CS 320: Homework #2

Due on February 10, 2017 at 10:50pm

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Problem Statement: Apply a 2-level carry-lookahead addition algorithm discussed in class to add the following two 16-bit numbers:

$$\begin{array}{rcl} & 0011010000110111_2 & & 13367_{10} \\ + & 0011110011011110_2 & + & 15582_{10} \\ \hline \end{array}$$

Bit level propogation and generation

$$g_i = a_i \cdot b_i$$

$$p_i = a_i \oplus b_i$$

Group level propogation and generation

$$G_i = \prod_{x=4i}^{4i+3} g_x$$

$$P_i = \begin{cases} 1 & \text{if } g_{4i+3} = 1 \\ 1 & \text{if earlier generate is true and all intermediate propagates are true} \\ 0 & \text{otherwise} \end{cases}$$

Values are displayed in the table below.

Calculating group level carries: $c_{i+1} = g_i + p_i \cdot c_i$

$$\begin{aligned} C_0 &= G_0 + P_0 \cdot C_0 &&= 1 \\ C_1 &= G_1 + P_1 \cdot C_1 &&= 1 \\ C_2 &= G_2 + P_2 \cdot C_2 &&= 1 \\ C_3 &= G_3 + P_3 \cdot C_3 &&= 0 \end{aligned} \tag{1}$$

Calculating bit level carries: $c_{i+1} = g_i + p_i \cdot c_i$

$$\begin{aligned} c_1 &= g_0 + p_0 \cdot c_0 &&= 0 \\ c_2 &= g_1 + p_1 \cdot c_1 &&= 1 \\ c_3 &= g_2 + p_2 \cdot c_2 &&= 1 \\ c_4 &= g_3 + p_3 \cdot C_0 &&= 1 \\ c_5 &= g_4 + p_4 \cdot c_4 &&= 1 \\ c_6 &= g_5 + p_5 \cdot c_5 &&= 1 \\ c_7 &= g_6 + p_6 \cdot c_6 &&= 1 \\ c_8 &= g_7 + p_7 \cdot C_1 &&= 1 \\ c_9 &= g_8 + p_8 \cdot c_8 &&= 0 \\ c_{10} &= g_9 + p_9 \cdot c_9 &&= 0 \\ c_{11} &= g_{10} + p_{10} \cdot c_{10} &&= 1 \\ c_{12} &= g_{11} + p_{11} \cdot C_2 &&= 1 \\ c_{13} &= g_{12} + p_{12} \cdot c_{12} &&= 1 \\ c_{14} &= g_{13} + p_{13} \cdot c_{13} &&= 1 \\ c_{15} &= g_{14} + p_{14} \cdot c_{14} &&= 0 \end{aligned}$$

Remaining calculations are displayed in the table

Least significant bit is on the left

bit	0	1	2	3		4	5	6	7		8	9	10	11		12	13	14	15	16
a_i	1	1	1	0		1	1	0	0		0	0	1	0		1	1	0	0	
b_i	0	1	1	1		1	0	1	1		0	0	1	1		1	1	0	0	
g_i	0	1	1	0		1	0	0	0		0	0	1	0		1	1	0	0	
p_i	1	0	0	1		0	1	1	1		0	0	0	1		0	0	0	0	
G_i					1					1					1					0
P_i					0					0					0					0
c_i		0	1	1		1	1	1	1		1	0	0	1		1	1	1	0	
C_i					1					1					1					0
S_i	1	0	1	0		1	0	0	0		1	0	0	0		1	1	1	0	

Ripple carry adder Least significant bit is on the right

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
carry		1	1	1	1			1	1	1	1	1	1	1			
a_i	0	0	1	1	0	1	0	0	0	0	1	1	0	1	1	1	
b_i	0	0	1	1	1	1	0	0	1	1	0	1	1	1	1	0	
sum	0	1	1	1	0	0	0	1	0	0	0	1	0	1	0	1	

	0011010000110111_2		13367_{10}
$+$	0011110011011110_2	$+$	15582_{10}
$=$	0111000100010101_2	$=$	28949_{10}

Conclusion:

Ripple Carry Adder and Carry-Lookahead Adder both generate the same accurate result!