

Warmup

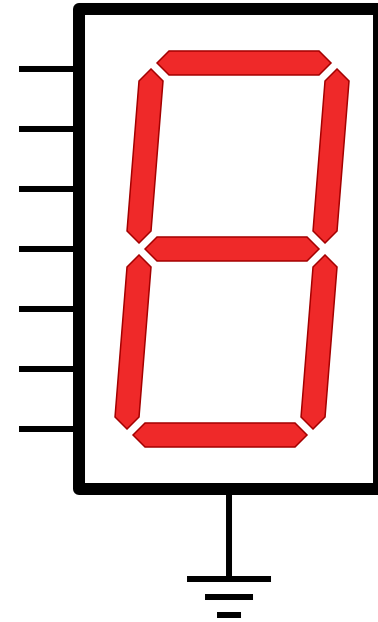
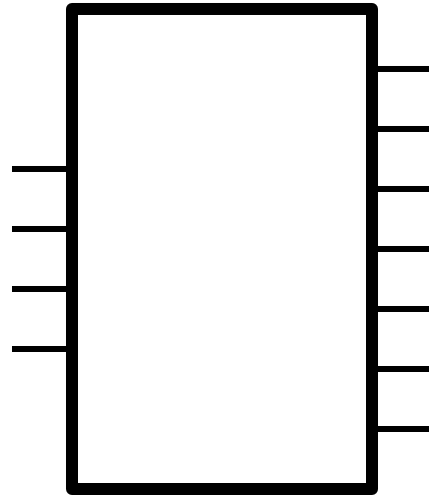
Use a k-map to find a minimal implementation of this truth table:

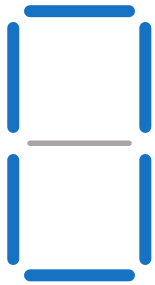
A	B	C	D		Y	A	B	C	D		Y
0	0	0	0		0	1	0	0	0		0
0	0	0	1		0	1	0	0	1		1
0	0	1	0		1	1	0	1	0		0
0	0	1	1		1	1	0	1	1		1
0	1	0	0		0	1	1	0	0		0
0	1	0	1		0	1	1	0	1		1
0	1	1	0		1	1	1	1	0		0
0	1	1	1		1	1	1	1	1		1

Respond at pollev.com/stevenbell699

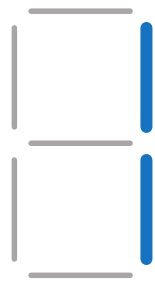
4-bit binary
number

7-segment
decoder

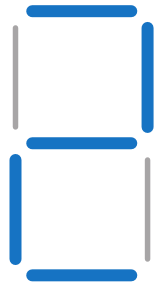




0



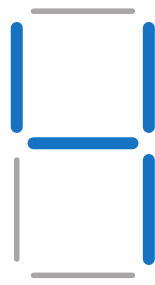
1



2



3



4



5



6



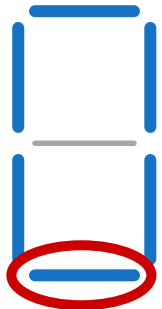
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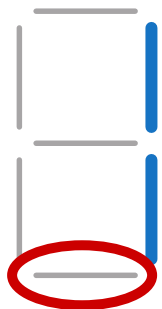
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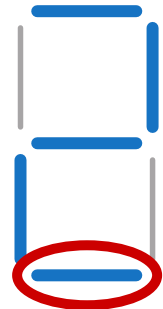
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0



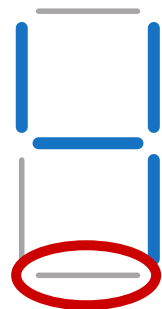
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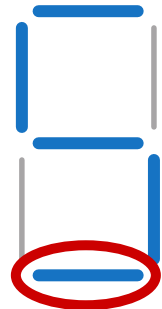
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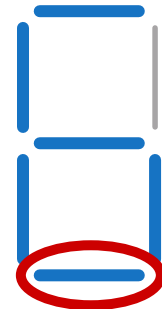
3



4



5



6



7



8



9

ES 4: Multiplexers and FPGAs

Steven Bell

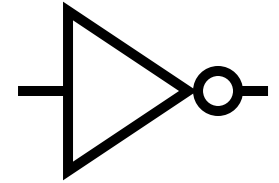
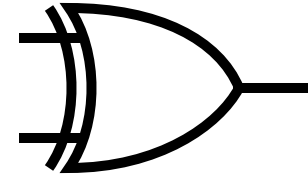
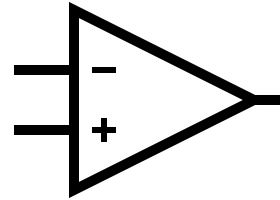
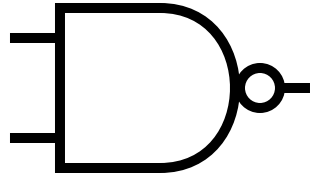
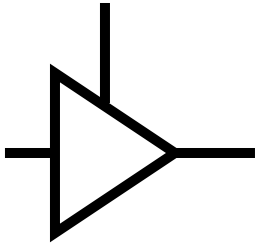
4 February 2019

By the end of class today, you should be able to:

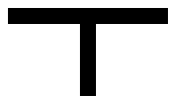
- Explain what a multiplexer is
- Draw a logic diagram using a 2^N -input multiplexer to implement an N-variable or (N+1)-variable boolean equation
- Describe the basic structure of an FPGA

Terminology

Which of these is not a digital circuit element?



V_{dd}

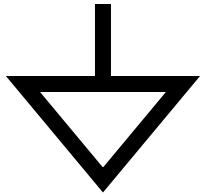
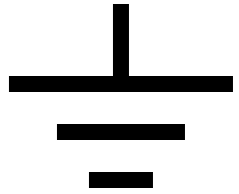


VDD

5V

HIGH

1



Ground

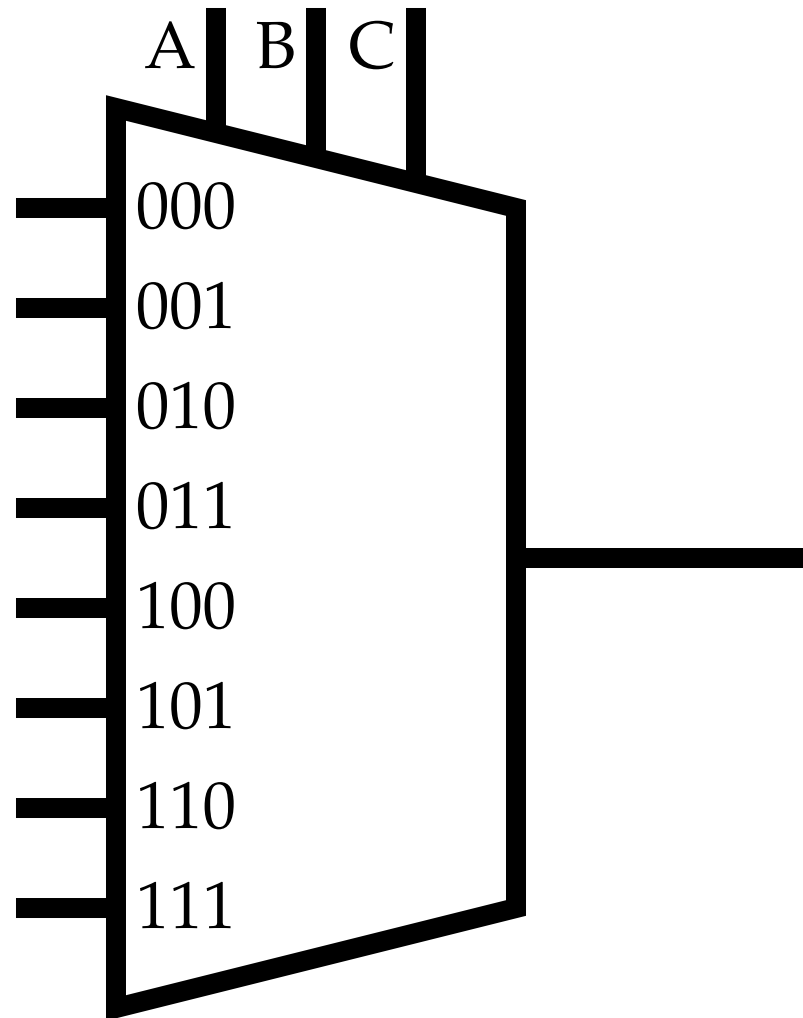
0V

LOW

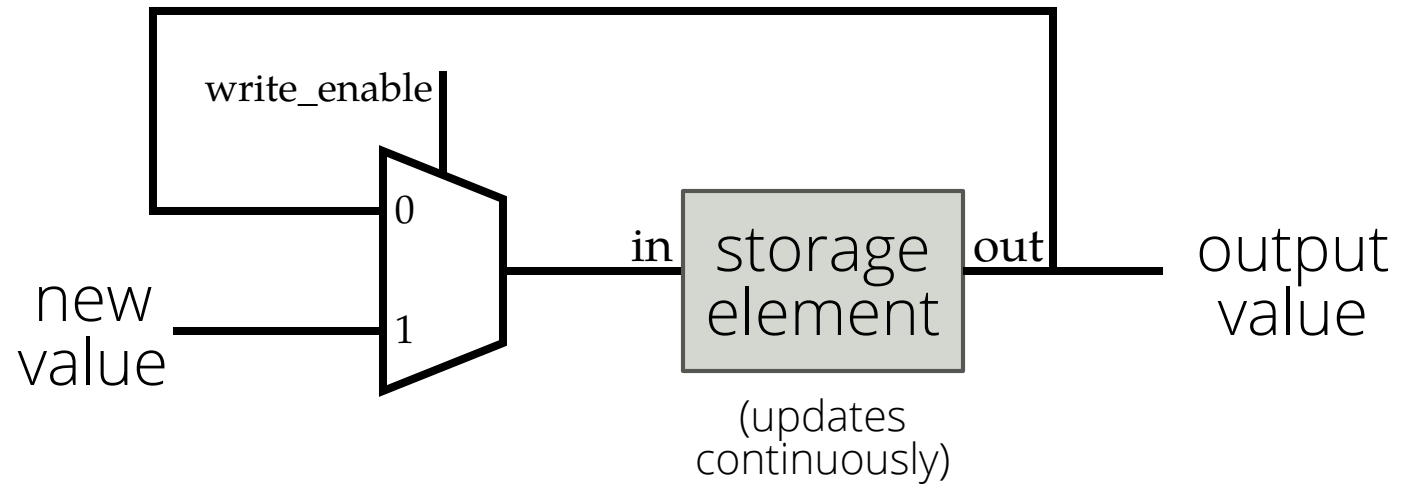
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Multiplexers

Select one of 2^N inputs based on the binary value of N control wires

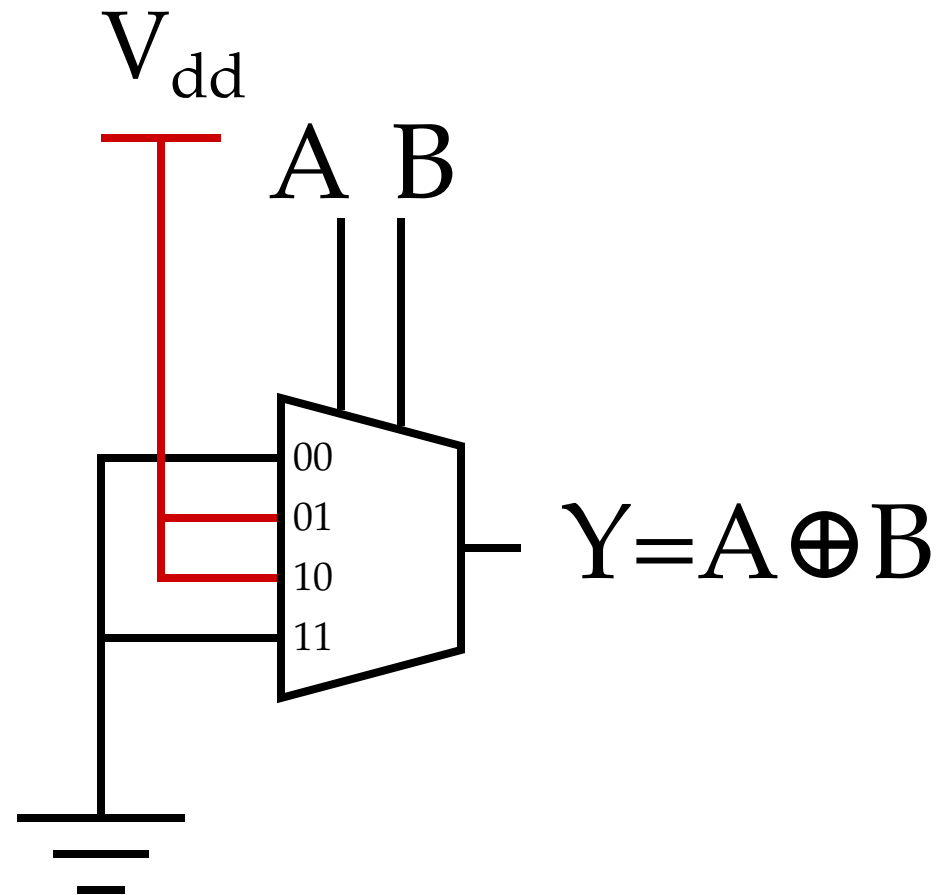


A practical example



Implementing XOR

Using a mux as a look-up table (LUT)



Multiplexer practice 1

Implement this logic equation using

- 1) discrete gates
- 2) 8:1 multiplexer
- 3) 4:1 multiplexer

$$Y = \bar{A}B + A\bar{B}\bar{C}$$

Implement a 2-bit adder with multiplexers

How are you feeling about multiplexers?

Respond at pollev.com/stevenbell699

iCE40UP block diagram

Clock stuff

Fixed-function multipliers

Fixed-function I/O modules

Memory

Logic "fabric"

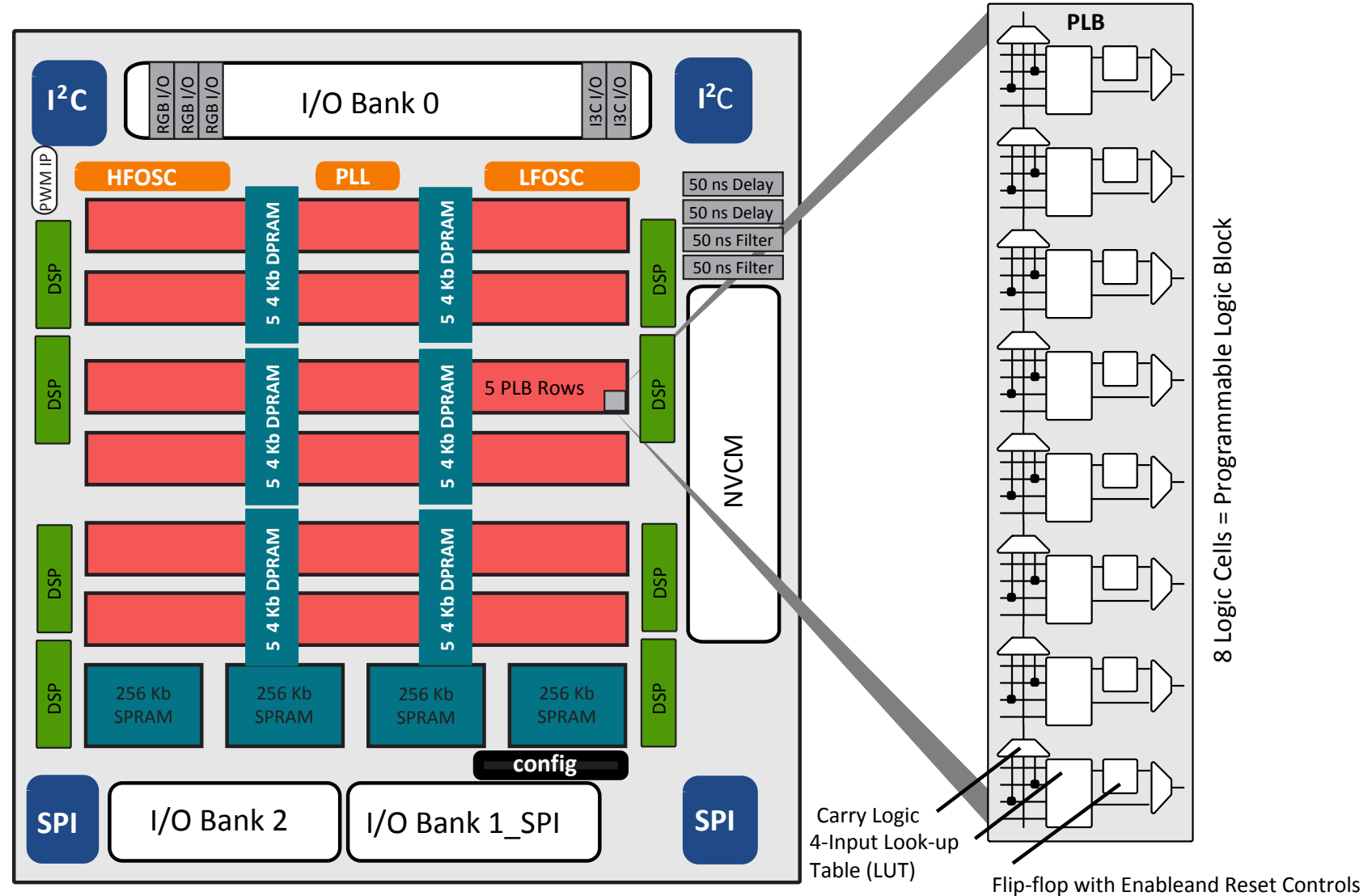


Figure 3.1. iCE40UP5K Device, Top View

iCE40UP logic element

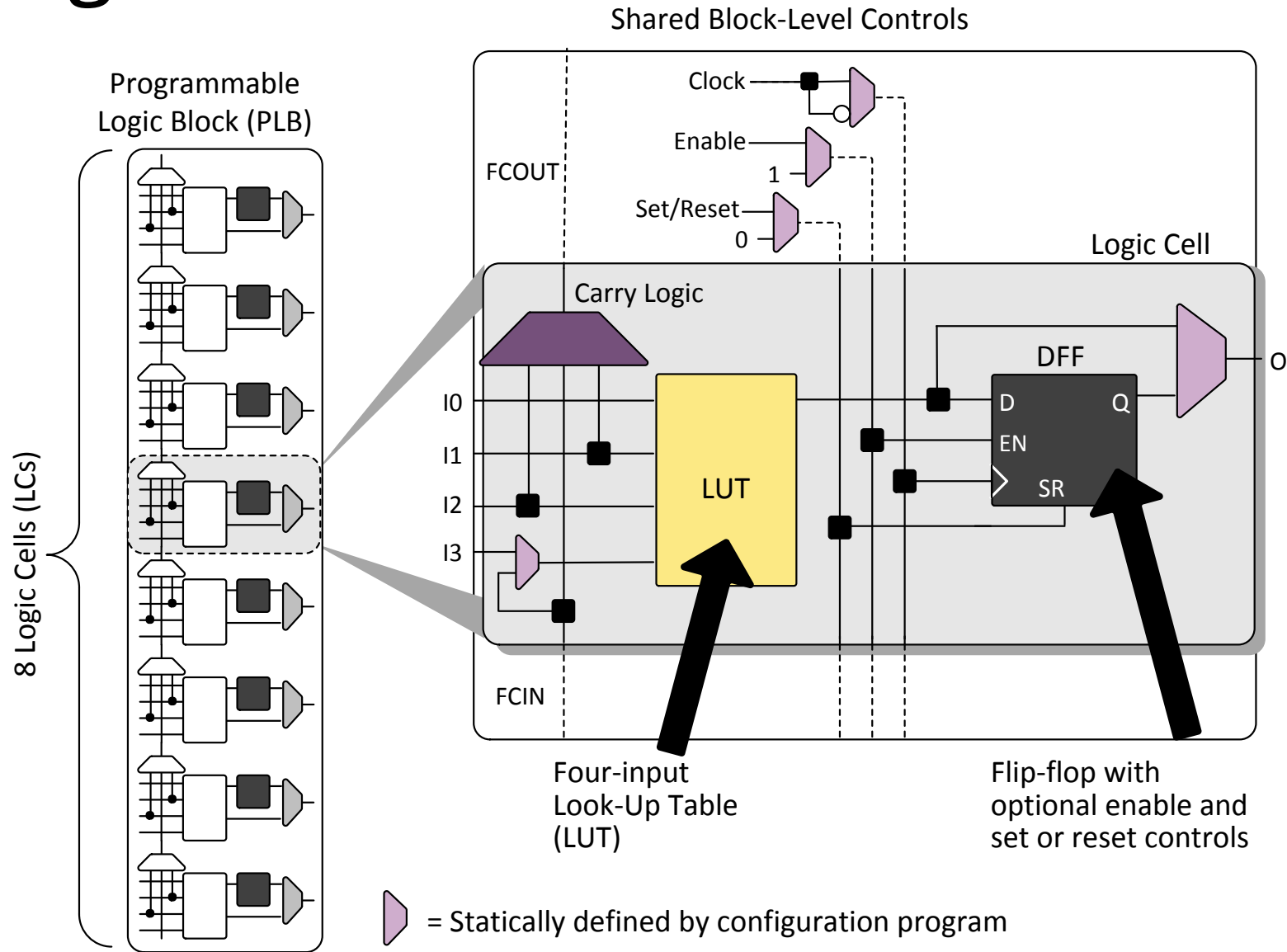
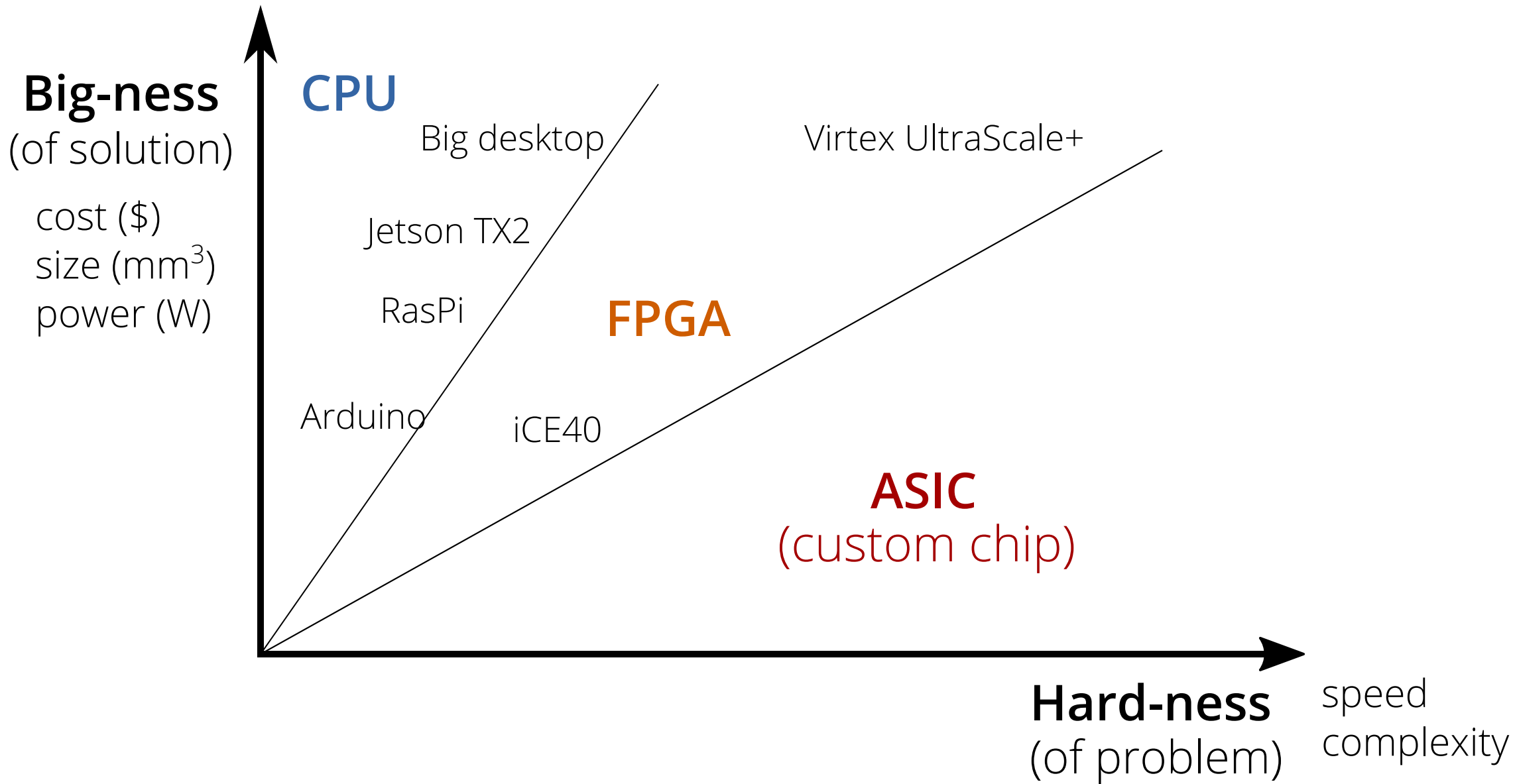


Figure 3.2. PLB Block Diagram

Will a time come when it's cheaper to use a microprocessor than to implement something with discrete logic gates?



For Wednesday

1. Read the book (2.9) and complete the pre-class quiz
2. Lab report 1 is due on Wednesday (2/6)
3. Homework 2 (posted tonight) will be due next Monday (2/11)