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A Review Downlink Performance Analysis of Signal Using MIMO Technology

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Abstract – A Review Paper of Demand for broadband services continues to grow. Conventional high-speed broadband solutions are based on wired-access technologies, such as digital subscriber line (DSL).This type of solution is difficult to deploy in remote areas, and furthermore it lacks support for terminal mobility. The WiMAX standard has emerged to harmonize the wide variety of different BWA technologies. Multiple Input Multiple Output (MIMO) multiplexing is a promising technology that could greatly increase the channel capacity without additional spectral resources. The challenge is to design low complexity and high performance algorithms that capable of accurately detecting the transmitted signals. As an extension to the basic MIMO mode, a number of 2x2 and 4x4 MIMO extensions are analyzed. Simulated Bit Error Rate and Signal to Noise Rate are presented for each link speed. Different aspects have been considered and discussed in this evaluation such as; signal to noise ratio, channel matrix conditionality, number of transmit and receive antennas, and other performance limiting factors. When we will work on the different MIMO techniques at the receiving end we will use different equalizer, different diversity techniques (SM,STBC,EigenBeamforming) different modulation techniques to see which one will shows the better BER performance with the relaying channel and AWGN channel.BER Performance comparisons and graphs have been generated using an optimized simulator. This simulator has been developed using MATLAB® platform.

Index Terms – MIMO, WiMAX, OFDM, Space Time Block Codes, Spatial Multiplexing, Eigen-beam forming.

1. INTRODUCTION

Orthogonal Frequency Division Multiplexing is a scheme used in the area of high-data-rate mobile wireless communications such as cellular phones, satellite communications and digital audio broadcasting. This technique is mainly utilized to combat inter-symbol interference, which will be described in the following document.. As an extension to the basic MIMO mode, a number of 2x2 and 4x4 MIMO extensions are analyzed. MIMO communications systems can exploit spatial multiplexing (SM) approach to increase the channel capacity and improve spectral efficiency as well as we are using the space time block code (STBC) and Eigen-beam forming approach too. Therefore, the MIMO SM-based system is one of currently promising techniques that can achieve high-speed wireless communications networks. In MIMO SM-based systems, independent data streams are transmitted from sufficiently-separated antennas. The different diversity techniques will calculate the BER with different channel and modulation technique and also the equalizer will play the important role in that process. These results in a linear increase in the channel capacity proportional to the minimum number of receive and transmit antennas. However, MIMO SM-based system requires powerful signal processing procedures at the receiver to efficiently recover the signal transmitted from the multiple antennas, and hence to explore the advantages of MIMO systems. Therefore, the potential advantages of MIMO system can be guaranteed and the wireless system will work in the best possible way. Some special detection techniques have been proposed in the literature in order to exploit the high spectral capacity offered by MIMO systems. The combination of OFDM and MIMO enables the frequency selective MIMO channel to be separated into many flat fading channels. This allows Equalization to be performed in the frequency domain on a sub-carrier by subcarrier basis. The MIMO OFDM is providing orthogonal carrier for the better result and the different MIMO modes will transmit the signal and equalizer will improving the signal quality on the receiver side.

2. (I.)WORKING PRINCIPLES

The OFDM technology was first conceived in the 1960s and 1970s during research into minimizing Inter-Symbol Interference, or ISI, due to multipath. OFDM is a special form of Multi Carrier Modulation (MCM) with densely spaced subcarriers with overlapping spectra, thus allowing for multiple-access. MCM) is the principle of transmitting data by dividing the stream into several bit streams, each of which has a much lower bit rate, and by using these sub-streams to modulate several carriers. This technique is being investigated as the next generation transmission scheme for mobile wireless communications networks. See that multiple-access is a transmission scheme where several simultaneous users can use the same fixed bandwidth. Some other m-a scheme are TDMA (Time Division Multiple Access), FDMA (Frequency Division Multiple Access and CDMA (Code Division Multiple Access).

3. OFDM STRUCTURES

All communication systems are, in its simplest form, composed of a transmitter, receiver and a channel of some sort for propagation. This is depicted in Fig. 1.

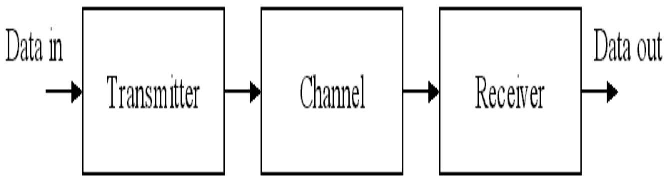

Fig.1. Simplified communications system

However, an OFDM system is more complicated as seen in Fig.2 Note that this block diagram will be used in this project and note that a typical OFDM system is a bit more involved than shown below.

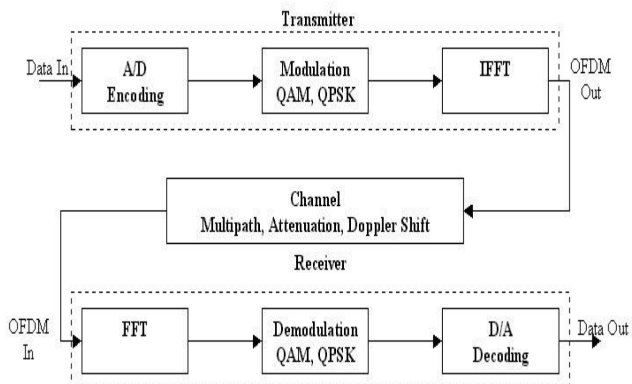

Fig. 2. OFDM block diagram

4. SPATIAL MULTIPLEXING SCHEME

The wireless channel constitutes a hostile propagation medium, which suffers from Fading (caused by destructive addition of multipath components) and interference from other users. Diversity is a powerful technique to combat fading and interference. Spatial diversity has become very popular in recent years since it can be provided without loss in spectral efficiency, see section 6.4. Because of its popularity and spectral efficiency, here is only transmission of spatial multiplexing considered

Spatial multiplexing transmits independent parallel data streams through multiple antennas at both transmitter and receiver, see Figure

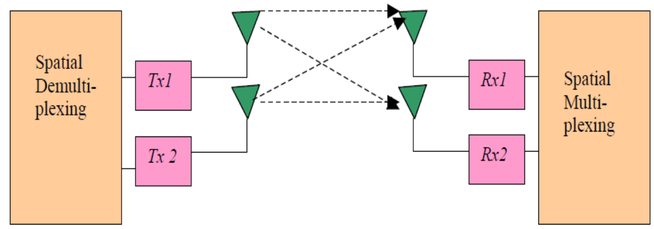

Figure3. Spatial multiplexing for 2x2 MIMO system

In a spatial multiplexing system the data stream to be transmitted is demultiplexed into lower rate streams which are then simultaneously sent from the transmitter antennas after coding and modulation. As soon as signals leave antennas at the transmitter they are mixed together in the wireless channel, since they use the same frequency spectrum. Each receiver antenna observes a superposition of the transmitted signals. The receiver then separates them into constituent data streams and remultiplexes them to recover the original data steam. This occurs for 2x2 MIMO system, as two unknowns are resolved from a linear system of two equations. Clearly the separation step determines the computational complexity of the receiver. In the following, both transmitter and receiver architecture is discussed.

5. SPACE-TIME BLOCK CODING

Space-Time Codes (STCs) have been implemented in cellular communications as well as in wireless local area networks. Space time coding is performed in both spatial and temporal domain introducing redundancy between signals transmitted from various antennas at various time periods. It can achieve transmit diversity and antenna gain over spatially uncoded systems without sacrificing bandwidth. The research on STC focuses on improving the system performance by employing extra transmit antennas In general, the design of STC amounts to finding transmit matrices that satisfy certain optimality criteria Constructing STC, researcher have to trade-off between three goals: simple decoding, minimizing the error probability, and maximizing the information rate. The essential question is: How can we maximize the transmitted date rate using a simple coding and decoding algorithm at the same time as the bit error the transmitted date rate using a simple coding and decoding algorithm at the same time as the bit error probability is minimized?

In a general form, an STBC can be seen as a mapping of nN complex symbols {s1, s2, SN} onto a matrix S of dimension nt × N:

$$\{s_1, s_2, \cdots, s_N\} \rightarrow \mathbf{S}$$

An STBC code matrix S taking on the following form:

$$\mathbf{S} = \sum_{n=1}^{n_N} (\bar{s}_n \mathbf{A}_n + j\tilde{s}_n \mathbf{B}_n),$$

Where {s1, s2, · ··,SnN } is a set of symbols to be transmitted with ¯sn = Re{sn} and ˜sn = Im{sn} and with fixed code matrices {An,Bn} of dimension nt× N are called linear STBCs.

6. BEAM FORMING

Through beam forming, a smart antenna algorithm can receive predominantly from a desired direction (direction of the desired source) compared to some undesired directions (direction of interfering sources). This implies that the digital processing has the ability to shape the radiation pattern for both reception and transmission [3] and to adaptively steer beams in the direction of the desired signals and put nulls in the direction of the interfering signals. This enables low co-channel interference and large antenna gain to the desired signal. Figure 2.11 shows the formation of transmit beams to desired users. Figure shows a receiver beam former which puts a null in the direction of interferer by choosing appropriate weights using adaptive beam forming algorithm

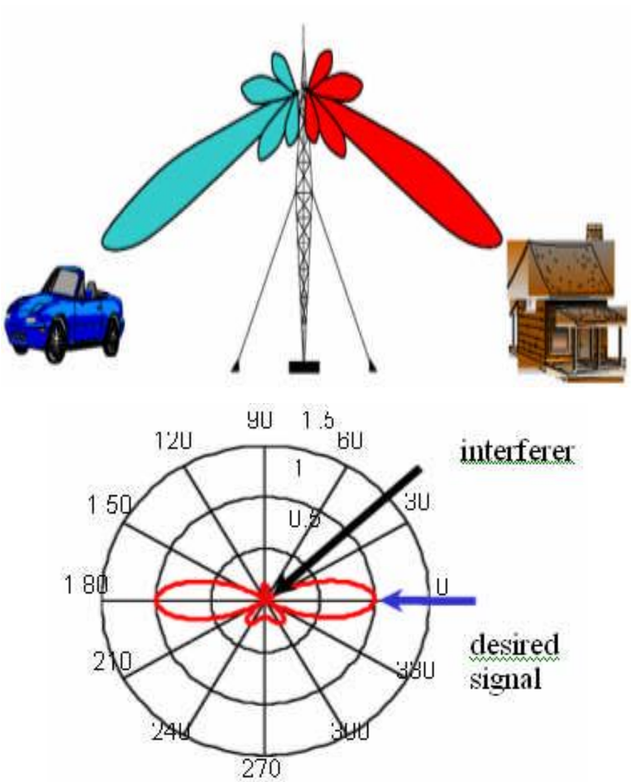

Figure4. Receiver beam forming reducing co-channel interference

Beam forming systems can be implemented in two ways; fixed beam forming systems or fully adaptive systems. A fixed beam forming system has a beam forming network (BFN) followed by RF switches which operate in the RF/analog domain. The switches are controlled by a control logic which selects a particular beam. Here the processing required is minimal as the control logic has to choose one of the predetermined set of weights to select a beam. In adaptive beam forming, the antenna gains or weights are chosen adaptively through running array algorithms in the digital Domain.

7. ADDITIVE WHITE GAUSSIAN NOISE (AWGN)

AWGN is a channel model in which the only impairment to Communication is a linear addition of wideband or white noise with a constant spectral density expressed as watts per hertz of bandwidth and a Gaussian distribution of amplitude. The model does not account for fading, frequency selectivity, interference, nonlinearity or dispersion. In the study of Communication systems, the classical (ideal) AWGN channel, with statistically independent Gaussian noise samples corrupting data samples free of inter-symbol interference (ISI), is the usual starting point for understanding basic performance relationships. An AWGN channel adds white Gaussian noise in the signal that passes through it.

8. RAYLEIGH FADING CHANNEL

Rayleigh fading is a statistical model for the effect of a Propagation environment on a radio signal such as that used by wireless devices. It assumes that the power of a signal that has passed through such a transmission medium (also called a Communications channels) will vary randomly or fade according to a Raleigh distribution, the radial component of the sum of two uncorrelated Gaussian random variables. It is reasonable model for troposphere and ionosphere signal propagation as well as the effect of heavily built up urban environment on radio signals. Raleigh fading is most applicable when there is no line of sight between the transmitter and receiver. In a multipath propagation environment, the received signal is sometimes weakened or intensified. The signal level of the received wave changes from moment to moment Multipath fading raises the error rate of the received data.

9. CONCLUSION

In our thesis we have worked on different antenna diversity under MIMO technique and implemented Beam forming, STBC, SM for BER analysis. We compared this three technique under different modulation scheme (BPSK, QAM) for our simulation model and we have compared result for BER in different antenna diversity 2*2 and 4*4 also, we will found when antenna diversity increases BER increases and to improve BER and ML and MMSE equalizer will be implemented and conclude that ML shows better BER performance as compared to MMSE, also we will consider different MIMO techniques like Beam forming, STBC and SM to evaluate better BER results.

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