ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Performance Analysis of Adaptive modulation and Coding (AMC) based WiMAX System including MIMO Technique

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Abstract

Adaptive modulation schemes for fading channels are usually required to fulfill certain long-term average BER targets. The analysis and design of variable-rate variable-power QAM schemes with average BER constraints are tackled for MIMO multiplexing. In closed-form policies are derived for continuous rate and power adaptation which are compared to the fully discrete policies In particular, if interference between Eigen channels is large, Multiple-Input Multiple-Output multiplexing should utilize only one of its Eigen channels, in which case all multiplexing gain is los WiMAX is the upcoming wireless system. In this paper, performance of wimax physical layer is simulated using MATLAB and bit error rate (BER) performance is observed. The BER level is depend on the modulation type, SNR value and channel behavior. To transmit the faithful data over these systems the BER performance is further improved using forward error correction codes (FEC) is performed at different iterations in MATLAB. BER performance is evaluated for these codes under different modulation schemes like QAM-4 QAM-8 and QAM-16. We will use Orthogonal Frequency Division Multiplexing to achieve high data rate necessary for intensive application. The Space-Time Block Coding (STBC) with Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) set-up for use in wireless channels.

Keywords: MIMO (Multiple-Input Multiple-Output),OFDM, STBC, WiMAX, M-QAM (Multilevel quadrature amplitude modulation), AMC, BPSK., etc.

Introduction

Wireless network is a type of network that utilizes some form of wireless link to communicate with each other. Wireless network comprises of different nodes which communicate with each other over a wireless channel, this wireless channel may be of radio wave or infra-red wave, which is responsible for establishment of wireless channel or wireless link between nodes. In this thesis we have worked out on WiMAX; to make the system more reliable we have used digital communication technique .Digital communication technique that provide many advantage over analog communication technique, it get easy to detect error in digital communication by adding Forward error correction code or backward error correcting code, which is not possible in analog communication. In digital communication first we converted data into signal using source coding, this source coded data is further encoded by using channel coding, which is used for error detection or error correction, in our thesis we have work on two type of channel coding called convolution code and turbo code. After channel coding this bit of stream is get modulated using one of the different modulation technique.

OFDM has become a popular technique for transmission of signals over wireless channels. OFDM has been adopted in several wireless standards such as digital audio broadcasting (DAB), digital video broadcasting (DVB-T), the IEEE 802.11a LAN standard and the IEEE 802.16a MAN standard

OFDMA System model

Orthogonal Frequency Division Multiplexing (OFDM) has been successfully applied to a wide variety of digital communication applications over the past several years. While OFDM principle was adopted as a physical layer for many important communication systems such as asymmetric digital subscriber loop(ADSL), Digital Audio Broadcasting (DAB),Digital Video Broadcasting (DVB), high-definition television (HDTV), wireless local area network (WLAN)and the fourth generation of mobile cellular, the theory,

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algorithms, and implementation techniques of OFDM are topics of high interest.

The complex baseband OFDM signal at output of the IFFT can be written as:

$$Xn = \frac{1}{\sqrt{N}}\sum_{l=0}^{N-1} X_{l}e^{j\frac{2\pi}{N}ni} \quad (1)$$

At the receiver, the received OFDM signal is mixed with local oscillator signal, with the frequency offset deviated from Δf the carrier frequency of the received signal owing to frequency estimation error or Doppler velocity, the received signal is given by:

$$\hat{x}_n = (X_n \otimes h_n)e^{j\frac{2\pi}{N}n\Delta fT} + z_n \quad (2)$$

The output of the FFT in frequency domain signal on the kth receiving subcarrier becomes:

$$\widehat{X}_k = \sum_{l=0}^{N-1} X_1 H_1 Y_{1-k} + Z_k \quad (3)$$

The first term of Equation (4) is a desired transmitted data symbolX_k. The second term represents the ICI from the undesired data symbols on other subcarriers in OFDM symbol H_k is the channel frequency response and Z_k denotes the frequency domain of z_n . The term $Y_{1-k}$is the coefficient of FFT (IFFT), is given by:

$$Y_{1-k} = \frac{1}{\sqrt{N}}\sum_{l=0}^{N-1} e^{j\frac{2\pi}{N}n(l-k+\Delta fT)} \quad (4)$$

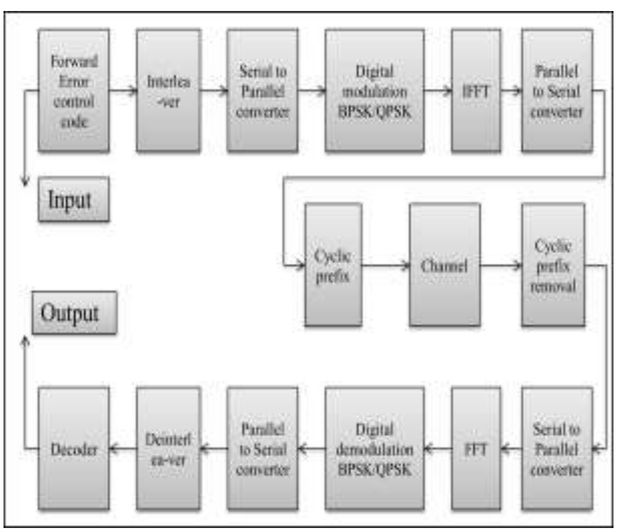
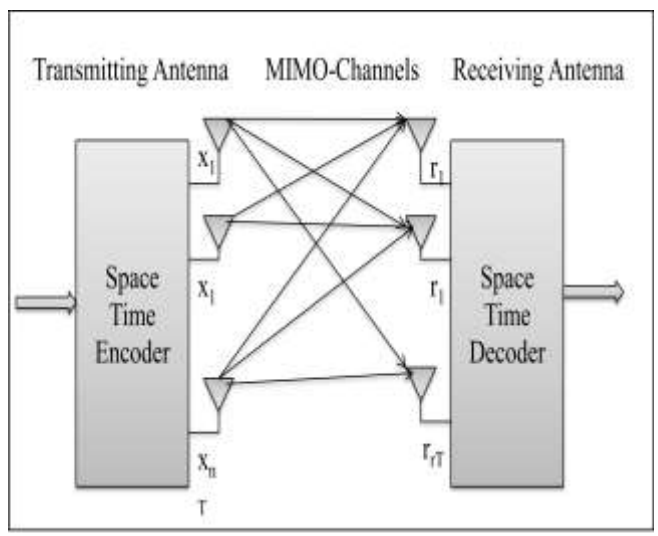


Fig.1 Block Diagram of OFDM system

MIMO System Model

Multi-antenna systems can be classified into three main categories. For Multiple antennas at the transmitter side are usually applicable for beam forming purposes. In Transmitter or receiver side multiple antennas for realizing different (frequency, space) diversity schemes. The third class includes systems with multiple transmitter and receiver antennas realizing spatial multiplexing (often referred as MIMO by itself).

In radio communications MIMO means multiple antennas both on transmitter and receiver side of a specific radio link. The case of spatial multiplexing different data symbols are transmitted on the radio link by different antennas on the same frequency within the same time interval. In Multipath propagation is assumed in order to ensure the correct operation of spatial multiplexing and since MIMO is performing better in terms of channel capacity in a rich scatter multipath environment than in case of environment with LOS. . It is achieves this by higher spectral efficiency (more bits per second per hertz of bandwidth) and link reliability or diversity (reduced the effect of fading). Because the properties, MIMO is an important part of modern wireless communication such as IEEE8002.16



Fig,2 MIMO system

MIMO with Alamouti Space Time Coding

The transmit diversity technique proposed by Alamouti was the first STBC. The encoding and decoding operation is carried out in sets of two modulated symbols. Hence, the information data bits are first modulated and mapped into their

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Scientific Journal Impact Factor: 3.449
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corresponding constellation points. Therefore, let us denote by x1 and x2 the two modulated symbols that enter the space–time encoder. They usually, in systems with only one transmit antenna, these two symbols are transmitted at two consecutive time instances t1 andt2. The times t1 and t2 are separated by a constant time duration T. In the Alamouti scheme, during the first time instance, the symbol x1 and x2 are transmitted by the first and the second antenna element, respectively. During the second time instance t2, the negative of the conjugate of the second symbol, i.e., –x2*, is sent to the first antenna while the conjugate of the first constellation point, i.e., x1*, is transmitted from the second antenna. The encoding operation is described in the Table 1.2. The transmission rate is equal to the transmission rate of a SISO system. The space–time encoding mapping of Alamouti's two-two-branch transmits diversity technique can be represented by the coding matrix:

$$X_1 = \begin{bmatrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{bmatrix} \quad (5)$$

In the coding matrix X1, the subscript index gives the transmit rate compared to a SISO system. For Alamouti's scheme, the transmission rate is 1. The rows of the coding matrix represent the transmit antennas while its columns correspond to different time instances.

It is clear that the encoding is done in both the space and time domains. The transmit sequence from antennas one and two byx^1 andx^2 , respectively.

$$x^{t1} = [x_1, -x*_2]$$
$$x^{t2} = [x_2, x*_1]$$

The key feature of the Alamouti scheme is that the transmit sequences from the two transmit antennas are orthogonal, since the inner product of the sequencesx^1 andx^2 is zero, i.e.

$$x^{t1} . x^{t2} = x_1 x*_2 - x*_2 x_1 \quad (6)$$

The code matrix has the following property:

$$X . X^H = \begin{bmatrix} |x_1|^2 + |x_2|^2 & 0 \\ 0 & |x_1|^2 + |x_2|^2 \end{bmatrix}$$
$$= (|x_1|^2 + |x_2|^2) I_2 \quad (7)$$

Where$I_2$is a2 X 2 identity matrix

At the receive antenna, the received signals over two consecutive symbol periods, denoted byr_1

And$r_2$for time t and$t + T$, respectively, can be expressed as

$$r_1 = h_1 x_1 + h_2 x_2 + n_1 \quad (8)$$
$$r_2 = -h_1 x*_1 + h_2 x*_2 + n_2 \quad (9)$$

Where n_1 and$n_2$are independent complex variables with zero mean and power spectral density$N0/2$ per dimension, representing additive white Gaussian noise samples at time t and $t + T$, respectively.

Time	Antenna 1	Antenna 2
Time t1	x_1	x_2
Time t2	$-x_2^*$	x_1^*

Table 1 Alamouti's Transmitting Diversity Scheme

Adaptive Modulation and Coding (AMC)

In order to improve system capacity, coverage reliability and peak data rate, the transmitted signal is subject to variation of interfering base stations, path loss, and noise and fading that affects the quality of received signal. The transmitted signal is modified through a process commonly referred to as link adaptation. Adaptive Modulation Coding (AMC) provides the flexibility to dynamically match the modulation-coding scheme (MCS) to the average channel conditions for each user. It is a user is close to the base station (BS), a higher modulation order (eg: 64QAM) with higher code rate is assigned. In contrast, modulation order (eg: 16QAM) will decrease, which a user is far from the base station (BS).

Different order modulation can allow to the transmitter to send more bits per symbol and thus achieve higher throughputs or better spectral efficiencies. When using a modulation technique such as 64-QAM, better signal-to-noise ratios (SNRs) are needed to overcome any interference and maintain a certain bit error ratio (BER). The different variants of QAM modulation are used in various communication scenarios, for to meet specific data rate performance. With AMC, the power of the transmitted signal is held constant over a frame interval, the modulation and coding format is changed to match the current received signal quality or channel conditions. In the system with AMC, users close to the Node B are typically assigned higher order modulation with higher code rates, but the modulation-order and/or code rate will decrease as the distance from Node B increases. AMC is most effective when combined with fat-pipe scheduling techniques such as those enabled by the Downlink Shared Channel. AMC combined with time domain scheduling offers the opportunity to take advantage of short term variations in a UE's fading envelope so that a UE is always being served on a constructive

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Scientific Journal Impact Factor: 3.449
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fade. It Rayleigh fading envelope correlation vs. time delay for different values of Doppler frequency. In the figure suggests that for lower Doppler frequencies it is possible to schedule a user on a constructive fade provided that the scheduling interval (i.e. frame size) is small and the measurement reports are timely (i.e. distributed scheduling). To take advantage of in this technique, both a smaller frame size and distributed scheduling have been proposed as part of the High Speed Downlink Packet Access (HSDPA) study item. The implementation of AMC offers several challenges. In order to select the appropriate modulation and the scheduler must be aware of the channel quality.

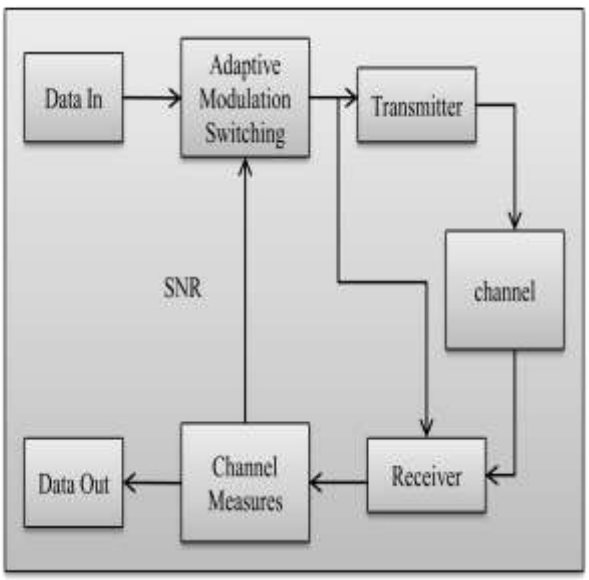

Fig.3 ADAPTIVE Modulation System.

Results and discussion

SYSTEM PERFORMANCE WITH MIMO 2X1 WiMAX

Result (2X1 MIMO WiMAX)				
SNR	Modulation Order	BER	RMSE	PSNR
0	2	0.0214	19.7796	22.2065
1	2	0.0108	13.6797	26.6237
2	2	0.0066	9.9961	28.7008
3	2	0.0023	6.0402	31.1601
4	2	0.0013	4.6729	42.6217
5	2	0.0007	3.5791	100
6	4	0.0006	2.9455	34.0508
7	4	0.0006	2.5684	36.3179
8	4	0.0006	2.5684	36.3378
9	4	0.0003	1.6931	100
10	4	0.0002	1.0082	100
11	8	0.0001	0.2307	51.4537
12	8	0.0002	0.6137	54.6629
13	8	0.0002	0.6137	100
14	16	0.0001	0.4773	42.4881
15	16	0.0000	0.3830	100
16	16	0.0008	1.6248	100
17	16	0.0010	2.3099	100
18	64	0.0010	2.6878	32.2699
19	64	0.0011	2.7121	33.5794
20	64	0.0011	2.7121	42.6037
21	64	0.0003	1.4703	66.4408
22	64	0.0001	0.4022	100
23	64	0.0003	1.1092	100
24	64	0.0002	1.0907	100
25	256	0.0003	1.0966	33.4440
26	256	0.0003	1.0966	78.7453
27	256	0.0003	1.0966	78.7453
28	256	0.0000	0.0118	100
29	256	0	0	100
30	256	0	0	100

Table.2 performance of 2 x1 MIMO WiMAX System

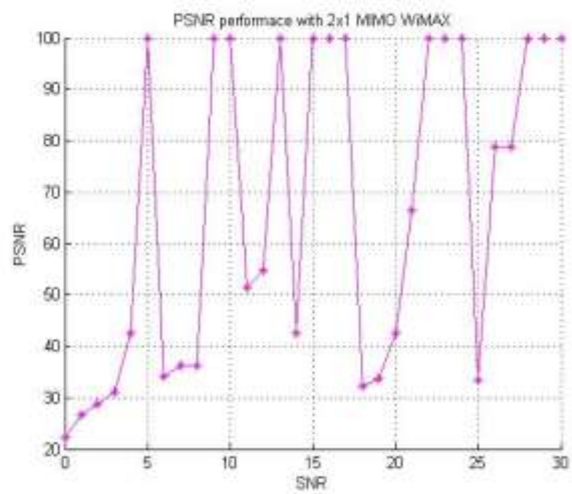

Fig.4 PSNR performace with 2x1 MIMO WiMAX

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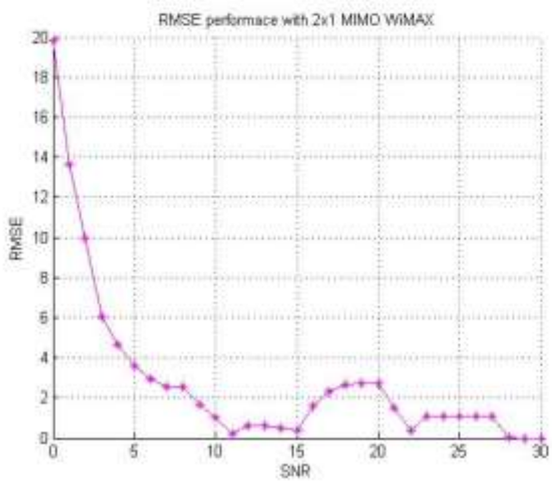

Fig.5 RMSE performance with 2x1 MIMO WiMAX System

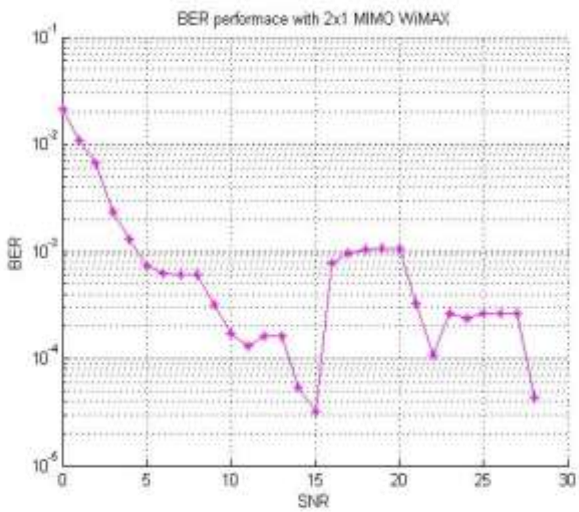

Fig.6 BER performance with 2x1 MIMO WiMAX System

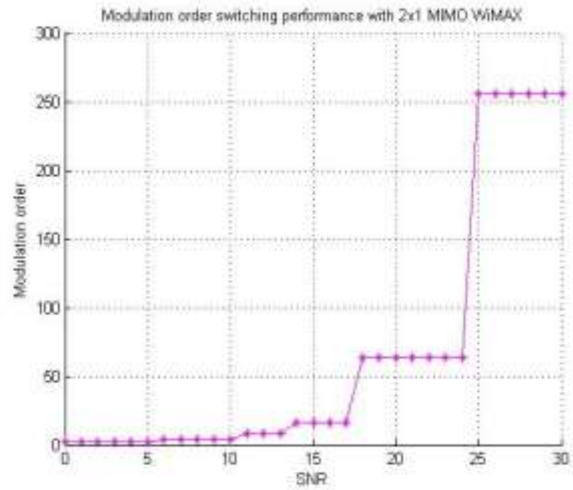

Fig.7 Modulation order switching performance with 2x1 MIMO WiMAX System

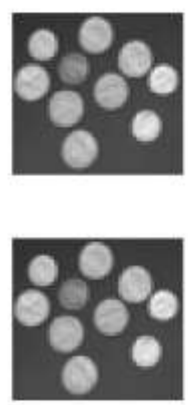

Fig.7

Conclusion

The wimax system simulation setup with Alamouti scheme has been developed. OFDM is a very attractive technique for wireless communications due to its spectrum efficiency. The image based data transmission scheme is evaluated successfully. In during simulation study various modulation schemes which support the high data rate are used for simulation, and performance enhancement with different receiver diversity has been demonstrated. This scheme due to higher frequency used in WiMAX system. It is found that with increase of modulation order the capacity enhancement is compare to SNR.

ISSN: 2277-9655
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