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Performance Analysis of STBC Channel Coding Techniques for LTE Advanced Systems

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Abstract: Wireless communication has become critical with the growth of usage of broadband services. The data traffic has been increasing day by day when compared to past few hours. Therefore the required bandwidth and modulation techniques using at present might not be successful from the proper transmission of large data. Here comes the MIMO technique where more than one antennas are used near the transmit as well as receiver ends. Therefore it is the need of the hour to use STBC (Space Time Block Coding) which uses transmit diversity for successful transmission.

I. INTRODUCTION

It is necessary to use the available spectrum efficiently for transmission of data. There is a need to improve the optimal STC techniques and spatial multiplexing schemes (SISO, MISO, SIMO, MIMO) to meet increasing data rates. Keeping this in mind, we provide a general theoretical analysis of different modulation techniques using MATLAB is done by comparing their SNR versus BER plots The modulation techniques include OSTBC, QPSK, BPSK, 16 & 64-QAM for different antenna configurations. The paper is organized as follows: Section 2 explains various factors responsible for signal loss. Section 3 gives brief explanation about MIMO. Section 4 provides explanation about STBC and final section gives the result.

II. FACTORS RESPONSIBLE FOR SIGNAL LOSS

The important factors responsible for the loss of wireless signal are:

A. Fading

It is defined as the attenuation or deviation of the transmitted signal with various variables. It is divided into two types- Slow fading and Fast fading. A channel which undergoes fading is called as fading channel.
Rayleigh fading: It is a statistical model for propagation effect on radio signal.

B. Multi Path Propagation

It is not necessary that both the transmitters and receivers should be in line of sight (LoS)., therefore there is no direct path for the transmitted signal. Due to the obstacles present between the transmitter and receiver, the signal reaches the receiver by different paths. As a result, the receiver receives more than one signal where all the signals are attenuated and corrupted. These obstacles include mountains, trees, static objects etc.

C. Interference

Due to multipath propagation, the receiver receives more than one signal at a time which results in overlapping of the signal which causes loss of information.

III. MIMO

Multiple Input Multiple Output (MIMO) communication systems are very reliable wireless systems in order to overcome the effect of multipath Rayleigh fading. In MIMO, multiple antennas are used which reduces the probability of data loss. In case of SISO, there exists only one antenna at transmit and receiver side and the signal gets only a single path for propagation. There are more possibilities in SISO for attenuation of signal since there are no other paths.

IV. SPACE TIME BLOCK CODES

Space time block coding is a technique in wireless communication where replicas of the data are transmitted through different transmitting antennas so that atleast one of those data streams will reach the receiver correctly without undergoing any changes. The main aim is to reduce the chance of data getting corrupted. An STBC is usually represented in form of a matrix- each row represents a time slot., each column represents one antenna's transmission over a period. The code rate of STBC measures the number of

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symbols it transmits per time slot on average over one block. Consider if a block of data encodes **k** symbols, the code rate is given by **r = k/T**.

Only one STBC can achieve code rate of unity (r = 1) ie the **alamouti code**.

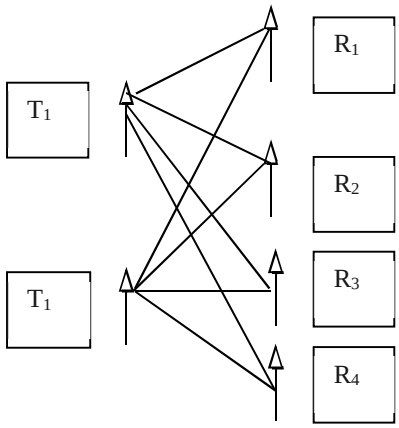
There are three types of STCs

1) Space Time Block Codes (STBC)
2) Space Time Trellis Codes (STTC)
3) Space Time Turbo Codes

Here we mainly focus on STBC.

A. 2×4 STBC

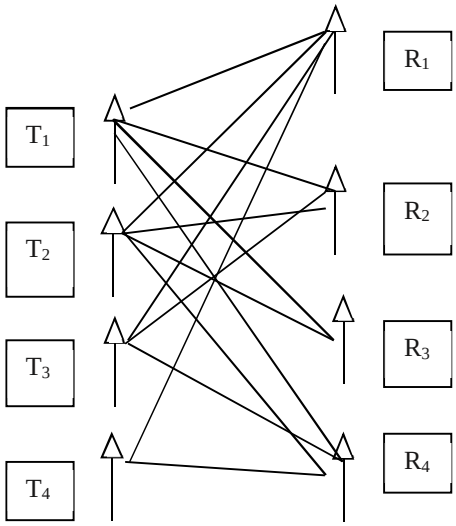
In 2×4 STBC, there are two antennas at transmitting side and four at Receiving antennas.
The figure shows the arrangement of transmitters and receivers.



B. 4×4 STBC

In 4×4 STBC there will be four number of transmitters and receivers where the signal will be transmitted through more than one antenna so that atleast one signal can be retrieved effectively by the receiver.
We have many benefits of 4×4 MIMO as it increases the capacity gain. While the concept of 4×4 MIMO has existed for atleast a decade, but actual deployment didnt start until 2016. These adavantages urged the mobile operators to use four transmitters receivers. Apart from adavantages, the installation of 4×4 STBC requires additional amplifiers, filters, antennas, cables etc which in turn increases the complexity and cost.
4×4 STBC matrix representation is as follows:

$$S=\begin{bmatrix} S_1 & -S_2 & -S_3 & -S_4 \\ S_2 & S_1 & S_4 & -S_3 \\ S_3 & -S_4 & S_1 & S_2 \\ S_4 & S_3 & S_2 & S_1 \end{bmatrix}$$

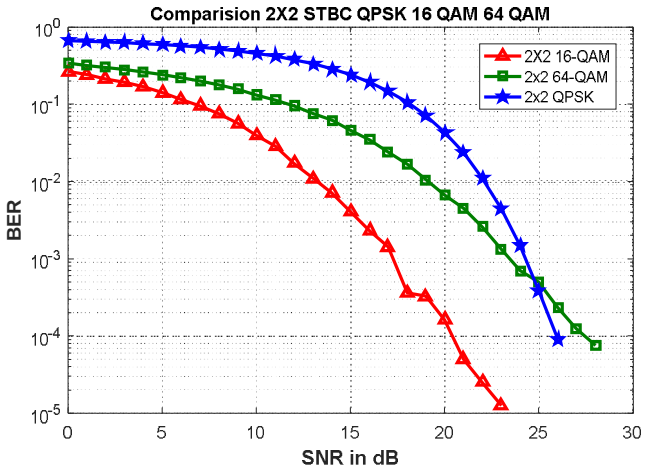


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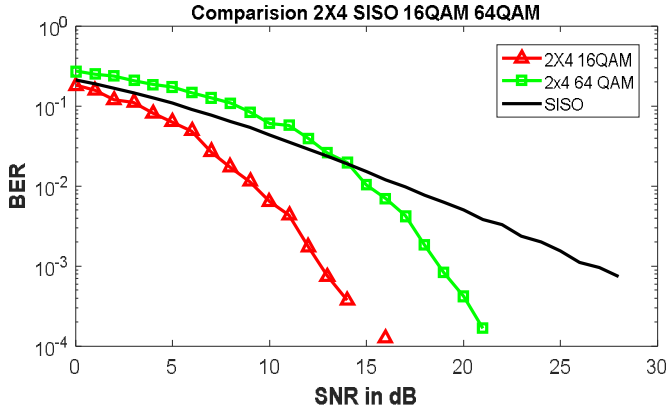
V. RESULTS

A. Below figure is the result of MATLAB stimulation of 2×2 STBC QPSK, 16-QAM, 64-QAM



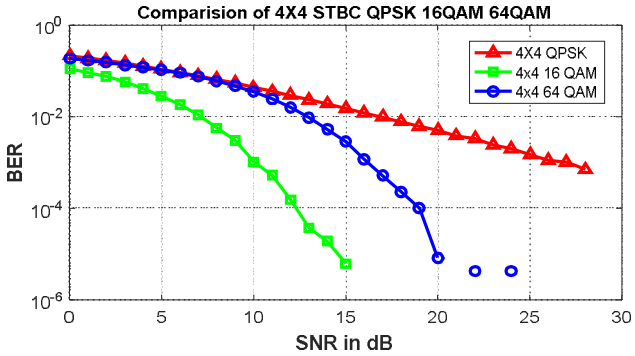
From the figure, it can be concluded that 2×2 16-QAM gives better results compared to other modulation techniques when there are two transmit receivers.

B. Below figure is the result of MATLAB stimulation of 2×4 SISO, 2×4 16-QAM, 2×4 64-QAM



From the figure, it can be concluded that 2×4 16-QAM gives better results compared to other modulation techniques when there are two transmit antennas and four receivers. It can be seen that when single input output are used, the BER is high that means the exact bits are not retrieved at receiver.

C. Below figure is the result of MATLAB stimulation of 4×4 STBC, 4×4 16-QAM, 4×4 64-QAM

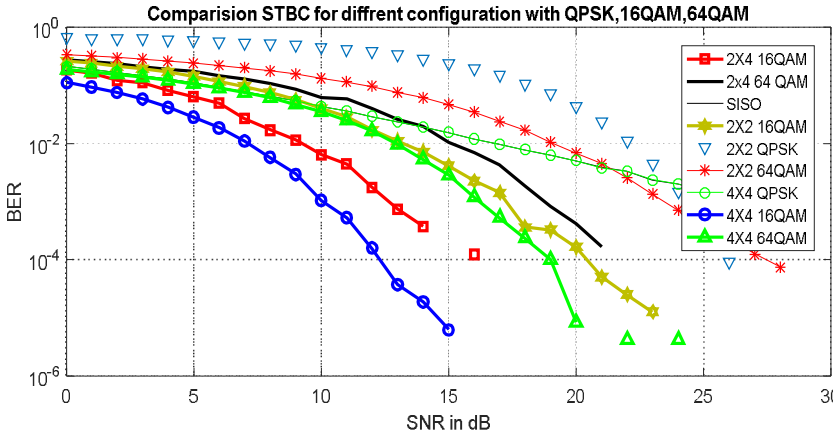


From the figure, it can be concluded that 4×4 16-QAM gives better results compared to other modulation techniques when there are four transmit antennas and four receivers.

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D. Overall Comparison Of Modulation Techniques

Below figure shows the overall comparison of different modulation techniques and can figure out the best technique:



From the figure, the 4×4 16-QAM gives better results ie., less BER when a stream of data is sent from transmitter to receiver. Therefore it can be concluded that if we use only single antenna for reception, the more will be the BER., if more number of antennas are used, BER will be reduced.

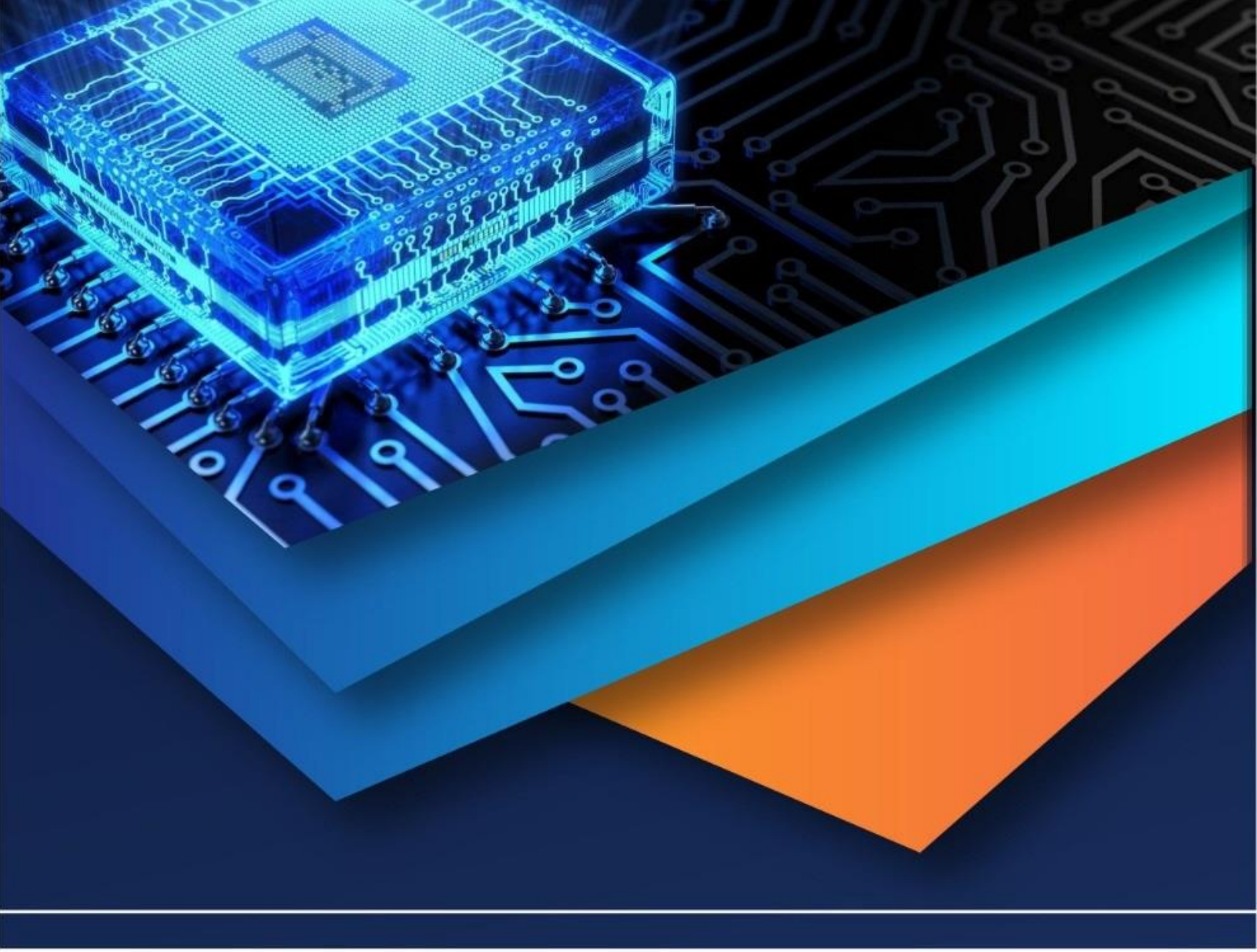
VI. CONCLUSION

Wireless communication is one of the important means of data transfer which is increasing day by day at a higher pace. So there must be capable channel for means of data transfer appropriately. According to our analysis, 4×4 (four number of transmitters and receivers) which uses 16-QAM modulation is recommended for data transmission since it gives the least BER. It can be extended further to 8×8 or 16×16 and check for transmission.

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