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A Survey: Orthogonal Frequency Division Multiplexing

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Abstract- **This paper is a survey regarding the orthogonal frequency division multiplexing. The requirement for high speed data transmission has increased, with the rapid growth of digital communication in recent years. UWB delivers much potential for design of high speed wireless communication system. MB-OFDM (UWB) offers high data rates access for wireless communications. OFDM system is use for high speed applications. Modulation and demodulations of signal is done with the help of IFFT/FFT controller respectively. OFDM is one of the efficient solutions for implementing high speed data transmission for wireless communications.**

Keywords - **FDMA, MB-OFDM, Orthogonal Frequency Division Multiplexing (OFDM), ultra wide band (UWB)**

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a multi-carrier modulation technique which divides the available spectrum into many carriers. OFDM uses the spectrum efficiently compared to FDMA by spacing the channels much closer together and making all carriers orthogonal to one another to prevent interference between the closely spaced carriers. The main advantage of OFDM is the ability to enhance the basic signals that overcome channel impairments. Multi-Band Orthogonal Frequency Division Multiplexing (MB-OFDM) transmitter too provide high speed for application than OFDM. Multi-Band Orthogonal Frequency Division Multiplexing (MB-OFDM) is a suitable solution to implementation of high speed data transmission in ultra wideband spectrum by dividing the spectrum available into multiple bands. In OFDM, the frequency band containing the message is divided up into parallel bit streams of lower-frequency carriers, or sub-carriers. OFDM is a multicarrier modulation technique, which provides high bandwidth efficiency because the carriers are orthogonal to each other and multiple carriers share the data among themselves.

The main advantage of this transmission technique is their robustness to channel fading in wireless communication environment. Orthogonal frequency-division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. OFDM over has ability to cope with severe channel conditions. OFDM has high spectral efficiency as compared to other double sideband modulation schemes, spread spectrum, etc. It can easily adapt to severe channel conditions without complex time-domain equalization. It is robust against narrow-band co-channel interference. Also robust against inter symbol interference (ISI) and fading caused by multipath propagation. It can be efficiently implemented using Fast Fourier Transform (FFT). OFDM has several advantages compared to other type of modulation technique implemented in wireless system. OFDM combats the effect of frequency selective fading and burst error. It overcomes the effect of ISI (intersymbol interference), bandwidth efficiency etc.

II. LITERATURE AND OVERVIEW

The ASIC Implementation of OFDM transmitter and receiver is based on WLAN for better optimized power and timing. RTL synthesis of transmitter and receiver blocks without (Viterbi) decoder is used in the receiver. The Punctured Convolution Coding (PCC) is used to improve the data rate and bandwidth is improved with Quadrature Amplitude Modulation techniques (QAM) . OFDM is implemented using IFFT/FFT controller. Separate clock are used for modulator/demodulator in transmitter/receiver section respectively to improve the data rate. Multi-VTH principles and Clock gating are applied to reduce power consumption. Novel circuit design strategies have been employed for realization of optimal hardware and power efficient architecture. This enabled the high-speed transmission system. Implementing low power techniques, the hardware elements can be reduced and it leads to less power consumption [1].

A study done on Multi-band-Orthogonal Frequency Division Multiplexing (MB-OFDM) Ultra-Wideband (UWB) signal transmission through a single-mode fiber which is based on intensity modulated laser via Radio over

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Fiber (RoF) system [2]. Packet Error Rate (PER) measurement is done to analyze and evaluate the system performance based on different optical fiber lengths, data rates, and transmitting UWB power levels. UWB signals send over RoF show very encouraging results over long distances even in the demanding ultra-wideband environment. PER degrades when data rate is increased, UWB power levels decreases or the fiber length is longer. Comparison between PER degradation in longer fiber case and lower UWB power gives a 2:1 relationship between the RF loss and optical loss[2].

Multi-Band Orthogonal Frequency Division Multiplexing (MB-OFDM) is a solution for implementation of high speed data transmission in ultra wideband spectrum by dividing the available spectrum into many bands. The structure of MB-OFDM system transmitter is introduced [3] and the design of transmitter baseband based on FPGA. The baseband of transmitter is one of the most important parts in OFDM system. The results of all modules designed shows that it has achieved the expected purpose both in precision and resource, with simplicity and high efficiency. It can meet the demand of MB-OFDM systems. The results indicate that the timing of each module is true for meeting demands of requirement. Baseband of transmitter provides the basis for the design of MB-OFDM system [3]. The figure below shows the set of orthogonal signals.

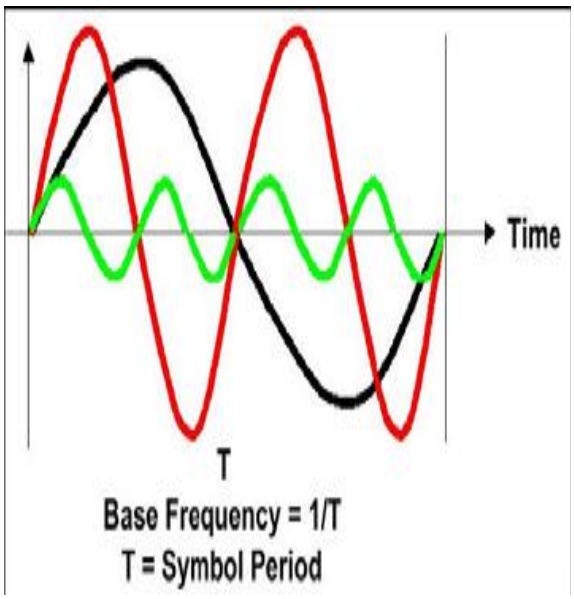

Fig.1: A set of orthogonal signals

OFDM Carriers:

OFDM is a special form of Multi Carrier Modulation (MCM) and the OFDM time domain waveforms are chosen such that mutual orthogonality is ensured even though sub-carrier spectra may over-lap. With respect to OFDM, it can be stated that orthogonality is an implication of a definite and fixed relationship between all carriers in the collection. It means that each carrier is positioned such that it occurs at the zero energy frequency point of all other carriers. The sinc function exhibits this property and it is used as a carrier in an OFDM system.

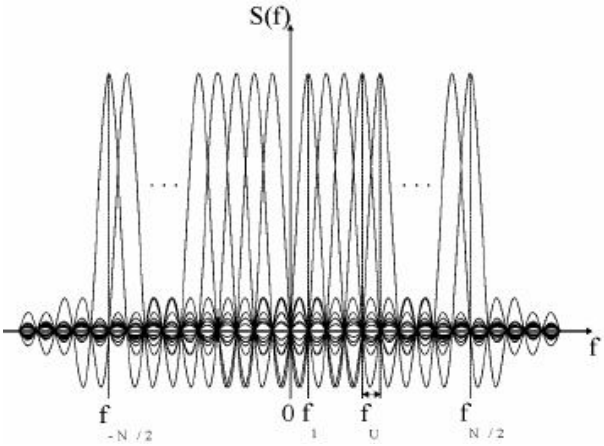

Fig.2: OFDM sub carriers in the frequency domain

FFT controller is one of the important parts of receiver in OFDM system for demodulation of signals. The design, implementation and synthesis of a FFT module that has been used in the OFDM based multiband UWB system to get the best results, although the work is applicable to many other OFDM based receiver systems. The requirements for FFT module within OFDM system coupled with modern digital architecture principles and low power design criteria to converge on optimized solution. The FFT design is applicable for implementation of IFFT module for design of transmitter with the inverse of FFT [4]. The multiband OFDM UWB shows to be a particular potential to consumer electronics as it offers a Wireless Personal Area Network (WPAN) connection for an uncompressed video at a low cost. A cost-effective and low power efficient multiband UWB receiver can be made viable [4].

Orthogonal frequency-division multiplexing (OFDM), coded OFDM (COFDM), and discrete multi-tone (DMT) forms of modulation are broadly scattering finding their way into wireless and wired communications in various appliances including digital television, high-speed wired data connections, and wireless local area networks. Increasing the level of assimilation by modern complementary metal oxide semiconductor (CMOS) processes and the associated computer-aided design tools communications in wired and wireless is made possible. The VLSI inferences of coded OFDM modems designed for various applications ranging from terrestrial digital broadcasting, to high-speed wired ADSL modems, to high-speed wireless LANs [5]. For long length FFTs operating at high data rates, the FFT section have need of large part of chip which increases the area and hardware circuitry, but new processes and possibly new FFT designs will require less area on chip the FFT. In the case of short-length FFTs as used in WLANs, the complete modem areas are already quite small and are approaching the size where they can fit on the corner of a chip. High-speed OFDM modems provide productive floor for the

communication systems architecture and VLSI system designer to thoroughly co-operate, particularly to reduce the power to extremely low levels consistent with long mobile battery use [5].

MB-OFDM (Multi Band Orthogonal Frequency Division Multiplexing) UWB devices suffer from frequency dependent non-idealities due to extreme wideband operation. An efficient methodology for BIST (Built in self-test) assisted testing, estimation and compensation of wideband (UWB) devices has been proposed [6]. The method uses an envelope detector at the output of the UWB transmitter to track the performance at each of its preferred operating frequencies and carry out compensation. Multi-way and unified are the two approaches have been developed for compensation and tradeoffs. End to end linearity development proves the effectiveness of the technique across wide operating frequency under minor as well as process skewed occurrences [6].

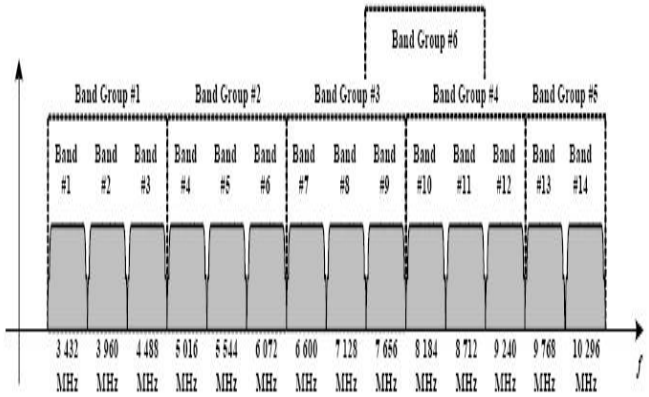

Fig.3: Band Groups in MB-OFDM UWB scheme

From the overall analysis of the literature review, the high data rates have been achieved with different techniques.as well as power consumption for the system is reduced.

Sr. no	Parameter	Ref[1]	Ref[2]	Ref[3]	Ref[4]
01	Data rate	91.83 Mbps	High	high	--
02	Power	54mW	--	--	Low
03	PER (packet error rate)	--	Degrades	--	--

III. CONCLUSION

Orthogonal frequency division multiplexing (OFDM) is a method of programming digital data on multiple carrier frequencies. OFDM can be used for improving the data rate as well as high speed for cellular communication. OFDM can be used for multi-band orthogonal frequency division multiplexing system which can be used for high speed data transmission. Multi-band Orthogonal Frequency Division Multiplexing (MB-OFDM) is a suitable solution for implementation of high speed data transmission in ultra wide band spectrum by dividing it into various bands. OFDM has high spectral efficiency as compared to other double sideband modulation schemes, spread spectrum etc. OFDM is robustness to channel fading in wireless environment. OFDM has been chosen for several current and future communications systems all over the world Mobile Wireless Communication, Terrestrial Digital Video Broadcasting, Digital Broadcasting etc. OFDM has also been accepted into several European wireless communications appliances such as the digital audio broadcast (DAB) and terrestrial digital video broadcast (DVB-T) systems. In addition to high-speed wireless applications, wired systems such as asynchronous digital subscriber line (ADSL).

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