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BER Performance Comparison of HIPERLAN/2 for different modulation schemes with ½ and ¾ code rates

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ABSTRACT
Simulation of ETSI's High Performance Local area Network Type 2(HIPERLAN/2) is presented. In this paper, we compare HIPERLAN/2 performance via a MATLAB/Simulink simulation with ½ & ¾ coding rate for different modulation schemes for additive white Gaussian noise (AWGN) channel. MATLAB/Simulink modeling demonstrated that the performance of ¾ code rate has a remarkable degradation in the Bit Error Rate (BER)compared to ½ code rate which is due to the considerable frequency selectivity of the channel. In this paper we showed that the BERs with code rate 1/2 for different modulation schemes change more slowly and thus yield more stable modes with regard to changing channel conditions than ¾ code rate. With coding rate 1/2, Signal to Noise Ratio (SNR) improvement compared to coding rate 3/4 (with puncturing) is achieved.

Keywords- **Bit Error Rate (BER), Code Rate, HIPERLAN/2, OFDM, Signal to Noise Ratio (SNR)**

I. INTRODUCTION
Higher data rates in wireless communication can be achieved by increased or more efficient use of, bandwidth and transmitting power. A key technique for spectral optimization is orthogonal frequency division multiplexing (OFDM) [1]. The European Telecommunication Standards Institute (ETSI) and IEEE have proposed OFDM for high-speed wireless LAN and it is being considered for 4G mobile. ETSI's proposed HIPERLAN/2 standard describes the physical (PHY) layer based on OFDM technology and the data rate of HIPERLAN/2 ranges from 6 to 54 Mbit/s depending on Quality of Service (QoS). It is designed to provide Wireless Local Loop (WLL) to core networks, e.g. Asynchronous Transfer Mode, GSM/UMTS or any IP-based multimedia network. The link adoption scheme automatically determines the data rate, coding rate and modulation type depending on the channel conditions.
Using a Matlab simulation model for HIPERLAN/2 with ½ and ¾ code rates the BER performance for different modulation schemes is compared. It can be easily seen that the BER curves for all modulations with ½ code rates are less degraded as compared to that with ¾ code rate. Also the SNR is improved for ½ code rate that for ¾ code rate.

II. THEORY OF OFDM
HIPERLAN/2 uses OFDM which is investigated in [3, 4] as modulation scheme due to its good performance on highly dispersive channels. The channel raster is equal to 20 MHz to provide a reasonable number of channels in 100 MHz bandwidth which may be the narrowest continuous system bandwidth available, for instance, in Japan. In order to avoid unwanted frequency products in implementations the sampling frequency is also chosen equal to 20 MHz at the output of a typically used 64-point IFFT. The obtained subcarrier spacing is 312.5 kHz. In order to facilitate implementation of filters and to achieve sufficient adjacent channel suppression, 52 subcarriers are used per channel. 48 subcarriers carry actual data and 4 subcarriers are pilots which facilitate phase tracking for coherent demodulation. The duration of the cyclic prefix is equal to 800 ns, which is sufficient to enable good performance on channels with (r.m.s.) delay spread up to 250 ns (at least).

The basic principle of OFDM is to split a high – rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers. Because the symbol duration increases for lower rate parallel subcarriers, the relative amount of dispersion in time caused by multipath delay spread is decreased. The frequency domain signals are converted into a time domain signals (sum of sinusoids) using Fast Fourier Transform (FFT) at the transmitter and the process is reversed at the receiver. Correlation with every basis function using an FFT determines the energy for each subcarrier. Since subcarriers are uncorrelated their spectra can overlap (enhancing spectral efficiency) without causing intercarrier interference (ICI). Delay spread (DS), the time difference between the first and last reception of the same symbol due to multipath effects in the channel, causes intersymbol interference (ISI). Hence, guard times are required to separate successive OFDM symbols, but contain no information and waste energy. The duration of an OFDM symbol is usually chosen to be six times the guard time to make the concomitant loss smaller than 1 dB [2]. The guard time must contain cyclically extended symbol to prevent ICI occurring due to loss of orthogonality. The complex envelope of the OFDM signal can be written as,

$$S_s(t) = \frac{1}{N}\sum_{n=0}^{N-1} A_n(t) e^{j[\omega_n t + \phi_n(t)]}$$

Where, $\omega_n = \omega_0 + n\Delta\omega$

III. SIMULATION MODEL

The HIPERLAN/2 simulation models with different modulation schemes are used. In our transceiver model, binary data bits are generated and then channel coded by a convolutional encoder. The forward error control is performed by a Convolutional encoder with rate ½ and constraint length seven. The further code rates 9/16 and ¾ are obtained by puncturing. The modes are chosen such that the number of encoder output bits fits integer number of OFDM symbols. With the Viterbi algorithm, the zero-valued dummy bit has no effect on the outcome of the decoder [4]. The 1/2 code rate can be increased to 2/3, 3/4 or 9/16 by a suitable puncturing code. Interleaving, with a block size corresponding to the number of bits in an OFDM symbol, reduces the effect of frequency selective fading in the radio channels. Binary values are then mapped according to different modulation schemes using respective modulators, which are normalized to achieve the same average power for all mappings. The IFFT converts all the mapped symbols in the frequency domain into a time domain signal for transmission.

Addition of extra zero bits in the OFDM symbol is used to avoid aliasing. Cyclic prefixing can be implemented by adding the last few bits of a symbol at the beginning of the symbol and is used for both timing and frequency synchronization [2]. On the receiver side, most of the functions are just the opposite of the equivalent transmitter blocks. The time domain signal is converted into the frequency domain by the FFT and symbols are extracted by a demodulator. Removal of pilot carriers, frame synchronization and elimination of cyclic prefixes are performed beforehand in the receiver block. After denormalisation, frames are passed through a de-interleaving process. . Viterbi algorithm is used to decode convolutionally encoded input data. With the Viterbi algorithm, the zero-valued dummy bit has no effect on the outcome of the decoder. Finally the received data bits are compared to the transmitted bits by a bit error calculator.

Table1: Table of mode dependent physical layer parameters of HIPERLAN/2 [3].

Data rate (Mbps)	**Modulation**	**Coding Rate (R)**	**Coded bits per carrier (N_{BPSC})**	**Coded bits per OFDM symbol (N_{CBPS})**	**Data bits per OFDM symbol (N_{DBPS})**
6	BPSK	½	1	48	24
9	BPSK	¾	1	48	36
12	QPSK	½	2	96	48
18	QPSK	¾	2	96	72
24	16QAM	½	4	192	96
38	16QAM	¾	4	192	144
48	64QAM	2/3	6	288	192
54	64QAM	¾	6	288	216

The standard modulation types and coding rates in the HIPERLAN/2 are summarized in table 1. The first six are mandatory and the last one is optional. A key feature of the physical layer is to provide several physical layer modes with different coding and modulation schemes, which are selected by link adaptation. BPSK, QPSK and 16QAM are the supported subcarrier modulation schemes. Furthermore, 64QAM can be used in an optional mode.

IV. RESULT

The main purpose of the simulation was to design a baseband HIPERLAN/2 model and observe its behavior under different channel conditions. The variation of bit error rate (BER) with signal-to-noise ratio (SNR) for coding rates of 3/4 (with puncturing) and ½ (mother code rate) are shown in Figs. In this section we present some simulation results showing the performance of HIPERLAN/2 with ¾ and ½ code rates for all the four modulation schemes (i.e. 16QAM, BPSK, QPSK & 64QAM)

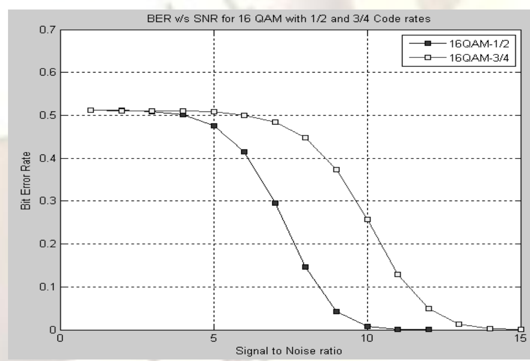

Fig. 1 BER vs. SNR curve of HIPERLAN/2 for 16QAM modulation with ½ & ¾ code rates.

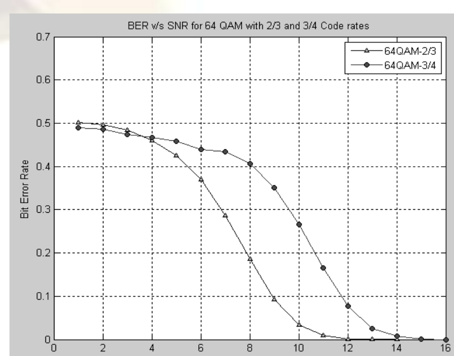

Fig. 2 BER vs. SNR curve of HIPERLAN/2 for 64QAM modulation with ½ & ¾ code rates.

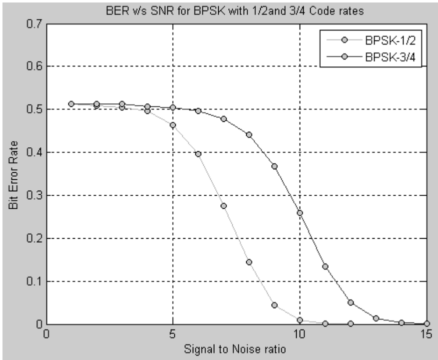

Fig. 3 BER vs. SNR curve of HIPERLAN/2 for BPSK modulation with ½ & ¾ code rates.

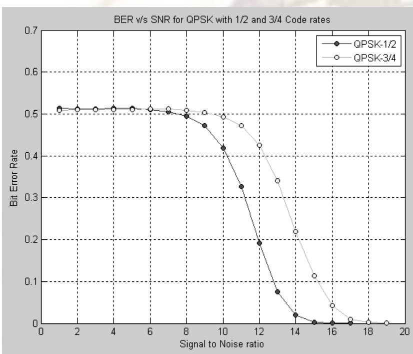

Fig. 4 BER vs. SNR curve of HIPERLAN/2 for QPSK modulation with ½ & ¾ code rates.

Figures 1-4 shows the BER vs. SNR plots for 16QAM, 64QAM, BPSK and QPSK modulations respectively for ¾ and ½ code rates. As can be seen that the curve for ¾ code rate in all cases is much more degraded than the curve for ½ code rate. The reason behind this is that while changing code rate ½ to ¾ code rate we are using puncturing. While increasing the code rate some of the bits output by the convolutional encoders are not transmitted. This increase in rate decreases the free distance of the code. The receiver inserts dummy bits to replace the punctured bits in the receiver. Due to this the performance for ¾ as compared to ½ code rate is losses.

V. CONCLUSION

The observation concerns the rate of change of BER with SNR in puncturing mode. Because HIPERLAN/2 works in different modes based on the link adoption scheme, it switches from one mode to another mode (i.e. from one data rate to another data rate) depending on the prevailing channel conditions. The rate of change of BER in puncturing mode in both BPSK and QPSK is quite high so the possibility of switching from a higher data rate to a lower data rate is very high even for a 1 dB fall in SNR. On the other hand, the BER with code rate ½ (when used as a mother convolutional code) change more slowly and thus yield more stable modes with regard to changing channel conditions than code rate ¾. A further important observation is that the effect of ½ and ¾ code rates on the performance of HIPERLAN/2 with BPSK and QPSK modulation schemes has been analyzed. As expected BPSK and QPSK have the same Eb/N0 requirement. The performance of the rate-¾ code shows a remarkable degradation compared to the rate- ½ code, which is due to the considerable frequency selectivity of the channel. With coding rate ½ SNR improvement compared to coding rate 3/4 (with puncturing) is achieved.

REFERENCES:

[1] Chang, R.W.: ‘Synthesis of band limited orthogonal signals for mulitchannel data transmission’, Bell Syst. Tech. J., 1996, 45, pp. 1775–1796

[2] Van Nee, R., and Prasad, R.: ‘OFDM for wireless multimedia communication’ (Artech House Boston, London, 2000)

[3] 3 ETSI TS 101 475 V1.1.1, ‘Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Physical (PHY) layer’, April 2000. http://www.etsi.org

[4] Heiskala, J., and Terry, J.: ‘OFDM wireless LANS a theoretical and practical guide’ (Sams Publishing, 2002)

[5] R.A.N. Ahmed and M. Berwick: ‘Performance analysis of HIPERLAN/2 in QAM mode with punctured and non-punctured convolutional coding’, Electronics Letter 31st March 2005 Vol. 41 No. 7.

[6] Jamshid Khun-Jush1, Peter Schramm1, Udo Wachsmann1, Fabian Wenger21 Ericsson Euro lab Deutschland GmbH, D-90411 Nürnberg, Germany 2 Ericsson Mobile Data Design AB, S-41266 Göteborg, Sweden ‘Structure and Performance of the HIPERLAN/2 Physical Layer’.

[7] OFDM Wireless LANs,: A Theoretical and Practical Guide, Juha Heiskala, John Terry Sams Publishing 2002.

[8] U. Dettmar, J. Khun-Jush, P. Schramm, J. Thielecke,U. Wachsmann. Modulation for HIPERLAN/2. Proc. of VTC '99 Spring (Houston), pp. 1094-1100.