel effect. This is a disadvantage caused by large bandwidth systems, because the complex equalization reduces battery life and in most cases, the channel cannot be perfectly equalized. In order to avoid complexity of equalization, 4G systems adopt modulation technique based on multicarrier systems such as OFDM or Multicarrier Code Division Access (MC-CDMA).[9] OFDM is most important modulation technique for 4G system since it is able to boost high speed transmission over wireless channels.

2.2 HISTORY OF OFDM:

The first practical implementation of OFDM was reported in the HF military systems developed by the US army. A major contribution to OFDM was presented in 1971 by Weinstein & Elbert, who used the Discrete Fourier Transform (DFT) to perform base band modulation & demodulation in parallel system.

Important contribution was from Peled & Ruiz in 1980, who introduced the Cyclic Prefix (CP) or cyclic extension to solve the orthogonality problem. Instead of using an empty guard space they filled guard space with cyclic extension of OFDM signals. In 1980’s OFDM was proposed for high-speed modem, digital mobile communications and high speed modems over power lines and digital magnetic recording. The use of OFDM has grown tremendously during the last 30 years as the technique has been implemented for digital audio broadcasting (DAB), digital
terrestrial TV, Asymmetric digital subscriber lines (ADSL) and Digital Video Broadcasting (DVB). OFDM increases frequency efficiency of the transmission / broadcasting system more economically. OFDM provides robustness against narrowband interference. OFDM makes feasible live TV broadcasting to and from mobile users. OFDM ascertains a means for the creation of single-Frequency TV broadcasting networks.[15-17]

OFDM is considered an important technique for wireless communications due to many advantages such as robustness in frequency-selective fading channels, high spectral efficiency and immunity to inter-symbol interference and so on. However, a major drawback of OFDM is the High Peak to Average Power Ratio (PAPR) of the transmitted signal. As the result of large peak power, the digital to analog converter may become highly complex and requires highly linear power amplifiers with a large back-off to avoid adjacent channel interference due to nonlinear effect. Hence dynamic range reduction is highly considerable aspect for the application of OFDM signal in power and band limited communication system that’s why it is critical to reduce the PAPR of OFDM system. [18, 19]

2.3 PAPR REDUCTION TECHNIQUES: AN OVERVIEW

Several techniques have been proposed to reduce the PAPR. These techniques can be mainly categorized as distortion, signal scrambling and probabilistic technique. The first kind is distortion technique, such as clipping, companding and so on. This kind of technique is simple and intuitive but it’s inevitable to cause some performance degradation. The second kind is signal scrambling technique. Signal scrambling techniques are of all variations; on how to scramble the codes to decrease the PAPR.
Coding technique is used for signal scrambling. In particular, the use of Golay complementary sequences, Barker codes are an efficient method to reduce the PAPR for a small number of subcarriers, but it has a weak point of decreasing the transmission rate significantly for a large number of subcarriers. The third kind is probabilistic technique including Selective Mapping (SLM) and the Partial Transmit Sequence (PTS). [18, 20]

2.3.1 Distortion technique:

The key element of all distortion techniques is to reduce the amplitude of sample power which exceeds a certain threshold. The peaks are reduced above a certain threshold directly by distorting the signal before amplification. More practical solutions are clipping, companding, peak cancellation, peak power suppression, weighted multicarrier transmission etc. This technique is simple but it is inevitable to cause some performance degradation.[18] Direct clipping is the simplest method to reduce PAPR by compressing the signal whose power exceed a certain threshold, but this method increases out of band energy.[20] However RBF(Radial Basis Function) can suppress both the PAPR and the out of band energy and obtain improved error performance than direct clipping. Clipping results in the undesirable widening of the signal spectrum and increases the out of band interference.

2.3.1.1 Recursive clipping:

Here clipping level is chosen in respect to the power of unclipped signal. The clipped signal is transformed to the frequency domain. Out of band components are filtered out and the signal is modulated again. The more appropriate solution is shaped window functions. In the Cosine, Kaiser and Hamming windows they have been
examined. It appears that peak windowing greatly reduces the out of band power of the clipped OFDM signal. [16] The clipping or windowing of the signal in the transmitter increases the packet error rate (PER) at the receiver. Modification of this method involves peak detection, generation of the appropriate impulses and frequency domain low pass filtering. [15]

May, T. and Rholing, H. proposed the method of PAPR reduction by manipulating the OFDM signal with a suitable additive correcting function. In this approach, the amplitude peaks are corrected (or signal is modified) in such a way that a given amplitude threshold of the signal is not exceeded after the correction. [21]

2.3.1.2 Peak Windowing:

Peak windowing technique provides better PAPR reduction than clipping. In windowing technique a large signal peak is multiplied with a certain window, such as Gaussian shaped window, Cosine Kaiser and Hamming Window. Since the OFDM signal is multiplied with several of these windows, the resulting spectrum is convolution of the original OFDM spectrum with the spectrum of the applied window. Van Nee and Wild [22] proposed that a large PAPR occur only rarely, it is possible to remove these peaks by the self interference. Peak windowing can achieve PAPR around 4dB for arbitrary subcarriers, with increase in BER and out-of-band (OOB) interference.

2.3.1.3 Companding:

Wang et al, [23] proposes a simple and effective Companding technique to reduce the PAPR of OFDM signal. Companding can be used to improve OFDM transmission performance. μ-law Companding technique is used to compand the OFDM signal
before it is converted into analog waveform. Athinarayanan Vallavaraj, Brain G. Stewart and David K. Harrison investigated the influence and effect of various $\mu$-law companding parameters to assist in reducing the high values of PAPR [24]. It has been discovered that the BER can be improved further over uncompanded OFDM and $\mu$-law Companded OFDM by increasing PR from 1 to higher values while keeping $\mu$ constant. Companding is highly used in OFDM system and speech processing where high peak occur rarely. Companding technique improves the quantization resolution of small signals at the reduction of the resolution of large signals. Since small signal occur more frequently than large signals, due to this technique, for large signal, the quantization error is significantly large which degrades the BER performance of the system.

2.3.2 Coding Technique:

Coding technique is an efficient method to reduce the PAPR for a small number of subcarriers, but it has a weak point of decreasing the transmission rate significantly for a large number of subcarriers. In this scheme the original data sequence is mapped onto a longer sequence with a lower PAPR in the corresponding OFDM signal. Basically, a coding scheme would involve a large look-up table and is more suitable for those OFDM systems with a small number of subcarriers.[25, 26]

2.3.2.1 Block Coding Technique:

In this technique the input data is encoded (Block Coding) [27] with a codeword of low PAPR. This reduces the PAPR as the number of carriers are increased however the encoding becomes more tedious and time consuming. The memory required to
store the codes and the CPU time needed to allocate appropriate code increases to a great extent as the number of carrier increase.

2.3.2.2 Sub Block Coding Technique:

Zhang Y., Yongacoglu A., Chouinard J. and Zhang. L. proposed the sub-block coding scheme in the form of redundant bit location optimized and combination optimized sub block coding with the last bit as an odd parity checking bit demonstrate lowest peak envelope power, for reducing PAPR of an OFDM signal [28]. This scheme for reducing the PAPR of OFDM has low complexity & is found that more than 3dB reduction in PAPR achieved when the code rate is ¾.

The Golay complementary sequences [29] is a very efficient method to reduce the PAPR less than 3dB for small number of subcarriers but it has weak point of decreasing the transmission rate significantly for a large number of subcarriers. Golay found several transforms of the sequences, which do not alter their properties and hence were shown to be invariant in term of the peak factors. Mao-Cho Lin et al considered SLM turbo coded OFDM scheme which has better PAPR reduction capability. [30, 31]

2.3.2.3 Block coding scheme with error correction:

Block code does not only reduce the PAPR but also provides error correction capability. In the transmitter of the system, k bit (4 bit) data block is encoded by a (n, k) block code with a generator matrix G, followed by the phase rotator vector $\theta$. A.E. Jones, et al[26] present a new block coding scheme for reduction of PAPR of an OFDM system with error correction capability. Wilkison, T.A. and Jones, A.E. which
provides only error detection method and this scheme provides error correction capability and improves the overall performance of OFDM system [25].

In short, the inherent error control capability and simplicity of implementation make the coding method more promising for a design of practical OFDM system.[32] However, the main disadvantage of this method is the good performance of the PAPR reduction at the cost of coding rate loss.

2.3.3 Probabilistic Technique:

Probabilistic technique is also called as the redundancy technique which consists of selective mapping (SLM) and the partial transmit sequence (PTS). The SLM and PTS approaches have received considerable attention in recent era for providing improved PAPR statistics of an OFDM signal. In SLM the transmitter selects one favorable transmit signal from a set of sufficiently different signals which all represent the same information, while in PTS the transmitter constructs its transmit signal with low PAR by coordinated addition of appropriately phased rotated signal parts.[33]

2.3.3.1 Tone Reservation (TR):

This method is proposed for PAPR reduction [34]. The main concept in this method is to keep a small set of tones for PAPR reduction. This method is based on adding a time domain signal with respect to the original multicarrier signal to reduce the peaks. It is convenient to compute this time domain signal at the transmitter and erase it at receiver. The selection of the appropriate tones to be reserved for PAPR reduction is bit complex but can be resolved. The amount of PAPR reduction depends on factors such as number of reserved tones, location of the reserved tones and amount of complexity.
This method explains an additive scheme for minimizing PAPR in the multicarrier communication system. It shows that reserving a small fraction of tones leads to large minimization in PAPR using a simple algorithm at the transmitter of the system without any additional complexity at the receiver end. Here, N is the small number of tones, reserving tones for PAPR reduction may present a non-negligible fraction of the available bandwidth and resulting in a reduction in data rate.[35] The advantage of TR method is that it is less complex, no side information as well as also no additional operation is required at the receiver of the system.

2.3.3.2 Tone Injection Technique:

The basic idea here is to increase the constellation size so that each of the points in the original basic constellation can be mapped into several equivalent points in the expanded constellation [35, 36]. Since each symbol in a data block can be mapped into one of several equivalent constellation points, these extra degrees of freedom can be exploited for PAPR reduction. In a multicarrier signal tones with matching phase the frequency is substituted in the basic constellation for a new larger constellation. The amount of PAPR reduction depends on the number of modified symbol in a data block.

2.3.3.3 Partial Transmit Sequence:

Muller and Hubber, [37] proposed an effective and flexible peak power reduction scheme for OFDM system by combining Partial Transmit Sequences (PTS) in 1997. The main idea behind the scheme is that, the data block is partitioned into non-overlapping sub blocks and each sub block is rotated with a statistically independent rotation factor. Side information is present in the transmitted signal. This side
information is nothing but the rotation factor generating time domain data with lowest peak amplitude. Among the redundancy techniques, the Partial Transmit Sequence (PTS) has proved efficient and distortion less by generating multiple candidate signals to reduce the PAPR, [37, 38]

2.3.3.4 Selective Mapping:

In SLM Technique, one OFDM signal with the lowest PAPR is selected for transmission at the transmitter from a set of sufficiently different candidate signals, which all represent the same data sequence. Each candidate signal is actually the IFFT of the original data sequence multiplied by an individual phase rotation vector. Bauml, R.W et al[39] proposed a method for PAPR reduction of multicarrier modulation by selected mapping. This scheme for the reduction of PAPR can be used for arbitrary number of carriers and any signal constellation. Selected mapping provides significant gains at moderate additional complexity. Even in single carrier systems where PAR grows as the roll-off factor of the pulse shaping filter decreases, selected mapping can be applied advantageously.

The paper, by Chin-Liang Wang [40] proposes a kind of low complexity conversions to replace the IFFT blocks in the conventional SLM method. They developed two novel SLM schemes with much lower complexity than the conventional one; the first method uses only one IFFT block to generate the set of candidate signals and the computational complexity required for the original M-1 LN-point IFFT blocks is reduced to (M–2) × 3LN complex additions (where M is number of data sequence), while the second proposed scheme uses two IFFT blocks. This method achieved better PAPR reduction performance.
E. Alsusa and L. Yang [41] proposed selective post-IFFT amplitude randomizing for PAPR reduction in OFDM system. This technique randomizes the amplitude of the signal after the IFFT process with the objective to achieve a significant reduction in the PAPR of the signal to be transmitted.

In PTS, the data block to be transmitted is partitioned into M separate sub-blocks which are combined to minimize PAPR. PTS is used to reduce the computational complexity. The PTS method uses the phase rotated sub-blocks in which the signal is partitioned. But this scheme requires the side information to be transmitted very carefully. SLM method does not require explicit side information. [42]

Seung Hee Han and Jae Hong Lee [43] propose a modified SLM technique for PAPR reduction of coded OFDM signal. In this technique, embedding the phase sequence, which is used to lower PAPR of the data block in the check symbols of the coded OFDM system i.e. uses simple block code method.

Yang Jie, Chen Lie, Lue Quan and Chen De, showed that, only one IFFT block is required at the transmitter and no side information needs to be transmitted. It reduced complexity of the system. BER of the modified SLM system is smaller than the basic OFDM system with the same SNR. [18, 44]

SLM is an efficient and distortion less scheme which selects the minimum PAPR sequence from a group of independent phase rotated sequences with different PAPR values. [45] However it has serious disadvantage, because the SLM uses many branches and IFFT blocks, it requires much system complexity and computational burden. Sang -Woo Kim et al [46] proposed new method which rotates the phase of input data after IFFT by using Wash Hadamard code to solve this problem.
Additionally, differential encoding may be applied before IFFT, so that differential
demodulation could be implemented at the receiver.

Recently, Breiling et al. [47] proposed a PAPR reduction method by SLM without
explicit side information. PAPR is reduced by using the standard arrays of linear
block codes. In this scheme, a signal with minimum PAPR from distinct signals is
chosen as the transmit signal, where distinct signals are constructed by scrambling a
codeword with the properly selected coset leaders. As the coset leaders are used only
for scrambling, no side information is required to be transmitted and the received
signal can be easily decoded by syndrome decoding.

Powerful channel equalization is not needed to combat ISI and if differential
modulation is applied, no channel estimation is required at all. Thus, the complexity
of OFDM systems can be much lower compared with a single carrier transmission
system.

M-ary Differential Phase Shift Keying (M-ary DPSK) is a bandwidth efficient digital
modulation technique and has recently attracted increased attention in mobile radio
where the available radio bandwidth is limited. Differential detection is still attractive
owing to its simplicity and robustness against the fast multipath fading experience by
receivers. Differential modulation or a one-tap equalizer can help to compensate for a
frequency flat fading channel. The fading process is characterized by a Rayleigh
distribution for a non line-of-sight path and a Rician distribution for a line-of-sight
path. [48] The modulation rate on each subcarrier is very low, each subcarrier
experiences flat fading in a multi-path environment and is easy to equalize. The need
for equalization can be eliminated by using Differential QPSK (DQPSK) modulation
where data is encoded as the difference in phase between the present and previous symbol at a time on the same sub carrier, differential modulation improves performance in environments where rapid changes in phase are possible. [49]

There are many issues to be considered before using the PAPR reduction techniques in a digital communication system. These issues include PAPR reduction capacity, power increase in transmit signal, BER increase in the system, loss in data rate, computational complexity increases and so on. Simultaneously most of the techniques are not proficient to obtain a large reduction in PAPR with low coding overhead, with low complexity, sacrifice of performance degradation and without transmitter and receiver symbol handshake.

OFDM is a promising technique for high speed data transmission in frequency selective fading environment. By converting a wideband signal into narrowband signal for parallel transmission, each narrowband OFDM signal suffers from frequency - flat fading and thus , need only a one-tap equalizer to compensate for the corresponding multiplicative channel distortion. To estimate the multiplicative channel response (CR) is to insert pilot symbols among transmitted data symbol [50] or use of coding technique in transmitter.

Mang-Xian Chang, et al presented a systematic approach for evaluating the Bit Error Probability (BEP) performance of OFDM receivers in Rayleigh fading when a linear pilot-assisted channel estimate is used. [55]
Table 2.2: Summary of OFDM system with respective PAPR and BER

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>AUTHOR</th>
<th>MODULATION SCHEME</th>
<th>PAPR Reduction in dB</th>
<th>BER</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAPR reduction using turbo coding</td>
<td>Abdulla A. Abouda [51]</td>
<td>QPSK</td>
<td>Exceeding 7dB can be reduced to 0.25% &gt;7dB, N=128</td>
<td>$6 \times 10^{-5}$</td>
</tr>
<tr>
<td>SLM technique with turbo coded OFDM</td>
<td>Mao, Chao Lin et al [30]</td>
<td>BPSK</td>
<td>6dB, N=128</td>
<td>$10^{-5}$</td>
</tr>
<tr>
<td>PAPR Reduction tech. of V-BLAST based MIMO-OFDM and SLM</td>
<td>Byung Moo Lee et al [70]</td>
<td>16 QAM</td>
<td>Side Information Power Allocation in the range of 20dB to 30dB</td>
<td>$10^{-3.5}$</td>
</tr>
<tr>
<td>Radial Basis function Network (RBFN)-SLM</td>
<td>Insoo Sohn [45]</td>
<td>QPSK</td>
<td>Reduces the PAPR substantially based on the optimum integration SLM and RBFN Methodology , 5.9dB, N=128</td>
<td>Not computed</td>
</tr>
<tr>
<td>SLM with convolutional code</td>
<td>Sumatni S. [44]</td>
<td>BPSK</td>
<td>8.2dB, N=120</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>Modified SLM encode the phase randomising sequence.</td>
<td>Emad Alsusa et al [41]</td>
<td>16QAM</td>
<td>7dB, N=256</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>SLM with Wash Hadamard transform.</td>
<td>Sang Woo Kim et al [52]</td>
<td>QPSK</td>
<td>7.9dB, N=64</td>
<td>Not computed</td>
</tr>
<tr>
<td>Modified SLM with Linear block code.</td>
<td>Yang Jie et al [18]</td>
<td>QPSK</td>
<td>5.5dB, N=64</td>
<td>$10^{-4.5}$</td>
</tr>
<tr>
<td><strong>Proposed Modified SLM with linear block code and extended hamming code.</strong></td>
<td>V.B.Malode and B.P.Patil [53, 54]</td>
<td>DQPSK</td>
<td>4.7dB, N=64</td>
<td>$10^{-2.5}$</td>
</tr>
</tbody>
</table>
Kamran Kiasaleh, et al investigated the performance of Differential Quaternary Phase Shift Keying (DQPSK) receivers impaired by mixer imbalance and timing error [56]. In wireless communication due to fading and multipath, the received signal suffers from random phase fluctuations. This in turn makes coherent demodulation scheme impractical. So it is recommended to use DQPSK. It supports high data rate transmission and generally requires no equalization at the receiver, making it simple and efficient. For this reason, the current North America Digital cellular (NADC) standards suggest $\pi/4$-shifted- DQPSK modulation for the current digital mobile communication system. America and Japan have adopted the DQPSK modulation method for digital cellular standards.

2.4 BIT ERROR RATE OF OFDM:

The performance of wireless communication systems is characterized by the BER, i.e., the probability of error at a specific signal-to-noise ratio. On the other hand, the reliability of a system is based on the BER requirements of a specific application. BER Performance in OFDM system is summarized in Table 2.2.

The various Selective mapping methods of OFDM system are reviewed for PAPR, which is summarized in Table 2.2. Many researchers, scientist, wireless application designers and engineers are working on SLM technique which improves the performance of OFDM system in PAPR reduction. The proposed method used SLM technique with extended hamming LBC and DQPSK mapping technique to reduce PAPR value. In the proposed method the PAPR values 4.7dB is achieved as shown in Table 2.2.
2.5 SUMMARY AND CONCLUSION:

Wireless communication is fastest and ever growing field of the world. The mobile radio communication evolved to the current 4G systems taking steps 1G, 2G, 3G since 1980. Looking at the current features it can be called as a leap in the sky. OFDM is used as a key part to achieve high data rate transmission with a limited bandwidth. Previously the use of OFDM was limited for specific military system. The introduction of CP in the OFDM signal boosted the use of OFDM in wireless communication system.

PAPR is a major drawback in the OFDM system. High PAPR compels the use of complex D/A converters as well as linear power amplifiers. Clipping, Companding, Windowing Block coding, selective mapping, PTS are the various techniques harnessed for PAPR reduction. The increase in BER at the receiver is also undesirable.

Some modifications are proposed in the current PAPR reduction technique to enhance their performance with respective BER.