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Performance Analysis of LDPC Coded WLAN Physical Layer under BPSK and 16-QAM

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Abstract

WLAN plays an important role as a complement to the existing or planned cellular networks which can offer high speed voice, video and data service up to the customer end. The aim of this paper is to analysis the performance of coded WLAN system for BPSK under AWGN channel. The low-density parity-check (LDPC) coding is considered as the high-performance channel coding scheme due to its good trade off between performance and complexity.The performance of LDPC (Low Density Parity check matrix code) encoder WLAN system is in terms of graph between BER and SNR. We also verify the system performance with different code rates and different parity check matrix.

Keywords: OFDM, BER, SNR, WLAN, AWGN, LDPC, Code rate.

1. INTRODUCTION

The Wireless Local Area Network (WLAN) technology is defined by the IEEE 802.11 family of specifications. The standard defines a medium access control (MAC) sub-layer and three physical (PHY) layers. The goal of the IEEE 802.11 protocol is to describe a wireless LAN that delivers services commonly found in wired networks, e.g., throughput, reliable data delivery, and continuous network connections. Orthogonal Frequency Division Multiplexing (OFDM) is a very attractive technique to achieve the high-bit-rate data transmission and is used in WLAN standard.

The OFDM system divides the wide signal bandwidth into many narrowband sub channels that are transmitted in parallel. The subcarriers are orthogonal to each other means that they are mathematical independent. In 1960, Chang [1] postulated the principle of transmitting messages simultaneously through a linear band-limited channel without ICI and ISI. The Saltzberg [2] in 1967 analyzed the performance of such a system. The major contribution to the OFDM technique is given by Weinstein and Ebert [3] which demonstrated the use of the discrete Fourier transform (DFT) to perform the baseband modulation and demodulation. Peled and Ruiz [4] suggested the filling of guard space with the cyclic extension of the OFDM symbol which solves the problem of orthogonality over dispersive channel.

A low-density parity-check (LDPC) code is a linear error correcting code, a method of transmitting a message over a noisy transmission channel,[12][13] . In 1962, Gallager reported work on binary codes defined in terms of low density parity check matrices (abbreviated `GL codes') [5, 6][14]. Low Density Parity Check codes can be specified by a Non-Systematic Sparse Parity-Check Matrix, H, having a uniform column weight, (≥3)and a uniform row weight. H is constructed at random subject to these constraints. An (n,j,k) LDPC code is specified by a parity check matrix,H having n-k rows, n columns and j 1's per column. The matrix defined in equation (1) is a parity check matrix with dimension n ×m for a (8, 4) code.

$$H=\begin{pmatrix} 0&1&0&1&1&0&0&1 \\ 1&1&1&0&0&1&0&0 \\ 0&0&1&0&0&1&1&1 \\ 1&0&0&1&1&0&1&0 \end{pmatrix} \qquad (1)$$

Tanner introduced an effective graphical representation for LDPC codes. The two types of nodes in a Tanner graph are called variable nodes (v-nodes) and check nodes (c-nodes). Figure is an example for such a Tanner graph . It consists of m check nodes (the number of parity

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bits) and n variable nodes (the number of bits in a codeword). The creation of such a graph is rather straight forward. It consists of m check nodes (the number of parity bits) and n variable nodes (the number of bits in a codeword).

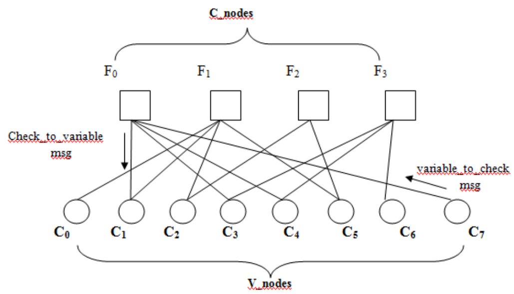

Figure 1: Tanner graph corresponding to the parity check matrix in equation (1)

we mainly considered the systematic block codes, such as CC and low-density parity-check (LDPC) codes. LDPC and the iterative decoding algorithm were first proposed by Gallager [6]. However, they had been silent for more than three decades until MacKay [7] rediscovered them. Recently, intensive research has been dedicated to LDPC due to its excellent performance. It has been used in IEEE 802.11n [8] and 802.16 [9] standards. Compared with the convolutional or Turbo coding, LDPC shows stronger error correction capability, lower decoding complexity and more flexible scalability.

2. PHYSICAL LAYER STRUCTURE OF WLAN

The complete channel encoding setup at transmitting side and decoding setup at receiving side of the WLAN physical layer is shown in figure 2. In this setup, the input binary data stream is ensured against errors with convolution codes and interleaved.The LDPC encoded bits are interleaved further prior to convert into modulation symbols in BPSK modulation. The symbols which are digitally modulated transmitted in parallel on subcarriers through implementation as an Inverse Fast Fourier Transform (IFFT). An OFDM system takes the source symbols in the frequency-domain. The inputs to an IFFT block are the symbols that brings the signal into the time domain. The IFFT takes in N symbols at a time, where N is the number of subcarriers in the system. Each of these N input symbols has a symbol period of T seconds. As we know that the basis functions for an IFFT are N orthogonal sinusoids. These N orthogonal sinusoids each have a different frequency and the lowest frequency is Decoding Cycle. Since the input symbols are complex, the value of the symbol determines both the amplitude and phase of the sinusoid for that subcarrier. The IFFT output is the summation of all N sinusoids. The block of N output samples from the IFFT make up a single OFDM symbol.To mitigate the effects of inter-symbol interference (ISI), each block of IFFT coefficients is typically presented by a cyclic prefix [5, 6, 7].

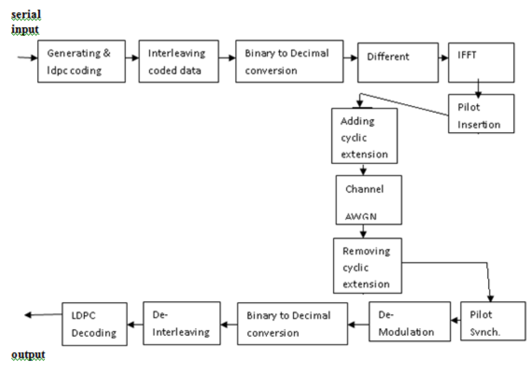

FIGURE 2: Block diagram showing WLAN Physical Layer transceiver

At the receiving side, a reverse process (including deinterleaving and decoding) is performed to obtain the original data bits. At the receiver, an FFT block is used to process the received signal and bring it into the frequency domain. Ideally, the FFT output will be the original symbols that were sent to the IFFT at the transmitter. The degradation of OFDM performance due to frequency offset or/and phase noise is much more severe in comparison with single carrier modulation [8, 9].

3. SIMULATION RESULTS

This system is simulated by introducing the LDPC encoder block. And the simulation is implemented
using matlab coding.. Parity-check matrix of the LDPC code is stored as a sparse logical matrix. As the order of modulation increases, the bit error rate (BER) increases. Forward Error correction (FEC) coding like LDPC coding is generally used to Improve BERperformance. LDPC provides large minimum distance and also the power efficiency of the LDPC code increases significantly with the code length.The WLAN system using different modulation schemes in the presence of AWGN channel was simulated using Matlab.The different digital modulation

schemes using for the simulation are BPSK. And QAM .We are using LDPC encoder with different code rate value ie (48 , 40) ,(48 ,44) and (48 , 46) under BPSK and QAM modulation in AWGN channel. Figure 3 display the performance on Additive White Gaussian Noise (AWGN) performance under BPSK modulation schemes for a LDPC Encoder with different rate value ie (48 , 40) ,(48 ,44) and (48 , 46) in AWGN channel.

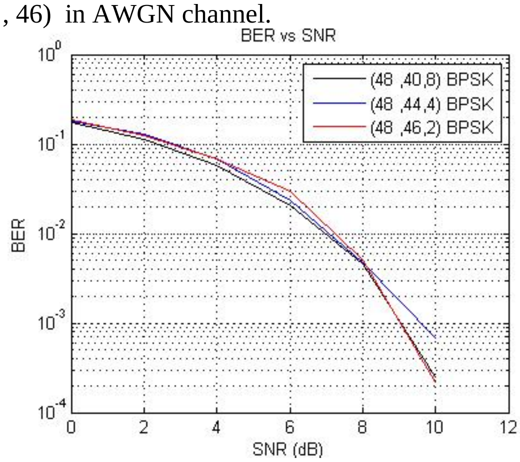

Figure 3 BER Vs SNR of BPSK in AWGN channel under LDPC

Fig 4 shows the simulation resu;ts of QAM under LDPC coding. We have seen that there is a reduction in BER with coding with less transmitted power, making the link power efficient.

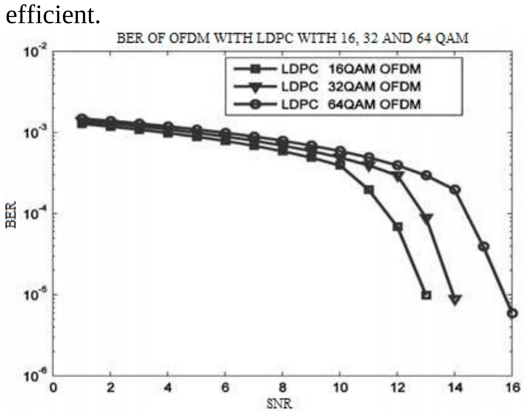

Figure 4 BER Vs SNR of QAM in AWGN channel under LDPC

4. CONSLUSION

A performance analysis of WLAN system adopting LDPC encoding with block interleaver has been carried out. The BER curves were used to measure the performance of BPSK modulation techniques. Performance results highlight the impact of modulation scheme and show that the implementation of an rated LDPC code under different modulation. From the overall comparison of LDPC encoder result, we find that code rate (48, 46) under BPSK gives the best result among all the rates i.e. (48, 40), (48, 44) and (48, 46) in Additive White Gaussian Noise (AWGN) channel as compared other modulation formats. From the overall comparison of LDPC encoder result in table 1, we find that code rate (48, 46) under BPSK gives the best result among all the rates.

Table 1 Comparison table of LDPC

Modulation format	**Code Rate**		
BPSK	**N=48, k=40, q=8**	**N=48, k=44, q=6**	**N=48, k=46, q=2**

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