Chapter 4
Functional Verification of ASICs for Performance Optimization in Front-End VLSI Design

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ABSTRACT

The designing of Application Specific Integrated Circuits (ASICs) starts with a behavioral description and ended up with commercial Integrated Circuits (ICs). The entire scenario is not that easy, rather involve several complex stages. The process carried out at the fabrication laboratories are referred as back end designing. The scope of this chapter involves designing of several digital modules which are combinational in nature and are very useful for designing several ASICs of modern-day use. The implementations have been carried out using Proteus. Software called Proteus is used to design, sketch, and combine electronic circuits. Finally, performance optimization has been achieved in terms of delay, hardware complexities and energy efficiency in case of designing approximate adder. Approximate adder finds its role in several domain such as digital signal processing, machine learning interface, cryptographic hush function, approximate computing and real time control system.

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1. INTRODUCTION

Modern days computational capabilities of various machines strongly depend on the hardware platforms used by them. Here hardware refers to an integrated system where many devices and circuitries are integrated for the purpose of carrying multiple functionalities like computation, data processing, communication and storage (Graham, 2000). VLSI stands for the Very Large-Scale Integration. Many domains can be observed in the electronics, in that domains VLSI is one. VLSI means to produce the integrated circuits or microchips, which include thousands and thousands or even billions of transistors and digital gadgets on a single piece of silicon. Electronic circuits typically consist of a single PCBA (Printed Circuit Board Assembly) that houses the CPU (Central Processing Unit), RAM (Random Access Memory), ROM (Read Only Memory), and other peripherals. However, an IC (Integrated Circuits) designer may incorporate all of these into a single chip by using the VLSI technology. VLSI is crucial in the development of the electronics and gadgets. VLSI makes the ICs very smaller in size this helps very much in building the many useful devices like laptops, smart watches, mobile phones, digital camera and more (Kim, 2005).

The ICs which are designed by this technology are very useful in the computational operations. ICs can be built by using the logic gates and transistors. VLSI design is the very important component in the present era. It totally changed the electronic industry by reducing the size of the IC (Integrated Circuit) and improving their functionality. The applications of the VLSI are many more ranging from the computers to the medical machines (Balasubramanian, 2021). This VLSI technology very much impacts almost every field in the present era. It is playing major role in the inventions of new things. VLSI technology fuels the automation systems, sensors, and processors used in automation and robotics, enabling robots to perform jobs accurately and effectively. Fig 1., illustrates the impact of VLSI in various domains. Integrated hardware systems are technically referred to as Integrated Circuits (IC) which are the outcome of VLSI (Very Large-Scale Integration) domain (Fan, 2023). Today at the age of silicon, the entire technological sector is getting revolutionize with machine learning, artificial intelligence, handling of huge amount of data in terms of processing and analyzing in different sectors like commerce, health care, education. VLSI technology and the design constraints are playing a very crucial role to get all these things happen in a smooth manner. For the last few decades, researchers are putting great efforts to overcome some of the designing constraints like speed, area and power in the VLSI sector. Different approaches are considered while designing an IC consisting of millions of transistors, so that the computational speed can be enhanced by limiting the propagation delay. Due to the miniaturization of devices, placement and routing are also very important. Different placement and routing algorithms play very crucial role to obtain such objectives. As majority of the devices are mobile in nature and get operated on battery power, low power consumption is also a very important design consideration to enhance the operational life of these devices (Chaurasiya and Shrestha, 2021). Gordon Moore, co-founder of intel made the one observation called Moore's law in 1965. Moore's law stated that transistor number on one chip is getting doubled approximately every two years. This observation was proved true after some years. Nowadays even millions and billions of transistors are also using for making of the one integrated circuit. many complex IC circuits are making nowadays using the VLSI technology. After inventing the VLSI technology many microprocessors and microchips were made for the computational work. ICs which are designed for performing a specific kind of computational activity are referred to as ASICs (Application Specific Integrated Circuits). On the other side several ICs are designed for handling multiple computational activities as desired. These are programmable in nature