Carry Lookahead Addition

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1 Administrivia

Announcements


Assignment

Read 4.6.

From Last Time

MIPS ALU.

Outline

1. Preliminaries, “constant time addition."

2. Four-bit full carry lookahead adder.

3. Four-big Group carry lookahead unit.

4. Building large adders.
2 Carry Lookahead Addition

1. Why bother with speeding up addition?

2. Divide and conquer approach to addition: \( s_i = ps_i \oplus c_i \), where \( ps_i = a_i \oplus b_i \).

3. Can we pre-compute the carries?

4. Carry generate: \( g_i = a_i b_i \).

5. Carry propagate: \( p_i = a_i + b_i \).

6. Illustration: look at \( p, g, \) and \( c \) for 11010101 and 01110011.

7. Some carry equations:
   
   (a) \( c_1 = g_0 + p_0 c_0 \)
   
   (b) \( c_2 = g_1 + p_1 c_1 = g_1 + p_1 g_0 + p_1 p_0 c_0 \)
   
   (c) \( c_8 = g_7 + p_7 g_6 + p_7 p_6 g_5 + \cdots + p_7 p_6 p_5 p_4 p_3 p_2 p_1 p_0 c_0 \)

8. A bit of recursion:

   (a) Base case: \( c_0 \)

   (b) Recursive step: \( c_i = g_{i-1} + p_{i-1} c_{i-1} \)

2.1 Carry Lookahead: The Big Picture

Restricting the carry computation circuitry to a tree structure:

What does this buy us?

2.2 Four-Bit Carry Lookahead Adder

1. Design a four-bit full carry lookahead adder.

   Block diagram:

   Block generate, propagate.

2. What is the fan-in?

3. What is the delay model from inputs to outputs?
### 2.3 4-Bit Group Carry Lookahead Unit

1. Design a 4-Group carry lookahead unit.

   Block diagram:

   ![Block diagram](image)

   Use of block generates, propagates.

2. What is the fan-in?

3. What is the delay model from inputs to outputs?

### 2.4 16-Bit Carry Lookahead Adders

Cascaded and full carry lookahead.

### 2.5 32-Bit Carry Lookahead Adders

Cascaded and full carry lookahead.