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Design and Development of HiperLAN/2 Physical Layer Model Based Wavelet Signals

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Abstract

HiperLAN (High Performance Radio LAN) is a Wireless LAN standard. It is defined by the European Telecommunications Standards Institute (ETSI). In ETSI the standards are defined by the BRAN project (Broadband Radio Access Networks). In this paper, we improve HIPERLAN/2 based Orthogonal Frequency-Division Multiplexing OFDM, based wavelet signals execution via a MATLAB/ Simulink simulation .These systems provide channel adaptive data rates up to 54 Mb/s (in a 20 MHz channel spacing) in the 5 GHz radio band. For dissimilar channels. MATLAB/ Simulink modeling proved that the performance of wavelet OFDM has a significant degradation in the packet (PDU or PSDU) error rate (PER) compared to based OFDM on Fast Fourier transform (FFT) due to the considerable channel models. With HiperLAN/2 based DWT-OFDM, Carrier-to-Noise Ratio (C/N) development compared to conventional HiperLAN/2 based FFT-OFDM is accomplished.

Keywords: HiperLAN/2, OFDM, DWT, IDWT.

1. Introduction

Designing for the first version of the standard, named HiperLAN/1, started 1991, when designing of 802.11 was by now going on. The aim of the HiperLAN was the high data rate, higher than 802.11. The standard was accepted in 1996. The functional specification is EN300652, the rest is in ETS300836. The standard covers the Physical layer and the Media Access Control part of the Data link layer like 802.11. There is a new sub layer named Channel Access and Control sub layer (CAC). This sub layer deals with the access requests to the channels. The achievement of the demand is dependent on the usage of the channel and the precedence of the request. CAC layer provides hierarchical independence with Elimination-Yield Non-Preemptive Multiple Access mechanism (EY-NPMA). EY-NPMA codes precedence choices and other functions into one variable length radio pulse preceding the packet data. EY-NPMA enables the network to function with few collisions even though there would be a large number of users. Multimedia applications work in HiperLAN because of EY-NPMA precedence mechanism. MAC layer defines protocols for routing, security and power saving and provides naturally data transfer to the upper layers. On the physical layer FSK and GMSK modulations are used in HiperLAN/1. HiperLAN/2 functional specification was achieved February 2000. Version 2 is designed as a fast wireless connection for many types of networks. Those are UMTS back bone network, ATM and IP networks. Also it works as a network at home similar to HiperLAN/1. HiperLAN/2 uses the 5 GHz band and up to 54 Mbit/s data rate. (J.Torsner and G. Malmgren, 1999) The physical layer of HiperLAN/2 is very similar to IEEE 802.11a wireless local area networks. However, the media access control (the multiple access protocol) is Dynamic TDMA in HiperLAN/2, while CSMA/CA is used in 802.11a. Basic services in HiperLAN/2 are data, sound, and video transmission. The accenting is in the quality of these services (QoS). The standard covers Physical, Data Link Control and Convergence layers. Convergence layer takes care of service dependent functionality between DLC and Network layer (OSI 3). Convergence sub layers can be used also on the physical layer to connect IP, ATM or UMTS networks. This characteristic makes HiperLAN/2 appropriate for the wireless connection of a variety of networks. On the physical layer BPSK, QPSK, 16QAM or 64QAM modulations are used. HiperLAN/2 offers security measures. The data are secured with DES or Triple DES algorithms. The wireless access point and the wireless terminal can authenticate each other. ETSI's suggested HIPERLAN/2 standard describes the physical (PHY) layer based on orthogonal frequency division multiplexing (OFDM) technology and link adaptation (Heiskala, 2002). The first technique is attractive due to capacity to deal with frequency-selective fading while link adaptation enables the system to dynamically trade-off link reliability and data rate according to the quality of the available radio link. This trade-off is achieved through the different transmission modes. In present time HiperLAN/2 physical layer used OFDM based on Fourier signals to represent data modulation and demodulation(Van Nee, 2000). In 2004 Zhang et al (H. Zhang et al, 2004) carried out research on DFT-OFDM and DWT-OFDM on different transmission scenarios. The DFT based OFDM (DFT-OFDM) has currently drawn most of attention in the area of wireless communication. To combat ISI, and ICI, cyclic prefix is inserted between DFT-OFDM symbols, and this will take up nearly 25 percent of bandwidth. To improve the bandwidth efficiency and ISI, ICI, DWT (discrete wavelet transforms) based OFDM (DWT-OFDM) is proposed. In this paper we give the performance comparisons of DFT-OFDM and DWT-OFDM on three different channel models. Simulation results show that DFT-OFDM and DWT-OFDM perform different when the transmission scenarios are different. This paper is focused on performance evaluation of HIPERLAN/2 based wavelet signals. A physical layer improvement simulator of HIPERLAN/2 was conceived in accordance with the standard defined by ETSI in (ETSI, 2001). This paper is structured as follows. In section 2 the simulation block diagram is described. Section 3 describes summarizes the results. Finally, Section 5 concludes the paper.

2. The Simulation Block Diagram

At first, a supplied a HiperLAN/2 physical layer model, from MathWorksTM in the MATLAB® & SIMULINK® R20013a software package, was modified and its performance measured. The new suggested transceivers for the HiperLAN/2 physical layer model based wavelet signals in different channels will be studied in this paper. The block diagram in Figure 1 represents the whole system model for proposed design.

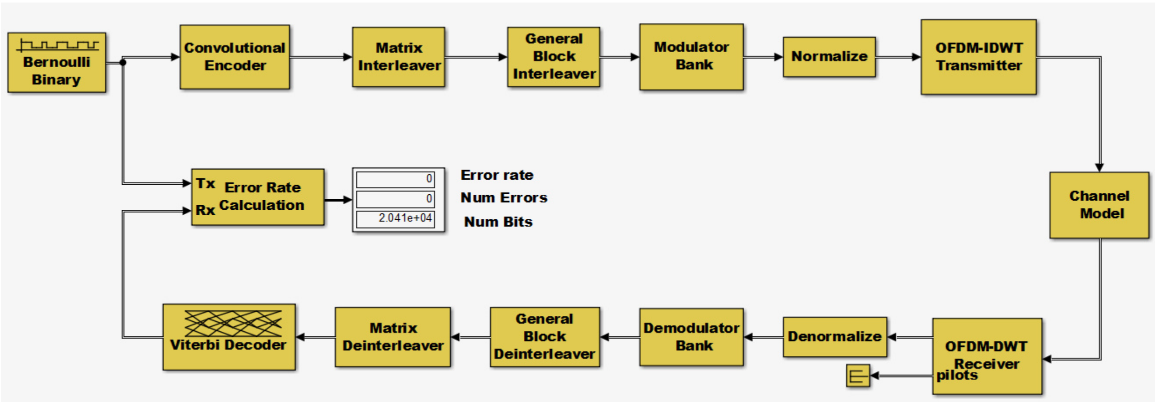

Figure 1. Simulation Block Diagram

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. Since transmission is conducted block-wise, when Forward Error Correction (FEC) is applied, the size of the data generated depends on the block size used. These data are converted into lower rate sequences via serial to parallel conversion the data are encoded when the encoding process consists of a concatenation of a Convolutional Code (R.A.N. Ahmed and M. Berwick, 2005). This means that the first data pass in the Convolutional encoder. It is a flexible coding process due to the puncturing of the signal and allows different coding rates. The last part of the encoder is a process of interleaving to avoid long error bursts using tail biting CCs with different coding rates (puncturing of codes is provided in the standard). Finally, interleaving is conducted using a two-stage permutation. The first stage aims to avoid the mapping of adjacent coded bits on adjacent subcarriers, while the second ensures that adjacent coded bits are mapped alternately onto relatively significant bits of the constellation, thereby avoiding long runs of lowly reliable bits. The training frame (pilot subcarriers frame) is inserted and sent prior to the information frame. The pilot frame is used to create channel estimation to compensate for the channel effects on the signal. The coded bits are then mapped to form symbols. The modulation scheme used as shown in Table.1

Table 1. Mode-dependent parameters (Angela Doufexi, 2002)

Mode	Modulation	Coding Rate *R*	Nominal Bitrates (Mb/s)	Coded Bits per Subcarrier	Coded Bits per OFDM Symbol	Data Bits per OFDM Symbol
1	BPSK	1/2	6	1	48	24
2	BPSK	3/4	9	1	48	36
3	QPSK	1/2	12	2	96	48
4	QPSK	3/4	18	2	96	72
5	16-QAM	9/16	27	4	192	108
6	16QAM	3/4	36	4	192	144
7	64QAM	3/4	54	6	288	216

This process converts data to the corresponding value of constellation, which is a complex word (with a real and an imaginary part). The bandwidth ($B = (1/T)$) is divided into N equally spaced subcarriers at frequencies ($k\Delta f$), k=0, 1, 2... N-1 with $\Delta f=B/N$ and, T, the sampling interval. The training frame (pilot subcarriers frame) is inserted and sent prior to the information frame. This pilot frame is used to create channel estimation, which is then used to compensate for the channel effects on the signal. To modulate spread data symbol on the orthogonal carriers, an N-point Inverse multi-wavelet transform IDWT is used, as in conventional OFDM. Zeros are inserted in some bins of the IDWT to compress the transmitted spectrum and reduce the adjacent carriers' interference. The added zeros to some sub-carriers limit the bandwidth of the system, while the system without the zeros pad has a spectrum that is spread in frequency. The last case is unacceptable in communication systems, since one limitation of communication systems is the width of bandwidth. The addition of zeros to some sub-carriers means not all the sub-carriers are used; only the subset (N_c) of total subcarriers (N_F) is used. Therefore, the number of bits in OFDM symbol is equal to $\log_2$(M)* N_c. Orthogonality between carriers is normally destroyed when the transmitted signal is passed through a dispersive channel. When this occurs, the inverse transformation at the receiver cannot recover the data that was transmitted perfectly. Energy from one sub-channel leaks into others, leading to interference. However, it is possible to rescue orthogonality by introducing a cyclic prefix (CP). This CP consists of the final *v* samples of the original *K* samples to be transmitted, prefixed to the transmitted symbol. The length *v* is determined by the channel's impulse response and is chosen to minimize ISI. If the impulse response of the channel has a length of less than or equal to *v*, the CP is sufficient to eliminate ISI and ICI. The efficiency of the transceiver is reduced by a factor of $\frac{K}{K+V}$; thus, it is desirable to make the *v* as small or *K* as large as possible. Therefore, the drawbacks of the CP are the loss of data throughput as precious bandwidth is wasted on repeated data. For this reason, finding another structure for FFT-OFDM as DWT-OFDM to mitigate these drawbacks is necessary. The Fourier based OFDM uses the complex exponential bases functions and it's replaced by orthonormal wavelets in order to reduce the level of interference. It is found that the Haar-based orthonormal wavelets are capable of reducing the ISI and ICI, which are caused by the loss in orthogonality between the carriers. The computation of DWT and IDWT for 64 point. After this, the data converted from the parallel to the serial form are fed to different Channel Models. In this model a set of five channels was chosen to address three different terrain types that are typical of the continental US. The parameters for the model were selected based upon some statistical models. The tables below depict the parametric view of the five channels more information about channel models in Table.2

Table 2. Channel models (Angela Doufexi, 2002)

Name	RMS Delay Spread	Characteristic	Environment
A	50 ns	Rayleigh	Office NLOS
B	100 ns	Rayleigh	NLOS
C	150 ns	Rayleigh	NLOS
D	140 ns	Rayleigh	LOS
E	250 ns	Rayleigh	NLOS

The receiver performs the same operations as the transmitter, but in a reverse order. In addition, multiwavelet OFDM includes operations for synchronization and compensation for the destructive channels.

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 wavelet transform signals structure based OFDM-DWT and comparing with OFDM-FFT system is achieved, beside the BER performance of the modified HiperLAN/2 transceiver structure considered in five channel models. Figures (2-8) presents the compressions performance results between HiperLAN/2 transceiver based Fourier and wavelet transform signals for the different modes of HIPERLAN/2 vs. average C/N for channel model A. Channel model A is typical of large office environments with non-line of- sight (NLOS) propagation. Note that similar results have been observed elsewhere (H. Li, 2000) . It can be seen that the C/N requirement increases for modes 1, 3, 2, 4, 5, 6, and 7 correspondingly. The degradation in performance in mode 2 (BPSK 3/4) is due to the fact that the punctured convolutional code does not cope well with the lack of frequency diversity in channel A. Errors due to large and deep fades in the frequency domain are difficult to correct using this code. Since mode 2 is inferior to mode 3 in terms of both C/N condition and data rate, it is extra for operation in channel A or like conditions. A reasonable point of operation for packet services without delay restriction can lie in a PER of 10^{-3} percent (J. Khun-Jush et al, 1999, A. Doufexi et al, 2001). Performance comparison results between two structures in channel A for all modes found in Table 3.

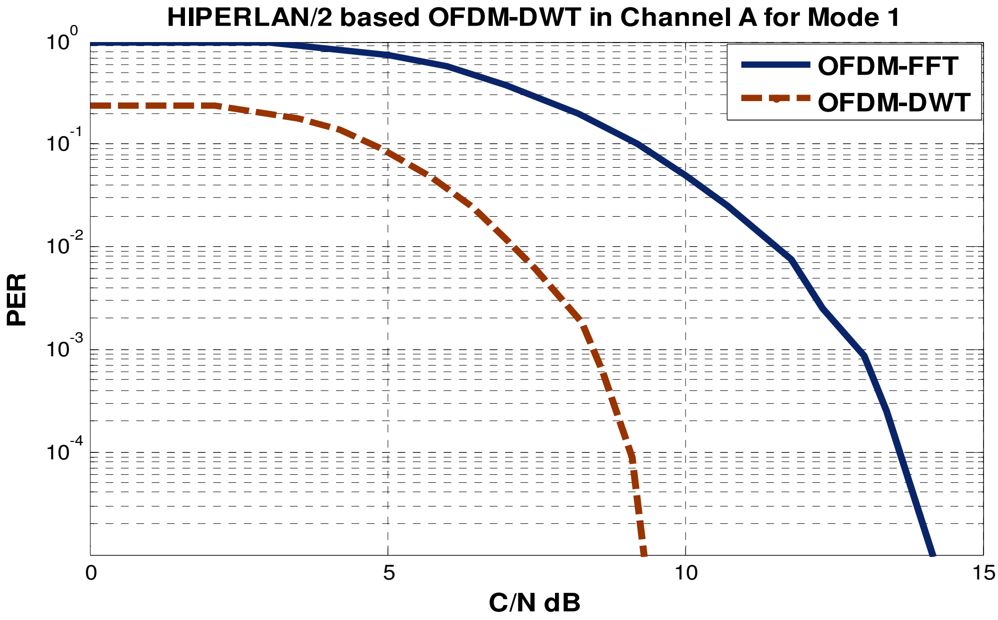

Figure 2. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in channel A for mode 1

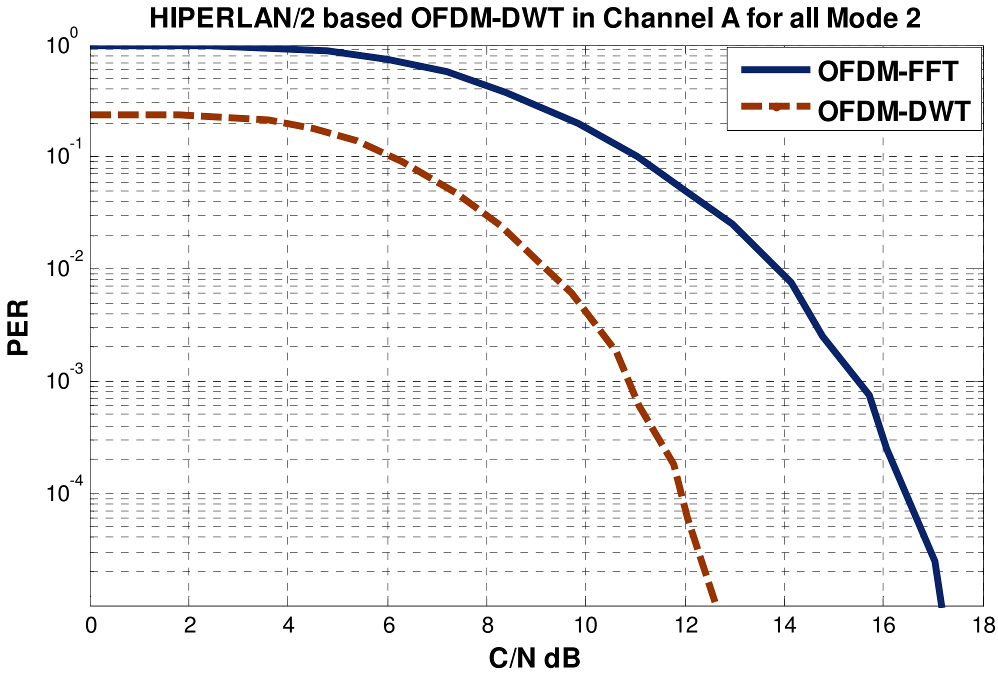

Figure 3. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in channel A for mode 2

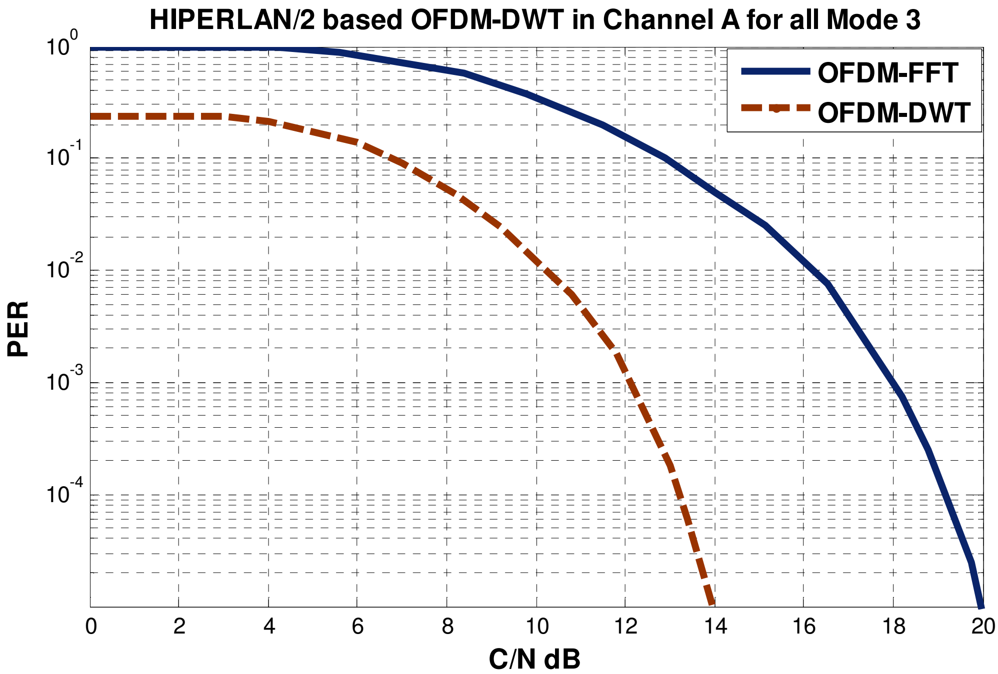

Figure 4. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in channel A for mode 3

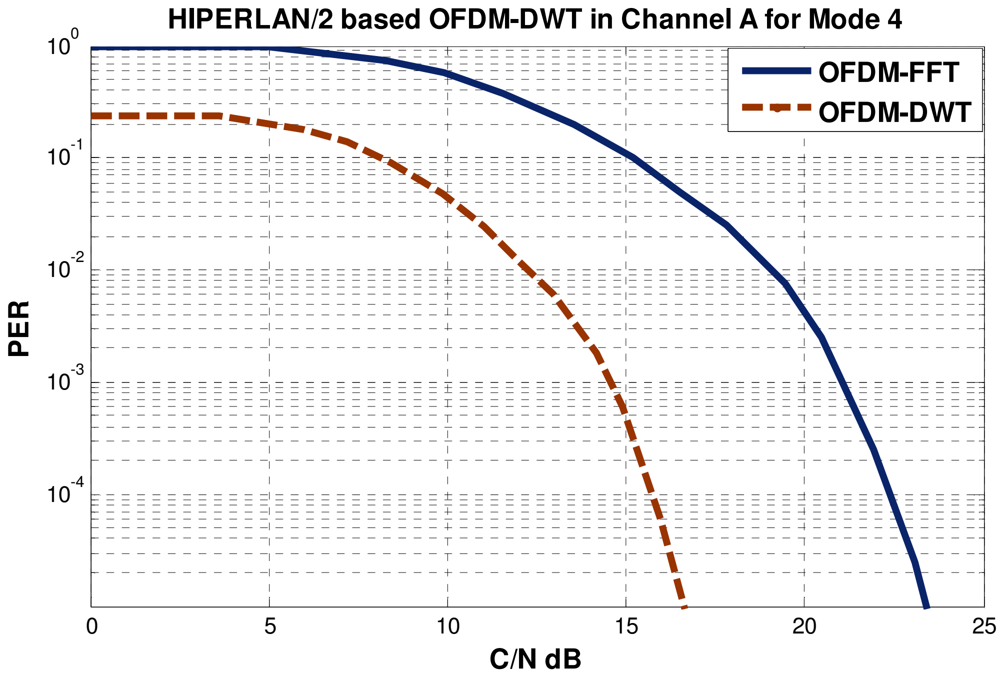

Figure 5. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in channel A for mode 4

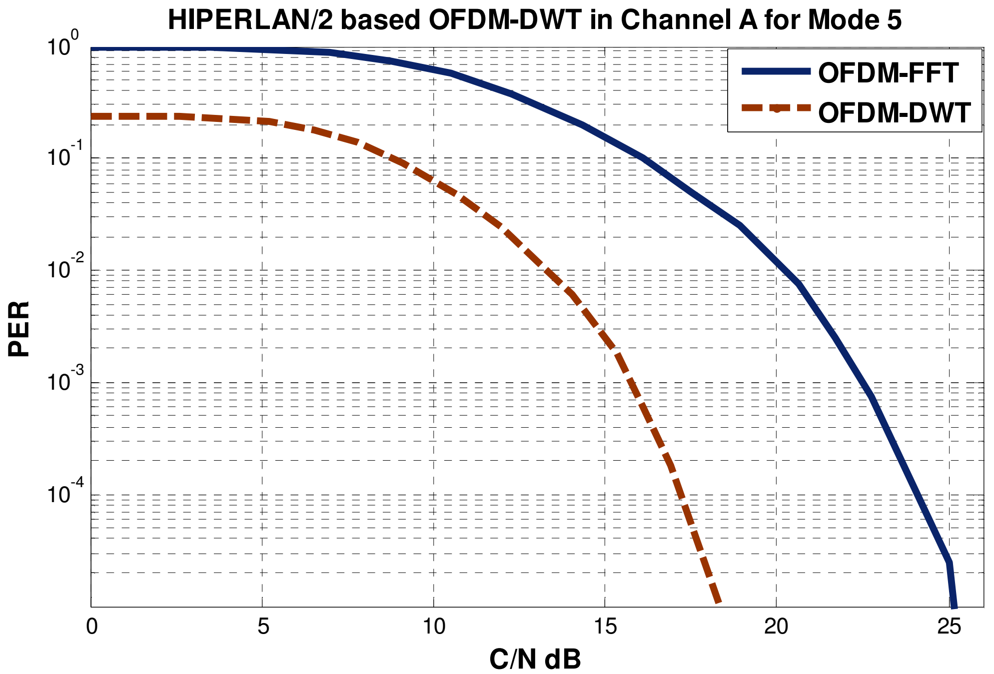

Figure 6. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in channel A for mode 5

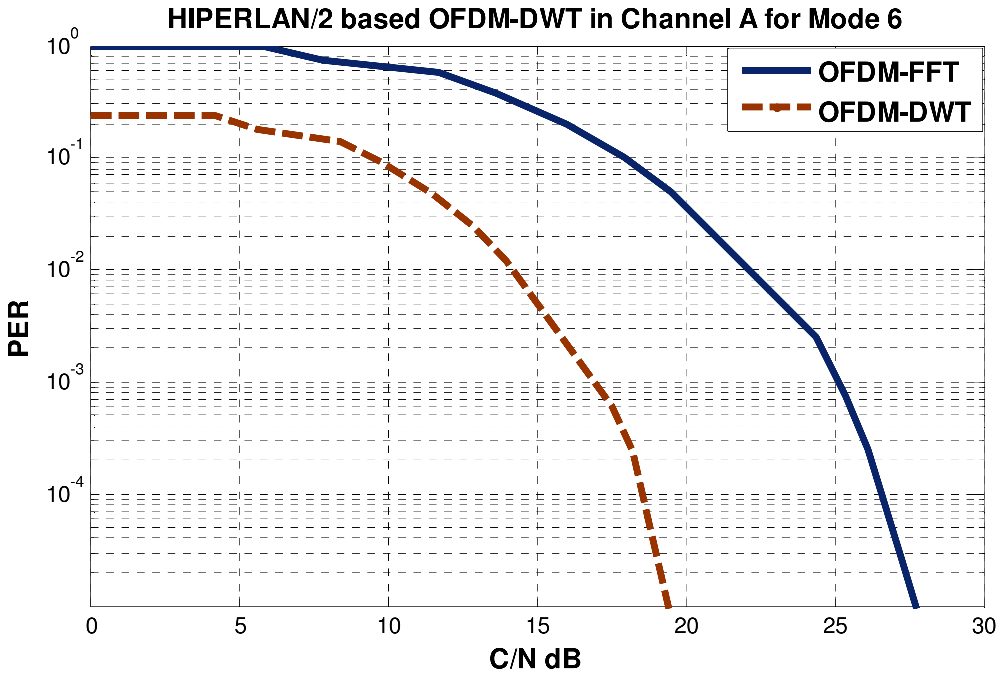

Figure 7. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in channel A for mode 6

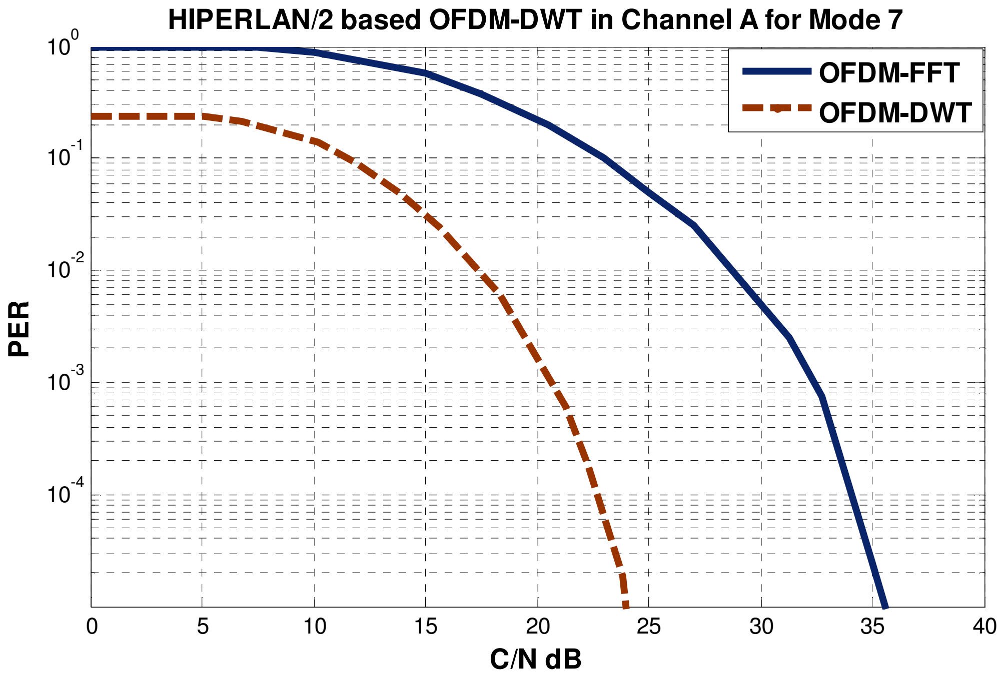

Figure 8. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in channel A for mode 7

Table 3. PER Performance comparison between conventional HiperLAN/2 and modified HiperLAN/2 in channel A for all modes

Channel For PER=10^{-3}	Mode 1 dB	Mode 2 dB	Mode 3 dB	Mode 4 dB	Mode 5 dB	Mode 6 dB	Mode 7 dB
HiperLAN/2 OFDM-FFT	13	15.5	18	21	22.5	25	32.5
HiperLAN/2 OFDM-DMWT	8.5	11.95	12	14.95	16	17	20.2

Figures (9-13). Shows PER performance vs. mean C/N for mode 5 for all the specified channels for conventional HiperLAN/2. It can be seen that as the delay spread increases, the performance is improved in the Rayleigh channels until the delay spread becomes so large that ISI and ICI become limiting factors (as is the case for channel E). Channels B, C, and D have increasingly better performances than channel A due to the increased frequency diversity of the channels. As probable, channel D has somewhat better performance than channel C because it is modeled as a Rician channel. In channel E the excess channel delay is much larger than the guard interval. As a consequence, ISI cannot be completely eliminated.

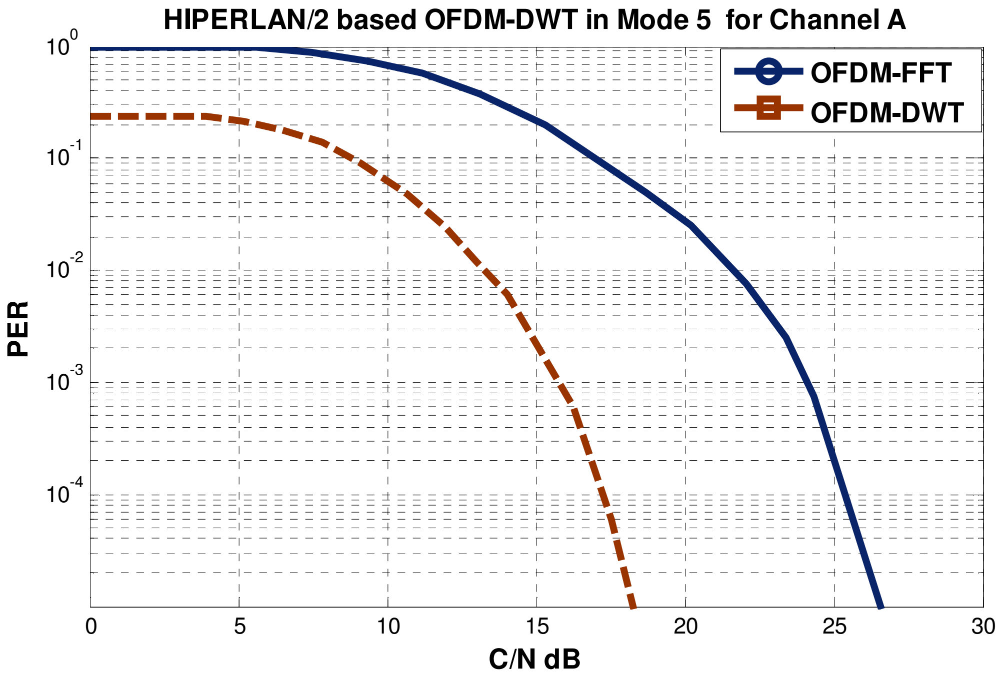

Figure 9. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in mode 5 for channel A

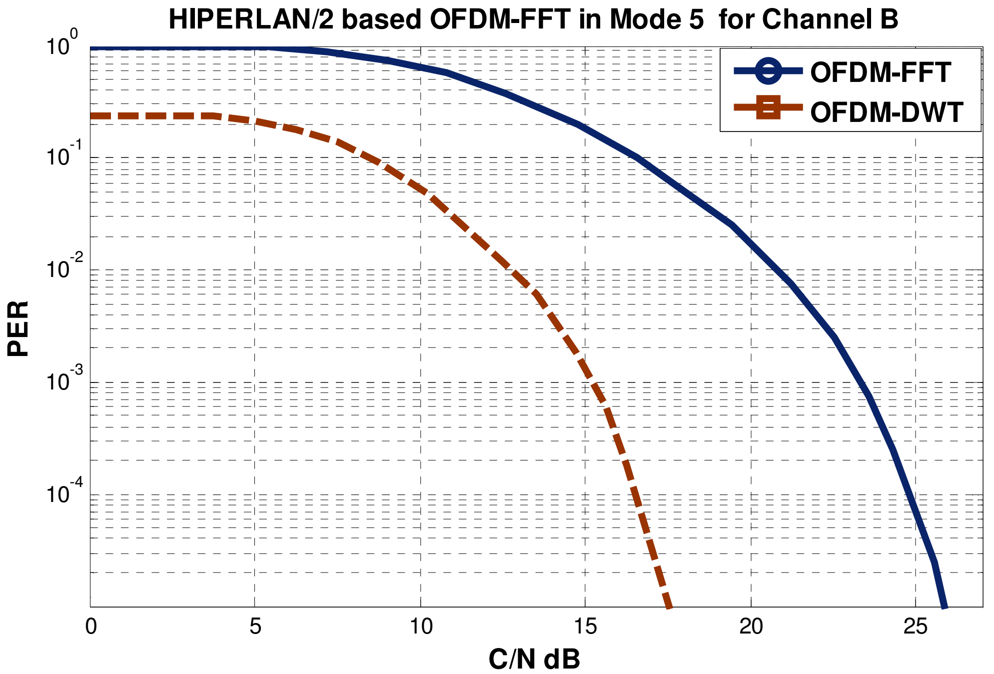

Figure 10. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in mode 5 for channel B

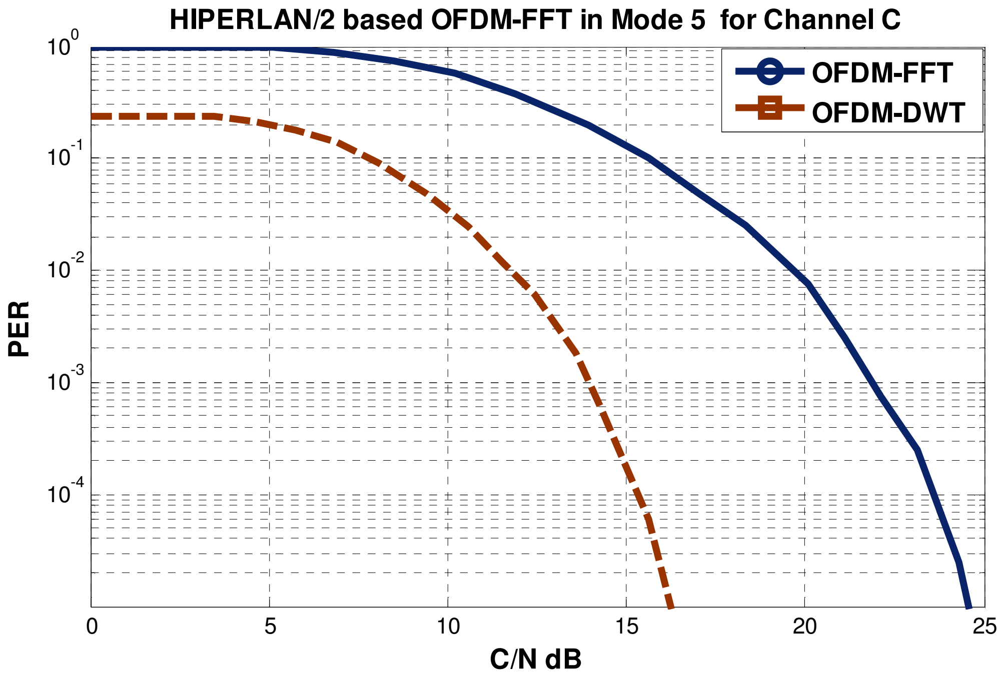

Figure 11. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in mode 5 for channel C

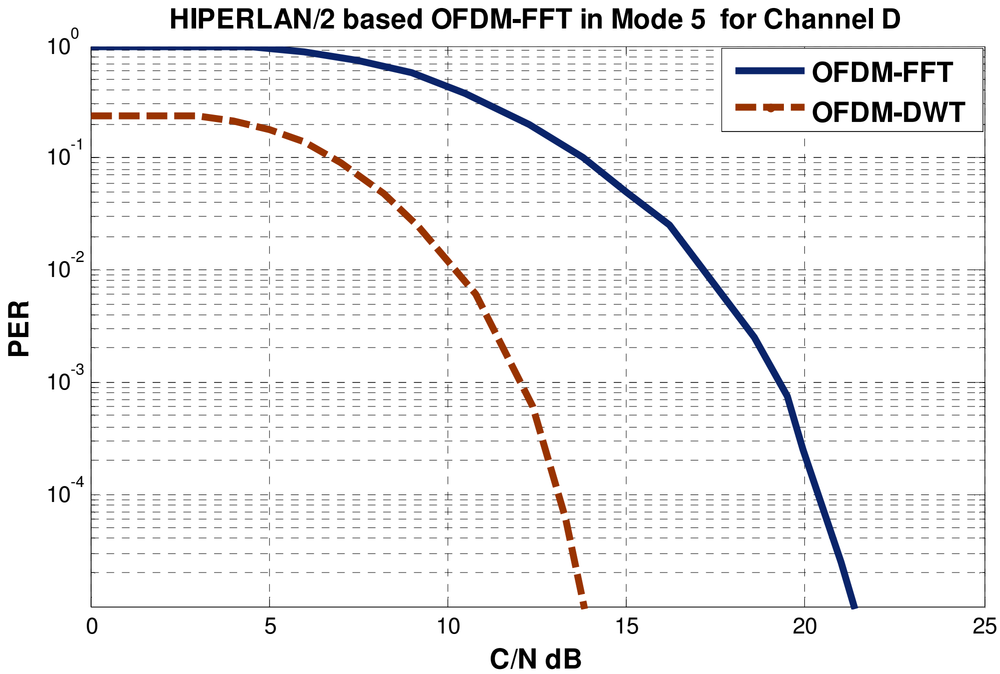

Figure 12. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in mode 5 for channel D

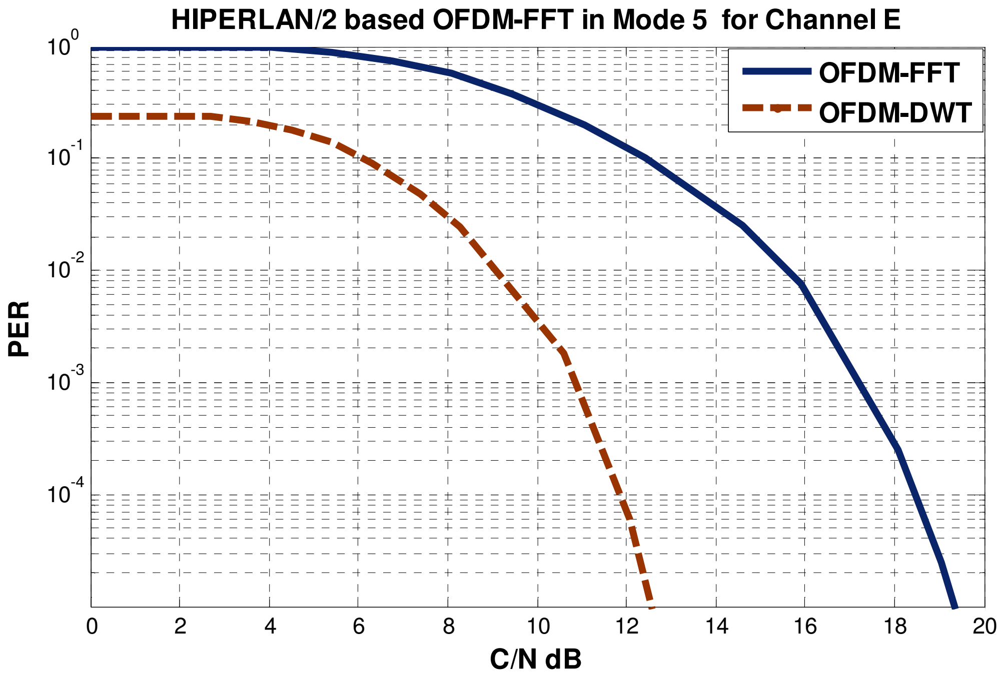

Figure 13. PER performance vs. mean C/N comparison between modified and conventional HiperLAN/2 in mode 5 for channel E

Table 4. PER Performance comparison between conventional HiperLAN/2 and modified HiperLAN/ for mode 5 in all the specified channels

Channel For PER= 10^{-3}	Channel A dB	Channel B dB	Channel C dB	Channel D dB	Channel E dB
HiperLAN/2 OFDM-FFT	24	23.5	22	19	17.6
HiperLAN/2 OFDM-DMWT	16	15	14	13	10.5

A number of significant results can be taken from Tables 3, 4; in this simulation, in most scenarios, HiperLAN/2 based OFDM-DMWT system was better than the conventional HiperLAN/2 based OFDM-FFT. The HiperLAN/2 based OFDM-DMWT system proved its effectiveness in combating the multipath effect on the all channels.

4. Conclusion

This work has presented the performance evaluation in a HIPERLAN/2 physical layer model in simulated in different channel models is considered. By simulation we have concluded that the modes definition is efficient to provide high data rates in accordance with the link quality. And the use of OFDM-DWT in HIPERLAN/2 transceiver can be a new domain to be exploited representing an improvement in the performance. An important reason for the consideration of OFDM-DWT is that these schemes are attractive to achieved much lower PER and better performance than OFDM-FFT. The proposed OFDM-DWT system is robust for multipath channels and does not require cyclically prefixed guard interval, which means that it obtains higher spectral efficiency than conventional OFDM .A future upgraded of this work is the implementation over the HIPERLAN/2 physical layer model in order to make possible to evaluate good performance that this technique can offer.

References

A. DOUFEXI ET AL 2001. A Study of the Performance of HIPERLAN/2 and IEEE 802.11a Physical Layers. *IEEE VTC '01 Spring*.

ANGELA DOUFEXI, S. A., MICHAEL BUTLER, ANDREW NIX, DAVID BULL, JOSEPH MCGEEHAN AND PETER KARLSSON, 2002. A Comparison of the HIPERLAN/2 and IEEE 802.11a Wireless LAN Standards. *IEEE Communications Magazine*, 172-180.

ETSI 2001. Broadband radio access network (BRAN) HIPERLAN Type 2; physical (PHY) layer. *tech. rep.,* *Standard, ETSI TS 101 475 v1.3.1*.

H. LI, G. M., AND M. PAULI, 2000. Performance Comparison of the Radio Link Protocols of IEEE802.11a and HIPERLAN/2. *IEEE VTC 2000*.

H. ZHANG ET AL 2004. Research of DFT-OFDM and DWT-OFDM on Different Transmission Scenarios. *Proceedings of the 2ndInternational Conference on Information Technology for Application (ICITA)*.

HEISKALA, J., AND TERRY, J, 2002. OFDM wireless LANS a theoretical and practical guide' (Sams Publishing, 2002).

J. KHUN-JUSH ET AL 1999. Structure and Performance of HIPERLAN/2 Physical Layer. *IEEE VTC '99 Fall, pp. 2667–71*.

J.TORSNER AND G. MALMGREN 1999. Radio Network Solutions for HIPERLAN/2. *Proc. of VTC '99 Spring (Houston), pp. 1217-1221*.

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.*

VAN NEE, R., AND PRASAD, R, 2000. OFDM for wireless multimedia communication. *Artech House Boston, London*

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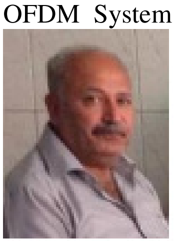

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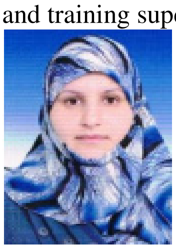

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