

Warmup question from the reading: is the following a *decoder* or a *multiplexer*?

Decoder

Multiplexer (mux)

None of the above

Start the presentation to see live content. For screen share software, share the entire screen. Get help at polllev.com/app

CS 240
Foundations of Computer Systems

WELLESLEY

Combinational Logic

Building blocks: encoders, decoders, multiplexers

Implementing choice and data flow with hardware

Abstraction!

<https://cs.wellesley.edu/~cs240/>

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Goal for the next 2 weeks: “Build” A Simple Processor

Instruction Fetch and Decode

Registers

ALU

Memory

Different chips, same foundations:

Image sources: nvidia.com/news wikipedia.org/wiki/Apple_silicon wikipedia.org/wiki/Central_processing_unit

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Toolbox: Building Blocks

Compiler/Interpreter

Operating System

ISA

Microarchitecture

Digital Logic

Devices (transistors, etc.)

Solid-State Physics

Processor datapath

Instruction Decoder

Arithmetic Logic Unit

Adders

Multiplexers

Decoders

Gates

Memory

Registers

Flip-Flops

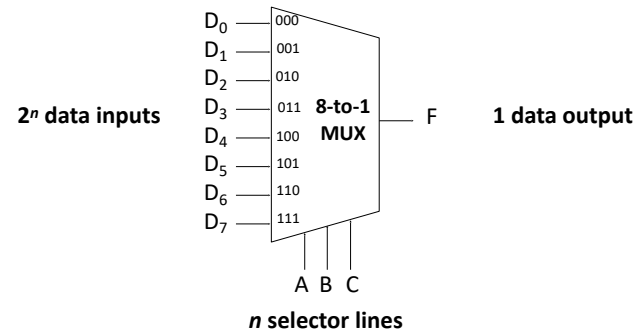
Latches

Abstraction!

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Multi-bit Multiplexers

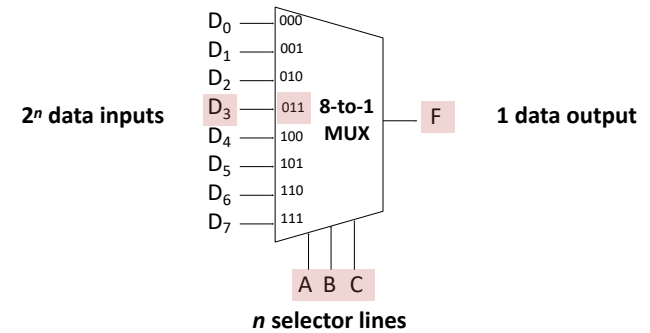
Select one of several inputs as output.



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Multi-bit Multiplexers

Select one of several inputs as output.

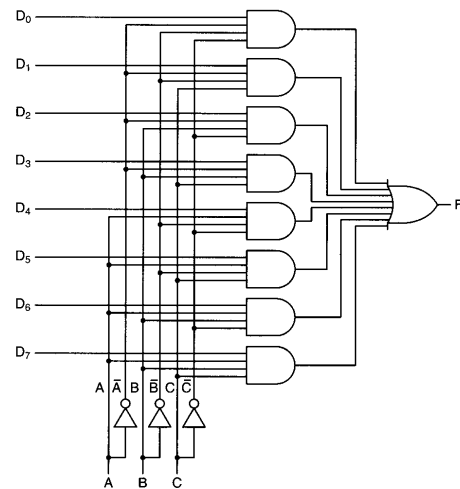


Example: selector lines ABC = 011

Output F = D₃

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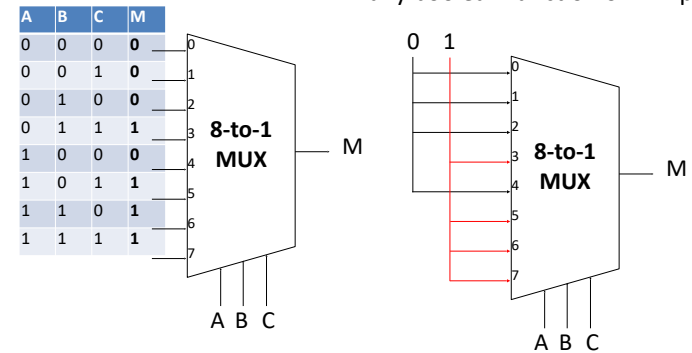
8-to-1 MUX with gates



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MUX + voltage source = truth table

We can use an 2ⁿ-to-1 mux to implement any boolean function on n inputs!



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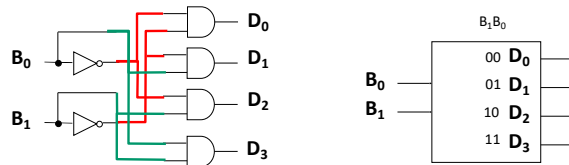
Decoders

Decodes input number, asserts corresponding output.

n -bit input (an **unsigned** number)

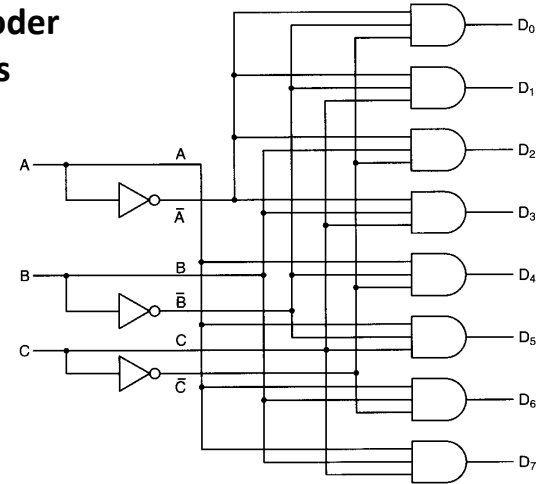
2^n outputs

Built with code detectors.



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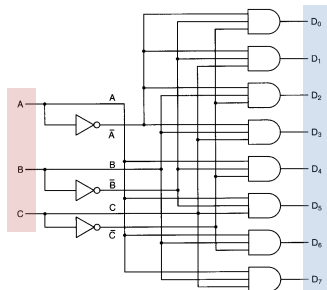
3-bit decoder with gates



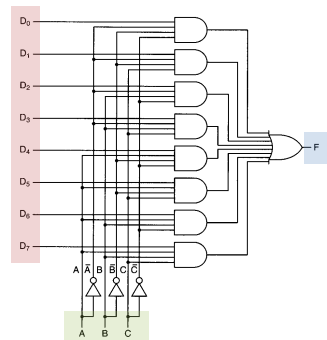
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Decoders and multiplexers

A decoder has an n -bit input and 2^n outputs. Only 1 output active at once.



A multiplexer has 2^n inputs, n selector wires, and 1 output.



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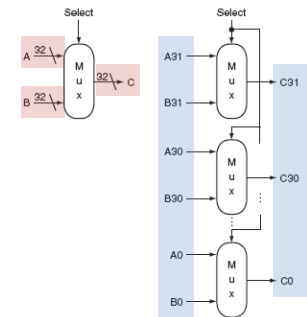
Buses and Logic Arrays

A bus is a collection of data lines treated as a single logical signal.

= **fixed-width value**

An array of logic elements (logical array) applies same operation to each bit in a bus.

= **bitwise operator**



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