

REVIEW ON IMPLEMENTATION OF OFDM SYSTEM USING SDR

Gagandeep S¹, Dr. K P Shashikala²

¹M.Tech Student, ECE, DSCE, Bengaluru

²Associate. Professor, ECE, DSCE, Bengaluru

Abstract - Software define radio is a communication system, where components that have been traditionally implemented in hardware and is implemented by means of software on a personal computer or embedded system. OFDM is multiplexing scheme which divide data stream into narrowband data stream so that channel can share the bandwidth available. Carrier data subcarrier which is transmitted using phase or amplitude modulation. This paper deals with a review of implementing OFDM system using XILINX VIVADO.

Key words: SDR, OFDM, USRP.

I. INTRODUCTION

Recently, demand of bandwidth is increasing, especially for mobile devices. Orthogonal Frequency Division Multiplexing (OFDM) is introduced as one of solutions to enable bandwidth efficiency and robustness due to inter symbol interference (ISI) in the consequence of multipath fading environment. The principle of OFDM is dividing high rate data stream into parallel low rate data streams using Fast Fourier Transform (FFT). Moreover, OFDM scheme is widely used in wireless communication system, such as IEEE 802.11 standard, cellular communication (e.g., WiMAX and LTE Advanced) and digital broadcasting standard (e.g., DVB-T). In addition, OFDM is combined by modulation with more bits per symbol to increase data transmission throughput. OFDM has been successfully implemented in wireless communication due to its advantages of reliability communication in multipath environment.

However, OFDM system has the problem in dealing with ISI effect particularly for the high data rate transmission. An equalizer is required to combat inter-symbol interference when OFDM symbol time is larger than delay spread. The implementation of equalizer requires more hardware complexity. The use of Software Defined Radio (SDR) can reduce hardware investment, as hardware implementation is changed into a software configuration.

II. Orthogonal Frequency Division Multiplexing (OFDM) Scheme

OFDM is multiplexing scheme which divide data stream became more narrowband data channel to share the bandwidth available. Narrowband channel is called subcarrier which transmit phase or amplitude modulated data signal. Different with Frequency Division Multiplexing (FDM), OFDM have subcarrier with orthogonally. This

orthogonally can reduce interference between subcarrier and increase spectrum efficiency utilization. Data bits' stream are converted from serial to parallel and each subcarrier is modulated using phase or amplitude modulation. Modulation process are called as symbol mapping. Each subcarrier is independently modulated. Then, all the modulated signals are carried by OFDM carrier use IFFT module to create complex signal containing all subcarriers. Data in parallel stream is converted to serial stream and real and imaginary signal respectively are processed on Digital to Analogue Converter (DAC). Both analogue signals are multiplied by radio frequency by shifting the phase by 90degree and summing both this signal and will be transmitted through antenna. Figure 1 shows the diagram of OFDM system. The receiver will receive real and imaginary signal separately and they are processed by low pass filter to eliminate mirrored frequencies. Then, they are quantized by Analogue to Digital Converter (ADC) block and the signal is processed by Fast Fourier Transform (FFT) module. The data symbols are demodulated by symbol mapping block according to the modulation used. Parallel data stream is converted into serial data to obtain the desired data. Received signal will be received many times due to multipath propagation especially in urban environment or mobile device are moving high speed. Line of sight and multipath signal have difference arrival time. It is called delay spread which can cause Inter Symbol Interference (ISI). OFDM scheme proposes to reduce ISI effect provided that can preserve orthogonality. Orthogonality in OFDM subcarrier along with addition of guard time (guard interval) helps in avoiding ISI. The OFDM guard time is included by insert zero padding (ZP) or cyclic prefix (CP). CP is introduced before the OFDM symbol. Let TG denote the length of CP and Tsub denote the duration of OFDM symbol without guard time. So, the extended OFDM symbols now have the duration of Tsym=Tsub+TG. Guard time is selected longer than multipath delay so as not to cause interference with the next OFDM symbol. The other advantage of CP is combating Inter Carrier Interference (ICI) which is crosstalk between subcarriers. OFDM system needs synchronization in the receiver side to find the beginning of each symbols correctly. Synchronization parameters include finding the right time delay, frequency deviation and phase shift of each symbols in the subcarrier. These parameters can be determined with addition redundancy in some of the subcarriers which transmitted. The redundancy is called pilot symbol or preamble. The parameters are known by looking pilot signal from data received and will be calculated for synchronization and channel estimation process. The

density of pilots determines quality of synchronization but decrease of data rate transmission.

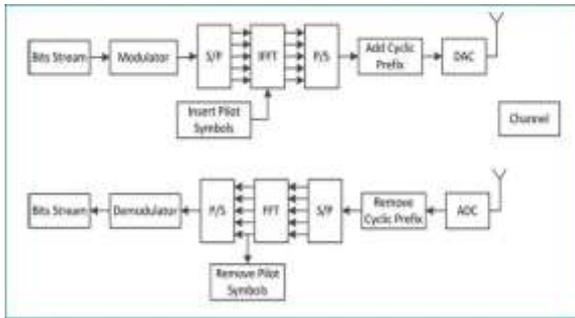
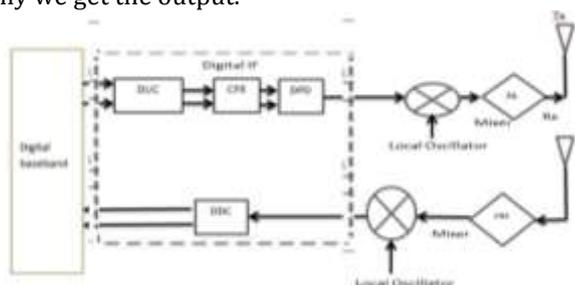


Fig1 OFDM transmitter and receiver

III. Software Defined Radio (SDR)

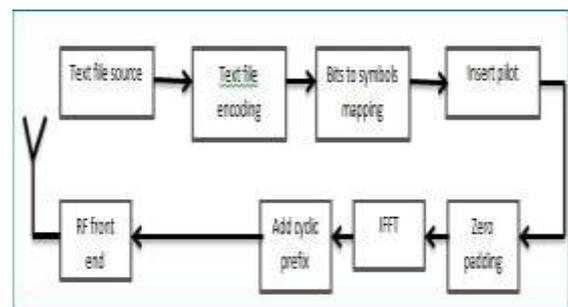
SDR is block communication system such as modulation, demodulation, filter, encoding and decoding, source coding, channel coding, etc, are provided as software code in the PC or embedded systems. These technologies help the researcher and provider to reduce the hardware investment to implement and examine the new standard communication or algorithm enhancement. The implementation is more flexible; all radio parameters are set through software configure for same radio device to be operated with any type of waveform. This contributes to development and research easier, faster and cheaper. There are several type SDR platform which widely implemented in the wireless communication research community, such as LabVIEW and open source GNU Radio. The first DUC (Digital Up converter) process which baseband signal is filtered and interpolated before it is quadrature modulated with a tune able carrier frequency. Second process is Crest Factor Reduction (CFR) and then Digital Pre-distortion (DPD) which is linearization techniques. High-speed mobile data versions employ non-constant envelope modulation techniques such as quadrature phase shift keying (QPSK) and quadrature amplitude modulation (QAM), so linearity is needed on the power amplifiers. Digital IF is converted to analogue signal through DAC block. Then, the signal is multiplied by local oscillator and through Power Amplifier (PA) then transmitted over antenna. In the receiver side received signal is low noise amplified and the signal is multiplied with the local oscillator and applied Digital down converter (DDC). In DDC is used to decrease the sampling rate and finally we get the output.



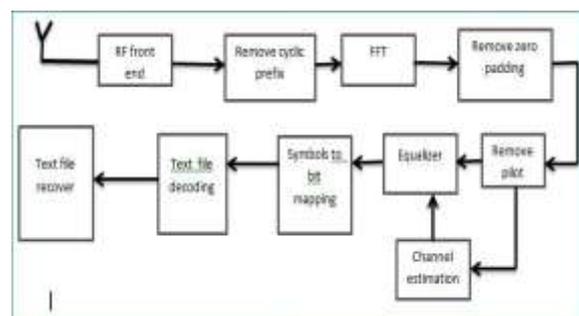
Fig(2) SDR Architecture

IV. SDR Implementation Using Universal Software Radio Peripheral (USRP)

The Below diagram gives the transmitter and receiver design of OFDM in SDR, initially a text file source (Input) is given and then the text file is encoded, to ensure that the text file is properly consumed. There are different types of encoding like convolution encoding reed Solomon encoding etc. The encoded symbol is given to symbol mapping, here the signal is modulated according to our requirement. Single frequency is transmitted over a communication system for supervisory, control, for reference purposes pilot signal are inserted as a reference for OFDM after every 12th data symbol. And then the zero padding is placed at the edges, it is the process of adding the zeros to increase the length of the signal. Here 6 zeroes are added at the start symbol and 5 zeroes as the stop symbol and 1 zero at the DC carrier. Perform the inverse FFT to convert frequency domain signal to time domain. Insert cyclic prefix which are used to avoid the aliasing effect and transmit the signal using USRP as RF front end.



Fig(3) Transmitter



Fig(3) Receiver

At receiver USRP initialize with open Rx session and signal configure. USRP IP's, gain and active antenna are determined. IQ rate and carrier parameters are same with transmitter configure. The cyclic prefix and offset frequency are removed and the signals are converted to frequency domain through FFT process. Guard band (zero padding) are removed at OFDM symbol edges, respectively. Pilot symbols removing is used as channel estimation reference. The multiple of data and channel estimation will obtain equalized data. Bits stream is obtained after passing the data through symbols to bits mapping block. The binary file is read and create to text file using text file decoding.

V. LITERATURE SURVEY

A Brief History of Software-Defined Radio and Cognitive Radio. The concept of software defined radio was first presented by Joseph Mitola in 1992. He defined a software defined radio as simply a radio in which the typical hardware components (amplifiers, mixers, oscillators, filters, etc.) have been replaced by software that performs the same function. His idealized depiction of a software radio had no analogue hardware parts; the antenna was directly connected to an analogue-to-digital converter and all processing of the signal was done digitally via software. In practice, due to the high bandwidths and sample rates required for RF operation, conventional microprocessors were not powerful enough to handle processing for an idealized SDR. This is still the case for some applications even today, though faster computing devices such as FPGAs and ASICs have made the idealized software radio a more feasible possibility. Most current SDR applications make use of hardware components to demodulate and down-sample the incoming signal to a bandwidth and sample rate that can be processed in software by the computing hardware available. One of the first major implementations of a software-defined radio was the U.S. Army's Speak Easy project in the 1990's. This project sought to use software to provide interoperability between 10 different radio platforms over a bandwidth of 2 to 2000 MHz Texas Instruments DSPs were used in addition to FPGAs. The final implementation consisted of several hundred.

In Paper [1] proposed that OFDM with BPSK modulation gives a better performance of communication compared to the OFDM with QPSK in terms of PRR. This is in line with the theory as the error distance of BPSK is larger than QPSK due to its optimum signalling format, referred as antipodal signalling.

In Paper [2] proposed implementation of a full functioning system for the OFDM signal generation, transmission and reception utilizing a USRP unit. We created the testing OFDM signal which is possible to generate by an arbitrary generator. Our system utilizing an SDR is capable of processing an OFDM signal using Simulink and Matlab software. After the reception, frame synchronization, equalization and demodulation are performed and data can be detected. The system is also capable of processing signal influenced by static multi-path propagation.

In paper [3], proposed an FPGA prototype of OFDM physical layer is presented. A rapid prototyping methodology that integrates MATLAB with Xilinx ISE was used in the development of the OFDM transceiver. As discussed in this paper. The main results of this experiments were that the optimum FFT/IFFT length was 1024 points and the best value for the SNR was 60dB; and they get that after this value there is no effect of varying the SNR value. After that, they observed the VHDL emulation of OFDM system using FPGAAadv7.2 program, then they could implement this

system on Xilinx Virtex-6 FPGA kit. They found that they could implement both transmit and receive functionality on a single FPGA kit, so by looping back the data.

In paper [4] proposed that USRP and GNU Radio is a reliable SDR platform tools to emulate the transceiver of digital communication system such as the simple system. The flexibility offers by this platform allows re-configurability at the software level while maintaining the same hardware to facilitate various communication protocols or standards. In the future, this paper shall be extended by exploring the capability of the platform in analysing the received signal in order to recover the information transmitted in practical wireless system.

In paper [5] proposed an implementation of sub-band OFDM on 8-core DSP is considered in this paper. It is shown that OpenMP approach gives about 7 times performance gain. This means that OpenMP gives the overheads which are small enough. This also allows to conclude, that multi-core implementation decreases the difference in processing time between usual and sub-band OFDM generation.

VI. CONCLUSION

The proposed work is to present hardware bit-error result that closely match the results obtained in simulation in results, and also to evaluate the suitability of a DSP for implementation of an OFDM transmitter and to analyze difficulties encountered in transitioning from simulation to a hardware implementation.

REFERENCES

- [1].Arief Marwanto, Mohd Adib Sarijari, Norsheila Faisal. "Experimental Study of OFDM Implementation Utilizing GNU Radio and USRP - SDR" Proceedings of the 2009 IEEE 9th Malaysia International Conference on Communications 15 - 17 December 2009.
- [2].Marek TICHY, Karel ULOVEC "OFDM System Implementation Using a USRP Unit for Testing Purposes" Dept. of Radio Engineering, Czech Technical University in Prague, Technicka 2, 166 27 Praha Jan 2013.
- [3]Mohamed Salah, Abdel-Halim Zekry "An Efficient FPGA Implementation of OFDM Physical Layer for SDR-Based Applications" December 2010.
- [4]Jusnaini Muslimin, Ani Liza Asnawi "SDR-based Transceiver of Digital Communication System using USRP and GNU Radio" International Conference on Computer & Communication Engineering 2016.
- [5]Paul B. Nikishkin, Sergey V. Vityazev Sub-band OFDM Implementation on Multicore DSP 24th Telecommunications forum TELFOR 2016