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Research paper

Comparative Analysis of High Speed Carry Skip Adders

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Abstract

In this paper we compared a high speed carry skip adders by considering parameters such as area, LUT'S, delay, power. When compared to conventional CSKA and other adders. Here in this project in first stage CSKA designed by using multiplexer as skip logic so by using this speed gets increased by skipping of carry. so here area gets increased so to reduce area another hybrid variable latency carry skip adder(Brent-kung adder) is designed .here power utilization also gets decreased, speed gets increased, but some delay is produced here to overcome that we followed a another method called Kogge-Stone adder here so it reduces the critical path delay. In Kogge-stone adder power is highly consumed due to more no of wiring connections so another adder was designed to reduce power consumption which is Sklansky adder which reduces power Consumption. This is done in Xilinx ISE 14.7 and power was analyzed using Xilinx power analyzer.

***Keywords**: Brent-Kung adder, Skip logic, Kogge-Stone adder, Sklansky adder.*

1. Introduction

Adders are an electronic circuit that performs adding of two numbers which produces sum and carry. They are building blocks in VLSI circuits are used in ALU'S and various types of microprocessors. They are used to compute instrumentation or defragmentation of values.

Types of adders

There are many types of adders like Ripple carry adder, carry select adder, carry bypass adder (also known as CSKA).

A) Ripple carry adder

A ripple carry adder is combination of two or more full adders by giving C_{in} as input, so there by carry gets propagated from one full adder to another one by producing sum and C_{out} as outputs.

B) Carry select adder

A carry select adder is combination of two ripple carry adders and a multiplexer. The inputs are given simultaneously to both ripple carry adders and sum of 1st ripple carry adder is propagated to 2nd one and these sum's of two ripple carry adders are sent through the multiplexer and final sum is caluculated.In same way final carry's of the RCA'S are multiplexed and final C_{out} is calculated.

C) Carry look ahead adder

A carry look ahead adder is fast parallel adder as it reduces more propagation delay by increasing complex hardware.

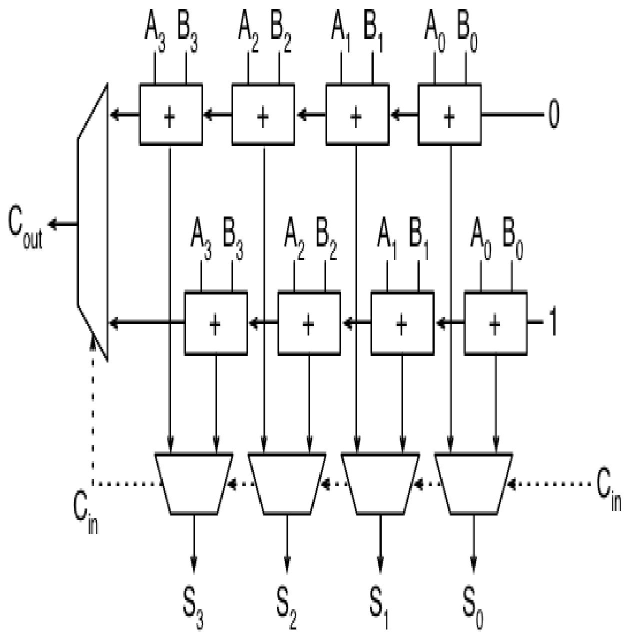

Fig. 1.1 Carry Select Adder

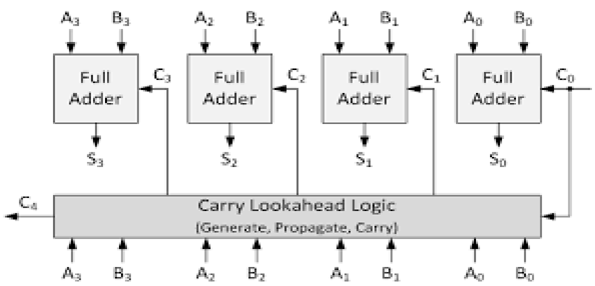

Fig. 1.2: Carry Look Ahead Adder

D) Carry skip adder

A carry skip is one which skips the carry by using combination of full adders, each full adder consists of 3 outputs one is sum another is carry and another is parity and these parity outputs of all full adders are given to skip logic which is combination of AND gate and a multiplexer. The output of the and gate is given as selection line for multiplexer and the inputs of the multiplexer are c_{in} and c_{out} based on selection line input c_{in} or c_{out} is selected.

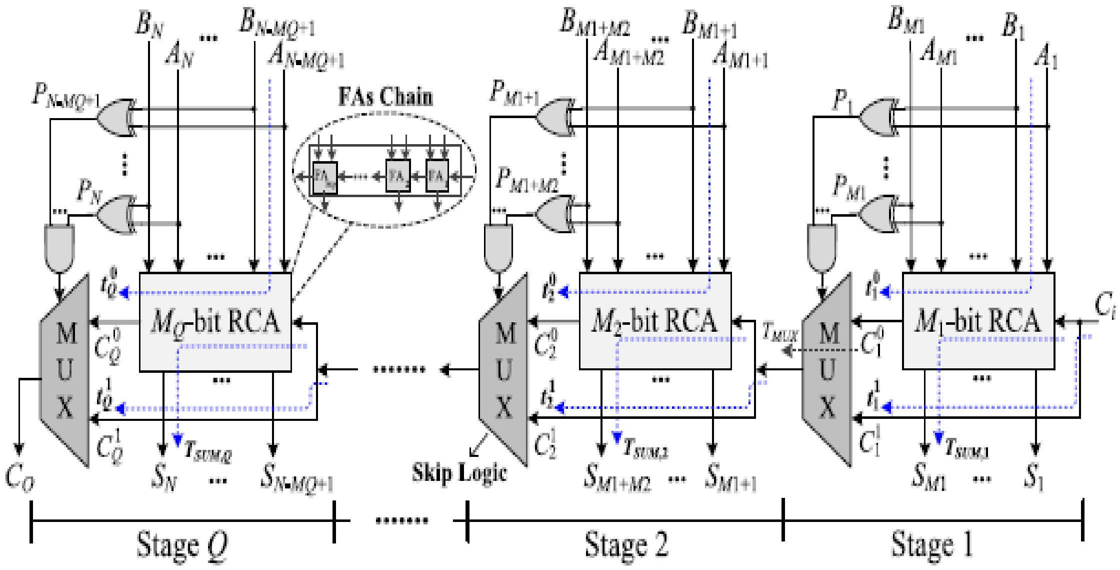

Fig. 1.3: Conventional CSKA

2. Parallel Prefix adders

A) Brent-Kung cska

The idea behind choosing this Brent-kung adder was that the critical path delay gets minimized when compared to conventional CSKA. So for that we replace some of the middle stages with a Parallel Prefix Adders.The internal structure of Brent Kung adder is shown in above figure 2.2 which contains 3 Stages pre processing stage , carry generation stage , post Processing stage.

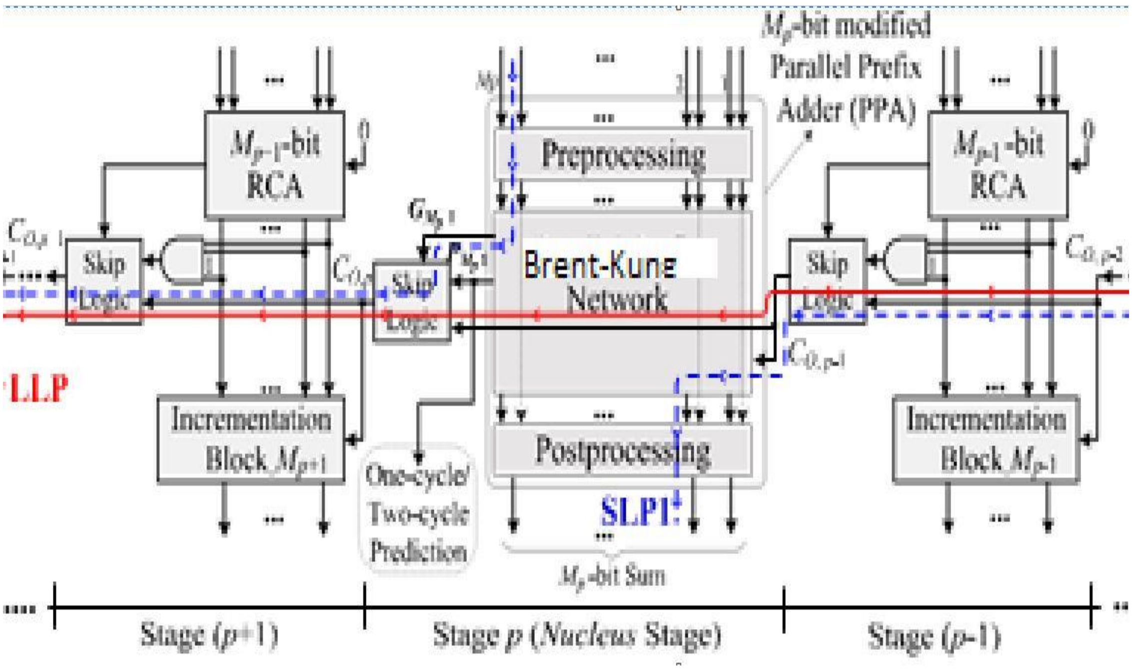

Fig. 2.1: Structure of Brent-Kung CSKA

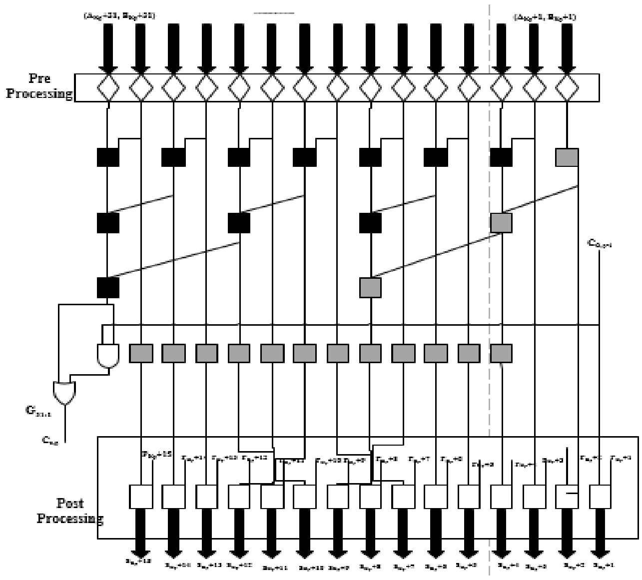

Fig. 2.2: Internal structure of Brent Kung cska

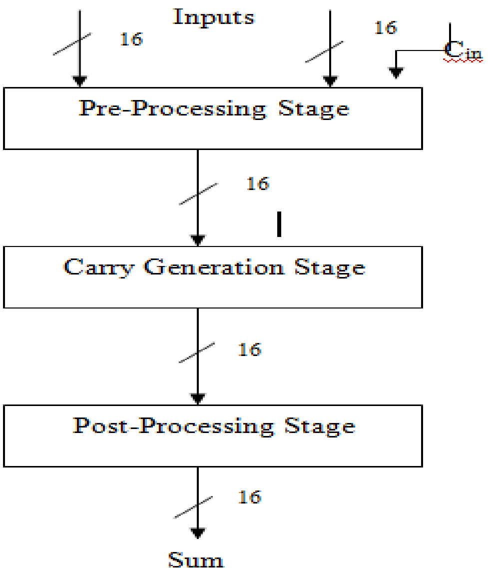

Fig. 2.3: Structure of Brent-Kung adder

In the Brent-Kung cska Black cell works 3 gates and gray cell works in two gates, the gray cell reduces delay because it works only in 2 gates. It consists of three stages, In preprocessing stage generate and propagate equations are obtained by equations.

$P_1 = A_1$ XOR B_1 (1)
$G_1 = A_1$ & B_1 (2)

In carry generation stage the equations are formed by

$C_p = P_1$ & P_0 (3)
$C_g = G_1 \| (P_1$ & $G_0)$ (4)

In the post processing stage the carry of the first bit is XOR with to the next bit of propagates ,then the output sum equation is obtained as

$S_i = P_i$ & C_{i-1} (5)

B) Kogge-Stone cska
To further reduce delay that is produced by the Brent-Kung the new structure was proposed was that Kogge-Stone adder.it reduces delay to much more extent and area also decreases as well as no of LUT'S also gets decreased. Kogge-Stone is parallel prefix form of carry-look ahead adder.Kogg-stone tree adder reduces the critical path to

$t_{tree}=t_{pg} + [\log_2 N]\, t_{AO} + t_{XOR}$ (6)

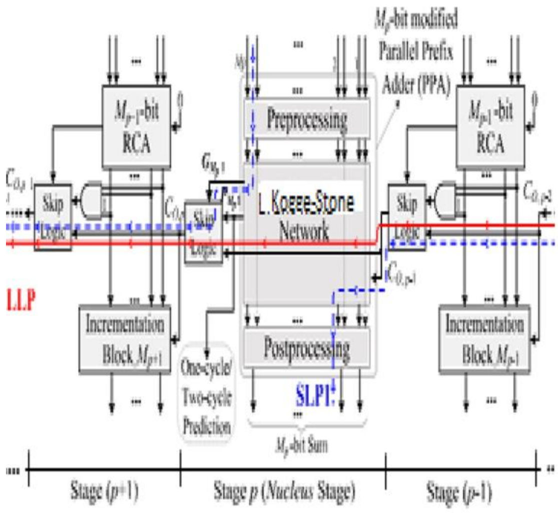

Fig. 2.4: Block diagram of Kogge-Stone cska

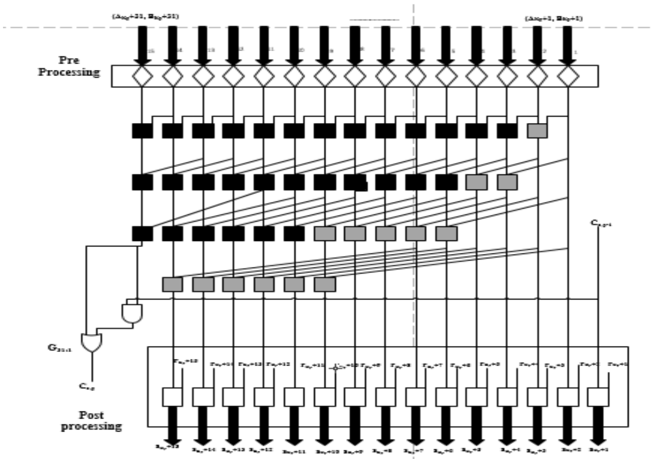

Fig. 2.5: Internal structure of Kogge-Stone cska

C) Sklansky cska
To overcome difficulties in Kogge-Stone new adder was proposed which is Sklansky adder in Kogge-stone adder area occupied is more because of large wiring capacitance hence power consumption also increases. The Sklansky is also known as divide-and-conquer-tree reduces delay to $\log_2$ N stages by computing intermediate prefixes along with larger group prefixes.

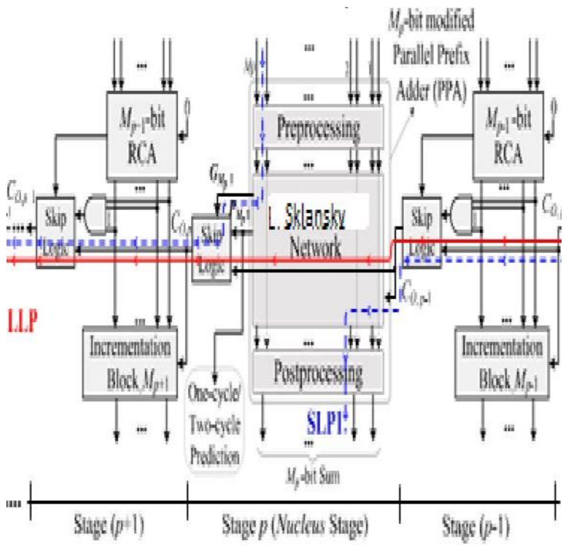

Fig. 2.6: Block diagram of Sklansky cska

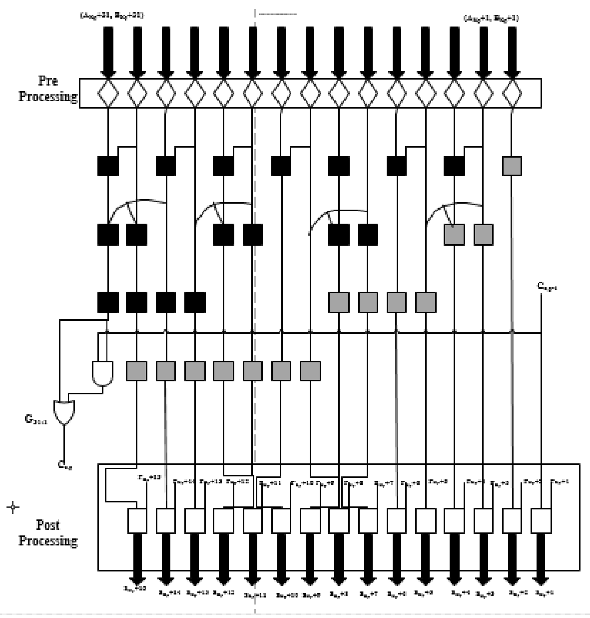

Fig. 2.7 Internal structure of Sklansky cska

3. Results

Comparison Table:

Table 3.1: Comparison table

Adder type	Delay (ns)	Power (watts)	Slices	No of LUT'S
CSKA	**24.342**	**0.027**	**28**	**48**
Brent-Kung	**23.094**	**0.023**	**49**	**87**
Kogge-Stone	**14.45**	**0.032**	**42**	**78**
Sklansky	**18.85**	**0.023**	**46**	**82**

Output Wave forms:

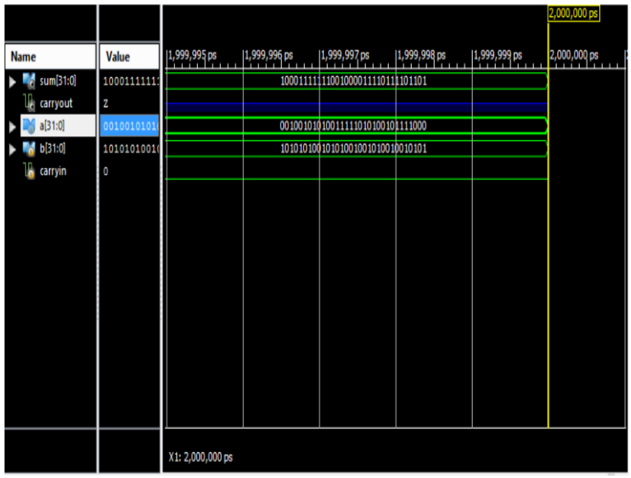

Fig. 3.1: Output wave form of CSKA's

The output waveform response of a 4 types of CSKA is same but delay is optimized over four CSKA like Brent Kung, Kogge-stone, and Sklansky CSKA'S

4. Conclusion

Analysis of different adders using Xilinx-Verilog programming is done and different parameters like delay, power and LUT's are compared as shown in table 1. From the obtained results it can be said that Kogge stone CSKA is preferred one for the applications where adder has to be implemented as its speed is more compared to conventional CSKA, Brent-Kung CSKA and Sklansky CSKA .The number of LUT's required for implementation of Kogge stone CSKA is also less compared to Brent-Kung CSKA and Sklansky CSKA so that the area can be reduced for hardware implementation of Kogge stone CSKA.

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