STUDY OF SYNCHRONIZATION TECHNIQUES FOR OFDM

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Abstract: - FDMA, TDMA and CDMA are the well-known multiplexing techniques used in wireless communication systems. In a typical terrestrial broadcasting, the transmitted signal arrives at the receiver using various paths of different lengths. Since multiple versions of the signal interfere with each other, it becomes difficult to extract the original information. The use of orthogonal frequency division multiplexing (OFDM) technique provides better solution for the above mentioned problems. OFDM technique distributes the data over a large number of carriers that are spaced apart at precise frequencies. This spacing provides the "orthogonally", which prevents the demodulator from seeing frequencies other than their own. The benefits of OFDM are high spectral efficiency, resiliency of RF interference, and lower multi-path distortion. OFDM is a powerful modulation technique that is capable of high data rate and is able to eliminate ISI. The use of FFT technique to implement modulation and demodulation functions makes it computationally more efficient.

Keywords: - OFDM, FFT, BPSK, RF, QPSK

1. INTRODUCTION

The data was modeled on a single carrier frequency in a simple transmission device. Each symbol then occupies the usable bandwidth fully. In the case of selective frequency channels, this type of device may trigger inter-symbol interference (ISI). The basic concept of OFDM is for each narrowband sub-canal to undergo almost slight fading in the range of orthogonal sub-canals. Multiplexing the orthogonal frequency division (OFDM) has now been the preferred wireless modulation strategy. OFDM is able to provide high rates of radio channel impairment with adequate robustness. Many testing centers worldwide have teams specializing in OFDM device optimization. A significant number of orthogonal, coordinating, narrow-band sub-carriers are distributed simultaneously in an OFDM system. The usable spectrum is divided by these carriers. The division of the subcontractors means that the spectral use is quite compact. The frequency domain is covered by OFDM and therefore the transmission rate may be increased. OFDM is primarily attracted by its method of treating the intrusion in multipath at the receiver. The phenomena multipath produces two results (a) Selective fading frequency and (b) Interruption interface symbols; (ISI).

LITERATURE SURVEY

In mid-1960s [23, 24] was released the idea of the use of simultaneous data transfer by the multiplication of frequency (FDM). This can trace some early production back to the 1950s. In January 1970, a U.S. patent was completed. The aim was to use parallel data streams and FDM with conflicting sub-channels in order to prevent the usage of high-speed equalization to fight pulse noise, multipath distortion and to make maximum use of bandwidth accessible. The first requests were made in military correspondence. The words discrete multicore (DMT), multi-channel modulation (MCM) which is also synonymous with OFDM in the area of telecommunications. Any operator of the OFDM is orthogonal to some other operator. However, MCM is not necessarily subject to this condition. A multi-career transmission system variant is an optimal one OFDM. As part of the modulation and demodulation phase Weinstein and Ebert [25] used Fourier's discrete transform [12] for parallel transmitting systems. Off-duty modems, digital mobiles [10] and high-density recording were investigated in the 1980s.

Different fast modems for telecommunications networks have been created. OFDM was used in the 1990s to communicate broadband data over cell FM radio channels [14], and cellular LAN.

Wireless, multimedia, large bit optical subscriber lines (HDSL) [16], digital asymmetries (ADSL [20]), VHDSL, DAB [18] and terrestrial HDTV. High speed digital subscriber lines [253].

The cumulative signal frequency band is split into N-sub channels in the classical parallel data structure. Each sub channel uses a different symbol and frequency multiplies the N substrates. It seems good to minimize spectral interference between channels to discourage inter-canal contact. Which add to the inefficient use of the open bandwidth? The proposals made in the mid-1960s were to use parallel and FSD data utilizing conflicting sub channels to exclude each signal rate b from one's own to avoid the usage of high speed equalization, to address impulsive noise and multi-track interference and to use the usable bandwidth in its entirety. To address this failure, the proposals were made.

2. MULTIPLE ACCESS TECHNIQUES

2.1 Duplication Duplexing

It is also advantageous to allow the subscribers to transmit information simultaneously to the base station while receiving information from the base station in wireless communications systems. This impact is called duplex, and inside each subscriber unit and base station there is a computer called duplexer. Frequency or time domain methods may be used for duplexing. Figure 2.1 shows the FDD and TDD Duplexing Division (Time Division Duplexing).

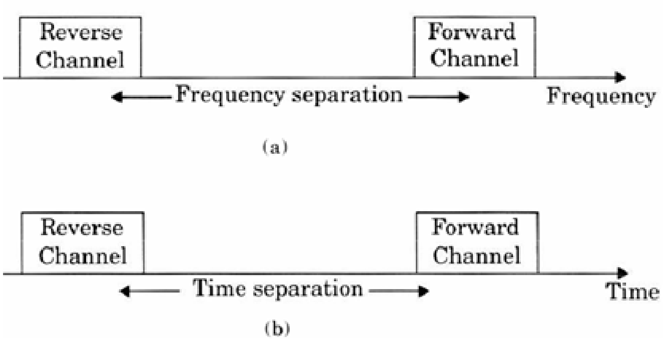


Figure 2.1: (a) FDD provides two simplex channels at the same time; (b) TDD provides at the same pace, two simplex time slots.

2.2 ***Multiple Access Frequency divisions***

The original multiple access strategy for mobile networks was the Multiple Access Division. In this process, a consumer receives or places a call with a pair of frequencies. Downlink (mobile base station) and one uplink pair are using one wavelength (mobile to base). This is known as duplexing of frequency separation. This frequency pair is not used during the call in the same cell or neighboring cells. No other person will share the same channel during the calling time. If an FDMA channel is not used, the channel is in idle position to raise or distribute bandwidth and cannot be used by other users. It is a wasteful resource basically. The FDMA scheme as seen in figure 2.2.

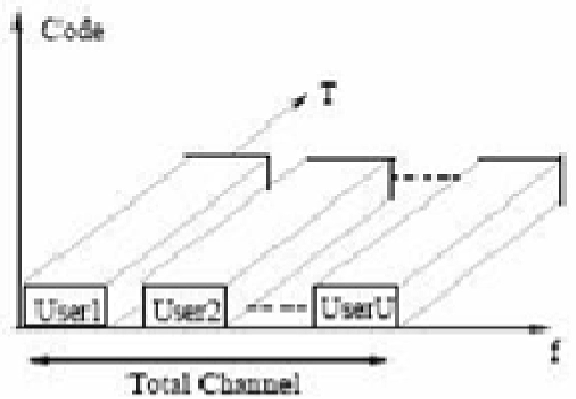


Figure2.2 Multiple Access Frequency Division (FDMA)

2.3 The Multiple Access Time division (TDMA)

The Multiple Access Time division (TDMA) increases spectrum quality by separating each frequency into slots. 2.3.2 The TDMA division enhances spectrum capacity. For a brief call time, TDMA enables any consumer to reach the entire radio frequency channel. This same frequency channel is shared with other users at various timeslots. The base station moves on the canal from user to user. For the second wave of telecommunications mobile networks, TDMA is the dominant technology. The radio spectrum is separated by the TDMA scheme and only a person is able to send and receive in each slot. Figure 2.3 shows that any consumer occupies a time slot that repeats cyclically such that a canal is seen as a specific time slot that reoccurs per frame, of which N timeslots are made up of a frame.

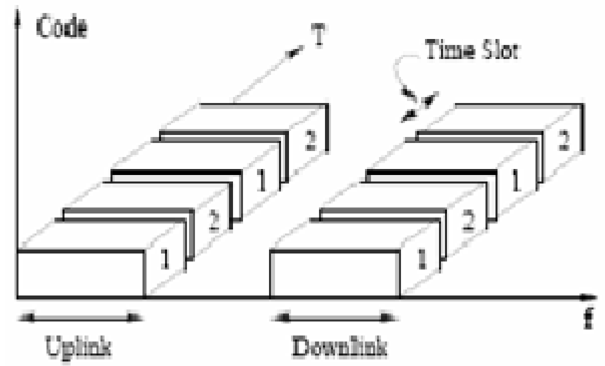


Figure 2.3: Time division multiple access (TDMA).

2.4 CDMA (Code Division Multiple Access

Code Division Multiple Access is based on Technology of the continuum "spread." It has long been used for strategic purposes because it's ideal for encrypted transmissions. CDMA permits a soft hand-off. This ensures that terminals can interact simultaneously with multiple base stations. In CDMA systems a very wide bandwidth signal called the spreading signal multiplies the narrowband message. The stretching signal is a pseudo-noise code series with a speed of the chip which is larger than the speed of the packet. As seen in figure 2.4, both CDMA users are on the same carrier frequency and will communicate at the same time.

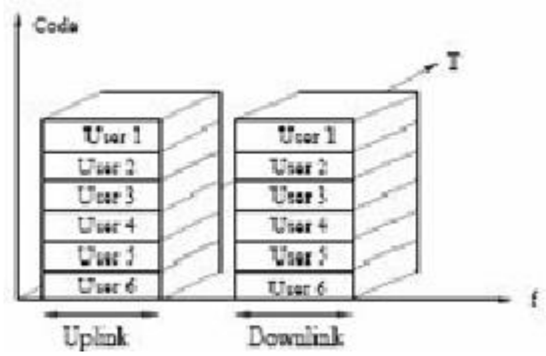


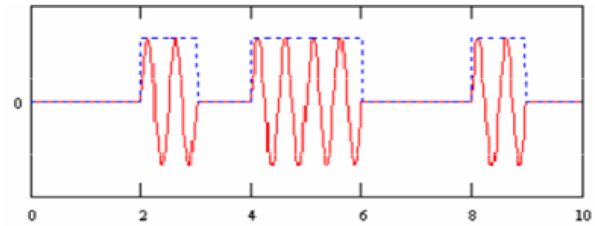
Figure 2.4: Code division multiple access (CDMA).

3. DIGITAL MODULATION TECHNIQUES

3.1 Keying amplitude-shift (ASK)

Amplitude-shift keying (ASK) is a form of amplitude modulation that represents digital data as variations in the amplitude of a carrier wave. In an ASK system, a symbol, representing one or more bits, is sent by transmitting a fixed-amplitude carrier wave at a fixed frequency for a specific time duration. For example, if each symbol represents a single bit, then the carrier signal will be transmitted when the input value is 1, but will not be transmitted when the input value is 0.

Any digital modulation scheme uses a finite number of distinct signals to represent digital data. ASK uses a finite number of amplitudes, each assigned a unique pattern of binary digits. Usually, each amplitude encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular amplitude. The demodulator, which is designed specifically for the symbol-set used by the modulator, determines the amplitude of the received signal and maps it back to the symbol it represents, thus recovering the original data. Frequency and phase of the carrier are kept constant.

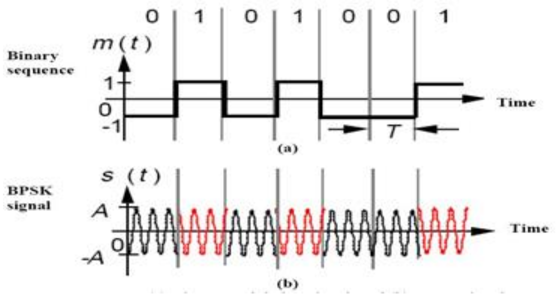


3.1 Binary ASK (OOK) signal

3.2 Keying Phase-Shift (PSK)

Phase-shift keying (PSK) is a digital modulation process which conveys data by changing (modulating) the phase of a constant frequency reference signal (the carrier wave). The modulation is accomplished by varying the sine and cosine inputs at a precise time. It is widely used for wireless LANs, RFID and Bluetooth communication.

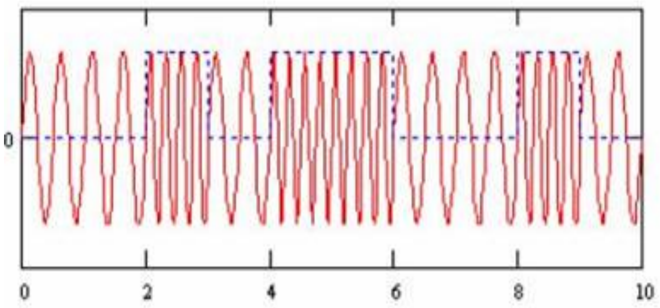
Any digital modulation scheme uses a finite number of distinct signals to represent digital data. PSK uses a finite number of phases, each assigned a unique pattern of binary digits. Usually, each phase encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular phase. The demodulator, which is designed specifically for the symbol-set used by the modulator, determines the phase of the received signal and maps it back to the symbol it represents, thus recovering the original data. This requires the receiver to be able to compare the phase of the received signal to a reference signal – such a system is termed coherent (and referred to as CPSK).



3.2 BPSK signal

3.3 Frequency Shift Curve

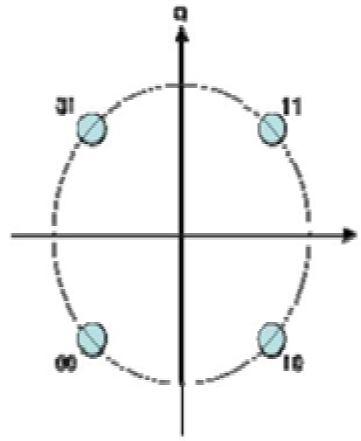
In FSK, in response to input, we adjust the frequency; In Binary FSK, for the same bit series as before, one frequency for 1 and the other frequency for 0 are used. The frequency f1 for bit 1 is higher than f2 for bit 0 in the illustration below.



3.3 Binary FSK signal

3.4 QPSK

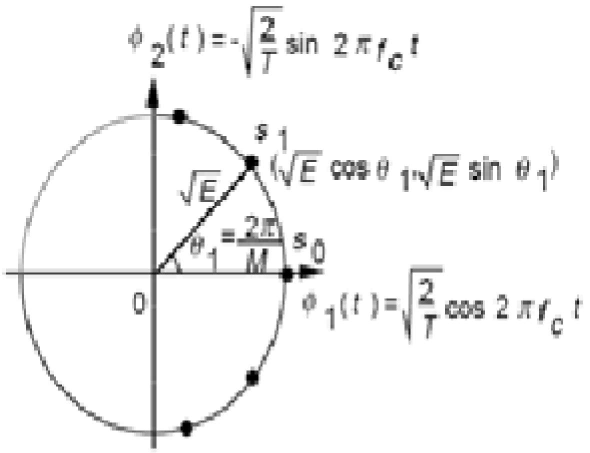
QPSK (4-year PSK) means the transmitted waveform process is changed. Any finite phase shift is specific digital information. The digital data allows a phase-modulated waveform to adjust the phase of a signal while its frequency and amplitude remain unchanged. A model carrier of QPSK is subject to four different phase changes that reflect symbols that may carry on α/4, 3α/4, 5μ/4, and 75-04 values. Two binary bits of data are shown in each icon



3.4 Constellation diagram for QPSK with Gray coding.

3.5 MPSK

Per piece of BPSK is transmitted separately. We transmit one or other sinusoid for the bit time Tb, depending on whether b(t) is logic 0, or logic 1, the sinusoids vary by 2μ/2 = 180° in step. We lump two pieces together at QPSK. We may transmit any four sinusoids of 2Tb length, the sinusoidal variations of 2′/4 = 90° in stage, depending on one of the four two-bit term evolves. You will stretch the system. Allow one to lump t all N bits such that there are 2 < = potential symbols in the N-bit sign stretching over NTb duration. Let us now reflect symbols with Nb = Ts symbols that are different in process of 2α/M from others.



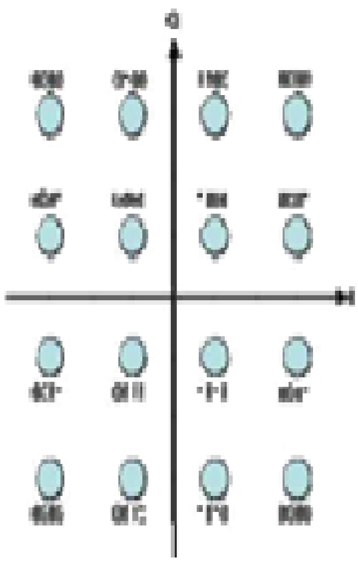
3.5 Constellation diagram for M-ary PSK

3.6 QAM

In BPSK, QPSK and M-ary PSK, one signal or another is transmitted in each symbol interval which differs in its phase but is of the same amplitude. In both of these schemes there fall on the diameter of a globe the end points of the signal vectors in the signal space. Now we have seen that the difference between the vector ends can rely upon our ability to differentiate one vector from another while noise is present. It is therefore very obvious that, by making signal vectors, not just in phases, but auch in amplitude, to increase a system's noise immunity. We name this a modulation of amplitude and phase change or square amplitude (QAM).

3.7 Rectangular QAM

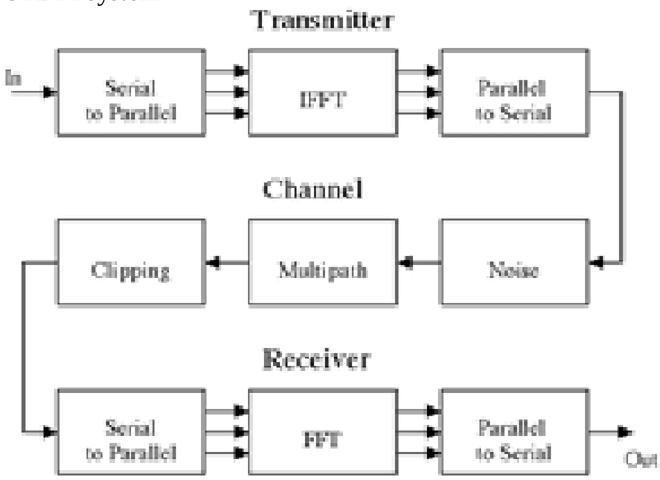
In general, rectangular QAM constellations are not ideal in the sense that the constellation points for a certain amount of energy are not maximally spaced. However, they have the tremendous benefit that two PAM signals can be conveniently conveyed on square carrier and can be demodulated easily. The non-quadrant constellations reach a considerably improved Bit-Errors (BER) rate but are more difficult to model and demodulate



3.7 Constellation diagram for rectangular 16-QAM.

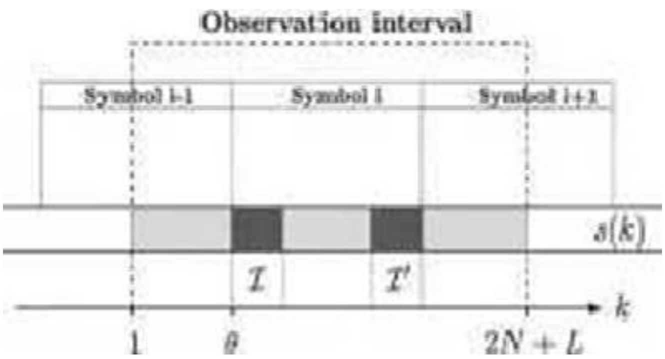
4. OFDM AND ML ESTIMATION

The diagram below shows the basic data flow chart of an OFDM system



The baseband OFDM device model we are looking at is shown by Fig. 1. Fig. 1. Inverted discreet transforming Fourier (IDFT) on N-parallel carriers modulates dynamic data symbols. The resulting OFDM symbol is transmitted serially via a distinct time channel, which is expected to respond to impulse samples shorter than L. The data is collected through a discreet Fourier transformation at the receiver (DFT). The last L sample of the OFDM symbol (long N samples) body is to be copied and appended to the full OFDM symbol as preamble, the cyclic prefix. It is an agreed way of preventing interplay (ISI) and orthogonality between subcarriers. This cyclic prefix plus the body (long samples of L+N) is the effectively conveyed duration of the OFDM sign. An analogous parallel orthogonal canal arrangement can be shown by inserting the cyclic prefix that enables easy calculation of the channel and equalization

ML estimation



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Structure of OFDM signal with cyclically extended symbols *s(k)*

Assume that we observe consecutive samples of, cf. Fig.4.9, and that these samples contain one complete-sample OFDM symbol. The position of this symbol within the observed block of samples, however, is unknown because the channel delay is unknown to the receiver.

Define the index sets.

$$\mathcal{I} \triangleq \{\theta, \cdots, \theta + L - 1\} \quad \text{and}$$
$$\mathcal{I}' \triangleq \{\theta + N, \cdots, \theta + N + L - 1\}$$

The set I'thus contains the indices of data samples that are copied into the cyclic prefix, and the set I contains the indices of the prefix. Collect the observed samples in the (2N+L)*1-vector \
I*U* I' are pairwise correlated, i.e

$$\forall k \in \mathcal{I}: \quad E\{r(k)r^*(k+m)\} = \begin{cases} \sigma_s^2 + \sigma_n^2 & m = 0 \\ \sigma_s^2 e^{-j2\pi\varepsilon} & m = N \\ 0 & \text{otherwise} \end{cases}$$

While the remaining samples r(k), k ¢ I*U* I are mutually uncorrelated. The log-likelihood function for U and ε , $\Lambda(\theta, \varepsilon)$ is the logarithm of the probability density function] |U , ε of the 2N+L observed samples in **r** given the arrival time U and the carrier frequency offset ε .In the following, we will drop all additive and positive multiplicative constants that show up in the expression of the log-likelihood function since they do not affect the maximizing argument. Moreover, we drop the conditioning on (U,ε) for notational clarity. Using the correlation properties of the observations **r** , the log-likelihood function can be written as

$$\begin{aligned}\Lambda(\theta, \varepsilon) &= \log f(\mathbf{r}|\theta, \varepsilon) \\ &= \log \left(\prod_{k \in \mathcal{I}} f(r(k), r(k+N)) \prod_{k \notin \mathcal{I} \cup \mathcal{I}'} f(r(k)) \right) \\ &= \log \left(\prod \frac{f(r(k), r(k+N))}{f(r(k)) f(r(k+N))} \prod f(r)k)) \right)\end{aligned}$$

is used for both one- and two-dimensional (1-D and 2-D) distributions. The product in (4)is independent of U (since the product is over all k) and ε (since the density M is rotationally invariant). Since the ML estimation of U and ε is the argument maximizing □(□ ,□) , we may omit this factor.Under the assumption that r is a jointly Gaussian vector, (4) is shown in the Appendix to be

$$L(\theta,\varepsilon) = |\gamma(\theta)| \cos(2\pi\varepsilon + Ð\gamma(\theta)) - \rho\phi(\theta) \text{-------------(5)}$$

where Ð denotes the argument of a complex number.

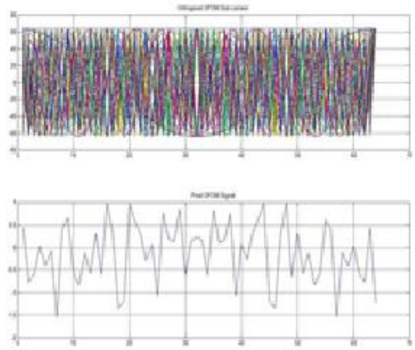
$$\gamma(m) \triangleq \sum_{k=m}^{m+L-1} r(k) r^*(k+N),$$

$$\Phi(m) \triangleq \tfrac{1}{2} \sum_{k=m}^{m+L-1} |r(k)|^2 + |r(k+N)|^2 \quad \textbf{-- (6,7)}$$

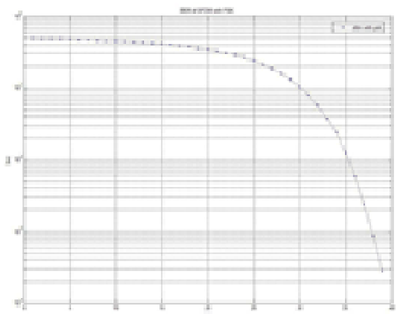
5. SIMULATION RESULTS

A synchronizer cannot differentiate between the channel's phase shifts and the phase shifts which are applied with the pause in time [4]. Time error criteria may vary from the order of one sample (wireless applications that monitor and correct the channel step via a channel parser) to a fraction of the sample (in, e.g., high bit-rate digital subscriber lines, where the channel is static and essentially estimated only during startup). Without an offset frequency, each sub-frequency channel's answer is zero at all other undertaking frequencies, i.e., the sub-channels may not interfere [2]. The frequency offset consequence is the lack of sound orthogonality. In [11], the resulting inter-transport intervention (ICI) was examined. Bounded by additive noise as well as by ICI, the effectiveness of signal to noise ratio SNR is less obvious

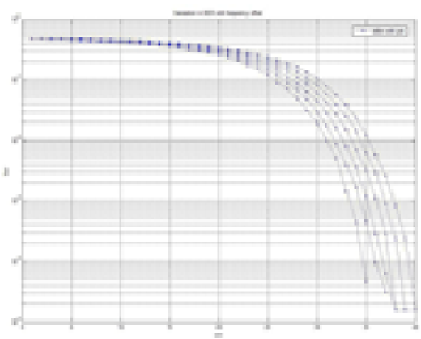
OFDM with 64 sub channels, simple OFDM symbol



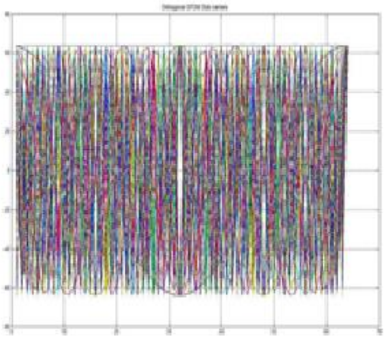
Bit error rate (BER) in OFDM using PSK as an Input Signal**.**



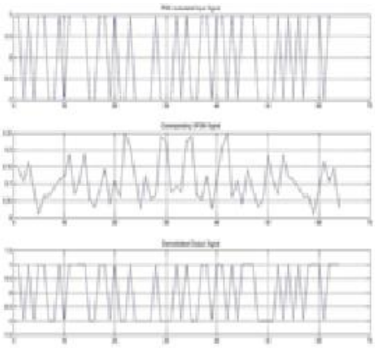
Effect of change in frequency offset in BER in OFDM



Orthogonal subcarriers in an OFDM signal. N=64.



A Simple OFDM Signal with PSK modulated input signal, and in absence of noise.



6. CONCLUSION

Through having overlap between carriers, OFDM allows effective use of the usable spectrum. The high data rate source is converted to multiple parallel lower data streams and thereby eliminates selective decay in frequency. The OFDM is a powerful modulation technique that is able to remove ISI and is capable of providing a high rate of data. The use of FFT techniques to execute modulation and demodulation functions makes it computationally effective.

SCOPE OF FUTURE WORK

The OFDM signal is highly susceptible to carriers and its high peak to average power ratio (PAPR). Those three OFDM-based transformer systems may therefore be checked.

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