CHAPTER ONE

INTRODUCTION

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1.1 Preface

This project is about implementing the IEEE 802.11g WI-FI MAC Layer using VHDL Language in field programmable gate array (FPGA). The Physical Layer is already implemented on the 24XStream wireless module.

The Wi-Fi (wireless fidelity) is used for WLAN, which are private, and local if a mono-polar antenna is used which is already provided with the Wireless module. [1]

The first IEEE802.11 is introduced in 1997. It supports 1 and 2 Mbps transmission rates at 2.4GHz band with either frequency hopping spread spectrum (FHSS) or Direct Sequence Spread Spectrum (DSSS). IEEE802.11a and IEEE802.11b were released in 1999 September. IEEE802.11a supports 6 to 54Mbps transmission rate with orthogonal frequency-division multiplexing (OFDM) at 5 GHz and IEEE802.11b supports 1 to 11Mbps with DSSS at 2.4GHz. The IEEE802.11g was ratified in 2003 June. It operates at 2.4 GHz same as IEEE802.11b but maximum transmission rate is 54 Mbps with OFDM same as IEEE802.11a. [2]

IEEE 802.11 defines the basic service set (BSS) as the building block of a wireless LAN. A basic service set is made of stationary or mobile wireless stations and an optional central base station, known as the access point (AP).

The BSS without an AP is a stand-alone network and cannot send data to other BSSs. It is called an ad hoc architecture. In this architecture, stations can form a network without the need of an AP; they can locate one another and agree to be part of a BSS. A BSS with an AP is sometimes referred to as an infrastructure network.[3]

Although wireless communications are considerably advance nowadays, but continuous researches and developments are essential requirements to bring wireless communication performance a leap further forward. The VHDL (Very High Speed Hardware Description Language) is defined in IEEE as a tool of creation of electronics system because it supports the development, verification, synthesis and testing of hardware design, the communication of hardware design data and the maintenance, modification and procurement of hardware It is a common language used for electronics design and development prototyping.[4]

IEEE 802.11 is a family of standards for Wireless Local Area Networks (WLAN). It defines design requirements for the MAC and PHY layer of WLAN transceivers. The original IEEE 802.11 specification was provided a common MAC layer specification on top of three different PHY layers.

There are two types of widely used hardware description languages i.e. Verilog HDL with C language like syntax, and the VHDL.[5]

A Field-Programmable Gate Array (FPGA) is a device that consists of an array of basic logic cells that can be configured after fabrication using a certain programming technology. That has the advantage that hardware designs can be instantiated and run in an actual hardware environment without the need to manufacture a new chip.[6]

A software-defined radio is a radio in which some or all of the physical layer functions are software defined. The broad implication of the term software defined is that different waveforms can be supported by modifying the software or firmware but not changing the hardware. FPGA-based SDR can support high data rates and high bandwidth waveforms in a relatively compact and low-power package.[7]

1.2 Problem statement

Due to the rapid advancement of the wireless technologies, a variety of devices are released frequently and the administrators will need to adapt to these changes. Moreover, adding new devices in rapid succession will produce a heterogeneous system. Furthermore, the rapid replacement of equipments will result in more Electronic wastes (E-wastes).

1.3 Proposed solution

The Field programmable gate array (FPGA) can be reconfigured to adapt to the frequent changes in the wireless technologies. Using the FPGA can reduce the cost and make the system more homogeneous. Additionally, it will reduce the amount of the E-wastes.

**1.4 Objectives**

A. To develop a code for reprogrammable platforms that can adapt to changes in the wireless technologies and reduce the cost comming from buying new hardware.

B. To solve the problem of the heterogeneous system.

C. To reduce the amount of E-wastes.

1.5 Methodology

Deductive research approach, also known as testing a theory, is used. It starts from the needs of the users to formulate a theory and then test it[8]. The theory that is being tested here is the ability to program different functions of IEEE 802.11 into one device.

The method that is being used is the Evolutionary Prototype. The Final result of this project will be a re-programmable device that can do the work of an IEEE 802.11 MAC layer. It can be further evolved into a more complex product by the future researchers.

The VLSI Trainer ST101 and Xilinx software are the tools that are being used in this project. Using the VHDL hardware description language to program the SPARTAN2 FPGA.

A testing program has been made using Visual Basic programming Language to evaluate the system performance.

1.5 Thesis Outlines

Chapter Two and chapter Three illustrate the literature review. The former gives an overview of the history of implementing IEEE 802.11 and similar wireless protocol on reprogrammable devices, also includes the pre-configuration of the FPGA used in this project. While the later is an overview of the aspects of software defined radio and the history of it on FPGA. An explanation of the project implementation is described in chapter Four. Then chapter Five is the conclusion and recommendation for future works.