Sharing expensive communication channels

Download the Logisim file called “MUX-DEMUX” and examine the “motivator” circuit within.

MUX-DeMUX

In this circuit you can see how one can use a MUX/DeMUX pair to effectively share an expensive communication channel. The communication channel may be a physical cable that traverses the ocean or may be wireless connection with a remote spacecraft. A MUX/DeMUX pair can connect one sender with one receiver. In the example the number of senders and receivers is equal (at 32) but they don’t need to be.

The sender and receiver are each specified separately as the select lines for the MUX and DeMUX respectively. Change the values for these select lines and observe that a change to the sender data input is reflected immediately in the receiver data.

Building a MUX with a decoder

Use the empty circuit called “MUX from decoder” to implement a 4-to-1 MUX. Start with a decoder and add whatever extra gates and wires are needed to turn it into a MUX. Label the select lines “…, s2, s1, s0” (use as many as you need) and label the data input lines “i3, i2, i1, i0”; call the output Z.

**Write an equation below that expresses the output Z as a function of the select and data inputs for the 4-to-1 MUX .**

Building a DeMUX with a decoder

Use the empty circuit called “DeMUX from decoder” to implement a 1-to-4 DeMUX. Start with a decoder. Add whatever extra gates and wires are needed to turn it into a DeMUX. Label the select lines “…, s2, s1, s0” (use as many as you need) and label the data input line “i”; call the outputs z3, z2, z1, z0.

**Write equations below that express the outputs as functions of the select and data inputs for the 1-to-4 DeMUX.**