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Design of Simulink Model For OSTBC And Performance Evaluation of Ieee 802.16 OFDM Phy Link With And Without Space-Time Block Coding For Wireless Communication

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ABSTRACT
Because of the rapid growth of Digital Communication in recent years, the need for high speed data transmission is increased. Orthogonal frequency division multiplexing (OFDM) technique is suitable for high speed communication because of its resistance to ISI (inter symbol interference) and it utilizes the bandwidth efficiently. OSTBCs are an attractive technique for MIMO wireless communications. They exploit full spatial diversity order and enjoy symbol-wise maximum likelihood (ML) decoding. However, they offer no coding gain. The combiner for OSTBC at the receiver side provides soft information of the transmitted symbols, which can be utilized for decoding or demodulation of an outer code.TCM is a bandwidth efficient scheme that integrates coding and modulation to provide a large coding gain. Concatenating TCM with an inner code will usually offer an improved performance. This illustrates the advantages of an OSTBC and TCM concatenation scheme: the spatial diversity gain offered by OSTBC and the coding gain offered by TCM. For comparison, two reference models containing only TCM or OSTBC are also provided. The diversity and coding gains of the concatenation scheme over the reference models can be clearly observed from the simulation results. Also this includes an end-to-end baseband model of the physical layer of a wireless metropolitan area network (WMAN), according to the IEEE® 802.16-2004 standard . More specifically, it models the OFDM-based physical layer, called Wireless MAN-OFDM, supporting all of the mandatory coding and modulation options.
Keywords: OFDM, MIMO, OSTBC, TCM, BER

I. INTRODUCTION

In earlier days we have Single Input Single Output (SISO) systems available, which consist of a single transmitting antenna and a single receiving antenna of a communication system. Speed of such SISO systems is not sufficient for the applications which require very high speed due to the increasing demands of the user in communication systems like internet etc. In order to attain high speed wireless reliable communication links we have the need for MIMO systems. Later on we have different configurations like SIMO, MISO [2] etc.

MIMO has multiple Input transmitting antennas and multiple output receiving antennas and, finally, MIMOmultiuser (MIMO-MU), which refers to a Configuration, that comprises a base station with multiple transmit/receive antennas interacting with multiple users, each with one or more antennas [1]. MIMO antenna cam be either at transmitter or receiver or at both. This system consists of several antenna elements, plus adaptive signal processing, at both transmitter and receiver. It exploits multipath instead of mitigating it [3]. Multiple input multiple output (MIMO) systems have attracted much attention because of high spectrum efficiency. The single most effective technique to accomplish reliable communication over a wireless channel is diversity which attempts to provide the receiver with the independently faded copies of transmitted signal with the hope that at least one of the replicas will be received correctly.

Diversity may be realized in many different ways, including frequency diversity, time diversity, antenna diversity, modulation diversity, etc. Many different detection techniques are developed to get the diversity gain introduced by MIMO techniques [9]. One of them is spatial Diversity technique in terms of Spatial Time Block codes (STBC) which is a old technique .As an advancement of this codes we designed Orthogonal Space Time Block codes and compared the performance with OSTBC to achieve high BER.

The paper is organized as follows. In Section II, importance and requirement of OSTBC is highlighted, Next, different STBC techniques are explained in Section III. The simulation methodology is discussed in Section IV. Results and analysis are presented in Section V. Finally, Section VI concludes this paper.

II.MOTIVATION FOR USING OSTBC

Wireless networks have quickly become part of everyday life. Wireless LANs, cell phone networks, and personal area networks are just a few examples of widely used wireless networks. However, wireless devices are range and data rate limited. The research community has spent a great deal of effort on finding ways to overcome these limitations. One method is to use Multiple-Input Multiple-Output (MIMO) links. The multiple antennas allow MIMO systems to perform precoding (multi-layer beamforming), diversity coding (space-time coding), and spatial multiplexing. Beamforming consists of transmitting the same signal with different gain and phase (called wights) over all transmit antennas such that the receiver signal is maximized. Diversity consists of transmitting a single space-time coded stream through all antennas. Spatial multiplexing increases network capacity by splitt ing a high rate signal into multiple lower rate streams and transmitting them through the different antennas. In spatial multiplexing, the receiver can successfully decode each stream given that the received signals have sufficient spatial signatures and that the receiver has enough antennas to separate the streams. The result of using these MIMO techniques is higher data rate or longer transmit range without requiring additional bandwidth or transmit power.

III.BACKGROUND

One of the methodologies for exploiting the capacity in MIMO system consists of using the additional diversity of MIMO systems, namely spatial diversity, to combat channel fading. This can be achieved by transmitting several replicas of the same information through each antenna. By doing this, the probability of loosing the information decreases exponentially [3]. The antennas in a MIMO system are used for supporting a transmission of a SISO system since the targeted rate of is that of a SISO system. The diversity order or diversity gain of a MIMO system is defined as the number of independent receptions of the same signal. A MIMO system with Nt transmit antennas and Nr receive antennas has potentially full diversity (i.e. maximum diversity) gain equal to Nt Nr.

The different replicas sent for exploiting diversity are generated by a space-time encoder which encodes a single stream through space using all the transmit antennas and through time by sending each symbol at different times. This form of coding is called Space-Time Coding (STC). Due to their decoding simplicity, the most dominant form of STCs are space-time block codes (STBC). In the next sections,
different STBC techniques were discussed.

A. Alamouti's STBC

In [14], Alamouti published his technique on transmit diversity. Historically, Alamouti's scheme was the first STBC [4]. The simplicity and structure of the Alamouti STBC has placed the scheme in both the W-CDMA and CDMA-2000 standards [3]. The Alamouti STBC scheme uses two transmit antennas
and Nr receive antennas and can accomplish a maximum diversity order of 2Nr [14]. Moreover, the Alamouti scheme has full rate (i.e. a rate of 1) since it transmits 2 symbols every 2 time intervals. Next, a description of the Alamouti scheme is provided for both 1 and 2 receive antennas, followed by a general expression for the decoding mechanism for the case of Nr receive antennas.

B. Orthogonal Space-Time Block Codes

The Alamouti scheme discussed in Section III-A is part of a general class of STBCs known as Orthogonal Space-Time Block Codes (OSTBCs) [4]. The authors of [15] apply the mathematical framework of orthogonal designs to construct both real and complex orthogonal codes that achieve full diversity. For the case of real orthogonal codes, it has been shown that a full rate code can be constructed [15]. However, for the case of complex orthogonal codes, it is unknown if a full rate and full diversity codes exist for Nt > 2 [3].

III.EXPERIMENTAL SET UP

Platform used one is MATLAB Simulink The platform of the simulator is Simulink version 8.3, as one part of Release 2014a from the MathWorks. Simulink is well integrated with the MATLAB environment, which means Simulink has good access to many MATLAB features. Simulink is a software tool to model, simulate and analyze dynamic systems including signal processing, communication systems and control systems .A feature of Simulink is that it is model-based.

In Simulink, the functions are performed by the blocks and the data can be transmitted between the blocks by the connecting lines, which represent the signals.

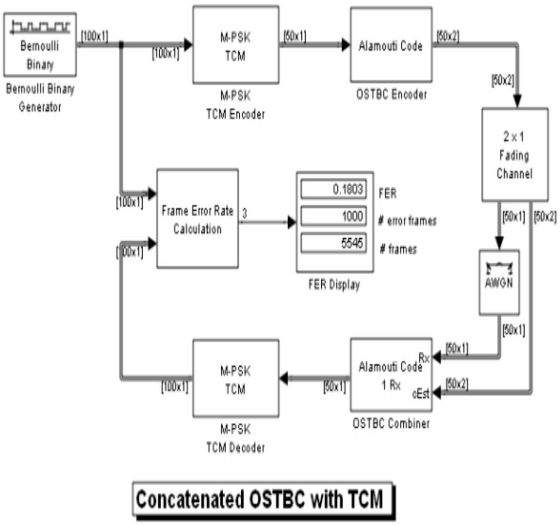


Fig 1.Concatenated OSTBC with TCM

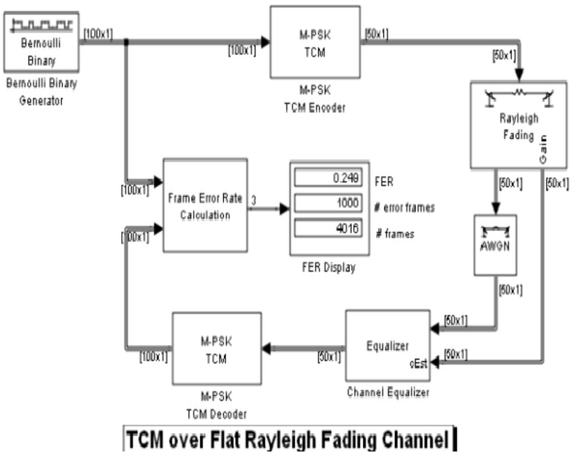


Fig 2.TCM Over Flat Rayleigh fading channel

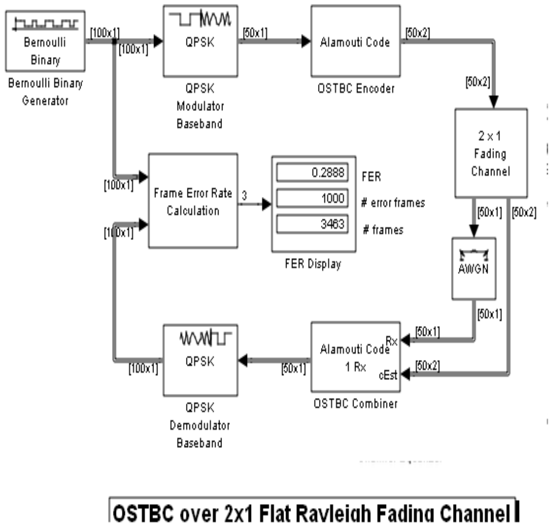


Fig 3.OSTBC Over 2X1Flat Rayleigh fading channel

Figure 4 and Figure 5 displays FER results withTCM Over Flat Rayleigh fading channel and OSTBC Over 2X1Flat Rayleigh fading channel, resulting into less FER with OSTBC.

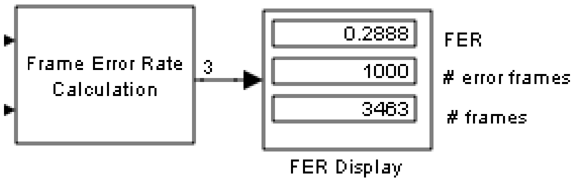


Fig.4.With OSTBC over Flat Rayleigh Fading Channel

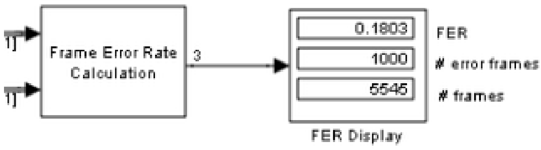


Fig.5.With TCM over Flat Rayleigh Fading Channel

IV.SIMULATION RESULTS AND ANALYSIS

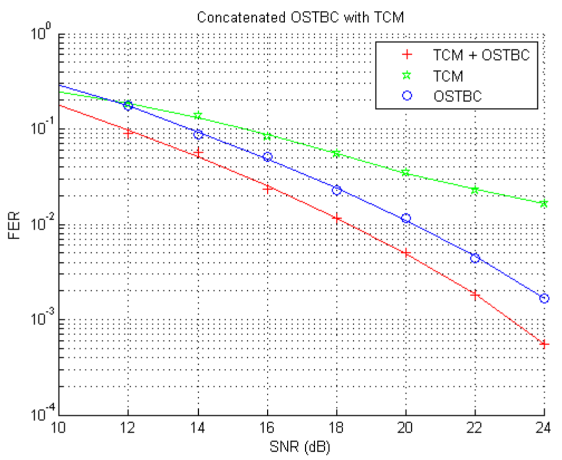


Fig.6. BER Vs SNR for concatenated OSTBC with TCM, TCM,OSTBC

The concatenation scheme provides a significant diversity gain over the TCM scheme and about 2dB coding gain over the Alamouti code.

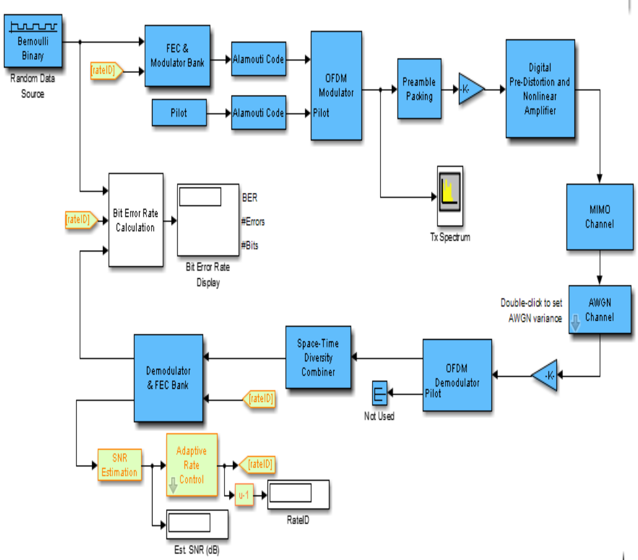


Fig 7. Simulation set up of OFDM PHY Link with STBC

The tasks performed in the communication system models include:

- ✓ Generation of random bit data that models a downlink burst, consisting of an integer number of OFDM symbols.
- ✓ **Forward Error Correction** (FEC), consisting of a Reed-Solomon (RS) outer code concatenated with a rate-compatible inner convolutional code (CC).
- ✓ **Data interleaving.**Modulation, using one of the BPSK, QPSK
- ✓ 16-QAM or 64-QAM constellations specified.
- ✓ Orthogonal Frequency Division Multiplexed (OFDM) transmission using 192 sub-carriers, 8 pilots, 256-point FFTs, and a variable cyclic prefix length.
- ✓ Space-Time Block Coding using an Alamouti code

This implementation uses the OSTBC Encoder and Combiner blocks in the Communications Blockset. A single OFDM symbol length preamble that is used as the burst preamble. For the optional STBC model, both antennas transmit the single symbol preamble.An optional memoryless nonlinearity that can be driven at several backoff levels.An optional digital pre-distortion capability that corrects for the nonlinearity.A Multiple-Input-Single-Output (MISO) fading channel with AWGN for the STBC model. You can choose a non-fading, flat-fading, or dispersive multipath fading channel for the non-STBC model.OFDM receiver that includes channel estimation using the inserted preambles. For the STBC model, this implies diversity combining as per Hard-decision demodulation followed by deinterleaving, Viterbi decoding, and Reed-Solomon decoding.

Fig 8. AMAM Plot at the nonlinearity output

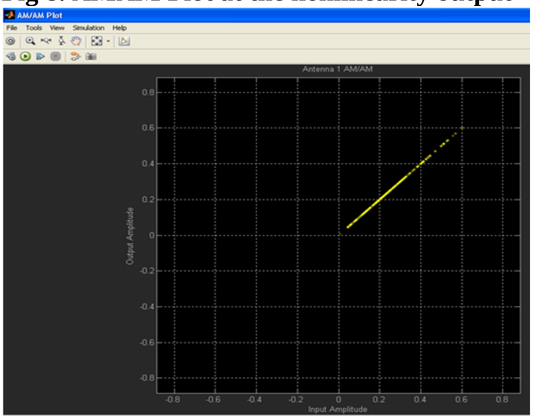


Fig 9. AMPM Plot at the nonlinearity output

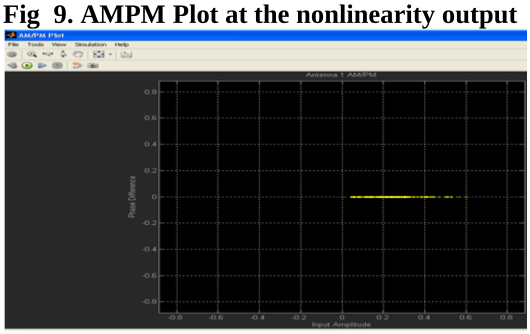


Fig10. Spectrum plot of channel

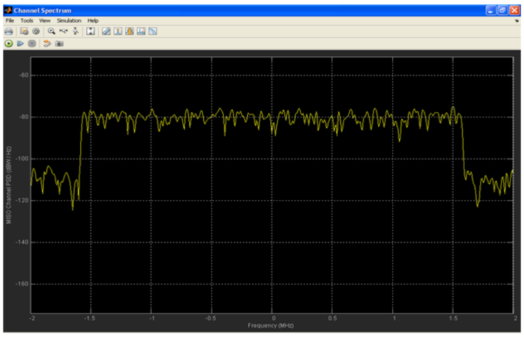


Fig 11. A scatter plot of the received signal prior to demodulation.

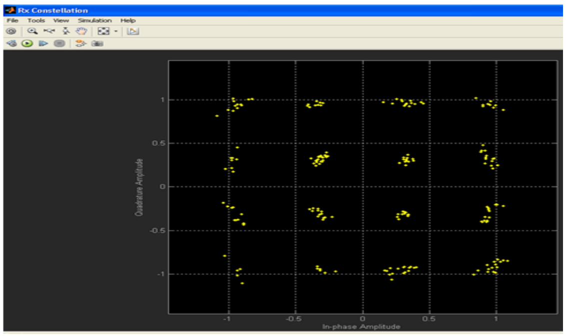
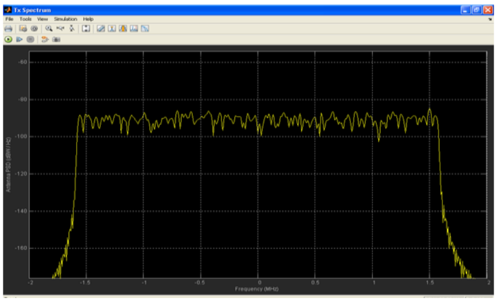


Fig12. Spectrum plot of the transmitted signal



The STBC link model uses a MISO fading channel to model a two transmitter, one receiver (2x1) system. The fading parameters specified are assumed to be identical for the two links. The Space-Time Diversity Combiner block uses the channel estimates for each link and combines the received signals .The combining operation performs simple linear processing using the orthogonal signalling employed by the encoder.

Furthermore, both models include blocks for measuring and displaying the bit error rate after FEC, the channel SNR and the rate_ID. Spectrum Scope blocks display the spectra of both the OFDM transmitter output and the faded AWGN channel output. Also, a Scatter Plot scope displays the AM/AM and AM/PM characteristics of the signal at the output of the memoryless nonlinearity. Finally, a Scatter Plot scope displays the received signal, helping you to visualize channel impairments and modulation adaptation as the simulation runs.

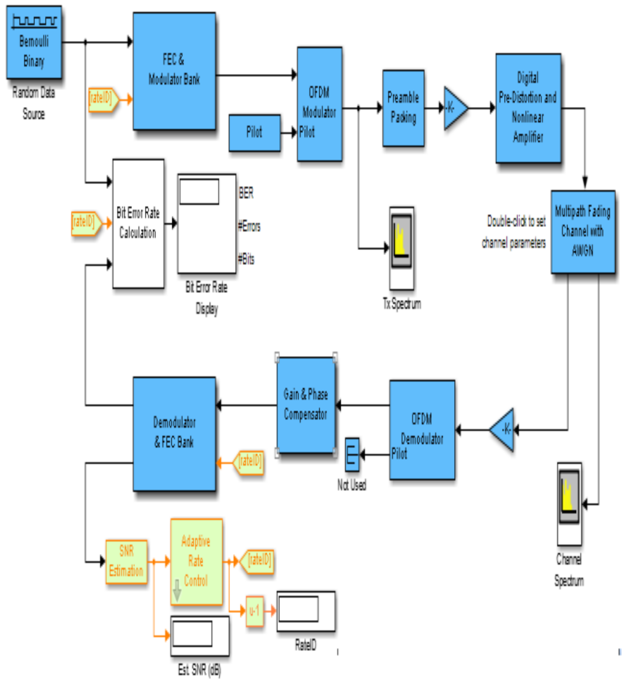


Fig 13. Simulation set up of OFDM PHY Link

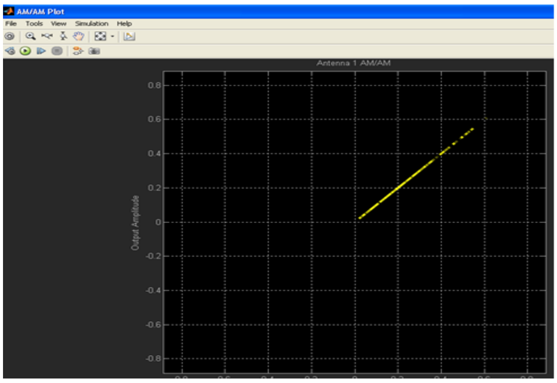


Fig 14. AMAM Plot at the nonlinearity output

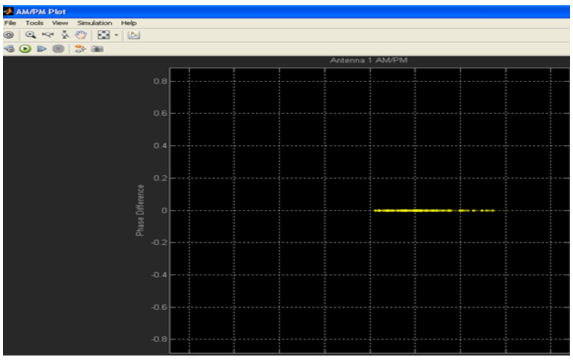


Fig 15. AMPM Plot at the nonlinearity output

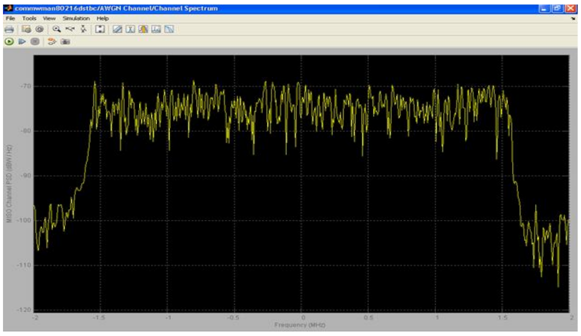


Fig 16. Plot of channel spectrum

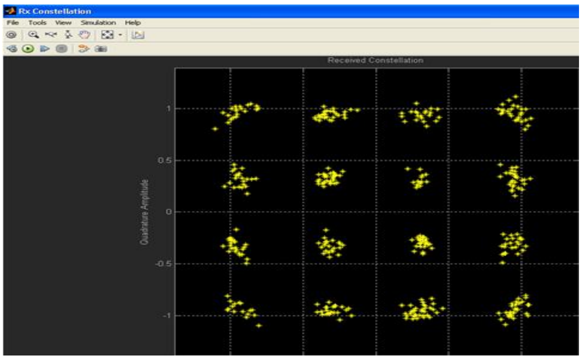


Fig 17. Plot of Receiver constellation

V.CONCLUSION

FER results withTCM Over Flat Rayleigh fading channel and OSTBC Over 2X1Flat Rayleigh fading channel, has been compared resulting into less FER with OSTBC.The combiner for OSTBC at the receiver side provides soft information of the transmitted symbols, which can be utilized for decoding or demodulation of an outer code. Concatenating TCM with an inner code will offered an improved performance. This illustrates the advantages of an OSTBC and TCM concatenation scheme, the spatial diversity gain offered by OSTBC and the coding gain offered by TCM. For comparison, two reference models containing only TCM or OSTBC are provided. The diversity and coding gains of the concatenation scheme over the reference models are clearly observed from the simulation results.

Also this included an end-to-end baseband model of the physical layer of a wireless metropolitan area network (WMAN), according to the IEEE® 802.16-2004 standard More specifically, it models the OFDM-based physical layer, called Wireless MAN-OFDM, supporting all of the mandatory coding and modulation options.

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