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"BER performance analysis and evaluation based on CFO and different channel capacity"

Sanjay Singh M.Tech (Digital Communication) Student, Madhyanchal Professional University, Bhopal

Mr. Ashish Nema, Asst. Professor. EC Deptt., Madhyanchal Professional University, Bhopal

Dr. Bhagwat Kakde Associate Professor, EC Deptt., Madhyanchal Professional University, Bhopal

Abstract

The performance of AWGN and Rayleigh fading channel with different subcarriers frequencies and channel capacity has been analyzed to show the BER performance indifferent condition. The performance clearly indicates the impact of our proposed system. It shows that the BER ratio may be decreased in case of increasing the channel subcarriers and the transmission strength is good. The performance of the multi-carrier transmission modulation scheme that uses multi-carrier transmission with OFDM have been analyzed with the BER ratio. The results show that that the increasing N can reduce the error and the channel strength is good. The results based on CFO have been considered also. It shows the degradation invoked by noise and non-ideal channel. Its shows the transmitting and receiving frequency mismatch and error chances can be recorded to show the system performance. In our case 16, 32, 64, 128, 256, 512 QAM based single carrier have been considered for CFO and 16, 32, 64 and 128 for BER performance.

Keywords: BER, CFO, DWT, FFT, ICI, IDWT, IFFT, ISI, OFDM

1. Introduction

Multi-carrier modulation (MCM) that is known as orthogonal frequency-division multiplexing (OFDM) has drawn considerable attention in high speed mobile communications due to its bandwidth efficiency, frequency diversity, and immunity to channel dispersion during the last decade.

- **Currently, MCM is being used in digital audio and video broadcasting, wireless local/metropolitan area networks, and asynchronous digital subscriber lines (ADSL). With recent advances in modulation and multiple access techniques, MCM becomes more and more popular. Today, the enormous increase in demand for high-speed data transmission by many wireless multi-media services pushes the development of advanced modulation and multiple access techniques that can provide reliable and high data rate transmission with high bandwidth efficiency and strong immunity to multi-path distortion.**
- **One of these combinations is the multi-carrier direct-sequence code division multiple access (MC-DS-CDMA) technique, which has been considered as an important technique for the fourth-generation wireless systems.**

- **In the MC-DS-CDMA systems, the transmitter transmits the serial-to-parallel (SP) converted data stream using a given spreading sequence in the time domain, so that the resultant spectrum of each sub-carrier can remain orthogonal and keep the minimum required frequency separation.**

2. System Design

In this section, the investigation of effects of bit error rate (BER) on the multi-carrier code-division multiple access frameworks system based on variant modulation scheme is introduced. Specifically, it provides careful consideration on the BER execution for the OFDM system including the timing jitter both. It includes additive white Gaussian noise (AWGN) channel and multi-way Rayleigh fading channel with frequency offset difference. The analytical expressions for the proposed system has been presented in presence of the timing, channel performance and temperature variance and then compare BER performance of the ideal multi carrier system with the BER performances affected by timing jitters when the timing jitters are independent and dependent, respectively.

4.2 Bit error rate

The bit error rate (BER) shows the bit lapses separated by the aggregate number of exchanged bits amid an examined time interim. BER is a unit less execution measure, regularly communicated as a rate. The bit lapse is the desire estimation of the BER. The BER can be considered as a surmised appraisal of the bit lapse likelihood. This appraisal is exact for quite a while interim and a high number of bit errors. Measuring the bit slip rate helps individuals pick the proper forward lapse adjustment codes. Since most such codes just bit-flips, however not bit insertions or bit identification, the hamming separation metric is the suitable approach to gauge the quantity of bit slips. The BER may be enhanced by picking solid sign quality by picking a moderate and hearty adjustment plan or line coding plan, and by applying channel coding plans, for example, repetitive forward slip revision codes. Twofold symmetric divert which is utilized as a part of investigation of interpreting slip likelihood in the event of non bursty bit blunders on AWGN channel without blurring. A most dire outcome imaginable is a totally arbitrary channel, where clamor absolutely commands over the helpful signal. In an uproarious channel, the BER is frequently communicated as a component of the standardized bearer to-commotion proportion measured meant Eb/N0 that is vitality license to commotion power phantom thickness proportion, or Es/N0 that is vitality per adjustment image to clamor ghostly thickness.

As the name suggests, a bit mistake rate is characterized as the rate at which slips happen in a transmission framework. This can be specifically interpreted into the quantity of lapses that happen in a string of an expressed number of bits. The meaning of bit blunder rate can be interpreted into a basic equation:

$$BER = \frac{Number\ of\ errors}{Aggregate\ number\ of\ bits\ sent}$$

In the event that the medium between the transmitter and collector is great and the sign to clamor proportion is high, then the bit slip rate will be little - conceivably inconsequential and having no observable impact on the general framework However in the event that commotion can be recognized, then risk the bit blunder rate should be considered. The primary explanations behind the corruption of an information channel and the comparing bit mistake rate, BER is commotion and changes to the engendering way (where radio sign ways are utilized). Both impacts have an irregular component to them, the commotion taking after a Gaussian likelihood capacity while the spread model takes after a Rayleigh model. This implies that investigation of the channel qualities are regularly embraced utilizing measurable examination procedures.

Sign to commotion proportions and Eb/No figures are parameters that are more connected with radio connections and radio correspondences frameworks. Regarding this, the bit blunder rate, BER, can likewise be characterized as far as the likelihood of lapse or POE. The focus this, three different variables are utilized. The errors capacity, erf, the vitality in one bit, Eb, and the commotion power unearthly thickness (which is the clamor control in a 1 Hz data transmission),It ought to be noticed that each diverse kind of regulation has its own particular quality for the mistake capacity. This is on account of every sort of balance performs distinctively in the vicinity of commotion. Specifically, higher request tweak plans (e.g. 64QAM, and so forth) that have the capacity to convey higher information rates are not as strong in the vicinity of clamor. Lower request tweak groups (e.g. BPSK, QPSK, and so on.) offer lower information rates however are more hearty.

The vitality per bit, Eb, can be controlled by isolating the bearer control by the bit rate and is a measure of vitality with the measurements of Joules. No is a force for each Hertz and along these lines this has the measurements of force (joules every second) isolated by seconds). Taking a gander at the measurements of the proportion Eb/No every one of the measurements offset to give a dimensionless proportion. It is critical to note that POE is relative to Eb/No and is a type of sign to commotion proportion. It can be seen from utilizing Eb/No, that the bit blunder rate, BER can be influenced by various components. By controlling the variables that can be controlled it is conceivable to enhance a

framework to give the execution levels that are needed. This is ordinarily embraced in the outline phases of an information transmission framework so that the execution parameters can be balanced at the introductory configuration idea stages. The impedance levels introduce in a framework is by and large situated by outside variables and can't be changed by the framework outline.

On the other hand it is conceivable to situate the transmission capacity of the framework. By decreasing the data transmission the level of impedance can be diminished. However lessening the transfer speed constrains the information throughput that can be accomplished.

It is likewise conceivable to build the force level of the framework so that the force per bit is expanded. This must be adjusted against components including the impedance levels to different clients and the effect of expanding the force yield on the extent of the force speaker and general force utilization and battery life, and so on. Lower request adjustment plans can be utilized, yet this is to the detriment of information throughput. It is important to adjust all the accessible variables to accomplish an agreeable bit blunder rate.

Ordinarily it is unrealistic to accomplish every one of the necessities and some exchange offs are needed. In any case, even with a bit lapse rate underneath what is preferably obliged, further exchange offs can be made as far as the levels of mistake remedy that are brought into the information being transmitted. Albeit more repetitive information must be sent with larger amounts of slip revision, this can help cover the impacts of any bit mistakes that happen, consequently enhancing the general bit blunder rate.

Bit mistake rate BER is a parameter which gives an astounding evidence of the execution of an information connection, for example, radio or fiber optic framework. As one of the primary parameters of enthusiasm for any information connection is the quantity of mistakes that happen, the bit blunder rate is a key parameter. Learning of the BER additionally empowers different components of the connection, for example, the force and data transfer capacity, and so on to be custom-made to empower the obliged execution to be acquired. As information blunders happen in an arbitrary manner it can take some while before a precise perusing can be increased utilizing ordinary information. With a specific end goal to abbreviate the time needed for estimations, a pseudorandom information arrangement can be utilized. To extend the purpose behind utilizing a pseudo arbitrary arrangements take the sample of a commonplace information join. To make a basic estimation of the quantity of slips that occur it is conceivable to utilize a lapse locator that thinks about the transmitted and got information and afterward checks the quantity of mistakes. In the event that one blunder were distinguished while sending 10^12 bits, then a first close estimation may be that the error rate is 1 in 10^12, however this is not the situation in perspective of the arbitrary way of any mistakes that may happen. In principle a vast number of bits ought to be sent to demonstrate the genuine blunder rate, yet this is clearly not possible.

The remaining commotion can be mimicked and acquainted with the collector utilizing a clamor diode generator. Blurring attributes for radio interchanges frameworks: It is critical to reenact the genuine qualities of the transmission way in as practical a route as would be prudent. With signs continually shifting as an aftereffect of numerous elements it is important to reproduce. To accomplish this for a radio connection it is important to utilize a blurring test system that adds Rayleigh blurring qualities to the sign. A refined blurring test system might likewise utilize various channels with variable time postponements to reenact changing way conditions. Albeit blurring test systems are confounded things of test hardware they find themselves able to give a sensible medium for testing bit slip rate, BER inside of the research center.

One of the fundamental precautionary measures when testing BER in the research facility is to guarantee that none of the transmitted sign holes straightforwardly into the collector and abstains from going through the blurring test system. On the off chance that the transmitter force is moderately high, then it is hard to give satisfactory levels of screening and a portion of the testing may not be legitimate. Awesome consideration must be taken to guarantee that the whole flag ventures by means of the blurring test system. Significant levels of screening may be needed. In a few events screened rooms have been utilize.

4.3 Proposed Method

The proposed system provides a detail analysis with variable timing jitters to analysis the error rate. It will provide the detail analysis based on different channel capacity. Specifically, we will give careful consideration on the BER execution of the multi-carrier code-division multiple access frameworks because of the timing jitter both in added AWGN channel and multi-way Rayleigh fading channel with different frequency offsets. We firstly formulate the analytical expressions for the signals in presence of the timing, channel performance and temperature variance and then compare BER performance of the system with the BER performances affected by timing jitters when the timing jitters are independent and dependent, respectively. BER sensitivity is also calculated. Figure 4.1 shows the flowchart of our work.

4.3.1 Approach

QAM supports both an analog and a digital modulation scheme. It passes on two simple message signs, or two advanced piece streams, by evolving (balancing) the amplitudes of two transporter waves, utilizing the amplitude shift keying (ASK) computerized adjustment plan or amplitude modulation (AM). The balanced waves are summed, and the subsequent waveform is a blend of both phase shift keying (PSK) and amplitude shift keying (ASK), or (in the simple case) of phase modulation (PM). In the advanced QAM case, a limited number of no less than two stages and no less than two amplitudes are utilized. PSK modulators are frequently composed utilizing the QAM rule, however are not considered as QAM since the adequacy of the balanced bearer sign is steady. QAM is utilized broadly as an adjustment plan for computerized telecom frameworks.

OFDM uses sinusoid frequency. Along these lines, every transporter is similar to a Fourier arrangement segment of the composite sign. Truth be told, it will be demonstrated later that an OFDM sign is made in the recurrence space, and afterward changed into the time area through the discrete fourier transform (DFT). Two occasional signs are orthogonal when the essential of their item, more than one period, is equivalent to zero. This is valid for certain sinusoids as illustrated in the below equations.

Continuous Time :

$$\int_0^T \cos(2\pi n f_0 t) \times \cos(2\pi m f_0 t) dt = 0 \quad (n \neq m)$$

Discrete Time :

$$\sum_{k=0}^{N-1} \cos\left(\frac{2\pi kn}{N}\right) \times \cos\left(\frac{2\pi km}{N}\right) = 0 \quad (n \neq m)$$

The carriers of an OFDM system are sinusoids that meet this prerequisite since every one is a various of a crucial recurrence. Everyone has a whole number of cycles in the essential period. The greatest number of bearers utilized by OFDM is limited by the size of the IFFT. This is determined in the following equation.

Carrier Count

$$N_{carriers} \leq \frac{IFFTsize}{2} - 2 \quad \text{(real - valued time signal)}$$
$$N_{carriers} \leq IFFTsize - 1 \quad \text{(complex - valued time signal)}$$

So as to create a genuine esteemed time signal, OFDM (recurrence) transporters must be characterized in complex conjugate sets, which are symmetric about the Nyquist frequency (f_{max}).

Let consider the issue of transmitting the sign $\tilde{x}_n[m]$ over the time-varying linear channel $c(t,\tau)$ without additional noise. If we call $c[m]$ the examining rendition of the channel, then the yield of got by the channel is:

$$\tilde{y}_n[m] = \sum_{l=0}^{N+L-1} \tilde{x}_n[l] c[m-l]$$

m = 0, 1,…, N+L-1

The receiver basically does the reverse operation to the transmitter. The signal received is $\tilde{y}_n[m]$ that has N+L-1 samples, before the demodulation, we need to drop the L last examples of the got sign, and after that uproot the watchman period, so as to utilize accurately the Fourier Transform properties. Without a doubt the demodulation operation is a straightforward FFT as per the IFFT utilized as adjustment. We have to discover N tests (one for each bearer) as at the modulator information, let apply an FFT to the signal $\tilde{y}_n[m]$.

$$\tilde{Y}_n[k] = \sum_{l=0}^{N-1} \tilde{y}_n[l] \exp\left(-2\pi jk \frac{l}{N}\right)$$

$$\tilde{Y}_n[k] = \sum_{l=0}^{N-1} \left(\sum_{m=0}^{N+L-1} \tilde{x}_n[m] c[l-m] \right) \exp\left(-2\pi jk \frac{l}{N}\right)$$

$$\widetilde{Y}_n[k] = \left(\sum_{m=0}^{N+L-1} \widetilde{x}_n[m]\right) \sum_{l=0}^{N-1} c[l-m] \exp\left(-2\pi jk\frac{l}{N}\right)$$

$$\widetilde{Y}_n[k] = \left(\sum_{m=0}^{N+L-1} \widetilde{x}_n[m] \exp\left(-2\pi jk\frac{m}{N}\right)\right) \Im(c[k])$$

The main term of the increase above resembles a Fourier Transform expression. Actually, on the off chance that we confine the summation record from m = 0 to m = N-1 it is identical to drop the L last examples of the sign $\widetilde{y}_n[m]$. So the signal produces by the demodulator is:

$$\widetilde{Y}_n[k] = \left(\sum_{m=0}^{N-1} \widetilde{x}_n[m] \exp\left(-2\pi jk\frac{m}{N}\right)\right) \Im(c[k])$$

$$\widetilde{Y}_n[k] = \Im(x_n[k]) \Im(c[k])$$

$$\widetilde{Y}_n[k] = X_n[k] C[k]$$

A basic division by the channel recurrence reaction gets back the transmitted sign. This balance does not require any evening out and the information tests are then joined back to the same size as the first information.

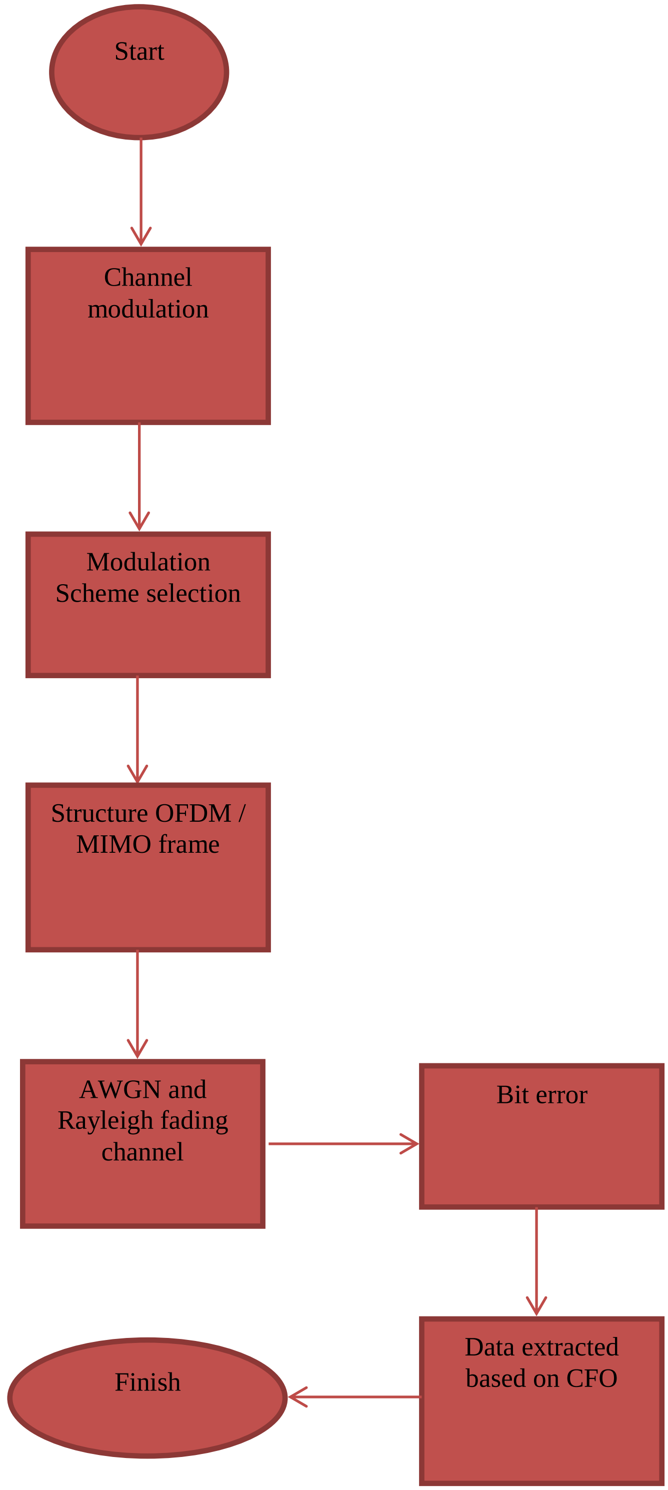

Figure 4.1: Flowchart

4.3.2 Algorithm

The following steps showed the process of our work:

Step 1: Channel modulation has been selected and the pilot symbols are generated according to the distribution equations specified.

Step 2: Modulation scheme has been selected.

Step 3: The symbols generated as the input for the error analysis.

Step 4: OFDM or MIMO frame has been selected.

Step 5: The timing frame and size are variant but for the different capacity it is same.

Step 6: Receiver side added the prefix input.

Step 7: AWGN and Rayleigh fading channels have been considered for the estimation.

Step 8: Receiver received the data.

Step 9: Different sensitivity have been considered for BER impact calculation.

Step 10: data extracted successfully.

Step 11: The error rate is calculated based on CFO variants along with the AWGN channel.

We have proposed this procedure to fulfill the objective of the efficient configuration of the proposed transmitter. It is important to dispense a fitting equalization bunch and/or a transmission rate of the optical banner according to the join's condition. For this reason, to start with, we constantly check the data transmission capability by observing BER. At the point when BER is debased beneath the pre-characterized BER limit, we select a lower-request QAM design than the present balance arrangement to enhance it. For this 16 QAM, 32 QAM, 64 QAM and 128 QAM are considered. On the other hand, if BER ends up being better than the lower uttermost spans of as far as possible, a higher-demand QAM design is given the high accuracy.

The above flowchart as shown in figure 4.1 suggest the modulation scheme applied and the error rates calculation at all the stages.

4.4 Result Evaluation

Multi-Carrier Code Division Multiple Access (MC-CDMA) is a multi-carrier transmission modulation scheme which is a method that uses multi-carrier transmission with OFDM. It is a spread spectrum but this spectrum is used in frequency domain. The following terminology is used in BER performance analysis.

- N: It indicates the number of sub-carriers.
- L: It indicates the length of spreading code.
- a: It indicates the timing jitters correlation ‘a=0’ indicates uncorrelated timing jitter and ‘a=1’ indicates full correlated timing jitter.

The BER performance results are shown below. The uncorrelated and correlated timing jitter with respect to AWGN and Rayleigh channel has been presented. The results are shown from figure 4.2. AWGN or white timing jitters affected BER have been shown by circle with dash. Correlated timing jitter affected BER is shown by star with dash. Zero timing jitter affected BER have been shown by plus with dash. Ideal BER performance without interference is shown by x-mark with the dash. The simulation parameter considered in each part is different the first parameter is shown in table 4.1. The parameter of N, L, a is shown in table 4.2.

Table 4.3 shows the second parameter and there N, L, a values are shown in table 4.4. Table 4.5 shows the next parameter there N, L, a values are shown in table 4.6. The improved results of BER performance are better in comparison to the traditional technique.

Table 4.1: Rayleigh/ AWGN Parameter

Parameter	
Channel Model	Rayleigh/ AWGN
Channel Bandwidth	5MHZ
Cyclic Prefix	[0 I 2 3]
HARQ combining	Incremental redundancy
Frame structure	TDD
modulation	16QAM

Table 4.2 N, L, a based on table 4.1

S. No	N	L	a	Channel
1	16	4	0.4	AWGN
2	16	4	0.4	Rayleigh Fading
3	16	4	0.5	AWGN
4	16	4	0.5	Rayleigh Fading

AWGN or white timing jitters affected BER have been shown by circle with dash. Correlated timing jitter affected BER is shown by star with dash. Zero timing jitter affected BER have been shown by plus with dash. Ideal BER performance without interference is shown by x-mark with the dash. The performance of BER based on the AWGN Channel parameters N=16, L=4, a=0.4 are shown below.

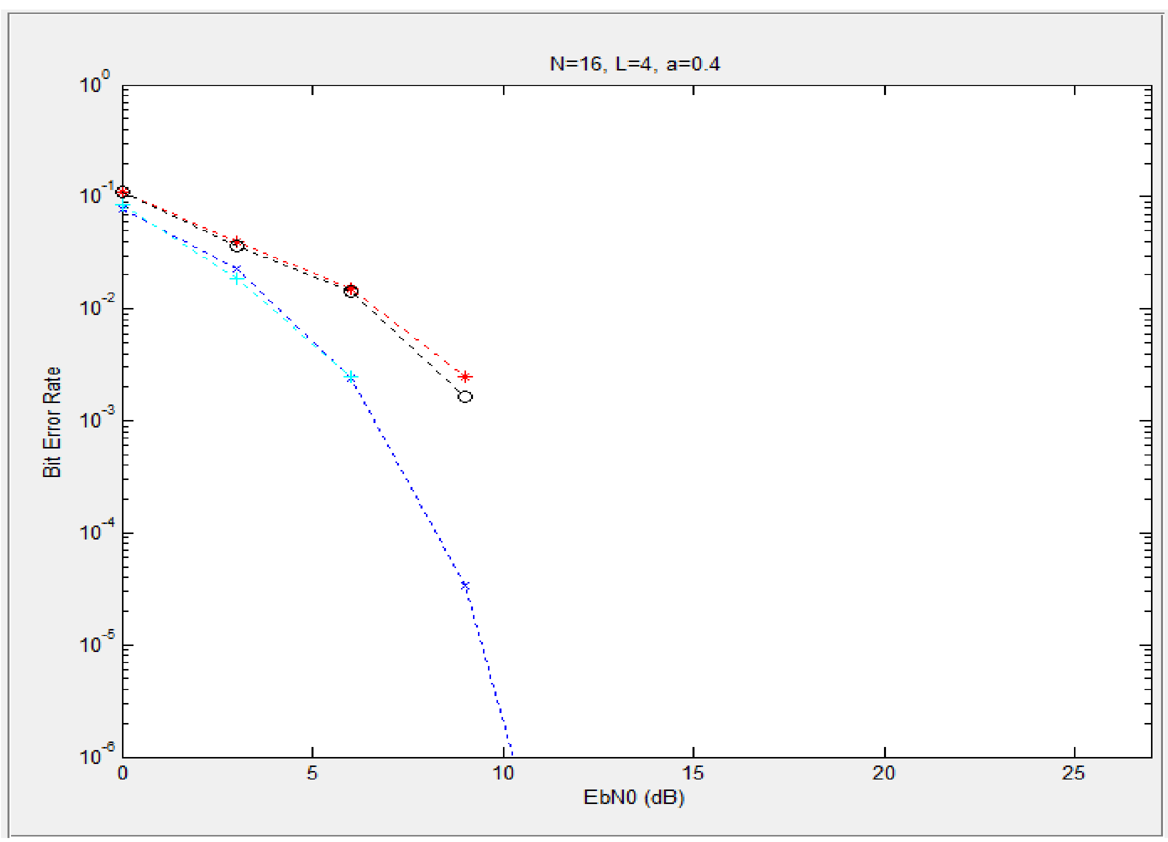

Figure 4.2: BER Performance under AWGN Channel (parameters N=16, L=4, a=0.4)

AWGN or white timing jitters affected BER have been shown by circle with dash. Correlated timing jitter affected BER is shown by star with dash. Zero timing jitter affected BER have been shown by plus with dash. Ideal BER performance without interference is shown by x-mark with the dash. The performance of BER based on the Rayleigh Fading Channel N=16, L=4, a=0.4 are shown below.

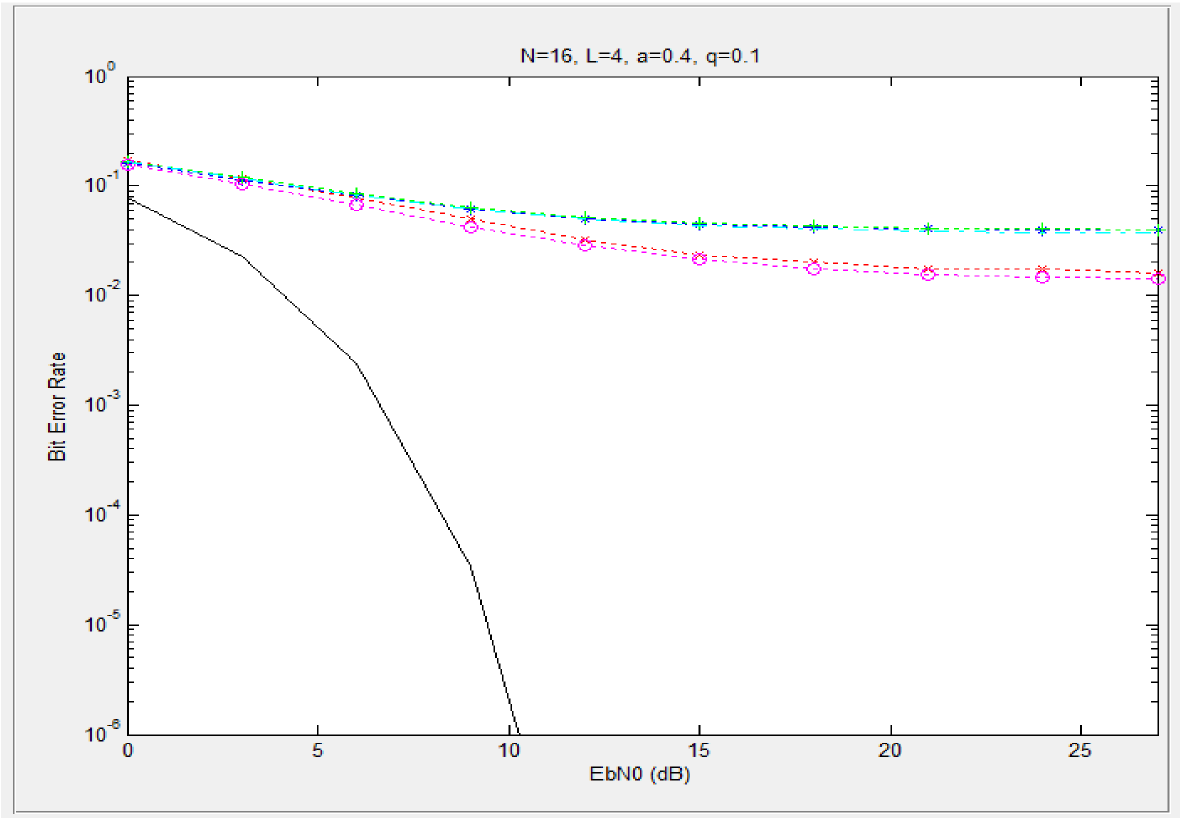

Figure 4.3: BER Performance under Rayleigh Fading Channel (parameters N=16, L=4, a=0.4)

AWGN or white timing jitters affected BER have been shown by circle with dash. Correlated timing jitter affected BER is shown by star with dash. Zero timing jitter affected BER have been shown by plus with dash. Ideal BER performance without interference is shown by x-mark with the dash. The performance of BER based on the AWGN Channel and Rayleigh Fading Channel N=16, L=4, a=0.5 are shown below.

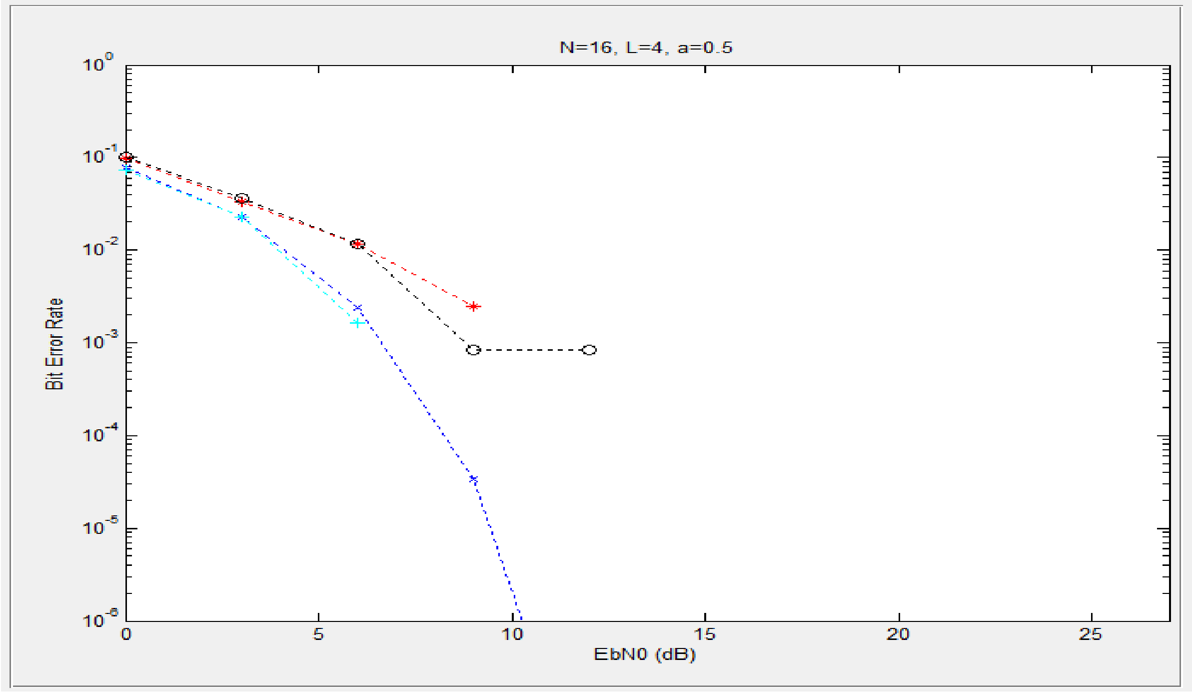

Figure 4.4: BER Performance under AWGN Channel (parameters N=16, L=4, a=0.5)

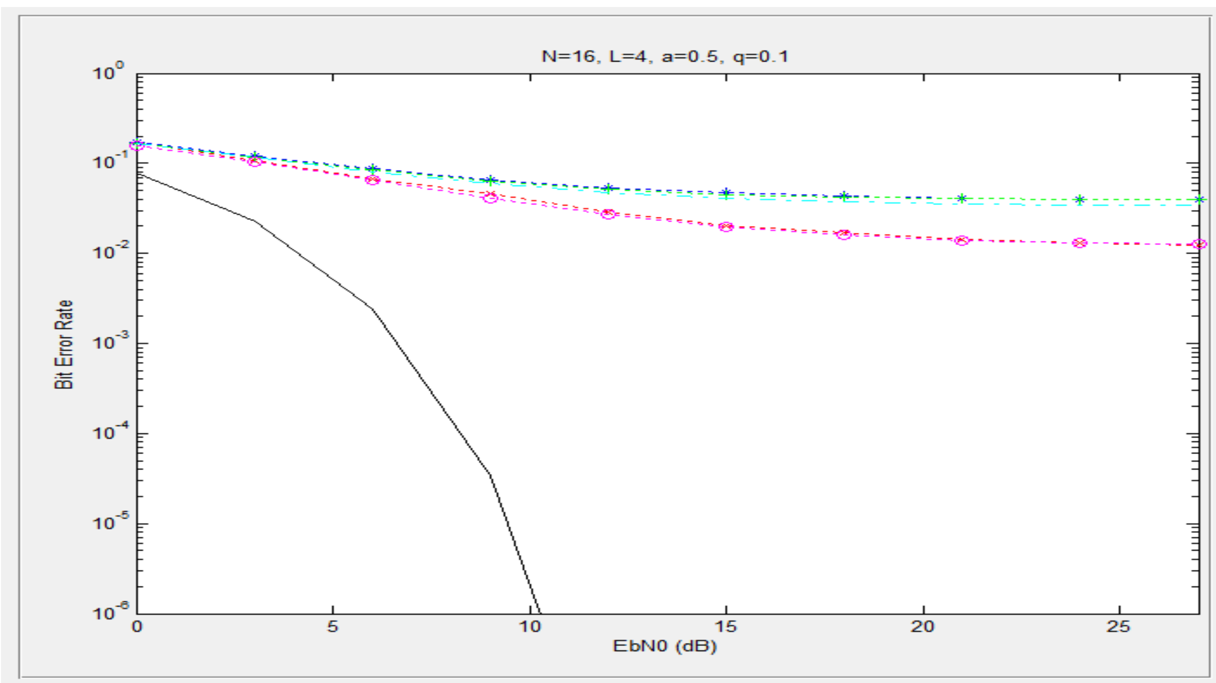

Figure 4.5: BER Performance under Rayleigh Fading Channel (parameters N=16, L=4, a=0.5)

Table 4.3: Rayleigh/ AWGN Parameter

Parameter	
Channel Model	Rayleigh/ AWGN
Channel Bandwidth	5MHZ
Cyclic Prefix	[0 I 2 3]
HARQ combining	Incremental redundancy
Frame structure	TDD
modulation	64QAM

Table 4.4: N, L, a based on table 4.3

S. No	N	L	a	Channel
1	64	4	0.4	AWGN
2	64	4	0.1	Rayleigh Fading
3	64	4	0.5	AWGN
4	64	4	0.5	Rayleigh Fading

AWGN or white timing jitters affected BER have been shown by circle with dash. Correlated timing jitter affected BER is shown by star with dash. Zero timing jitter affected BER have been shown by plus with dash. Ideal BER performance without interference is shown by x-mark with the dash. The performance of BER based on the AWGN Channel and Rayleigh Fading Channel N=64, L=4, a=0.4 are shown below.

AWGN or white timing jitters affected BER have been shown by circle with dash. Correlated timing jitter affected BER is shown by star with dash. Zero timing jitter affected BER have been shown by plus with dash. Ideal BER performance without interference is shown by x-mark with the dash. The performance of BER based on the AWGN Channel and Rayleigh Fading Channel N=64, L=4, a=0.5 are shown below.

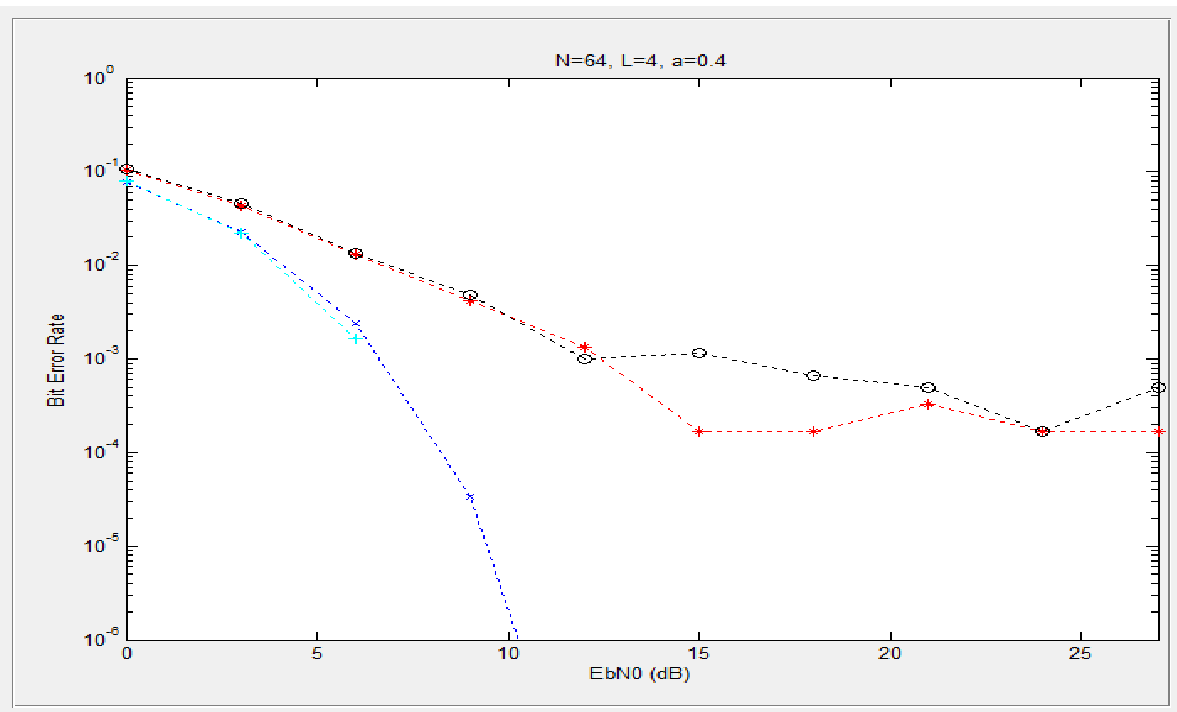

Figure 4.6: BER Performance under AWGN Channel (parameters N=64, L=4, a=0.4)

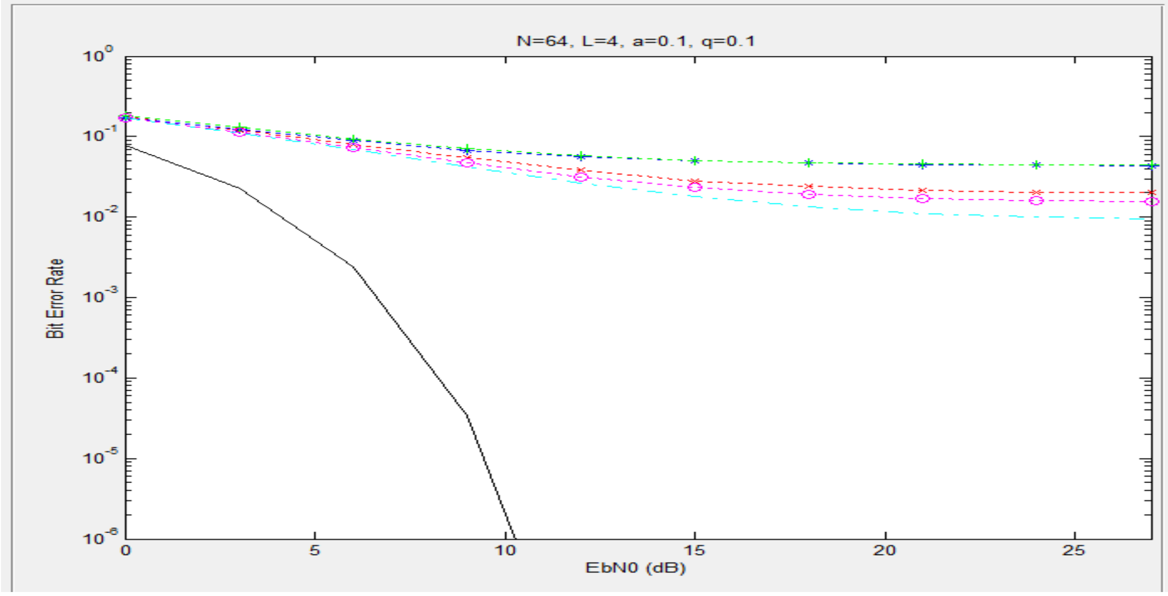

Figure 4.7: BER Performance under Rayleigh Fading Channel (parameters N=64, L=4, a=0.4)

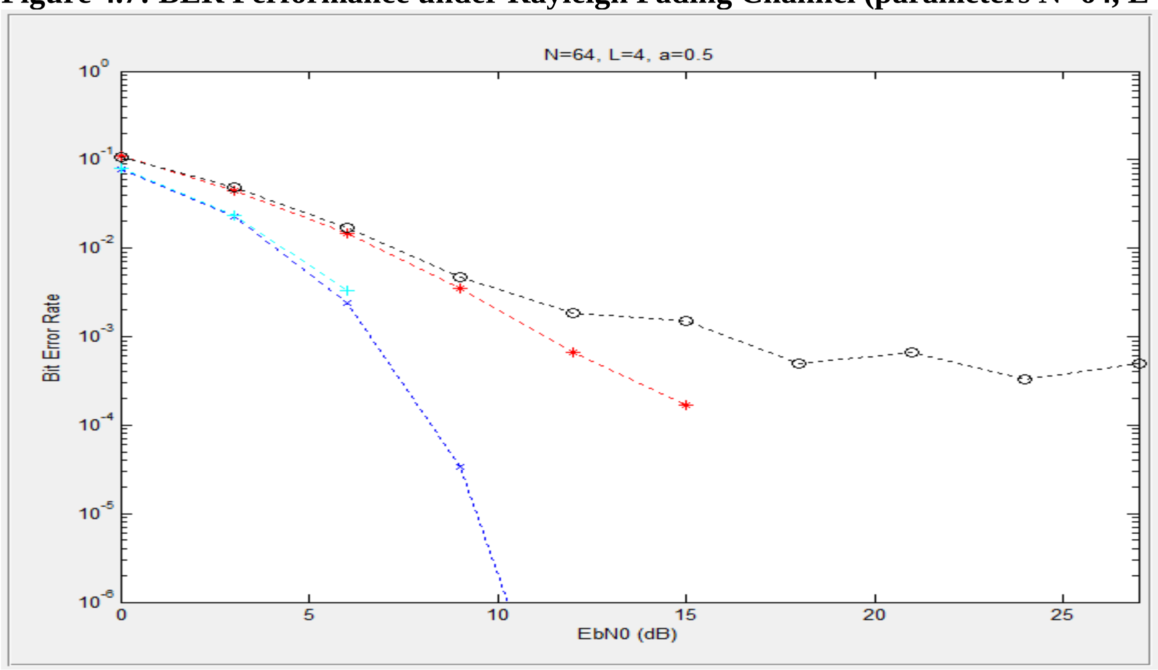

Figure 4.8: BER Performance under AWGN Channel (parameters N=64, L=4, a=0.5)

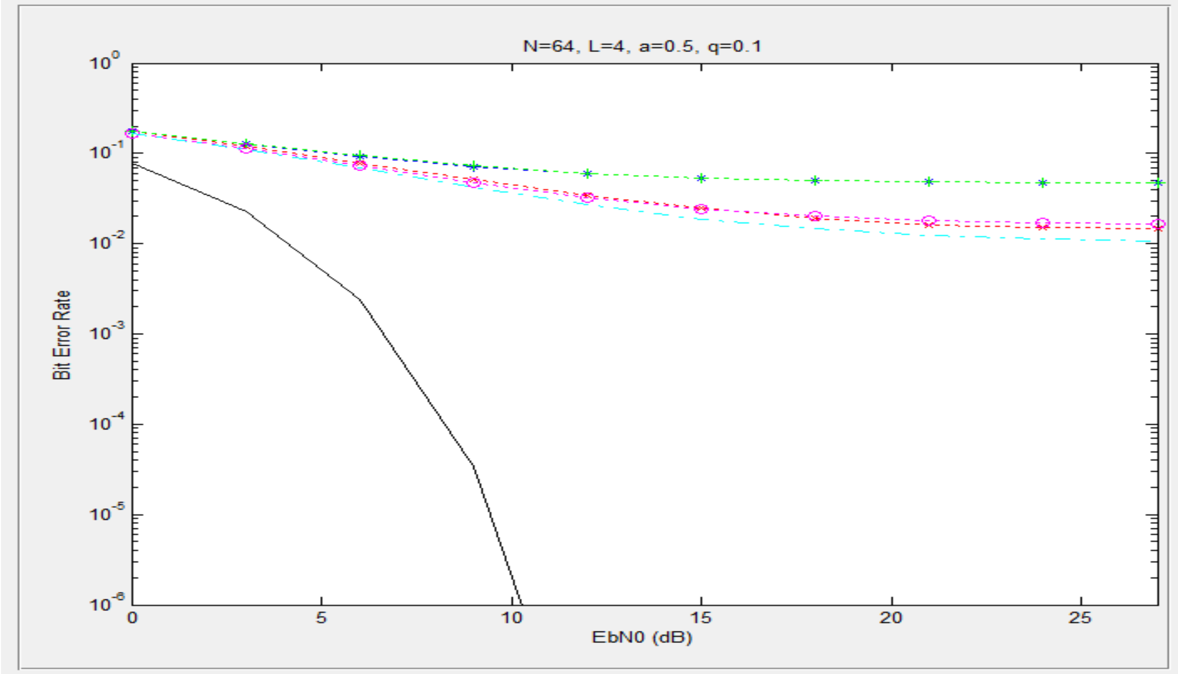

Figure 4.9: BER Performance under Rayleigh Fading Channel (parameters N=64, L=4, a=0.5)

Table 4.5: Rayleigh/ AWGN Parameter

Parameter	
Channel Model	Rayleigh/ AWGN
Channel Bandwidth	5MHZ
Cyclic Prefix	[0 I 2 3]
HARQ combining	Incremental redundancy
Frame structure	TDD
modulation	64QAM

Table 4.6: N, L, a based on table 4.5

S. No	N	L	a	Channel
1	128	4	0.1	AWGN
2	128	4	0.5	AWGN
3	128	4	0.9	AWGN
4	128	8	0.1	AWGN
5	128	4	0.9	Rayleigh Fading

AWGN or white timing jitters affected BER have been shown by circle with dash. Correlated timing jitter affected BER is shown by star with dash. Zero timing jitter affected BER have been shown by plus with dash. Ideal BER performance without interference is shown by x-mark with the dash. The performance of BER based on the AWGN Channel and Rayleigh Fading Channel for N=128 are shown below.

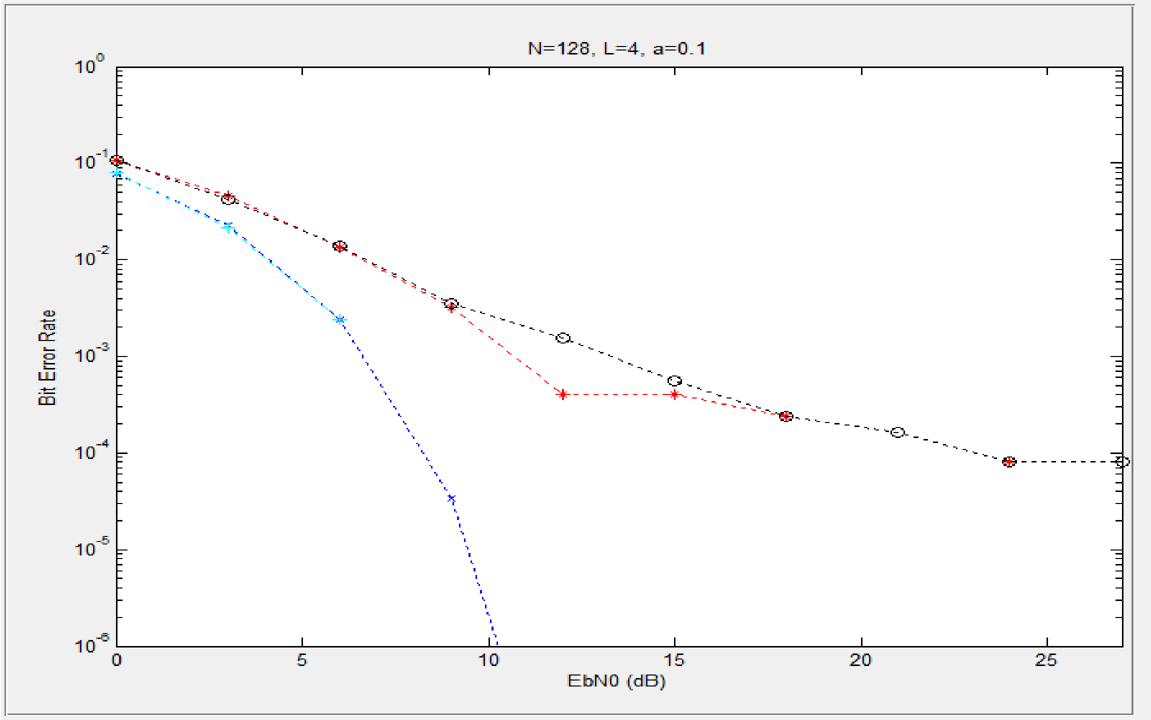

Figure 4.10: BER Performance under AWGN Channel (parameters N=128, L=4, a=0.1)

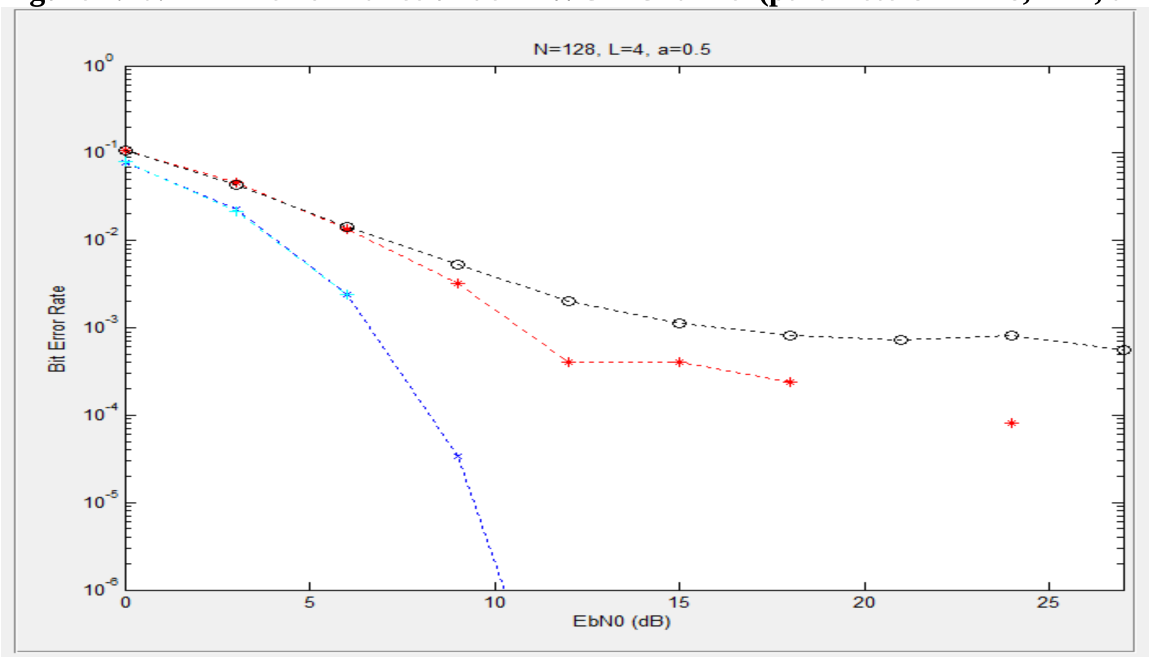

Figure 4.11: BER Performance under AWGN Channel (parameters N=128, L=4, a=0.5)

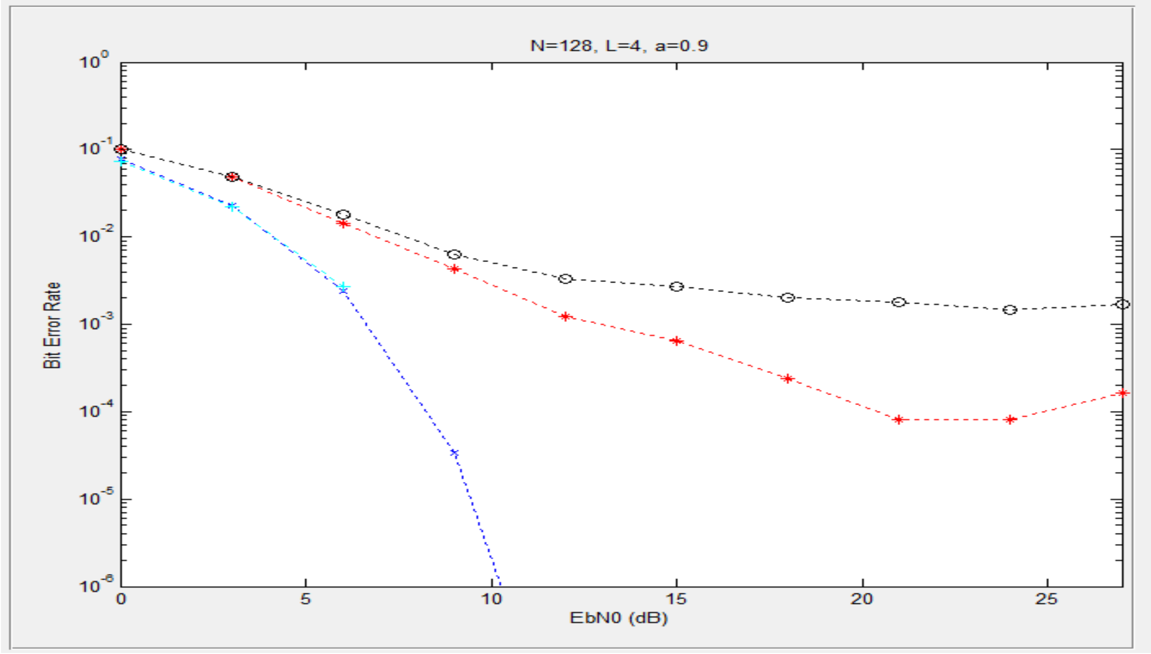

Figure 4.12: BER Performance under AWGN Channel (parameters N=128, L=4, a=0.9)

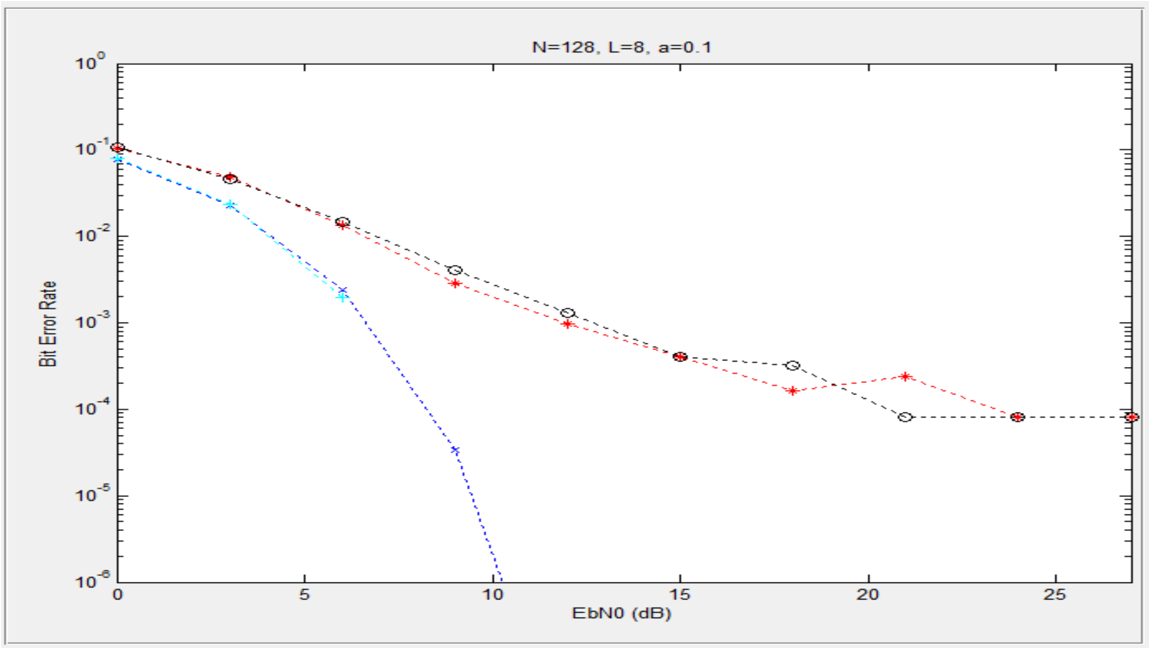

Figure 4.13: BER Performance under AWGN Channel (parameters N=128, L=8, a=0.1)

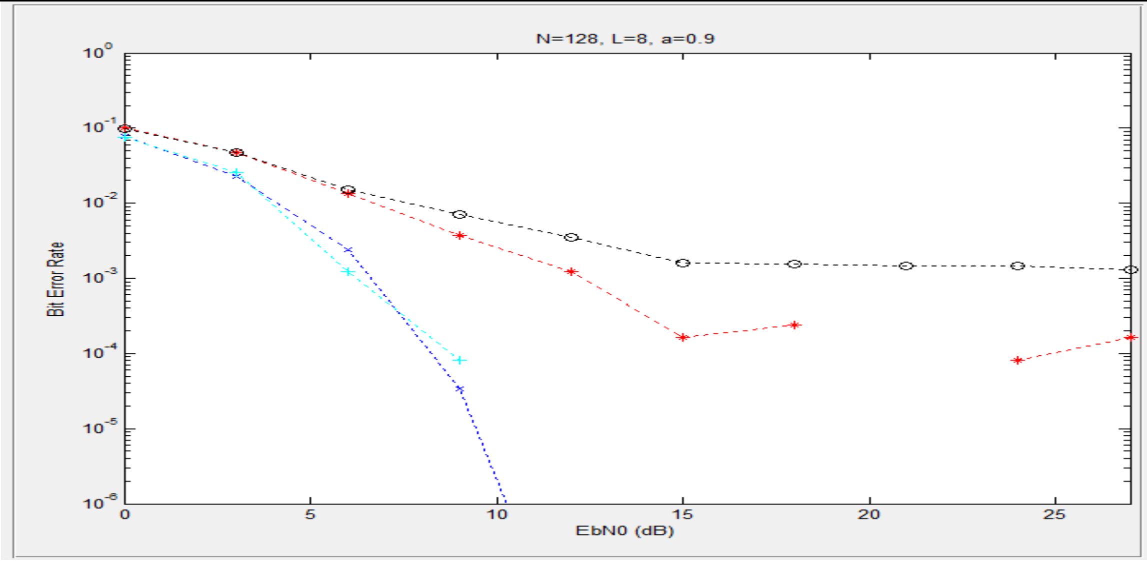

Figure 4.14: BER Performance under Rayleigh Fading Channel (parameters N=128, L=8, a=0.9)

The results based on CFO has been shown first. It shows the degradation invoked by noise and non-ideal channel. It shows the the transmitting and receiving frequency mismatch and error chances can be recorded to show the system performance. In our case 16,32, 64, 128, 256, 512 QAM based single carrier have been considered. It is clear from figure 4.15 to 4.20 that increasing N has decreasing error rate and the constellation points appear noisy.

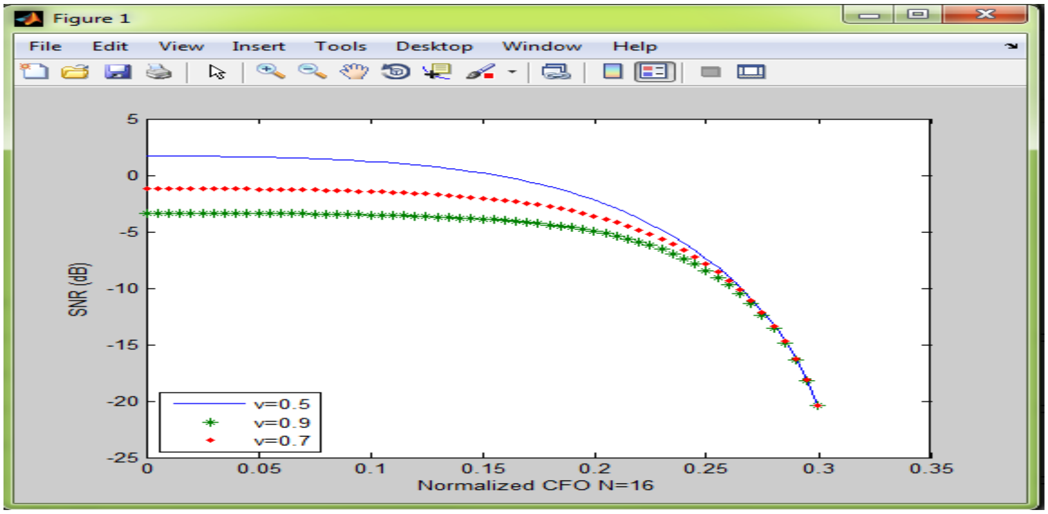

Figure 4.15: CFO at N=16

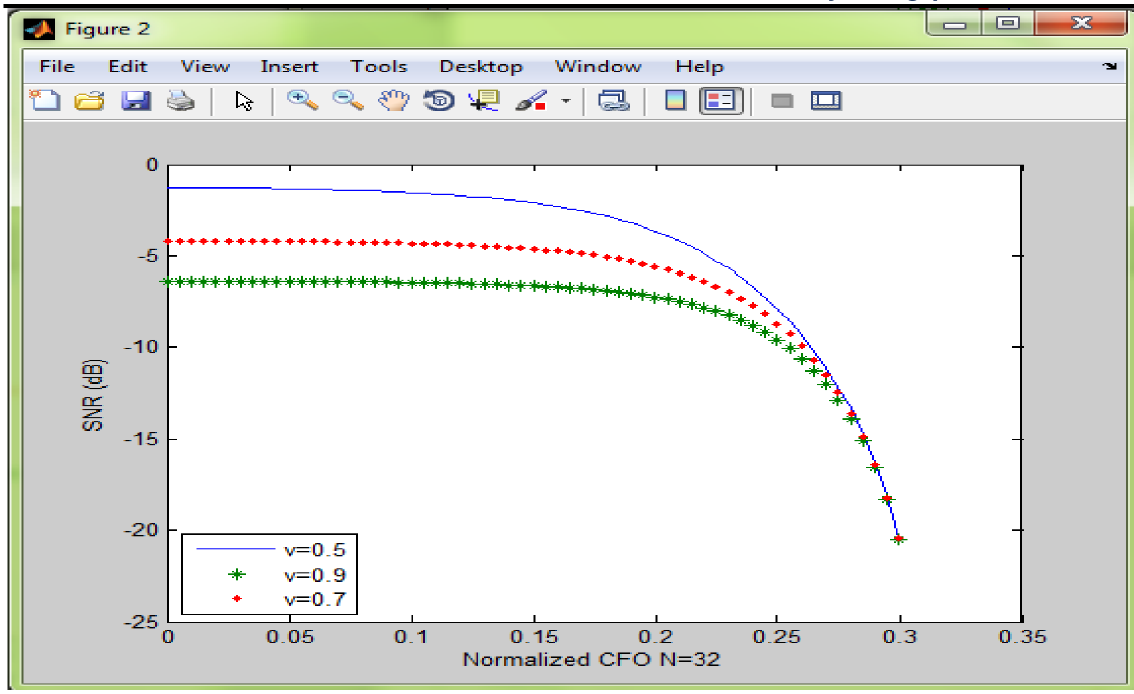

Figure 4.16: CFO at N=32

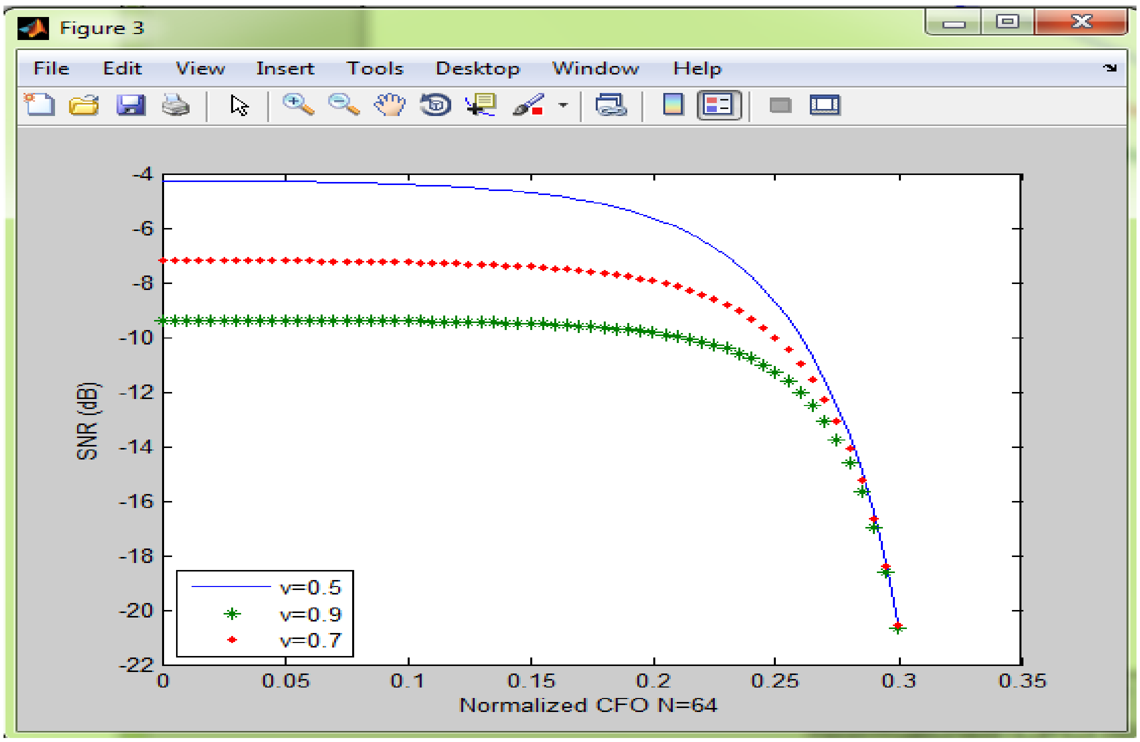

Figure 4.17: CFO at N=64

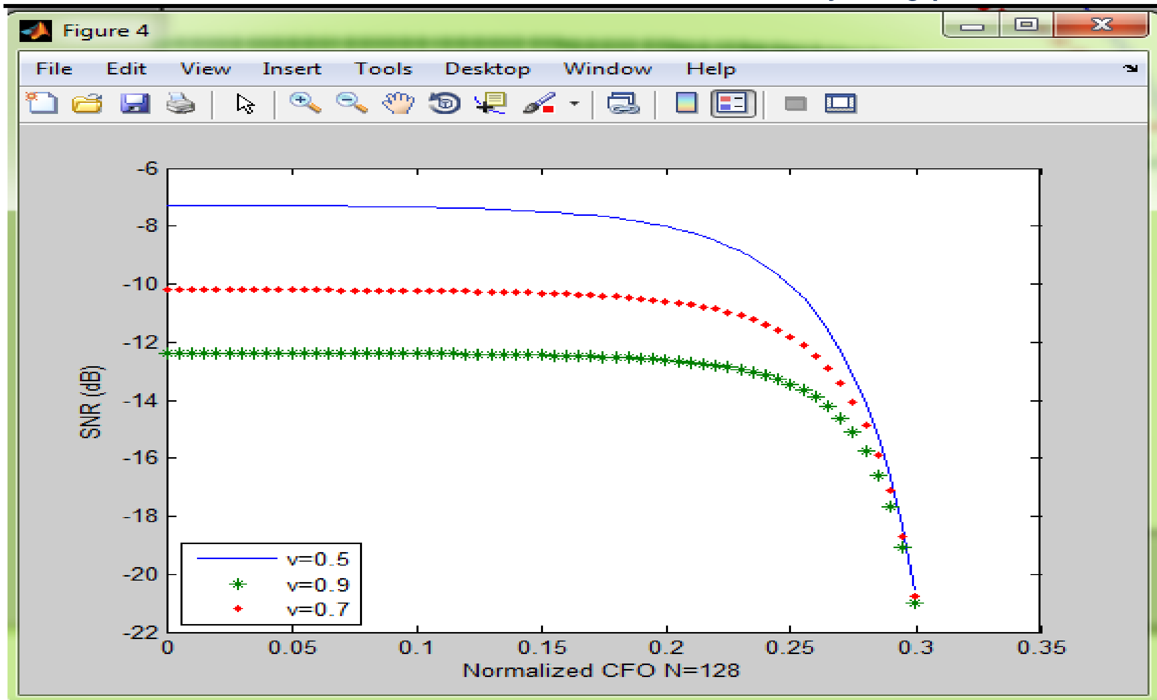

Figure 4.18: CFO at N=128

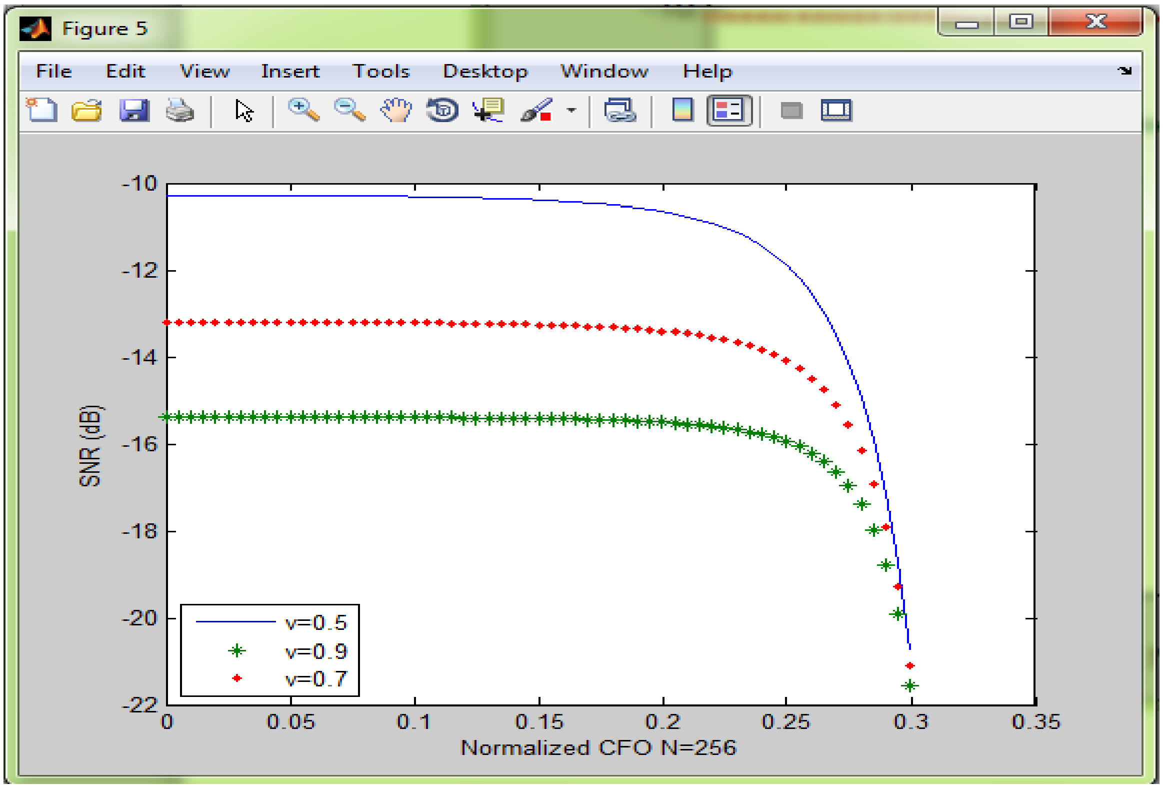

Figure 4.19: CFO at N=256

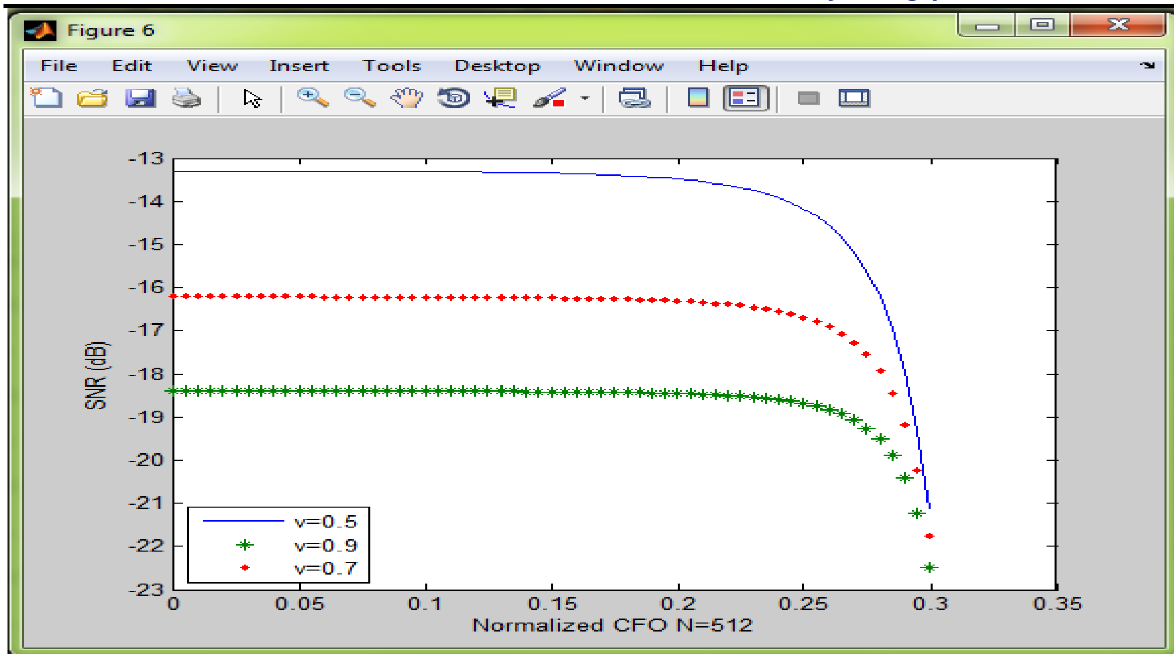

Figure 4.20: CFO at N=512

It is shown that for a given BER degradation, the values of the frequency offset and the line width of the carrier generator that are allowed for OFDM are orders of magnitude smaller than for single carrier systems carrying the same bit rate.

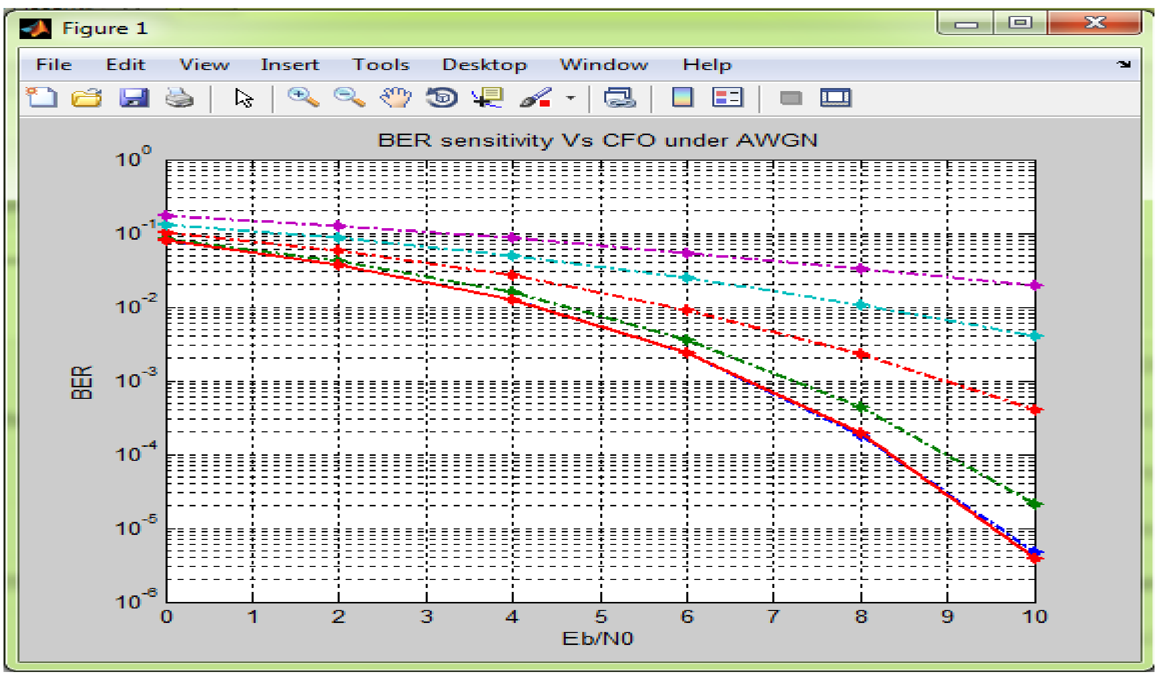

Figure 4.21: BER Sensitivity

The result comparison from our proposed methodology and the previous methodology is shown in table 4.7 which shows the significant improvement in our method.

Table 4.7 Comparison Table

S.No	Parameter	Previous Method[23]	Proposed Method
1	Modulation Scheme	16-QAM, 64-QAM	16-QAM,32-QAM, 64-QAM, 128-QAM,
2	Sub Carrier Mapping	Localized	Localized, Variance
3	Channel	AWGN	AWGN, Rayleigh Fading
4	Error Rate Calculation	BER	BER, CFO
5	Frequency Division	OFDM	OFDM and MIMO

The result based on fractional Fourier transform with CFO and FFT are shown below.

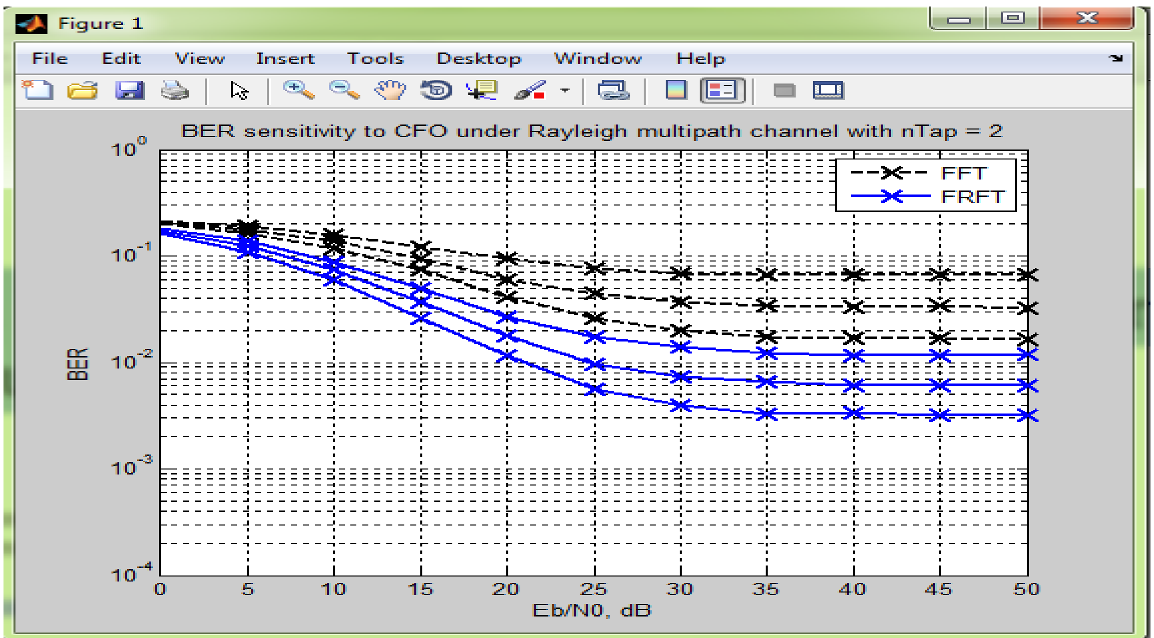

Figure 4.22: BER Sensitivity to CFO

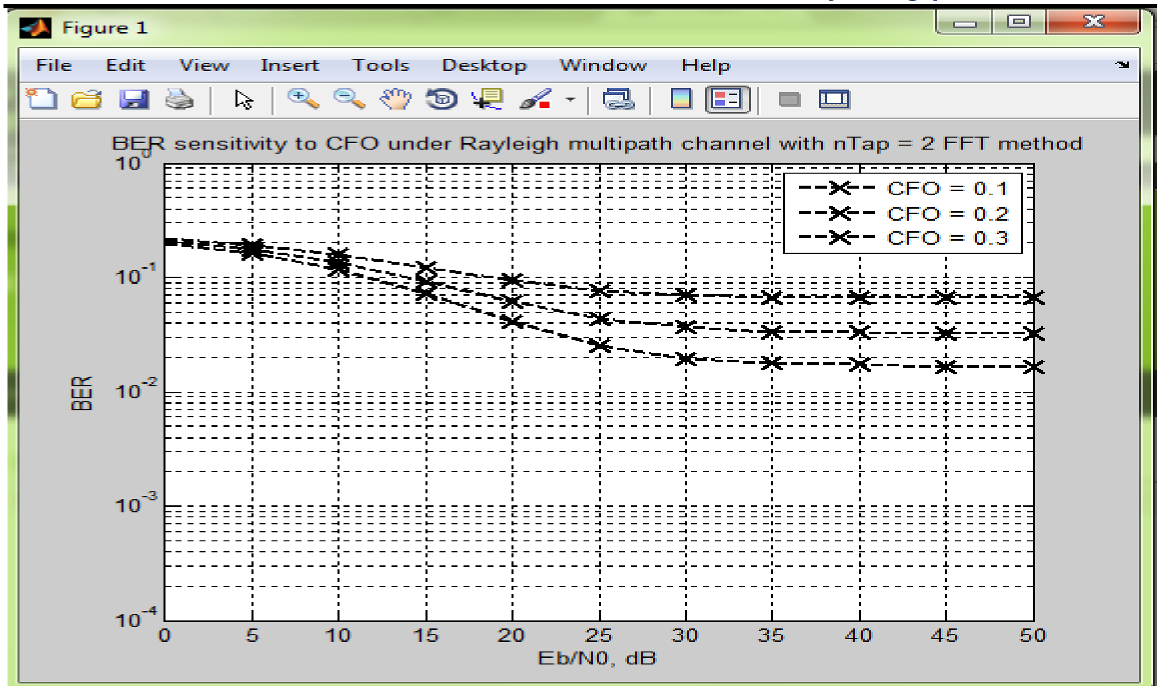

Figure 4.23: BER Sensitivity to CFO with FFT

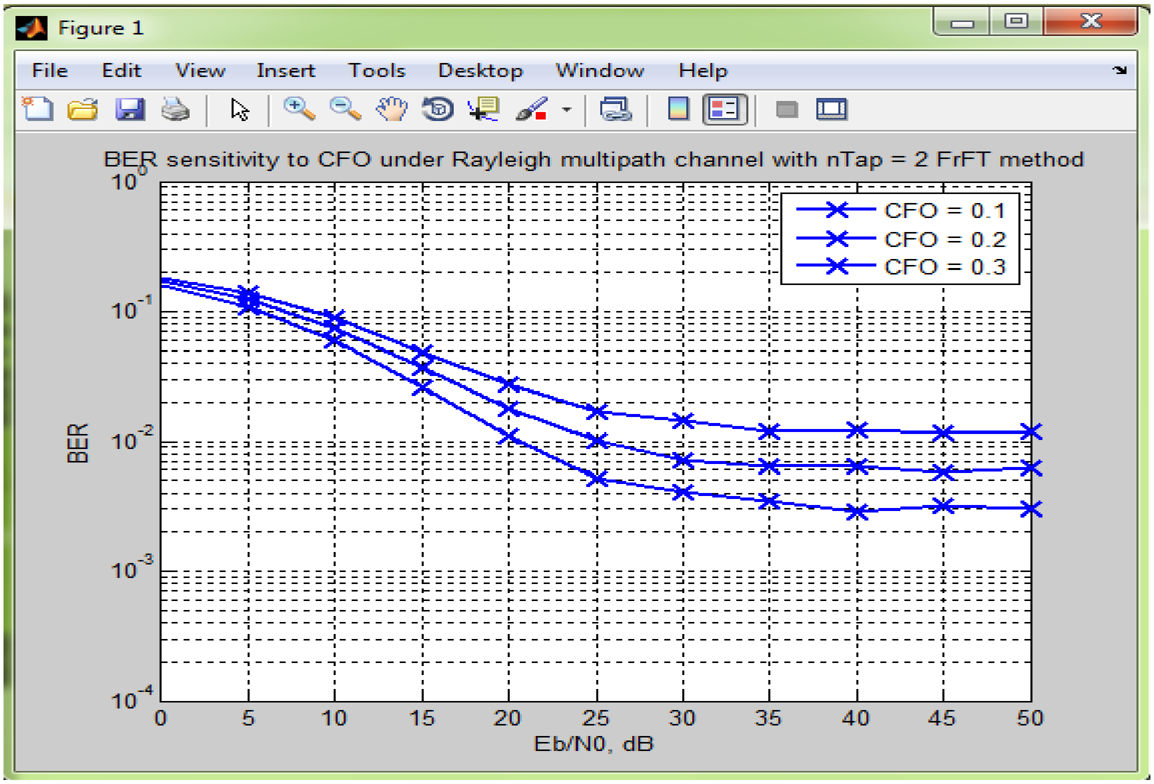

Figure 4.24: BER Sensitivity to CFO with FRFT

Conclusions and Future Directions

The performance of AWGN and Rayleigh fading channel with different subcarriers frequencies and channel capacity has been analyzed to show the BER performance in different condition.

- The performance clearly indicates the impact of our proposed system.
- Conclusions and Future Directions
- It shows that the BER ratio may be decreased in case of increasing the channel subcarriers and the transmission strength is good.

- The performance of the multi-carrier transmission modulation scheme that uses multi-carrier transmission with OFDM have been analyzed with the BER ratio.

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