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Estimating the Channel with Different Fading Characteristics and to Develop an Algorithm to Minimize the Effect of Fading for Broadband Services in Multiple Path Communication in Wi-Max

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Abstract— *WIMAX, the world wide interoperability for microwave access, is a technology which provides wireless transmission of data in variety of ways, ranging from point to point links to the full mobile cellular access. The WIMAX physical layer is based on orthogonal freq division multiplexing a scheme that offers good resistance to multipath, and allows WIMAX to operate in NLOS conditions; MOBILE WIMAX uses OFDM as a multiple access technique, whereby different users can be allocated different subsets of the OFDM tones. OFDMA facilitates the exploitation of frequency diversity and multiuser diversity to significantly improve the system capacity. The objective of this paper is to develop an OFDM transceiver model for 802.16d (FIXED WIMAX), 802.16e (MOBILE WIMAX) that could be implemented with various modulation schemes.*

Key words: WIMAX, WIMAX PHYSICAL LAYER, MOBILE WIMAX, FIXED WIMAX, OFDM, OFDMA.

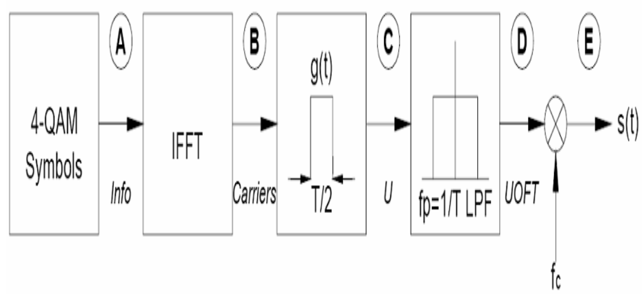
I. INTRODUCTION

WIMAX, the world wide interoperability for microwave access, is a technology which provides wireless transmission of data in variety of ways, ranging from point to point links to the full mobile cellular access .The technology based on the IEEE 802.16 provides broadband services for fixed and mobile subscribers [1]. IEEE 802.16d supports fixed broadband services; an amendment to the IEEE 802.16d that could add mobility support is IEEE 802.16e forms the basis for the WIMAX solution for the nomadic and mobile applications and is referred to as mobile WIMAX [2].

The WIMAX physical layer is based on orthogonal frequency division multiplexing a scheme that offers good resistance to multipath, and allows WIMAX to operate in NLOS conditions; MOBILE WIMAX uses OFDM [3] as a multiple access technique, whereby different users can be allocated different subsets of the OFDM tones. OFDMA facilitates the exploitation of frequency diversity and multiuser diversity to significantly improve the system capacity [4]. OFDM a transmission scheme called multicarrier modulation ,divides a high bit rate stream into several parallel lower bit rates streams and modulating each stream on a separate carriers-often called subcarriers [3] ,OFDM minimizes ISI [5] by making the symbol duration larger enough so that the channel induced delays –delay spread are an insignificant delay of symbol duration ,therefore in high data rate systems in which the symbol duration is small being inversely proportional to the data rate, splitting the data stream into parallel streams increases symbol duration such that the delay spread is only a small fraction of symbol duration.

Fig. 1 OFDM Transmitter

OFDMA a hybrid of FDMA and TDMA is an multiple access technique [4] where the users are dynamically assigned subcarriers in different time slots, OFDMA is flexible multiple access technique and the significant advantage of OFDMA relative to OFDM is its potential to reduce the transmit power



and to relax the peak to average power ratio problem. Lower data rates and burst data are handled much more efficiently in OFDMA than in single user OFDM [6].

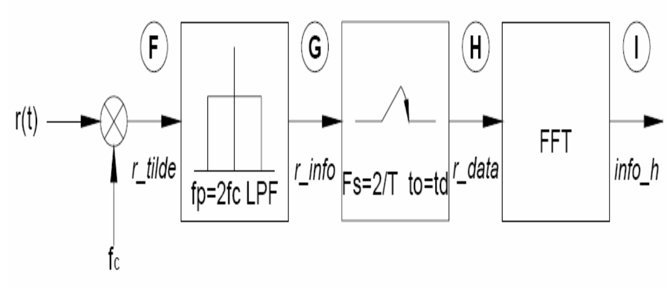
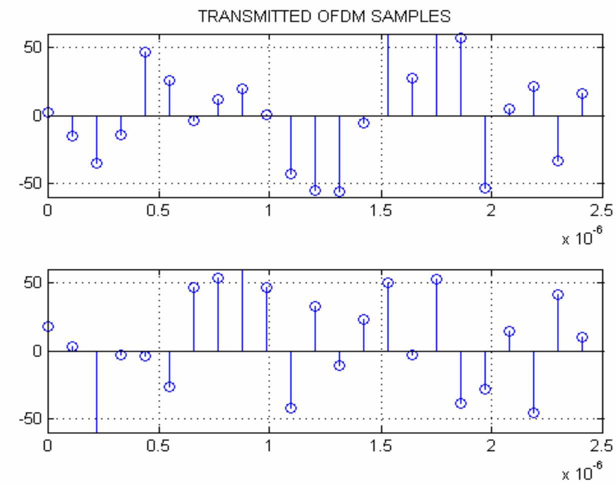


Fig. 2 OFDM Receiver

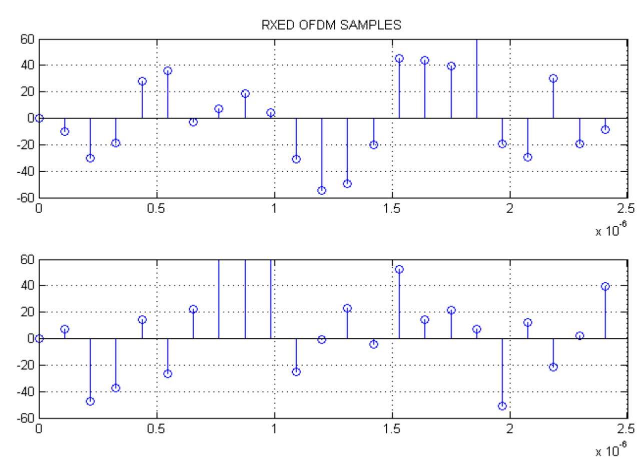
II. SIMULATION OF PHYSICAL LAYER IMPLEMENTATION

We have developed a transceiver model that could generate OFDM symbols for 802.16d (fixed WIMAX) and for 802.16e (mobile WIMAX)[1][2].

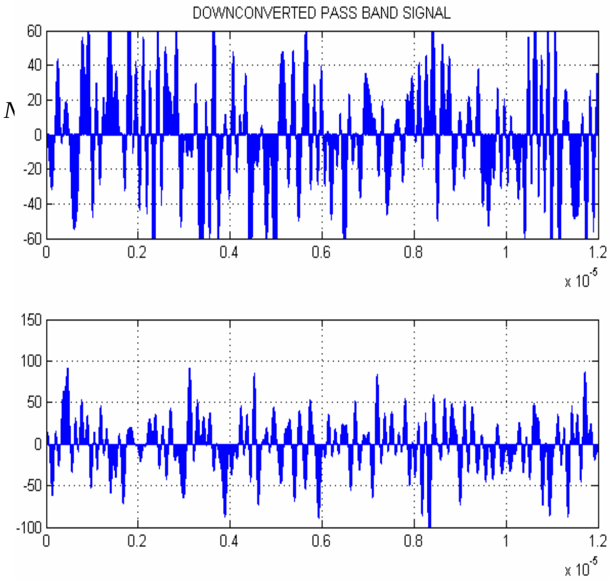


The baseband data randomly generated has been modulated to QPSK and the modulated output is applied to serial to parallel converter which would place the data over the subcarrier and enables interleaving. The computational complexity of an OFDM system is considerably reduced with the inclusion of single IFFT block replacing many modulators and filters. The pass band signal will undergo different fading conditions and the received output at the receiver would be converted to frequency domain by FFT block [3].

Digital Down-Converter (DDC) converts a digitized real signal centered at an intermediate frequency (IF) to a basebanded complex signal centered at zero frequency. In addition to down conversion, DDC's typically decimate to a lower sampling rate, allowing follow-on signal processing by lower speed processors.



a. FADING CHANNEL CHARACTERISTICS



wireless communications, fading is deviation of the attenuation that a signal experiences over certain propagation media. The fading may vary with time, geographical position or radio frequency, and is often modeled as a random process. A fading channel is a communication channel that experiences fading. In wireless systems, fading may either be due to multipath propagation, referred to as multipath induced fading, or due to shadowing from obstacles affecting the wave propagation, sometimes referred to as shadow fading.

b. FADING CHANNEL SIMULATION

We consider uncoded transmission over a synchronous flat fading multiple-access (uplink) OFDM discrete time system with N users and L sub-carriers (referred to as sub bands) for each user. The signal received at time n is given by:

$$\mathbf{y}(n) = \sum_{i=1}^{N}\sum_{j=1}^{L}\sqrt{h_{i,j}}(n)\mathbf{s}_{i,j}(n)x_{i,j}(n) + w_{i,j}(n)$$

where xi,j(n) denotes the transmitted symbol, si,j the spreading sequence, wi,j(n) the additive Gaussian noise and hi,j (n) the stationary and ergodic channel gain corresponding to User i in sub-band j. The hi,j (n) are assumed to be i.i.d., and to result from a combination of fast (assumed Rayleigh) fading and slow fading [4]. Equivalently, hi,j results from the product of a fast fade rid(n) and a slow fade hi,j(n). We assume ri,j(n) to be unit mean. Equivalently, hi,j(n) is the short-term mean of hi,j(n) (hence the symbol hi,j for the slow fade). We assume that hi,j(n) is known perfectly at the transmitter and receiver at time n.

Note that, with appropriate scaling, we may assume that the noise variance is unity. The short-term means hi,j (n) for each user and each sub-band are fed back from the base-station to all the users in the system. Since most OFDM systems in use today use the conventional matched filter receiver, we assume the same for our OFDMA system, with one matched filter for every Spreading sequence si,j.

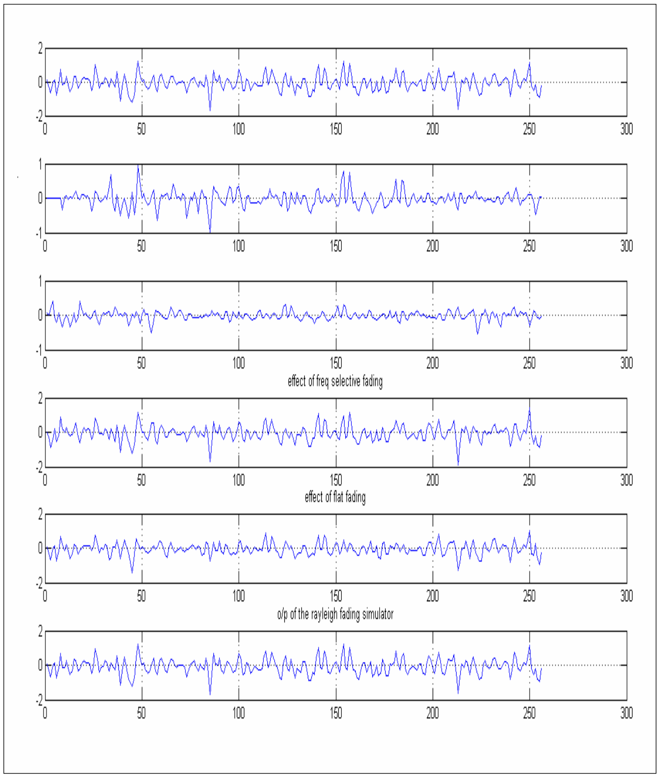


Fig. 3 Frequency Selective Fading

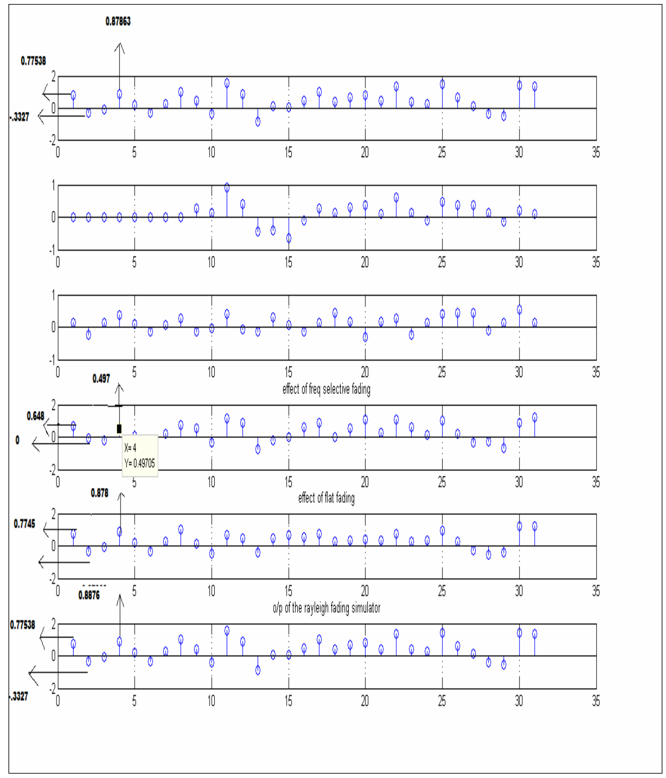


Fig. 4 Flat Fading

We assume that any two spreading Sequences have a constant cross correlation given by PWe.

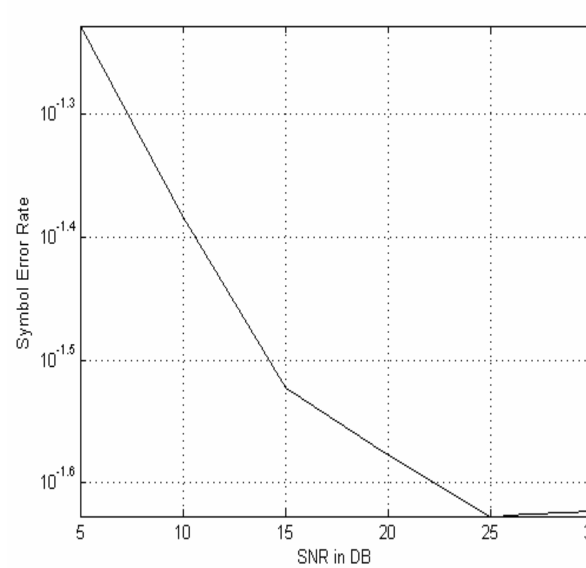
$$\mathbf{E_H} \sum_{j=1}^{L} P_{i,j} = \bar{P} \text{ for } 1 \le i \le N.$$

Now characterize the constraints imposed on this system by practical requirements. The power of each User i is required not to exceed p on average, where the average is over the composite fading distribution hi,j (n). Constructing a matrix H(n) whose (i, j) element is hi,j(n) and denoting the power of User i in sub-channel j by Pi,j ,we have EH cj”=, Pi,j = p for 1 5 i 5 N.

First, we analyze the MC-CDMA system given with one sub-band per user, i.e. with L = 1. This is equivalent to a synchronous OFDMA system without inter-symbol interference (ISI). There are three well known techniques for dynamic rate adaptation OFDM systems: multi-code, multi-bit Rate and variable constellation size methods, which are explained in [1]. To maintain continuity with previous sections, we focus on variable-constellation size schemes in this paper. In a variable constellation size scheme, each user is assigned a single spreading sequence.

c. EQUALIZER IMPLEMENTATION

The primary function of the equalizer is to compensate the effect of distortion introduced by the fading channel over the transmitted OFDM symbols. MMSE EQUALIZER has been implemented over the MATLAB and the effect of SNR over symbol error rate has been calculated for the BPSK signals and could be extended over any modulated schemes.



CONCLUSIONS

The baseband data randomly generated has been modulated to QPSK and the modulated output is applied to serial to parallel converter which would place the data over the subcarrier and enables interleaving, the computational complexity of an OFDM system is considerably reduced with the inclusion of single IFFT block replacing many modulators and filters. The passband signal will undergo different fading conditions and the received output at the receiver would be converted to frequency domain by FFT block. A Rayleigh fading simulator has been developed to determine the performance in wide range of channel conditions, both frequency selective fading and flat fading conditions are simulated depending on gain and time delay settings. MMSE EQUALIZER has been implemented over the MATLAB and the effect of SNR over symbol error rate has been calculated for the BPSK signals and could be extended over any modulated schemes.

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