Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 2, Issue. 6, June 2013, pg.350 – 352

RESEARCH ARTICLE

Comparative Study of Different Application of OFDM in FPGA Implementation

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Abstract— FPGA provides cost effective solutions to most of the circuits. OFDM is a technique which uses multi-carriers for the modulation in which each sub-carrier can be modulated separately. Due to this multiple carriers share the data among themselves. Due to OFDM channel fading can be minimized & channel equalization becomes simpler. This survey paper highlights different approaches of implementation of OFDM in FPGA along with their application in different fields.

Key Terms: - FPGA (Field Programmable Gate Arrays); Orthogonal frequency division multiplexing (OFDM); Field programmable gate array (FPGA); Hardware description language (HDL); bit error rate (BER); signal to noise ratio (SNR); Frequency Division Multiple Access (FDMA)

I. INTRODUCTION

Now a day's wireless communication is used in many areas. Wireless communication using OFDM has many advantages. Channel equalization using OFDM is easy as compare to adaptive equalization. Also spectrum available can be used more efficiently with help of OFDM. Applications such as DAB, HDTV, Wireless LAN (IEEE 802.11a, g) where high baud rate & less noise are essential features, OFDM can be efficiently used. FPGAs can used to implement the hardware of any system at very less cost. A time consuming and expensive redesign of a board can often be avoided through application-specific integration of IP cores in the FPGA - an alternative for the future, especially for very specialized applications with only small or medium volumes. The objective behind this paper is to compare different a high speed base band wireless communication system on the bases of their application & advantages. A VHSIC hardware description language (VHDL) is a very power tool used to describe behaviour of integrated circuits. We can simulate the transmitter & the receiver in the Communication system with help above mentioned tools.

1.1 Basic elements of OFDM Communication system

In OFDM communication system [10], serial binary input is applied to the scrambler & then channel coding is applied to improve the bit error rate. Depending on the application, the corresponding modulation scheme is applied (BPSK or QPSK).Now this modulated data is converted into size M parallel stream. Now using inverse FFT of size N, these M streams are modulated with different sub-carriers. A typical OFDM transmitter is as shown in fig (1a).

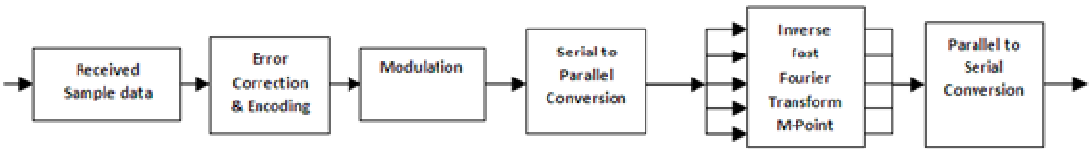

Figure (1a) OFDM Transmitter

Similarly at the receiver side by the use of size N FFT, the received data is splits into N parallel stream. Then it is demodulated & using error correcting method proper data is obtained. A typical OFDM transmitter is as shown in fig (1b).

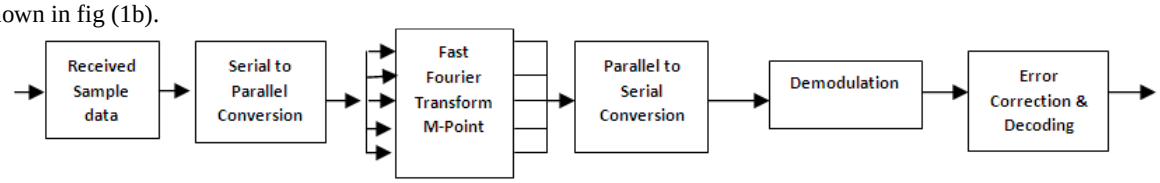

Figure (1a) OFDM receiver

So from the above discussion we can say that OFDM is best suited for the wireless communication system. Also it can remove all the disadvantages that are caused by multipath propagation.

1.2 FPGA

Field Programmable Gate Arrays are one of the popular devices in VLSI industry. A typical integrated circuit performs a particular function defined at the time of manufacture. In contrast, the FPGA's function is defined by a program written by someone other than the device manufacturer. [8] FPGA contains similar type of logic modules that can be connected together to have a desired operation to be performed. Complex designs are created by combining these logic modules to create the desired circuit. A typical FPGA is as shown in fig (1c).

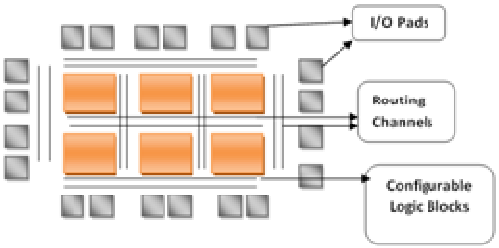

Figure (1c) FPGA

II. LITERATURE SURVEY

CURRENT System-on-Chip (SOC) platforms provide wide range of programmable processors and ASIC components .These components provide user, a flexibility & reduction of cost of implementation. ASIC are not suitable were flexibility is required. By implementing the OFDM using FPGA, performance can be increased.

In 2004 C. Ebeling, C. Fisher, G. Xing, M. Shen & H. Liu [1] proposed The RaPiD implementation has about six times the performance/cost of a DSP implementation, while an ASIC has about six times the performance/cost of RaPiD.

In 2008 S.Haene, D. Perels & A Burg [2] proposed that A real-time MIMO-OFDM physical layer transmitting at a peak data rate of 216Mbit/s over 20MHz bandwidth was prototyped and characterized through measurements. Real-time operation of the system on an FPGA was achieved by diligent selection and optimization of the employed transceiver algorithms for the FPGA implementation and by careful design of the corresponding transceiver hardware architecture.

In 2011 P. J. Lobo, F. Pescador, G. Maturana & M. C. Rodríguez [3] proposed that it could be possible to integrate the whole system (i.e. receiver and gateway) in a single platform with one DSP and the FPGA, especially considering that current versions of the DSPs. A combined SoC that includes both the communications and video peripherals would be perfectly fit for the task. Other functional combinations are possible, such as a receiver and gateway without video decoding capabilities or even a system with just the gateway functionality. In the latter case, a smaller and cheaper processor could be used.

In 2012 Z. Iqbal, S Nooshabadi & Heung-No Lee [4] proposed that OFDM gives an efficient way to design the IEEE 802.16 system for FPGA. A special double-buffering design method is used to implement the interleaver with minimum memory requirement and initial latency. The data rate of the standard is doubled with the help of efficient design methodologies and optimization. This approach can also be used to design other high-speed communication systems or to improve their speeds.BER performance four systems Vs modulation is as shown in figure 2(a).

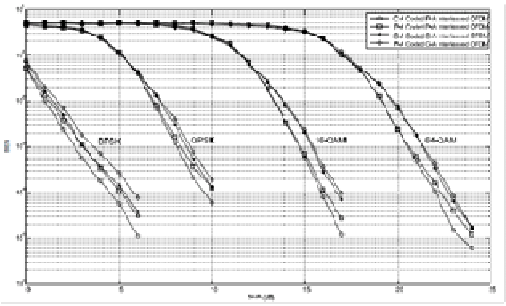

Figure 2(a)

There are few more works which implemented the OFDM in FPGA for different applications. Ludovico de Souza et al [5] shows that FPGA implementation of 802.11 wireless modem is possible. Another work by Y. Kim et al [6] shows the implementation of IEEE 802.11 wireless LAN which support both OFDM & DSSS "Direct Sequence Spread Spectrum"; which is implemented using combination of FPGA & ARM7 processor. Moisés Serra [7] designed the OFDM transmitter having specifications: 64-IFFT, 16 QAM, 36Mbits/s.

III. CONCLUSION

OFDM is the most effective scheme in multi-carrier transmission. It is very popular in high speed communication systems. In basic OFDM system consist of PSK Modulator/Demodulator, FFT/IFFT module, serial to parallel/parallel to serial converters. I have presented different applications of OFDM implementation in FPGA. Each application discussed is having its own advantages & disadvantages.

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