# Multiplexers & Demultiplexers

Convenience in circuit design

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# Agenda

1. Announcements
   - Project 4
2. Multiplexers & Demultiplexers
   - Introduction
   - What are Muxes and Demuxes?
   - Muxes and Demuxes In-Depth
   - Applications

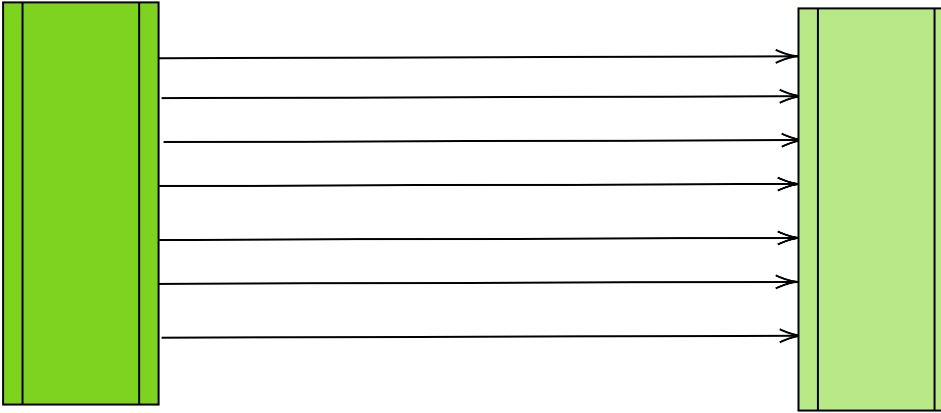
# Announcements

# Project 4

- Project 4's been released, and the name of the game is multipliers.
- You'll find everything you need under the 'week 5' section on the course website
- Today's lecture will give you background knowledge that will help you implement multiplexers and demultiplexers.
- More info to come at the end of lecture

# Muxes and Demuxes

# An example



- We've started creating circuits that have a sizable amount of wires associated with them
- It turns out, extending **all** of these wires is pretty expensive and space-consuming, given just how many wires we have to build

# Parallel Signals

- This phenomenon is known as having many **parallel signals**.
- They use a ton of wires!
- I'm sure everyone is well aware of how much more effort it is to place one extra line of wires in Minecraft, which makes you wonder how much harder it is to do in real life
- If we're going to be extending these wires over long distances, are there more efficent ways to handle that many signals?

# Parallel Signals

- Yes!!!
- Your answer can be found in **Multiplexers** and **Demultiplexers**.

# Multiplexers & Demultiplexers

- A **Multiplexer** is often called a 'mux'.
- A **Demultiplexer** is often called a 'demux'.

# Multiplexers & Demultiplexers

- A **Multiplexer** is often called a 'mux'.
- A **Demultiplexer** is often called a 'demux'.
- The question is- what are they?

# Need necessitates solution

- The need for **Multiplexers** arose due to the presence of a certain problem in digital circuit design.
- Think back to our bus designs, and our encoders and decoders
- It turns out, there are a lot of different circuits that would require us to have a fair amount of parallel wires.
- In other words, it's a **common problem** in digital logic design to have to deal with a multitude of **parallel signals**.

# What are they?

- A **Multiplexer**, or **Mux**, takes a bunch of parallel wires and condenses all of them down to a singular `OUT` wire and a few `SELECT` wires.
- A **Demultiplexer**, or **Demux**, takes a singular `IN` wire and a few `SELECT` wires, and sends the `IN` signal down the appropriate output wire.

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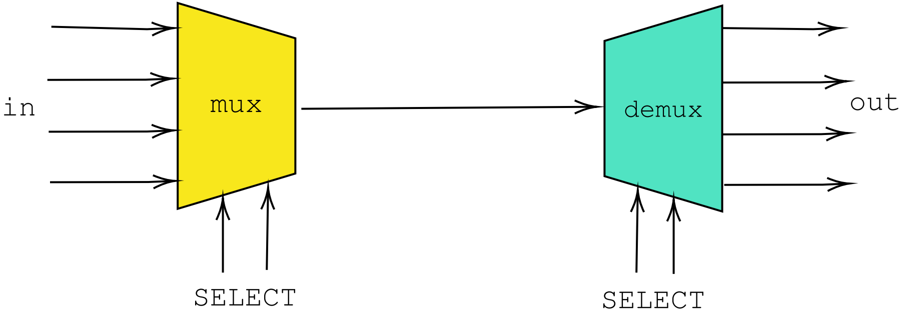
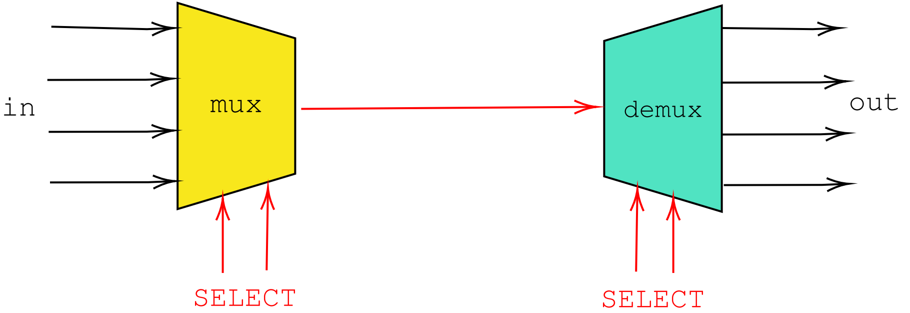


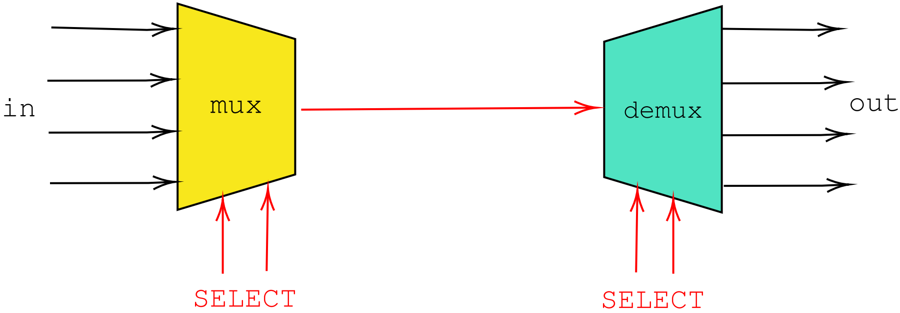
# What can we observe?

- In the earlier example, instead of having to carry 4 wires across the distance spanned by the mux and demux, we only needed the singular output wire and the selector wires
- In other words, we only need to worry about carrying the wires highlighted in red across the distance spanned by the mux and demux



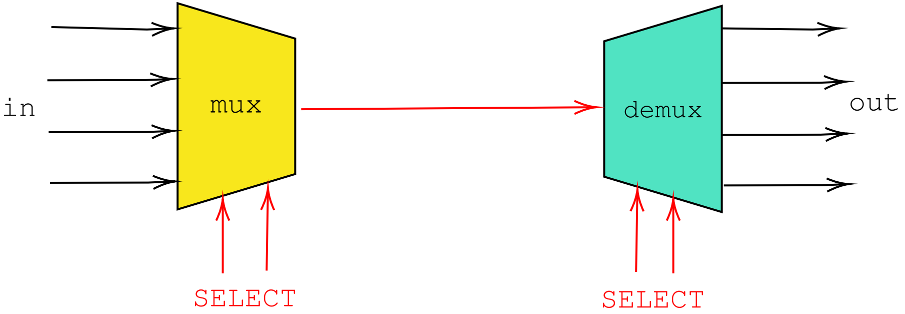
# What can we observe?

- The OUT wire is simple enough- that's the signal that we ultimately want to transfer across
- As for the SELECT wires, they're a little more nuanced
- Can anybody guess why (if we have 4 inputs/outputs) we need two SELECT wires for our mux/demux combo?

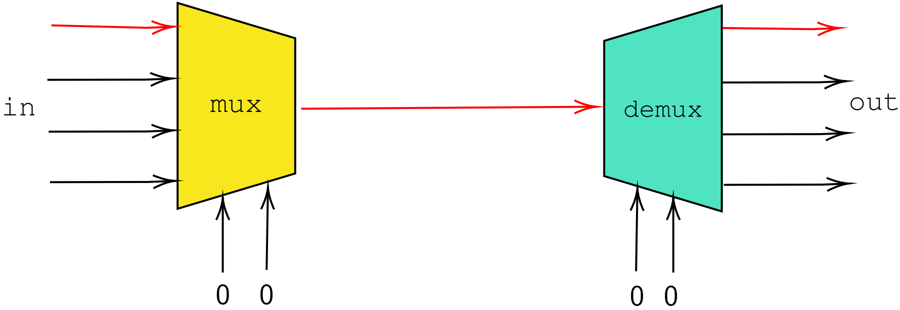


# What can we observe?

- If we want to signify which of the four inputs are being transmitted across the OUTPUT channel, we can go ahead and represent which one it is by using binary



# 4 × 1 Multiplexer & Demultiplexer Example



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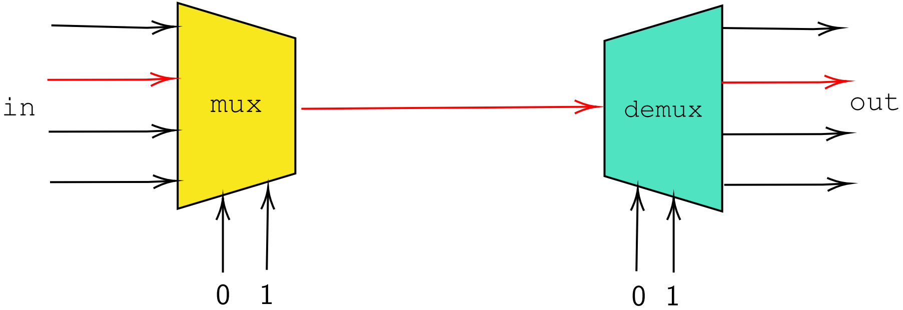

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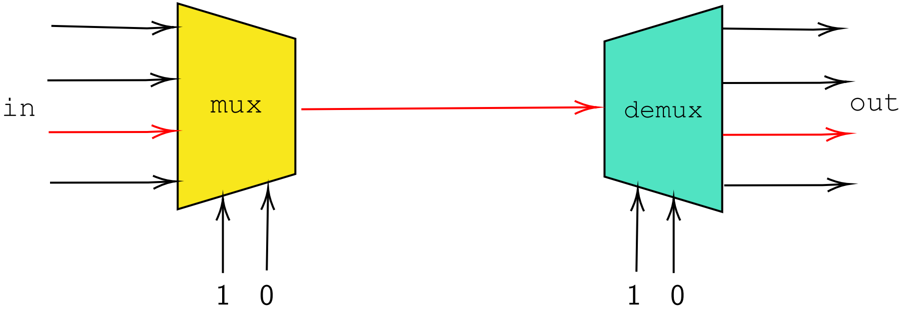

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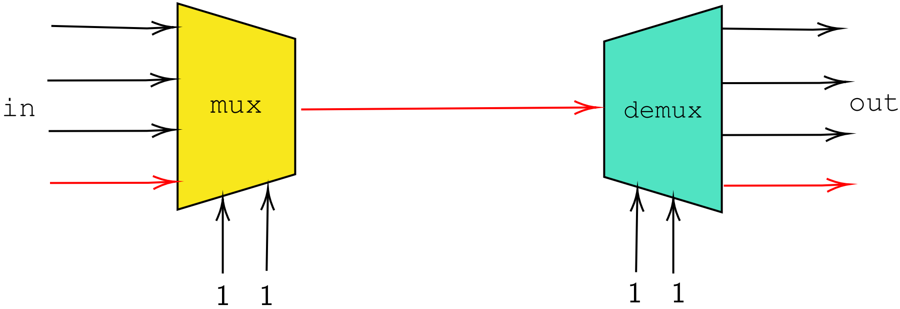


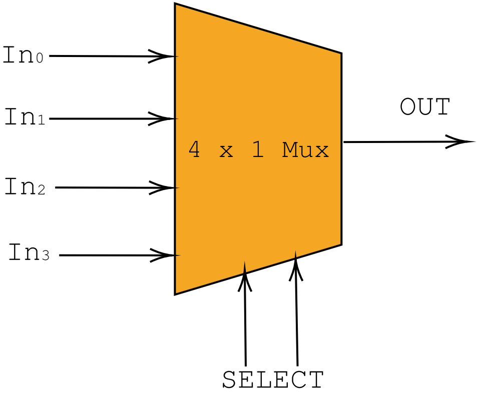
# Immediate Observations

- We need less wires to carry signals across long distances (this is good!)
- We can only carry one signal across this channel at once (this may be bad!)
- In summary- it's all about tradeoffs

# Muxes & Demuxes In-depth

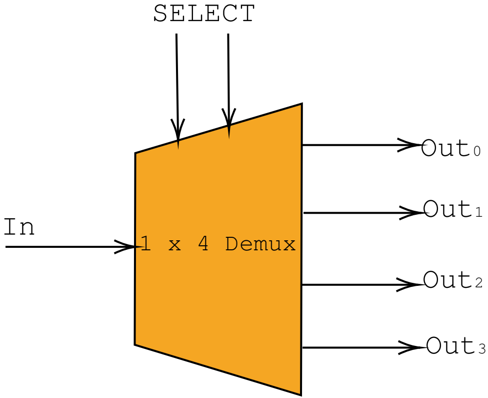
# Multiplexer

- Now that we understand multiplexers conceptually, can you think of how you'd build it with the logic gates we've learned?



# Demultiplexer

- Here's the complement, a 1 × 4 Demultiplexer. As you can imagine, demistifying the internal logic components is pretty similar to what we did for the mux.



# Applications