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PERFORMANCE OF 16-QAM MIMO SCHEME FOR DATA TRANSMISSION THROUGH ADDITIVE WHITE GAUSSIAN NOISE CHANNELS

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ABSTRACT
WiMAX is a promising technology which can offer high speed data, voice and video service up to the customer end. The development of 802.16e standards for Broadband Wireless access technology was motivated by rapidly growing need for high-speed and cost-effective access. In this paper analysis of IEEE-802.16e (WiMAX model) using 16-QAM modulation techniques with combination of (2×2, 2×4 and 2×8) MIMO and (1×2) SIMO system and input signal is transmitted through the Additive White Gaussian Noise channel. The simulation analysis has been done through Simulink MATLAB R2013a toll and results drown between Bit-Error-Rate versus Signal-to-Noise Ratio.

Keyword: IEEE-802.16e, (2×2, 2×4 and 2×8) MIMO, (1×2) SIMO, Additive White Gaussian Noise, Modulation.

INTRODUCTION
WiMAX works on the same principles as Wi-Fi - it sends data from one computer to another via radio signals. A computer equipped with WiMAX would receive data from the WiMAX transmitting station. The fastest Wi-Fi connection can transmit up to 55 megabits per second under optimal conditions. WiMAX is capable to handle up to 70 megabits per second. Even if that 70 megabits is split up between a few hundred home users or several dozen businesses and provides at least the equivalent of cable modem transfer rates to each user. WiMAX outdistances Wi-Fi by miles. WiMAX coverage is measured in sq. Km/s, while that of Wi-Fi is measured in sq. meters. The biggest difference isn't speed; it's distance. Wi-Fi's range is about 100 feet (50 m). WiMAX covers a radius of 50 miles (50 km) with wireless access. The increased range is due to the power of the transmitter and frequencies used. WiMAX is not designed to clash with Wi-Fi, but to coexist with it.

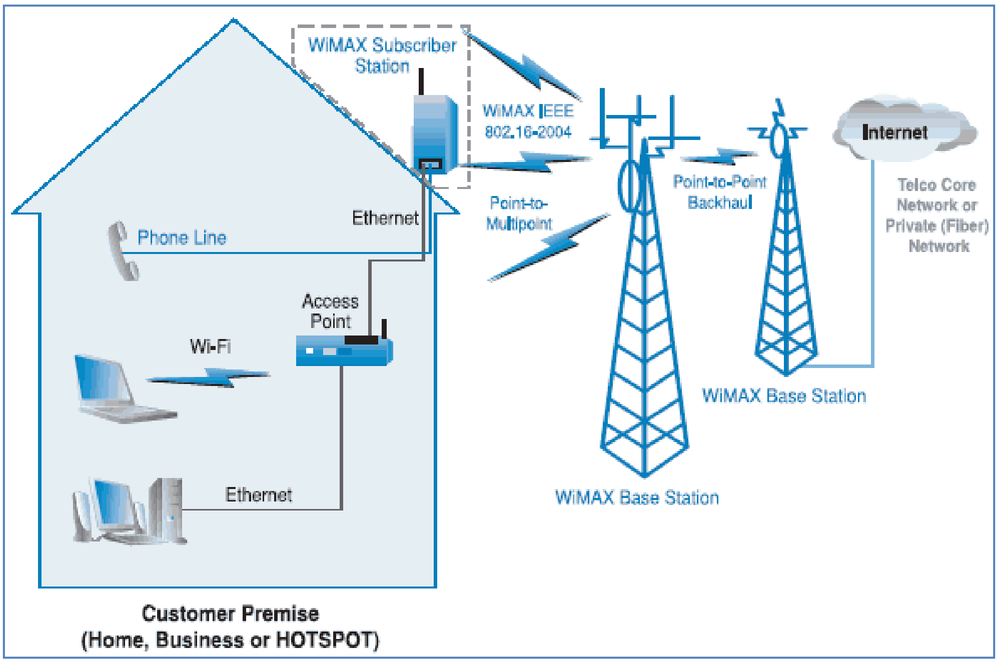

Fig.1: WiMAX base Station to user

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MIMO SYSTEM MODEL

Multiple-Input Multiple-Output (MIMO) technology is a wireless technology that uses multiple transmitters and receivers to transfer more data at the same time. Multiplexing exploits the structure of the channel gain matrix to obtain independent signaling paths that can be used to send independent data. A narrowband point-to-point communication system of Nt transmit and Nr receive antennas is shown in Figure 2. The transmitted matrix is a $Nt \times 1$ column matrix X, where Xi is the i^{th} component transmitted from the antenna i.

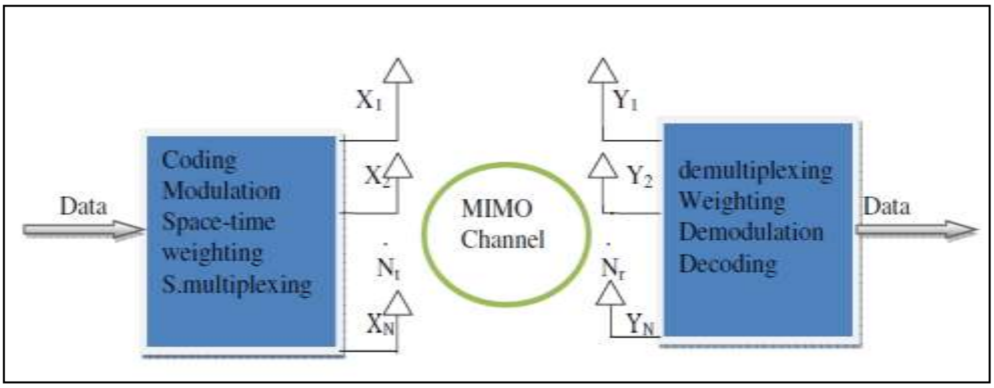

Fig 2 MIMO Model

Since each of the receive antennas detects all of the transmitted signals, there are N x N independent propagation paths, where there are transmit and receive antennas. This allows the channel to be represented as N x N matrix. Again using a 2 x 2 System as an example, the matrix below is obtained as:

$$H = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \quad (1)$$

Each of the elements in the channel matrix is define an independent propagation path. The transmitted signal can be represented as a vector, as can the received signal. Hence, the system can be represented as the following equation.

$$Y = HX + n \quad (2)$$

Where Y is the received signal vector, H is the channel Matrix, X is the transmitted signal vector, and n is the noise. The transmitted signals in the vector Y are complex signals, as the channel matrix values and the received signals in vector X. The complex form in each of the elements in the vectors represents the power of the signal and its phase delay. The complex form of the elements of the channel matrix 'H' represent the attenuation and phase delay associated with that propagation path.

OFDM

The concept of Orthogonal Frequency Division Multiplexing (OFDM) has been known since 1966, but it only reached sufficient maturity for deployment in standard systems during 1990s. OFDM is an attractive modulation technique for transmitting large amounts of digital data over radio waves. One major disadvantage of OFDM is that the time domain OFDM signal which is a sum of several sinusoids leads to high peak to average power ratio (PAPR). Number of techniques has been proposed in the literature for reducing the PAPR in OFDM systems. OFDM is a Multicarrier Transmission technique which divides the available spectrum into many carriers each one being modulated by a low data rate stream. OFDM is similar to Frequency Division Multiple Access (FDMA) in that the multiple user access is achieved by sub-dividing the available bandwidth into multiple channels, which are then allocated to users. However OFDM uses the spectrum much more efficiently by spacing the channels more closely together.

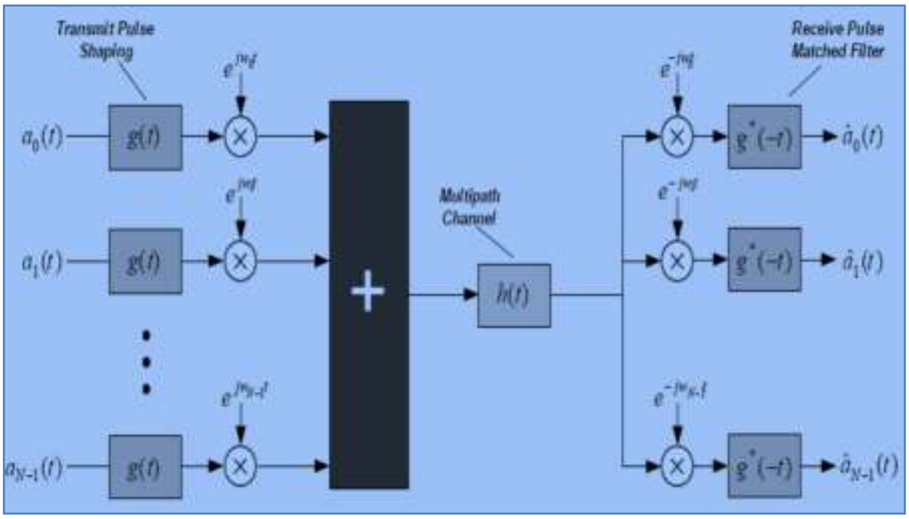

Fig. 3: OFDM is a multiplexing Technique

The Orthogonal frequency-division multiplexing (OFDM), is wide band digital communication technique that is based on block modulation. With the wireless multimedia application becoming more and more popular, the required bit rates are achieved due to OFDM multicarrier transmissions. For video communication, very high bit rate/high-speed communication is required.

AWGN CHANNEL NOISE LEVEL

The AWGN Channel block adds white Gaussian noise to a real or complex input signal. When the input signal is real, this block adds real Gaussian noise and produces a real output signal. The relative power of noise in an AWGN channel is typically described by quantities such as:

1) Signal-to-noise ratio (SNR) per sample. This is the actual input parameter to the AWGN function.
2) Ratio of bit energy to noise power spectral density (PSD) (Eb/No). This quantity is used by Barstool and performance evaluation functions in this toolbox.
3) Ratio of symbol energy to noise power spectral density (PSD) (Es/No).

If the average received power is P'[W] and the noise power spectral density is N_0 [W/hz], the AWGN channel capacity is:

$$c_{awgn} = W \log_2\left(1 + \frac{p'}{N_0 W}\right) \text{ Bit/Hz} \quad (3)$$

Where P'/NoW is the received signal-to-noise ratio (SNR).

1. When the SNR is large (SNR >> 0 dB), the capacity C≈ W $\log_2$ P'/N_0W is logarithmic in power and approximately linear in bandwidth (BW). This is called the bandwidth-limited regime.
2. When the SNR is small (SNR << 0 dB), the capacity C≈ W $\log_2$ e is linear in power but insensitive to bandwidth.

SIMULATION RESULTS THROUGH MATLAB

The name MATLAB stands for matrix laboratory. MATLAB was invented in the late 1970s by Cleve Moler, chairman of the computer science department at the University of New Mexico. It is developed by The Mathworks; Inc. (http://www.mathworks.com) .It is an interactive, integrated, environment, for numerical computations, symbolic computations and for scientific visualizations. It is a high-level programming language, Program runs in interpreted, as opposed to compiled, mode. In this analysis we are used in AWGN channel and different combination of antenna systems like (2*2, 1*2, 2*4 and 2*8) with 16-QAM (Quadrature amplitude modulation or M-ary techniques) modulation schemes used. The simulation results are shown in figure 4 and the result analysis are shown in table 1.

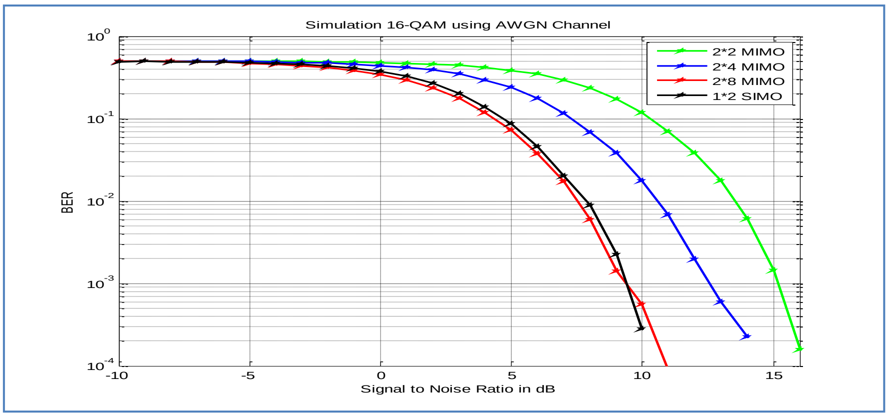

Fig. 4: Performance of 16-QAM with AWGN channel

Table 1: Performance analysis of 16-QAM with AWGN channel

System	Modulation/Channel	BER	SNR in dB
2×2	**16-QAM with AWGN Communication**	10^{-3}	15.3
1×2		10^{-3}	12.5
2×4		10^{-3}	9.2
2×8		10^{-3}	9.0

CONCLUSION

The wireless communication industry is facing new challenges due to constant evolution of new standards (2.5G, 3G, and 4G). Wireless systems are expected to require high data rates with low delay and low bit-error-rate (BER). The performance is displayed in figure 4 in terms of the BER verses SNR logarithmic plot. In the table 1 in this plot we analysis the 2*2 MIMO antenna system, SNR is increased 2.8dB on BER at 10^{-3} as compared to 1*2 SIMO antenna systems.

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