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BER ANALYSIS OF BPSK BASED MIMO & MIMO-OFDM SYSTEM

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Abstract

This paper focuses on BER analysis of BPSK based MIMO & MIMO-OFDM system. Nowadays, there is a requirement of higher data rate for wireless communication systems. In this paper we are going to compare MIMO & MIMO-OFDM system & how MIMO-OFDM is used to overcome high data rate problem is shown. MIMO is a multiple antenna technology. MIMO systems employ multiple antennas at both the transmitter & receiver to improve the range & performance of communication system. OFDM is a category of multicarrier modulation technique. In OFDM sub-carrier frequencies are orthogonal to each other i.e. they cannot interfere with each other (cross-talk between the sub-channels is eliminated). For transmission of signals over wireless channels OFDM is a very popular modulation technique. To reduce inter symbol interference (ISI) & to enhance system capacity OFDM for MIMO channels is considered. MIMO & MIMO-OFDM module is carried out through Matlab simulation.

I. INTRODUCTION

Increasingly, the driving force behind future growth in the telecommunication industries is seen to be broadband wireless access to the Internet and wireless data connectivity to mobile users. Multiple Input Multiple Output (MIMO) and Orthogonal Frequency Division Multiplexing (OFDM), which are new physical layer technologies capable of supporting the ever-increasing appetite for capacity and data rates, are the topic of this project. Multiple input multiple output orthogonal frequency division multiplexing has attracted a tremendous attention due to its large potential capacity and high-speed data rates. For the transmission of higher data rate more bandwidth is required. But due to the limitations of spectral bandwidth, it is often impractical or sometimes very expensive to increase bandwidth. For this purpose multiple transmit & multiple receive antennas are used for spectrally efficient transmission. The MIMO system can improve the capacity by a factor of the minimum number of transmit and receive antennas compared to single input single output (SISO) system with flat Rayleigh fading or narrowband channels.

Because multiple data streams are transmitted in parallel from different antennas there is a linear increase in throughput with every pair of antennas added to the system. Unlike traditional ways of increasing throughput, MIMO systems does not increase bandwidth in order to increase throughput, it simply exploit the spatial dimension by increasing the number of unique spatial paths between the transmitter and receiver.

OFDM for MIMO channels is considered here which reduces intersymbol interference (ISI) & enhances system capacity.Intersymbol interference (ISI) is caused by multipath in band limited (frequency selective) time dispersive channels distorts the transmitted signal, causing bit errors at the receiver. The influence of ISI and the ICI generated by multipath environments can probably be removed totally in OFDM system.MIMO technology leverages multipath behavior by using multiple, “smart” transmitters and multiple receivers with an added “spatial” dimension to dramatically increase performance and range. Using MIMO multiple antennas can send and receive multiple spatial streams at the same time.

Orthogonal Frequency Division Multiplexing (OFDM) is a popular modulation scheme that is used in wireless LAN standards like 802.11a, HIPERLAN/2 and in the Digital Video Broadcasting standard (DVBT), metropolitan area network (MAN), digital audio broadcasting (DAB), it is also used in the ADSL standard.

OFDM and MIMO will serve as the physical layer of two key technologies for future mobile communication systems: UMTS LTE and WiMax. WiMax is a technology that is expected to deliver last mile wireless broadband access, while LTE is the 4G evolution of cellular systems.

II.PRINCIPLE OF MIMO

Various schemes that employ multiple antennas at the transmitter and receiver are being considered to improve the range and performance of communication systems. Today multiple-input multiple-output (MIMO) system is a most promising multiple antenna technology. MIMO system consists of multiple antennas at both the transmitter and the receiver as shown in Figure 1.

In conventional wireless communication, a single antenna is used at the source & another single antenna is used at the destination. In certain cases, this gives rise to problems with multipath effects. When an electromagnetic field (EM field) is met with obstructions such as hills, canyons, buildings & utility wires, the signals are scattered, & thus they take many paths to reach the destination. The late arrival of scattered portion of the signal causes problems such as fading, cut-off & intermittent reception. In digital communication systems such as wireless internet, it can cause a reduction in data speed & an increase in the number of error at the receiver. With the use of multiple antennas at the transmitter & receiver, along with the transmission of multiple signals (one for each antenna) at the source & the destination, eliminates the effect of multipath wave propagation .

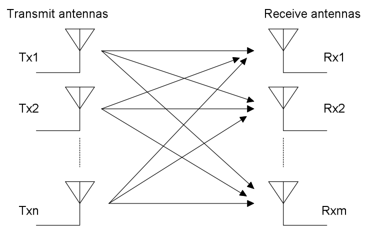

Fig. 1 General block diagram of MIMO

MIMO communication consists of multiple antennas at both the transmitter and receiver to exploit the spatial domain for spatial multiplexing and/or spatial diversity.

Spatial multiplexing is generally used to increase the capacity of a MIMO link by transmitting independent data streams in the same time slot and frequency band simultaneously from each transmit antenna, and differentiating multiple data streams at the receiver using channel information about each propagation path.

Spatial multiplexing techniques makes the receiver very complex, and therefore they are typically combined with Orthogonal frequency-division multiplexing (OFDM) or with Orthogonal Frequency Division Multiple Access (OFDMA) modulation, where the problems created by a multi-path channel are handled efficiently.

In short Multiple-input multiple-output (MIMO) wireless technology offers increased spectral efficiency through spatial multiplexing gain, and improved link reliability due to antenna diversity gain.

III. MIMO TECHNIQUES

As said before, the constant growth of data necessity by the mobile communication systems has motivated to develop new technique to give an answer to that demand. One of these techniques for increasing the amount of information that can be transmitted is MIMO. MIMO (multiple-input and multiple-output) techniques are part of the so called multi-antenna technologies. MIMO is currently use in WLAN (Wireless Local Area Networks) and is being considered as a candidate to be used for wider range wireless networks. Multiple antennas, both at the base station and at the mobile equipment, together with a sophisticated signal processing can improve drastically the performance of the wireless link, even under the worst case scenarios, without line of sight and fast moving mobile users. In a MIMO system diversity is a fundamental parameter to consider.

LizhongZheng y David N. C. Tse said that multiple antenna techniques can be used to increase the diversity or the degrees of freedom of the wireless communication systems. Their proposal was that both gains can be achieved at the same time, albeit there is a trade-off between them. The more independently faded channels we have the higher the diversity of the system will be. That effect is used for transmitting the same information through independent channels and average the received signal. The maximum diversity that is attainable in a system with {m, n} antennas (m transmitting antennas and n receiving antennas) is d = m . n. This will enable it to reduce the probability of error by a factor of 1=SNR compared to those of a normal system with just one antenna in transmission and one in reception, {m , n} = {1 , 1} where the probability of error will decrease by a factor of only 1=SNR. SNR stands for Signal to Noise Ratio and is the result of dividing the signal power by the noise power. The signals coming from different directions provide various degrees of freedom in communications. You can get the same effect even when the antennas are located nearby if there is dispersion. Essentially, if the channel response between pairs of transmit-receive antennas fades independently it can be said that there are multiple independent spatial channels. If we transmit independent information for each of these channels it can be increased the transmission rate. In a channel, {m,n}, with m transmitting antennas and n receiving antennas and rich scattering, there is min {m, n} degrees of freedom.

IV. PRINCIPLE OF MIMO-OFDM

Orthogonal Frequency Division Multiplexing (OFDM) is one of the most promising physical layer technologies for high data rate wireless communications due to its stoutness to frequency selective fading, low computational complexity and high spectral efficiency. OFDM can be used with a Multiple-Input Multiple-Output (MIMO) transceiver to increase the diversity gain and the system capacity by exploiting spatial domain. Because the OFDM system provides numerous parallelnarrowband channels, MIMO-OFDM is considered a key technology in high-data rate systems means in future broadband wireless access such as Wi-Fi – 802.11n, Wi-MAX – 802.16e (a.k.a 802.16-2005), 3G / 4G.

Orthogonal Frequency Division Multiplexing (OFDM) and Multiple-Input Multiple-Output (MIMO) are cutting edge physical layer technologies slated to be employed in 4G wireless cellular standards such as 3GPP Long Term Evolution (LTE/LTE-A), Worldwide Interoperability for Microwave Access (Wi-MAX) and high speed WLAN standards. Such 4G cellular standards are visualized to support data rates in excess of 100 Mbps through OFDM, MIMO, dynamic carrier aggregation and thus enable a diverse plethora of applications in the wireless ecosystem such as broadcast/multicast video, HDTV on demand, high speed internet access and interactive gaming amongst others.

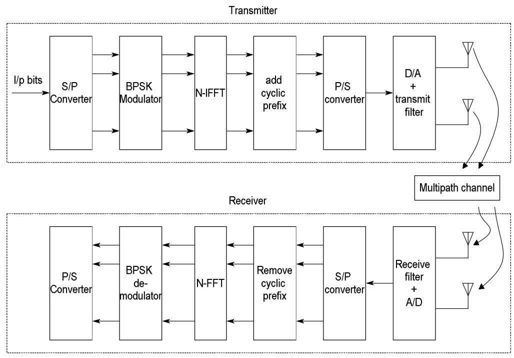

Fig.2 Block diagram of 2*2 MIMO-OFDM

The Orthogonal Frequency Division Multiplexing (OFDM) is very important transmission technique that belongs to the category of multicarrier modulation techniques. It solves the problems like ISI etc encountered by the conventional single carrier transmission techniques for high data rate transmission. In addition to this it provides higher bandwidth efficiency as compared to conventional multicarrier modulation techniques. Similar to conventional multicarrier modulation techniques, here the single high data rate stream is divided into several low data rate streams and modulated over different subcarriers. The only difference is the orthogonality of the subcarriers. The word orthogonal indicates that there exists a precise mathematical relationship (i.e. independence) between the frequencies of the subcarriers used in OFDM system. The subcarrier frequencies are selected in such a way that they are orthogonal to each other. Due to orthogonality property of subcarriers they can overlap each other in the frequency domain without interfering with each other and thus resulting in the higher spectrum utilization or greater spectrum efficiency, and also the data can be recovered on the receiver side without any Inter Channel Interference (ICI). That means it solves the problem of bandwidth requirement for data users.

V. RESULT

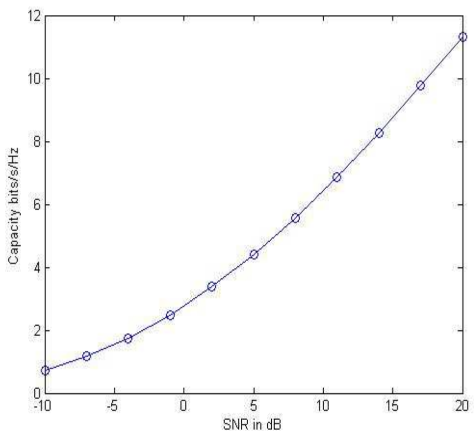

Fig.(a) SNR versus capacity bits/hz plot of 2*2 MIMO.

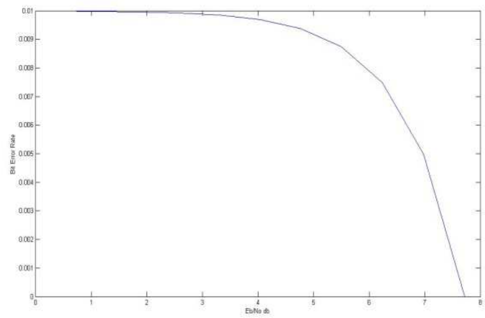

Fig.(b) BER versus Eb/No db plot of 2*2 MIMO

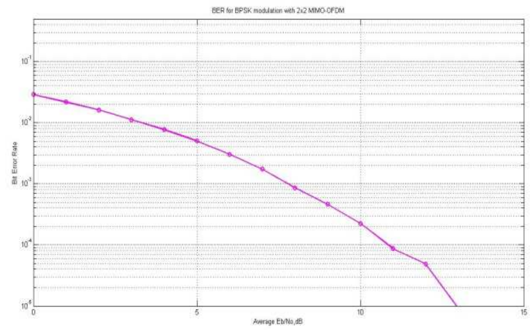

Fig.(c) BER versus Eb/No plot of 2*2 MIMO-OFDM

VI. CONCLUSIONS AND FUTURE WORK

Since radio resources are scarce and data rate requirements keep increasing, spectral efficiency is a rigorous requirement in present and future wireless communications systems. MIMO-OFDM has become a new star in the constellation of wireless and mobile communications. In addition to increasing spectral efficiency, MIMO can also be used to reduce transmitting power while keeping

coverage areas constant. The use of MIMO technique in future transmission systems for broadcasting, multicasting and unicasting represents real business logic also for broadcasting corporations because of the possible reduction in transmission stations.

By using MIMO-OFDM technique BER rate will greatly reduced it is shown in the waveform which is necessary in new wireless applications.

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