BER Improvement of DS-CDMA System under AWGN and Rayleigh Fading channel with various Spreading Codes.

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Abstract : In a wireless mobile communication system, a signal can travel from transmitter to receiver over multiple reflective paths; this phenomenon is referred to as multipath propagation. The distortion of signals caused by multipath is known as fading. This multipath propagation causes the signal at the receiver to distort and fade significantly, decreasing signal to noise ratio hence leading to higher bite error rate. In this paper the work focuses on to improve the BER in a multipath fading channel. SNR is an indicator commonly used to evaluate the quality of communication link. BER is inversely proportional to SNR so high SNR results in low BER and vice versa. For reliable communication system, its BER should be as low as possible. In this paper,the work is done on BER performance of DS-CDMA for spreading codes Gold, Kasami and maximum length sequence code under AWGN and Rayleigh fading channel for BPSK and DPSK modulation schemes The MATLAB code is used for simulation to obtain the results.It was found that BER is minimum for AWGN channel compared to Rayleigh fading channel.

Index Terms–BER, DS-CDMA, Fading, Multipath Fading Channel, Spreading Codes, SNR.

I.INTRODUCTION

As wireless communication becomes a worldwide communication standard for transmitting the data, the major challenge is to convey the information as efficiently and reliably as possible through the limited bandwidth. There is always more than one propagation path in between each transmitter and receiver. Transmitted signals arrive at the receiver via a direct path which is known as Line of Sight (LOS) and through multiple paths by the reflection, scattering and diffraction of surrounding things such as buildings, trees or any obstacles. Fading is another channel impairment faced by multipath channel. This "multipath fading" occurs as general multipath components that arrive with various phases and at some of the points in free space, the components cancel each other, which cause deep fades in the received signal level. So when simultaneous multiple communications are carried out, then in the multipath environment, the interference causes from different directions will also increase respectively. This multipath propagation results in the signal, present at the receiver side to distort and fade significantly, reducing Signal to Noise Ratio (SNR) hence leading to higher Bit Error Rate (BER). BER is used to check the performance of wireless communication system which measures the reliability of that communication system [2].

CDMA is a well-known radio communication technique to allow multiple users to share the same spectrum simultaneously. Direct Sequence Code Division Multiple Access (DS-CDMA) is the most popular of CDMA techniques. The DS-CDMA transmitter multiplies each user's signal by a distinct code waveform. The detector receives a signal composed of the sum of all users' signals, which overlap in time and frequency. In a conventional DS-CDMA system, a particular user's signal is detected by correlating the entire received signal with that user's code waveform. It is difficult to judge the number of path at receiver and then allocate them the number of correlators. In a wireless communication system, a signal goes from transmitter to respective receiver over multiple reflective paths and this phenomenon is referred to as multipath propagation.

The distortion of many signals caused by multipath is known as fading and due to fading in a wireless communication system, the signal received with multiple numbers with deep fade then received power is less than noise power hence performance of wireless system is not good i.e. BER is greater[3] .

In this paper, DS-CDMA system is implemented with Gold, Kasami and Maximum length sequence code under AWGN and Rayleigh channel for BPSK and DPSK modulation schemes. The remainder of this paper is organized as follows: Section II, explain system architecture for DS-CDMA system with various fading channels.Section III explain methodology. Section IV explains various spreading codes. Section V deals with simulation results and VI draws some conclusions.

II.SYSTEM ARCHITECTURE

The framework outline for performance examination of DS CDMA with various fading channels is as shown in figure 1. At the transmitter, the data is encoded utilizing codes. The encoded data is then change into an information modulated symbol arrangement with a base band modulator. The modulated symbol arrangement is spread in time space by a chip sequence of PN code generator, generally Walsh code and PN succession. The data is moulded and gone through channel for transmission. At the beneficiary end, the data is increased with chip grouping by the connections in the recipient. The data is then summed and increased by nearby created spreading code, which is de spreading. The data is demodulated and decoded and unique information can be recuperated.

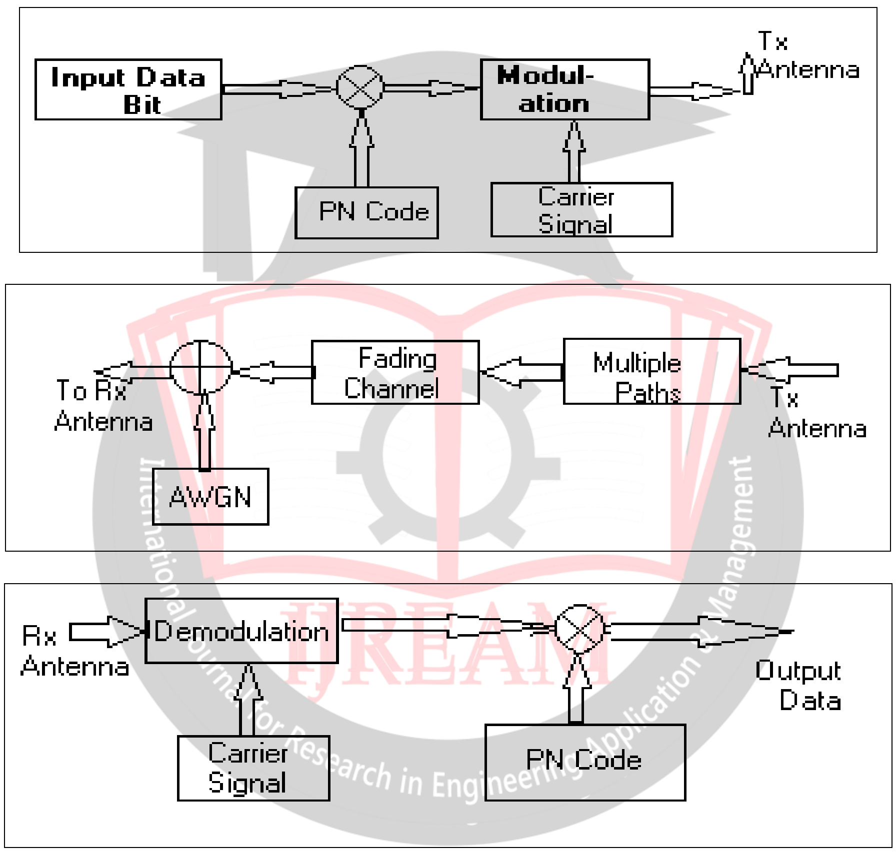


Figure 1: System Architecture

III.RESEARCH METHODOLOGY

Modulation is an important step of communication framework The easiest way to send the low frequency signal over long distance is to change a transmittable signal according to the information in the message signal. This alteration is called modulation and it is the modulated signal that is transmitted. The receiver then recovers the original signal through a process called demodulation. Modulation techniques are expected to have three positive properties:

Good Bit Error Rate performance: Modulation schemes should achieve low BER (Bit Error Rate) in the presence of fading, Doppler spread, interference and thermal noise.

Power Efficiency: Saving of power is one of the critical design challenges in portable and mobile applications. Nonlinear amplifiers are usually used to increase power efficiency. However, nonlinearity may degrade the BER performance of some modulation schemes. Constant envelope modulation techniques are used o prevent the re growth of spectral side lobes during nonlinear amplification.

Spectral Efficiency: The modulated signals power spectral density should have a narrow main lobe and fast roll-off of side lobes. Spectral efficiency is measured in units of bit/sec/Hz.

Digital Modulation:

The modulation scheme is used to map the coded bits to a form that can be effectively transmitted over the communication channel. The digital modulation converts the digital information signal into the signal which can be transferred to the communication channel. In this paper, BPSK and DPSK modulation schemes are tested. In digital modulation, analog carrier is modulated by modulated by a discrete signal. Digital modulation methods can be considered as digital-to-analog conversion, and corresponding demodulation or detection as analog - to - digital conversion. The changes in the carrier signal are chosen from a finite number of M alternative symbol (the modulation alphabet).If the alphabet consist of M= 2N alternative, each symbol represents a message consisting of N bits. The digital modulation schemes can be categorized basically either on the basis of their detection characteristics or in terms of their bandwidth compaction characteristics. The basic criteria for best modulation scheme depends on BER, SNR(Signal to Noise Ratio), available Bandwidth, power efficiency, better Quality of Service and cost effectiveness. The performance of each modulation scheme is measured by estimating its probability of error with an assumption that system are operating with Additive White Gaussian Noise. Modulation methods which are capable of transmitting more bits per symbol are more immune to error caused by noise and interference induced in the channel. The delay distortion can be an important measure while deciding modulation scheme for digital radio.

Bit Error Rate (BER):

The BER, or quality of the digital link, is calculated from the number of bits received in error divided by number of bits transmitted.

$$BER = \frac{(Bits in Error)}{(Total Bits Sent)} \qquad \text{-----------} \qquad (1)$$

In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors. The BER is the number of bit errors divided by the total number of transferred bits during a particular time interval.BER is a unit less performance measure often expressed as a percentage.

Signal to Noise Ratio (SNR):

SNR is the ratio of the received signal strength over the noise strength in the frequency range of the operation. Noise strength, in general, can include the noise in environment and other unwanted signals (interference).BER is inversely related to SNR, i.e. high BER causes low SNR. High BER causes increase packet loss, increase in delay and decreases throughput [7] [8]. The exact relation between the SNR and the BER is not easy to determine in multichannel environment. SNR is an indicator commonly used to evaluate the quality of communication link and measured in decibels and represented as

$$SNR = 10\log_{10}\frac{Signal Power}{Noise Power} \qquad \text{------------} \qquad (2)$$

SPREADING CODES

Various spreading codes used for checking BER performance of DS-CDMA system are as below:

Gold Code:

A Gold code that is also known as Gold sequence, it is a type of binary sequence which is generally used in satellite navigation (GPS) and telecommunication (CDMA).Gold codes are named after scientist Robert Gold. The Gold codes are having bounded small crosscorrelations within a particular set, which is required when multiple devices are broadcasting in the similar frequency range and a set of Gold sequences consists of 2n− 1 sequences, whereas each one having a time period of 2n – 1 .Gold codes can be created with the following mentioned steps i.e. take two maximum length sequences having the same length of 2n− 1 in such a way that their absolute cross-correlation is not greater than or equal to 2(n+2)/2, where n indicates size of the LFSR which is required to generate the maximum length sequence and the set of the 2n−1 Ex-ORs of the two sequences in their different phases (i.e. translated into all corresponding relative positions) is actually a set of Gold codes and the highest absolute value of cross-correlation in this set of obtained codes is determined by (2(n+2)/2 + 1) for even n and that is (2(n+1)/2 + 1) for odd n. The Ex-OR of two various Gold codes from the similar set is another Gold code so within a given set of Gold codes almost half of the codes are balanced one and the number of 1's and 0's varies by only one [11][14].

Kasami Code:

Kasami sequences are actually binary sequences that having length of 2N-1, where N is an even integer and Kasami sequences have good cross-correlation values that approaches the Welch lower bound. There are generally two types of Kasami sequences: one is the small set and the another is large set and the process of generating a Kasami sequence which is initiated by creating a maximum length sequencex(n), here value of n=1…. 2N-1. Maximum length sequences are generally periodic sequences with a time period of exactly 2N-1 and a secondary sequence is obtained from the initial sequence by cyclic decimation sampling as b(n) = x(q*n), where q = 2N/2+1 and newly generated sequences are then created by simply adding x(n) sequence and cyclically time shifted versions of b(n) by using mod-two arithmetic that is also called as the Ex-OR operation[11][14] .

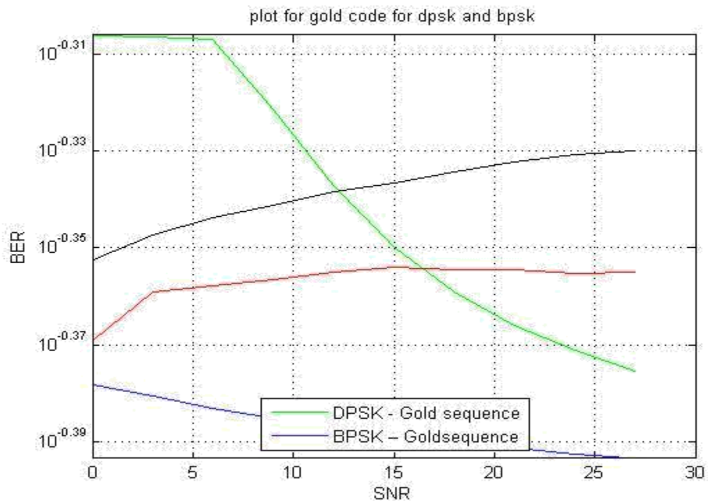
Pseudo Noise sequence code:

A maximum length sequence (MLS) is actually a type of PN binary sequence and they are the bit sequences that are created by using maximal linear feedback shift registers (LFSRs) and they are periodic and regenerate every binary sequence that can be given by the shift registers (means for length-n registers they produce a sequence of length 2n − 1). An MLS is known as n-sequence. Generally, MLSs are having flat spectrum but with the exception of a near-zero DC value. Practical applications for MLS are the measurement of impulse responses (example of room reverberation) and also it can be used to derive pseudo-random sequences in digital communication direct sequence spread spectrum (DS-SS) and frequency-hopping spread spectrum transmission systems [14].

IV.RESULTS AND DISCUSSION

BPSK and DPSK symbols are used for the simulation. These symbols are spread with the spreading code sequences. The simulation results are obtained using kasami code, Gold Code and PN code with AWGN channel and Rayleigh fading channel.

The performance of DS-CDMA system with gold code under AWGN and Rayleigh fading channel for single user using BPSK and DPSK modulation scheme is as shown in figure 2. It is noted that for AWGN channel, BER is less for BPSK modulation than that of DPSK modulation scheme and the performance of AWGN channel is found to be better than than that of Rayleigh fading channel. Moreover, the nature of plot is steep for Rayleigh fading channel.

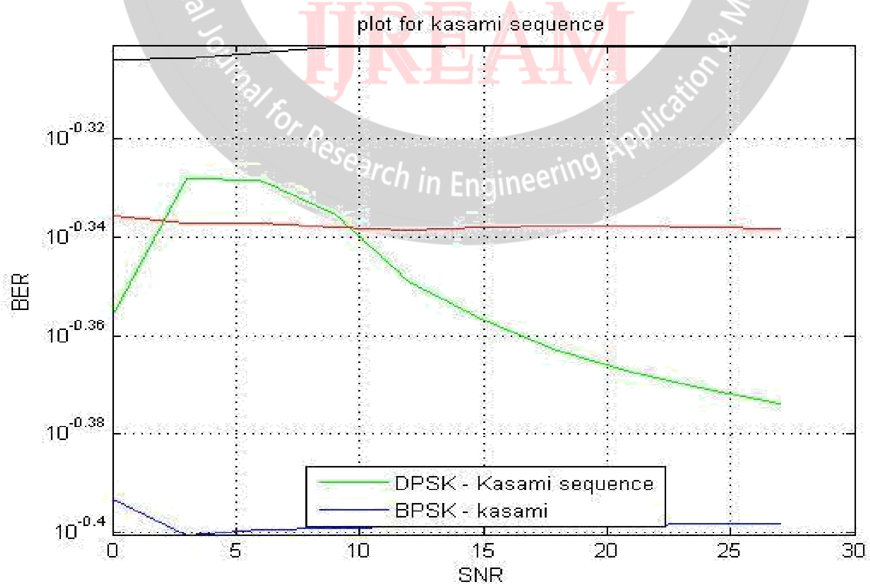


AWGN channel
---- Gold code with DPSK
---- Gold code with BPSK

Rayleigh channel
--- Gold code with DPSK
--- Gold code with BPSK

Figure 2: Performance Of DS-CDMA System With Gold Code Under AWGN and Rayleigh Fading Channel For Single User Using BPSK And DPSK Modulation Scheme.

The performance of DS-CDMA system with kasami code under AWGN and Rayleigh fading channel for single user using BPSK and DPSK modulation scheme is as shown in figure 3.It is observed that under AWGN channel with BPSK modulation offers good results as compared to that of DPSK, BER remains same for a wide range of SNR. For Rayleigh channel, BER is slightly less for DPSK than that of BPSK and for both modulation schemes nature of BER is almost linear for some range of SNR.Thus if we compare kasami code with respect to fading channels irrespective of modulation scheme, we observe that for AWGN channel BER performance is better than that of Rayleigh fading channel.

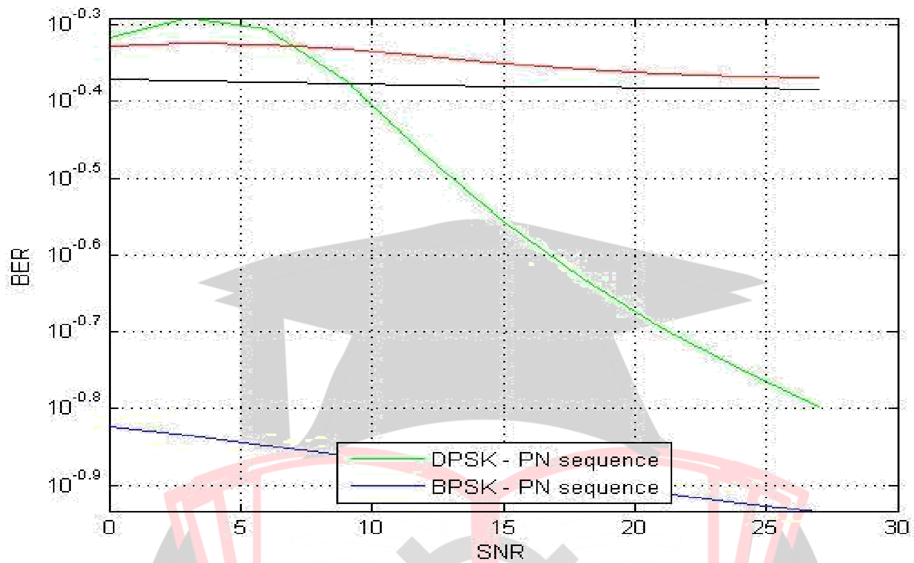


AWGN channel
----Kasami code with DPSK
----Kasami code with BPSK

Rayleigh channel
---- Kasami code with red DPSK
---- Kasami code with BPSK

***Figure 3: The Performance of DS-CDMA System With Kasami Code Under AWGN And Rayleigh Fading Channel For Single User Using BPSK And DPSK Modulation Scheme*.**

The performance of DS-CDMA system with PN code under AWGN and Rayleigh fading channel for single user using BPSK and DPSK modulation scheme is as shown in figure 4.It is observed that under AWGN channel BER is minimum for BPSK modulation and hence preferred. For Rayleigh channel, BER is less using BPSK than that of DPSK modulation method.

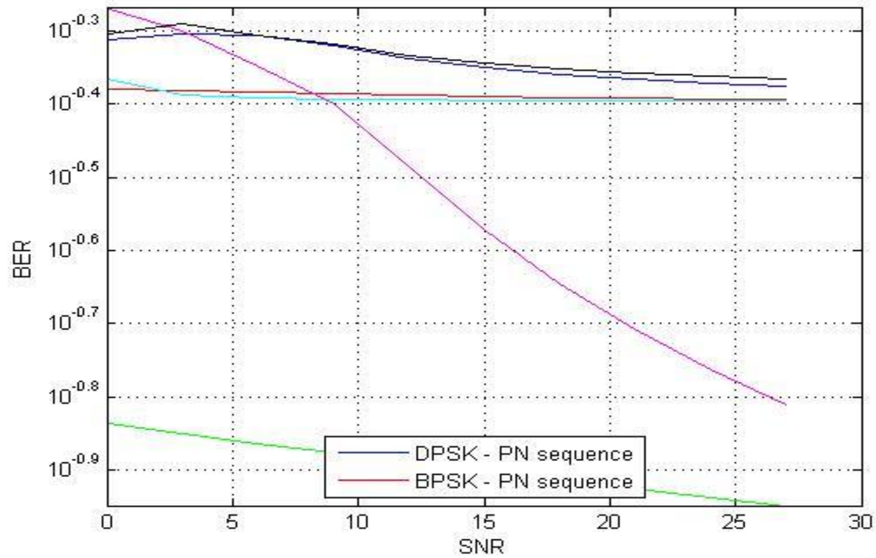


AWGN channel
---- PN code with DPSK
---- PN code with BPSK

Rayleigh channel
----PN code with DPSK
---- PN code with BPS

Figure 4: The Performance Of DS-CDMA System With PN Code Under AWGN and Rayleigh Fading Channel for Single User using BPSK and DPSK Modulation Scheme.

The performance of DS-CDMA system with Gold code, Kasami code and PN code under AWGN channel for single user using BPSK and DPSK modulation scheme is as shown in figure 5.



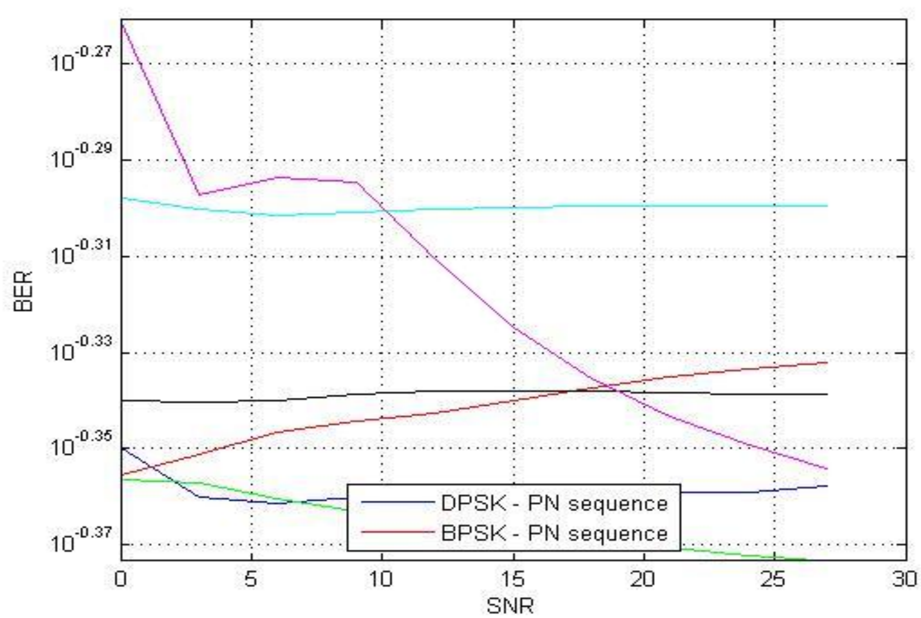
AWGN channel Rayleigh channel

---- Kasami Code with DPSK ---- Gold code with DPSK ---- PN code with DPSK

---- Kasami Code with BPSK ---- Gold Code with BPSK ---- PN code with BPSK

Figure 5: The Performance Of DS-CDMA System With Gold Code, Kasami Code And PN Code Under AWGN Channel For Single User Using BPSK And DPSK Modulation Scheme.

It is found that BER is less for PN sequence rather than other two sequences using BPSK modulation scheme. The performance of DS-CDMA system with Gold code, Kasami code and PN code under Rayleigh fading channel for single user using BPSK and DPSK modulation scheme is as shown in figure 6. By observing the plot for Rayleigh fading channel with kasami, gold and PN code, it is noted that BER is less for PN code compared to other two codes using BPSK modulation scheme.



----Kasami Code with DPSK ---- Gold code with DPSK ---- PN code with DPSK

---- Kasami Code with BPSK ---- Gold Code with BPSK ---- PN code with BPSK

Figure 6: The Performance Of DS-CDMA System Withgold Code, Kasami Code And PN Code under Rayleigh Fading Channel For Single User Using BPSK And DPSK Modulation Scheme

V.CONCLUSIONS

In telecommunication field the major challenges is to convey the information as efficiently as possible through limited bandwidth, though the some of the information bits are lost in most of the cases and signal which is sent originally will face fading. To reduce the bit error rate the loss of information and signal fading should be minimized.We have check the BER performance of DS-CDMA system with spreading codes like Gold, Kasami and PN code under AWGN and Rayleigh fading channel for single user using BPSK and DPSK modulation schemes. The performance of DS-CDMA system in AWGN channel shows that BER is minimum with PN code using BPSK modulation scheme and hence reliable. Also we observe that BER is minimum for BPSK than that of DPSK modulation with PN code in AWGN and Rayleigh fading channel for single user.

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