

# ECE154A — Discussion 00

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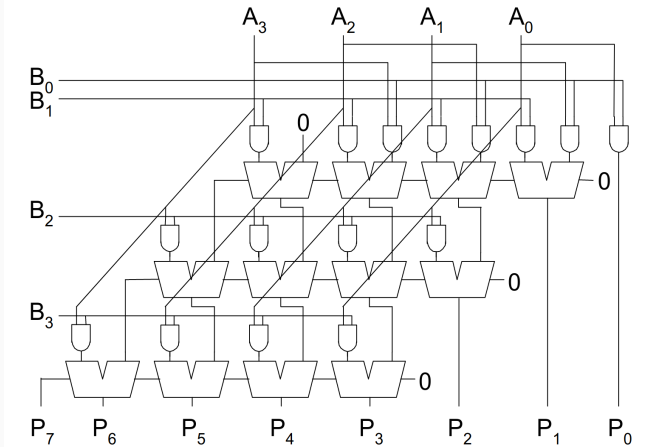
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October 8, 2021

## Keep your eyes open for...

- PSet 1: due ~~Wednesday, Oct 6~~ Monday, Oct 11
- Lab 2: should be officially assigned soon

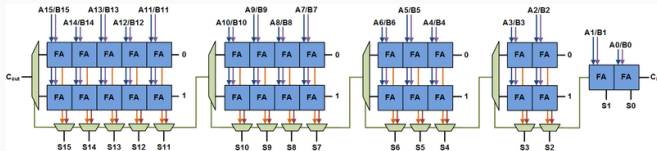
## Array Multiplier — Practice Problem



Let  $t_{AND} = 2\text{ps}$ ,  $t_{XOR} = 4\text{ps}$ ,  $t_{OR} = 1\text{ps}$ .

What is the critical path delay?

# Carry-Select Adder



# Carry-Select Adder

- Write a logic expression for the 2:1 muxes.
- Write boolean expressions for both outputs of the full adder cells.
- Identify the critical path, and calculate the delay (assume path-invariant full adder)
- Derive general expressions for area and delay in an N-bit carry-select adder, split into k blocks.

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$$Out = !Sel * a + Sel * b$$
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$$S = X \oplus B \oplus C_{in}; C_{out} = A * B + A * C_{in} + B * C_{in}$$

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- Derive general expressions for area and delay in an N-bit carry-select adder, split into k blocks.

$$A = kA_{FA} + \frac{N}{k-1}(2kA_{FA} + (k+1)A_{MUX}); t = kt_{FA} + \frac{N}{k-1}t_{MUX}$$

Wait, we can replace some of those cells with half-adders (constant  $C_{in}$ ). . .

- Write Boolean expressions and draw gate diagrams for half-adders with either constant carry in.
- Assume a delay of  $\frac{1}{3}t_{FA}$  along all paths of the half-adders. Without changing the core idea, suggest a change to the structure of the adder to reduce delay.

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- Write Boolean expressions and draw gate diagrams for half-adders with either constant carry in.
- Assume a delay of  $\frac{1}{3}t_{FA}$  along all paths of the half-adders. Without changing the core idea, suggest a change to the structure of the adder to reduce delay. Group as 5-4-4-3 instead of 4-4-4-4. Reduced initial carry chain saves a full-adder delay. Discuss: why can't we keep doing this?

# Mystery Code!

0x00000004	main:	li \$a0, 1
0x00000008		jal mystery
0x0000000c		addu \$a0, \$0, \$v0
0x00000010		jal mystery
0x00000014		addu \$a0, \$0, \$v0
0x00000018		jal mystery
0x0000001c		addu \$a0, \$0, \$v0
0x00000020		jal mystery
<hr/>		
0x80000004	mystery:	lui \$t0, 0xffff
0x80000008		lui \$t2, %Hi(mystery)
0x8000000c		ori \$t2, %Lo(mystery)
0x80000010		addiu \$t1, \$0, 0
0x80000014		andi \$a0, \$a0, 0xffff
0x80000018		add \$v0, \$a0, \$t1
0x8000001c		lw \$t3, 12(\$t2)
0x80000020		and \$t3, \$t3, \$a0
0x80000024		or \$t3, \$t3, \$a0
0x8000002c		sw \$t3, 12(\$t2)
0x80000030		jr \$ra

What does it do? After 1 run? 2? N?