Lecture 10: March 3, 2021
Computer Architecture and Organization-I
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Carry Save Adder (CSA)

Carry save adder (CSA) is effective while adding more than two numbers.

Example: addition of three n-bit numbers (in CSA)

An n-bit CSA consists of n-disjoint full adders (Figure 29(b)).

Addition four n-bit numbers is shown in Figure 29(a).

Addition of six n-bit numbers is shown in Figure 29(c).

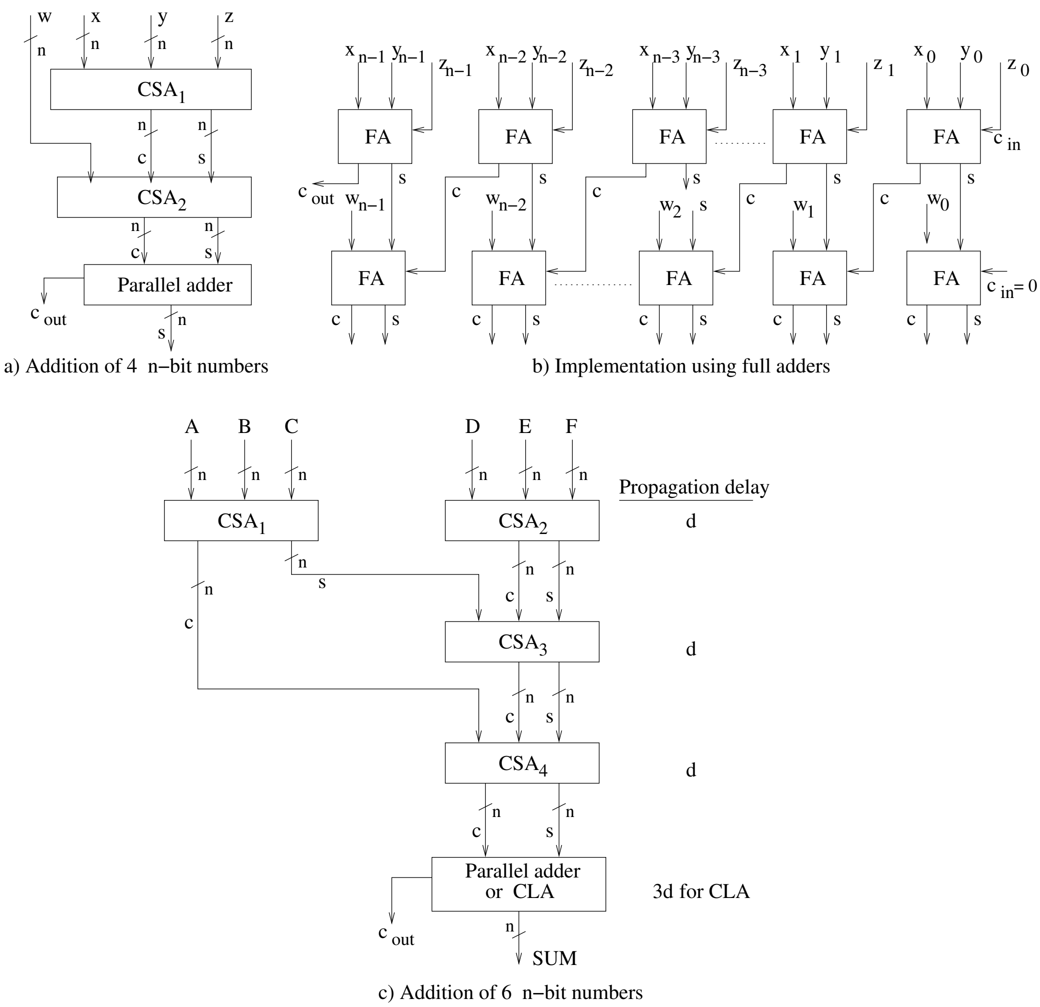

Figure 29: Carry save addition

0.9 Multiplication Instruction Implementation

0.9.1 Multiplication in sign magnitude

Simplest implementation of fixed point multiplication instruction is using conters.

Let multiplicand is P and Q is the multiplier.

Product is targeted to store in CP.

In counter based implementation, CP is a counter.

Following steps computes $CP = P \times Q$. all four QC, CQ, MC and CP are counters.

1. Let QC$\leftarrow$ $multiplier$; CQ$\leftarrow$ $multiplier$; MC$\leftarrow$ $multiplicand$; CP$\leftarrow$ 0
2. If MC and/or CQ = 0, then exit
3. Decrement CQ [CQ=CQ-1]; Increment CP [CP=CP+1]
4. If CQ$\neq$ 0, then go to Step 3
5. Decrement MC [MC=MC-1]; Copy QC to CQ [CQ$\leftarrow$ QC]
6. If MC$\neq$ 0, then go to Step 3
7. Output CP as product

This method is simple but very slow.

Alternative implementation can be add multiplicand (M) Q (multiplier) times.

That is,

Initialize PRODUCT (M$\times$ Q) = 0 and then

Perform PUODUCT = PRODUCT + M $\cdots$ Q times.

This implementation requires a counter to store the multiplier.

Multiplication of n-bit numbers in sign magnitude can also be implemented following the steps used in multiplication of decimal numbers (shift/addition technique).

Example: Multiplication of 8-bit numbers

$$Y = y_7y_6\cdots y_1y_0 = 01100101 \text{ and } X = x_7x_6\cdots x_1x_0 = 11011101.$$

To compute magnitude of product P = $p_6p_5\cdots p_1p_0$, the 7 magnitude bits of Y and X are to be multiplied.

	1100101	$y_6y_5y_4y_3y_2y_1y_0$
	1011101	$x_6x_5x_4x_3x_2x_1x_0$
0000000	1100101	P_0
000000**0**	0000000	P_1
00000**11**	0010100	P_2
0000**110**	0101000	P_3
000**1100**	1010000	P_4
00**00000**	0000000	P_5
0**110010**	1000000	P_6

P_i is the partial product. Therefore, the magnitude of product is

$$P = \sum_{i=0}^{n-2} 2^i Y x_i$$

Sign of P -that is, p_7 = 1 (XOR of y_7 and x_7).