MODELLING OF A CDMA2000 TO EMULATE A WIRELESS CHANNEL

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ABSTRACT

This work deals on simulation and evaluation of the performance of physical layer of wireless communication system of CDMA-2000 requirement using radio configuration-3 under forward fundamental channel 1x in terms of bit error rate (BER) by using MATLAB 7.9.0 (2009b). Built-in functions in MATLAB 7.9.0(2009 b) version were used to achieve this. A signal simulator was employed according to the physical layer requirement of the IMT-2000 CDMA system. The data was transmitted in a frame-by-frame basis through a time-varying channel. The transmitted signal was degraded by AWGN at the front end of the receiver. A rake receiver was employed at the receiver in order to down samples and de-correlates pilot bits and data. On the basis of simulated result of CDMA2000 Physical layer under AWGN channel it was found out that at gated transmission rate of (1/4) a better system performance was obtained looking at the BER than that at gated transmission rate of (1/2).

Key words: CDMA2000 1x RTT, MATLAB, Simulink, BER

1. INTRODUCTION

In the cellular telephone industry, CDMA is primarily an air- interface and access technique that transmits bits of information through wideband, spread spectrum radio interface that is based on D-SSS (direct sequence spread spectrum) techniques [2]. “CDMA2000 represents a family of standards and it includes, CDMA2000 1X, CDMA2000 1xEv-Do technologies, CDMA2000 1xEV-DO Release 0,CDMA2000

1xEVDO Rev A, CDMA2000 1xEV-DO Rev B, ultra-mobile broadband (UMB)**"[1]** . "IS-95 transmission protocol employs CDMA and evolution form IS-95A to IS-95B to CDMA2000"[1], [3] Strict power control, soft handoffs, spread of the spectrum and error control coding play a very important role in the design and operation of a CDMA-based system. The general trend CDMA IS-95 A works on "GSM, IS-95 B works on GPRS and 1XRTT/3XRt CDMA2000 works on W-CDMA and the technology that worked behind all these standards are TDMA, EDGE and UWC- 136" [1]. Although the air interface is significantly different in the case of CDMA compared with the TDMA technique, the core fixed network infrastructure that supports the wire interface is very similar to the structure of the GSM core network [4]. In fact, the core networks for North American CDMA and TDMA systems are more or less identical [5].

2. RELATED WORKS

[6] in their paper, affirmed that "CDMA2000 RTT provides protocols and services that correspond to the bottom two layers international organization standardization /open systems interconnection (ISO/OSI) Reference model"[13].

[7] In his research, wrote, the physical layer interconnects the device to the physical media. The physical layer is responsible for transmitting and receiving bits over the physical medium. Since the physical medium in this case is over the air, the layer would have to convert bits into waveforms (i. e, modulation) to enable their transmission through air. In addition to modulation, the physical layer also carries out the coding functions at the bit and frame levels [8].

[9] Certified that Cdma2000 is a registered certification mark of the Telecommunications Industry Association (TIA).

[10] suggested in their papers that in order for cdma2000 to be backward compatible with IS-95 networks, its radio interface must retain many of the attributes of the IS-95 air interface design', such as provision of higher data rates through code aggregation and "are achieved through either reduced spreading, or multiple code channels. In addition, there are a number of major enhancements in the cdma2000 physical layer that facilitate advanced data services with higher rates and improved capacity" [11].

3. METHODOLOGY

This study is carried out with MATLAB 7.9.0 (R2009b) which is "MATRIX LABORATORY" in full. In this computer-based design research, the implementation of cdma2000 through an AWGN (Add White Gaussian Noise) channel represented by channel model subsystem, were monitored, and acquisition about its parameters were being measured. Already built functions in this MATLAB were used to achieve this.

The key components of the physical layer are the transmitting base station, channel, and mobile receiver. These three components are represented in the block diagram as shown in Fig 1.which is further subdivided into the block diagram as shown in Fig 2

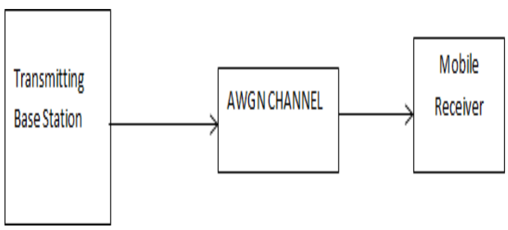


Figure 1 Key components of the CDMA 2000 Physical Layer

The transmitting base station in turn includes the encoder and transmitter, while the mobile receiver includes the decoder and receiver subsystem.

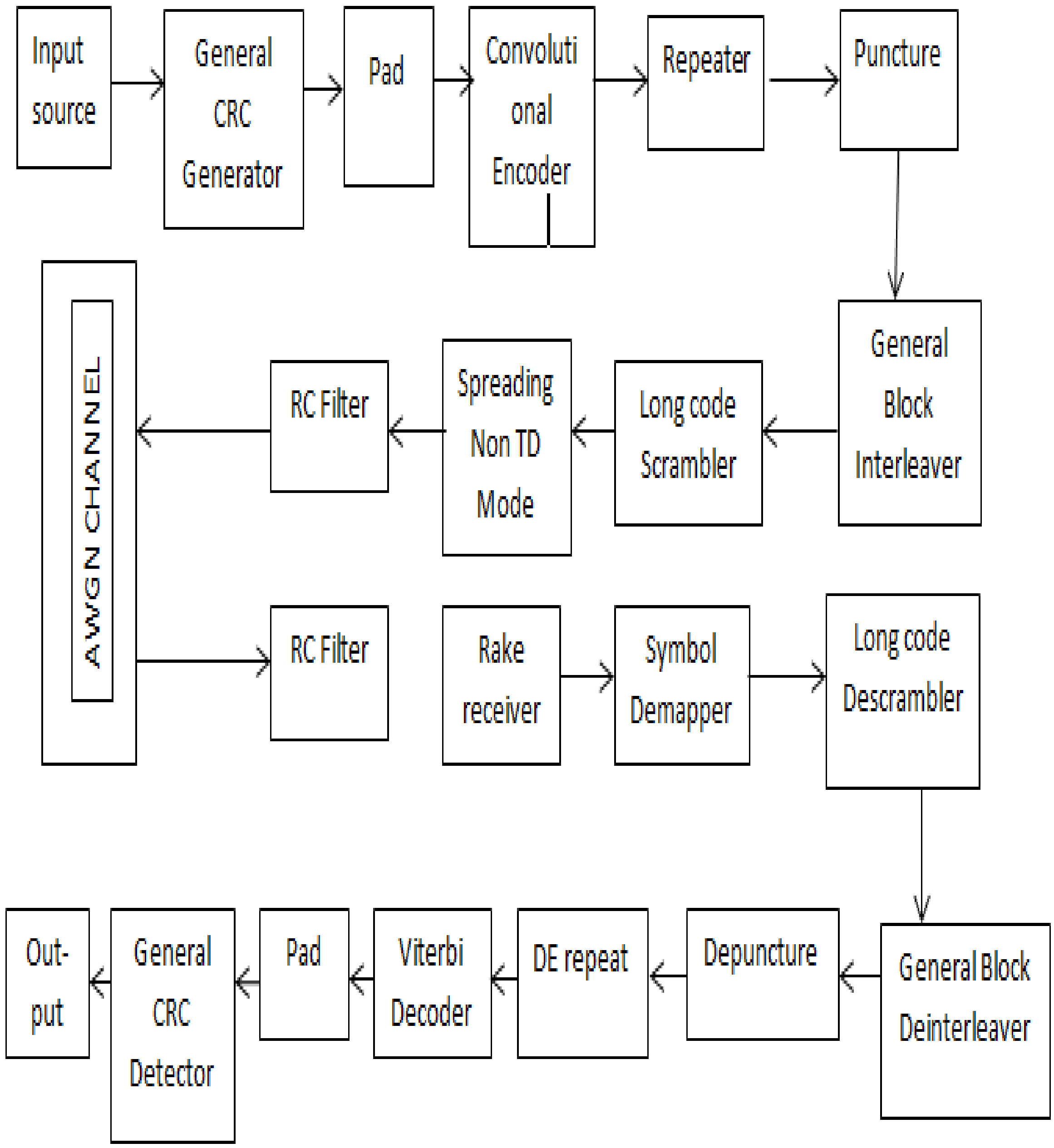


Figure 2 Subdivisions of the CDMA 2000 Physical Layer.

The block diagram represented in Fig 1 was further subdivided into the block diagram represented in Fig 2.

The MATLAB modelling of CDMA2000 Physical layer forward channel is represented in Fig 3.This model carries out the various functionalities represented in Fig 2.

The input source of Fig 2 is equivalent to the Bernoulli binary generator of Fig3.

The general CRC generator, pad, convolutional encoder, repeater, puncture and general block interleaver are all encompassed in the encoding section of the Fig .3.

The long code scrambler, spreading non TD mode and the RC filter of Fig 2 are also encompassed in the transmitter section of Fig 3. The AWGN channel of Fig 2 is equivalent to the channel model of Fig 3.

The AWGN "model does not account for fading, frequency selectivity, interference, nonlinearity or dispersion. Channel capacity C for the AWGN channel is given by" [14]–

$$C = \frac{1}{2}\log\left(1 + \frac{P}{n}\right),$$ Eqn 1

Where P is maximum channel power;

n is variance of noise.

Probability density function of AWGN is given by equation below,

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$ Eqn 2

Where parameter σ is its standard deviation; its variance is therefore σ 2.

The RC filter, Rake receiver, Symbol demapper, and long code descrambler of Fig 2 are all encompassed in the receiving section of Fig.3 and it performs the opposite of the transmitting section function.

The general block interleaver, depuncture, derepeater, Viterbi decoder, pad, general crc detector of Fig 2 is equivalent to the decoding section of the Fig 3.

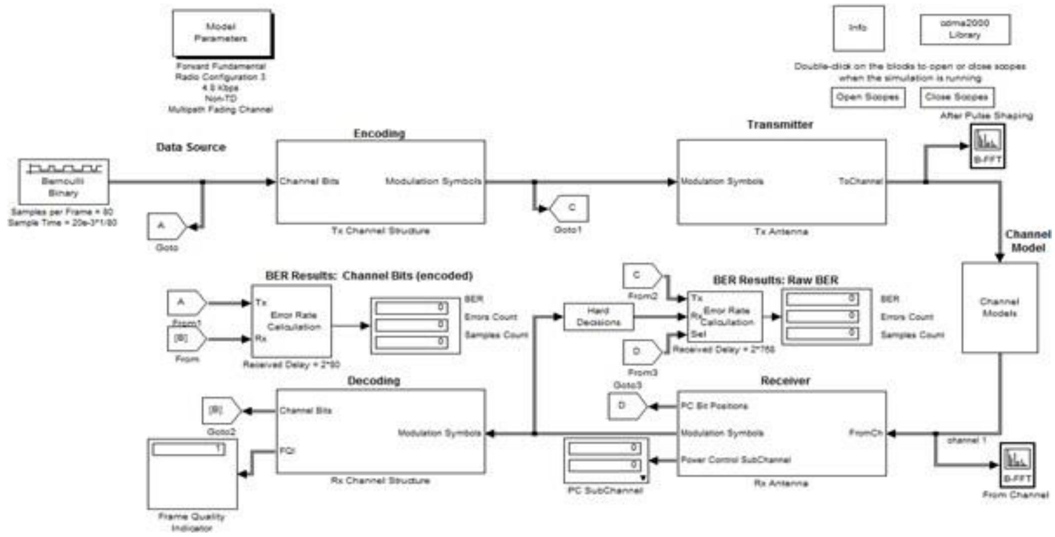


Figure 3 Designed Physical layer forward channel Mode

4. SIMULATION

Base Station simulation

The base station which is the transmitter part of the CDMA2000 model has the following parameters as shown in in Table 1. AWGN (Add White Gaussian Noise) channel which is our model for the block has the following parameters as shown in Table 2. The mobile receiver which is the receiver part of our CDMA2000 model has the following parameters as shown in Table 3

Table 1 Transmitter base station parameter

Parameter	Values	Specification
Probability	0.5	generator
Sample time	20e-3*1/80	generator
samples per frame	80	generator
Generator polynomial	[8 7 4 3 1 0]	CRC generator
Checksums per frame	1	CRC generator
Coding	Convolution	Encoder
Encoder structure	(9, [765 671 513 473])	Encoder
Puncture vector	[1]	Encoder
Forward traffic channel walse code length	256	Tx
Tx rate	¼	Tx
Tx rate	½	Tx
Tx diversity mode	Non-TD	Tx
Channel	AWGN(Eb/No=(1-10)db&1w)	Channel
Rx	Rack receiver	Rx
Decoder	Viterbi	Decoder
Radio configuration	RC-3	CDMA
Traceback depth	30	Decoder

The simulation was carried out under 0.04 MATLAB seconds, at gated transmission rate of ¼ and ½ .The results were recorded at the before decoding and after decoding stages respectively as shown in Table 1, 2, 3 and 4 respectively. A graph of BER against Eb/No was plotted as depicted in Fig 4, 5, 6 and 7 using the results generated from the above simulation.

Table 2 AWGN Channel Parameters

Parameter	Values	Specification
Bit Error Rate (Eb/No)	(1-10) db	Channel
Power	1w	channel

Table 3 Mobile receiver-parameters

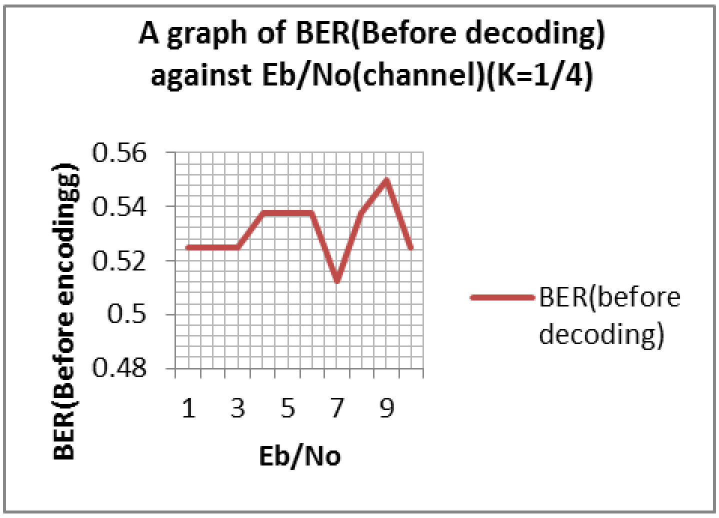
Parameter	Values	Specification
Rx	Rack receiver	Rx
Decoder	Viterbi	Decoder
Radio configuration	RC-3	CDMA

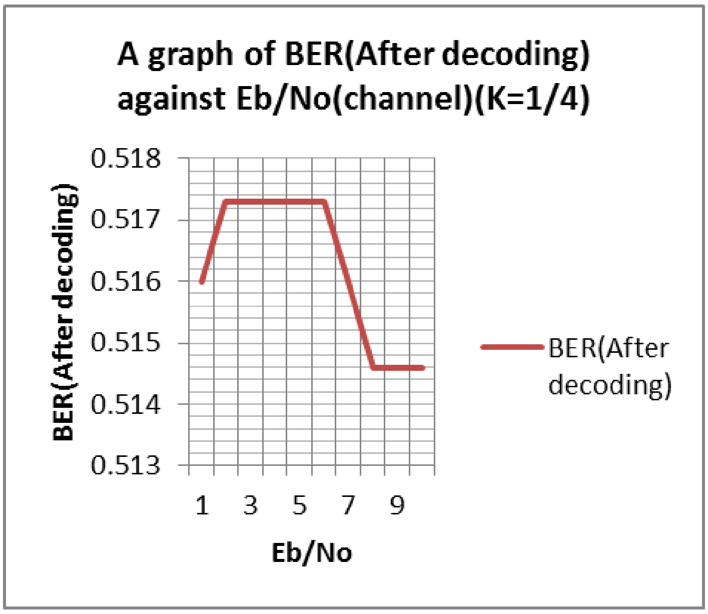
Table 4 BER results before and After decoding at K=1/4

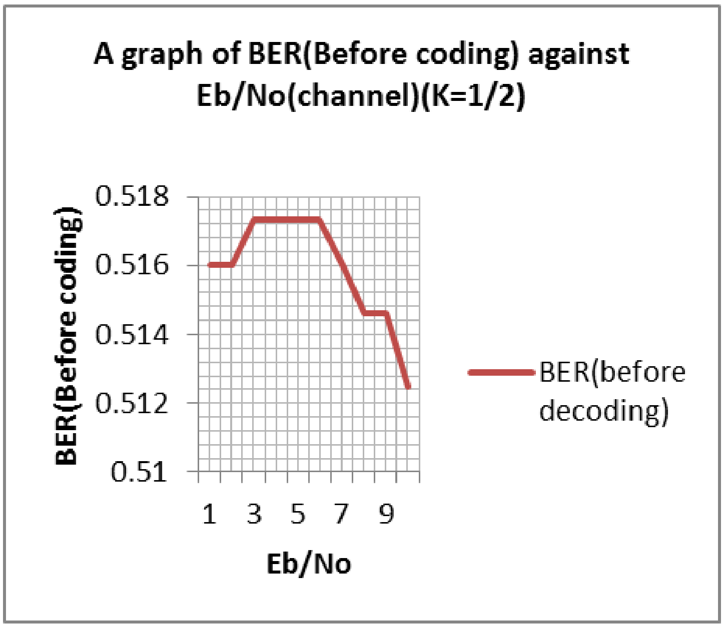
Eb/No(channel)	BER(before decoding)	BER(After decoding)
1	0.525	0.516
2	0.525	0.5173
3	0.525	0.5173
4	0.5375	0.5173
5	0.5375	0.5173
6	0.5375	0.5173
7	0.5125	0.516
8	0.5375	0.5146
9	0.55	0.5146
10	0.525	0.5146

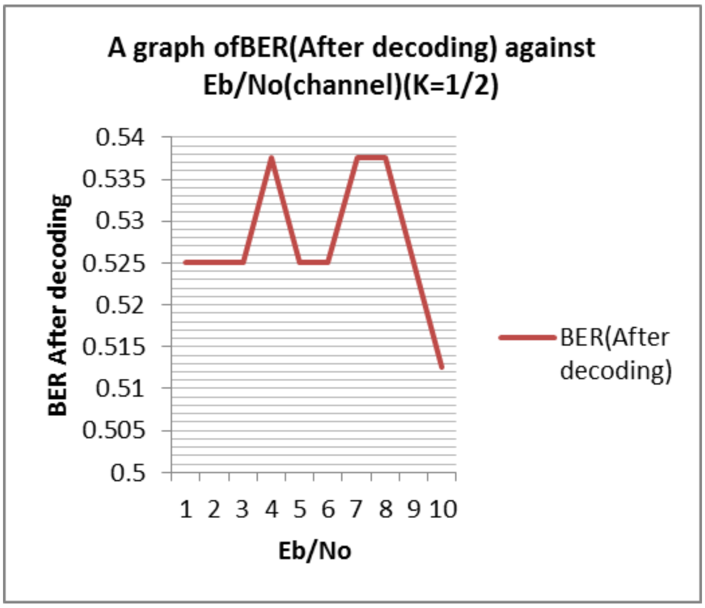
Table 5 BER results before and After decoding at at K=1/2

Eb/No(channel)	BER(before decoding)	BER(After decoding)
1	0.516	0.525
2	0.516	0.525
3	0.5173	0.525
4	0.5173	0.5375
5	0.5173	0.525
6	0.5173	0.525
7	0.516	0.5375
8	0.5146	0.5375
9	0.5146	0.525
10	0.5125	0.5125









5. CONCLUSION

It is observed from the simulation result that the system BER/capacity is restricted by both the channel condition and gated transmission rate. A signal simulator was employed according to the physical layer specification of the IMT-2000 CDMA system. The data was transported in a frame by frame basis through a time-changing medium. The transmitted signal is degraded by AWGN at the front end of the receiver. A rake receiver is used at the receiver in order to down samples and de-correlates pilot bits and data.

As a result of the Matlab/simulink simulation of CDMA2000 Physical layer under AWGN channel it was observed that at gated transmission rate of (1/4) a better system performance was obtained looking at the BER than that at gated transmission rate of (1/2).

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