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1/17/22

CS M151B HW3

539 14. 8 bit Integer Each step - 4 time units

Hardware

① Product = Product + multiplicand (4 time units)

② shift multiplicand left, multiplier right (simultaneous) (4)

8 iterations for 8 bit integer → 8 × (4 + 4) = 64

Software

① Product = product + multiplicand (4)

② shift multiplicand left (4)

③ Shift multiplier right (4)

8 iterations → 8 × (4 + 4 + 4) = 96

Hardware: 64 time units Software: 96 time units

540 15. 31 adders stacked vertically 8 bit integer 4 time units/adder

Adding two 8-bit integers means you need 7 adders

$7 \text{ adders} \times \frac{4 \text{ time units}}{\text{adder}} =$ **28 time units**

16. 8-bit integer 4 time units/adder Fast multiplication

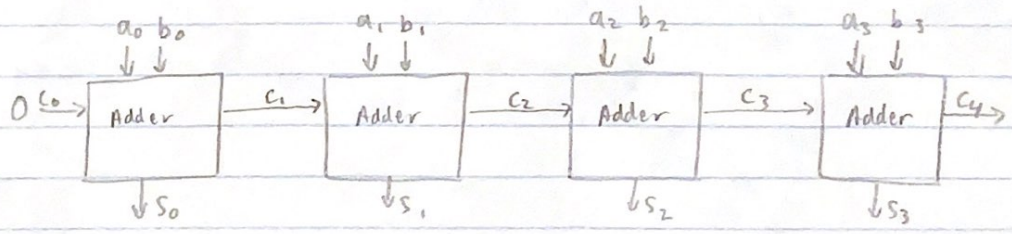
The idea behind this approach is to use the adders in parallel to be more efficient - we use $\log_2(n)$ time units where n is the number of bits.

$4 \cdot \log_2(8) = 4 \cdot 3 = 12$ **12 time units**

1653 28. only OR or AND terms - T

OR of several AND terms - 2T

Ripple Carry



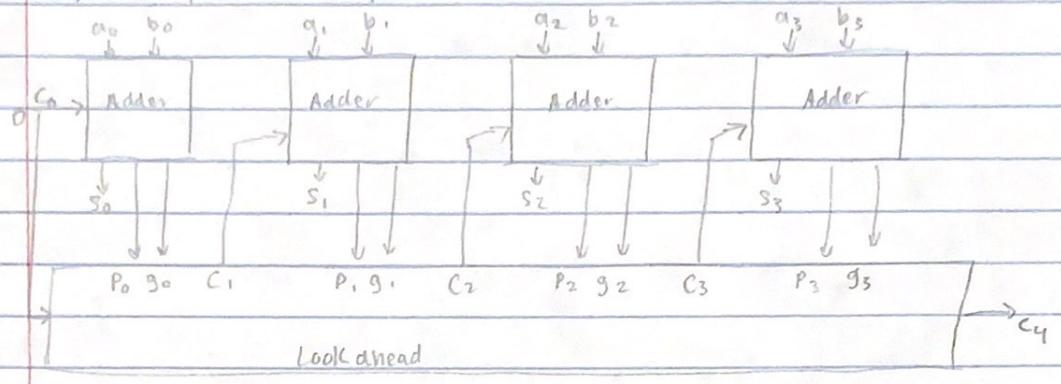
T0: $a_0\ a_1\ a_2\ a_3\ b_0\ b_1\ b_2\ b_3\ C_0$ T6: $S_2\ C_3$

T2: $S_0\ C_1$ T8: $S_3\ C_4$

T4: $S_1\ C_2$

The total time needed for the 4-bit Ripple-carry adder is 8T.
The path is from $a_0, b_0, c_0 \rightarrow s_3, c_4$ and this takes 8 time units.

4-bit Carry Lookahead Adder



T0: $a_0 a_1 a_2 a_3 b_0 b_1 b_2 b_3 C_0$
T1: $p_0 p_1 p_2 p_3 g_1 g_2 g_3 g_4$
T2: S_0
T3: $C_1 C_2 C_3 C_4$
T5: $S_1 S_2 S_3$

The total time needed for the 4-bit Carry Lookahead adder is 5T.
The path is from the p (propogate) and g (generate) signals to the S_0, then all the carries, then finally all the sums.

29. 16-bit Ripple Carry Adder
↳ For ripple carry adder, time required is 2 × # Bits
There will be a 32T delay.

? Ripple Carry of 4-bit groups that use carry lookahead
↳ For ripple carry adder, time required is 2 × # Bits
Each 4-bit block takes 8T, and all 4 blocks perform in parallel
It takes 4T for the carry-lookahead stuff (see bracket above)
There will be a 12T delay

? 16 bit carry lookahead adder
↳ Same as #28, but connected (4)
There will be a 8T delay.

31.

Full carry - Lookahead adders (4 4-bit Carry Lookaheads)

- As we saw in #28, it takes 5T for a single 4-bit Carry lookahead adder.
- Connecting them all together into 4 consecutive ones means that the Total Delay is 8T.

Carry Save

- According to the diagram, carry save would take 6T. The first level would take 3T, the second level 2T, and the third level 1T. Thus, the total time would be 6T.