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Performance Analysis of Modulation Techniques in MIMO Rician Channel for WCDMA System

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Abstract *–In today communication network the major challenges is to integrates a wide variety of serves, convey the more information as efficiently as possible through limited bandwidth and providing high data rates. Some of information bits are lost in most of the cases and signal which is sent originally will face fading. To reduce the bit error rate and signal fading require high data rate modulation schemes.3GPP Release 7 (HSPA+) WCDMA systems introduced two features Higher Order Modulation (HOM) and Multiple Input Multiple Output (MIMO).This paper focuses on the performance analysis of 16 QAM and 64 QAM in multiple input multiple output (MIMO) Transmission in the Rician channel by considering two encoding REED SOLOMON Encoding and BCH Encoding in WCDMA system. The analysis has been performed by using MATLAB for simulation and evaluation of Bit Error Rate (BER) for W-CDMA system.*
Keywords *- WCDMA, MIMO, QAM, Rician Channel, BCH Encoding, REED SOLOMON Encoding.*

I. INTRODUCTION

Wideband Code Division multiple Access (WCDMA) system, standardized under the 3rd Generation Partnership Project (3GPP), is one of the most widely deployed 3G wireless cellular networks. WCDMA is being used by Universal Mobile Telecommunication System (UMTS). WCDMA system is capable of providing high date rate signal transmission over the air, thus providing high quality data, multimedia, streaming audio, streaming video and broadcast type services to the network. WCDMA requires a minimum bandwidth allocation of 5MHz, which is an important distinction from the other generation standards. Packet data rates up to 2Mb/s per user in indoor or small-cell outdoor environments and at rates of up to 384 Kbit/s in wide-area coverage is supported by WCDMA. Third generation systems are designed for multimedia communication which can be enhanced with high quality video.

WCDMA technology is the most widely used third generation system which is spreading over a wide bandwidth by multiplying the user information with spreading sequence in WCDMA. W-CDMA uses noise-like broadband frequency spectrum it provide high resistance to multipath fading this was not present in 2nd generation (2G) communication system. In 2G communication network widely used Gaussian Minimum Shift Keying (GMSK) modulation. This modulation can only transmit data rate of 1 bit per symbol. So this kind of modulation scheme is not suitable for providing higher data rate in the next generation communication system. So there is a need the performance analysis of suitable new modulation, error correction coding and technology to be used in WCDMA system to improve the system performance in a multipath fading channel. Each release of 3GPP specification introduces new technologies and features towards better broadband access in wireless WANs. Release 7 of 3 GPP (HSPA+) provide new features are higher order modulation and multiple input and multiple output (MIMO) both on downlink and uplink that enable improved data rate and number of simultaneous user supported, both feature improve the spectrum efficiency, especially for the users in good channel condition [1]. In recent years, there has been a significant interest in using dual antenna arrays in wireless communication systems due to the information theoretic results suggesting possible extraordinary capacity gains of multiple transmit and receive antenna systems [2]–[4]

This paper evaluates the performance of 16 QAM & 64 QAM in MIMO channel when the channel is subjected to Rician Fading, by using two different encoding REED Solomon encoding and BCH encoding in WCDMA system. The analysis has been performed by using MATLAB for simulation and evaluation of Bit Error Rate (BER) for both modulation technique and analysis which modulation gives better result in Reed Solomon encoding and BCH encoding. This paper is organized as follows: Section **I1** describes the stimulation model. The Multiple input and multiple output (MIMO) is given in Section 111.The BCH encoding and Reed Solomon encoding describe in Section IV. Section V discusses about the results. Section VI gives concluding remarks.

II. STIMULATION MODEL

Stimulated model for this work is shown in Fig-1 .this model is stimulated by MATLAB. A DSSS WCDMA system spreads the baseband data by directly multiplying the baseband data pulses with a pseudo-noise (PN) sequence that is produced by a pseudo-noise (PN) code generator [5]. A single pulse of the PN waveform is called chip .The user data is multiplied with PN code. After that on the multiplied signal implement error correction coding such as Reed Solomon encoding and BCH encoding particularly with 16 QAM or 64 QAM modulation techniques in W-CDMA system. The Modulated signal is transmitted by MIMO Transmission over the Rician channel. At the receiver, the Spread spectrum signals are demodulated by cross-correlation with locally generated version of the pseudo random carrier. After that demodulation, signal is decoded. The Cross-correlation with the correct PN sequence dispreads the spread spectrum signal and restores the modulated message in the same narrow band as the original data[6]. Finally calculate BER at the received signal.

There are many fading effects that can be categorized as large-scale and small-scale fading. When there is a dominant non fading signal component present, such as a line-of-sight propagation path, the small scale fading is called as Rician fading and the envelope is described by a Rician pdf. [7]

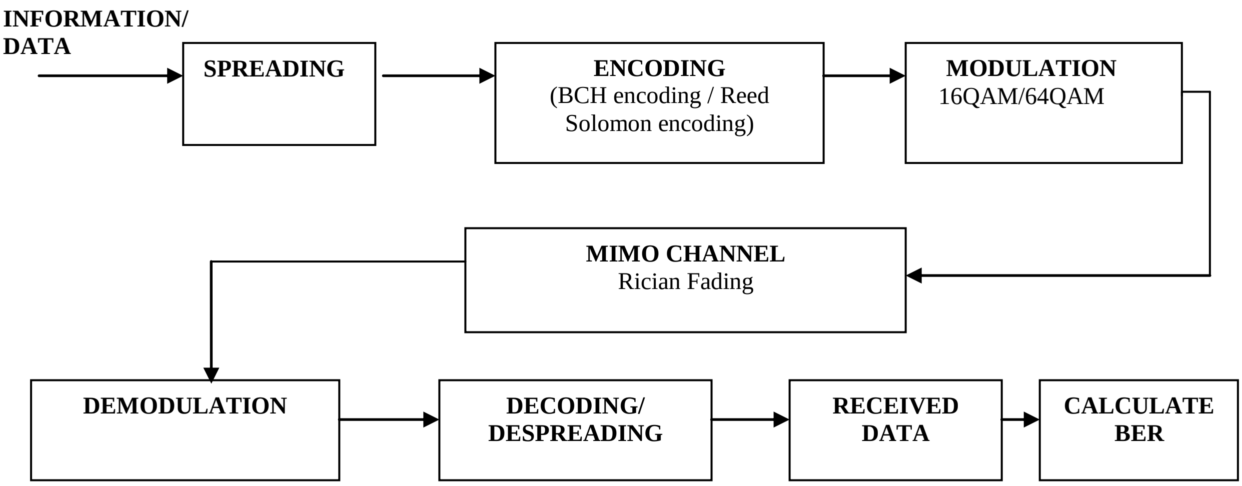

Fig. 1 Stimulation model

III. MULTIPLE INPUT MULTIPLE OUTPUT (MIMO)

MIMO transmission utilizes multiple transmit and receive antennas, to improve the channel capacity .MIMO increase the channel link range and data throughput without increase in transmit power & no additional bandwidth providing. MIMO systems can improve the spectrum efficiency over single antenna transmission systems, this can be achieves by spreading the same total transmit power over the antenna array that improve the array gain, A Release 7 MIMO capable UE can receive data rates up to 28.8 Mbps in a 5 MHz carrier. Release 7 HSPA+ standardizes the scheme of downlink MIMO called D-TxAA (Dual-Transmitter Adaptive Array).D-TxAA is restricted to dual transmit and receive antennas.[1]. For dual stream MIMO, received chips can be modeled as [1]

$$\vec{y}[n] = [H^1 \quad H^2].\begin{bmatrix}\vec{x}^1[n]\\ \vec{x}^2[n]\end{bmatrix} + \vec{z} \qquad (1)$$

Where $H^i = [\vec{h}_1^i, \dots, \vec{h}_{d-1}^i, \vec{h}_d^i, \vec{h}_{d+1}^i, \dots, \vec{h}_k^i], i = 1,2$ is the channel convolution matrix from the ith transmit antenna to the receiver.$\vec{y}[n]$ denotes the received chip and $\vec{x}^i[n] = [[x_{n+1}^i, \dots, x_{n+d-1}^i, x_{n+d}^i, x_{n+d+1}^i, \dots, x_{n+k}^i]^T]$,$i = 1,2$ represents the transmitted chip from ith transmit antenna. $\vec{z}$ denotes the channel fading.

IV. ENCODING

A. BCH Encoding

Bose –Chaudhuri –Hocquenghem (BCH) Codes are important classes of linear block code. These codes are multiple error correcting and detecting codes and a generalization of the Hamming code. BCH Codes are characterized for any positive integers m $(m \geq 3)$ and t error $(k \leq 2^{m-1})$ by the following parameters

Block length:	$n = 2^m - 1$
Parity check bits:	$n - k \leq mt$
Minimum distance:	$d \geq 2t + 1$

Each BCH codes can detect and correct up to t random errors per code word. The BCH codes offer flexibility in the choice of code parameter mainly block length and code rate.

In BCH codes, α is a primitive element of GF(2^m). The generator polynomial is the lowest degree polynomial over GF(2) which has $\alpha, \alpha^2, \alpha^3, \dots\dots, \alpha^{2t}$. The codeword length is $2^m - 1$ and t is the number of correctable error. The generator of the binary BCH codes is found to be least common multiple of the minimal polynomial of each α^i term$(0 < i < 2t)$. For the generator polynomial simplification considering every even power of a primitive element has the same minimal polynomial as some odd power of the element.

The generator polynomial $g(x)$ of BCH codes for t-correctable error and length of codeword $2^m - 1$ is given by

$$g(x) = LCM\{\phi_1(x), \phi_3(x), \dots\dots \phi_{2t-1}(x)\} \qquad (2)$$

B. REED SOLOMON Encoding

Reed-Solomon codes are subclass of nonbinary *cyclic* codes. It operates on multiple bits rather than individual bits. A RS codes with symbols made up of *m*-bit sequences, where *m* is any positive integer having a value greater than 2. R-S (*n*, *k*) codes on *m*-bit symbols exist for all *n* and *k* for which. [8]

$$0 < k < n < 2^m + 2 \quad (3)$$

Where *n* is the total number of code symbols in the encoded block and *k* is the number of data symbols being encoded. The conventional R-S (*n*, *k*) codes are,

$$(n, k) = (2^m - 1, 2^m - 1 - 2t) \quad (4)$$

Where *t* is the symbol-error correcting capability of the RS code, and the number of parity symbols are $n - k = 2t$. An extended R-S code can be made up with $n = 2^m$ or $n = 2^m + 1$, but not any further. Reed-Solomon codes achieve the largest possible minimum code distance for any linear code with the same encoder input and output block lengths. For nonbinary codes, the distance between two codeword is defined as the number of symbols in which the sequences differ (Hamming distance).

For Reed- Solomon codes, minimum distance is given by

$$d_{min} = n - k + 1 \quad (5)$$

The RS code is capable of correcting any combination of t or fewer errors, where *t* can be expressed as

$$t = \left\lfloor \frac{d_{min}-1}{2} \right\rfloor = \left\lfloor \frac{n-k}{2} \right\rfloor \quad (6)$$

The RS codes provide a wide range of code rates that can be chosen to optimize performance.

V. RESULT

The WCDMA model is simulated for 16QAM and 64 QAM modulations in two error control encoding such as BCH encoding and REED SOLOMON encoding by the MIMO Transmission in the presence of Rician fading. The simulation parameters used in the simulation are given in Table 1. Then the BER performance of WCDMA is calculated and compared by varying the SNR of the Rician channel. The BER is the number of bit received as errors divided by the total number of transmitted bits during a studied time interval.

Table 1: Simulation Parameters

Parameter	**Value**
System	WCDMA
No. of users	1
Modulation technique	16 QAM / 64 QAM
MIMO Tx and Rx Antenna	2×2
Type of Fading Channel	Rician channel
Encoding	BCH Encoding / Reed Solomon Encoding

Figure 2, The graph compare the Bit error rate (BER) and Signal to Noise ratio (SNR) for 16QAM and 64QAM modulation in WCDMA system by BCH encoding over the Rician channel by MIMO transmission , the result show that 64QAM has low BER than the 16 QAM .If the SNR varied from 0 to 10 dB, The 64 QAM give better result than the 16 QAM over the Rician channel by using BCH encoding .Each symbol of 16QAM conveys 4 bits per symbol but that of 64-QAM is 6 bits/symbol. SNR is defined as the ratio between signal power to noise power and it is normally expressed in decibel (dB).

Figure 3 shows the BER comparison of 16 QAM and 64 QAM by using Reed Solomon encoding over the Rician channel in MIMO WCDMA system. It is observed that a similar trend is found when the encoding is done by Reed Solomon encoding again bit error rate of 64 QAM is low in comparison to 16 QAM .It shows that 64 QAM modulation gives better performance in MIMO Rician fading. If compare the bit error rate of 16QAM and 64QAM in both encoding, the result shows that bch encoding gives low BER in comparison to Reed Solomon encoding for both 16 QAM and 64 QAM modulation. The result verified that BCH encoding is better than the Reed Solomon encoding

Higher order QAM modulation schemes are vulnerable to error and error correction Coding gives higher chances of signal survivability in multipath fading Channel and thus enhances the system performance

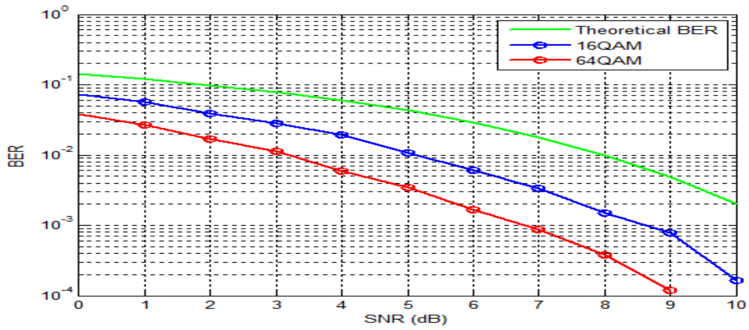

Fig2. Comparison of 16QAM / 64 QAM in Rician channel by using BCH encoding.

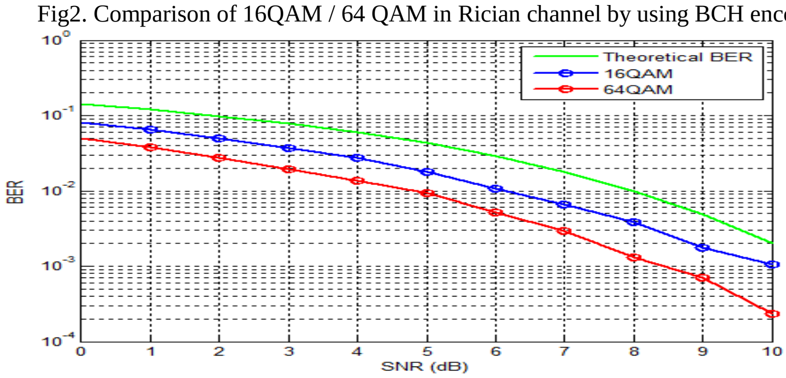

Fig3. Comparison of 16QAM / 64 QAM in Rician channel by using Reed Solomon encoding.

VI. CONCLUSION

The performance of WCDMA system has been analyzed for two modulation techniques 16QAM and 64QAM by considering the Reed Solomon encoding and BCH encoding in MIMO Rician channel , to reduce the error performance of the signal and compare which modulation and encoding gives better result through MIMO Channel in the presence of Rician fading. The performance of W-CDMA system in MIMO Rician channel shows that 64QAM modulation technique has a better performance compared to that of 16-QAM. From the stimulated result we have seen that BER of 64 QAM is lesser in comparison to 16 QAM in both encoding (Reed Solomon encoding and BCH encoding) .we compare BER by varying SNR from 0 to 10 dB. But if compare the BER performance of BCH encoding and reed Solomon encoding the result shows that the BCH encoding gives better BER performance in comparison to Reed Solomon encoding in MIMO Rician channel.

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