Optimization of Bit Error Rate Analysis of the V-BLAST MIMO channels - A Review

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Abstract

The Bit Error Rate calculation is very important phenomena in the wireless communication. Antenna is mainly used as a device to transmit and receive signal in wireless communication. To get better facility from this device it is necessary to modify or synthesize the geometric configuration or the other parameter of the device. There are many communication channels like flat fading Rayleigh channels, Gaussian channel. Rician fading channels etc. and various modulation techniques like BPSK, QPSK,QAM, etc. which are mentioned in this paper .Any communication channel can be used with any modulation technique for communication and best result for BER can be calculated..

KEYWORDS*: MIMO, BER, BPSK, QPSK, VBLAST.*

1. INTRODUCTION

BER analysis is very important in any type of communication. In wireless communication transmitting and receiving antennas are used. Communication system may be SISO or MIMO. SISO means Single Input Single Output. MIMO means Multiple Inputs Multiple Outputs. In SISO only one antenna is used at Transmitting end and one antenna is used at receiving end. In MIMO more than one antenna are used at transmitting end and at receiving end. From many research it has been observed that MIMO gives better result in communication than SISO. Some of the benefits of MIMO in wireless communication are higher capacity, better transmission quality, increased coverage, improved user position estimation. In a wireless communication channel, the transmitted signal can travel from transmitter to receiver over multiple reflective paths. This gives rise to multipath fading which causes fluctuations in amplitude, phase and angle of arrival of the received signal. For example, the transmitted signal from the BTS (base transceiver station) may suffer multiple reflections from the buildings nearby, before reaching the mobile station. It is called multipath fading channels. A model is necessary to predict the effects of this fading accurately in order to mitigate it effects. Some of the models used to model multipath fading are
1)Rayleigh Fading model
2)Rician Fading model etc.

The delays associated with different signal paths in a multipath fading channel change in an unpredictable manner and can only be characterized statistically. When there are a large number of paths, the central limit theorem can be applied to model the time-variant impulse response of the channel as a complex-valued Gaussian random process. When the impulse response is modelled as a zero mean complex-valued Gaussian process, the channel is said to be a Rayleigh fading channel. The model behind Rician fading is similar to that for Rayleigh fading, except

that in Rician fading a strong dominant component is present. This dominant component can for instance be the line-of-sight wave. There are many schemes that can be applied to MIMO systems such as space time block codes, space time trellis codes and the Vertical Bell Labs Space-Time system (V-BLAST). There are many V-BLAST systems like V-BLAST system with Maximum Likelihood (ML), Zero Forcing (ZF) and Minimum Mean Squared Error (MMSE).V-BLAST performs well when channel estimates are good. For long distance communication information signals called baseband signals are modulated. Modulation may be Amplitude modulation, Frequency modulation or Phase modulation. There are many modulation techniques like ASK, FSK, PSK, BPSK, DPSK, QPSK, QAM. From the literature, it is observed that any modulation technique can be used with any channel for transmitting and receiving the signal. For each BER verses SNR has been calculated and try to get better result.

Sr. No.	**Author**	**Title of the Paper**	**Conclusion**
1.	Shreedhar. A. Joshi et al.(2001)	*Performance analysis of MIMO technology using v-blast technique for different linear detectors in a slow fading channel*	This paper proposed the performance evaluation of V-BLAST with several detectors (ZF, MMSE) in slow fading channels. Furthermore, the introduction of SIC schemes still improves the independent coded V-BLAST system. . In this way, it is proved that, MIMO is an important key technology for the Fourth generation wireless networks.
2.	Nasir D. Gohar et al.(May-June 2003)	*V-BLAST: a space-division multiplexing technique Providing a spectral efficiency necessary for high Data rate wireless networks*	V-Blast is an SDM technique whose spectral efficiency is amazingly very high. V-BLAST is future technology for high data rate wireless networks. Application of SD algorithm to VBLAST architecture has shown promising results to enhance its spectral efficiency even further.
3.	Mr. Shreedhar A. Joshi	*Error rate analysis of the v-blast MIMO channels using interference cancellation detectors*	Multiple Input Multiple Output (MIMO) systems which have recently emerged as a key technology in wireless communication systems for increasing both data rates and system performance. The Vertical Bell Labs Space-Time Architecture (V-BLAST) is one of the schemes, which can be applied to MIMO wireless system. This paper proposes

			signal detectors for V-BLAST architecture with Maximum Likelihood (ML), Zero-Forcing (ZF), Minimum Mean-Square Error (MMSE), and Successive Interference Cancellation (SIC) detectors and simulates these structures in Rayleigh fading channel. The proposed analysis also compares the performances of MIMO system with different modulation techniques like BPSK and QPSK in Fading and A WGN channels. Based on bit error rates, we analyze the performance and the computational complexity of these schemes.
4.	Sergey Loyka and Francois Gagnon(July-2004)	*Performance Analysis of the V-BLAST Algorithm: An Analytical Approach*	This approach presents a new geometrical view of the V-BLAST and explains some of its properties in a complete and rigorous form, including a statistical analysis of Post processing signal-to-noise ratios for a $2\times n$ system (where n is the number of receive antennas).Closed-form analytical expressions of the vector signal at ith processing step and its power are presented.. It is shown that the optimal ordering is based on the least correlation criterion and that the after-processing signal power is determined by the channel correlation matrices in a fashion similar to the channel capacity. Closed-form analytical expressions are derived for outage probabilities and average BER of a $2\times n$ system. The effect of the optimal ordering is shown to be to increase the first step SNR by 3 dB (rather than to increase the diversity order as one might intuitively expect based on the selection combining argument) and to increase the second step outage probability twice.
5.	Pravin Kumar Barmashe, Prof. Rajesh Nema	*Performance Evaluation of V-Blast MIMO System using BPSK*	This paper presents an asymptotic analysis of the VBLAST scheme at high SNR region. Both the ZF -V-BLAST, MMSE-V -BLAST and QR-V-BLAST are analyzed with respect to their SNR

			and BER performances. Even we extended our analysis with linear and non-linear detectors like MMSE-OSIC and ZF-OSIC estimators and found that MMSE method is the best solution in detectors in BPSK.
6.	Xiang Liu and Lajos Hanzo (2006)	*Accurate BER Analysis of QPSK Modulated Asynchronous DS-CDMA Systems Communicating over Rayleigh Channels*	This paper investigated the average BER performance of an asynchronous DS-CDMA system using I/Q modulation and random spreading sequences, when communicating over Rayleigh channels. A new closed-form expression was derived for the conditional CF of the MAI. Furthermore, an accurate expression based on the CF approach was provided for calculating the average BER of the system, which requires only a single integration. The accuracy of our accurate BER expression was confirmed by our simulation results for various spreading sequence lengths. By contrast, the limited accuracy of the SGA was also demonstrated, which becomes more prevalent when a low number of interferers is encountered and short spreading sequences are used.
7.	Sanchis-Borras et al.	*Performance of QSTBC and VBLAST algorithms for MIMO channels in tunnels*	Multiple- input–multiple output (MIMO) systems is strongly affected by the properties of the channel matrices. In tunnels, despite the small angular spreads of the rays, it has already been shown that the average mutual information can be strongly enhanced using MIMO rather than single-input–single-output (SISO). Furthermore the use of polarization diversity is also studied. In this paper for a (4,4) MIMO transmission in tunnels at 3 GHz and using compact arrays, MIMO outperforms SISO in terms of not only mutual information but also of bit error rate assuming the same transmitting power and the same throughput. Furthermore comparisons between QSTBC and VBLAST clearly show that QSTBC must be chosen since the correlation coefficients between antennas

			strongly increase at great distances from the transmitter.
8.	Serdar Ozyurt and Murat Torlak	*An exact outage analysis of zero-forcing v-blast with greedy ordering*	An outage probability analysis is carried out on zero-forcing (ZF) vertical Bell Labs Layered Space-Time (VBLAST) algorithm based on a greedy selection of decoding order, which is optimal in diversity-multiplexing trade off sense. We provide a mathematical framework to make the analysis tractable and derive the probability density function expressions of the squared sub stream gains. Especially, we obtain compact expression on the joint pdf of squared sub stream gains for any number of transmit and receive antennas. Moreover using the analytical results, we illustrate the optimum cut-off value under optimal power allocation that minimizes the total consumed power for a given target total rate. Finally we provide numerical results and verify our analysis by means of simulations
9.	Ronald B¨ohnke and KarlDirk Kammeyer(July 2006)	*SINR Analysis for VBLAST with Ordered MMSESIC Detection*	This paper presented a new unified approach to the SINR analysis of V-BLAST with (ordered) ZF- or MMSE-SIC detection. Based on geometrical considerations, the SINR distribution of the first layer was calculated f or different receiver architectures by first conditioning on, and then averaging over the effective channel gain of the second layer. The effects of an optimized detection order and MMSE interference suppression were investigated separately and visualized by means of the conditional cdf of SINR1. Furthermore, it was shown analytically that the optimal ordering is even more important in combination with MMSE filtering.
10.	Nirmalendu Bikas Sinha et al. (Feb.2010)	*Optimization of MIMO detectors: Unleashing the multiplexing gain*	The MIMO principle is based on a rich multipath environment without a normal Line-of-Sight (LOS) that is the Rayleigh flat fading channel, due to movement or

			other changes in the environment, LOS situation can arise. So finally we proposed that ML detector for MIMO-V-Blast in slow fading channel with QPSK modulation is the ultimate optimization technique in the next generation broadband communication system.
11.	Vikas Chauhan et al.(2011)	*Comparative BER Performance of PSK based modulation Techniques under Multipath Fading*	• BER for BPSK and QPSK are similar except a 0 BER can be obtain for BPSK at a lower E b/N0 (I .e lower signal power). • . BER obtained for all PSK schemes under 4-Path Rayleigh Fading Channel are lower than the 1-Path Rayleigh Fading Channel. • BER obtained for GMSK is higher compared to BER obtained for BPSK and QPSK but at higher E b/N0 , the BER for GMSK is lower than both BPSK and QPSK.
12.	Shreedhar A Joshi1 et al.(Nov.2011)	*Analysis of V-BLAST Techniques for MIMO Wireless Channels with different modulation techniques using Linear and Non Linear Detection*	Based on bit error rate, we show the performance of these receiver schemes indicates that the ordered OSIC detector based receiver with ZF or MMSE combined with symbol cancellation and optimal ordering to improve the performance with lower complexity and compare the computational complexity of these schemes. The different modulation schemes definitely help in analyzing these detection algorithms. The Maximum-Likelihood (ML) detection most effectively balances the accuracy of symbol detection with any SNR values.
13.	Gurpreet Singh et al (2012).	*BER analysis of v-blast MIMO systems under various channel modulation techniques in mobile RADIO channels*	In this paper, we studied MIMO V-BLAST system performance under i.i.d Rayleigh channel. Further this system is compared with different modulation technique and system gets better result in BPSK modulation .Fig.5 shows the simulation results for BPSK modulation with only ML decoding technique using various antennas at input and output. In this we will more optimal result for 4 x 4

			antennas for VBLAST system.
14.	Prof. Shreedhar. A. Joshi et al .(2012)	*Performance Analysis of V-BLAST Detection Techniques For MIMO Technology*	This paper provided a general multiple antenna system(MIMO) with the V-BLAST technique using several detectors (MMSE, ML, ZF and QR). We conclude that the performance is limited by error propagation. A comparative study of various linear and non linear detectors is made by comparing their outputs with reference to the plots of BER and their corresponding SNR. We show the benefits of ordering strategy over SIC and PIC cancellation methods. MIMO is an important technology for enabling the wireless industry to deliver a vast potential and promise of wireless broadband. However, the drawback of BLAST algorithms is the propagation of decision errors. Furthermore, due to the interference suppression, early detected symbols at the receiver benefit from lower diversity than later ones. Thus, the algorithm results in unequal diversity advantage for each symbol.
15.	Vinay Panwar et al(2012)	*Bit Error Rate (BER) Analysis of Rayleigh Fading Channels in Mobile Communication*	Bit error rate performances for Mobile communication with BPSK transmission schemes have been evaluated with random data. Two types of fading, large-scale and small scale were described. Generation of Rayleigh faded envelope for varying number of paths are shown. BER Performance of a BPSK signal in presence of AWGN and Rayleigh Channel.
16.	C. Sanchis-Borras,et al.(2012)	*MIMO Performances in Tunnel Environment: Interpretation from the Channel Characteristics*	The MIMO channel characteristics around 3 GHz deduced either form the modal theory or from measurements strongly varies with the distance between the transmitter and the receiver. As soon as this distance becomes greater than 100 m, the VBLAST algorithm does not give satisfying results due to the increase of the correlation between array elements and of the condition number of the transfer matrix. OSTBC or QSTBC must thus be chosen and, for the same bit rate,

			outperforms SISO in terms of bit error rate. Similar results were obtained for other carrier frequencies between 3 and 5 GHz.
17.	G.Tharakanatha et al. (Sep.2013)	*Implementation and Bit Error Rate analysis of BPSK Modulation and Demodulation Technique using MATLAB*	This paper performs the Bit Error Rate analysis using Matlab Graphical User Interface., BER Tool. Two types of simulations are performed, one is theoretical simulations and it is verified with the Monte Carlo design simulations. Later on a BPSK system is simulated using the Matlab text editor. The design of the BPSK system in MATLAB Simulink is performed and all the results are plotted.

II. CONCLUSION

It is observed, from above literature that in wireless communication MIMO technology is better than SISO. V-BLAST architecture is used in most of the cases for better and less complex circuitry. Till now researchers have proposed BER calculation in flat fading Rayleigh Channel and the modulation is BPSK. In our thesis we can change either channel or modulation technique or both to improve SNR and reduce BER.

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