*International Journal of Engineering Science Invention*
*ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726*
*www.ijesi.org ||Volume 4 Issue 2 || February 2015 || PP.16-26*

# Dynamic Power Allocation for Mc-Cdma System Using Iterative Water Filling Algorithm (Iwfa)

P.Merin Dayana[1], S.Denitta Adline[2]
[1]*(Communication System, FX Engineering College/ Chennai Anna University, India)*
[2]*(Communication System, FX Engineering College/ Chennai Anna University, India)*

***ABSTRACT :*** *Power control in Multi Carrier Code Division Multiple Access ( MCCDMA) based wireless cellular network is of great importance. The power allocation methodology to enhance the performance of the MCCDMA system by limiting interference noise is at the expense of signaling overhead due to sharing of Channel State Information (CSI). The distributed algorithms that manage the power level based on the user's SINR requirements needs the complete knowledge of Channel State Information (CSI) .Since the CSI is subjected to the errors because of the imperfect channel estimation/measurement due to the time varying nature of the channels, the distributed power control algorithm is not globally optimum. The water filling algorithm is used to allocate proper power for every sub channel in order to improve channel capacity. The water filling algorithm distributes power among all users with the help of SINR that is received by the transmitter instead of getting full Channel State Information (CSI).*

***KEYWORDS –*** *CSI-Channel State Information, IWFA-Iterative Water Filling Algorithm, MCCDMA-Multiple Carrier Code Division Multiple Access, OFDM-Orthogonal Frequency Division Multiplexing, SINR-Signal to Interference plus Noise Ratio.*

## I. INTRODUCTION

Multicarrier Code Division Multiple Access (MC-CDMA) has drawn significant interest as a major candidate for next generations of high data rate mobile networks. It is a multicarrier transmission technique that might be viewed as a combined OFDM/CDMA communication system. Due to the simultaneous transmissions, sub-carriers interface with each other and limit the wireless network performance. One important interference mitigation technique in MCCDMA is transmitter power control at the physical layer. The power control method focused on balancing (equalizing) the SINRs on all radio links through centralized operations requires an added infrastructure, latency and network vulnerability to give better response. The distributed algorithms that manage the power level based on the user's SINR requirements needs the complete knowledge of Channel State Information (CSI). Since the CSI is subjected to the errors because of the imperfect channel estimation measurement due to the time varying nature of the channels, the distributed power control algorithm is not globally optimum. The water filling rule is a tool used to allocate proper power for every user in order to improve system capacity performance with global constraint and imperfect Channel State Information. Multi-carrier Code Division Multiple Access (MC-CDMA) plays a major role in $4^{th}$ Generation (4G) wireless mobile technology. It is an efficient technique. But there are some parameters which pull down its efficiency. Power control in Multi-carrier Code Division Multiple Access (MC-CDMA) based wireless network is of great importance. Iterative Water Filling Algorithm (IWFA) is an algorithm, which is used to allocate power to the sub channels. Iterative Water Filling Algorithm (IWFA) will allocate power to the users with the help of carrier to noise ratio. Since power is allocated to the users by carrier to noise ratio, over use of power is reduced. To maximize the capacity of a rayleigh fading channel, the water filling algorithm is used. OFDM modulation divides the total bandwidth into N sub channels. Large number of sub channels cause each sub channel experience a flat fading channel if the proper cyclic prefix is added to the end of each Orthogonal Frequency Division Multiplexing (OFDM) symbol. The water filling algorithm assigns more power to sub channels which experience good condition and may assign no power to bad conditioned sub channels (sub channels with deep fading).

## II. MULTI-CARRIER CODE DIVISION MULTIPLE ACCESS (MC-CDMA)

Multi-carrier Code Division Multiple Access (MC-CDMA) represents a fusion of two radio access techniques, namely OFDM (orthogonal frequency division multiplexing) and CDMA (Code division multiple access). OFDM, the technology at the heart of digital broadcast television and radio, solves the difficult inter symbol interference problem encountered with high data rates across multipath channels. By dividing the bandwidth into many small orthogonal frequencies (efficiently achievable using the Fast Fourier Transform), the data can be transmitted across multiple narrowband channels, which suffer only from flat fading.

CDMA, the technology chosen for the third generation of mobile phone networks exploits the diversity in the radio channel to improve performance and allows better spectral efficiency and easier base station placement compared to second generation systems. Multi-carrier Code Division Multiple Access (MC-CDMA) systems many aspects of these two technologies to provide a communication system that has the advantages of both. In the Multi-carrier Code Division Multiple Access (MC-CDMA) system each data bit is transmitted in parallel on multiple independently fading subcarriers. The Code Division Multiple Access (CDMA) coding is applied across the carriers, with each carrier modulated by a single code chip. The advantage of these systems is that the small number of users allows the computationally complex maximum likelihood detection to be used. The disadvantage may be that the diversity of the channel may not be fully exploited. Code division multiple access (CDMA) is a multiplexing technique where a number of users simultaneously and asynchronously access a channel by modulating and spreading their information bearing signals with pre assigned signature sequences.

It has been considered to support multimedia support multimedia services in mobile radio communications because it has its own capabilities to cope with asynchronous nature of multimedia data traffic, to provide high capacity over conventional access techniques such as time division multiple access and frequency division multiple access. Multicarrier modulation scheme often called OFDM has drawn a lot of attention in the field of radio communications. This is mainly because of the need to transmit high data rate in a mobile environment which makes a highly hostile radio channel.

There are many possible ways to interpret and implement MC-CDMA. The approach used here to introduce it is to combine direct sequence CDMA (DS-CDMA) and OFDM. Like OFDM, the MC-CDMA signal is made up of a series of equal amplitude subcarriers. Unlike OFDM, where each subcarrier transmits a different symbol, MC-CDMA transmits the same data symbol over each Nth subcarrier. MC-CDMA applies spreading in the frequency domain by mapping a different chip of the spreading sequence to an individual OFDM subcarrier. The MC-CDMA transmitter can be implemented by concatenating a DS-CDMA spreader and an OFDM transmitter. The input data sequence is first converted into a number of parallel data sequences; then each data sequence is multiplied by a spreading code. The data in the spreading bits are modulated in the baseband by IDFT and converted back to serial data. The spreading sequence in MC-CDMA provides multiple access capability. A guard interval with cyclic extensions similar to OFDM is inserted between symbols to counter ISI caused by multipath fading. Similar to OFDM systems, MCCDMA systems are very sensitive to nonlinear amplification and require linear amplifiers. Two parameters that affect MCCDMA design and performance are the guard interval and the number of subcarriers. At the receiver a coherent detection method is employed to successfully despread the signal. The received signal, after down conversion and digitization, is first coherently detected with DFT, then multiplied by a gain factor.

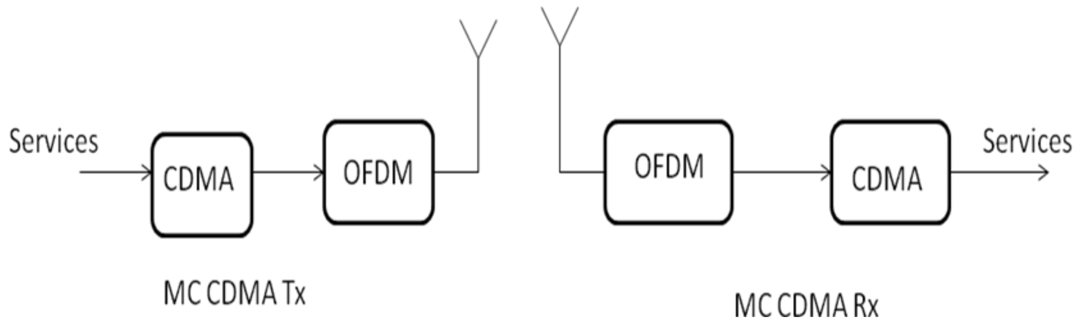


Fig 1: Basic Block Diagram

**Code Division Multiple Access (CDMA) :**Code division multiple access (CDMA) is a channel access method used by various radio communication technologies. It should not be confused with the mobile phone standards called CDMA. One of the concepts in data communication is the idea of allowing several transmitters to send information simultaneously over a single communication channel. This allows several users to share a band of frequencies (see bandwidth). This concept is called multiple access. CDMA employs spread-spectrum technology and a special coding scheme (where each transmitter is assigned a code) to allow multiple users to be multiplexed over the same physical channel. By contrast, time division multiple access (TDMA) divides access by time, while frequency-division multiple access (FDMA) divides it by frequency. CDMA is a form of spread-spectrum signaling, since the modulated coded signal has a much higher data bandwidth than the data being communicated. An analogy to the problem of multiple access is a room (channel) in which people wish to talk to each other simultaneously.

To avoid confusion, people could take turns speaking (time division), speak at different pitches (frequency division), or speak in different languages (code division). CDMA is analogous to the last example where people speaking the same language can understand each other, but other languages are perceived as noise and rejected. Similarly, in radio CDMA, each group of users is given a shared code. Many codes occupy the same channel, but only users associated with a particular code can communicate.

CDMA is a spread spectrum multiple access technique. A spread spectrum technique spreads the bandwidth of the data uniformly for the same transmitted power. A spreading code is a pseudo-random code that has a narrow ambiguity function, unlike other narrow pulse codes. In CDMA a locally generated code runs at a much higher rate than the data to be transmitted. Data for transmission is combined via bitwise XOR (exclusive OR) with the faster code. The figure shows how a spread spectrum signal is generated. The data signal with pulse duration of (symbol period) is XOR with the code signal with pulse duration of $T_c$ (chip period). (Note: bandwidth is proportional to $1/T_b$ where T = bit time) Therefore, the bandwidth of the data signal is $1/T_b$ and the bandwidth of the spread spectrum signal is $1/T_c$. Since $T_c$ is much smaller than $T_b$, the bandwidth of the spread spectrum signal is much larger than the bandwidth of the original signal. The ratio $T_b/T_c$ is called the spreading factor or processing gain and determines to a certain extent the upper limit of the total number of users supported simultaneously by a base station.

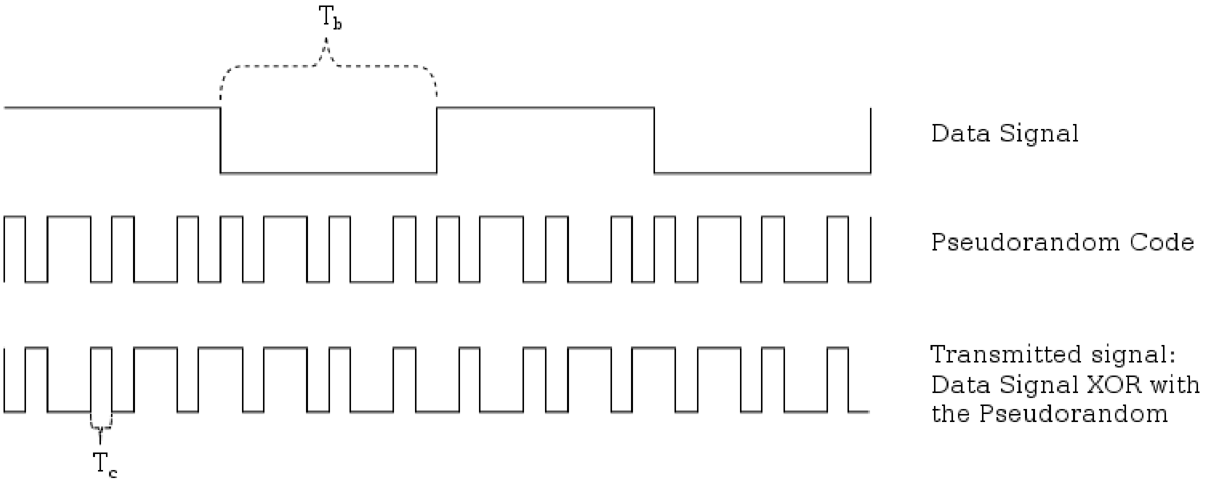


Fig 2: CDMA Signal

Each user in a CDMA system uses a different code to modulate their signal. Choosing the codes used to modulate the signal is very important in the performance of CDMA systems. The best performance will occur when there is good separation between the signal of a desired user and the signals of other users. The separation of the signals is made by correlating the received signal with the locally generated code of the desired user. If the signal matches the desired user's code then the correlation function will be high and the system can extract that signal. If the desired user's code has nothing in common with the signal the correlation should be as close to zero as possible (thus eliminating the signal); this is referred to as cross correlation. If the code is correlated with the signal at any time offset other than zero, the correlation should be as close to zero as possible. This is referred to as auto-correlation and is used to reject multi-path interference.

CDMA gives a cellular service company high capacity because it shares the same local wireless signal with many customers. It has up to 10 times the capacity compared to earlier analog cellular technologies and up to five times that of Global System for Mobile communication, or GSM-based, services. Greater capacity means far less likelihood that the service drops your call or cannot connect you because of heavy system use. A CDMA voice call is not only a digital data stream, it is an automatically encrypted one that is very difficult to intercept and eavesdrop; even if a well-equipped listener could tune into the frequency, he would need to know your code to decode the conversation. As with the secure on-line transactions you have with your bank and Web-based stores, CDMA mixes the data that constitutes your call with pseudo-random bits, resulting in a signal that appears as nonsense to an outsider. CDMA provides secure communications for the military, for example, as the technology resists interference from jamming and other threats. A CDMA cell phone employs a dynamic power control system to limit radio interference. Because nearby phones use the same frequency, they will interfere with each other's signal if the transmitting power is too high. CDMA automatically adjusts the power level to one that's powerful enough to provide a clear call but not so powerful that it creates excessive interference.

Because it is not always transmitting at peak power, the call uses less energy from the phone's battery. One major problem in CDMA technology is channel pollution, where signals from too many cell sites are present in the subscriber’s phone but none of them is dominant. When this situation arises the quality of the audio degrades. Another disadvantage in this technology when compared to GSM is the lack of international roaming capabilities. The ability to upgrade or change to another handset is not easy with this technology because the network service information for the phone is put in the actual phone unlike GSM which uses SIM card for this. One another disadvantage is the limited variety of the handset, because at present the major mobile companies use GSM technology. Disadvantages of using Code Division Multiple Access the handset is network locked. There is no availability of variety of handsets and services for you. You cannot switch to a new CDMA phone without deactivating your old phone before activating your new phone on the same network. CDMA network coverage is not available in all countries.

**Orthogonal Frequency Division Multiplexing (OFDM):**Orthogonal Frequency Division Multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over copper wires, used in applications such as digital television and audio broadcasting, DSL broadband internet access, wireless networks, and 4G mobile communications. Orthogonal frequency-division multiplexing (OFDM) is essentially identical to Coded OFDM (COFDM) and discrete multi-tone modulation (DMT), and is a Frequency-Division Multiplexing (FDM) scheme used as a digital multi-carrier modulation method. The word coded comes from the use of Forward Error Correction (FEC). A large number of closely spaced orthogonal sub-carrier signals are used to carry data on several parallel data streams or channels. Each sub-carrier is modulated with a conventional modulation scheme at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth.

The primary advantage of Orthogonal Frequency Division Multiplexing OFDM over single-carrier schemes is its ability to cope with severe channel conditions (for example, attenuation of high frequency in long copper wire narrowband interference and frequency-selective fading due to multipath) without complex equalization filters. Channel equalization is simplified because OFDM may be viewed as using many slowly modulated narrowband signals rather than one rapidly modulated wideband signal. The low symbol rate makes the use of a guard interval between symbols affordable, making it possible to eliminate inter symbol interference (ISI) and utilize echoes and time-spreading (that shows up as ghosting on analogue TV) to achieve a diversity gain, i.e. a signal-to-noise ratio improvement. This mechanism also facilitates the design of single frequency networks (SFNs), where several adjacent transmitters send the same signal simultaneously at the same frequency, as the signals from multiple distant transmitters may be combined constructively, rather than interfering as would typically occur in a traditional single-carrier system.

- DAB –OFDM forms the basis for the Digital Audio Broadcasting (DAB) standard in the European market.
- ADSL-OFDM forms the basis for the global ADSL (asymmetric digital subscriber line) Standard.

If this was not enough it is also being used for digital terrestrial television transmissions as well as DAB digital radio. A new form of broadcasting called Digital Radio Mondiale for the long medium and short wave bands is being launched and this has also adopted COFDM. Then for the future it is being proposed as the modulation technique for fourth generation cell phone systems that are in their early stages of development and OFDM is also being used for many of the proposed mobile phone video systems. OFDM, orthogonal frequency division multiplex is a rather different format for modulation to that used for more traditional forms of transmission. It utilizes many carriers together to provide many advantages over simpler modulation formats.

An OFDM signal consists of a number of closely spaced modulated carriers. When modulation of any form- voice, data etc, is applied to a carrier then sidebands spread out either side. It is necessary for a receiver to be able to receive the whole signal to be able to successfully demodulate the data. As a result when signals are transmitted close to one another they must be spaced so that the receiver can separate them using a filter and there must be a guard band between them. This is not the case with OFDM. Although the sidebands from each carrier overlap, they can still be received without the interference that might be expected because they are orthogonal to each another. This is achieved by having the carrier spacing equal to the reciprocal of the symbol period.

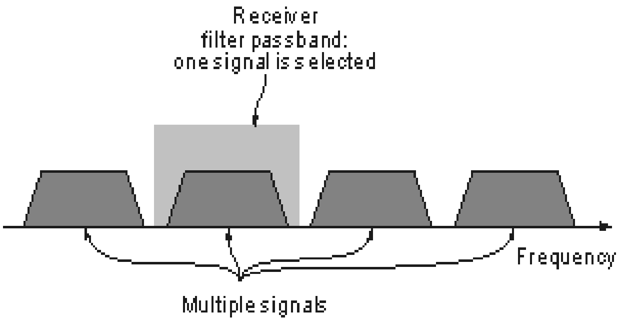


Fig 3: Traditional view of receiving signals carrying modulation

To see how OFDM works, it is necessary to look at the receiver. This acts as a bank of demodulators, translating each carrier down to DC. The resulting signal is integrated over the symbol period to regenerate the data from that carrier. The same demodulator also demodulates the other carriers. As the carrier spacing equal to the reciprocal of the symbol period means that they will have a whole number of cycles in the symbol period and their contribution will sum to zero - in other words there is no interference contribution.

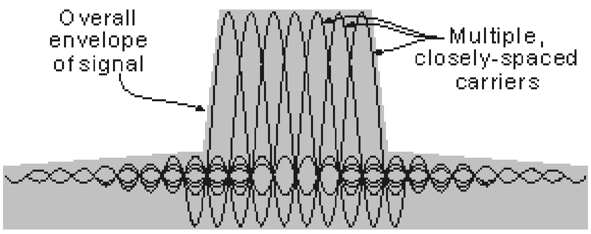


Fig 4: OFDM Spectrum

One requirement of the OFDM transmitting and receiving systems is that they must be linear. Any non-linearity will cause interference between the carriers as a result of inter-modulation distortion. This will introduce unwanted signals that would cause interference and impair the orthogonality of the transmission. In terms of the equipment to be used the high peak to average ratio of multi-carrier systems such as OFDM requires the RF final amplifier on the output of the transmitter to be able to handle the peaks whilst the average power is much lower and this leads to inefficiency. In some systems the peaks are limited. Although this introduces distortion that results in a higher level of data errors, the system can rely on the error correction to remove them. The data to be transmitted on an OFDM signal is spread across the carriers of the signal, each carrier taking part of the payload. This reduces the data rate taken by each carrier. The lower data rate has the advantage that interference from reflections is much less critical. This is achieved by adding a guard band time or guard interval into the system. This ensures that the data is only sampled when the signal is stable and no new delayed signals arrive that would alter the timing and phase of the signal.

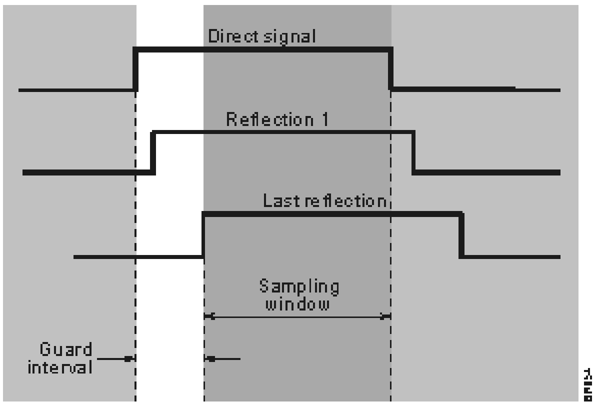


Fig 5: Guard Interval

The distribution of the data across a large number of carriers in the OFDM signal has some further advantages. Nulls caused by multi-path effects or interference on a given frequency only affect a small number of the carriers, the remaining ones being received correctly. By using error-coding techniques, which does mean adding further data to the transmitted signal, it enables many or all of the corrupted data to be reconstructed within the receiver. This can be done because the error correction code is transmitted in a different part of the signal. The “orthogonal” part of the OFDM name indicates that there is a precise mathematical relationship between the frequencies of the carriers in the system. In a normal FDM system, the many carriers are spaced apart in such way that the signals can be received using conventional filters and demodulators. In such receivers, guard bands have to be introduced between the different carriers (Fig. 2.), and the introduction of these guard bands in the frequency domain results in a lowering of the spectrum efficiency. It is possible, however, to arrange the carriers in an OFDM signal so that the sidebands of the individual carriers overlap and the signals can still be received without adjacent carrier interference. In order to do this the carriers must be mathematically orthogonal. The receiver acts as a bank of demodulators, translating each carrier down to DC, the resulting signal then being integrated over a symbol period to recover the raw data. If the other carriers all beat down to frequencies which, in the time domain, have a whole number of cycles in the symbol period (t), then the integration process results in zero contribution from all these carriers. Thus the carriers are linearly independent (i.e. orthogonal) if the carrier spacing is a multiple of 1/t.

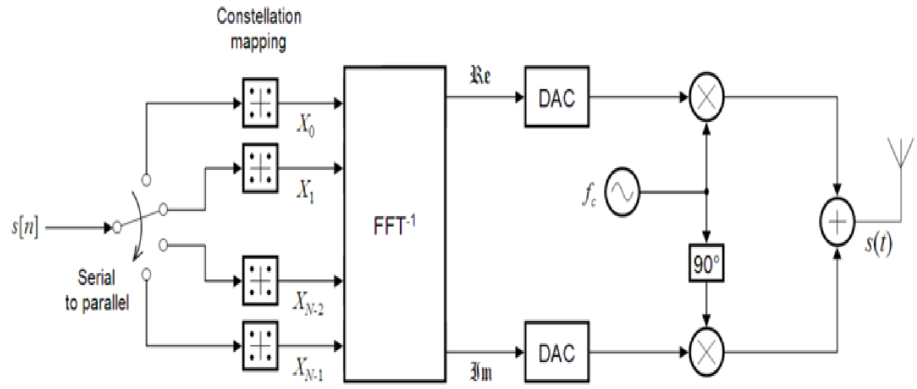


Fig 6: OFDM Transmitter

An OFDM carrier signal is the sum of a number of orthogonal sub carriers, with data on each sub-carrier being independently modulated commonly using some type of (QAM) or (PAS).This composite baseband signal is typically used to modulate a carrier. s(n) is serial stream of binary digital. By these are first demultiplexed into N parallel streams, and each one mapped to (possibly complex) symbol stream using some modulation constellation. Note that the constellations may be different, so some streams may carry a higher bit-rare than others. An inverse is computed on each set of symbols. Giving a set of complex time-domain samples. These samples are then mixed to pass band in the standard way. The real and imaginary components are first converted to the analogue domain using (DACs) the analogue signals are then used to modulated and waves at frequency respectively. These signals are then summed to give the transmission signal s(t).

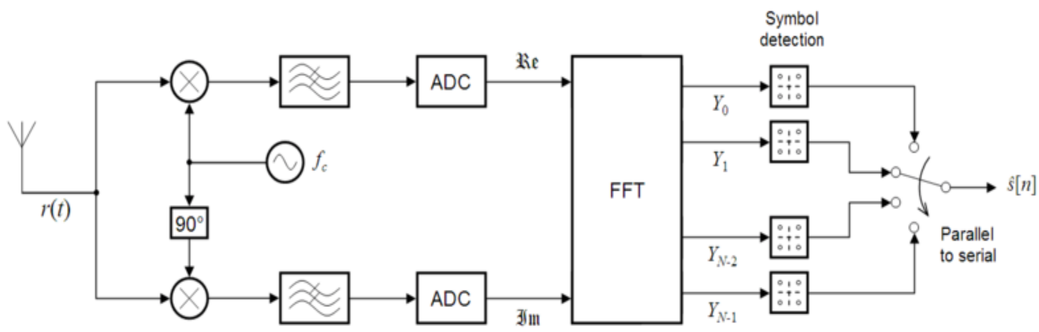


Fig 7: OFDM Receiver

The receiver picks up the signal r(t), which in then quadrature-mixed down to baseband using cosine and sine waves at the carrier frequency. This also creates signals centered on 2fc, so low-pass filters are used to reject these. The baseband signals are then sampled and digitized using (ADCs), and a forward is used to convert back to the frequency domain. This returns N parallel streams, each of which is converted to binary stream using an appropriate symbol. These streams are then recombined into a serial stream, s[n], which is an estimate of the original binary stream at the transmitter.

## III. THE FOURIER TRANSFORM

The Fourier transform allows us to relate events in time domain to events in frequency domain. There are several version of the Fourier transform, and the choice of which one to use depends on the particular circumstances of the work. The conventional transform relates to continuous signals which are not limited to in either time or frequency domains. However, signal processing is made easier if the signals are sampled.
Sampling of signals with an infinite spectrum leads to aliasing, and the processing of signals which are not time limited can lead to problems with storage space. To avoid this, the majority of signal processing uses a version of the discrete Fourier transform (DFT). The DFT is a variant on the normal transform in which the signals are sampled in both time and the frequency domains. By definition, the time waveform must repeat continually, and this leads to a frequency spectrum that repeats continually in the frequency domain. The fast Fourier transform (FFT) is merely a rapid mathematical method for computer applications of DFT. It is the availability of this technique, and the technology that allows it to be implemented on integrated circuits at a reasonable price, that has permitted OFDM to be developed as far as it has. The process of transforming from the time domain representation to the frequency domain representation uses the Fourier transform itself, whereas the reverse process uses the inverse Fourier transform.

Direct application of the definition of the DFT to a data vector of length n requires n multiplications and n additions a lot of $2n^2$ floating-point operations. This does not include the generation of the powers of the complex nth root of unity ω. To compute a million-point DFT, a computer capable of doing one multiplication and addition every microsecond requires a million seconds, or about 11.5 days. Fast Fourier Transform (FFT) algorithms have computational complexity O (n log n) instead of $O(n^2)$. When using FFT algorithms, a distinction is made between the window length and the transform length. The window length is the length of the input data vector. It is determined by, for example, the size of an external buffer. The transform length is the length of the output, the computed DFT. An FFT algorithm pads or chops the input to achieve the desired transform length. The following figure illustrates the two lengths.

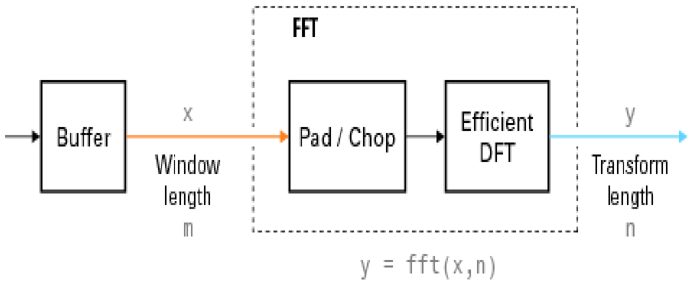


Fig 8: FFT Block Diagram

The execution time of an FFT algorithm depends on the transform length. It is fastest when the transform length is a power of two, and almost as fast when the transform length has only small prime factors. It is typically slower for transform lengths that are prime or have large prime factors. Time differences, however, are reduced to insignificance by modern FFT algorithms such as those used in MATLAB. Adjusting the transform length for efficiency is usually unnecessary in practice.

## IV. PROGRAM FLOW CHART

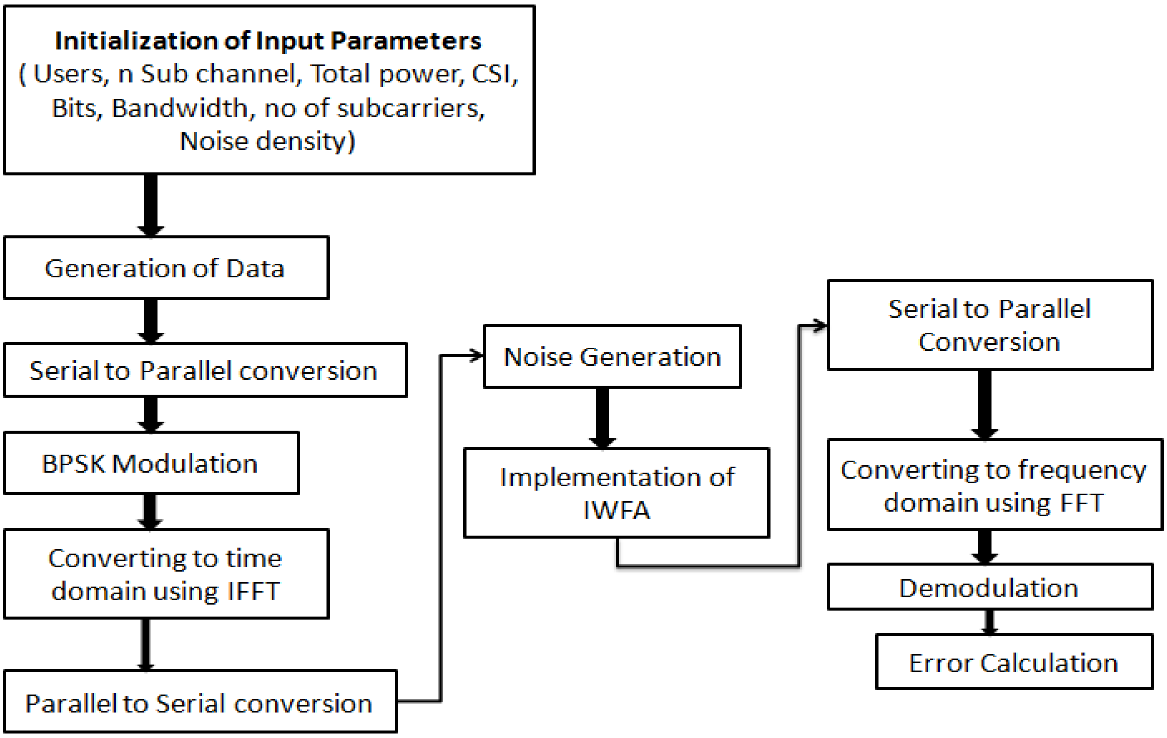


Fig 9: Program Flow Chart

Proceeding with the project, initially we define the input parameters and they are as follows. Users, n sub channels, total power, channel state information, bits, band width, no of sub carrier, noise density. Using the equation data (i)=2*round(rand)-1.We generate random data. The key words used ‘round’ proceeds the random values. Now the data which is generated is converted from serial to parallel by using the key word ‘reshape’ as seen in equation usage. S=reshape(data, c, data).Modulation is that changing any one of the parameter of high frequency signal (carrier signal) with respect to the instantaneous amplitude of low frequency signal (message signal).A carrier signal is generated and it is multiplied with the expand data to proceed the modulated signal. Using inverse Fast Fourier Transform (ifft) we convert a signal from frequency domain to time domain. The data is again ‘reshape’ to convert from parallel to serial as the data cannot be transmitted parallely through the channel. Noise is generated. Iterative water filling algorithm (IWFA) is implemented to maximize the capacity of frequency selective channel, the water filling algorithm is used. OFDM modulation divides the total bandwidth into N-sub channels cause each sub channel experience a flat fading channel if the proper cyclic prefix is added to the end of each OFDM symbol. The water filling algorithm assigns more power to sub channels which experience good condition and may assign no power to bad conditioned sub channel (sub channels with deep fading).At the receiver side now the data is converted to parallel from serial form using the ‘reshape’ keyword. Fast Fourier Transform (FFT) is done to convert from time to frequency domain. By using the keyword ‘trap’, the signal is integrated and we get the demodulated signal. After demodulation at the receiver the signal is checked for errors and calculation of error is done. Then the error free signal is received by the receiver.

The general form for BPSK follows the equation:

$$s_n(t) = \sqrt{\frac{2E_b}{T_b}}\cos\left(2\pi f_c t + \pi(1-n)\right), n = 0,1. \qquad \text{-(1)}$$

This yields two phases, 0 and π. In the specific form, binary data is often conveyed with the following signals:

$$s_0(t) = \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c\ t + \pi) = -\sqrt{\frac{2E_b}{T_b}}\cos(2\pi f c^t) \qquad \text{-(2)}$$

for binary "0"

$$s_1(t) = \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t) \qquad -(3)$$

for binary "1"

where $f_c$ is the frequency of the carrier-wave.

Hence, the signal-space can be represented by the single basis function

$$\phi(t) = \sqrt{\frac{2}{T_b}}\cos(2\pi f_c t) \qquad -(4)$$

where 1 is represented by $\sqrt{E_b}\,\phi(t)$ and 0 is represented by -.$\sqrt{E_b}\,\phi(t)$

This assignment is, of course, arbitrary. This use of this basis function is shown at the end of the next section in a signal timing diagram.

**Water Filling Algorithm :** Water filling algorithm is a general name given to the ideas in communication systems design and practice for equalization strategies on communications channels. As the name suggests, just as water finds it level even when filled in one part of a vessel with multiple openings, as a consequence of pascal's law, the amplifier systems in communications network repeaters or receivers amplify each channel up to the required power level compensating for the channel impairments. The transmit power is poured on top of the channel. The amount of water that end up in each sub channel corresponds to the amount of transmit power allocated to the sub channel. The transmit power is "poured" on top of the channel quality profile. The amount of water that ends up in each resource corresponds to the amount of transmit power allocated to the resource. The concept of water filling can be extended to multiple users, where one resource is allocated to one user. Unfortunately, the computational complexity of the ideal solution explodes.

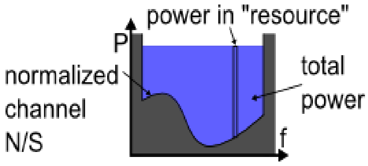


Fig 10: water filling

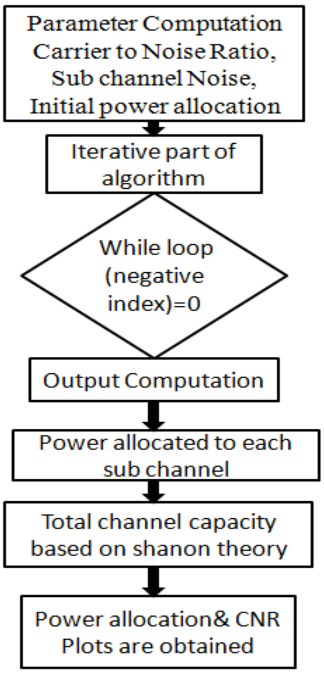


Fig 11: Algorithm Flow chart

**Iterative Water Filling Algorithm :** During initialization of the input parameters, some sub-channel will be allocated with 'negative' power. In the iterative part of the algorithm the sub channels which are allocated by the negative power will get eliminated. Iteration is done using 'while' loop and by initializing negative index to zero, only the sub channels which are allocated by the 'positive' power will be remained. The amount of power that is allocated to each sub-channel is computed. Total capacity of the channel is based on Shannon theory. The amount of information that can be reliably transmitted over a communication channel. Through Shannon theory error free transmission if the data is possible. Carrier to Noise Ratio (CNR) is calculated power is allocated to each sub-channel and plotted in the form of graph.

## V. RESULTS AND DISCUSSIONS

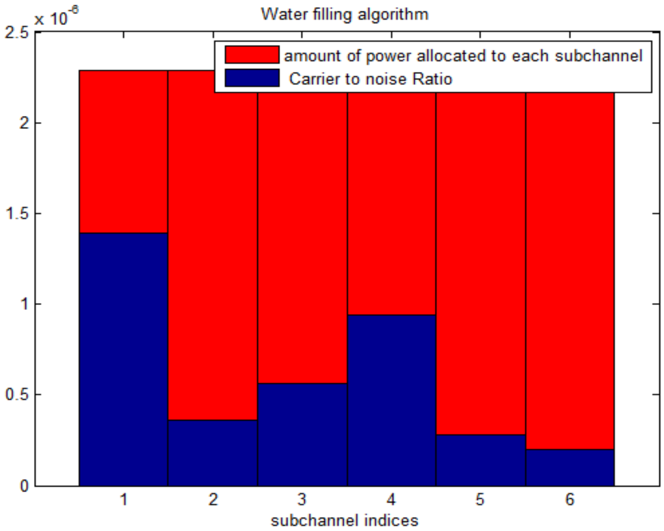


Fig 12: waveform for water filling algorithm

This graph is generated to show the water filling algorithm. It has six sub channels .Blue color indicates carrier to noise ratio and red color indicates amount of power allocated to each user. The sub channel 6 is having low carrier to noise ratio (i.e.,) less noise, so required power is allocated to that sub channel. So the allocated bits will be transmitted efficiently. For sub channel 1 carrier to noise ratio value is high (i.e.,) noise is high, so less power will be allocated. By using this algorithm in Multi Carrier Code Division Multiple Access technique overuse of power is reduced.

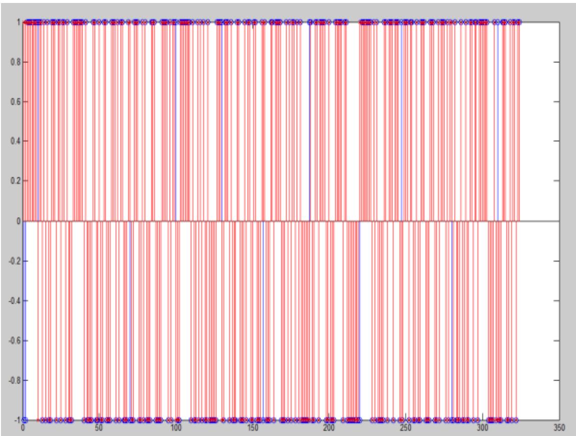

Fig 13: Demodulated wave

In this graph, red color indicates the transmitted wave, blue color indicates received wave. The combined blue and red color in the graph indicates the error. In this graph there are 12 errors.

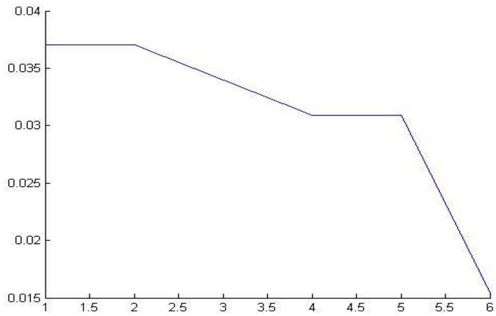


Fig 14: BER vs Number of Users

The graph plotted for BER and Number of users. Representing X-axis as number of users and Y-axis as BER. Power control in Multi Carrier Code Division Multiple Access (MC-CDMA) based wireless cellular network is of great importance. The sub channels with less noise can transmit data efficiently and some sub channels which are affected with more noise cannot transmit data efficiently and to these sub channels also more power is allocated. In this way power is wasted. By using Iterative Water Filling Algorithm we are allocating power dynamically to all the sub channels in such a way that the sub channels with more noise will be allocated less power or no power and the sub channels with less noise will be allocated with more power. In this way the power wastage is avoided.

## VI. CONCLUSION

The sub channels with less noise can transmit data efficiently and some sub channels which are affected with more noise cannot transmit data efficiently and to these sub channels also more power is allocated. In this way power is wasted. By using Iterative Water Filling Algorithm we are allocating power dynamically to all the sub channels in such a way that the sub channels with more noise will be allocated less power or no power and the sub channels with less noise will be allocated with more power. In this way the power wastage is avoided.

## REFERENCES

[1] G.K.D. Prasanna Venkatesan and V.C. Ravichandran,"Performance analysis of MC-CDMA for wideband channels", Information technology journal,2007 Asian Network for scientific Information.

[2] Teruya Fujii, Noboru Izuka, Hiroyoshi Masui, and Atsushi Nagate,"A proposal of sub-carrier selecting MC-CDMA system for 4G systems", 2005 IEEE.

[3] G.K.D.Prasanna Venkatesan, and V.C.Ravichandran, "Performance analysis of dynamic sub-carrier allocation technique for adaptive modulation based MC-CDMA system", JCSNS International Journal of Computer Science and Network Security, VOL.7 No.2, February 2007

[4] I.J. Information Technology and Computer Science, 2012, 3, 16-23.

[5] IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 4, NO. 6, NOVEMBER 2005

[6] L. J. Cimini Jr., "Analysis and simulation of a digital mobile channel using orthogonal frequency division multiplexing," IEEE Transactions on Communications, vol. 33, no. 7, pp. 665– 675, 1985.

[7] H. Kattoush, W. A. Mahmoud, and S. Nihad, "The performance of multiwavelets based OFDM system under different channel conditions," Digital Signal Processing, vol. 20, no. 2, pp. 472–482, 2010.

[8] Sundhar"An Efficient Power Control Algorithm for MCCDMA-MIMO System using Iterative Water Filling Game Theory" European Journal of Scientific Research .ISSN 1450-216X Vol. 89 No 4 October, 2012, pp.602-611. EuroJournals Publishing, Inc. 2012