**CHAPTER-1**

**INTRODUCTION**

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Due to wide spread use of microprocessors and signal processors, implementation of high performance arithmetic hardware has always remained an attractive design problem. Arithmetic and Logic Unit (ALU) is the workhorse of microprocessors and determines the speed of operation of the processor. All modern processors include standalone hardware for computation of basic arithmetic operations. In addition to fast arithmetic hardware, processors are also equipped with on-chip memory (cache) to achieve significant performance improvement by avoiding delay due to data access from main memory.

An Arithmetic Logical Unit is the very important subsystem in the digital system design. It is an integral part of a computer processor and a combinational logic unit that performs its arithmetic and logic operations. ALUs of various fixed bit-widths and full precision bit width are frequently required in very large-scale integrated circuits (VLSI) from processors to application specific integrated circuits (ASICs).Nowadays ALU is getting smaller and more complex to enable the development of a more powerful but smaller computer and processors. The need for high speed, less power consumption and compatible processors has been increasing as a result of computer, digital signal processing and networking applications. Arithmetic operations such as multiplication, addition, division and subtraction and logical operations such as AND, OR, NOT,XOR are using all type of processors used in various applications.

Traditional logic computation is irreversible since the outputs do not have enough information to reconstruct the inputs. In logic calculation, if there are ‘p’ inputs and ‘q’ outputs such that p > q, then at least (p-q) bits of information are lost. As an example, a logic gate with two inputs and one output destroys at least one bit of information during computation. Landauer’s principle states that each bit of information that is disregarded results in dissipation of heat, regardless of underlying technology. The amount of dissipated heat is at least kTln2 joules for every bit of lost information, where k is the Boltzmann’s constant and T is the absolute temperature. At room temperature, this amount becomes 2.9\*10-21 Joules. According to the problem of heat dissipation arises from, (1) technological deviation from ideality of switches and materials and (2) Landauer’s principle.

In 1973, Bennett showed that KTln2 energy would not dissipate from a system as long as the system allows the reproduction of the inputs from observed outputs. The current technologies have addressed the first part of the problem by reducing the heat loss. However, information loss in irreversible computation, which is the second part of the problem, will cause a considerable amount of heat generation in the near future due to increasing density of circuits.