CHAPTER 7
An Analysis of OFDM Architecture for Fixed WIMAX

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ABSTRACT

Error free transmission is one of the prime goals in wireless communications. With the increase in multimedia applications, large amount of data is being transmitted over wireless communications. This requires error free transmission more than ever and to achieve error free transmission multiple antennas can be implemented on both stations i.e. base station and user terminal with proper modulation scheme and coding technique. The 4th generation of wireless communications can be attained by Multiple-Input Multiple-Output (MIMO) in combination with Orthogonal Frequency Division Multiplexing (OFDM). MIMO multiplexing (spatial multiplexing) and diversity (space time coding) having OFDM modulation scheme are the major area to focus. MIMO multiplexing increases a network capacity by splitting a high signal rate into multiple lower rate streams. MIMO allows higher throughput, diversity gain and interference reduction. It also fulfills the requirement by offering high data rate through spatial multiplexing gain and improved link reliability due to antenna diversity gain. The main drawbacks faced by the users are power dissipation in data reordering. In this paper by using VLSI design technique and four different modules for FFT and IFFT process based on Radix-2 and Radix-8 method power dissipation can be minimized.

Keywords: *wireless communications, FFT and IFFT process, antenna diversity gain etc*

INTRODUCTION

Nowadays communication plays an important role in the day to day life. Peoples are using various mode of communication to share their ideas and thoughts. In order to improve the quality of communication there are lot technology and generation were came such as 1G, 2G, 3G, 4G. Each and every generation overcome the defects in the previous one. Today 4th generation is used along with the Wi-Max and MIMO. There are various technology and modules were introduced to make the generation very effective but the cost of the hardware was high and it fail to process the upcoming data transmission and to do so different module is required to make the communication very effective. In our proposed system four different modules were

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used to process the different rate of data and the cost was effectively reduced and no separate hardware is required to process the data up to 256bits.

Line-Of-Sight Propagation: Line-of-sight propagation refers to electro-magnetic radiation or acoustic wave propagation. Electromagnetic transmission includes light emissions traveling in a straight line. The rays or waves may be diffracted, refracted, reflected, or absorbed by atmosphere and obstructions with material and generally cannot travel over the horizon or behind obstacles.

IEEE 802.11g: The third enhanced standard of IEEE was 802.11g. This standard was basically based on OFDM modulation but on 2.4GHz which is available universally. It defines the throughput of 54 Mbps for data communications.

IEEE 802.11n: 802.11n is also derived from the previous versions of 802.11 standards by addition of multiple-input multiple-output (MIMO). By adding more antennas on both transmitter and receiver gives us increased in data rate via spatial multiplexing and spatial diversity by using coding schemes like Alamouti coding. The speed can increase up to 100 Mbit/s, which is 4-5 times faster than 802.11g.

IEEE 802.16d: 802.16d came out in 2003 and the main objective of 802.16d was to make compatibility between the European Telecommunications Standards Institute (ETSI) Hyper MAN with the IEEE wireless MAN standards.

LITERATURE SURVEY

Fast Fourier transform (FFT) processing is one of the key procedures in popular orthogonal frequency division multiplexing (OFDM) communication systems. Structured pipeline architectures, low power consumption, high speed and reduced chip area are the main concerns in this VLSI implementation. The efficient implementation of FFT/IFFT processor for OFDM applications is presented. The processor can be used in various OFDM-based communication systems, such as Worldwide Interoperability for Microwave access (Wi-Max), digital audio broadcasting (DAB), and digital video broadcasting-terrestrial (DVB-T) [1]. The physical layer of OFDM-MIMO was designed using VLSI technology in this pipelined architecture to the baseline MIMO-OFDM physical layer implementation was compared this show that at least 30 percent of the resources in the baseline MIMO-OFDM system can be saved using this architecture, while achieving the same data rate [2].

An efficient ordering scheme for an ordered successive interference cancellation detector is determined under the bit error rate minimization criterion for multiple-input multiple-output (MIMO) communication systems using transmission power control. Ordering strategy that makes the channel gains converge to their geometric mean was derived [3]. As the number of antennas increases, channel estimation becomes challenging because the number of unknowns increases, and the power is split at the transmitter. Design a low complexity optimal training scheme for block transmissions over frequency-selective channels with multiple antennas.

Consist of maximizing a lower bound on the ergodic (average) capacity that is shown to be equivalent to minimizing the mean-square error of the linear channel estimator [4]. The channel sounding technique using MIMO software radio architecture for the double directional and multi-link MIMO channel measurements. Advantages and issues are discussed in comparison with the conventional MIMO channel sounders, and then the implementation plan [6]. For the OFDM system with two transmit antennas and one to four receive antennas and using QPSK modulation, show that the this method has only a 4dB loss compared to the ideal case where the channel is known at the receiver [10].

EXISTING SYSTEM

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From the above papers we came to know that MIMO and WiMAX are used to achieve the 4th generation wireless network with great speed but the implementation of the network is very difficult and cost effective and separate module is required and if we use FFT algorithm along with OFDM the drawbacks can be eliminated.

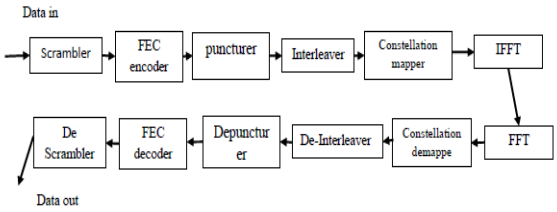

Fig 1: Existing system Block Diagram-1

In the field of wireless communication OFDM (Orthogonal Frequency Division Multiplexing) is the suitable candidate to overcome the problems like multi-path fading, ISI (Inter Symbol Interference), ICI (Inter Carrier Interference), low bit rate capacity, need higher power to transfer the data etc. With increasing data transfer rate, it is very important that data must be transmitted with carefully and reliable transmission should be take place in wireless link. So OFDM is combined with suitable channel coding scheme to perform reliable transmission, when OFDM is combined with channel coding scheme then it is called CODED OFDM or COFDM. Coding scheme must be chosen for any system which satisfies requirements of high data rate as well as good error capability and according to complexity, suitable delay and desired coding gain for system.

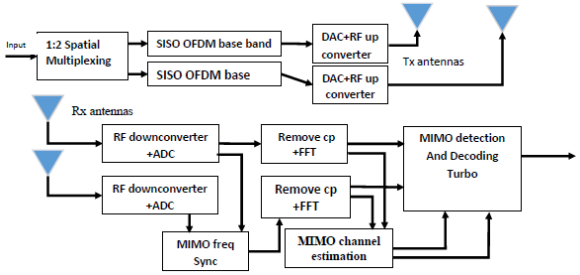

Fig 2: Existing system Block Diagram-2

The basic design methodology to implement the COFDM transmitter and receiver is the divide and conquer scheme in which first COFDM transceiver is divided into two main parts COFDM Transmitter and COFDM Receiver. After it COFDM transmitter block is further divided into sub-blocks and same in case of COFDM receiver is performed. Then sub-blocks of COFDM transmitter and receiver is designed and results are verified. After verification of each block's result blocks are merged then COFDM transmitter and COFDM receiver are assembled which called COFDM Transceiver and then result of COFDM Transceiver is verified.

PROPOSED SYSTEM

Design of an FFT/IFFT processor for Mimo-Ofdm systems is aimed at designing an Ofdm using vhdl and to be implemented in a FPGA device. The combination of the Mimo signal processing with Ofdm communication system is considered as a promising solution for enhancing the data rates of the next generation wireless communication systems operating in frequency-selective fading environments. Wireless networking using the 802.11 standard has become common in the home and has a significant and

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growing role in corporate settings. Broadband wireless systems based on orthogonal frequency division multiplexing will allow packet based high data rate communication suitable for video transmission and mobile internet applications. The 64 point fast Fourier transform (fft)/ inverse fft (ifft) processor is applied in a multiple-input multiple-output orthogonal frequency-division multiplexing based IEEE 802.11n wireless local area network baseband processor.

Data Reordering: The function of module 1 is to reorder the input sequences. The action of the operation is to separate the four adjoining sequences by one delay unit. The separated data will be reordered among four sequences by the appropriate operation of the switch. The separated data will be adjusted by the delay elements, as shown in fig. 4.1. The reordered data will be separated into 32 groups for 64-point. Based on the data ordering and the concept of group in module 1, the operation of fft/ifft with multiple data sequences can be implemented more efficiently.

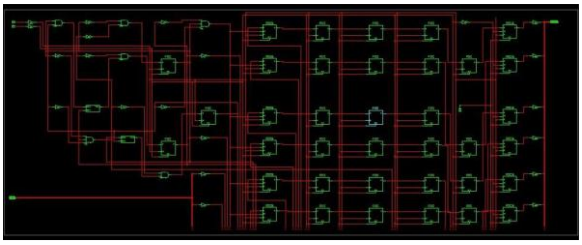

Fig 3: Module 1 Data Reordering

Data Storing: Module 2 consists of a memory,4 butterfly units of radix-2 FFT algorithm (BU_2), two complex multipliers, two ROMs, and some multiplexers

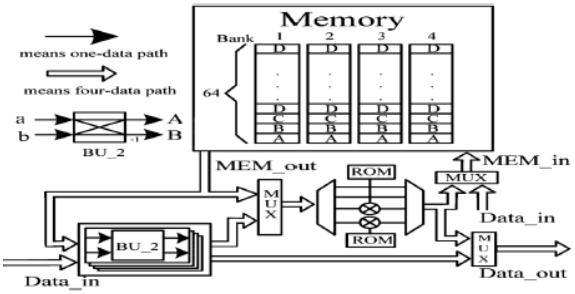

Fig 4: Module 2 Data Storing

OFDM: The IFFT and FFT are used for modulating and demodulating individual OFDM sub carriers to transform the signal spectrum to the time domain for transmission over the channel and then by employing FFT on the receiving end to recover data symbols in serial order. The second key principle is the cyclic prefix (CP) as Guard Interval (GI). CP keeps the transmitted signal periodic. One of the reasons to apply CP is to avoid intercarrier interference (ICI). Interleaving is the third most important concept applied. The radio channel may affect the data symbols transmitted on one or several sub carriers which lead to bit errors. To encounter this issue we use efficient coding schemes.

SIMO: Single-Input Multiple-Output is the system using one antenna at transmitter and multiple antennas at the receiver. It provides receiver diversity which receive the strongest signal from several transmit antennas. Generally, it is used in Uplink environment.

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MISO: In Multiple-Input Single-Output two or more number of antennas are used in the transmitter and one antenna at the receiver. It provides transmit diversity because of multiple antenna at a transmitter side. MISO technology has applications in WLAN, MAN and digital television (DTV). Commonly, it is used in downlink scenarios.

MIMO: Multiple-Input Multiple-Output uses multiple antennas at both sides which provides transmit diversity and receiver diversity. It's applicable in every kind of networks like PAN, LAN, WLAN, WAN, MAN. MIMO system can be applied in different ways to receive either a diversity gain, capacity gain or to overcome signal fading.

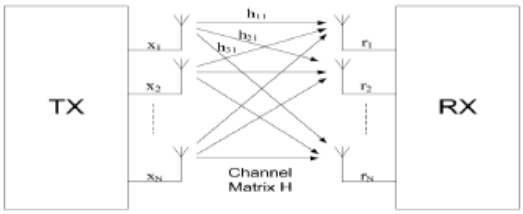

Fig 5: MIMO System Model

MIMO-OFDM Signal Model: Multiple-input multiple-output (MIMO) in combination with orthogonal frequency division multiplexing (OFDM) is the promising technique to achieve the high data rates and large system capacity for wireless communication systems in frequency selective fading environments. The most likely application of MIMO is the next generation wireless local area network (WLAN). The current standards of WLAN i.e. IEEE 802.11a and IEEE 802.11g are basically relying on OFDM but to achieve higher data rates they are based on MIMO. The quality of wireless link is basically depended on three factors the transmission rate, the transmission range and the transmission reliability. With the emergence of MIMO assisted OFDM system, the above factors can be improved concurrently. The main advantage of wireless LAN is the deployment in indoor environments. All individual functions of OFDM like IFFT, FFT and CP when applied to every single transmit and receive antenna (MIMO) makes it MIMO-OFDM.

WiMax: The WiMAX network architecture basically relies on standard IP protocols and its compatible frameworks like IP Multimedia subsystem (IMS). WiMAX forum formed two working groups one is to define the network specifications called Network Working Group (NWG) and second is Service Providers Working Group (SPWG) to determine requirements and priorities.

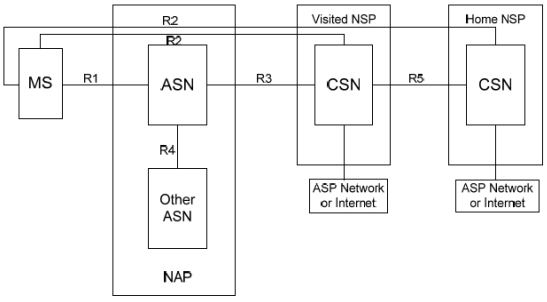

Fig 6: WiMAX network reference model with component

RESULTS AND DISCUSSION

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We apply our ideas and simulate the modules by using ModelSim XE III 6.3 and designed VLSI hardware using Xilinx. The simulation results have two parts first we will cover module1 and module 2 in simulation using ModelSim XE III 6.3

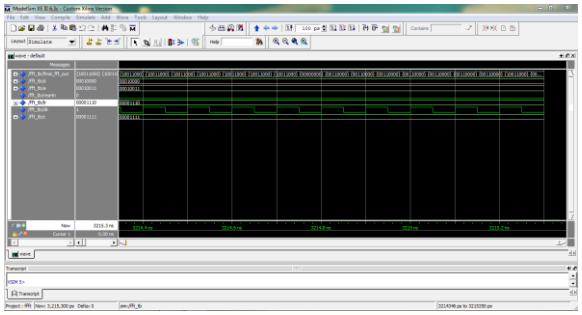

Fig 7: Simulation Output

CONCLUSION AND FUTURE WORK

A novel 64-point FFT/IFFT processor for a MIMO OFDM system has been proposed. In this design, 64-point FFT/IFFT can be supported. The number of complex multiplications can be reduced effectively by using higher radix FFT algorithm. High Data output rate can be obtained. Deal with Multiple data sequence and Reduce hardware complexity. It is also used to Reduces complex multiplications. In our proposed system power dissipation can be minimized using VLSI technique. In future the work can be concentrated on the type of processor instead of FFT one can design any other processor used to reduce the cost so it can be implemented everywhere.

REFERENCES

[1]. Xiaoli Ma “Optimal Training for MIMO Frequency-Selective Fading Channels” IEEE Transactions On Wireless Communications 2011

[2]. Fabien Delestre and Yichuang Sun “A Channel Estimation Method for MIMO-OFDM Mobile WiMAX Systems” School of Engineering and Technology University of Hertfordshire, 2008

[3]. A. Anbarasan, K. Shankar “Design and Implementation of Low Power Fft/Ifft Processor For Wireless Communication” International Conference on Pattern Recognition, Informatics and Medical Engineering, March 21-23, 2012

[4]. K. Karthikeyan Associate Scientist - R&D “VLSI Design and Implementation of MIMO-OFDM System for Wireless Communications” European Journal of Scientific Research 2012

[5]. Layak Ali Sd, K. Kishan Rao “Efficient Power Allocation for LDPC-Coded MIMO Systems” International Journal of Power System Operation and Energy Management, 2011

[6]. T. Shankar “ Joint Estimation of Impairments for OFDM and MIMO OFDM Systems” International Journal of Computer Applications (0975 – 8887) June 2011

[7]. Jun-ichi Takada, “On the Channel Sounding Technique using MIMO Software Radio Architecture” Tokyo Institute Of Technology, Japan 2010

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ISBN: 978-93-5786-261-5, www.aetsjournal.com ―Handbook of research in Embedded, Real time Systems and High Performance Computing

[8]. Dr. Gordon Stu "MIMO Space-Time Block Coding (STBC) Simulations" Personal & Mobile Communications, April 2009

[9]. M.P.Chitra, Dr.S.K.Srivatsa Research Scholars, "advances in mobile computing" International Conference on Advances in Computing 2009

[10]. Srinivasa rao. Konatala "Adaptive MIMO-OFDM Scheme for Data Rate Increase through Fading Channel" International Journal of Electronics and Computer Science Engineering 2009

[11]. WEI ZHANG "Space-Time/Frequency Coding For Mimo-Ofdm In Next Generation Broadband Wireless Systems" IEEE Wireless Communications June 2007

[12]. Minjae Kim, Hyoungsuk Jeon, Hyuckjae Lee "Performance Comparison of MIMO Channel Sounder Architecture in Between TDM scheme and FDM scheme" IEEE transaction 2007

[13]. Hlaing Minn, Member, IEEE, Naofal Al-Dhahir, Senior Member "Training Signal Design for MIMO OFDM Channel Estimation in the Presence of Frequency Offsets" IEEE transactions on communications-2006

[14]. Vahid Tarokh, Member, IEEE, Hamid Jafarkhani, and A. R. Calderbank, Fellow, "IEEE Space–Time Block Codes from Orthogonal Designs" IEEE TRANSACTIONS ON INFORMATION THEORY. JULY 1999

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