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MIMO System Performance Analysis Using Higher Modulation Order

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ABSTRACT

The increased competition for digital systems and the development of Internet-related material in practical environments has sparked interest in high-speed technologies. Multiple transmit and receive antennas are used to create multiple input multiple output (MIMO) channels to accomplish these objectives. MIMO systems significantly increase system capacity by manipulating the spatial dimension via spatial multiplexing, reliability through diversity and reduction of interference in multiple users. Massive MIMO becomes a main fifth generation (5G) mobile communications technology that will enhance huge performance like higher data rates , higher reliability, lower latency and more channel capabilities MIMO diversity systems are mixed with orthogonal frequency division multiplexing (OFDM) to create MIMO-OFDM systems for further increase the device efficiency and protect toward fading. Diversity is a multipath-fading strategy used to counter it. Space Diversity method employing various number of antenna are used at transmitter and receiver side.

Keywords:- MIMO, OFDM, 5-G, spatial multiplexing, multipath-fading

1. INTRODUCTION

A) MULTIPLE INPUT MULTIPLE OUTPUT (MIMO)

Massive number of spatial multiplexing data streams integrated with high order constellations is the key to building efficient future wireless technology which will meet the bandwidth and transmission speed requirements of modern-day communications. Low order constellations consume more amount of energy to transmit same amount of information, compared to high orders, which transmit more bits per each constellation symbol. Multi Input Multi Output (MIMO) systems have become the necessary standard for building efficient wireless technologies such as Long Term Evolution (LTE), IEEE802.11/802.16 and is also requirement for 5G wireless systems.

Therefore it is important to investigate the behaviour of bit error rates for both conventional and massive MIMO systems with high order constellations, which are essential to achieve spectral efficiency for 5G standard communications.

2. PROPOSED METHODOLOGY

Part 1

The simulation consists of an end-to - end system that shows the encoded and/or transmitted signal, the channel model, and the reception and demodulation of the received signal. It also provides the no-diversity link (single transmit-receive antenna case) and the theoretical performance of the second order diversity link for comparison. It is assumed that the channel is perfectly known to the receiver for all systems. We run a simulation over a range of Eb / No points to generate BER results, which allow us to compare the different systems.

PART 2: Space-Time Block Coding with Channel Estimation

Using orthogonal theory, Alamouti's broadcast diversity regime has led to the idea of space-time block codes, leading to an arbitrary range of transmitter antennas. They showed that the Alamouti scheme is the only full rate system for two broadcasting antennas for complex signal constellations. In this section, we achieve a system like this, with two antennas (i.e. a 2x2 network), and without the estimate of the channel. This is to be extracted from the received signal in a realistic scenario where the information on the channel state is not known at the receiver.

PART 3: Orthogonal Space-Time Block Coding and Further Explorations

The performance data will be analyzed with respect to orthogonal space-time block coding with a half-rate code using the four transmitting antennas (4x1 system). We hope the system will offer a range of 4 and compare it with systems with 1x4 and 2x2, which are also of the same range of diversities. We will use the QAM scheme to allow a fair comparison.

PART 4: Development of 4x4 System with higher modulation order (64, 256 QAM) for 5G

Based on the above understanding of 2x2, 1x4 and 4x1 system as well as diversity system. Here we will develop a higher order MIMO system with the capabilities of higher modulation incorporation. The results will be showed in the form of BER plot and constellation plot.

RESULTS

We run the simulation over a range of Eb/No points to generate BER results that allow us to compare the different systems. Also observe that transmit diversity has a 3 dB disadvantage when compared to MRC receive diversity. This is because we modeled the total transmitted power to be the same in both cases. If we calibrate the transmitted power such that the received power for these two cases is the same, then the performance would be identical. The theoretical performance of second-order diversity link matches the transmit diversity system as it normalizes the total power across all the diversity branches as shown in Fig. 1.

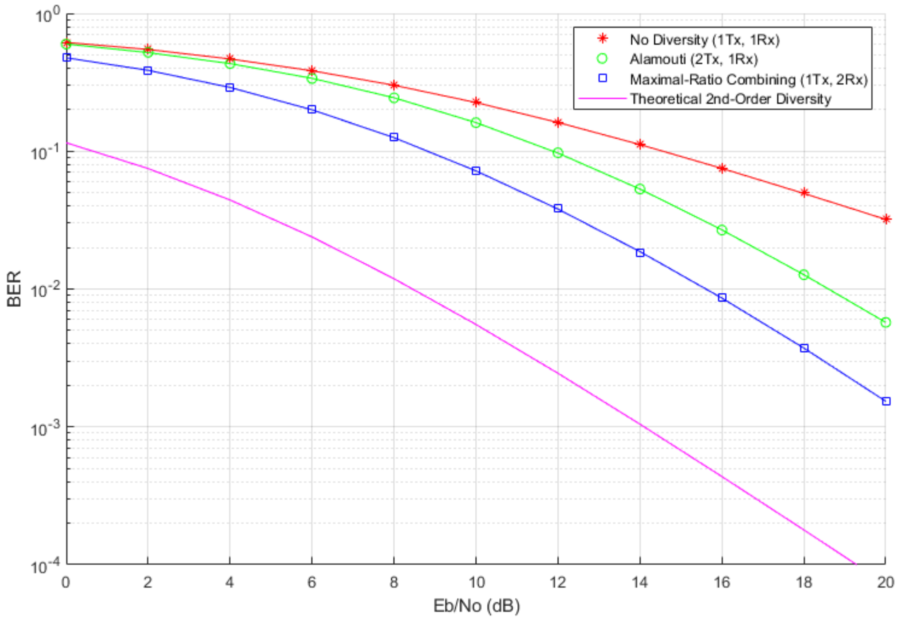

Figure 1 Transmit vs. Receive Diversity

For the 2x2 simulated system, the diversity order is different than that seen for either 1x2 or 2x1 systems in the previous section. Note that with 8 pilot symbols for each 100 symbols of data, channel estimation causes about a 1 dB degradation in performance for the selected Eb/No range. This improves with an increase in the number of pilot symbols per frame but adds to the overhead of the link. In this comparison, we keep the transmitted SNR per symbol to be the same in both cases as shown in Fig. 2.

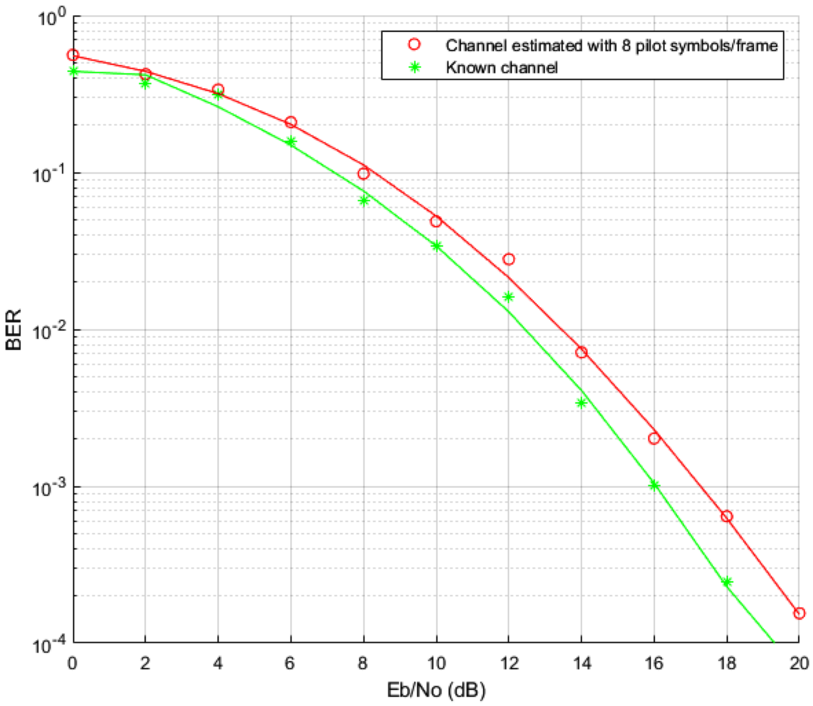

Figure 2 Channel Estimation

As expected, the similar slopes of the BER curves for the 4x1, 2x2 and1x4 systems indicate an identical diversity order for each system. Also observe the 3 dB penalty for the 4x1 system that can be attributed to the same total transmitted power assumption made for each of the three systems. If we calibrate the transmitted power such that the received power for each of these systems is the same, then the three systems would perform identically. Again, the theoretical performance matches the simulation performance of the 4x1 system as the total power is normalized across the diversity branches as shown in Fig. 3.

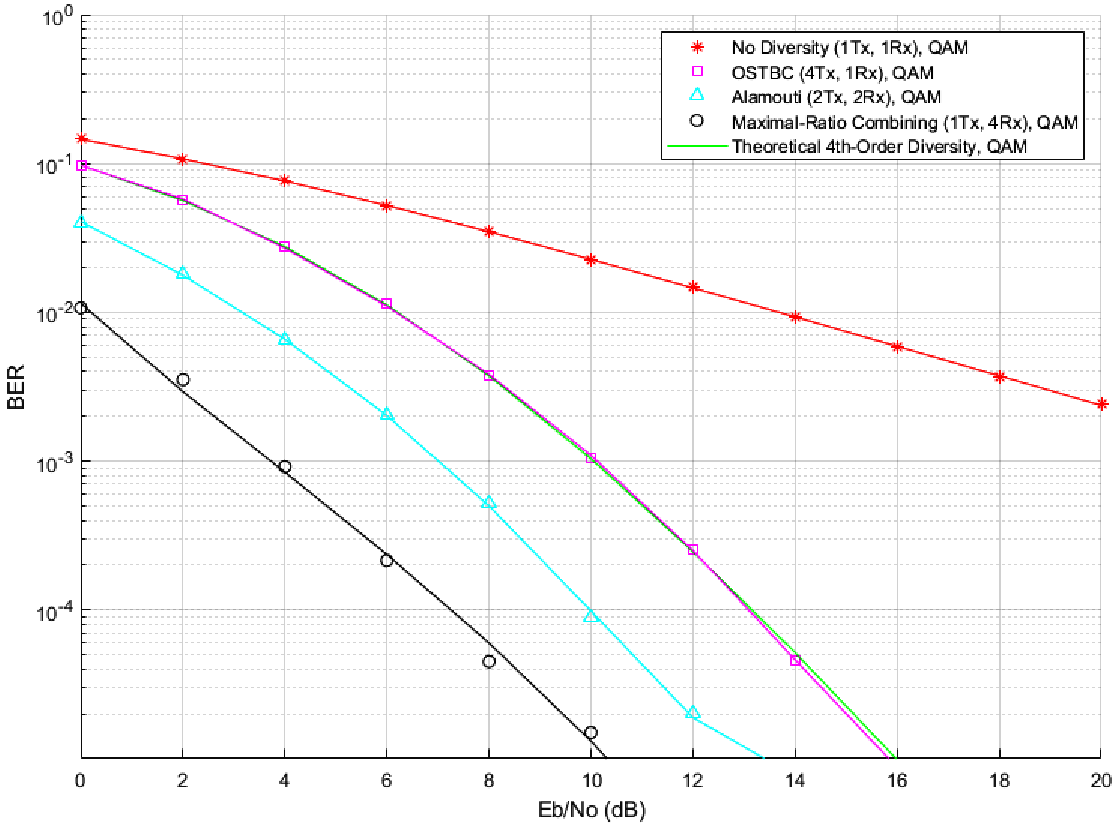

Figure 3 Transmit vs. Receive Diversity

To check the efficiency of the proposed method we have tested by varying different modulation schemes with different transmitters. It helps in the formulation of the transmit-end precoding matrices and their application to a MIMO-OFDM system. Initially in Fig. 4 we are able to perfectly decode the 256 QAM signal for 16 and 32 transmitters. From Fig. 4 and 5 we can see that the constellation are perfectly decoded after the equalization.

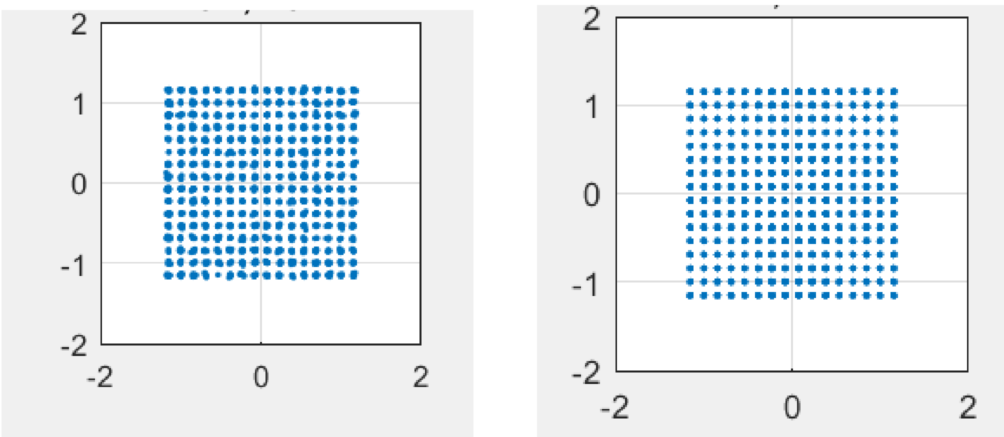

Figure 4 Snapshot of TX-16-256

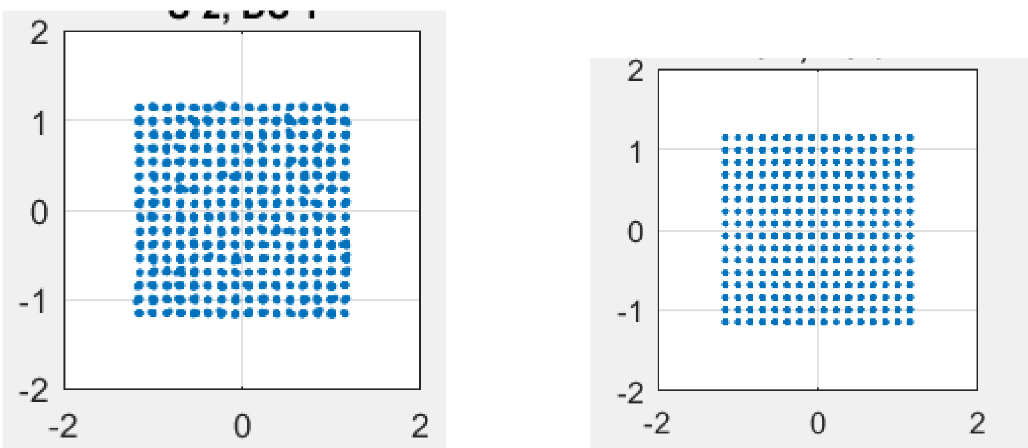

Figure 5 Snapshot of TX-32-256

Similarly, using the 64 transmitters with different modulation schemes of QPSK and QAM the signal is perfectly decoded.

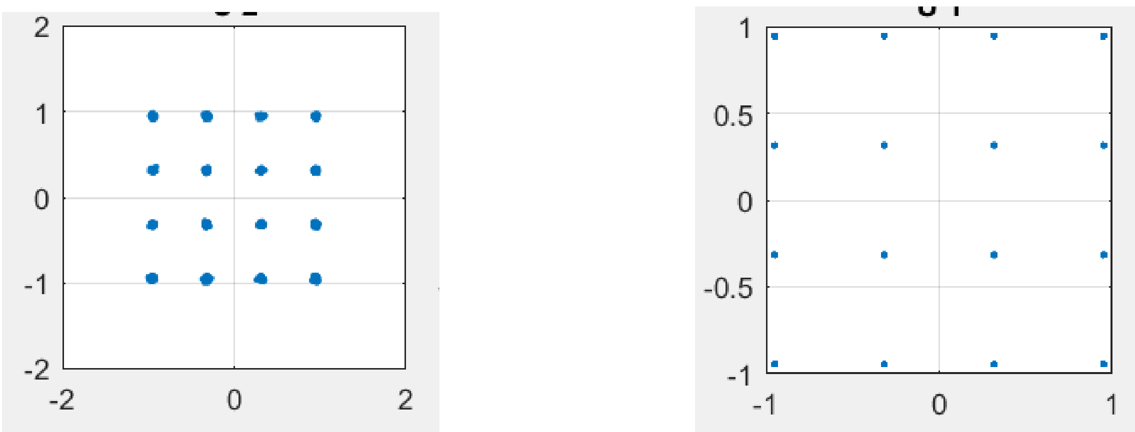

Figure 6 Snapshot of 64_tx_16qam

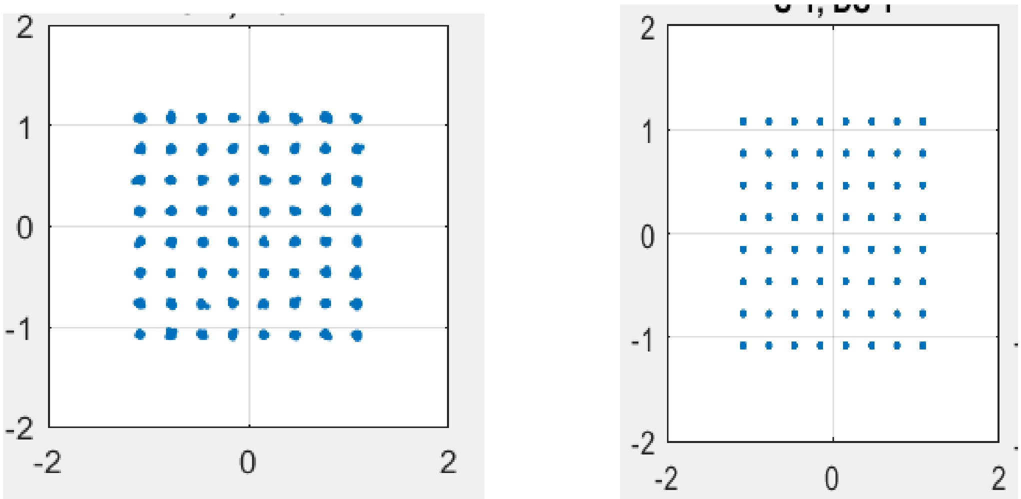

Figure 7Snapshot of 64_tx_64QAm

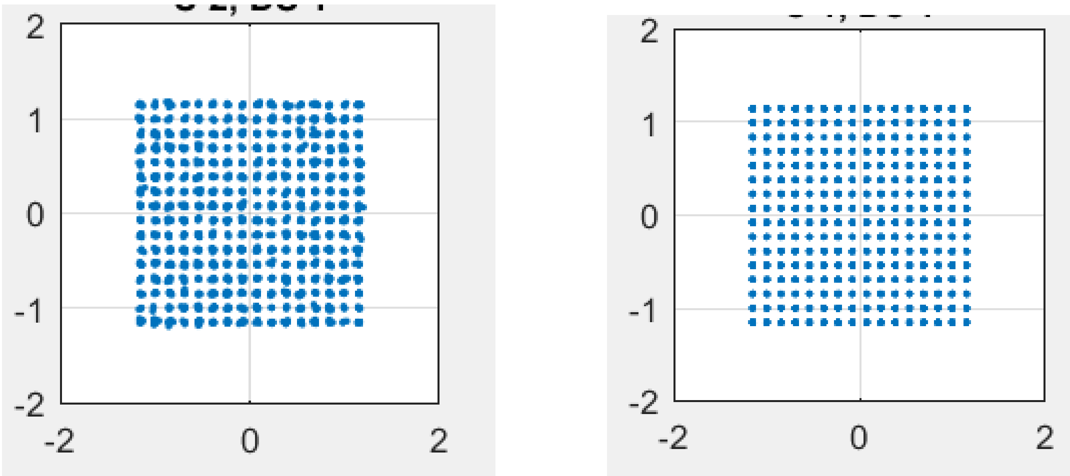

Figure 8 Snapshot of 64tx_256QAM

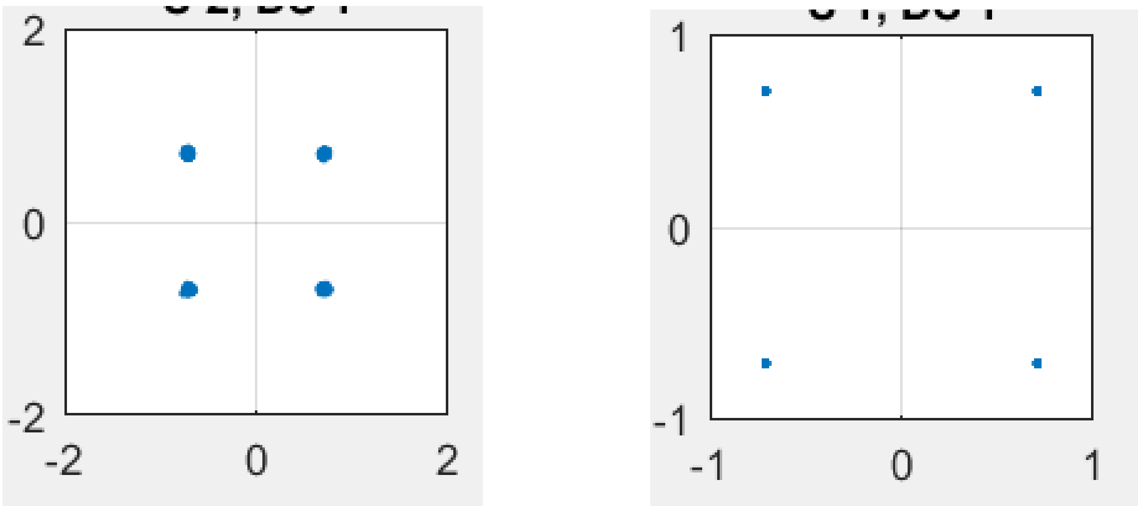

Figure 9 Snapshot of 64_tx_QPSK

3. CONCLUSION

The fifth generation of mobile communications (5 G) is intended to attend potential enormous load requirements, and the massive multiple input multiple output (MIMO) technique that enables hundreds of antenna elements has attracted attention as a main antenna configuration for planned 5G. MIMO innovation provides wireless communication a breakthrough. The system provides a lot of advantages which help to address most of the wireless channel hurdles along with resource constraints. In contrast to the time and frequency dimensions used in traditional single-antenna (single-input single-output) wireless systems, the MIMO system utilizes the spatial dimension (supplied at the transmitter and reciever by multiple antennas). While it is incredibly efficient in terms of efficiency, it is still hard to adapt with an increment in the amount of radiating elements due to its exponential growing complexity.

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