Volume 3, Issue 2, February 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Determination and Analysis of Bit Error Rate using Theoretical, Semi-Analytic and Monte-Carlo Simulation Method

Er. Jagat Dhiman[1], Er. Bhubneshwar Sharma[2], Er Sukhbir Singh[3]
[1]M.Tech student, Department of ECE
Eternal University, H.P (India)
[2]Assistant Professor, Department of ECE
Eternal University, H.P (India)
bhubnesh86@gmail.com
[3]Lecturer, Department of ECE
Eternal University, H.P (India)

Abstract: **In this research paper, we used three different kinds of methods that are theoretical, semi analytical and Monte Carlo for producing bit error rate analysis. It is possible to evaluate the estimated standard deviation of the measured BER, like in a Monte Carlo simulation, so that it is possible to associate a confidence to the results. We test the methods both in a simple optical system distorted by group velocity dispersion (GVD) and in more complex differential phase shift keying (DQPSK) systems. In the last we measured computational savings up to 70% compared with ordinary methods. E_b/N_0 range in all the below mentioned method is taken as same i.e. 0:17dB, and also modulation type is considered to be DPSK (Differential Phase shift keying) for all methods .Later we plot the bit error rate waveform in all the methods to know variation of BER with respect to E_b/N_0 range. Bit error rate tool can generate a large set of theoretical bit error rate assuming that for all types of modulations. Typically number of error value at least hundred producing accurate bit error rate, if the number of the bit value is so small then the simulation will calculate few errors and error rate might be accurate. Bit error rate runs the simulator function ones for each value of the E_b/N_0 in order to gather bit error rate data. BER tool loads the model into memory which in turn initializes several variables in the MATLAB workspace, runs the simulation once for each value of Eb/N0, and gathers BER data. BER tool creates a list in the data viewer.**

Keywords- Group Velocity Dispersion, Differential Phase shift keying, Differential Quadrature Phase Shift keying.

1. INTRODUCTION

The Error Rate Calculation compares input data from a transmitter with input data from a receiver. It calculates the error rate as a running statistic, by dividing the total number of unequal pairs of data elements by the total number of input data elements from one source. We can compute either symbol or bit error rate, because it does not consider the magnitude of the difference between input data elements. If the inputs are bits, then the block computes the bit error rate. If the inputs are symbols, then it computes the symbol error rate. The bit-error rate is the main performance parameter of a digital communication system [1]. The growing complexity of optical links has increased the impact of nonlinear effects calling for efficient numerical algorithms for BER estimation. One way to lower the spectral noise density is to reduce the bandwidth, but we are limited by the bandwidth required to transmit the desired bit rate (Nyquist criteria).We can also increase the energy per bit by using higher power transmission, but interference with other systems can limit that option [2]. A lower bit rate increases the energy per bit, but we lose capacity. Ultimately, optimizing Eb/No is a balancing act among these factors. The bit error rate is one of the most important quality criteria for digital transmission systems. As many systems are too complex for an analytical derivation, Monte Carlo simulation is often applied for bit error rate estimation. If the transmission system employs a Log APP decoder [3], which outputs the a-posteriori log-likelihood ratio (LLR) of each bit, there are two different methods available. Here in the block diagram given below the message comes from information source which can be measured in bits .Message comes from source information is electrical in nature it will be unsuitable for immediate transmission .On source side there is a transmitter that is a device that makes electrical information suitable for efficient transmission over a given channel .Transmitter modulate or change some parameters like amplitude and frequency .Channel is used to refer the frequency range allocated to particular sequence. Noise may interfere the signal at any point in communication system which will affect when signal is weak [4]. Noise means unwanted energy. Important function of receiver is to demodulate and output of receiver is fed to loudspeaker.

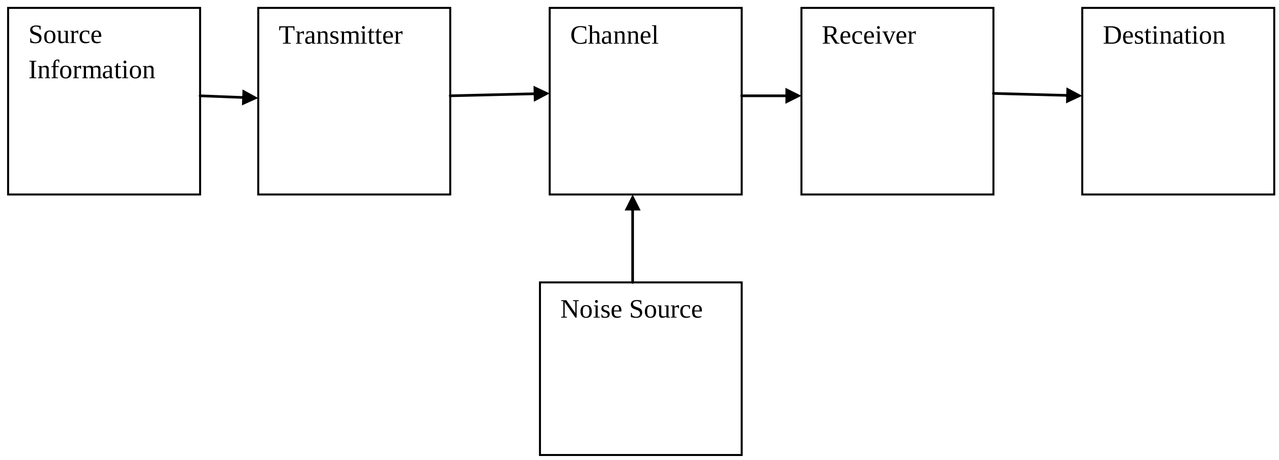

Figure1. Block diagram of Communication System

2. ANALYSIS OF THE BER

The BER may be analyzed using stochastic computer simulations [5].It can be demonstrated with two different definations.

- Binary symmetric channel (used in analysis of decoding error probability in case of non-burst bit errors on the transmission channel)
- Additive white Gaussian noise (AWGN) channel without fading.

A worst case scenario is a completely random channel, where noise totally dominates over the useful signal [6]. This results in a transmission BER of 50% In a noisy channel, the BER is often expressed as a function of the normalized carrier-to-noise ratio measure denoted by E_b/N_0 (energy per bit to noise power spectral density ratio), or Es/N0 (energy per modulation symbol to noise spectral density).Bit error rate may be expressed in mathematical terms as shown below

$$BER_i = 1/2 \mathrm{erfc}\, [\sqrt{E_{b,i}/N_0}] \qquad (1)$$

Table1.Different kinds of modulations and their order.

S.NO	MODULATION	MODULATION ORDER	OTHER CHOICE
1	PSK	2	Diversity order>=1
2	QPSK	4,8,16,32,64 OR high power of 2	Diversity order>=1
3	DPSK	4	Diversity order>=1
4	PAM	2,4,8,16,32,64 or high power of 2	
5	QAM	4,8,16,32,64,128,256,512,1064 or high power of 2	Diversity order>=1
6	FSK	2	Diversity order>=1

People usually plot the BER curves to describe the functionality of a digital communication system. In optical communication, BER (dB) vs. Received Power (dBm) is usually used; while in wireless communication, BER (dB) vs. SNR (dB) is used[7]. Measuring the bit error ratio helps people choose the appropriate forward error correction codes. A more general way of measuring the number of bit errors is the Levenshtein distance.

3. TECHNIQUES FOR FINDING BIT ERROR RATE

SEMI -ANALYTIC METHOD

simulations can improve their speed with a slight degradation in accuracy by using the semi-analytic method. In contrast to the dimensioning process, cell-planning tools perform the calculation based on the Knowledge of the site locations and the intensity of traffic in a given scenario [8]. Hence a slightly more complicated process has to be adopted in order to apply the semi-analytic method in cell-planning tools. Briefly, the statistics of power requirements in each pixel inside the coverage of each sector has to be calculated first, then based on the offered traffic the blocking probability could be calculated [9]. The capacity N is calculated based on the power requirement distribution for a given inter-site distance. By noting that the interference ratio is independent of the inter-site distance, it is possible to incorporate the change in performance due to different inter-site distances by including the effect of thermal noise. Instead of repeating the interference ratio calculation for another inter-site distance, it is possible to correct the interference ratio by Including the thermal noise floor in the calculation [10]. At the end a capacity-coverage trade-off curve can be created.

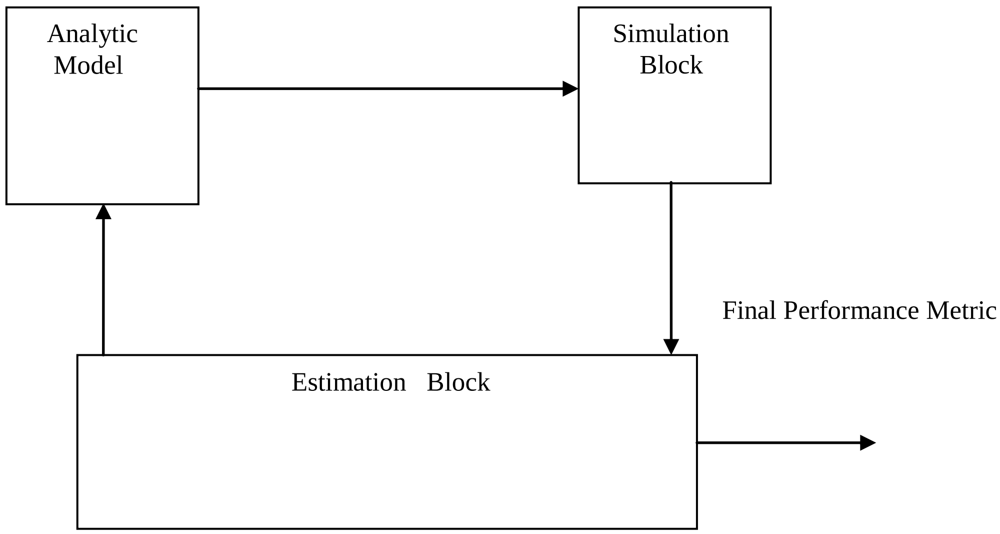

Figure2. Semi Analytic Approach

MONTE CARLO METHOD

Monte Carlo BER estimation can be defined with the help of two different BER samples [11].For determining bit error rate of Transmission system, We have two kinds of BER samples are considered

(a) Hard BER sample

For given signal,

$Z_H = 0$ if $u = \hat{u}$.

$= 1$ if $u \neq \hat{u}$. Where soft output is then reseperented into its sign $\hat{u}$ = sign (L) and its magnitude λ= abs (L)

(b) Soft BER Samples

For given signal,

$Z_S = [1 \div 1+e^{\lambda}]$ where λ is the magnitude and this magnitude represent the reliability.

4. RESULTS AND DISCURSION

BER can also be defined in terms of the probability of error (POE),

$$POE = \tfrac{1}{2}(erf)\sqrt{E_b}/N_0 \qquad (2)$$

Where erf is the error function, Eb is the energy in one bit and No is the noise power spectral density (noise power in a 1 Hz bandwidth) [12]. The error function is different for the each of the various modulation methods. What is more important to note is that POE is proportional to Eb/No, which is a form of signal-to-noise ratio [13]. The energy per bit, Eb, can be determined by dividing the carrier power by the bit rate. As an energy measure, Eb has the unit of joules. No is in power (joules per second) per Hz (seconds), [14] so Eb/No is a dimensionless term, or simply, a numerical ratio.

METHOD1. (THEORETICAL) Consider following specification E_b/N_0 range =0:17dB, Chanel type = AWGN ,Modulation type= DPSK ,Chanel coding = block Coding type = Reed Solomon ,Modulation order =4 , Decision Method = Hard ,N=7 ,K= 4 ,d_{min} =4.

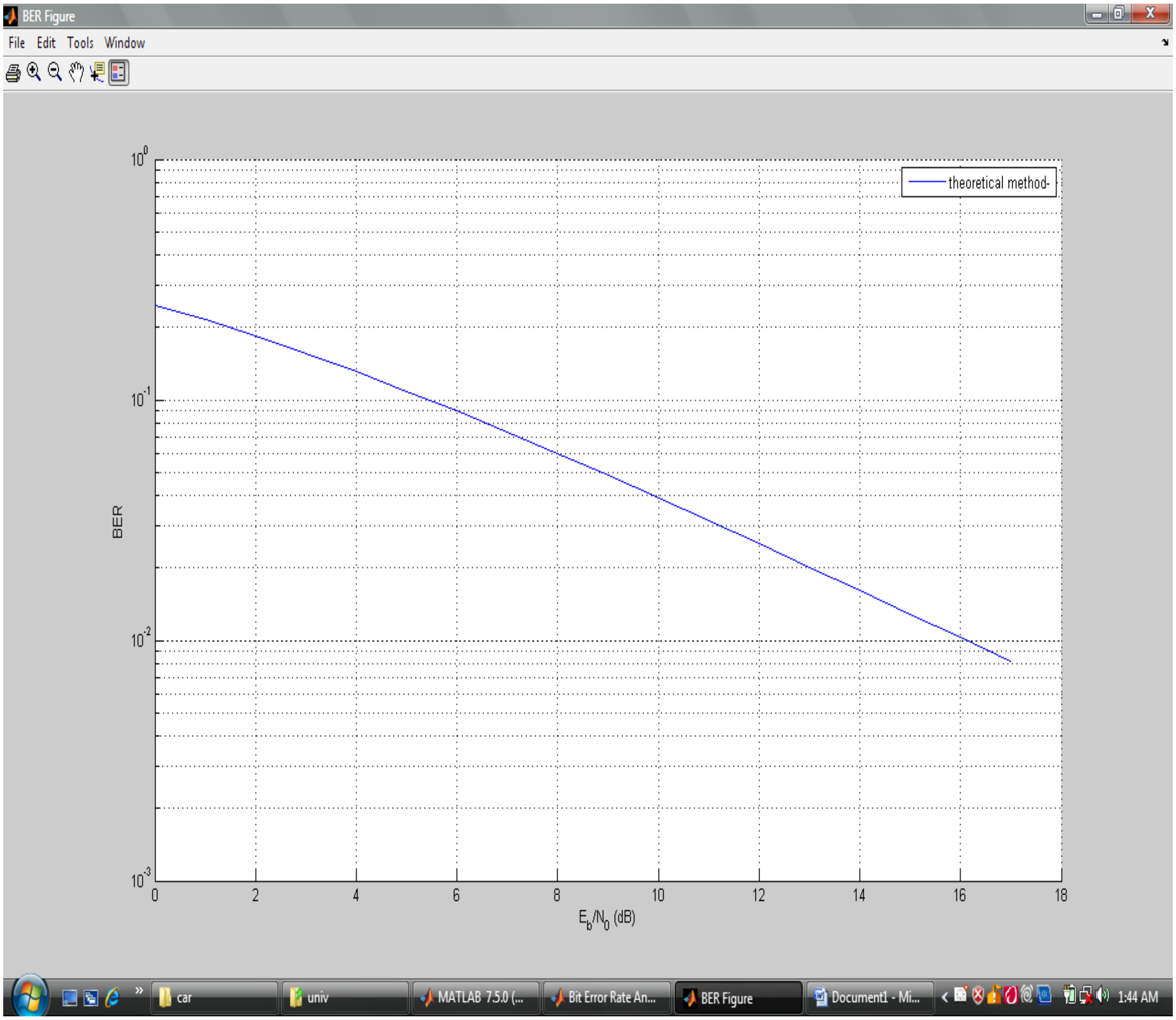

Figure3. Bit error rate versus E_b/N_0 Waveform for Theoretical method.
Line conventions 1. Blue line represents Theoretical method.

METHOD 2. (SEMI ANALYTIC) Consider following specifications, E_b/N_0 range =0:17 dB, Modulation type =DPSK, Modulation Order=4, Sample per Symbol= 32 Received filter coefficients, Numerator ones (16, 1)/16. Denominator = 2.

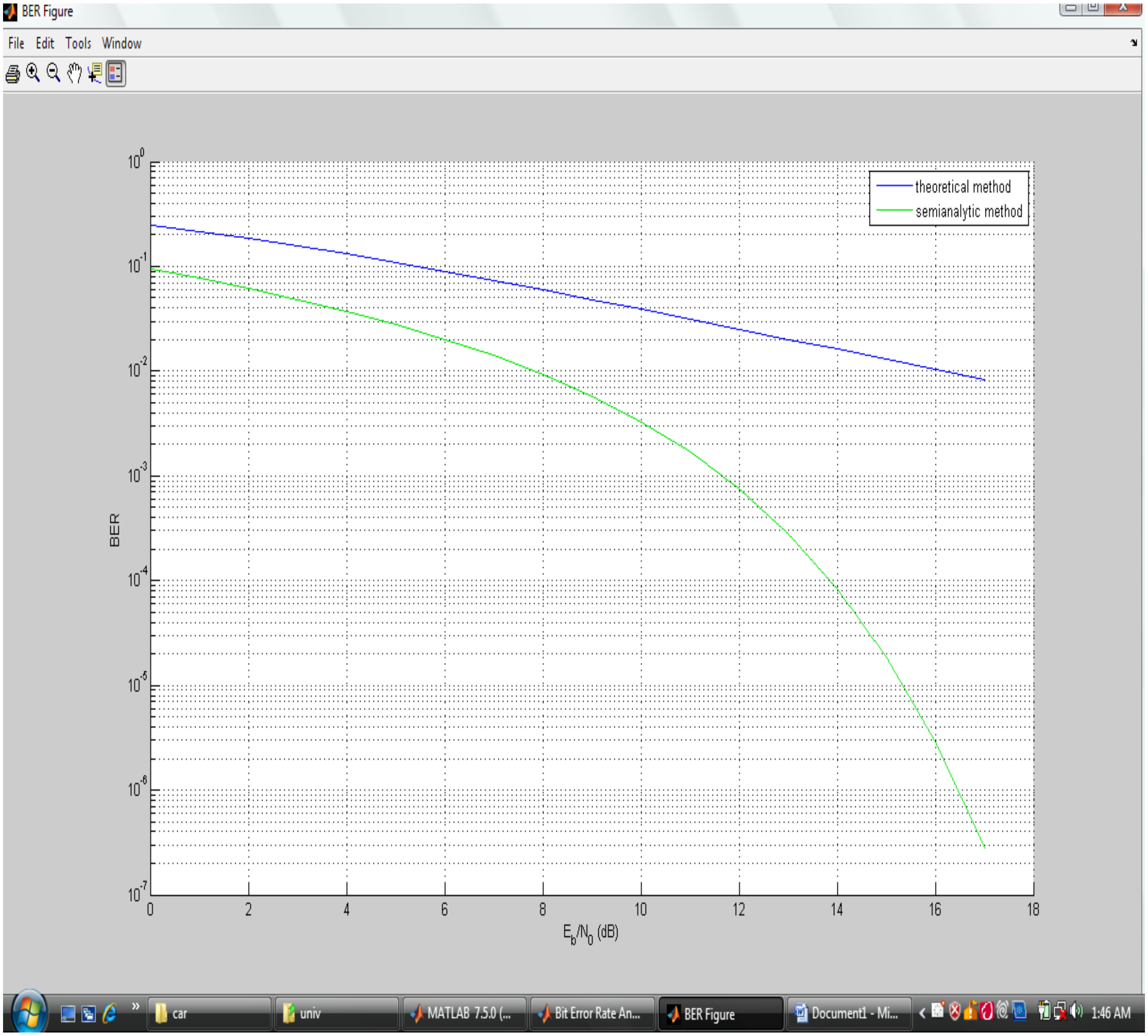

Figure4. Bit error rate versus E_b/N_0 Waveform for Theoretical method
Line conventions 1. Blue line represents Theoretical method.
2. Green line represents Semi analytic method.

METHOD3. (MONTE CARLO) Consider following specifications , E_b/N_0 range =0:3:14, BER variable name =gray BER, Simulator limits = number of bits =1e8.

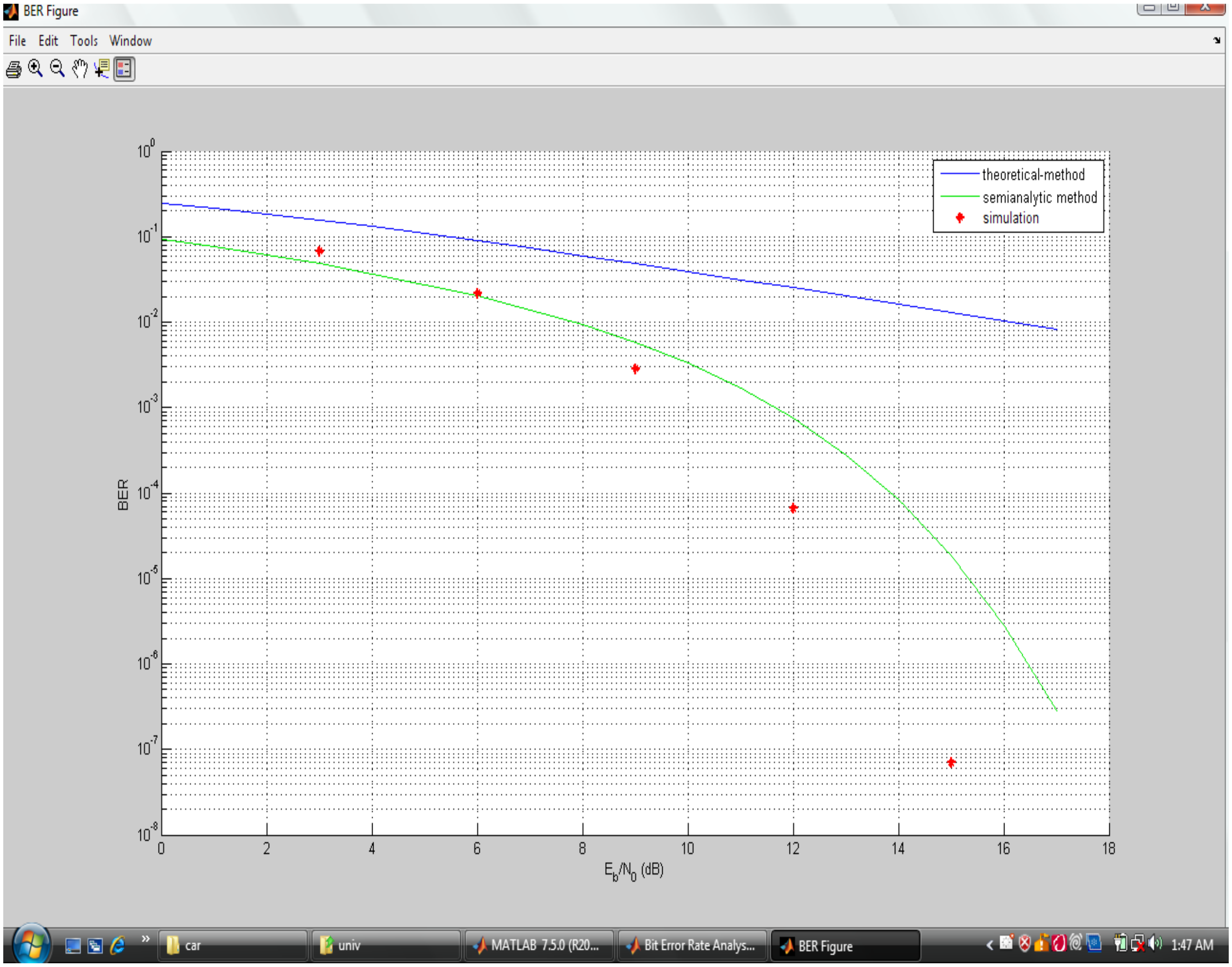

Figure5. Bit error rate versus E_b/N_0 Waveform for Theoretical method

Line conventions 1. Blue line represents Theoretical method.
2. Green line represents Semi analytic method.
3. Red star represents Monte Carlo simulation.

5. CONCLUSION

From the above discursions it is found that simulation based on three above mentioned methods are easier to verify and and easy to find the errors more quickly. Monte Carlo is one of the methods that is restricted nowadays and also found costlier in today's computer time .Monte Carlo method waits for the error and number of assumptions about the form of decision metric. Semi- analytical method affects the Gaussian noise .Simulation ends when it either detects a target number of errors or processes a maximum number of bits whichever occurs first. BER Tool plots the theoretical curve in the BER Figure window along with the earlier simulation results. The simulation must send the final error rate data to the MATLAB workspace as a variable .The variable must be a three-element vector that lists the BER, the number of bit errors, and the number of processed bits. This three-element vector format is supported by the Error Rate Calculation block.

REFERENCES

[1] H. J. Richter, A. Y. Dobin, O. Heinonen, K. Z. Gao, R. Veerdonk, R. T. Lynch, J. Xue, D. Weller, P. Asselin, M. F. Erden, and R. M. Brockie, "Recording on bit-patterned media at densities of 1 Tb/in² and beyond, " IEEE Transactions on Magnetics, vol. 42, pp. 2255-60, 2006.

[2] J. Fidler, T. Schrefl, D. Suess, O. Ertl, M. Kirschner, and G. Hrkac, "Full micromagnetics of recording on patterned media," Physica B, vol. 372, pp. 312-15, 2006.
[3] M. E. Schabes, " Micromagnetic simulations for terabit/in2 head/ media systems, " Journal of Magnetism and Magnetic Materials, vol. 320, pp. 2880-2884, 2008.
[4] B. Livshitz, A. Inomata, H. N. Bertram, and V. Lomakin, "Analysis of recording in bit patterned media (BPM) with parameter distributions," Journal of Applied Physics, vol. 105, pp. 07C111, 2009.
[5] P. Hoeher, I. Land, and U. Sorger, "Loglikelihood values and Monte Carlo simulation some fundamental results," in Proc. Int. Symp. on Turbo Codes & Rel. Topics, Brest, France, Sept. 2000, pp. 43–46.
[6] J. Hagenauer, E. Offer, and L. Papke, " Iterative decoding of binary block and convolutional codes , " IEEE Trans. Inform. Theory, vol. 42, no. 2, pp. 429–445, Mar. 1996.
[7] I. Land , P . Hoeher, and U. Sorger, "On the interpretation of the APP algorithm as an LLR filter," in Proc. IEEE Int. Symp. Inform. Theory (ISIT), Sorrento, Italy, June 2000, p. 415.
[8] S. L. Smith and G. C. Orsak, " A Modified Importance Sampling Scheme for the Estimation of Detection System Performance," IEEE Trans. Commun., vol. 43, no. 2/3/4, pp. 1341-1346, Feb/Mar/Apr. 1995.
[9] D. van den Borne, S. L. Jansen, G. D. Khoe, H. de Waardt, "Line Optimization in Long-Haul Transmission Systems with 42.8-Gbit/s RZDQPSK Modulation," in Proc. OFC '06, Anaheim, CA, paper OFD2, 5- 10 Mar. 2006.
[10] O. V. Sinkin, R. Holzlohner, J. Zweck and C.R. Menyuk,"Optimization of Split-Step Fourier Method Modeling Optical-Fiber Communications Systems," J. Lightw. Technol., vol. 21, no. 1, pp. 61-68, Jan. 2003.
[11] A. H. Gnauck and P. J. Winzer, "Optical Phase-Shift-Keyed Transmission," J . Lightw. Technol., vol. 23, no. 1 , pp.115-130, Jan. 2005
[12] A. A. Al-Orainy and J. J. O'Reilly, "Error probability and approximations for influence of crosstalk on wavelength division multiplexed systems," Inst. Elect. Eng. Proc. J. Optoelectron., vol. 137, no. 6, pp. 379–384, 1990.
[13] I. T. Monory and E. Tangdiongga, " Performance evaluation of optical cross - connects by saddle for the approximation," J. Lightwave Technol., vol. 16, pp. 317–323, Mar. 1998.
[14] J. J. O'Reilly and R. F. Rocha , " Improved error probability evaluation methods for direct detection optical communication systems," IEEE Trans. Inform. Theory, vol. IT-33, pp. 839–848, June 1987.

Authors

Er. Jagat Dhiman was born in 1988. He received Bachelor's Degree in applied electronics and instrumentation control Department of kurukshetra university under the college JMIT Haryana and pursuing his Master's degree in E&CE Department from Eternal University. His research area of interest are digital Signal processing, Control system and instrumentation. He is pursuing his masters thesis under supervision of his M. Tech guide Er. Bhubneshwar Sharma .He has also published two international journals in reputed journals of engineering and research.

Er. Bhubneshwar Sharma was born in 1986. He received Bachelor's Degree in Electronics and Communication Engineering from Jammu University in 2007 and received Master's degree in Electronics and Communication Department from Punjab in 2009. He is currently working as Assistant Professor in the Department of Electronics and Communication Engineering in Eternal University, Himachal Pradesh, India. He is pursuing Ph.D. He has published research papers in International Journals and presented his work at conferences. He pursues a broad range of research interests that include Digital signal processing, neural networks, Wireless sensor networks. His comprehensive academic background coupled with an Excellent Knowledge and versatile experiences vibrate him with confidence.

Er. Sukhbir Singh was born in 14 January, 1985. He did his engineering in Electronics and Communication from Guru Nanak Dev Engineering College, Ludhiana in 2008. He then did his Masters in same stream from Punjabi University, Patiala in 2012. During his Master's thesis, he worked on improving receiver sensitivity in low cost optical links using semiconductor optical amplifiers. Currently, he is working as lecturer in Electronics department at Eternal University, H.P, India. He has published many research papers in international journals and conferences and attended workshops. His research area of interest includes Optical communications, Signal processing etc. At present he is guiding students for their master's thesis.

