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Performance Evaluation of Uncoded Adaptive OFDM System Over AWGN Channel

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ABSTRACT: *The demand for high-speed mobile wireless communications is rapidly growing. OFDM technology promises to be a key technique for achieving the high data capacity and spectral efficiency requirements for wireless communication systems of the near future. It is adopted as a standard for HYPERLAN & IEEE 802.11. It offers considerable high data rate, high spectral efficiency, high power efficiency, multipath delay spread tolerance. It has a flexibility to adapt the modulation scheme on subcarriers according to the channel performance, i.e. signal-to-noise ratio (SNR). In this paper, we analyze the Bit Error Rate (BER),Mean Square Error(MSE), Spectral Efficiency, Throughput performance of adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel.*

Keywords - *BER , MSE, OFDM, SNR, Spectral Efficiency, Throughput.*

I. Introduction

Orthogonal Frequency Division Multiplexing (OFDM) is a digital multicarrier modulation scheme, which uses a large number of closely spaced orthogonal sub-carriers. Each sub-carrier is modulated with a conventional modulation scheme at a low symbol rate, maintaining data rates similar to conventional single carrier modulation schemes in the same bandwidth . OFDM signals are generated using the Fast Fourier transform. Each individual carrier, commonly called a subcarrier, transmits information by modulating the phase and possible amplitude of the subcarrier over the symbol duration[1]. The goal for the fourth generation (4G) of mobile communications system is to seamlessly integrate a wide variety of communication services such as high speed data, video and multimedia traffic as well as voice signals. One of the promising approaches to 4G is adaptive OFDM (AOFDM). In AOFDM, adaptive transmission scheme is employed according to channel fading condition with OFDM to improve the performance [1].

II. System Model

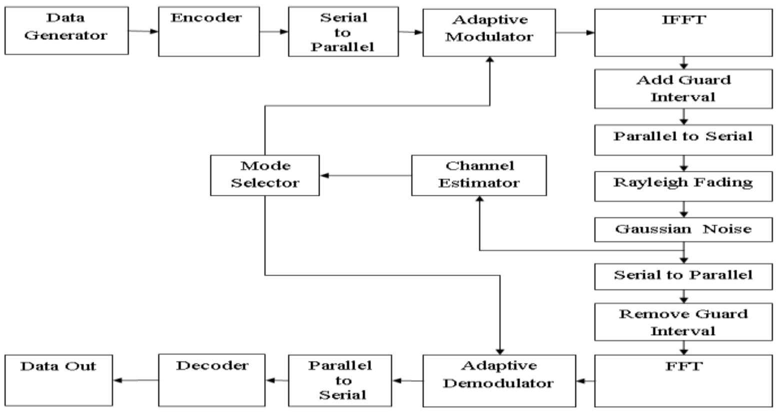

Figure 1. Adaptive OFDM system

The system model for Adaptive OFDM system is as shown in figure1.The data is generated with the help of data generator. It is represented by a code word that consists of prescribed number code elements. The transmitter first converts this data from serial stream to parallel sets. Each set of data contains one symbol, Si, for each subcarrier .For example, a set of four data would be [S0 S1 S2 S3]. The resilience to severe channel conditions can be further enhanced if information about the channel is sent over a return-channel. Based on this feedback information, adaptive modulation, channel coding and power allocation may be applied across all sub-carriers, or individually to each sub-carrier. An inverse Fourier transform (IFFT) converts the frequency domain data set into samples of the corresponding time domain representation of this data. Specifically IFFT is useful for OFDM because it maintains orthogonality between subcarriers. Since the duration of each symbol is long, it is feasible to insert a guard interval between the OFDM symbols, thus eliminating the intersymbol interference. Then, the parallel to serial block creates the OFDM signal by sequentially outputting the time domain samples. At receiver guard interval is removed. FFT is applied to have frequency domain signals. Adaptive demodulator does the reverse of modulator. Channel estimator senses the channel. Mode selects the appropriate modulator demodulator pair according to instantaneous SNR[2].

The channel estimation and mode selection are done at the receiver side and the information is sent to the transmitter using a feedback channel [8]. In this model the adaptation is done frame by frame. The channel estimator is used to estimate the instantaneous SNR of the received signal. Based on the instantaneous SNR calculated, the best mode will be chosen for the next transmission frame. This task is done by the mode selector block. At the transmitter the adaptive modulator block consists of different modulators which are used to provide different modulation modes. The switching between these modulators will depend on the instantaneous SNR. This block diagram is used to describe three types of adaptive modulation schemes which is based on BPSK,QPSK & QAM. The goal of adaptive modulation is to choose the appropriate modulation mode for transmission in each subband, given the local SNR, in order to achieve good trade-off between spectral efficiency and overall BER .

3. System Parameters

Table1. System Parameters

Parameter	Value
IFFT size	512
Number of subchannels N	512
Number of subband	32
Number of subcarriers per subband	16
SNR	0-30dB
Guard interval N/4	128
Pilot interval	8
Modulation scheme	BPSK,QPSK,QAM
Channel length L	16
Number of pilots(P= N/8)	64

OFDM system parameters considered here to analyze the Bit Error Rate (BER),Mean Square Error, Spectral Efficiency, Throughput performance of adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel are mentioned in Table1

4. Results And Discussions

Here we analyzed the the Bit Error Rate (BER),Mean Square Error, Spectral Efficiency, Throughput performance of adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel. It is observed from “Fig.2” that for SNR is in between 0 dB - 3dB, highest modulation scheme i.e.64QAM is used. For SNR is between 3dB - 6dB, 32QAM is used. When SNR is in between 6dB - 9dB modulation scheme 16 QAM is used. For SNR in between 9dB - 12dB, 8QAM is used. For SNR is between12dB- 15dB lower modulation scheme i.e. QPSK is used & for SNR is from 12dB-18dB lowest modulation scheme i.e. BPSK is used. For value of SNR above 18dB signal is not transmitted. Thus adaptation adaptation is achieved on the basis of instantaneous SNR. Instantaneous SNR is shown in “Fig.3”. It increases with SNR value.

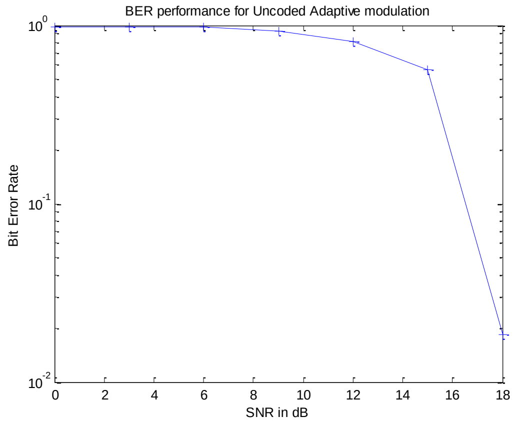

Figure 2. BER Performance of Uncoded AOFDM with BPSK,QPSK,QAM

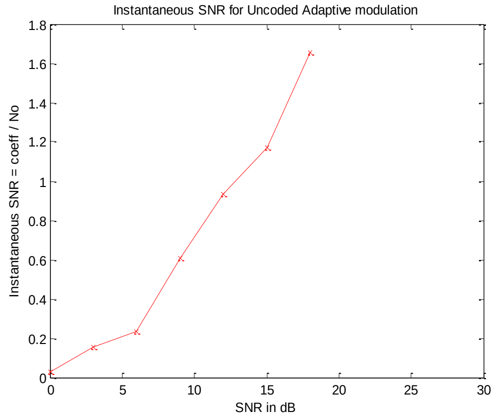

Figure 3. Instantaneous SNR of Uncoded AOFDM with BPSK,QPSK,QAM

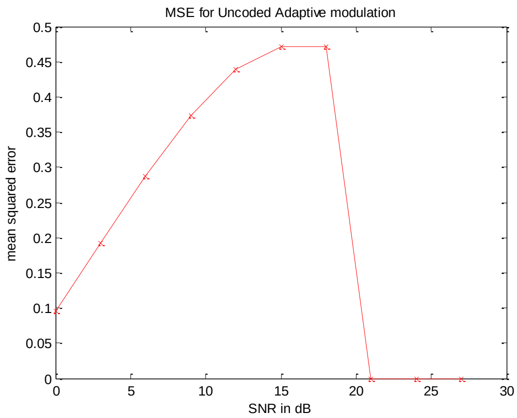

Figure 4. Mean Square Error of Uncoded AOFDM with BPSK,QPSK,QAM

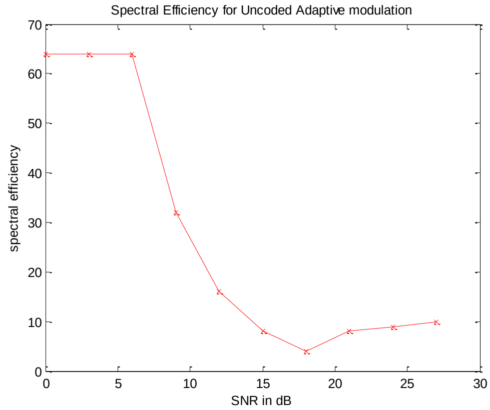

Figure 5. Spectral efficiency of Uncoded AOFDM with BPSK,QPSK,QAM

Mean Square Error (MSE) of OFDM with BPSK,QPSK,QAM is shown in “Fig. 4”. MSE of AOFDM increases from 0.1 to 0.48 for SNR value from 0dB to 20dB. For SNR above 20dB it becomes 0 as no transmission is there.

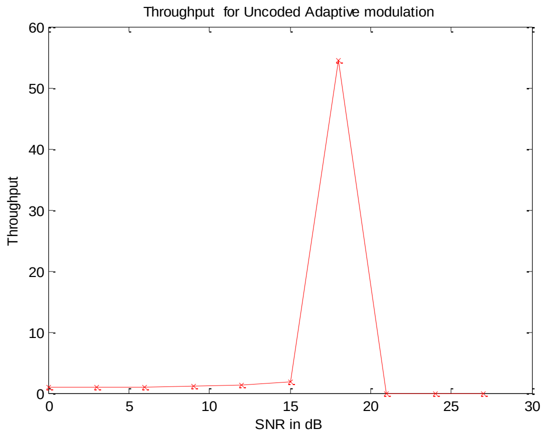

Figure 6. Throughput of Uncoded AOFDM with BPSK,QPSK,QAM

Spectral efficiency & Throughput of OFDM with BPSK,QPSK,QAM is shown in “Fig.5” & “Fig.6” respectively . For SNR 0dB to 6 dB AOFDM shows better Spectral efficiency as about 65% .As SNR is still increasing accordingly Spectral efficiency decreases .When SNR is upto 12 dB Throughput of AOFDM is less due to higher modulation schemes . As SNR increases above 12dB lower level modulation schemes as QPSK & BPSK are employed so Throughput increases. Throughput is maximum for SNR values 12dB to 18 dB. After

SNR above 18 dB it decreases. For SNR values in between 21dB to 27 dB Throughput is minimum i.e. 0 due to no transmission.

5. Conclusions

One of the promising approaches to 4G is adaptive OFDM (AOFDM). In AOFDM, adaptive transmission scheme is employed according to channel fading condition with OFDM to improve the performance . In this paper, we evaluated the Bit Error Rate (BER),Mean Square Error(MSE), Spectral Efficiency, Throughput performance of uncoded adaptive OFDM with BPSK,QPSK & QAM modulation over AWGN channel. It is observed that according to instantaneous SNR suitable modulation scheme is employed. If SNR from 0dB to 6dB spectrally efficient modulation schemes such as 64 QAM & 32 QAM are used .Hence Spectral Efficiency of proposed system is more for SNR values 0dB to 6dB & Throughput is low almost zero. For SNR values 12dB to 18 dB lower modulation schemes as QPSK & BPSK are used .So Spectral Efficiency of system is minimum while throughput is maximum value.Hence Adaptive modulation achieves a good tradeoff between throughput and overall BER.

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