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# Improving Capacity of Reception Quality in Mobile Communication Networks Using Ber Performance Metric

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## ABSTRACT

The advent of Wideband Code Division Multiple Access (WCDMA) technology offered networks solutions to the incessant signal deterioration of ongoing calls experienced in 2nd Generation Wireless Networks (2GWN). Resulting in swiftly adjustment in networks communication services, from the transmission of Base Station (BS) to mobile or downlink transmission in different modulation schemes. Nevertheless, the problem of Bit Error Rate (BER) is growing inevitably to a large scale fading of wireless communication channel's characteristics. As a result of ubiquitous occurrences of bit errors on a digital channel, the BER key performance parameters has inflated wireless networks channel to frequently require for increase in bandwidth. Practically, this paper considers procedures to mitigate the fading problems currently experienced by network subscribers. However, the solution to the problem is to supplement a smart antenna, a fading margin on the transmitter or alternative statistical assigning patterns on fading channels. This approach use two or more inputs on the receiver while ensuring efficient correlation of signal and overall system performance improvement on the fading channels. The work further specifies performance analysis on PSK, DPSK and FSK modulation techniques subjected to Additive White Gaussian Noise (AWGN) and Multipath Rayleigh Fading (MRF) initiated by the channel. Performance modeling was carried out to obtain an efficient networks service delivery as well as proffer direction to networks operators on superlative practices. The model was simulated based on a realistic field data using a robust Programming tools (MATLAB) for evaluation of Bit Error Rate (BER) and Signal-To-Noise Ratio (SNR) respectively for mobile networks optimization. The simulation results confirmed that BER thresholds should be carefully chosen in order to minimize networks defect and to deliver the optimal and efficient rating to the digital signal quality.

**Keywords**: Capacity of Reception Quality, Mobile Communication Networks, Ber Performance Metric.

## 1. INTRODUCTION

Since the advent of Telecommunication Technology, data has been sent via non-electronic (e.g. optical, acoustic, mechanical) means with little or no error. However, the first data electromagnetic transmission applications in modern times were telegraphy (1809) and teletypewriters (1906) which use digital signals.

But in the beginning of 21st century, error detection has been an unavoidable case in digital transmission, because of the advancement of technology on the communication or transmission systems there has been a dramatic shift in the market dynamics of telecommunication services. The advancement of digital transmission and communication systems brought about various devices through which the computer uses for communication and transmission, these devices are computer buses, peripheral equipment (parallel ports and serial ports (1969)), FireWire (1995), USB (1996), cable network and wireless network. Data transmission is utilized in computer networking equipment such as modems (1940), Local Area Network (LAN) adapters (1964), repeaters, hubs, microwave links, wireless network access points (1997) etc. Bits error has always been a trending case that causes a drawback in digital transmission and communication, researchers have put their hands on deck to detect this errors and scientist are digging deep to correct these errors in the systems and are yet to attain that.

That is why this research work is focused on managing bit error key performance analysis via wireless network optimization. The ultimate function of the physical layer in any digital communication system is to transport bits of data through a medium (such as copper cable, optical fiber, or free space) as quickly and accurately as possible. Hence, two basic measures of physical layer performance relate to the speed at which the data can be transported (the data rate) and the integrity of the data when they arrive at the destination. The primary measure of data integrity is called Bit Error Ratio (BER). The BER is an indication of how often data has to be retransmitted because of an error. Higher BER may indicate that a slower data rate would actually improve overall transmission time for a given amount of transmitted data since the BER might be reduced, lowering the number of packets that had to be present.

When data is transmitted over a data link, there is a possibility of errors being introduced into the system. Bit Error (BE) is the number of received bits of a data stream over a communication channel that have been altered due to certain inevitable key performance parameters such as: noise, interference, jitter, distortion or bit synchronization errors, BE is also known as End-to-End. If errors are introduced into the data, then the integrity of the system may be compromised. As a result of this, Bit Error Rate (BER) provides an ideal way necessary to assess and manage the performance of the system

BER can be directly translated into the number of errors that occur in a string of a stated number of bits. It is the number of bit errors divided by the total number of transferred bits during a studied time slots. It is also known as the percentage of bits that have errors relative to the total number of bits received in a transmission. It is a unit less performance measure, often expressed as a percentage. The definition of bit error rate can be translated into a simple relation.

$$\text{Bit Error Rate, BER} = \frac{\boldsymbol{Numbers\ of\ Errors\ (N_e)}}{\boldsymbol{total\ number\ of\ bits\ sent\ (N_b)}}$$

If the medium between the transmitter and receiver is good and the signal to noise ratio is high, then the bit error rate will be very small - possibly insignificant and having no noticeable effect on the overall system. However, if noise can be detected, then there is a chance that the bit error rate will need to be considered. The bit error probability $P_e$ is the expectation value of the bit error ratio. The bit error ratio can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors. The bit error probability $Pb_e$, which is equal to the BER, is derived from the symbol error probability using the simple relationship

Bit Error Probability $Pb_e$

$$Pb_e = \frac{P_e}{log_2 n}$$

OR

$$Pb_e = \frac{\mathbf{P_e}}{\mathbf{log_2\, m}} \leq \boldsymbol{P_b(e)} \leq \boldsymbol{P(e)}$$

There is nothing as a zero bit error rate. In practice, if the oise level is sufficiently small, then the probability of causing an error is some very small number such as $10^{-12}$ or less but not zero. It is also concluded that in order to achieve a BER of $10^{-10}$ the SNR needs to be greater than 13 dB for PAM-2, 16 dB for PAM-3 and 18 dB for PAM-5 coding, respectively.

For example, a transmission might have a BER of $10^6$, meaning that, out of 1,000,000 bits transmitted, one bit was in error. Data transmitted may be digital messages originating from a data source, for example a computer or a keyboard. It may also be an analog signal such as a phone call or a video signal, digitized into a bit-stream for example using pulse-code modulation (PCM) or more advanced source coding (analog-to-digital conversion and data compression) schemes. This source coding and decoding is carried out by codec equipment.
As an example, assume this transmitted bit sequence:

0 1 1 0 0 0 1 0 1 1

And the following received bit sequence:

0 0 1 0 1 0 1 0 0 1

The number of bit errors (the underlined bits) is, in this case, 3. The BER is 3 incorrect bits divided by 10 transferred bits, resulting in a BER of 0.3 or 30%.

Total number of bits $\boldsymbol{N_b}$ = 10

Total number of bit error $\boldsymbol{N_e}$ = 3

BER = $\frac{\boldsymbol{N_e}}{\boldsymbol{N_b}} = \frac{3}{10}$ = 0.3
The Percentage error $P_e$ = BER $* 100$ = 0.3 * 100 = 30 %
In practice, very low error rates may not be possible in case of noisy channels because the processing delay and implementation complexity might become very high. BER is used to quantify a channel carrying data by counting the rate of errors in a data string. It is used in telecommunications, networks and radio systems.

However, it is observed that there are so many key performance parameters that causes or add bad effects to wireless networks. These key performance parameters are: noise, interference, distortion, and jitter etc, that is why there is a constant need to manage these basic key performance parameters for wireless network optimization in order to analyze the ratio of the number of bits error and the total number of transmitted bits because one of the goal of any communication system is to communicate or transmit and receive data without any error. Therefore managing BER is a very important indicator to show how good a communication system is designed in order to attain the height of optimizing a wireless network system through bit error minimization.

### 1.1 Statement of the problem

What causes an imbalance link in a digital wireless transmission or communication system is bit error. Bit Error is the number of received bits of a data stream over a communication channel that have been altered due to certain inevitable BER key performance parameters such as: noise, interference, jitter, distortion, bit synchronization error factors, attenuation, wireless multipath fading, etc. These factors are the key performance parameters that disrupt a digital signal. Although a wireless network is any type of computer network that uses wireless data connections for connecting different network nodes whose main purpose is for communication and transition of data between various systems, there are still untraceable signals that perplex the original digital signals. Wireless networking is a connection between various equipment locations. At the time of implementing and administering wireless telecommunications networks using radio communication system which takes place at the physical level (layer) of the Open System Interconnection (OSI) model network structure, the transmission line is not traceable because its transmission automatically connects itself in the cloud.

## 2. RELATED WORKS

Umoren et al (2013) discloses that three stages must be accomplished to ensure the proper functioning of a network. These stages include: **planning, deployment and optimization**. The major causes of network defects lies in planning and deployment stages. Basically, Bit Error Rate (BER) is used to quantify a channel carrying data by counting the rate of errors in a data string. It is used in telecommunications, networks and radio systems. It is a key parameter that is used in assessing systems that transmit digital data from one location to another. Systems for which BER is applicable include radio data links as well as fiber optic data systems, Ethernet, or any system that transmits data over a network of some form where noise, interference, and phase jitter may cause degradation of the digital signal. Although there are some differences in the way these systems work and the way in which bit error rate is affected, the basics of bit error rate itself are still the same. When data is transmitted over a data link, there is a possibility of errors being introduced into the system. If errors are introduced into the data, then the integrity of the system may be compromised.

As a result, it is necessary to assess the performance of the system, and bit error rate, BER, provides an ideal way in which this can be achieved. Unlike many other forms of assessment, bit error rate, BER assesses the full end to end performance of a system including the transmitter, receiver and the medium between the two. In this way, BER enables the actual performance of a system in operation to be tested, rather than testing the component parts and hoping that they will operate satisfactorily when in place. Due to the ubiquitous occurrences of bit errors on a digital channel, the BER key performance parameters has caused wireless networks channel to frequently require for increase in bandwidth. To this effect, there is a redundancy on the wireless networks.

The performance of digital modulation techniques on how to manage BER key performance parameters for an efficient digital signal optimization on a transmission or communication channel have been frequently evaluated by researchers in the past. Mrityunjay prasad Tripathi et al (2013) considers the performance of Additive White Gaussian Noise (AWGN) and Rayleigh channels for comparison. Although, the simulated results present better BER performance but there was need to improve the power requirements of the modulation techniques. In the further future the performance will be evaluated under the multipath fading channel with Rayleigh and Racian channel. Also the performance will be evaluated by varing the various simulation parameters as Doppler shift and sampling time.

M. A. Masud et al (2010) reveals that, errors can be easily produced as the number of users is increased and the mobile terminal is subjected to mobility. Thus, it has driven many researches into the application of higher order modulations. Enhance Data Rate for the GSM Evolution (EDGE) is proposed as a transition to 3G as a new Time Division Multiple Access (TDMA) based radio access using the current (800, 900, 1800 and 1900 MHz) frequency bands. In their work, the noted that EDGE enables significantly higher peak rates and approximately triples the spectral efficiency by employing 8-Phase Shift Keying (8PSK) modulation.

## 3. THE EVALUATION TECHNIQUES OF BIT ERROR RATIO

The optimistic measurement of BER is roughly two different methods which are widely used in communication industry as illustrated in Figure 2.4.

**Method A**

The use of an equipment to generate and transmits a special test signal to DUT (Device Under Test) and after receiving/decoding the received signal, the DUT measure BER. In order to do this way, the DUT should know exactly what the transmitted data is. Usually we use a known/fixed bit stream (e.g. predefined test Vector) or a bit stream that can be generated by a known algorithm (e.g. PN data).

**Method B**

An equipment generate and transmit a special test signal to DUT, the DUT receive and transmit it back to the equipment and the equipment compares what it transmitted and what it received from DUT. In this case, DUT does not need to know what the test signal is. In many wireless communication (e.g. Bluetooth, WCDMA) this kind of method is used. The industry standard defines a specific test mode (e.g. Test Loopback Mode) to measure BER in this method.

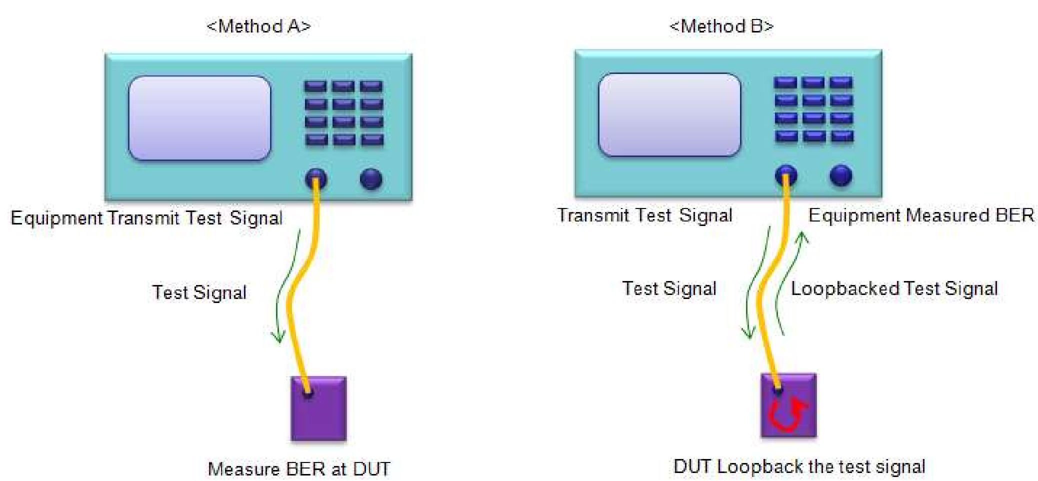


**Fig 1: A Bit Error Testing (BERT) scheme**

### 3.1 BER on a Digital Signal

One of the critical functions (goal) of any communication system is to transmit and receive data without any error. That is, the communication system has as little BER as possible during transmission and reception process. Therefore, BER is a very important indicator to show how good a communication system is designed. In order to prove that a communication system is well designed, there must be a prove that the estimated (theoretically calculated BER) is lower than a certain acceptance level and the measured BER after building the device is lower than a certain acceptance level.

### 3.2 Effects of BER on Cellular Network (WCDMA/GSM)

Wideband Code Division multiple Access (WCDMA) is used by Universal Mobile Telecommunication System (UMTS) as a platform of the 3rd generation cellular communication system. W-CDMA uses noise-like broadband frequency spectrum where it has high resistance to multipath fading where as this was not present in conventional narrowband signal of 2nd generation (2G) communication system. High data rate signal transmission can be transmitted over the air by using W-CDMA system, thus enabling of multimedia rich applications such as video streams and high resolution pictures to end users. Thus, we need suitable modulation technique and error correction mechanism to be used in W-CDMA system. In 2G networks, Gaussian Minimum Shift Keying (GMSK) modulation scheme is widely used in GSM (Global System for Mobile) Communication. This modulation can only transmit data rate of 1 bit per symbol. So it is quite sure that this kind of modulation scheme is not suitable for the next generation communication system. So, there is a need to study the performance of new modulation technique that could deliver higher data rate effectively in a multipath fading channel.

However, the implementation of high data rate modulation techniques that have good bandwidth efficiency in W-CDMA cellular communication requires perfect modulators, demodulators, filter and transmission path that are difficult to achieve in practical radio environment. Modulation schemes which are capable of delivering more bits per symbol are more immune to errors caused by noise and interference in the channel. Rate adaptation and other frame recovery schemes have also been proposed to improve packet loss resilience and increase the throughput of wireless networks. More recent proposals have begun to look at using information, i.e. data bits, at sub-frame level. For example, with frame combining, multiple possibly erroneous receptions of a given frame are combined together to recover the original frame without further retransmission. Partly motivated by this trend, this research began to study the positions of erroneous bits within frames. It is believed that repeatable and predictable patterns are very helpful for designing sub-frame level mechanisms such as frame combining.

### 3.3 Bit Error Ratio (BER) and Signal to Noise Ratio (SNR)

In telecommunication transmission, the **Bit Error Rate (BER)** is the percentage of bits that have errors relative to the total number of bits received in a transmission. For example, a transmission might have a BER of $10^{-6}$, meaning that, out of 1,000,000 bits transmitted, one bit was in error. The BER is an indication of how often data has to be retransmitted because of an error. Too high a BER may indicate that a slower data rate would actually improve overall transmission time for a given amount of transmitted data since the BER might be reduced, lowering the number of packets that had to be present. The BER may be improved by choosing strong signal strength by choosing a slow and robust modulation scheme or line coding scheme, and by applying channel coding schemes such as redundant forward error correction codes (S. M. Jahangir Alam, 2011). The transmission BER is the number of detected bits that are incorrect before error correction, divided by the total number of transferred bits (including redundant error codes). Normally the transmission BER is larger than the information BER. The information BER is affected by the strength of the forward error correction code.

**3.4 Signal-to-Noise Ratio (SNR or S/N)** is a measure used in science and engineering to quantify how much a signal has been corrupted by noise. It is defined as the ratio of signal power to the noise power corrupting the signal. A ratio higher than 1:1 indicates more signal than noise (S. M. Jahangir Alam, 2011). While SNR is commonly quoted for electrical signals, it can be applied to any form of signal. In less technical terms, signal-to-noise ratio compares the level of a desired signal (such as music) to the level of background noise. The higher the ratio, the less obtrusive the background noise is. SNR is sometimes used informally to refer to the ratio of useful information to false or irrelevant data in a conversation or exchange. The concepts of SNR and dynamic range are closely related. Dynamic range measures the ratio between the greatest undistorted signal on a channel and the smallest detectable signal, which for most purposes is the noise level. S/N measures the ratio between an arbitrary signal level and noise. Measuring S/N requires the selection of a representative or reference signal. It is usually taken to indicate an average signal-to-noise ratio, as it is possible that (near) instantaneous signal-to-noise ratios will be considerably different.

## 4. ANALYSIS

In the performance analysis towards the management of digital signal in a telecommunication system, there have been so many evolving techniques that can be used to suppress errors that may result from any performance parameter. These performance monitoring techniques helps in monitoring these errors in a communication system; among all these systems include:

(a) Monitoring of basic optical parameters (wavelength, power and SNR)
(b) Dispersion parameters (Chromatic Dispersion and Polarization Mode Dispersion (PMD) )
(c) Bit-level performance parameters (eye opening, Q-factor, and BER).

Among all these performance monitoring techniques used in communication systems to monitor and track down bit errors, BER monitoring technique is the adequate efficient technique in all digital communication systems.
Many techniques and algorithms have been developed by earlier researchers to monitor BER key performance parameters in order to attain a considered optimization level and to reduce error redundancy. One of the existing system is the pseudo-error counting scheme.

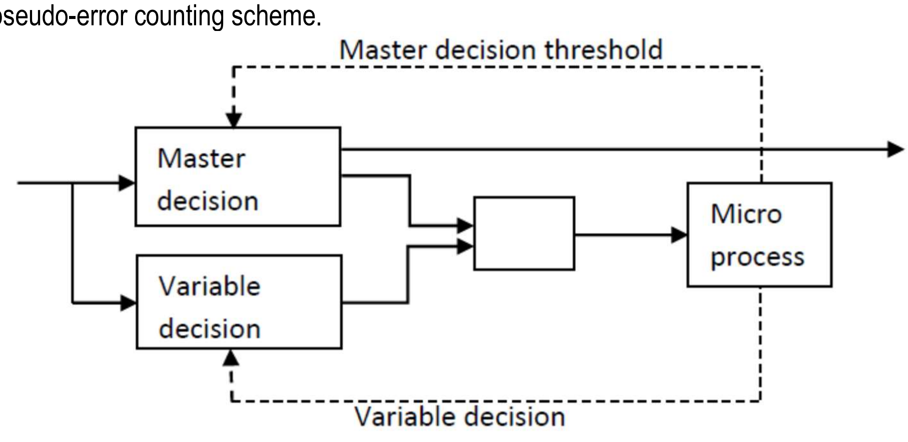


**Fig.2: Pseudo-error counting scheme. (Sung-Man Kim, 2010)**

Sung-Man Kim (2010) elaborated on the analysis of pseudo-error counting scheme or technique. He clearly illustrated that BER monitoring technique is the ultimate goal to performance monitoring in all digital communication system. In their paper, they analyze a pseudo-error counting scheme and propose an algorithm to achieve both BER monitoring and adaptive decision threshold optimization. FIG.3.1 Pseudo-error counting scheme. In this scheme, the "master decision gate" is for communication and the "variable decision gate" is for BER monitoring and adaptive decision threshold optimization. Thus the *master decision threshold* is the main decision threshold required to be optimized. The *variable decision threshold* is the secondary decision threshold used to obtain the pseudo error.

The pseudo error is generated by the decision difference between the two decision thresholds; one is decided by the *master decision threshold* and the other is decided by the *variable decision threshold*. The exclusive OR (XOR) gate generates '1' when the outputs of the two decision gates are different. The microprocessor counts the total number of pseudo errors and controls the master and variable decision threshold. Although the exact values of the true BER and the pseudo BER are different, the dominant parts of the two BERs become similar especially when the variable decision threshold (VDT) is far enough apart from the master decision threshold (MDT). In the pseudo-error counting scheme, assuming a Gaussian approximation, the true BER of the received signal and the pseudo BER counted in microprocessor are given by the following relation

$$BER_{true} = 0.25 \cdot \left\{ erfc\left(\frac{D - V_0}{\sigma_{0\sqrt{2}}}\right) + erfc\left(\frac{V_1 - D}{\sigma_1\sqrt{2}}\right) \right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

$$BER_{pseudo} = 0.25 \cdot \left| erfc\left(\frac{D_v - V_0}{\sigma_{0\sqrt{2}}}\right) - erfc\left(\frac{D_m - V_0}{\sigma_0\sqrt{2}}\right) \right| +$$

$$0.25 \left| erfc\left(\frac{V_1 - D_v}{\sigma_1\sqrt{2}}\right) - efrc\left(\frac{V_1 - D_m}{\sigma_{1\sqrt{2}}}\right) \right| \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots..(2$$

## 5. SYSTEM DESIGN

The system design have to do with the study and process of applying a modulated technique for the development of a simulated (simulinks) expert system for an illustrated scheme for the management of BER key performance parameters for wireless network optimization. The design of a system for the testing of BER requires a transmitter, a receiver and a channel. We begin by generating a long sequence of random bits provided as inputs to the transmitter. The transmitter modulates these bits onto some form of digital signals which is scale through a modulated channel. Some certain frequencies of BER key performance parameters are introduced into these channels as receiver's inputs. To this effect, this will cause an attenuation, fluctuation, fading, jitter arise, and redundancy in the digital signals causing some level of errors, inconsistencies, delay, inefficient, inaccurate and non optimized digital signals in the receiving side of the communication system.

A logic mechanism gate known as the exclusive OR (XOR) gate is used to generate '1' when the outputs of the two decision gates are different and "0" when the outputs of the two decision gates are not different and it is being optimized by the decision threshold. The design of this system is accompanied by an inbuilt microprocessor which is used to count the total number of pseudo errors and controls the master and variable decision threshold to gain access to a perfect optimization of these end-to-end key performance parameters of a wireless networks. Figures 3a – 3b show a schematic illustration of a simple model of a transmission line of BERT system that is used in this project. The optical signal is generated by a Bernoulli Binary Generator; it generates randomly sequence of bits and transmits this sequence of bits into a digital signal.

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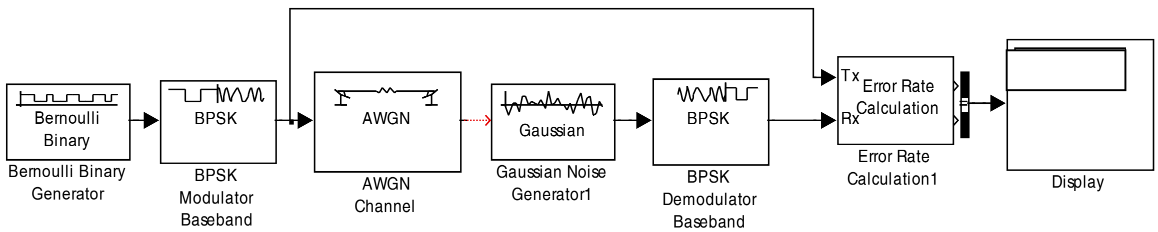



**Fig 3a: System design for AWGN channel**

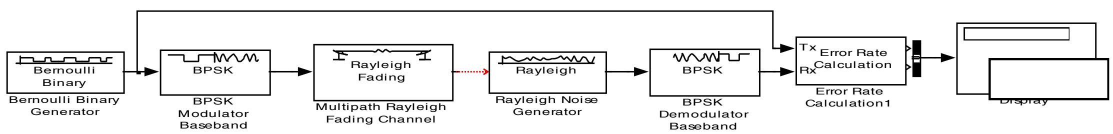



**Fig 3b: System design for Rayleigh fading channel**

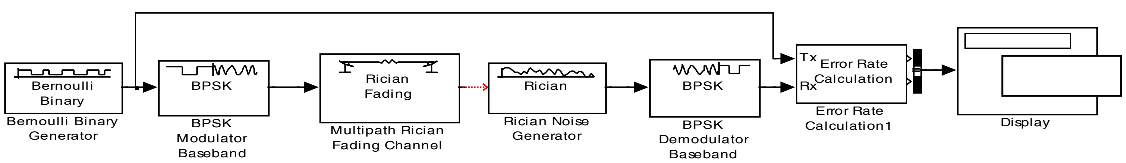



**Fig 3c: System design for Rician fading channel**

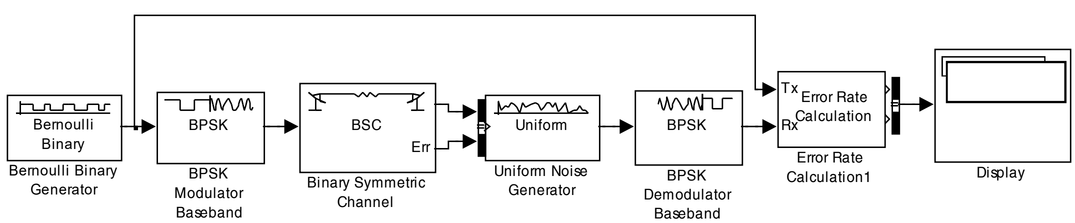



**Fig 3d: System design for BSC channel**

This digital signal then passes through a transmission line that primarily consists of a modulation technique; the modulation technique used in this project is Binary Phase Shifting Key (BPSK) technique. The modulated signal passes through a communication pathway and encountered inducted noise in the channel. There are different types of channel; this research is limited to the following types of channels: AWGN channel, Multipath Rayleigh channel, Multipath Rician channel, and Binary Symmetric channel (BSC). Each of these communication channels has their own degradation factors that affect the communication channel. The inducted noise is with respect to each of the channels and they are: AWGN Noise Generator, Rayleigh Noise Generator, Rician Noise Generator and Uniform Noise Generator respectively. The demodulator demodulates the digital signal before calculating the amount of bit errors that affects the digital signal.

## 6. MODEL DESIGN

In this research, a new technical model is proposed. It is accompanied with an algorithm to achieve an accurate BER system. The worst case scenario affecting the complexity of the algorithm against achieving a clear accurate and efficient digital signal optimization on wireless networks is put into perfect consideration. The emphasis on this model design is on mobile networks (WCDMA) via any communication system. This model introduces the basic concepts of noise in a receiver and how to properly model that noise to avoid high amount of BER. The proposed scheme uses a processing gain serial pseudo noise modulation as a multirate strategy. Third generation (3G) cellular mobile communication systems will support several kinds of communications services.

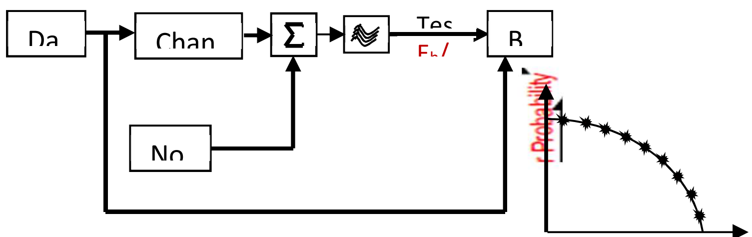



**Fig 4: A Typical Baseband System**

The Typical Baseband System examined in figure 4 has a channel that include frequency-dependent distortion but not noise. From the schematic system, it is observed that the baseband signals are sent down a transmission line, cable or wire. The signal may be corrupted by frequency-dependent and dispersive effects, as well as added noise. In this example, there is one noise source, which may be adjusted to define any desired signal-to-noise ratio at the input to BER measurement comparator and error counter (Corry Edelman, 2010).

### 6.1 Modeling of Bit Errors over Wireless Channel

There are a large number of theoretical models proposed for describing communication bit errors over various wireless channels. Among these models, Finite-State Markov Chain based models are among the most popular. For example, Zorzi et al. investigate the behavior of block errors in data transmission over fading channels. Besides these Markovian models, Kopke et al. propose to use a chaotic map as a model for bit errors over wireless channels and describe how to determine the model parameters based on measurement data. In WCDMA systems the access scheme is Direct Sequence Code Division Multiple Access (DS-CDMA) in which each user is assigned a particular code sequence which is modulated on the carrier along with the digital data. The Spread Spectrum Multiple Access (SSMA) techniques are characterized by the use of high rate code which has the effect of spreading the bandwidth of the data signal. The Direct Sequence Spectrum is the most commonly used technique among the different spread spectrum technique such as Frequency hoping and Time hoping. In this technique, the transmission system combines with the sending data signals having high data rate sequence and that divides the user data according to a spreading ratio.

Transmitter converts an incoming data (bit) stream into a symbol string where each symbols represent a group of one or more bits, this techniques is reliable and highly resistance to interference and give the opportunity to multiple users where they can communicate through one channel (Prasad, 1996). Multiple Access Interference (MAI), have significant impact on the network capacity of the wireless communication system. However, it is not clear how exactly the MAI affects performances including throughput and delay. The overall performance also requires accurate calculation of

BER in the presence of MAI, performance analysis is not easy to implement and can generally only be implemented with considerable computational effort (Gaurav et al 2001). To compute BER of a DS-CDMA system which depend on a set of parameters such as numbers of simultaneous users (k), the Processing Gain ($G_p$), Signal to Noise Ratio ($E_b/N_o$). the exact calculation of BER in the presence of MAI is difficult and emphasis has been given to bounds and approximation (Pursely, 1977). A simple approximation is to treat MAI as standard Gaussian and the bit errors are independent.

### 6.2 Model of Radio Frequency (RF) for Bit Error Ratio

A radio is a technology that allows for the transmission of sound or other signals by modulation of electromagnetic waves. It captures (receive) the amount of signal sent over a radio waves and render the modulated signal as sound, it continues the broadcasting of sound recordings via the internet in the style of traditional radio. The Radio Frequency (RF) is the rate of occurrence of the signal sent over a radio wave with respect to time. In RF system, a carrier is modulated based on the input data and some defined modulation format. In general, this signal may be represented as a complex envelope about the carrier.

This offers simulation efficiency not possible if the signal is represented as a baseband signal. However, when adding noise, the complex envelope representation must be considered. Noise should therefore also be added as a complex envelope. Furthermore, it is desirable that the In-phase (I) and Quadrature (Q) components of the envelope be uncorrelated, the I and Q are also known as the amplitude modulated sinusoids (Gast Matthew, 2005). Some authors find it more convenient to refer to only the amplitude modulation (baseband) itself by those terms (Frank L.E, 1969).

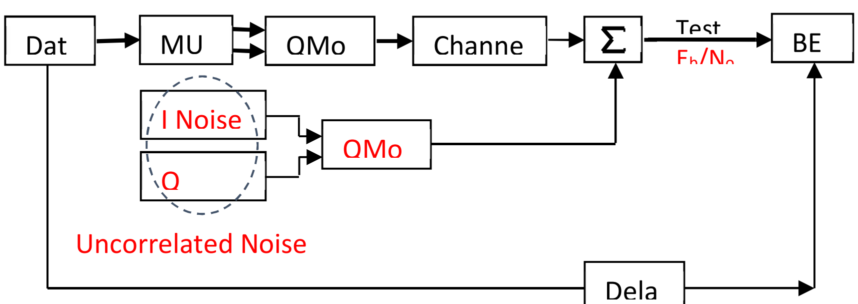



**Fig 5: A Typical Radio Frequency (RF) System**

In the RF system, data are created in the same manner as for the baseband system. Then, they are modulated, often using a quadrature scheme for higher throughput. In this case, noise added at RF should be similarly modulated starting with uncorrelated Gaussian noise sources (Edelman 2010). According to Edelman analogy, The RF system is seen to be similar to the baseband system, except that noise is injected at RF as a complex modulation envelope, and is uncorrelated with the transmitted signal. As previously mentioned, the system delay must be accounted for. If an automatic synchronization function is provided, only an upper bound need be specified. If a system is modeled using only digital signal processing functions, including digital filtering, the delay can usually be found by inspection and analysis. However, if the system includes analog or RF models, the delay is often not easily obtained without additional simulation. A possible approach is to excite the system with an impulse (a signal of very narrow, ideally infinitely small width) and observe the output time domain response. Another is to graphically compare the reference and test bit streams. Note that for a RF system, just as with noise, the impulse source should be amplitude-modulated onto an RF carrier. However, a separate I and Q impulse source is not required. This allows the simulator to sample just the impulse signal's envelope, not the carrier itself, which is much more efficient.

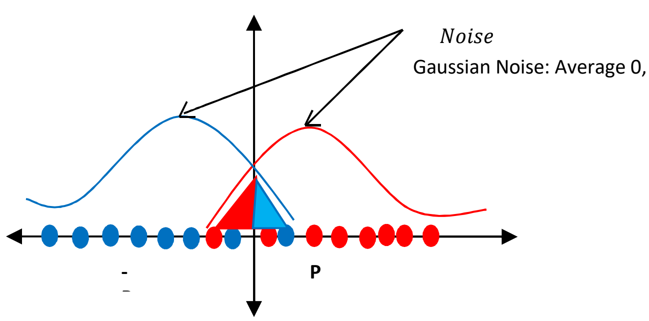
### 6.3 Alternating Current Circuit and Model of Narrowband Signal

An Alternating Current (ac) is application of voltage vs. time function that is sinusoidal with a frequency, *f*, of 50 0r 60 Hz. When it is applied to a typical circuit or device, it causes a current that is also sinusoidal. Generally, there is a constant phase difference, φ, between the two sinusoids. The stimulus of the sinusoids voltage is usually defined to have zero phase (i.e. it is arbitrarily chosen as a convenient time reference). So the phase difference is attributed to the current function, e.g. $\sin(2\pi ft)$ whose orthogonal components are: $\sin(2\pi ft)\cos\emptyset$ and $\sin(2\pi ft + \pi/2)\sin(\emptyset)$. and when φ happens to be such that the in-phase component is zero, the current and voltage sinusoids are said to be in quadrature (i.e. they are orthogonal to each other). In this case, no electrical power is consumed; it is temporarily stored by the deviceand given back, once every $\frac{1}{f}$ seconds. It is noted that the term in quadrature only implies that the two sinusoids are orthogonal, not that they are components of another sinusoid.

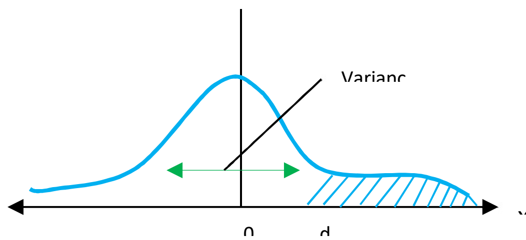
### 6.4 BER Key Performance parameters

Assuming the communication system is exposed to noise (noise has a random characteristics); it cannot be explained or modeled as any fix or deterministic pattern. The pattern of a noise can be model by a certain statistical model. First, it is appropriate to define the statistical properties of noise when analyzing a system under noise. In most cases, 'Normal Distribution' is often used because it has some theoretical background called "Central Limit Theorem". Assuming this noise has a Normal Distribution: under this noisy situation all the data does not superimpose onto a single dot anymore. Some data would map onto lots of scattered around the ideal locate, most of the dots still appear closer to the ideal location while some deviate very far from the ideal location, not all of the deviated dots causes bit errors.

In this model formulation any red dots can still be decoded as '+1' as long as it stays on the right side of the graph and any blue dots can still be decoded as '-1' as long as it stays on the left side of the graph. In this case, the deviation does not cause any bit error. But if any dots deviates in its ideal location, the deviated dots cause bit error rate; the deviation of the dots location is caused by the noise and the noise is based on the 'Normal Distribution' which explains the deviation of dots from the ideal location. Bit error rate is frequently expressed as a probability$(p_e)$ of bit error rate and it lies between 0 and 0.5. Therefore the probability of bit errors for the red and blue dots can be illustrated below.

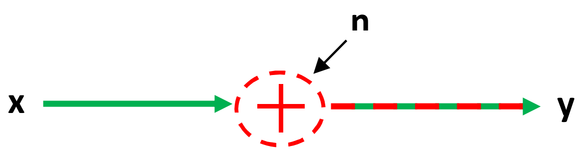



BER means the probability that a noise power becomes larger than a certain level (criteria). The square of standard deviation (variance) is known as the noise power, as the spread of the variance increases, the spread of the Gaussian noises increases, the mathematical analysis of BER can be done simply by taking the area after a certain value under the normal distribution graph as shown below.



*The distribution of Noise*

The performance model of noise in a wireless communication system is illustrated below.




x = transmitted symbol
n = noise of the receiver
y = received symbol

In communication channel where the noise is a White Gaussian noise process then the system is known as Addictive White Gaussian Noise (AWGN) system. The relation is given as: $x = 1 = -\sqrt{p}\ and\ \ x = 0 = \sqrt{p}$

$$y = x + n \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . (1.0)$$

BER is bound to occur if $\boldsymbol{y}\ \geq 0;$ this is because the amount of noise *n,* is greater than or equivalent to the amount of transmitted signal $(n \geq x)$ or the amount of transmitted signal plus the additive noise is greater than the maximal signal voltage which is zero (0). The noise probability of bit error rate noise $(p_e)$ is frequently expressed as:

$$p_e = 0 \leq p_e \leq 0.5$$

If the noise process is wide, then Gaussian noise will have a Gaussian Probability Density Function (PDF), the system model is known as "AWGN channel". The model for Gaussian PDF of noise (distribution of noise power) is given as:

$$F_n(n) = \frac{1}{\sqrt{2\pi\sigma^2}}\ e^{\frac{-x^2}{2\sigma^2}} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . . (1.1)$$

Assuming a situation where the probability of noise power is greater than "d", then the probability of deviated data bits is greater than "d". To this effect, a resultant of higher bit error ratio will occur causing the integrity of the communication system to be truncated. The relation for achieving the Gaussian probability of noise power that is greater than "d" is given as:

$$P(x \geq d) = \int_{d}^{\infty} \left( \frac{1}{\sqrt{2\pi\sigma^2}} . e^{\frac{-x^2}{2\sigma^2}} \right) dx \dots \dots \dots \dots \dots \dots \dots . (1.2)$$

Let's modify the equation above into a form that is closer to physical mean and that can be solved a little bit easily. Sometimes this step is often ignored when calculating BER. There is a lot of software (even pocket calculate) that can do this. But for the purpose of clearer understanding of the meaning of this mathematical form is why this step is not ignored in this research work. The probability of bit error (BER) is denoted as $P(x \geq d)$ and in order to find the probability of this error (BER), the following derivation needs to be calculated.

$$P(x \geq d) = \int_{d}^{\infty} ( \frac{1}{\sqrt{2\pi\sigma^2}} . e^{\frac{-x^2}{2\sigma^2}} ) dx \dots \dots \dots \dots \dots \dots \dots \dots (1.3)$$

$$= \int_{d}^{\infty} ( \frac{1}{\sqrt{2\pi\sigma^2}} . e^{-\frac{1}{2}(\frac{x}{\sigma})^2} ) dx$$

$$note\ that\ \frac{x}{\sigma} = t, and\ dx = \sigma . dt$$

$$= \int_{\frac{d}{\sigma}}^{\infty} ( \frac{1}{\sqrt{2\pi\sigma^2}} . e^{-\frac{1}{2}t^2} ) \sigma . dt$$

$$= \int_{\frac{d}{\sigma}}^{\infty} ( \frac{1}{\sqrt{2\pi\sigma^2}} . e^{-\frac{1}{2}t^2} \sigma ) dt$$

The physical meaning of $\frac{d}{\sigma}$ is Signal to Noise Ratio (SNR). The probability of Errors is determined by SNR. The conclusion to this relation is:

$$P(x \geq d) = \int_{d}^{\infty} ( \frac{1}{\sqrt{2\pi}} . e^{-\frac{1}{2}t^2} ) dt \dots \dots \dots \dots \dots (1.4)$$

## 7. BER MODEL FORMULATION

Although simple mathematical does not mean simple physical solution, in this section, we would only look at the mathematical aspect of reducing BER. Since BER means the area under the normal distribution that is greater (or less) than a certain level, if this area is reduced, then BER is reduced. We can mathematically think of doing this in two methods:

1. **Increasing the Threshold Value:** The first method is by increasing the threshold value (labeled as 'p' and '-p').The physical meaning of increasing 'p' an '-p' simply imply the transmitting of the bit in higher power (voltage). However, this would cause more energy consumption. In the first diagram of figure 3.5 below, there is a comparison between [Case A] and [Case B], and it is intuitively noticed that [Case B] has less area of Bit Errors.

2. **Reducing the area of Bit Error:** The second method of reducing the area of Bit Error is by reducing the deviation of the probability distribution function. Less deviation of the probability distribution function means less mean power of the noise. This is not easy to achieve in real implementation. In the second diagram of figure 3.5, when [Case C] and [Case D] are compared, it is noticed that [Case D] would have less BER. However, in many case we don't have any control of changing the property of noise.

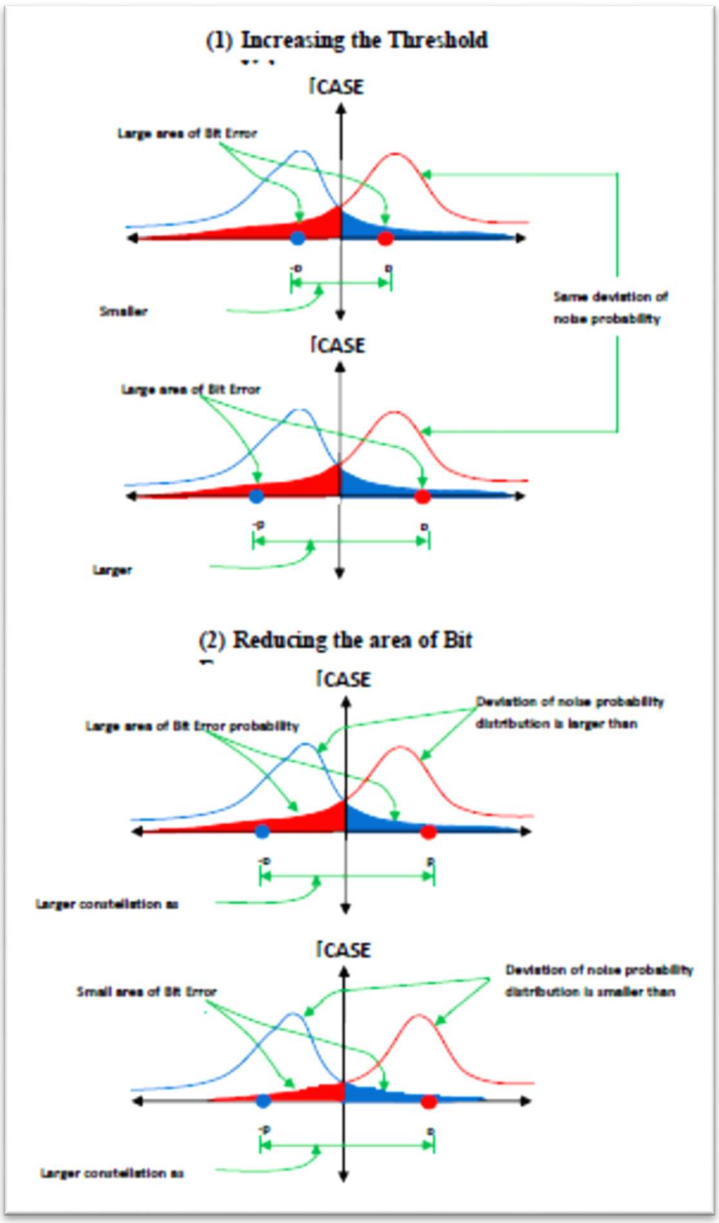


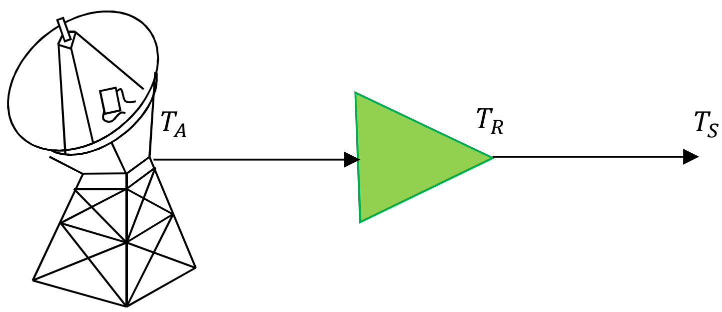

**Fig. 6: The two methods on how BER can be reduced**

**Controlling the System Noise**
Controlling system noise tends to be very confusing in a communication system, that's why the issue of noise needs to be properly treated in order to avoid system or bit errors. The simulation of BER is not implemented directly via the mathematical and statistical analysis. This section conveys how to properly model noise for accurate BER.

**Understanding the Receivers Noise**
In every communication, the receiver's side is always affected, this is because the amount of noise injected into the communication channel is always infect the digital stream of flowing signals. According to Corry Edelman, the receiver's noise is defined by the total sum of the noise temperature, and if we classify it as $T_s$ then

$$T_S = T_A + T_R \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (.15)$$

$$\begin{aligned} where:\ & T_R \rightarrow Noise\ Temperature\ due\ to\ Antenna \\ & T_A \rightarrow Noise\ Temperature\ due\ to\ Receiver \\ & T_S \rightarrow The\ total\ sum\ of\ noise\ Temperatur \end{aligned}$$




The description of the noise performance of a carrier is done through the analysis of Noise Temperature. In the consideration of these entities ($T_A\ and\ T_R$), it is very important to consider them as different entities. Then the noise temperature for each can be defined. The sum of the total receiver's noise temperature $T_S$ is therefore the sum of the antenna and receiver's-only noise temperature.

**7.1 Algorithm**
The algorithm is displayed for performance evaluation of the computation of BER and degradation factor with number of noise at different value of SNR causing a delay in a cell for an optimum performance evaluation. The flowchart shows how the flow of digital signals encounters degrading factors and optimized these factors. The algorithm is represented in a flowchart as shown figure 7.

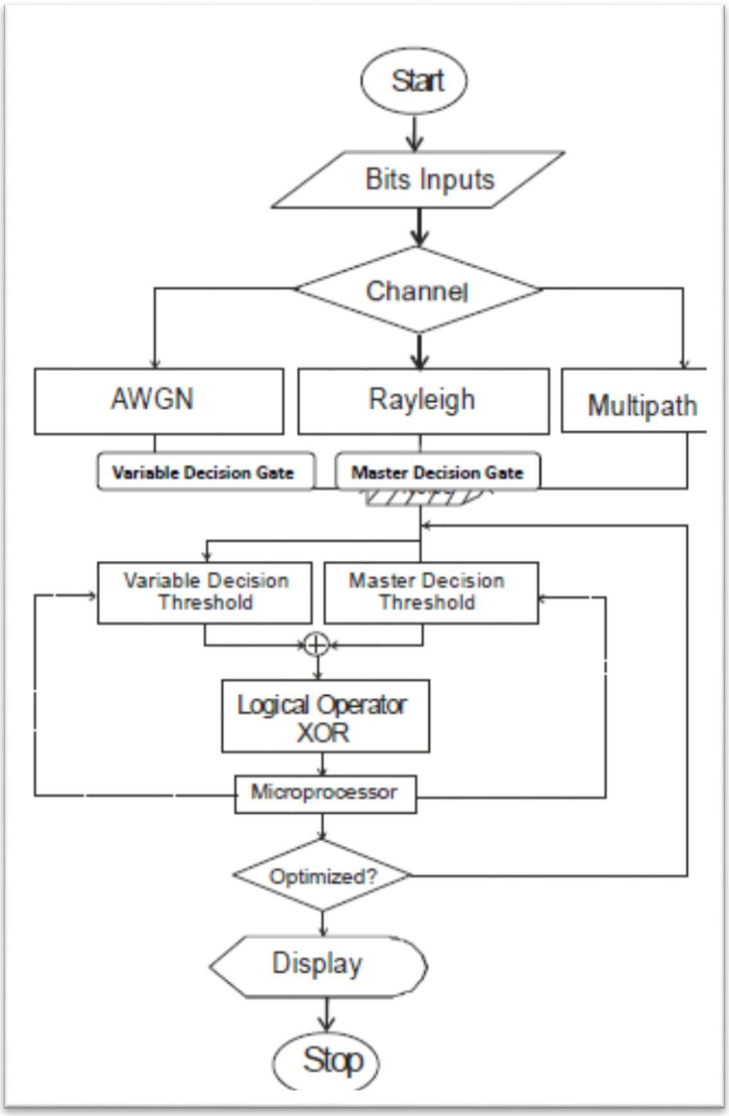



**Fig 7: An Algorithm for Managing BER in a Communication System**

### 7.2 Implementation Parameters

The implementation of this system is done by generating a long sequence of random bits provided as inputs to the system transmitter; the transmitter converts these sequences of bits to some form of digital signal which is scaled through a modulated path. There is an induction of some certain key performance parameters of BER at different frequencies of the modulated path which serves as the receiver's. To this effect, there would be a drop down, delay and slow flow of digital signal in a modulated pathway. Table 1 and 2 shows the different modulation types, orders and communication channels which are used at the time of implementing this research work.

**Table 1: Modulation Types and its Orders in an AGWN and Rayleigh channel.**

| CHANNEL TYPE | MODULATION TYPE | MODULATION ORDER |
|---|---|---|
| | | 2 |
| | | 4 |
| | PSK | 8 |
| | | 16 |
| | | 32 |
| AWGN | | 2 |
| | | 4 |
| | DPSK | 8 |
| | | 16 |
| | | 32 |
| RAYLEIGH | | 2 |
| | | 4 |
| | FSK | 8 |
| | | 16 |
| | | 32 |

**Table 2: implementing three Modulation Types on different Orders in an AGWN channel.**

| CHANNEL TYPE | MODULATION TYPE | MODULATION ORDER |
|---|---|---|
| | | 2 |
| AWGN | | 4 |
| | PSK + DPSK + FSK | 8 |
| RAYLEIGH | | 16 |
| | | 32 |

Table 4.1 shows the two communication channel, three modulation types and five modulation orders that are restricted to this work. Each of these communication channels is implemented on the three modulation types. It is observed that each of the modulation types have five modulation orders and each of these modulation orders are simulated with each of the modulation type on each of the channel.

Table 2 describes two communication channels, three modulation types and five modulation orders. In the implementation of this work, all the modulation types are simulated with various modulation orders and on different communication channels.

**4.2 Sample Implementation Input and Output Snapshots**

The sample implementation of this research work is simulated with different data from different modulation type of different communication channels on each modulation order.

In order to achieve a proper implementation of Bit error ratio of input signal to noise signal of AWGN channel at DPSK modulation at different modulation order, it was first of all implemented with each modulation order. For example; there is a separate simulation for each modulation type respectively to each modulation order in an AWGN channel.

That is to say that in AWGN channel, there is a simulation on PSK modulation type on each modulation order of 2,4,8,16,32 and 64. Still on that same channel, there is also a simulation on DPSK modulation type on different modulation orders such as: modulation order of 2,4,8,16,32 and 64. Finally, on that same channel, there is a simulation on FSK modulation type on the various modulation orders of 2,4,8,16,32 and 64. See appendices for more details.

**Performances of WCDMA in AWGN Channels**

Simulated performances displaying the best optimized modulation order in a PSK modulation type of an AWGN channel.

**Table 3: Comparison of Modulation Orders on a PSK Modulation Type in an AWGN channels.**

| $E_b/N_o$ | Bit error ratio at different modulation order | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 8 | 16 | 32 | 64 |
| 0 | 0.0786 | 0.0786 | 0.1227 | 0.1744 | 0.2256 | 0.2651 |
| 1 | 0.0563 | 0.0563 | 0.1008 | 0.1535 | 0.2073 | 0.2497 |
| 2 | 0.0375 | 0.0375 | 0.0806 | 0.1338 | 0.1892 | 0.2345 |
| 3 | 0.0229 | 0.0229 | 0.0622 | 0.1155 | 0.1714 | 0.2194 |
| 4 | 0.0125 | 0.0125 | 0.0459 | 0.0986 | 0.1538 | 0.2043 |
| 5 | 0.0060 | 0.0060 | 0.0319 | 0.0829 | 0.1368 | 0.1895 |
| 6 | 0.0024 | 0.0024 | 0.0205 | 0.0682 | 0.1207 | 0.1747 |
| 7 | 0.0008 | 0.0008 | 0.0120 | 0.0543 | 0.1055 | 0.1599 |
| 8 | 0.0002 | 0.0002 | 0.0062 | 0.0415 | 0.0915 | 0.1452 |
| 9 | 0.0000 | 0.0000 | 0.0027 | 0.0300 | 0.0784 | 0.1307 |
| 10 | 0.0000 | 0.0000 | 0.0010 | 0.0202 | 0.0661 | 0.1165 |
| 11 | 0.0000 | 0.0000 | 0.0003 | 0.0126 | 0.0545 | 0.1030 |
| 12 | 0.0000 | 0.0000 | 0.0001 | 0.0070 | 0.0435 | 0.0903 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0034 | 0.0332 | 0.0785 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0014 | 0.0241 | 0.0675 |
| 15 | 0.0000 | 0.0000 | 0.0000 | 0.0005 | 0.0163 | 0.0572 |
| 16 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0101 | 0.0475 |
| 17 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0056 | 0.0382 |
| 18 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0028 | 0.0295 |

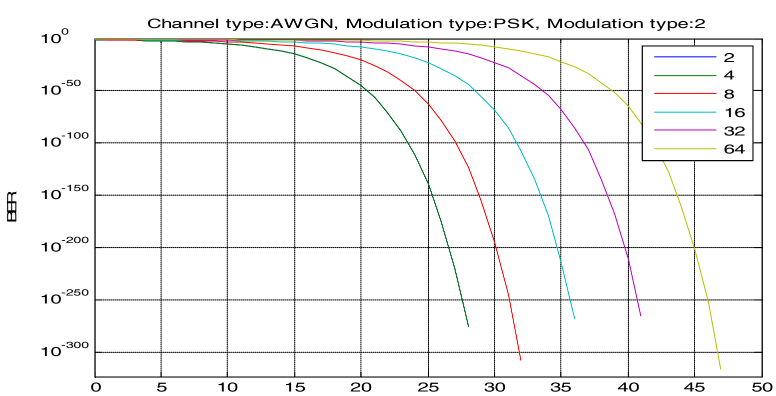



**Fig 8: Modulation orders of PSK modulation type in AWGN channel**

A practical performances of BER on the various modulation order of DPSK to show the best fit modulation order of an AWGN channel in WCDMA.

**Table 4: BER of AWGN channel at various modulation orders of DSPK modulation type.**

| $E_b/N_o$ | Bit error ratio at different modulation order | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 8 | 16 | 32 | 64 |
| 0 | 0.1839 | 0.1639 | 0.1967 | 0.2431 | 0.2822 | 0.3043 |
| 1 | 0.1420 | 0.1303 | 0.1688 | 0.2190 | 0.2629 | 0.2954 |
| 2 | 0.1025 | 0.0993 | 0.1433 | 0.1956 | 0.2440 | 0.2802 |
| 3 | 0.0680 | 0.0719 | 0.1200 | 0.1733 | 0.2255 | 0.2651 |
| 4 | 0.0406 | 0.0487 | 0.0987 | 0.1523 | 0.2074 | 0.2499 |
| 5 | 0.0212 | 0.0305 | 0.0790 | 0.1328 | 0.1893 | 0.2347 |
| 6 | 0.0093 | 0.0172 | 0.0609 | 0.1149 | 0.1714 | 0.2195 |
| 7 | 0.0033 | 0.0086 | 0.0446 | 0.0983 | 0.1538 | 0.2044 |
| 8 | 0.0009 | 0.0036 | 0.0306 | 0.0827 | 0.1367 | 0.1896 |
| 9 | 0.0002 | 0.0013 | 0.0194 | 0.0681 | 0.1206 | 0.1748 |
| 10 | 0.0000 | 0.0003 | 0.0111 | 0.0542 | 0.1055 | 0.1601 |
| 11 | 0.0000 | 0.0001 | 0.0056 | 0.0413 | 0.0915 | 0.1453 |
| 12 | 0.0000 | 0.0000 | 0.0024 | 0.0298 | 0.0784 | 0.1308 |
| 13 | 0.0000 | 0.0000 | 0.0009 | 0.0201 | 0.0662 | 0.1166 |
| 14 | 0.0000 | 0.0000 | 0.0002 | 0.0124 | 0.0546 | 0.1030 |
| 15 | 0.0000 | 0.0000 | 0.0000 | 0.0069 | 0.0436 | 0.0904 |
| 16 | 0.0000 | 0.0000 | 0.0000 | 0.0034 | 0.0333 | 0.0786 |
| 17 | 0.0000 | 0.0000 | 0.0000 | 0.0014 | 0.0241 | 0.0676 |
| 18 | 0.0000 | 0.0000 | 0.0000 | 0.0005 | 0.0163 | 0.0573 |

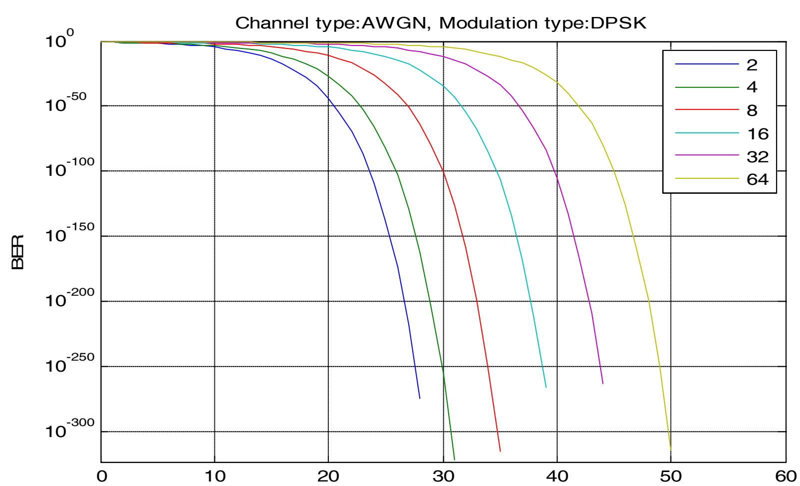



**Fig 9: Performance comparison of different DPSK modulation orders in an AWGN channel.**

BER of Input signal to noise signal AWGN channel at FSK modulation at different modulation orders

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**Table 5: BER of AWGN channel at various modulation orders of FSK modulation type.**

| $E_b/N_o$ | Bit error ratio at different modulation order | | | | |
|---|---|---|---|---|---|
| | 2 | 4 | 8 | 16 | 32 |
| 0 | 0.3033 | 0.2293 | 0.1947 | 0.1747 | 0.1610 |
| 1 | 0.2664 | 0.1848 | 0.1456 | 0.1217 | 0.1047 |
| 2 | 0.2264 | 0.1399 | 0.0992 | 0.0747 | 0.0580 |
| 3 | 0.1844 | 0.0977 | 0.0598 | 0.0389 | 0.0260 |
| 4 | 0.1424 | 0.0616 | 0.0308 | 0.0163 | 0.0088 |
| 5 | 0.1029 | 0.0339 | 0.0129 | 0.0051 | 0.0021 |
| 6 | 0.0683 | 0.0158 | 0.0041 | 0.0011 | 0.0003 |
| 7 | 0.0408 | 0.0059 | 0.0010 | 0.0002 | 0.0000 |
| 8 | 0.0213 | 0.0017 | 0.0001 | 0.0000 | 0.0000 |
| 9 | 0.0094 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| 10 | 0.0034 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 11 | 0.0009 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 15 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

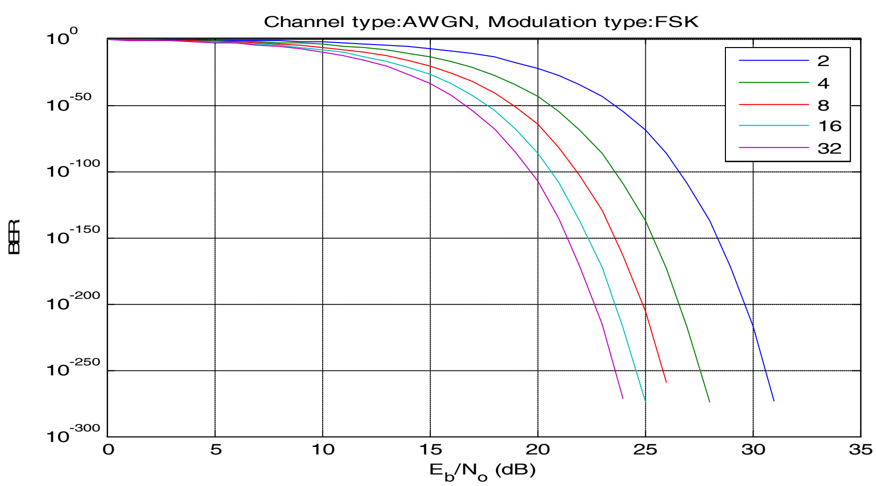


**Fig 10: performance comparison of different FSK modulation orders in an AWGN channel.**

**Performances comparison of Modulation Types on Modulation Orders of AWGN Channel**

The performance comparison of different modulation types such as PSK, DPSK and FSK is implemented on the different modulation orders such as: modulation order of 2, 4, 8, 16, 32 and 64 in an AWGN channel of WCDMA.

**Table 4.6: Performance of different modulation types in AWGN channels at order of 2.**

| $E_b/N_o$ | Bit error ratio at different modulation types | | |
|---|---|---|---|
| | PSK | DPSK | FSK |
| 0 | 0.0786 | 0.1839 | 0.3033 |
| 1 | 0.0563 | 0.1420 | 0.2664 |
| 2 | 0.0375 | 0.1025 | 0.2264 |
| 3 | 0.0229 | 0.0680 | 0.1844 |
| 4 | 0.0125 | 0.0406 | 0.1424 |
| 5 | 0.0060 | 0.0212 | 0.1029 |
| 6 | 0.0024 | 0.0093 | 0.0683 |
| 7 | 0.0008 | 0.0033 | 0.0408 |
| 8 | 0.0002 | 0.0009 | 0.0213 |
| 9 | 0.0000 | 0.0002 | 0.0094 |
| 10 | 0.0000 | 0.0000 | 0.0034 |
| 11 | 0.0000 | 0.0000 | 0.0009 |
| 12 | 0.0000 | 0.0000 | 0.0002 |
| 13 | 0.0000 | 0.0000 | 0.0000 |
| 14 | 0.0000 | 0.0000 | 0.0000 |
| 15 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.0000 | 0.0000 | 0.0000 |

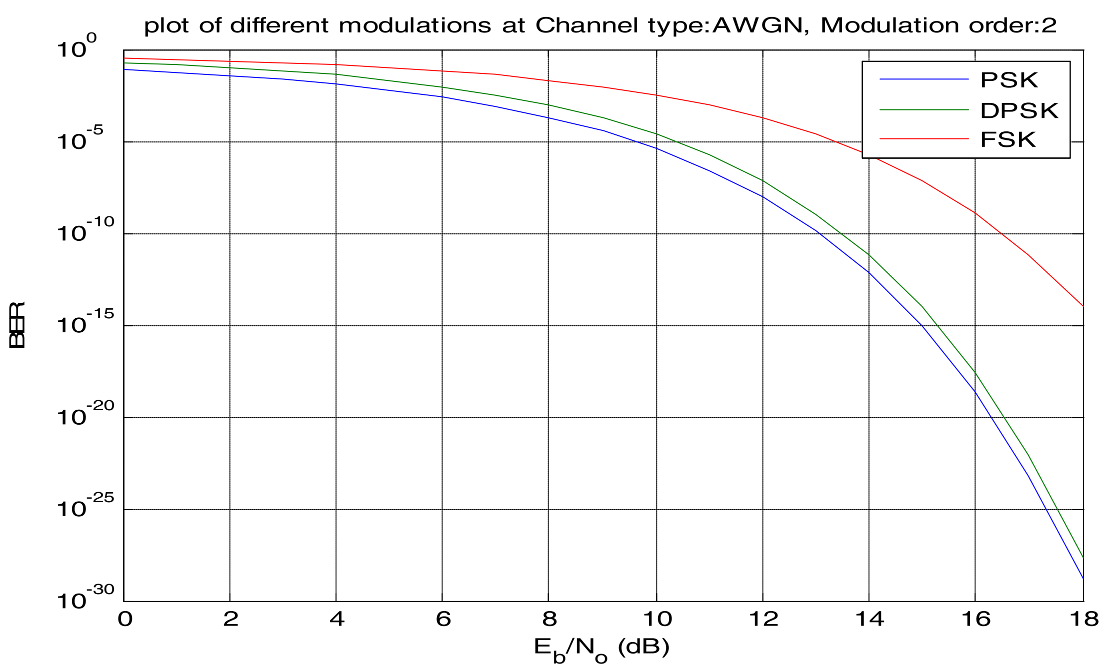


**Figure 11: Performance of PSK, DPSK and FSK in modulation order of 2.**

## 8. RESULTS AND DISCUSSION

Based on the generated data by the computer simulation of wireless digital signal of a communication system such as the WCDMA, the models and the model relationship using modulation orders of 2, 4, 8, 16, 32 and 64 on PSK, DPSK and FSK modulation techniques of both AWGN and Rayleigh channels between BER as a function of the parameters shown in all the tables of chapter four. The simulation is followed by using m file. In this approach, the simulation is successfully done by using PSK, DPSK and FSK modulation techniques. The desired BER graphs obtained for simulation in AWGN and Rayleigh channels.

### 8.1 The Performance Result of BER in an AWGN Channel

In the AWGN; PSK has six modulation orders, DPSK also has six modulation orders but FSK has only five modulation orders. In table 3 and fig 1, it is observed that the modulation order of 4 is the best while modulation order of 64 has the worst BER. In table 4 and figure 2, the modulation order of 2 is the best whereas modulation order of 64 has the worst case scenario. In table 5 and figure 2, the highest modulation order which is 32 has the best BER while the lowest modulation order has the worst BER.

### 8.2 Performance Comparison in an AWGN Channel

In the performances comparison of the different modulation types; it is observed that PSK has the best BER in modulation order of 2 and 4 and the worst is DSPK respectively. FSK has the best BER in modulation order of 8, 16 and 32 and the worst is DSPK. In order to predict the best and optimized BER at a specified error signal, PSK is the best followed by DPSK.

### 8.3 Performance Comparison in a Rayleigh Channel

In the performances comparison of the different modulation types; it is observed that PSK has the best BER in modulation order of 2 and 4 and 8, the worst are FSK and DSPK respectively. Whereas in the modulation order of 16 and 32, has the best BER and the worst BER is DPSK.

### 8.4 Performance Results on Both Channels

The desired BER graphs are obtained for simulation in AWGN and in a Rayleigh channels. PSK and DPSK modulation techniques in AWGN channel has good performances while FSK has the worst when it is compared to that of Multipath Rayleigh channel in the lowest modulation order. Also, the performance of PSK and FSK degrades when the channel is subjected to Multipath fading with increasing value of Doppler shift (Hz).
In other words, it performs poorly as the speed of mobile terminal is increased. Moreover, the system performs badly as the number of users is increased. Comparison between PSK and FSK modulation schemes shows that FSK performs very poorly in the lower modulation orders and performs better in the highest modulation order of both AWGN (LOS channel) and Multipath Rayleigh fading channel.

The simulation of DPSK shows that it neither has the best or the worst case BER among the modulation techniques. It is suspected that the degradation of the modulation techniques is because the variation of amplitude with phase causes errors in the constellation of the wireless digital signal. The reason behind the poor performances of DPSK and FSK of W-CDMA system in multipath fading channel is basically due to the interference between adjacent carriers phase in the constellation of these modulation techniques.

**9. CONCLUSION**

In this research work, we have presented experimental results from a practical study for understanding the key performance parameters of bit errors and how to manage them in order to obtain an optimum and efficient digital signal for a wireless network. An example is the characteristics of bit error ratio of IEEE 802.11 transmissions. We have identified two major communication channels such as: AWGN channel and Multipath Rayleigh channel, it discusses the three modulations techniques which are PSK, DPSK and FSK and on different modulation orders to enable a proper performance comparison to find a suitable BER. As a result of the lack of detailed knowledge of how the hardware vendors implement their WLAN chips, it is difficult to pinpoint the exact causes of the bit error patterns that we have discovered from our experiments. However, we believe that identifying repeatable and predictable bit error patterns that are caused by hardware, not induced by channel fading, it is important in itself because the patterns may provide valuable insights for modeling sub-frame bit errors.

Bit Error Rate Testing (BERT), is a powerful tool for end to end testing of digital transmission systems. A BER test provides a measurable and useful indication of the performance of the system that can be directly related to its operational performance. If the BER rises too high then the system performance will noticeably degrade. If it is within limits then the system will operate satisfactorily. Numerical simulation shows a noticeable improvement of the system BER after optimization of the suggested processing operation on the detected electrical signals at central wavelengths, the optimum solution is to reduce the bit error rate by testing and comparing the various modulation techniques.

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