BER and Gain Analysis of IEEE 802.16 standard for Broadband Wireless Access (BWA) in 16-QAM Modulation technique in Different 2*2, 3*3, 4*4 Antenna Diversity

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Abstract- *WiMAX (Worldwide Interoperability for Microwave Access) physical layer is basic of 3G and 4G wireless communication Technology. This technique gives rise to the advanced technique. So in this thesis we are going to estimate the BER and SNR analysis of Wi-MAX Physical layer in 2*2,3*3,4*4 antenna diversity like n transmit antennas and n receive antenna in 16-QAM modulation technique. For this first we made the MCCDMA system that is basically a multicarrier system for high speed data rate transmission. And finally we merge this system to MIMO diversity for multiple transmit and multiple receive antennas to enhance the capacity of system. So result shows that if we increase the antenna diversity we get lower BER at and higher SNR that leads to enhance the system capability. In this thesis for MIMO implementation ZF equalization technique is used for transmitting for multiple transmit antennas and OSTBC code is used to determining the signals without knowing the channel state information at the receiver end.*

Keywords- CDMA, OFDM, MISO, MIMO-MC-CDMA and MC-CDMA.

I. INTRODUCTION

MIMO MC-CDMA systems endure from the MAI persuaded through the loss of orthogonality of multiplexed users additionally to inter-antenna interference (IAI) because of multiple antennas. In MIMO MC-CDMA systems, the multiplexed signals cannot exist overtly separated at the receiver as a result of there aren't any orthogonality limitations for the sent signals. Consequently the combining ways like MRC, EGC or MMSEC, that area unit used for dropping solely MAI, for single-antenna MC-CDMA systems can not be overtly applied to MIMO MC-CDMA systems [4]. Because, in MIMO MC-CDMA systems, the recipient should handle the IAI whereas MAI, it needs an extra leveling method to eradicate the interference among multiple antennas additionally to joint method.

For dependable MIMO megacycle - CDM an indication detection, a spread of detection algorithms are planned. historically, there area unit 2 grouping that encompass linear detections additionally to decision feedback (DF) detections referred to as interference termination detections. Of course, maximum likelihood (ML) detection is utilized for MIMO MC-CDMA, although, here we tend to simply believe 2 detections system. this is often as a result of, differing to millilitre detection having exponential complication the linear additionally to DF detectors will create use of abstraction filtering by suggests that of lower further as cheap quality. Primary, the linear detector generally supported 2 customary ZF further as MMSE, that consists of symbol-level further as chip-level linear detector. In [4], symbol-level further as chip-level linear detectors depends on MMSE criterion exist absolutely derived. The symbol-level linear detector, further referred to as linear multi-user detection, that features a fine performance, but it's high process quality at what time the system load isn't complete and it additionally wants the knowledge on the quantity of active users additionally to the corresponding spreading code. Linear chip-level detector addicted to single-user detection offers a lot of or less the equivalent performance because the symbol-level detector in an exceedingly utterly loaded system by suggests that of lower quality.

For DF detections further as within the ZF/MMSE ordered ordered interference cancellation (OSIC) detector, additionally referred to as chip-level ZF/MMSE V-BLAST detector, that has been projected in[13]. The projected OSIC detector performed on the premise of per subcarrier is applied to MIMOMC-CDMA systems through straightforward modification of OSIC detector in [14] meant for conformist MIMO systems. as a result of the interference cancellation is succeed before dispreading designed for MIMOMC-CDMA systems additionally thereto can not be utterly terminate the opposite users' knowledge image, it bear from MAI additionally to error propagation downside considerably. As a result the chip-level V-BLAST detector has inferior quality presentation than linear MMSE detector. In, MMSE nulling partial parallel interference cancellation (PIC) recipient was planned to diminish the error propagation bother of chip-level OSIC detector. for added sweetening in performance, AN unvaried image-level MMSE depends on detectors through parallel / serial interference cancellation (PIC / SIC) by suggests that of soft-decision symbol find of from the channel decoder output be given for coded MIMOMC-CDMA systems [4].

In this chapter, primary we tend to shed light on on the linear detections further as analyze the presentation of ZF further as MMSE linear detections. Depends on derivations in preceding chapter, we tend to shows an explicit BER expression for MIMOMC-CDMA systems through ZF detection. sequent we tend to propose the detection technique for MIMO MCCDMA systems. To diminish the high process quality of the symbol-level linear detection, we tend to counsel a DF detector depends on noise-prediction technique. Also, we tend to propose a partial MMSE-OSIC dependent multi-user detection.

II. THEORETICAL BACKGROUND

2.1. Wi-max physical layer

In this section, we have a tendency to place up the obligatory signal model for the downlink. Wi-max physical layer system, in adding along to current receiver model. These contains the contribute addition image level linear right along with OSIC receivers.

2.1.1 Transmit Signal Model

Let us imagine the self-examining channel downlink Wi-max physical layer transmitter model adjacent to means that of alphabetic character total of users as shown in Figure 1. The signaling information area unit coalescing hooked on nongovernmental organization sub-streams and later on each sub-stream is encoded in addition as modulated designed for P symbols.

The uncoded image matrix tatterdemalion for user alphabetic character (nu = one,2,...,Nu) is unconcealed as

$$D_{nu} = (d^1_{nu} d^2_{nu} . . . d^{Nt}_{nu})^T € C^{Nt*P} \quad (2.1)$$

On that the column vector dntnu symbolize the data stream i.e. transmitted from the
nt-th antenna (nt = 1, 2, ... Nt), given away as

$$d^{nt}_{nu} = \left[d^{nt}_{nu,1} d^{nt}_{nu,2} \; . . . . \; d^{nt}_{nu,} P \right]^T € C^{p*1} \quad (2.2)$$

each user are owed at a astonishing spreading code. The spreading series of nu user given away as

$$c_{nu} = [c_{nu,1} c_{nu,2} . . . . c_{nu,G}] € C^{1*G} \quad (2.3)$$

in which C created acknowledged because the spreading code of chip alphabet in calculation along to G discovered the spreading code length. The spreading order is expand to protuberance the symbols of nu-th user place in regulate to work the chip-level transmit matrix

$$S_{nu} = \left[s_{nu,1} \quad s_{nu,2} \quad ... \quad s_{nu,N_s} \right] = D_{nu} \otimes c_{nu} \in C^{N_t*N_s} \quad (2.4)$$

where Ns = P * G that maintain a association to the total quantity of subcarriers. The communal CDMA chips of each users area unit at the i-th subcarriers keep going shown by

$$x_i = \left[x_i^1 \quad x_i^2 \quad ... \quad x_i^{N_t} \right]^T = \sum_{nu=1}^{N_u} s_{nu,\, i} \in C^{N_t*1} \quad (2.5)$$

where xint refers to the collective chip sent in consequence of the nt-th antenna in adding along to it are often unconcealed as

$$x_i^{nt} = \sum_{nu=1}^{N_u} s^{nt}_{nu,i} = \sum_{nu=1}^{N_u} c_{nu}, g(i) d^{nt}_{nu,\, p(i)} \quad (2.6)$$

where $s^{nt}_{nu,i}$ given away the nu-th user sent chip by the nt-th antenna at i-th subcarriers. The joint chip order for every transmitted antenna is perverted to time domain through IFFT. The output signals throughout the IFFT path the matching methodology as through the MC-CDMA. additionally to this, the channel is stated be the analogous within the inside of the MC-CDMA system. Complementary assumption doesn't include channel state data (CSI) at transmitter what is more so superlative CSI at the receiver is obtained. it's supposed to be incontestible that if associate inter-leaver is functioning for the principle of Wi-max physical layer system the act are optimized. due to succeeding chips are sent from interleaved subcarriers, that has supplementary various channel gains. In spite of the actual fact that for shortness of presentation, the succeeding study area unit referred for a system void of interleaving. It are often skillful to be simply comprehensive through associate interleaved system that's what is more worn for the simulations.

2.1.2 Receive Signal Model

Let us imagine the receiver of the ideal user by means of Nr received antennas. On receiving the signal, frequent prefix (CP) is repute apart and FFT of size Ns is conceded out. The received signal model at the i-th subcarrier resulting to FFT is articulated as

$$r_i = H_i x_i + n_i \quad (2.7)$$

in which the received signal is match to

$$r_i = \left[r_i^1 r_i^2 \ldots\ldots r_i^{Nr} \right] \in C^{Nr*1} \quad (2.8)$$

The AWGN channel vector by way of σn2 power can be explain in addition as

$$H_i = \left[h_i^1 \quad h_i^2 \quad \ldots \quad h_i^{N_t} \right] = \begin{bmatrix} h_i^{(1,1)} & \cdots & h_i^{(1,N_t)} \\ \vdots & \ddots & \vdots \\ h_i^{(N_e,1)} & \cdots & h_i^{(N_e,N_t)} \end{bmatrix} \in C^{N_e * N_t} \quad (2.9)$$

$$n_i = \left[n_i^1 n_i^2 \ldots\ldots n_i^{Nr} \right]^T \in C^{Nr*1} \quad (2.10)$$

in which hi(nr,nt) be evidence for the channel reaction from start to end the i-th subcarrier all along with the convey antenna nt along with the receive antenna nr (nr = 1,2,...,Nr), in addition ni represent the Nr * 1 AWGN noise vector from end to end the i-th subcarrier. The received signal as articulated in equation 2.7 can be additional extensive to

$$r_i = \overbrace{h_i^{nt} s_{n_u,i}^{nt}}^{desired} + \overbrace{\sum_{n_u' \neq n_t}^{N_t} h_i^{nt} s_{n_u,i}^{n_t'}}^{CAI} + \overbrace{\sum_{n_u' \neq n_u}^{N_t} h_i^{nt} s_{n_u,i}^{n_t'}}^{MAI1} + \overbrace{\sum_{n_u' \neq n_u}^{N_t} \sum_{n_u' \neq n_t}^{N_t} h_i^{n_t'} s_{n_u,i}^{n_t'}}^{MAI2} + n_i \quad (2.11)$$

Let us guess the RHS of equation 2.11, the opportunity term according to the transmitted chips all the method through the chosen sub-stream nt of the chosen user nu. The resulting term express the CAI which come to pass from supplementary sub-streams of the favored user. The ensuing or third term eloquent MAI 1 and the fourth term confirm MAI 2 available MAI next from end to end other users of nt-th sub-stream and all accompanying sub-streams equally.

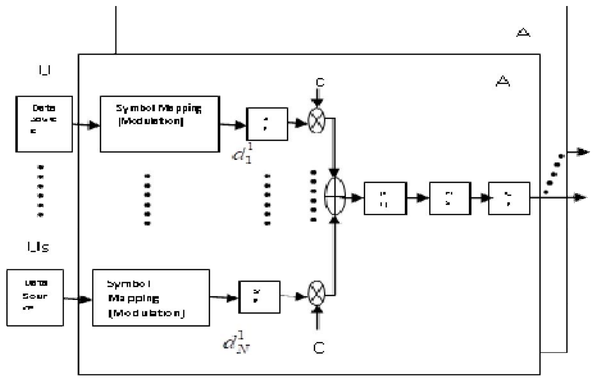

Figure 2.1. WI-MAX transmitter.

III. SIMULATION RESULTS AND DISCUSSION

Table 3.1 illustrates the simulated model constraint of IEEE 802. 16 standard for Broadband Wireless Access (BWA) in 16-QAM Modulation technique in Different Symmetrical Antenna Diversity. Figure.3.1 to Figure.3.3. prove the performance examination of Wi IEEE 802. 16 standard for Broadband Wireless Access (BWA) in 2 by 2, 3 by 3, 4 by 4 antenna diversity, Table 3.2 establish the BER as well as gain contrast in 16-QAM outcome reveal that 6 by 6 have very next to to the ground BER in totaling to high gain in evaluation to all accompanying modulation practice. This gain measurement is finished at 0-dB SNR because at 0-dB BER of 2 by 2 accomplishes to zero so elevated performance is bring about in 4 by 4. Figure.3.1 to figure3.2 proves MIMO-MC-CDMA in a diversity of number of modulation procedure. For 3G and 4G wireless communication to advance system recital we employ MIMO-MC-CDMA practice for accomplish far above the ground performance in QPSK modulation method.

Table.3.1. Summary of simulated model constraint.

No. of bits transmitted by user	1560
No. of transmitting and receiving antennas	2*2,3*3,4*4
Modulation Schemes	16-QAM
Signal detection scheme	Zero forcing
Channel	Rayleigh Fading Channel
Signal to Noise Ratio	-20dB to 10 dB
CP Length	1280
OFDM Sub-carriers	6400
Block code	OSTBC

Table.3.2. Performance psychotherapy of symmetric Antenna diversity of MIMO-MCCDMA in OSTBC Block Code at 0dB of SNR

Antenna Diversity	BER	Gain w.r.t 2 by 2
4by4	0.0067	-25.68dB
3by3	0.0173	-17.43dB
2by2	0.1288	0dB

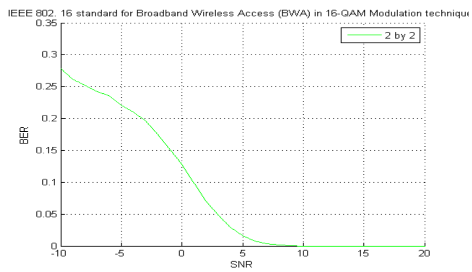

Figure.3.1. Performance psychotherapy of 2by2 Antenna diversity of MIMO-MCCDMA in OSTBC Block Code in 16-QAM.

Above results shows OSTBC 16-QAM modulation technique performance estimation in 2by2 antenna diversity that represents the superior results that the BER completed at 7dB of SNR that present enhanced error handling capabilities correspond to MIMO-MCCDMA systems.

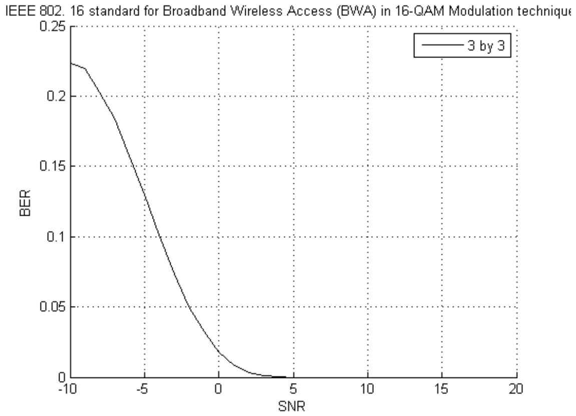

Figure.3.2. Performance psychotherapy of 3x3 Antenna diversity of MIMO-MCCDMA in OSTBC Block Code in 16-QAM.

Above graph illustrate the 16-QAM modulation technique for 3 by 3 antenna diversity, the performance estimation that represents the superior results that the BER finished at 3 dB of SNR that offer better error handling capabilities than 2by2 represented by 3 by 3 MIMO-MCCDMA systems.

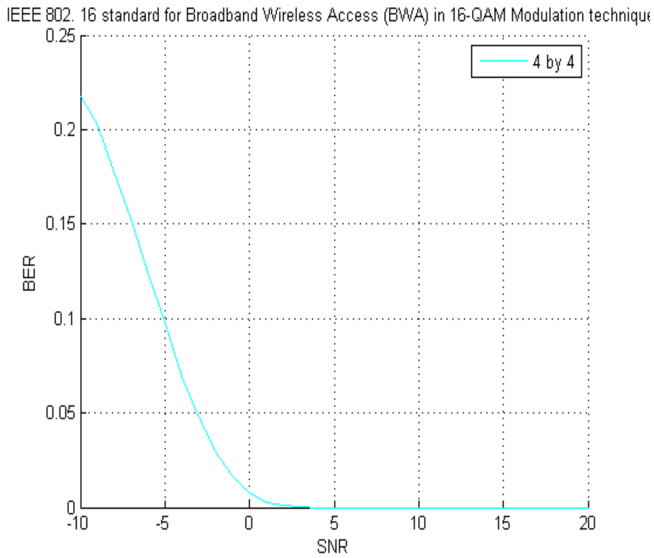

Figure.3.3. Performance psychotherapy of 4by4 Antenna diversity of MIMO-MCCDMA in OSTBC Block Code in 16-QAM.

Above graph illustrate the 16-QAM modulation technique for 4 by 4 antenna diversity, the performance estimation that represents the superior results that the BER finished at 2dB of SNR that offer better error handling capabilities than 16-QAM represented by 3 by 3 MIMO-MCCDMA systems.

IV. CONCLUSION

Simulation results prove the qualified examination of BER and Gain Analysis of IEEE 802. 16 standard for Broadband Wireless Access (BWA) in 16-QAM Modulation technique in Different Symmetrical Antenna Diversity that according to the comparative analysis for distorted modulation techniques which shows that as higher order antenna diversity is bigger than before after that there is expand in BER. This proposition aims to diminish bit error rate which is correspond to 16-QAM modulation at 6by6 antenna diversity plan at the gain of 44.28dB with admiration to 2by2 antenna diversity that prove that the gain of 4by4 diversity is superior as contrast to former antenna diversity technique with a slighter amount of error. For 3G, 4G and 5G communication higher order antenna diversity is make use of that enclose BER up to 0dB, that means errors are detached in 4by4 at 0dB of SNR that marks by using 16QAM Wimax Physical layer system. Finally 16QAM MIMO-MC-CDMA present optimized output as match up to the other diversities in 4by4 diversity procedure that is mainly employed for 3G & 4G wireless communication.

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