ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 6, June 2016

BER Comparison of SC-FDMA and OFDM System Using Different Modulation Techniques

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ABSTRACT: OFDM (Orthogonal frequency division multiplexing) is a technique used in wireless communication network to transfer the data on a high speed through multiple sub carriers. OFDM is a technique which uses multiple sub carriers to transfer the data over the channel. The data is transferred over multiple or different channels and the carriers of the channels are orthogonal or independent to their adjacent signals. To achieve this carrier must be placed exactly at the nulls modulation spectra of adjacent signals. There are many problems in OFDM like OFDM does not support the ICI. If the peak of signals goes into non linear region, it will cause the distortion in the signals due to Inter Carrier Interference (ICI). To overcome this problem we use an efficient method known as SC-FDMA. SC-FDMA is known as Single Carrier Frequency Division Multiple Access because it transmits the data serially. SC-FDMA uses the STBC codes to solve the problem of ICI. STBC (Space Time Block Coding) is used to transfer the multiple copies of data to more than one antenna. It is used in Wireless communication for replicating the transferred data at more than one receiver's end. It also guarantees the reliable data transmission.

KEYWORDS: OFDM; SC-FDMA; STBC; MIMO; Bit error rate; Wireless communication

I. INTRODUCTION

OFDM (Orthogonal Frequency Division Multiplexing) is an effective method or technique adopted in wireless channels. The wireless channels must be selective and time variance based. OFDM is an efficient technique which poses the property of flexibility and multicarrier modulation. OFDM is a technique, method or scheme for digital multi-carrier modulation using some closely spaced subcarriers, a previously modulated signal modulated into other signal that have high frequency and bandwidth. OFDM is used in many fields like DAB, Digital Video Broadcasting. OFDM transfers the data with a high transmission rate. OFDM also has the ability to solve the problem of multi path interference and frequency fading. OFDM uses the orthogonal subcarriers for data transmission.

STBC (Space Time Block Coding) is used to transfer the multiple copies of data to more than one antenna. It is used in Wireless communication for replicating the transferred data at more than one receiver's end. It also guarantees the reliable data transmission. Sometimes data to be transferred gets corrupted with the effect of reflection, refraction or scattering. Sometimes some data also gets tempered due to thermal noise which affects the quality of data at the receiver side. This problem results that there is a scope of being able to use one or more of the received copies to correctly decode the received signal. STBC helps to produce the more accurate information from received signals by combining them together.

II. RELATED WORK

In **[1]** a closed form formula is derived for the bit error rate (BER) of orthogonal-frequency-division-multiplexing (OFDM) with M-ary differential-phase-shift-keying (MDPSK) systems in frequency-selective Rayleigh and Rician fading channels with diversity reception. New BER curves were obtained as a function of the rms delay spread of the diffused component for three different types of delay profiles: (1) one-sided exponential, (2) uniform and (3) double spike profiles. In **[2]** author derived the BER performance of OFDM system, and quantify the effects of channel

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impairments such as Doppler Shift due to user mobility and High-Power Amplifier (HPA) distortion when amplifying the transmitted OFDM symbol. It was shown that the resulting inter-carrier interference (ICI) generated by these impairments becomes very significant in OFDM system, and severely degrades its BER performance. In **[3]** author presented an efficient technique for the BER of OFDM system over Nakagami–m fading channels, using well known characteristics function based analysis approach. The average BER expressed in terms of the higher transcendental function such as the confluent hyper geometric functions. The numerical results showed that depending on the number of channel taps, the BER performance may degrade with increasing values of Nakagami–m fading parameters. In **[4]** author presented a work in which a guard interval (GI) was inserted using cyclic prefix (CP) and zero padding (ZP) techniques to achieve an error free communication. BER performance for OFDM with 16-QAM with varying length of GI was presented in this paper. In **[5]** the performance of OFDM- BPSK,-QPSK and -QAM system by using forward error correcting codes (convolutional , reed Solomon as well as concatenated coding) schemes that were used to encode the data stream in wireless communications AWGN channel has been reported. In **[6]** author investigated the bit error rate (BER) performance of Orthogonal frequency division multiplexing (OFDM)-Binary phase shift keying (BPSK) OFDM-Quadrature phase shift keying (QPSK), OFDM-Quadrature amplitude shift keying (QAM) over different fading channels. The performance of transmission modes were evaluated by calculating the BER versus signal to noise ratio (SNR) under the Additive white Gaussian noise(AWGN), Rayleigh fading, Rician fading, Nakagami-m fading channel. In **[7]** author investigated adaptive modulation & ICI self-cancellation methods for combating the effects of channel fading & ICI respectively. These methods were compared in terms of BER performance, bandwidth efficiency, and computational complexity. In **[8]** BER performance of BPSK modulation and OFDM -BPSK System over Rayleigh fading channel was analyzed. In **[9]** author investigated the bit error rate performance of cooperative Diversity for M-ary QAM OFDM-based system with best-relay selection up to 512-ary QAM because 256 ary is already developed. In **[10]** author presented a comparison of the performance of OFDM system using different modulation schemes under the influence of AWGN and Rayleigh fading channel. Simulations of OFDM signals were carried out with Rayleigh faded signals to understand the effect of channel fading and to obtain optimum value of BER. In **[11]** exact closed-form expressions were derived for calculating the average BER of OFDM systems in the presence of Carrier Frequency Offset and Phase Estimation error in the context of frequency-selective Nakagami-m fading channels.

III. PROPOSED WORK

As per literature it is concluded that the work is much effective with STBC in OFDM system but as per new technology if we replace the traditional OFDM system with SC-FDMA then the system will be more effective and fast. In SC-FDMA, different sets of non overlapping Fourier Coefficients are assigned to different users and multiple accesses is made possible.SC-FDMA is different from OFDM as it is single carrier transmit scheme whereas OFDM is multi carrier transmit scheme. Like OFDM, SC-FDMA has various advantages like low PAPR, low sensitivity to carrier frequency offset, etc. The STBC (Space-Time Block Code) is used with SC-FDMA which works on MIMO (multi input multi output). This code is used to reduce BER (Bit Error Rate).

SC-FDMA (Single Carrier Frequency Division Multiple Access) is a technique which transmits the data serially. In this modulation technique, the value of PAPR is reduced to an extent as compare to OFDM system. Moreover, this system is less sensitive to frequency offset in comparison with the traditional modulation technique. SC-FDMA is more robust with respect to frequency selective fading. SC-FDMA works like OFDMA but the difference is of DFT mapped. In the SC-FDMA, data mapped converts the data bits into modulation symbols. These modulation symbols are converted into a block which consists of N symbols. N symbols are converted into the frequency domain because N-point is in time domain. At last, these frequency domain samples are converted into subset of M subcarriers. M should be greater than N. In case of OFDM, IFFT is used to convert the M point into time domain samples. Consequently, for the lower PAPR SC-FDMA modulation has been preferred.

IV. METHODOLOGY

In this paper the STBC coding is applied for the coding the signal that is to be sends to the receiver. Along with this the SC-FDMA is used instead of OFDMA. The methodology of the proposed work is given below:

Step I Initially a random signal is generate from the transmitter side that is send to the receiver end. This signal contains the information that is to be transmitted.

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Step II Next step after the generation of the signal is to apply modulation on the generated signal. The modulation is done so that it is generated signal is transmitted to the receiver end without any distortion.

Step III In this step the STBC coding is applied over modulated signal. This is done in order to reduce the effect of the BER as multiple signals are transmitted through the channels.

Step IV After the coding of the modulated signal is done, now the signal is transmitted over the channel to the receiver. In this proposed work the traditional OFDM is replaced with the SC-FDMA. As in SC-FDMA the multiple Accesses among users is made possible by assigning different users different sets of non-overlapping Fourier-coefficients.

Step V Next step is to send the signal over the channel so that it is received by the receiver. After passing through the channel the signal is received at the receiver end.

Step VI Finally the receiver received the signal and the calculation of the performance parameters is done. BER is calculated that will show the efficiency of the system.

V. SIMULATION RESULTS

In this section there is discussion about the results of proposed method of routing in the wireless sensor network. The traditional OFDM system is replaced with the SC-FDMA system along with this the STBC codes are used. The graphs given below explain that the proposed method is better and efficient than the traditional method. BPSK, QPSK and 64-QAM are used for the simulation purpose.

Fig. 1 represents the comparison graph of bit error rate (BER) performance of STBC based SC-FDMA with 64-QAM and QPSK modulation. The graph shows that the value of BER for QPSK is less than higher order modulation scheme i.e. 64-QAM**.**

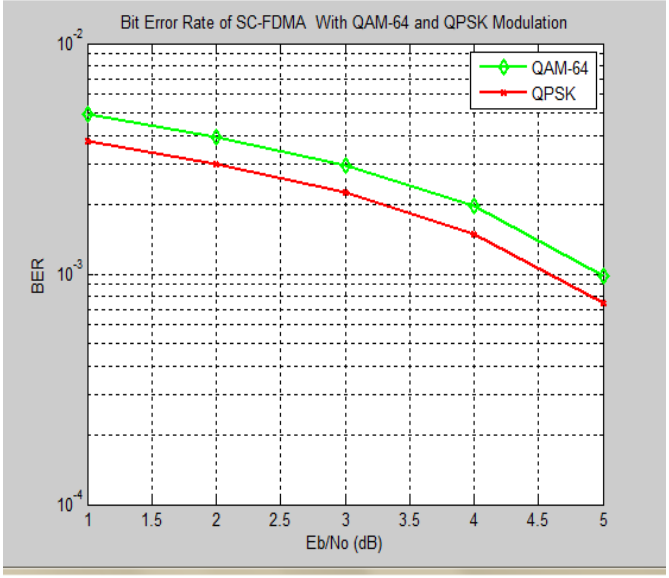

Fig. 1: BER comparison graph of SC-FDMA with 64-QAM and QPSK modulation

Fig. 2 represents the comparison graph of BER performance of STBC based SC-FDMA with QPSK and BPSK modulation. It is concluded from the graph that the results are better for BPSK modulation. From these two graphs it is clearly visible that the BER is less for the lower order modulation.

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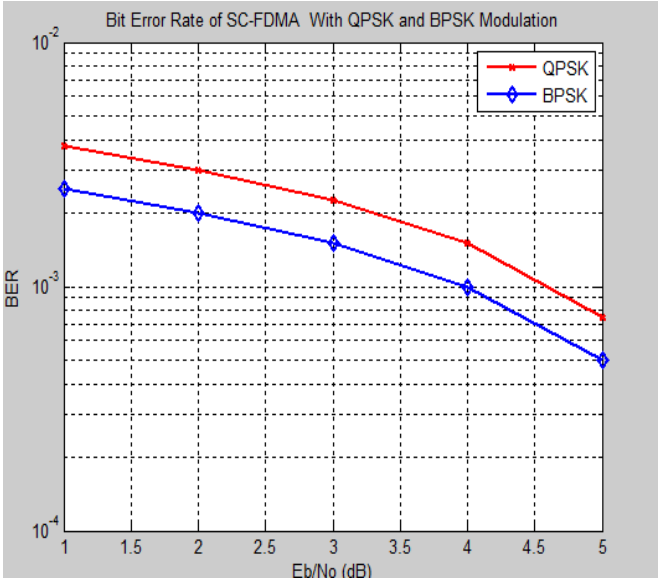

Fig. 2: BER comparison graph of SC-FDMA with
. QPSK and BPSK modulation.

Fig. 3 represents the comparison graph of BER performance of OFDM with two different modulation techniques i.e. BPSK and QPSK. It is seen from the graph that QPSK modulation has best result than BPSK modulation. Therefore, we can say that in case of OFDM the value of BER is reduced in QPSK modulation. Thus it is concluded that in case of OFDM the higher order modulation best supports the BER performance.

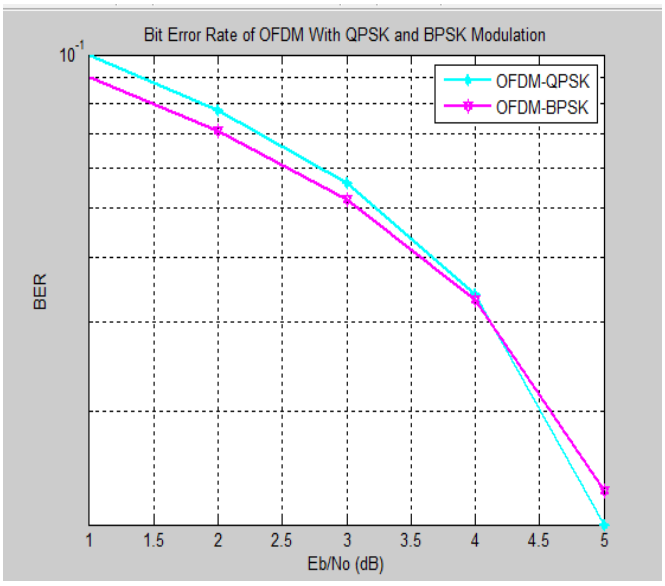

Fig. 3: BER comparison graph of OFDM with
QPSK and BPSK modulation.

Fig. 4 represents the comparison graph of BER performance of SC-FDMA with three different modulation techniques i.e. 64-QAM, QPSK and BPSK. The graph shows that the BPSK modulation gives the best result for BER i.e. the value of BER is found less in case of BPSK modulation.

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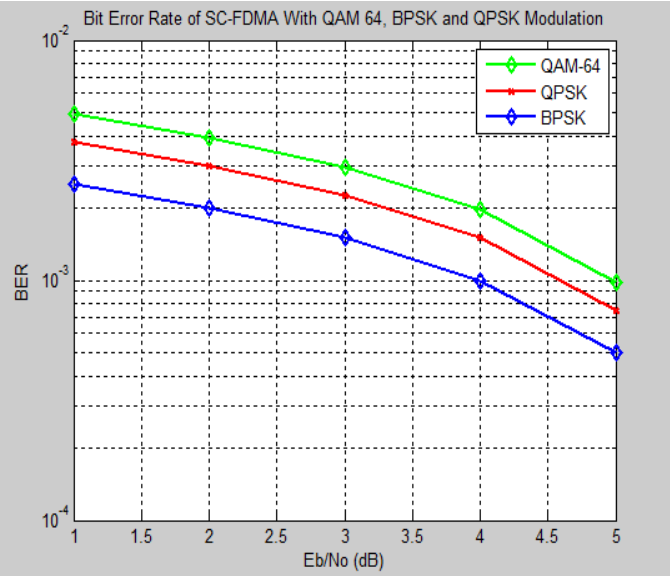

Fig. 4: BER comparison graph of SC- FDMA with 64-QAM, QPSK and BPSK modulation.

Fig. 5 represents the comparison graph of BER performance of SC-FDMA with 64-QAM, QPSK and BPSK whereas OFDM with QPSK and BPSK. It is concluded from the graph that BER of SC-FDMA is less than OFDM. Thus the proposed work i.e. SC-FDMA scheme outperforms OFDM scheme in terms of BER.

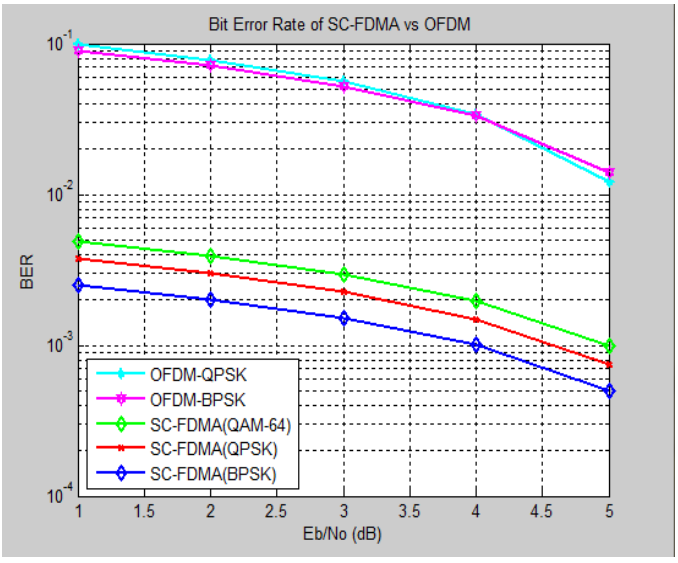

Fig. 5: BER comparison of SC-FDMA with OFDM.

VI. CONCLUSION AND FUTURE WORK

In this paper, the STBC based SC-FDMA system is proposed. Performance of applying STBC code with SC-FDMA is investigated over AWGN channel and comparison is made with three different modulations BPSK, QPSK and 64-

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QAM. Initially the work was start with OFDM but OFDM faces the problem of ICI which occurs due to distortion in the signals. SC-FDMA along with STBC codes is used in this paper to overcome the problem of ICI. Moreover it is observed from the simulation result that the proposed SC-FDMA scheme has best results compare to OFDM scheme in terms of BER.

In future, some other STBC codes can be introduce to the system to make it more efficient and robust. System can also switch to any other modulation technique also in order to make system better and efficient.

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BIOGRAPHY

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