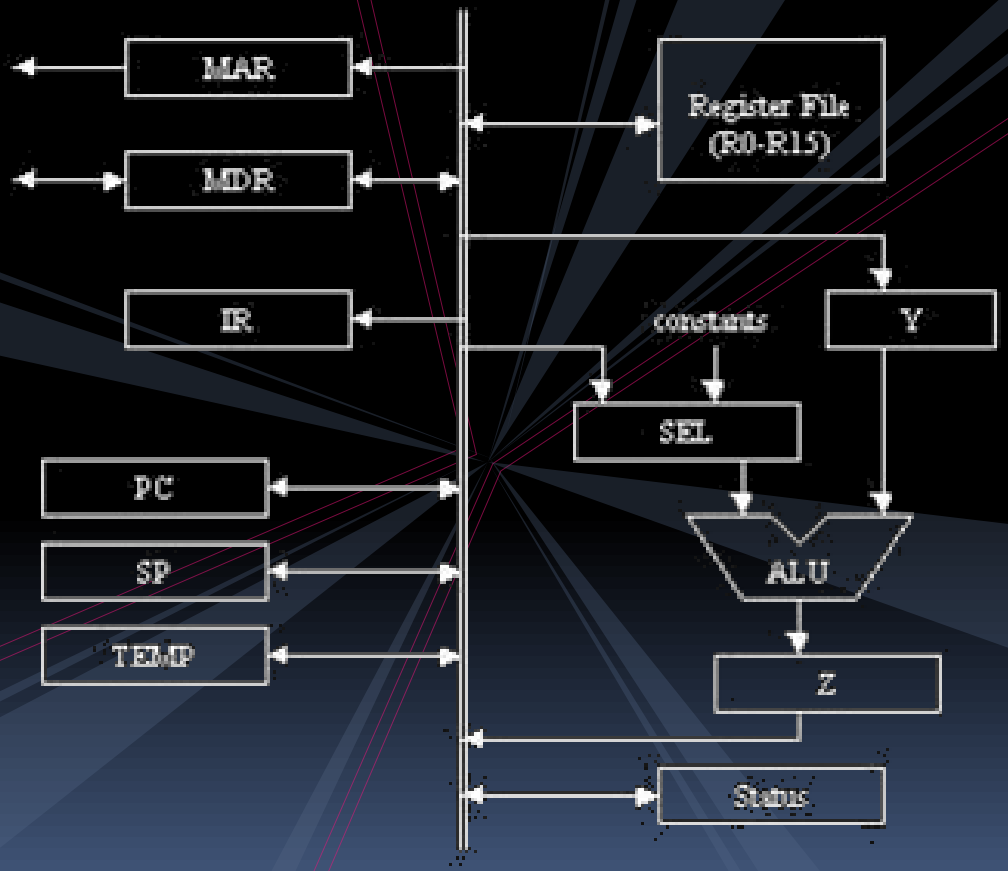
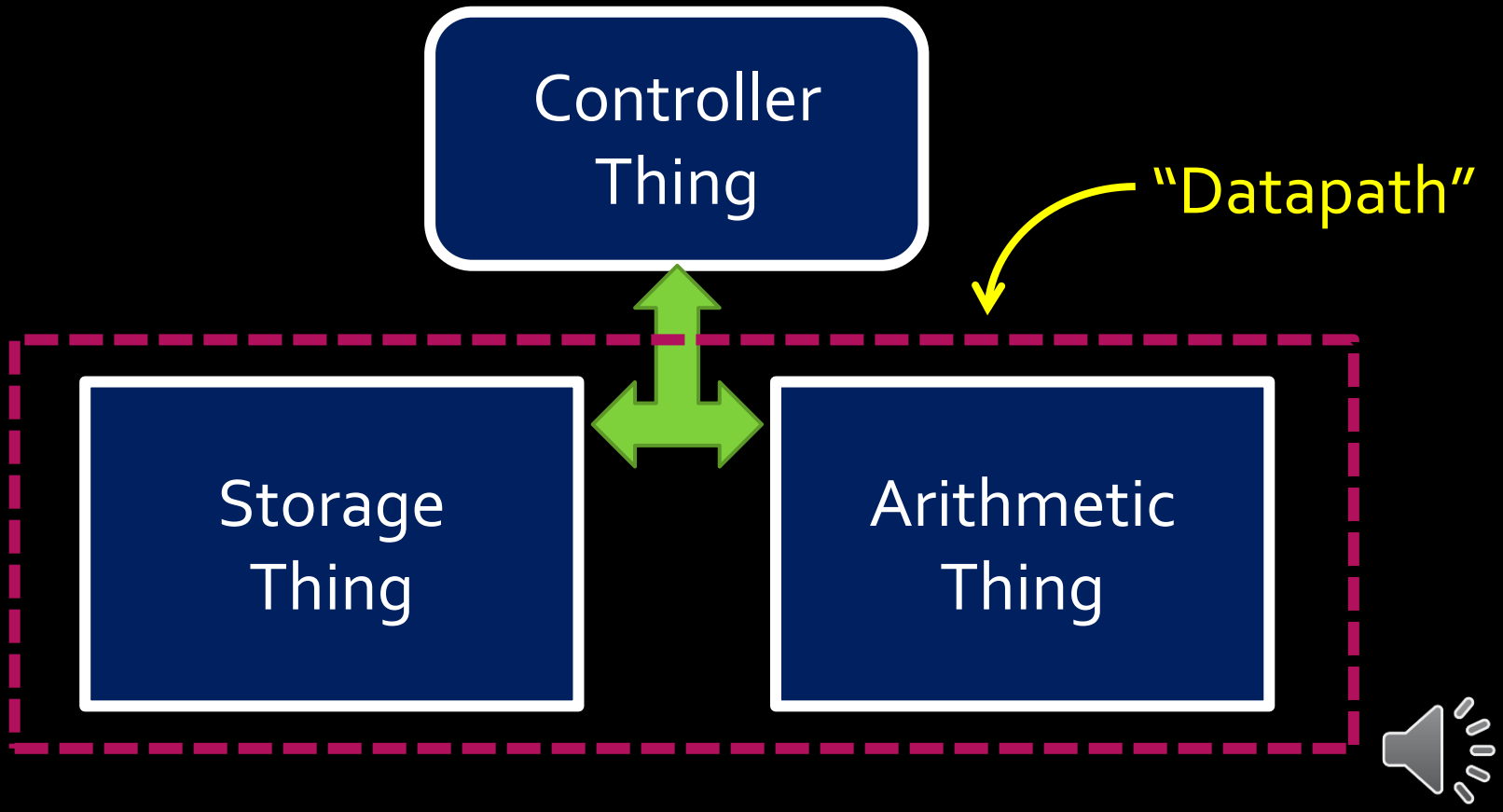
Week 6, part E: Datapath



Deconstructing processors

- Where and how does computation happen?



Datapath vs. Control

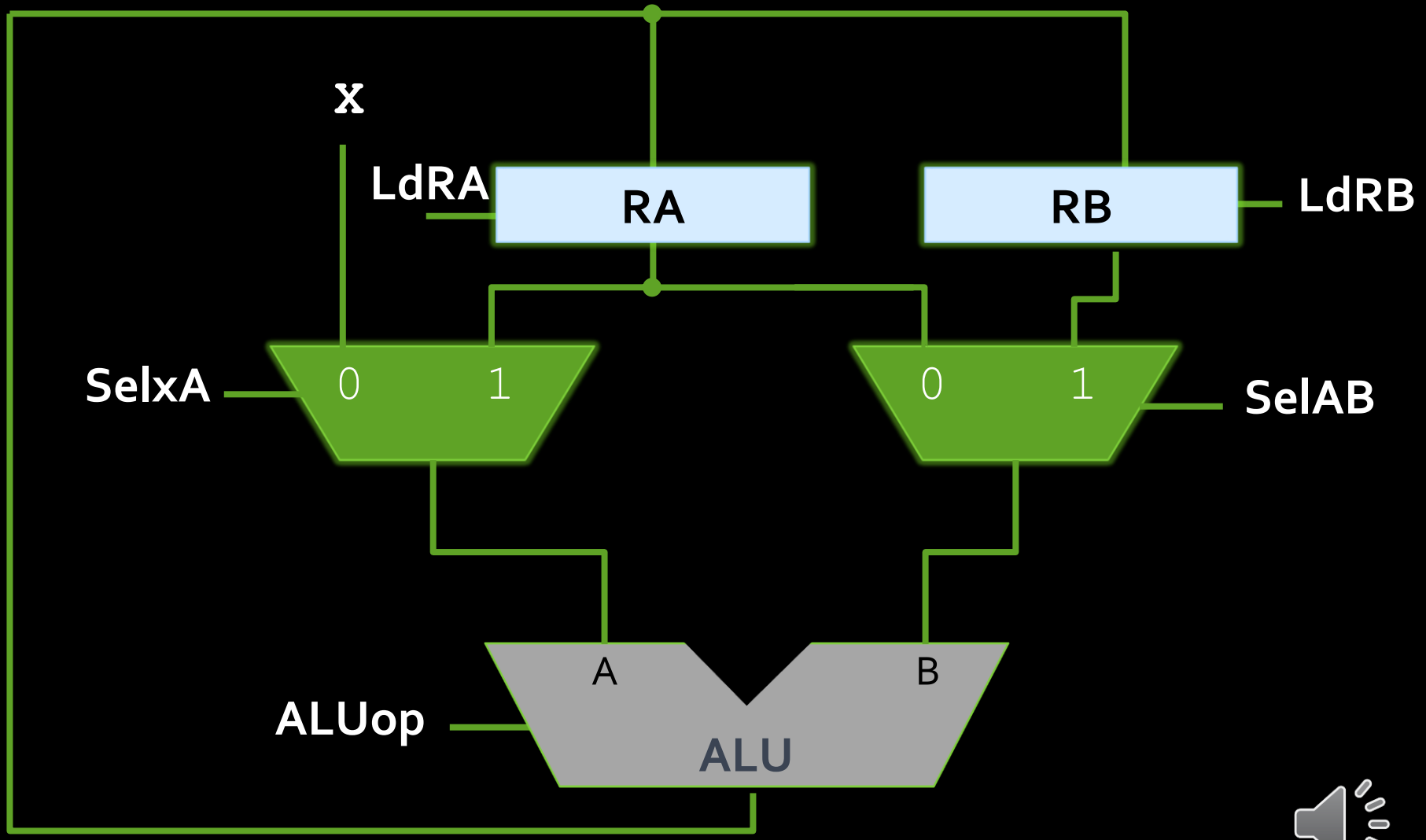
- Datapath: where all data computations take place.
  - Usually: registers, computational units, and a bunch of wires and muxes to connect them

- Control unit: orchestrates the actions that take place in the datapath.
  - The control unit is a big finite-state machine that instructs the datapath to perform all appropriate actions.

Example: Calculate $x^2 + 2x$

- Given an external input x.
- How would you compute $x^2 + 2x$ with components you've seen so far?
- Components needed:
  - ALU (to add, subtract and multiply values)
  - Multiplexers (to determine what the inputs should be to the ALU)
  - Registers (to hold values used in the calculation)

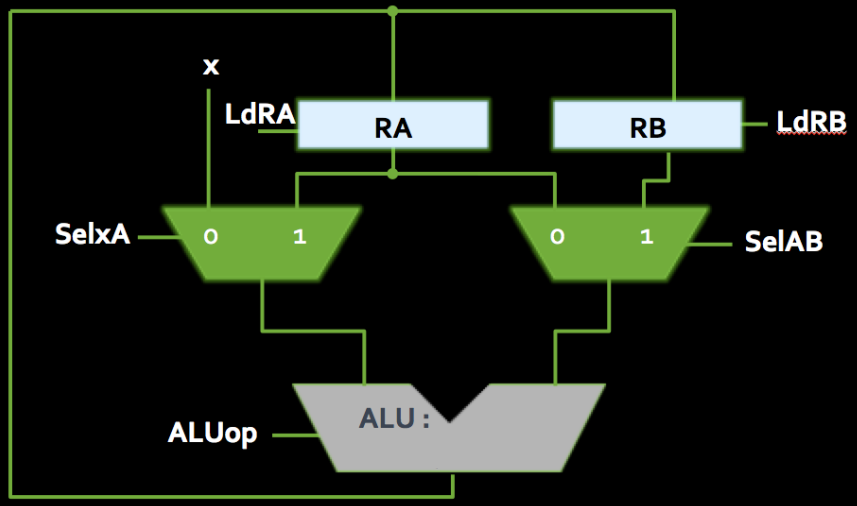
Example schematic



Making the calculation

Steps for $x^2 + 2x$:

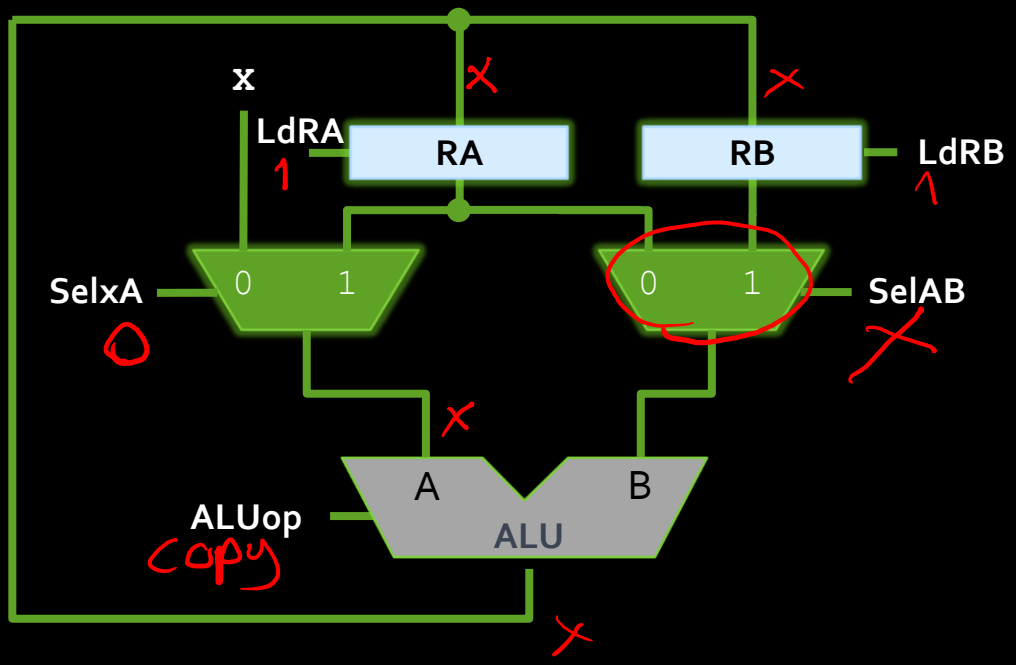
- Load X into RA & RB
- Multiply RA & RB
  - Store result in RA
- Add X to RA
  - Store result in RA
- Add X to RA again
  - ALU output is $x^2 + 2x$.
- How do we make this happen?
  - We send control signals at the right time



Making the calculation

Steps for $x^2 + 2x$:

- Load X into RA & RB



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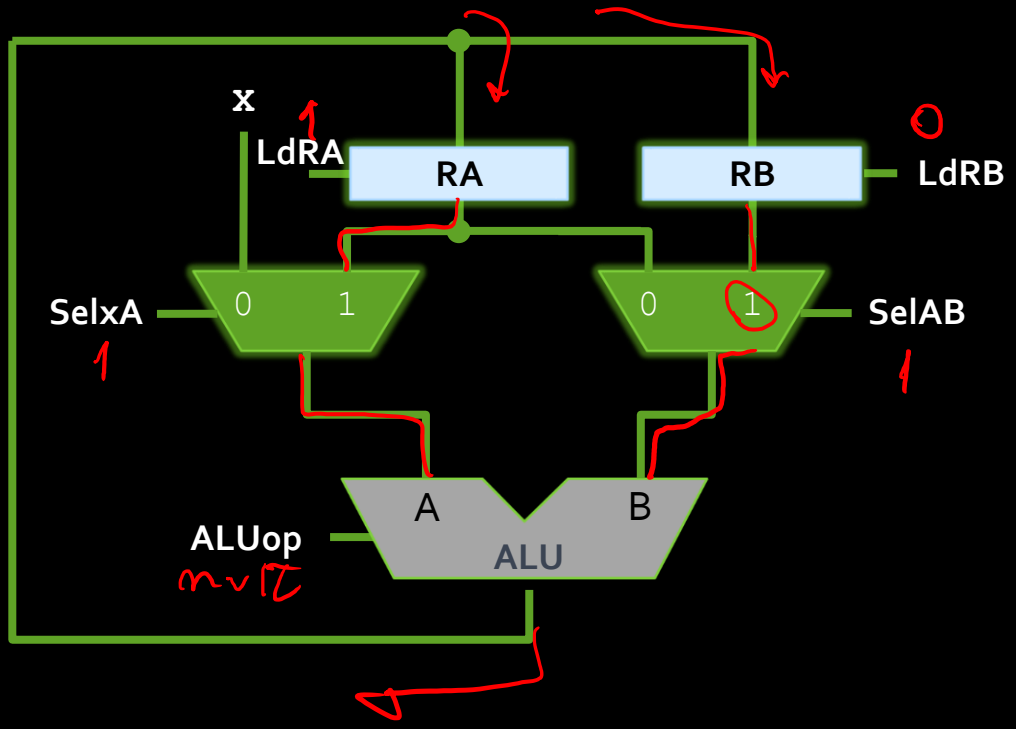

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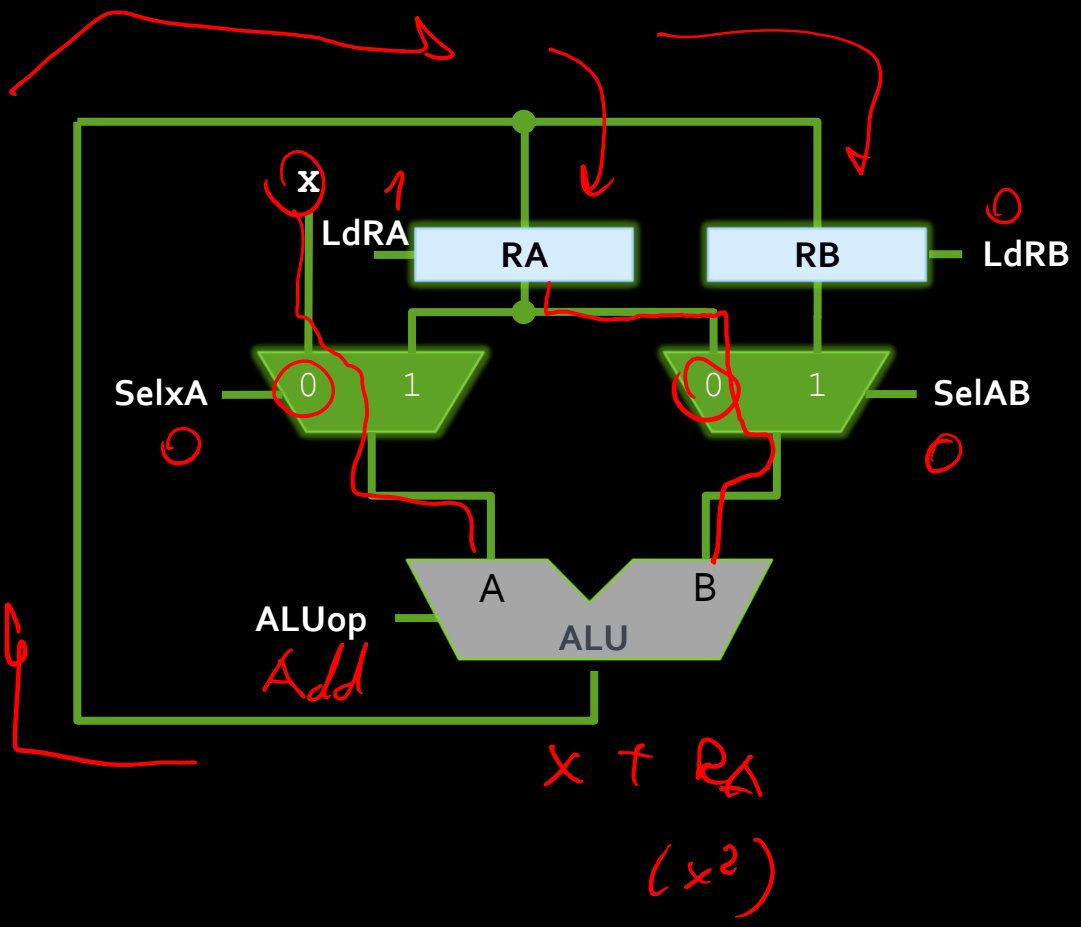

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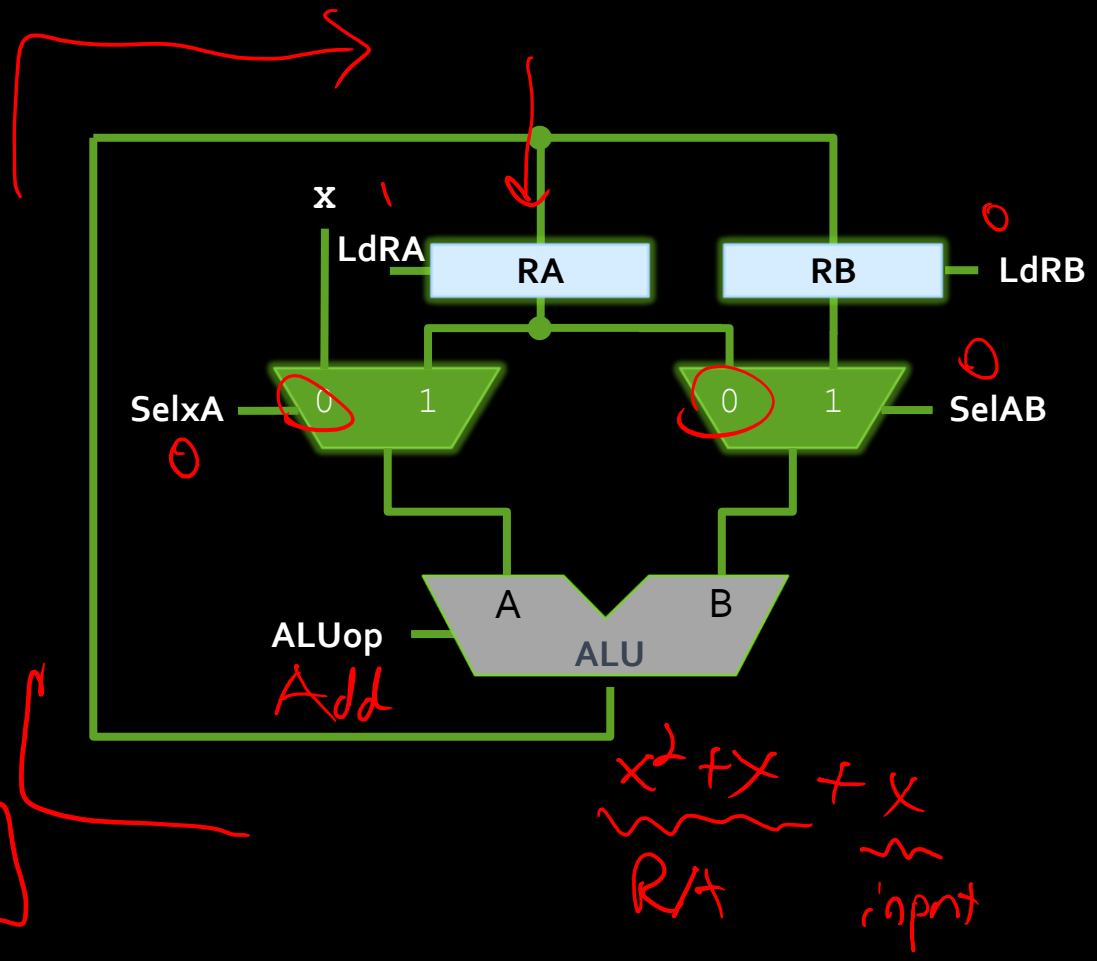

Making the calculation happen

	High-level Steps	Control Signals				
Step		**SelxA**	**SelAB**	**ALUop**	**LdRA**	**LdRB**
0	Load X into RA & RB	0	X	Copy	1	1
1	Multiply RA & RB, store result in RA	1	1	Mult	1	0
2	Add X to RA, Store result in RA	0	0	Add	1	0
3	Add X to RA again, ALU output is $x^2 + 2x$.	0	0	Add	1	0

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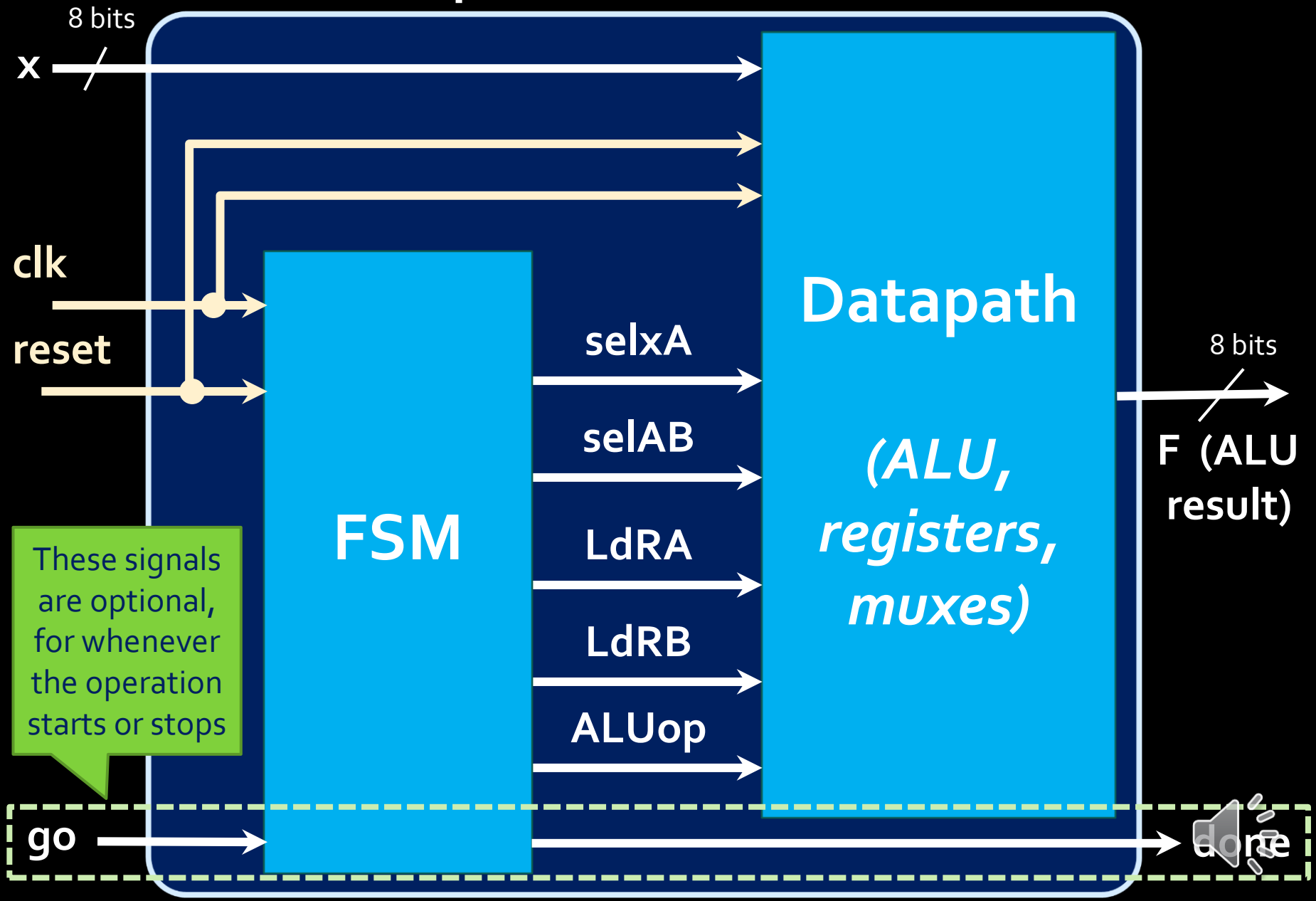
Who sends these signals?

Control Unit

- Basically, a giant Finite State Machine
  - Synchronized to system-wide signals (clock, reset)
- Outputs the datapath control signals
  - SelxA, SelAB => control mux outputs (ALU inputs)
  - ALUop => controls ALU operation
  - LdRA, LdRB => controls loading for registers RA, RB
- Sometimes also output a done signal, when the computation is complete
  - Yet another output; not shown in our datapaths

Datapath + Control



The "Storage Thing"

- We have an ALU.
- We understand the concept of a datapath.
- How do we get A and B for the ALU?
- How do we get things into the registers?
- Tune in next week to learn more about:
  - Storage
  - The MIPS-32 data path
  - The MIPS-32 control unit

same bat time, same bat channel