Wavelet based WiMAX (WT-WiMAX) Impressive Contender of FFT-WiMAX

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Abstract
Wavelets Transform in wireless system provides higher resiliency to Inter Symbol Interference (ISI) and inter-carrier interference (ICI). Wavelets propose an orthogonal base of multi-carrier modulation and have drawn massive attentions from wireless industry in recent years. BER of fast Fourier Transform (FFT) based WiMAX configuration and Wavelet Transform (WT) based WiMAX configuration is evaluated in this paper. The BER performance is validated over AWGN channel incorporated divergent digital modulation and diverse Convolution Code (CC) rate. The BER performance is verified via BER as a function of SNR. The outcome reveals a considerable enhancement in BER for a given SNR using WT-WiMAX in comparison to FFT-WiMAX.

Keywords
OFDM, FFT, SNR, BER, AWGN

I. Introduction

WiMAX (Worldwide Interoperability for Microwave Access) purpose is to distribute wireless broadband access to users with coverage distances in the order of miles. It typically is much easier to install, much easier to adapt and more reliable. It offers the services to assist customers not supported or otherwise not pleased on using the wired broadband alternatives available. The Institute of Electrical and Electronics Engineers (IEEE-802.16) group has released a set of standards that demonstrate WiMAX configuration. The first IEEE 802.16 standard for conventional WiMAX was released in year 2001 at spectrum 10 GHz to 63 GHz and to deal with the line of sight (LOS) access. It was recapitulated in standard IEEE 802.16d-2004 after number of updates and is identified as the “Fixed WiMAX”. Mobile broadband wireless access was released as standard 802.16e-2005 identified as “Mobile WiMAX” in year 2005. Recently, it released standard 802.16-2009 for both fixed and mobile wireless transmission and identified as the “Air Interface for Fixed and Mobile Broad-band Wireless Access System” [1-2].

In mobile WiMAX, the system’s resources are dynamically allocated to deliver high data rates seamlessly to terminals traveling at vehicular speeds. It provides supplementary services such as web browsing, streaming media, immediate messaging, and additional content. The physical layer of the IEEE 802.16 standard based on OFDM has already been defined in close collaboration with the European telecommunications standards institute (ETSI) high-performance metropolitan area network (Hiper-MAN). Physical layer based on orthogonal frequency division multiplexing (OFDM), a modulation scheme that offers good quality resistance to multipath. The technique works in NLOS (Non-line-of-sight) conditions. The 802.16 standard provides adaptable data rate while preserving the requisite quality of service. Many applications need higher error resilience and latency that straight aspect into the QoS. The system resources are allocated and scheduled dynamically by the base station on a frame by frame basis to keep up with the need of the users in the environment [3, 4]. Hence WiMAX uses a combination of adaptive modulation schemes and coding ranging from rate QPSK to 5/6 rate 64QAM.The amount of error correction applied to each transmission is adjustable and can be changed depending on the required QoS and based on the reliability of the link between each user and the base station.

II. Wavelet Transform (WT) in Communication System

To improve the performance and less significant disturbance/interference, WT may be utilized as opposed to FFT. The Wavelet Transform (WT) is an apparently technologically sophisticated transform as opposed to the fast Fourier transform (FFT). WT will present the time and frequency domain portrayal of signals while in opposition FFT presents just the frequency domain portrayal of signals. WT is implemented as a signal processing tactic in plentiful communication regions of multicarrier modulation (MCM) and wireless communication. Earlier, to emphasize the bandwidth efficiency, ICI and ISI, wavelet transforms incorporated OFDM was examined. WT-OFDM can definitely better overcome narrowband interruption as a consequence of attractive high spectral control capabilities of wavelet filters, as well as considerably more tolerant concerning ICI than standard FT-OFDM [5]. WT-OFDM does not use the concept of guard band (Cyclic Prefix CP) that’s why data rate will be more like compared to those of FFT follows [6]. Hence due to improved orthogonality among spectral repression and subcarriers, WT-OFDM is anticipated to reduce the consumption of bandwidth trucking from accumulation of CP all of which will reduce the ISI and ICI [5]. WT-OFDM promises main side lobe of far lower magnitude than that of FFT-OFDM and also being far less influenced by this shift [7].

The performance of FFT-OFDM over WT-OFDM is evaluated overpower line channels, and it has been observed that WT-OFDM provides considerable improvement in terms of transmission efficiency. The wavelet OFDM provides the orthogonal basis and also satisfies the accurate reconstruction, thereby providing significant BER improvement over FFT-OFDM [8]. The BER performance of WT-OFDM is also evaluated over flat as well as frequency selective fading channels and it has been concluded that the use of wavelets influence the BER performance significantly [9]. The overall performance of FFT-OFDM is measured against WT-OFDM over AWGN channel and concluded that its performance is superior to FFT-OFDM [10]. A concise review of Diverse Wavelet in Orthogonal Wavelet Division Multiplex for DVB-T is presented [11] and concluded that Haar transform has better performance in comparison to all other transforms in wavelet family.

III. Implemented WiMAX Model

The developed FFT-WiMAX and WT-WiMAX model structure have been simulated using MATLAB and the overall performance is expressed using SNR vs. BER variations. In the transmitter, the first process is data generation and randomization. It is really chiefly jumbling of data to generate random arrangement to optimize coding effectiveness. The Forward Error Correction

(FEC) technique incorporated in WiMAX standard is RS codes and convolution codes. RS codes essentially add redundancy to the data hence enhances block error reduction.

Convolution Code (CC) incorporated shift register which accepts the information data bits and encoded bits are generated by using the modulo-2 addition of the contents of the shift register along with input data bits. The block diagram for the simulated system is depicted in fig. 1.

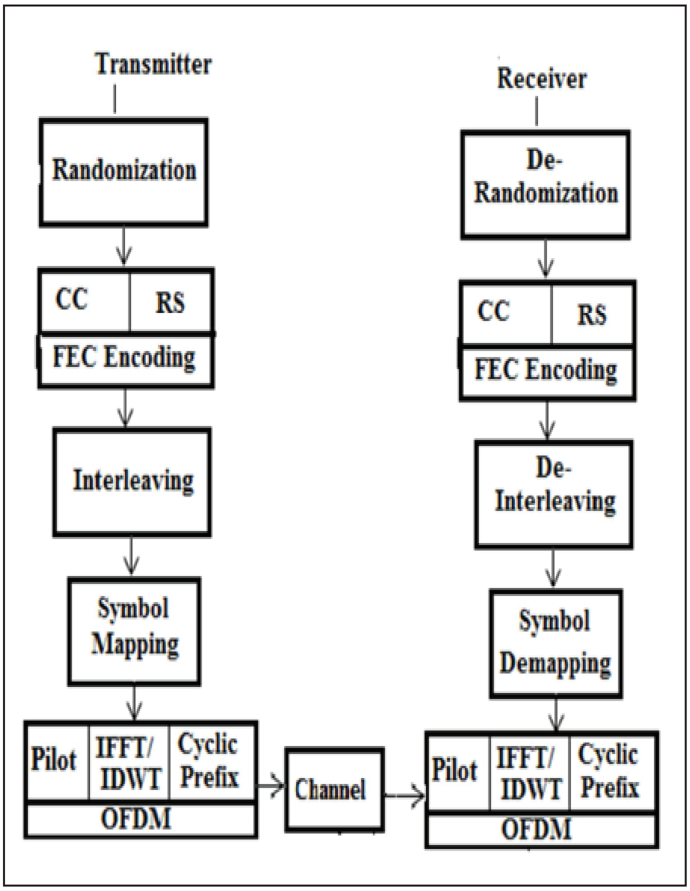


Fig. 1: Basic Structure of Developed WiMAX Model

Interleaving endeavors to distribute transmitted data bits in frequency or time or perhaps both of them to accomplish acceptable bit error rate after demodulation. Digital modulation is the process for mapping the digital data to analog form so that it could be transmitted over the channel. Stalwartly linked to modulation is the inverse approach, referred to as demodulation, performed by the receiver to get back the transmitted digital information. Distinct, coherent mapping employed are m-ary phase shift keying (M-PSK) and m-ary-quadrature amplitude modulation (M-QAM). Pilot insertion is employed for channel estimation and synchronization goal.

IV. Results & Discussion

The resiliency against time and frequency fluctuation of the channel is more in WT-OFDM as compared to FFT-OFDM. The FFT-WiMAX and WT-WiMAX model is implemented in MATLAB. The BER performance of WT-WiMAX in AWGN channel is compared with the FFT-WiMAX. This is apparent from Fig. 2 to figure 3 that WT-WiMAX gives better outcome than FFT-WiMAX under diverse modulation schemes since it is rather less susceptible to Doppler frequency variations.

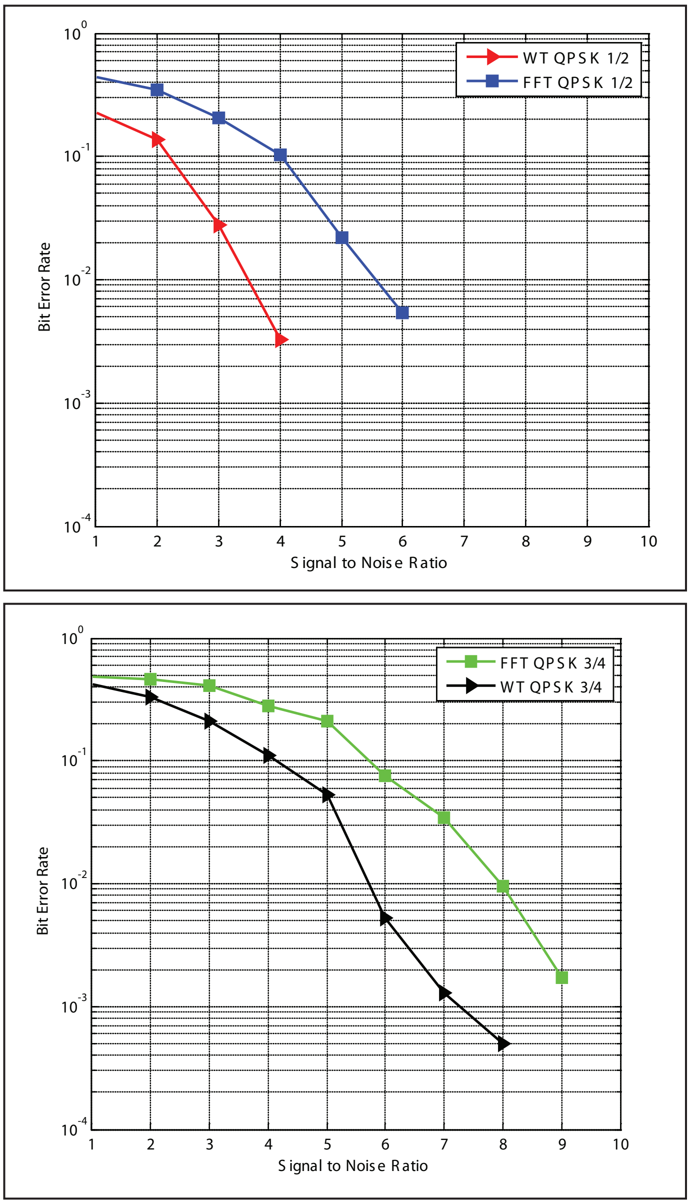
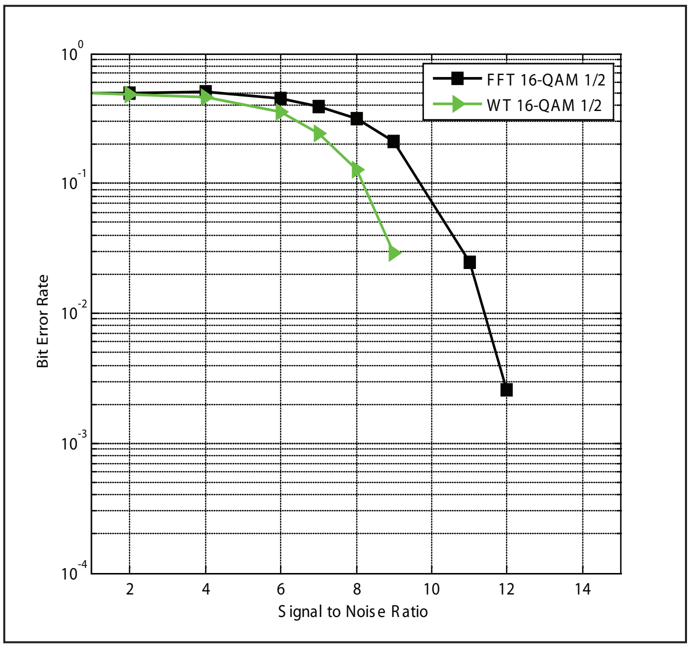


Fig. 2: BER Comparison WT-WiMAX & FFT-WiMAX for QPSK Modulation Under Divergent Code Rates



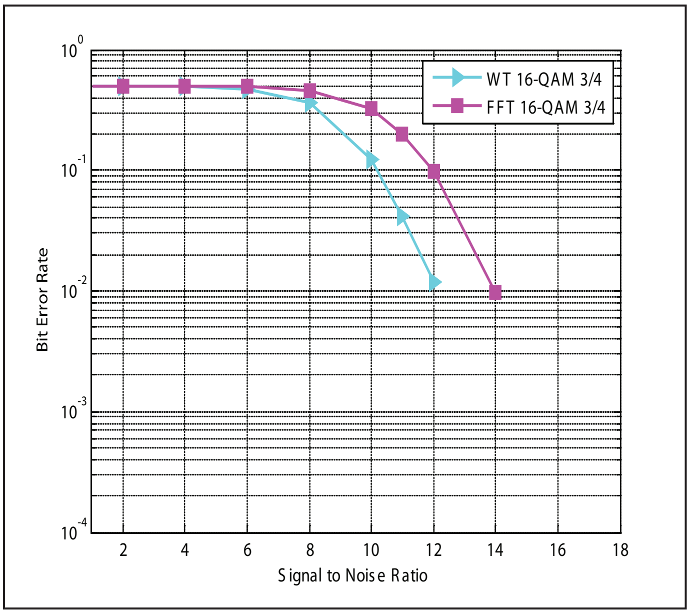


Fig. 3: BER Comparison WT-WiMAX & FFT-WiMAX for 16-QAM Modulation

The orthogonality of WiMAX sub-carriers will be affected by the blended outcome of the channel due to the time and frequency selectivity. The BER performance of WT-WiMAX is compared with the FFT-WiMAX. This is apparent from figure above that WT-WiMAX performs better than FFT-WiMAX for diverse modulation schemes since it is rather less susceptible to Doppler frequency variations. Table 1 shows the BER of WT-WiMAX and FFT-WiMAX under QPSK modulation.

Table 1: Bit Error Rate for various SNR values QPSK

SNR(dB)	BER QPSK – ½		BER QPSK- ¾	
	FFT-WiMAX	WT-WiMAX	FFT-WiMAX	WT-WiMAX
1	0.4410	0.2212	0.4807	0.4204
2	0.3529	0.1103	0.4605	0.3246
4	0.0825	0.0066	0.3129	0.1145
6	0.0024	0	0.1010	0.0104
8	0	0	0.0061	0.0006
10	0	0	0.0011	0
13	0	0	0	0
15	0	0	0	0
18	0	0	0	0
22	0	0	0	0

V. Conclusion

In this paper, the performance of the developed system is tested under divergent modulations and code rates. The overall performance outcome illustrates that WT-WiMAX is a possible replacement to FFT-WiMAX but nevertheless at the expense of significantly increased the complexity of equalization. An enhancement of SNR in the range of 6–10 dB is reported for WHT-WiMAX to accomplish the suitable BER with different modulation schemes along with diverse CC code rate.

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