

Improving HiperLAN/2 Physical Layer Model Based Multiwavelet Signals by using Block Turbo Codes System

Dr. Mohammed Aboud Kadhim^{1*} Aktham Hasan Ali² Aassia Mohammed Ali Jasim Al-A'assam³
Foundation of Technical Education, Institute of Technology Baghdad, Iraq

*Email: makaboud@gmail.com

Abstract

The progress of broadband wireless communication systems should cope with different performance restrictive challenges that include channel fading as well as size and power limitations at the mobile units. In this paper, the Block Turbo Codes (BTC) is evaluated for the HiperLAN/2 OFDM system based multiwavelet signals. Matlab software-simulated physical layer performance results are presented show that Packet-Error- Rate (PER) performance is improved when using block turbo codes in the HiperLAN/2 system. We also show that the frequency interleaver has a big impact on the performance of the turbo decoding process and that increasing its size lead to good performance when compared to the convolutional code

Keywords: HiperLAN/2, OFDM, DMWT, IDMWT, BTC, PER.

1. Introduction

Broadband wireless access to multimedia supporting backbone networks has been quickly drawing attention toward omnipresent communications scenario. newly, a couple of standardizing bodies and research institutes have been energetically working to establish high-speed wireless Local Area Networks (WLANs) (ETSI, 1999). This centralized Time Division Duplex/ Time Division Multiple Access (TDD/TDMA) cellular network will chiefly operate in an indoor environment (i.e. coverage range of 50 m) with limited user mobility (i.e. 3m/s). The Orthogonal Frequency Division Multiplexing (OFDM) has been chosen as the physical layer modulation scheme for its good spectral efficiency and its robustness towards multipath propagation. The chosen channel coding scheme is the 64 states Convolutional Code (CC). To adapt the transmitted bit rate to the channel conditions, the user data rate can vary from 6 to 54 Mb/s by changing the CC code rate and the sub-carrier modulation. The objective of this study is to advance the HiperLAN/2 system based multiwavelet signals performance with a further robust channel scheme than the CC specified. In this view, Turbo codes (C. Berrou, 1993), well identified for their performance approaching Shannon's theoretical limit, seem particularly attractive. This paper focuses on Block Turbo Codes BTC (R. Pyndiah, 1994) because they perform very well even for high code rates and they present high-quality free distances even for small block sizes. The mother Forward Error Correction code specified in the H/2 standard is a traditional convolutional code of rate $\frac{1}{2}$ and constraint length 7. Turbo-codes are a more recent coding scheme initially introduced by Berrou et.al. In 1993 (C. Berrou, 1993). The very high-quality performance of turbo codes raised a large interest in the coding community and they were included in some standards such as UMTS (TS 25.212, 1999) and DVB-RCS (DVB-RCS001, 1999) in the previous years in order to provide the protection required for high QoS services. Turbo-codes are worth being studied as another to the convolutional codes because they need a lower carrier-to-Noise Ratio (C/N) to reach a given PDU Error Rate (PER) than a convolutional code (P. Robertson, 1997, D. Lacroix, 1997, D. Lacroix, 1999, D.Lacroix, 2000, R.A.N. AHMED AND M. BERWICK, 2005). This higher coding gain enables to use a further efficient transmission mode (combination of coding rate and modulation scheme) more often and so to get better the system throughput. Otherwise, turbo codes enable to significantly lower the PER at the top of the physical layer and consequently to use Automatic Repeat request (ARQ) algorithms less often, which improves the overall system efficiency as well (D. Lacroix, 1999). This paper is organized as follows. In section 2 the simulation block diagram is described. Section 3 describes summarizes the results. Finally, Section 5 concludes the paper.

2. System Model

The new proposed structures for the HiperLAN/2 physical layer model based multiwavelet signals in different channel models will be studied in this paper. The block diagram in Figure 1 represents the whole system model for proposed design.

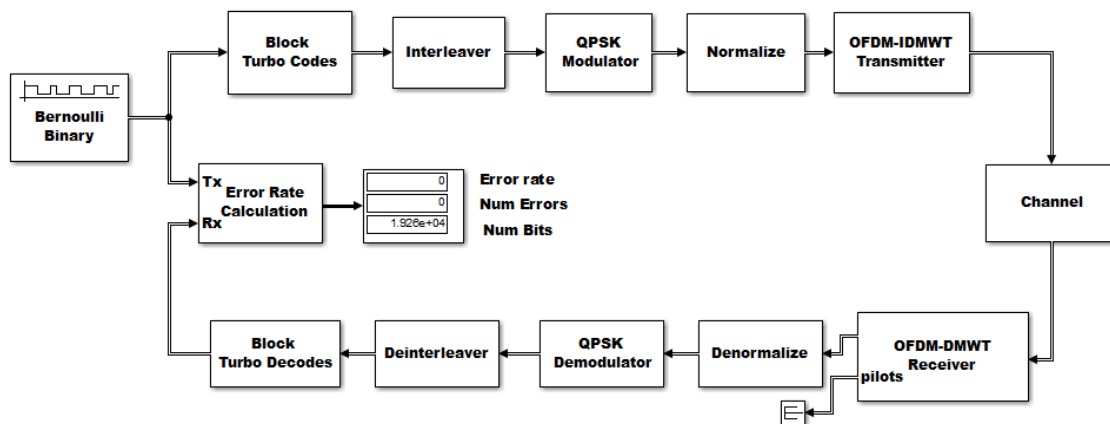


Figure 1. Simulation Block Diagram

The Block diagram in Figure 1 represents the whole system model for the HiperLAN/2 Transceiver based Multiwavelet Transform signals system is used for multicarrier modulation. The HiperLAN/2 Transceiver structure is divided into three main sections: transmitter, channel, and receiver: Data are generated from a random source and consist of a series of ones and zeros. The HIPERLAN/2 physical layer is based on OFDM to mitigation frequency selective fading while providing high-quality spectral efficiency (Table 1). In the TDMA frame, the data payload has a fixed length of 54 bytes. Those payloads are first coded with a CC of generator polynomial (133,171) and constraint length K equal to 7. The coded payload is then mapped to an integer number of OFDM symbols, whose value is definite by the sub-carrier modulation and the coding rate chosen for transmission. The puncturing schemes are applied in order to increase the code rate of 1/2 of the convolutional mother code to 9/16 or 3/4. A uniform row/column interleaver of depth of one OFDM symbol is then used to avoid error bursts at the input of the convolutional decoder in the receiver. The interleaved data is mapped to data symbols according to the select sub-carrier modulation. The OFDM symbol is implemented by an Inverse Discrete Multiwavelet Transform (IDMWT), The computation of DMWT and IDMWT for 64 point as in (ABBAS HASAN KATTOUSH A, 2009) and is formed of 48 data symbols and 4 pilots to make possible coherent reception. The PHY burst is formed by adding to the modulated data payload a training sequence of four OFDM symbols. The OFDM receiver essentially performs the reverse operations of the transmitter, together with time and frequency synchronization and channel correction using the training sequence inserted at the beginning of each data payload.

3. Simulation Results of the Proposed Design:

The PHY layer simulation results take the form of packet (PDU or PSDU) error rate (PER) vs. average C/N. In this part the simulation of the modified HiperLAN/2 transceiver based multiwavelet transform signals structure based OFDM-DMWT when using Block Turbo Codes and comparing when without using Block Turbo Codes system is achieved, beside the PER performance of the modified HiperLAN/2 transceiver structure considered in channel models. The Packet Error Rate (PER) performance is evaluated with QPSK modulation for the extended BTC (1024, 676) and the expurgated BTC (961,625) with the optimal and the sub-optimal BCH decoding algorithms and compared to the specified CC with equivalent code rate ($R=2/3$) on the theoretical Rayleigh (Figure.1), and in the HiperLAN/2 environment (Figure.2), The block turbo decoding is performed with 4 iterations. The channel corresponds to a Non Line Of Sight closed office environment (BRAN WG3 PHY Subgroup, 1998). The interleaver is the specified uniform row/column interleaver with a depth of one OFDM symbol (i.e. 96 bits for QPSK modulation). No BTC puncturing has been considered, thus the coded block are not exactly equal to the data payload length of 54 bytes and padding has to be introduced to obtain an integer number of OFDM symbols per coded data payload. For simulations the channel varies for each coded data payload (i.e. 1056 bits corresponding to 11 OFDM symbols for QPSK modulation). With the specified row/column interleaver, the BTC(961,625,16) obtained from the concatenation of two expurgated BCH (31,25,4) codes and decoded with the optimal algorithm gives the best performance on the HiperLAN/2 channel and outperforms the CC by 1 dB for a PER of 10^{-3} . In the contrary to the performance obtained on the theoretical Rayleigh channels, the other schemes have worse performance than the CC in this HiperLAN/2 environment. The extended BTC (1024, 676, 16) obtained from the concatenation of two extended BCH (32, 26, 4) codes and decoded with the optimal algorithm is more than 4 dB away from the CC at a PER of 10^{-3} . With the elementary decoding sub-optimal algorithm, the performances of the two BTC are worse (by about 2.5 dB at a PER of 10^{-3} than with the optimal elementary decoding algorithm and the expurgated BTC (961,625) is still much better than the extended BTC (1024, 676), but performs close to the specified CC.

The codes have the same free distance, thus at high Signal to Noise Ratio (SNR), the performance difference is not due to the code structure but to the decoding process. More precisely, considering the two BTC, which are decoded with the same algorithm, the performance difference can only be explained by the sensitivity of the turbo decoder to the correlation of the input samples that influence the propagation of the extrinsic information in the iterative decoding process. This is a known fact for classical parallel convolutional turbo codes (J. Hokfelt, 1999). In order to explain this behavior in the HiperLAN/2 environment, the correlation between the input samples of the decoder for the expurgated BTC (961,625) and the extended BTC (1024, 676) was analyzed.

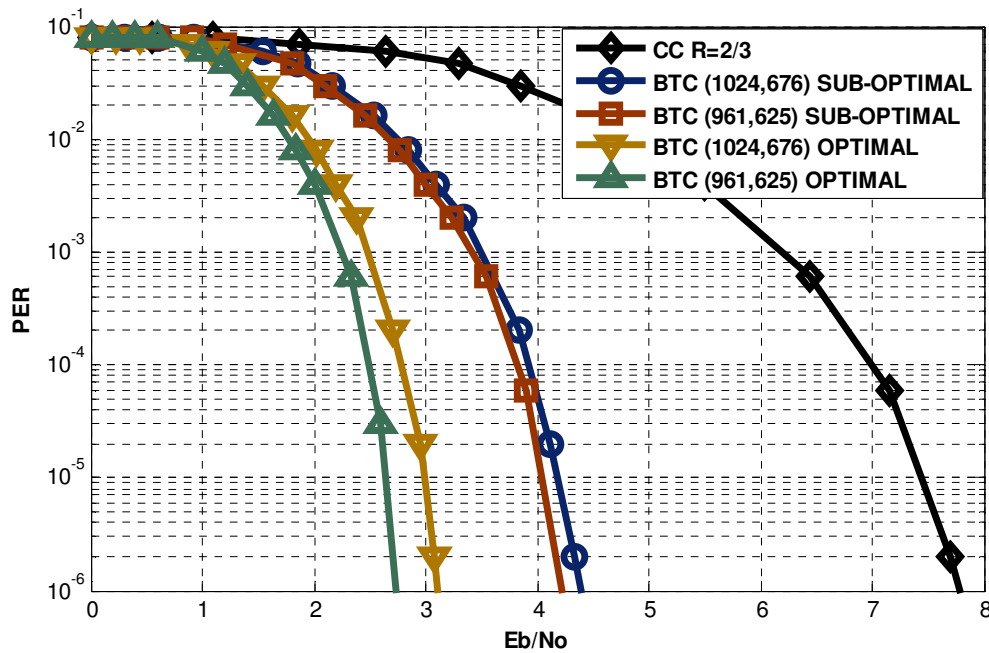


Figure.1: Performance comparison of the 2 BTC schemes (optimal and sub-optimal algorithms) with the convolutional code (R=2/3) with QPSK on the theoretical Rayleigh channel.

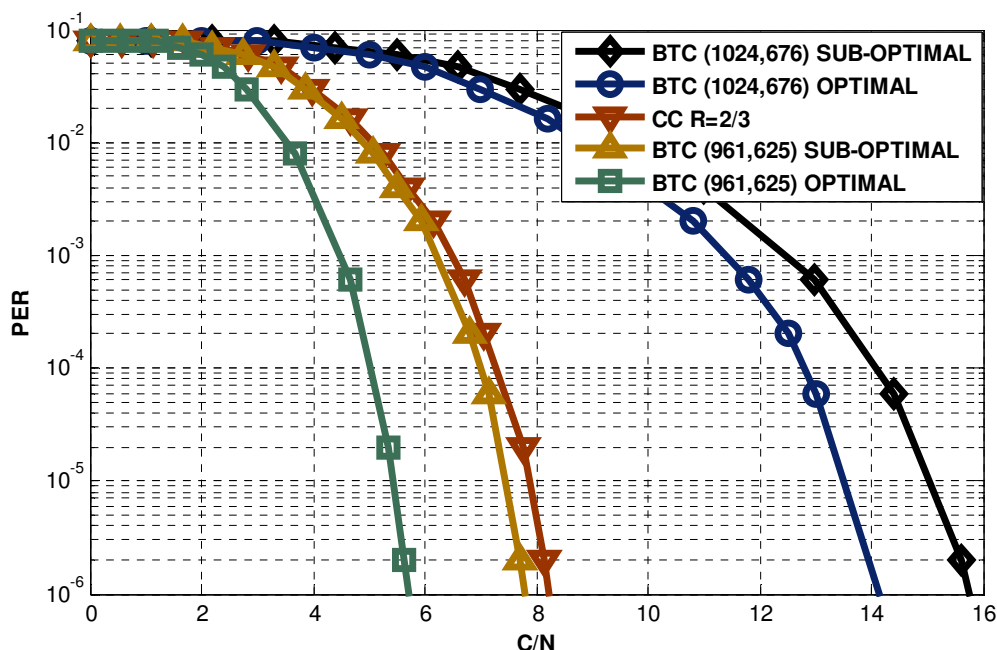


Figure.2: Performance comparison of the 2 BTC schemes (optimal and sub-optimal algorithms) with the convolutional code (R=2/3) with QPSK in the HiperLAN/2 environment.

4. Conclusion

The selected optimization to the HiperLAN/2 physical layer based OFDM-DMWT for the BRAIN air interface has existed in this paper. The simulation results show good performance in terms of PER for each of these techniques, which were tested in different indoor environments. BTC have been evaluated on the HiperLAN/2 Physical Layer Model Based Multiwavelet Signals system. BTC (961,625) outperforms the particular CC (R=2/3) and that the extensive BTC (1024, 676) gives unexpectedly bad performance. It is shown that the not good performance of the extensive BTC (1024, 676) comes from a critical repartition of the correlation at the input of the turbo decoder. By modifying the particular HiperLAN/2 interleaver for the extensive BTC(1024,676) in order to obtain the same repartition of the correlation as for the BTC(961,625), the performances of the two BTC stick jointly which is steady with the results on the theoretical Rayleigh channel. However, considering only code properties, they should be much better than the CC, this shows that BTC are still sub-optimal on the HiperLAN/2 multipath channel. For BTC to give high-quality performance, the correlation at the input of the turbo decoder must increase uniformly along the lines and the columns of the product matrix.

References

- ABBAS HASAN KATTOUSH A, W. A. M., S. NIHADIC, 2009. The performance of multiwavelets based OFDM system under different channel conditions. *Digital Signal Processing*, p. YDSPR:943.
- BRAN WG3 PHY SUBGROUP 1998. Criteria for Comparison. ETSI/BRAN document no. 30701F, 1998.
- C. BERROU, A. G., P. THITIMAJSHIMA, 1993. "Near Shannon limit error-correction coding: Turbo codes". in *Proc. IEEE ICC'93, Geneva, Switzerland, pp. 1064-1070, May 1993*.
- D. LACROIX, D. C. A. 1997. Channel coding and number of carriers for a COFDM air interface. ETSI BRAN document N° wg3td85, October 97.
- D. LACROIX, P. B. 1999. On the choice of radio interface for high speed radio LAN's. *Annals of Telecommunications*, Sept-Oct 1999.
- D.LACROIX, D. C. 2000. A study of OFDM parameters for high data rate radio LAN's. *Proc.of VTC 2000-Spring, Tokyo, 13-18 May 2000, pp. 1075-1079*.
- DVB-RCS001 1999. Digital Video Broadcasting (DVB) ; Interaction channel for satellite distribution systems. November 1999.
- ETSI 1999. Broadband Radio Access Networks (BRAN); High Performance Radio Local Area Network (HIPERLAN) type 2; Requirements and architectures for wireless broadband access. *ETSI TR 101 031, V2.2.1, January 1999*.
- J. HOKFELT, O. E. A. T. M. 1999. Turbo Codes: Correlated Extrinsic Information and its Impact on Iterative Decoding Performance", *Proc. of IEEE VTC'99, Houston, USA, May 1999*.

- P. ROBERTSON, P. H., E. VILLEBRUN, 1997. Optimal and suboptimal maximum a posteriori algorithms suitable for turbodecoding". . *European Transactions on Telecommunications, March-April 1997, vol.8, pp119-125.*
- R. PYNDIAH, A. G., A. PICART AND S.JACQ, 1994. Near optimum decoding of product codes",. *in Proc. of IEEE GLOBECOM'94, San Francisco, USA, vol.1/3, pp. 339- 343.*
- R.A.N. AHMED AND M. BERWICK 2005. Performance analysis of HIPERLAN/2 in QAM mode with punctured and non-punctured convolutional coding. *Electronics Letter , Vol. 41 No. 7.*
- TS 25.212 1999. 3rd Generation Partnership Project (3GPP) ; Technical Specification Group (TSG) ; Radio Access Network (RAN) ; Working Group 1 (WG1) ; Multiplexing and channel coding (FDD). October 1999.

AUTHORS' BIOGRAPHIES



Dr. Mohammed About Kadhim

Received his B.Sc., and M.Sc. in Electrical and Electronic Engineering from the Faculty of Electrical and Electronic Engineering, Communication Engineering, University of Technology in 1996 and 2002, and he received his PhD in Electrical and Electronics Engineering , Wireless and Mobile Systems from the School of Electrical and Electronics Engineering, USM University, Malaysia in 2011. He is currently a Lecturer, researcher and training supervisor at the Foundation of Technical Education, Baghdad, Iraq. His current research interests include Microstrip Antennas, Implantable Antennas for Medical Applications, Silicon-based Millimeter-Wave/THz on-Chip Antennas, Low-Temperature Co-fired Ceramic-based System-on-Package Technology, Microwave Circuits, Radio-over-Fiber Techniques, WiMAX Transceivers Design, Electronic Circuit Design, OFDM System Design , RF Systems, Wireless Systems , Wired & Wireless Network Administration.



Eng. Aktham Hasan Ali

Received his B.Sc. Academy of Engineering - Sarajevo - Bosnia's Republic in 1981, and received the M.Sc. degree in Electrical Engineering - University of Belgrade in 1983. Currently he is Assist Lecturer, Researcher and training supervisor, Dep. of Electronic in Institute of Technology Baghdad.



Eng. Aassia Mohammed Ali Jasim Al-A'assam

Received her B.Sc in Electronics from Department of Electrical Engineering, University of Technology, Iraq 1983. Received the M.Sc degree in Communications Engineering from Department of Electrical Engineering, University of Technology, Iraq 1989. Currently she is Assist Lecturer, Researcher and training supervisor, Department of Electronic in Institute of Technology Baghdad.