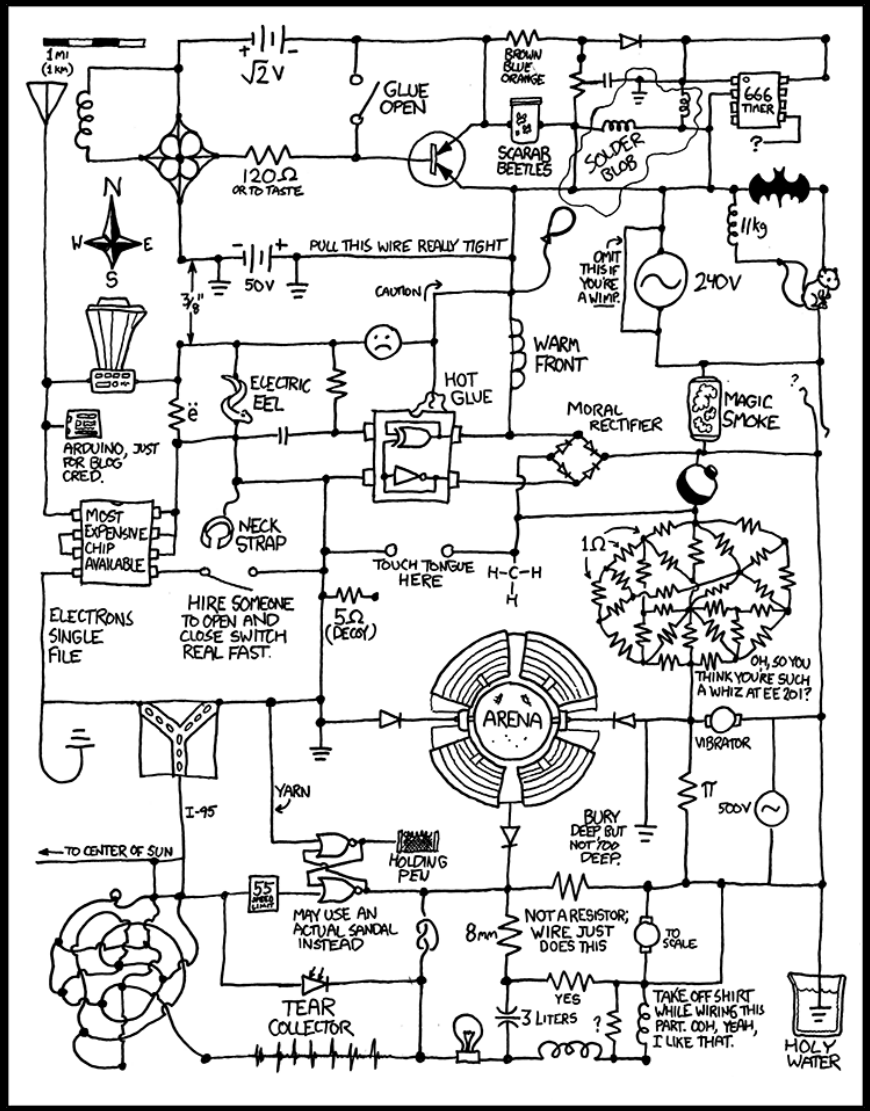
EECS 370 Discussion



xkcd.com

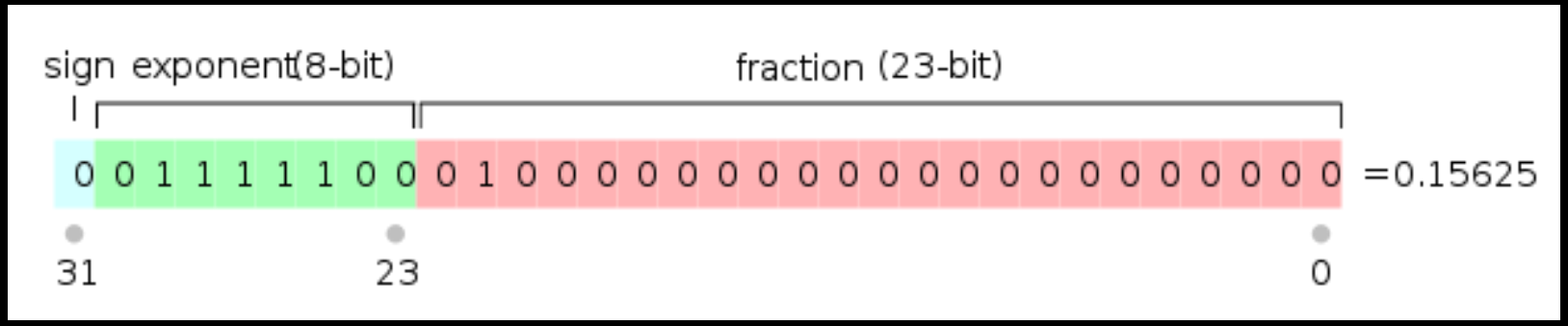
EECS 370 Discussion

Topics Today:

- Floating Point
- Finite State Machines
- Combinational Logic
- Sequential Logic

EECS 370 Discussion

Floating Point



Exponent

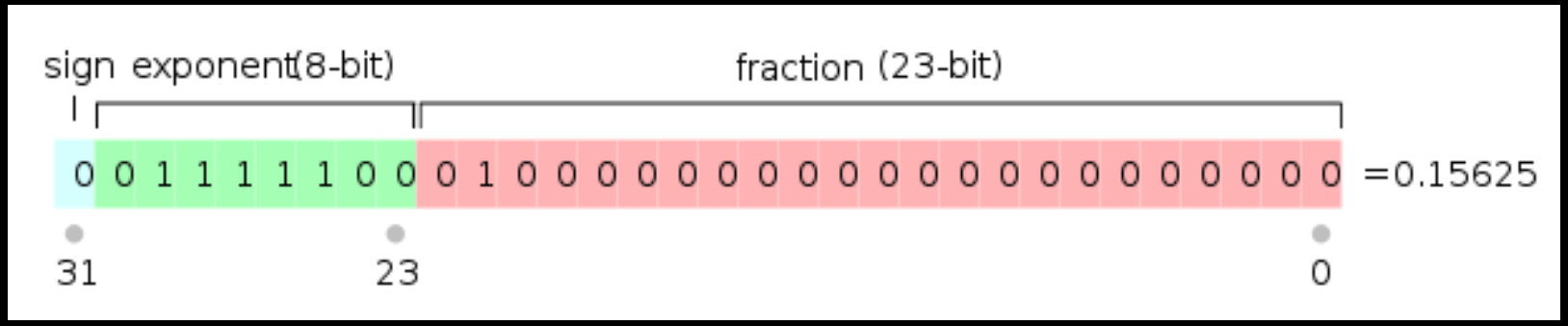
Biased by 127

Significand

Additional 1 before the decimal sign

EECS 370 Discussion

Floating Point



Don’t forget about zero!

EECS 370 Discussion

Floating Point

Addition

$-1.1011*(2^2) \quad + \quad 1.01*(2^0)$

EECS 370 Discussion

Floating Point

Addition

$-1.1011*(2^2) \quad + \quad 1.01*(2^0)$

$= -1.0110*(2^2)$

EECS 370 Discussion

Floating Point

Addition

$-1.1011*(2^2)$ + $1.01*(2^0)$

[-6.75] [1.25]

$= -1.0110*(2^2)$

[-5.5]

EECS 370 Discussion

Floating Point

Multiplication

$-1.1011*(2^2)$ * $1.01*(2^0)$

[-6.75] [1.25]

EECS 370 Discussion

Floating Point

Multiplication

$-1.1011*(2^2)$ * $1.01*(2^0)$

[-6.75] [1.25]

$= -1.0000111*(2^3)$

EECS 370 Discussion

Floating Point

Multiplication

$-1.1011*(2^2)$ * $1.01*(2^0)$

[-6.75] [1.25]

$= -1.0000111*(2^3)$

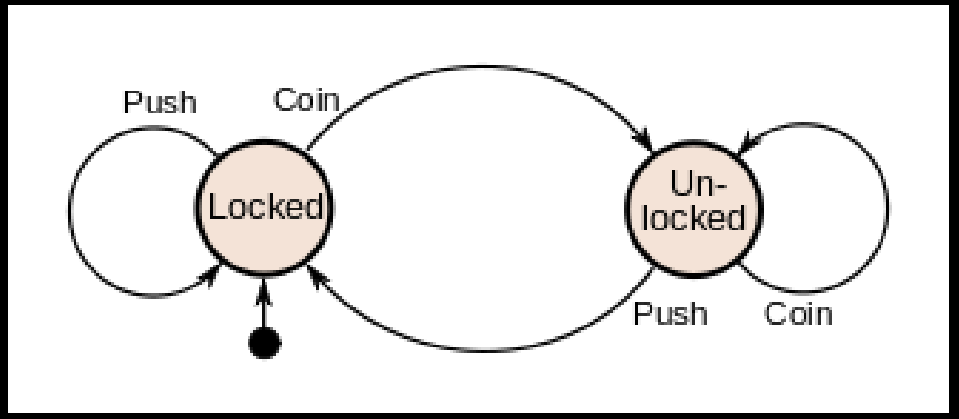
[-8.4375]

EECS 370 Discussion

Finite State Machines

Diagram of State, Conditions to change state, and Outputs

Conditions to change are based on inputs



EECS 370 Discussion

Finite State Machines

Example: Output a 1 on the pattern 001

States:

Pattern ‘1’

Pattern ‘0’

Pattern ‘00’

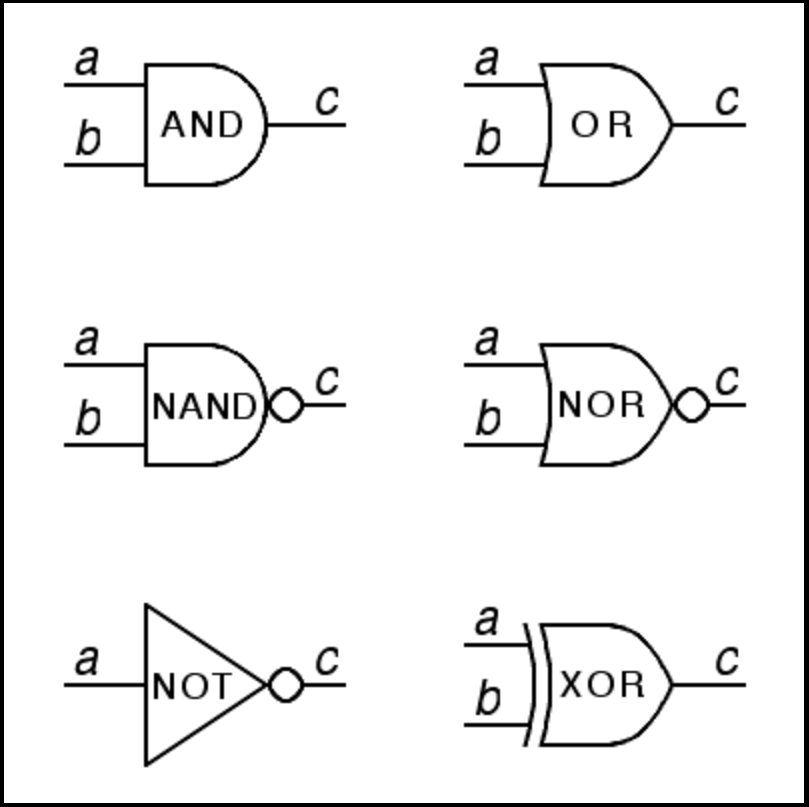
Pattern ‘001’ => Output = 1

EECS 370 Discussion

Combinational Logic

Digital circuit representing a Boolean equation

Truth tables!!

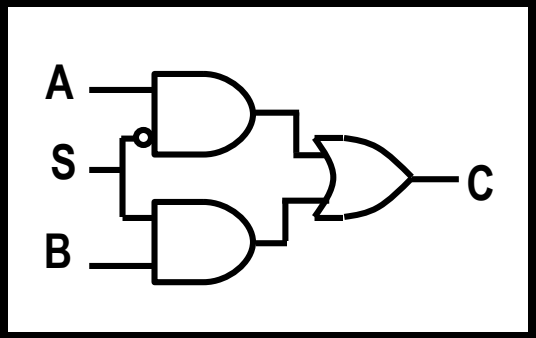


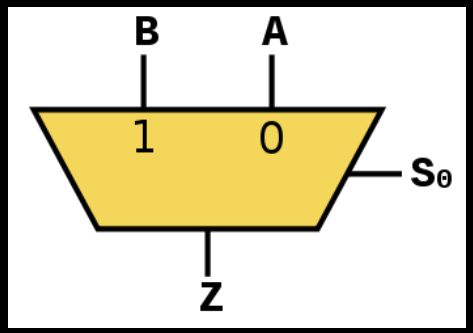
EECS 370 Discussion

Combinational Logic

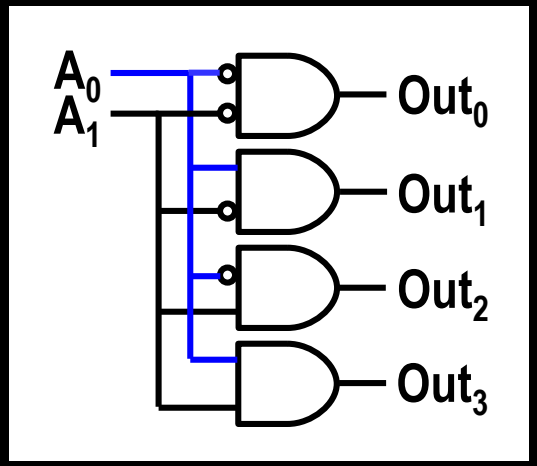
More Complex Circuits:

Mux





Decoder

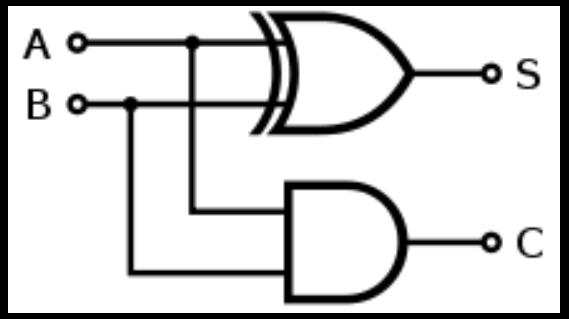


EECS 370 Discussion

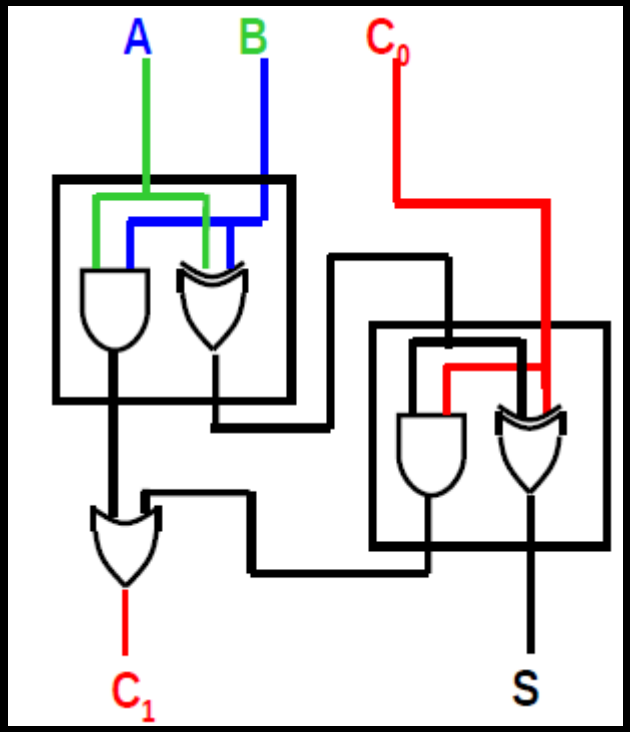
Combinational Logic

More Complex Circuits:

Half Adder



Full Adder

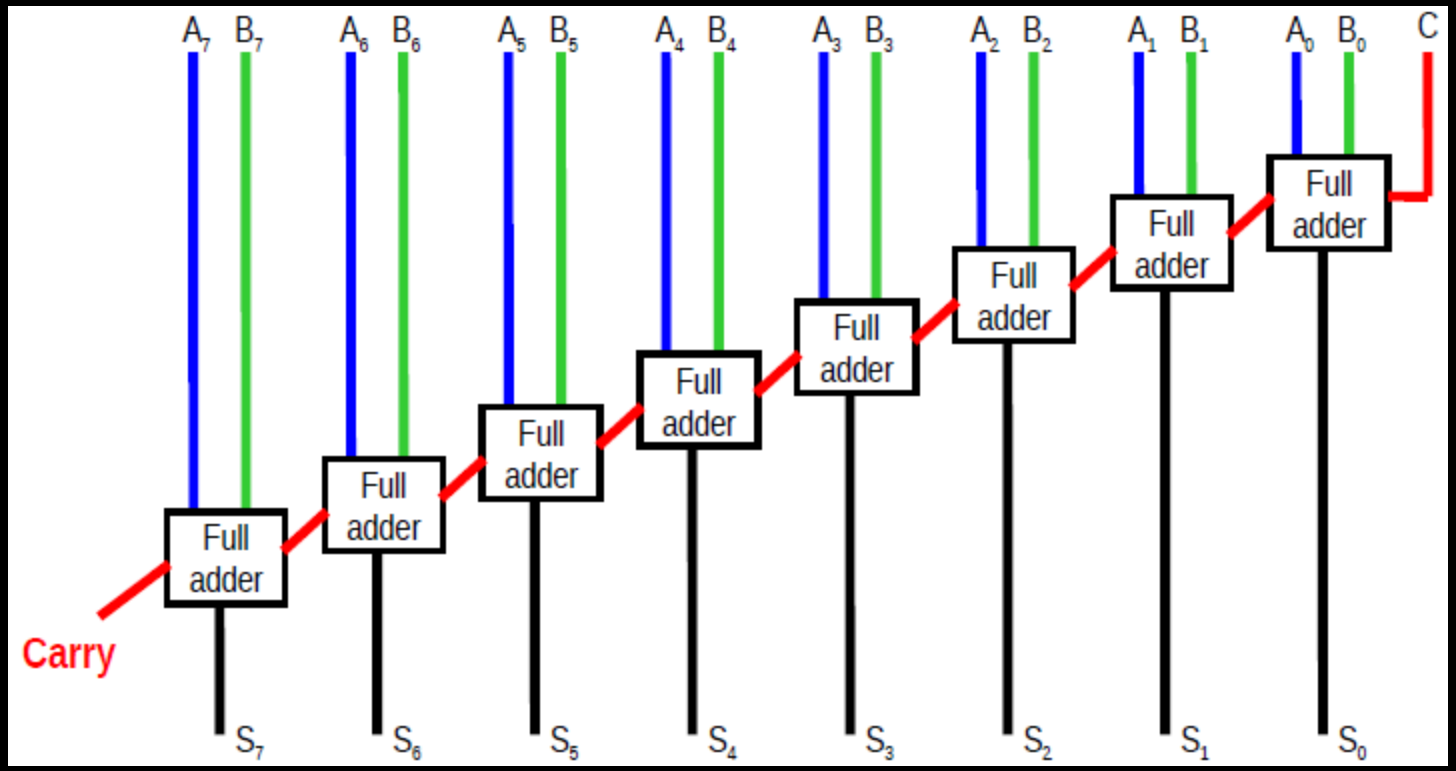


EECS 370 Discussion

Combinational Logic

More Complex Circuits:

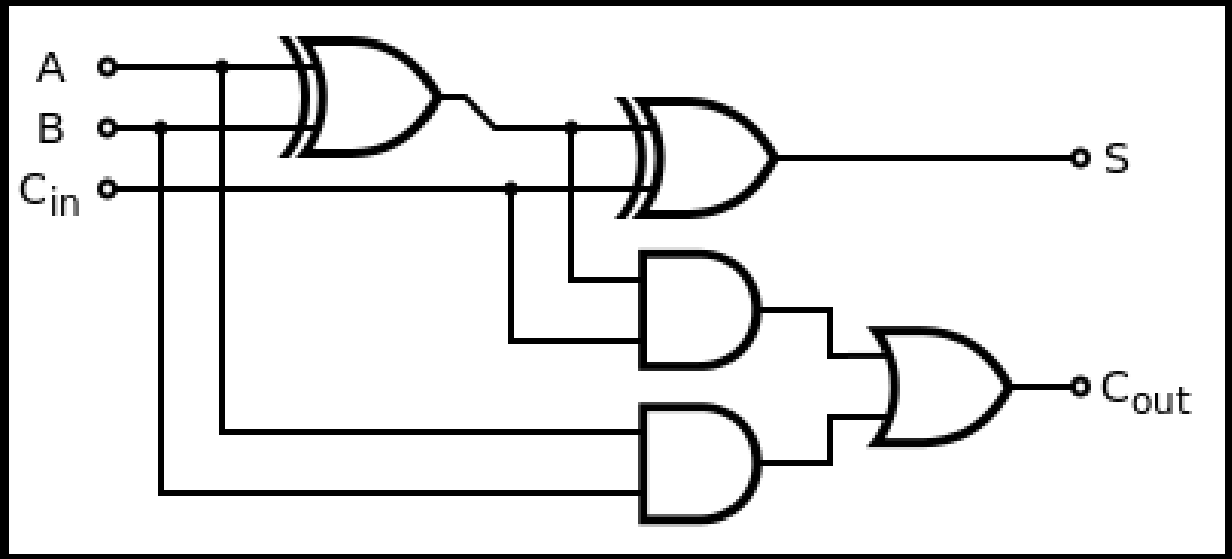
Ripple Carry Adder



EECS 370 Discussion

Combinational Logic

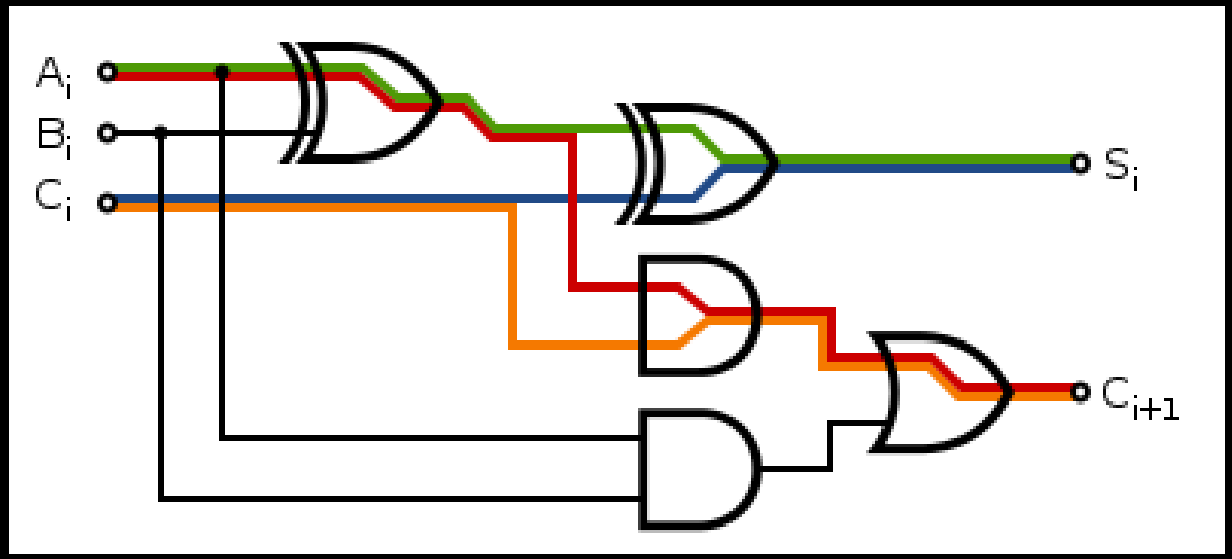
Propagation Delay



EECS 370 Discussion

Combinational Logic

Propagation Delay



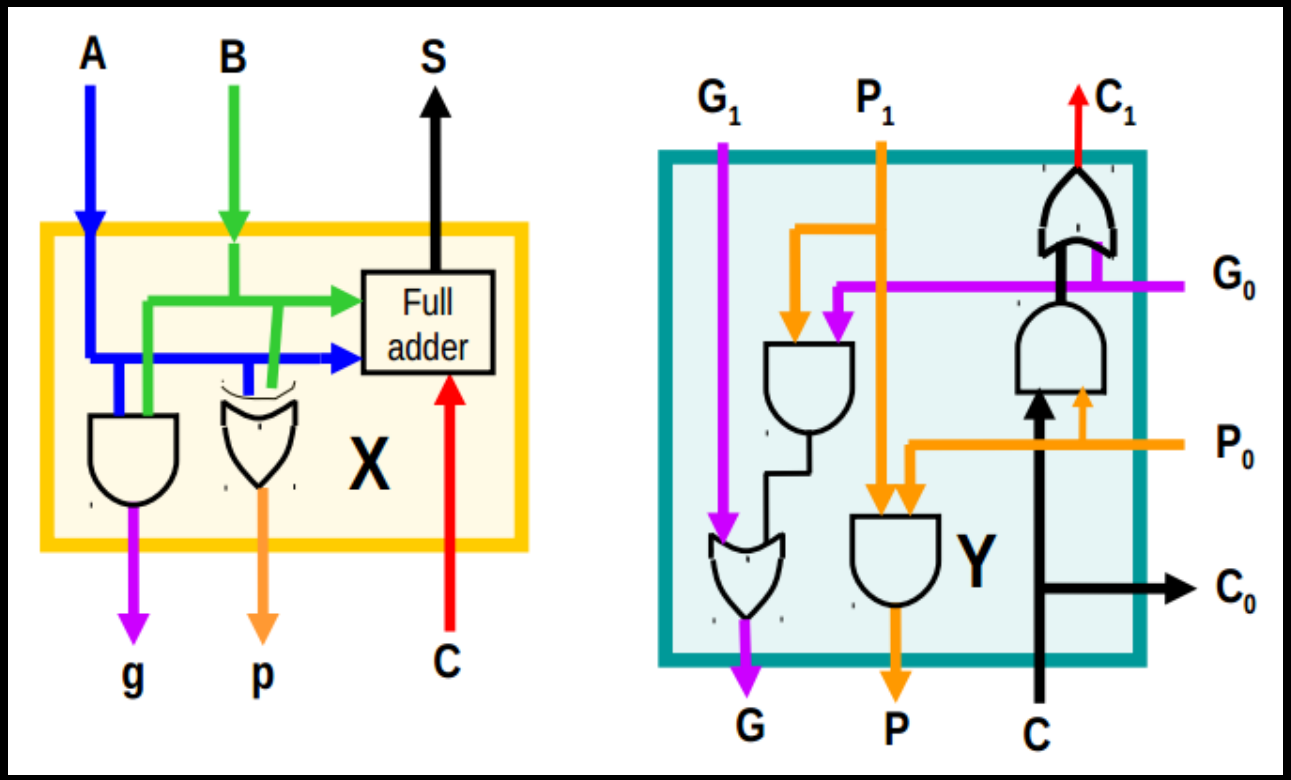
Slows down the speed of your circuit!

EECS 370 Discussion

Combinational Logic

Most Complex Circuits:

Carry Look-ahead Adder



EECS 370 Discussion

Sequential Logic

Combinational Logic

- Stateless
- Output is direct function of current input

Sequential Logic

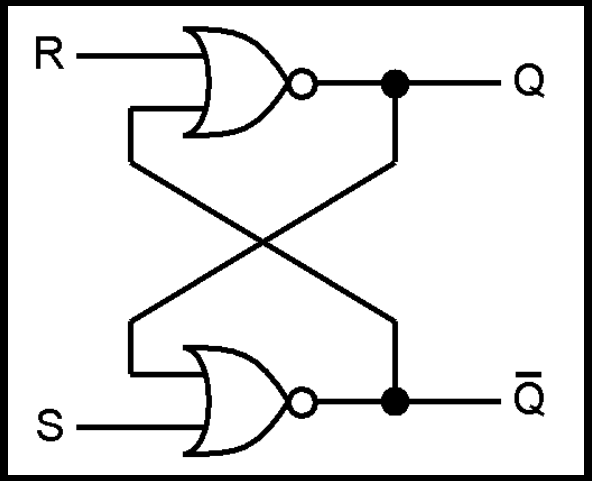
- Stateful
- Output is function of current input and past input
- Clocked!

EECS 370 Discussion

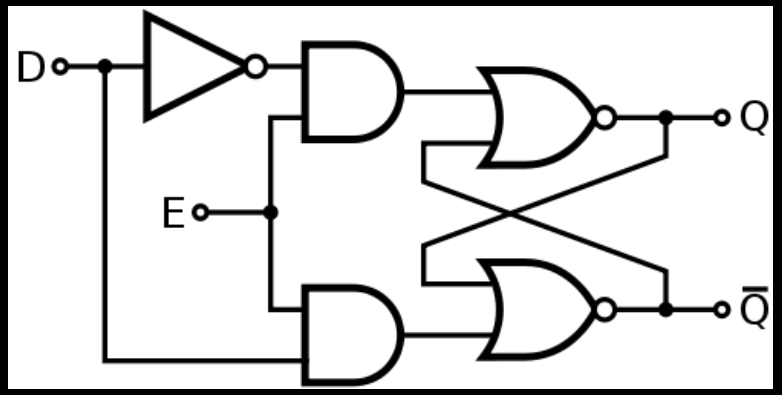
Sequential Logic

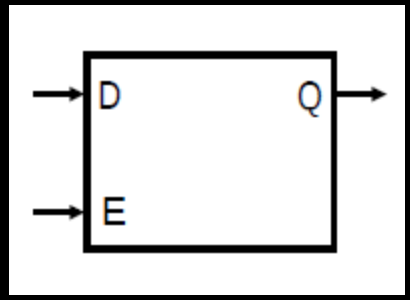
Latches

SR Latch



D Latch



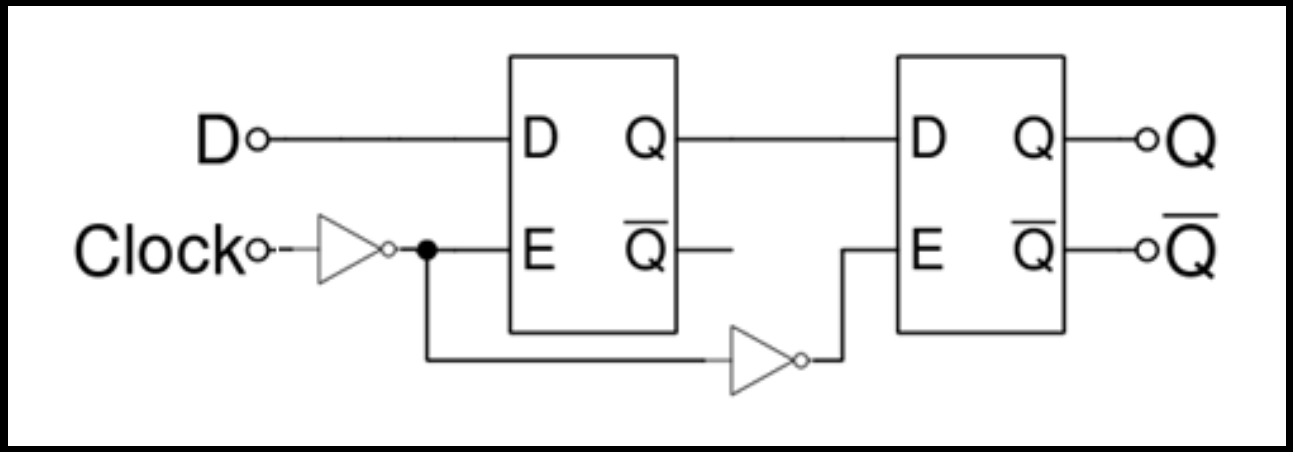


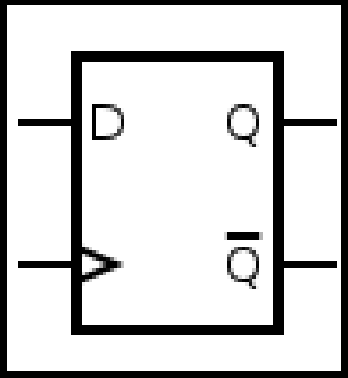
EECS 370 Discussion

Sequential Logic

Flip Flops

Positive Edge Triggered





EECS 370 Discussion

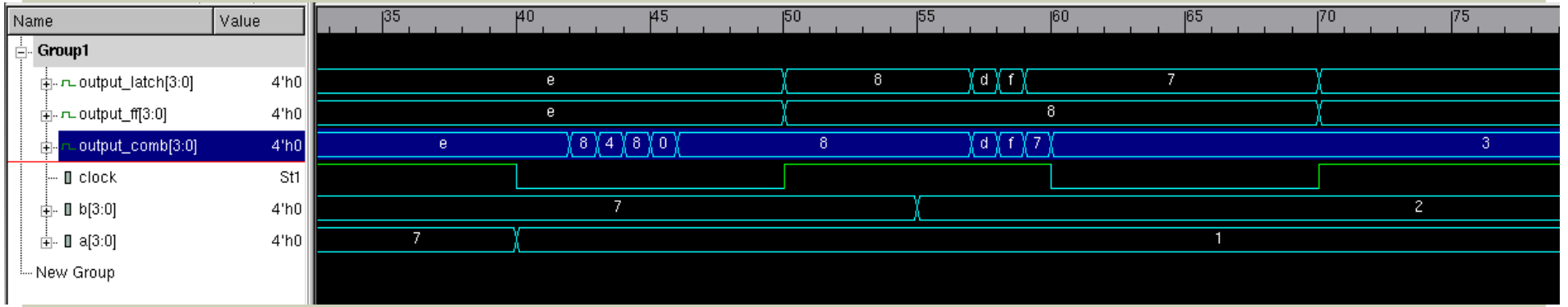
Sequential Logic

Why do we want clocked logic?

- Specifies a time by which all operations are “done”
- Results before that time do not matter

AN EXAMPLE OF WHY THIS MATTERS

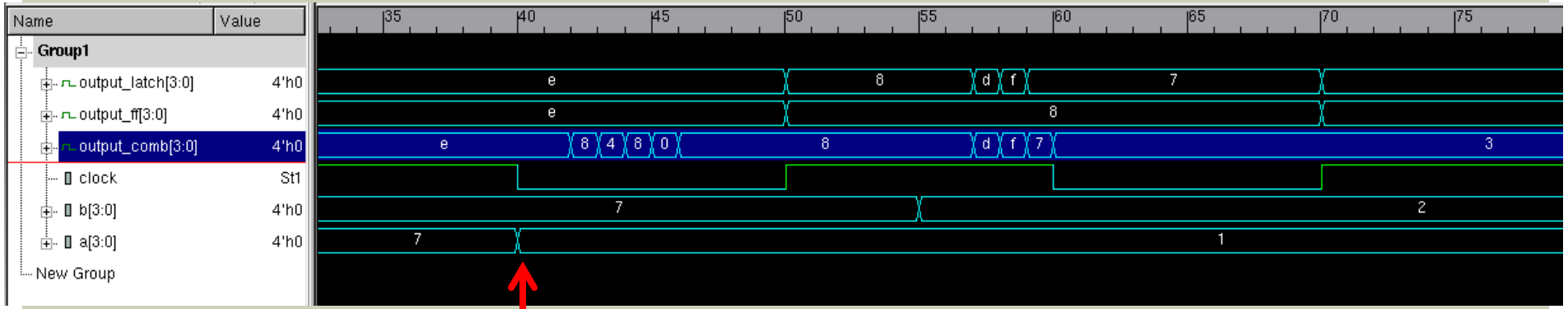
- Delays in combinational circuits are very real.



- Here's an example with a **ripple carry adder.**

AN EXAMPLE OF WHY THIS MATTERS

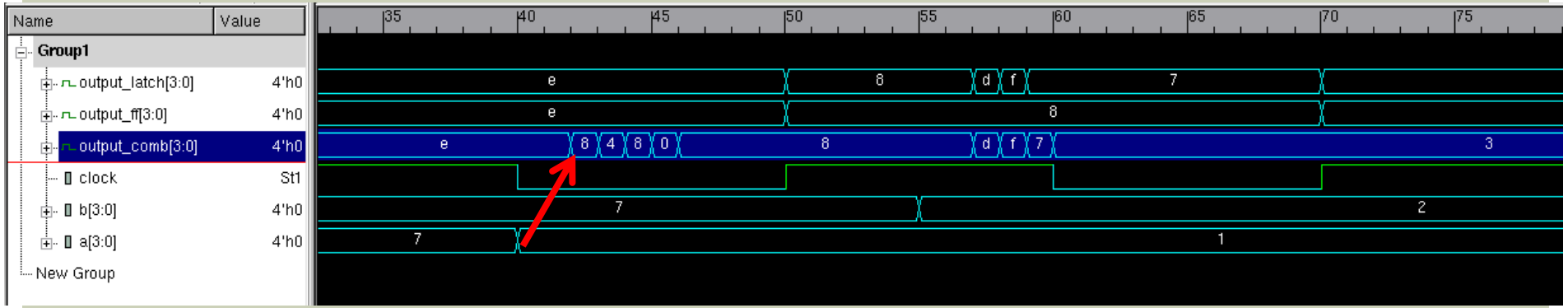
- Let's zoom in on the interesting part.



The value of a goes from 7 to 1 here

AN EXAMPLE OF WHY THIS MATTERS

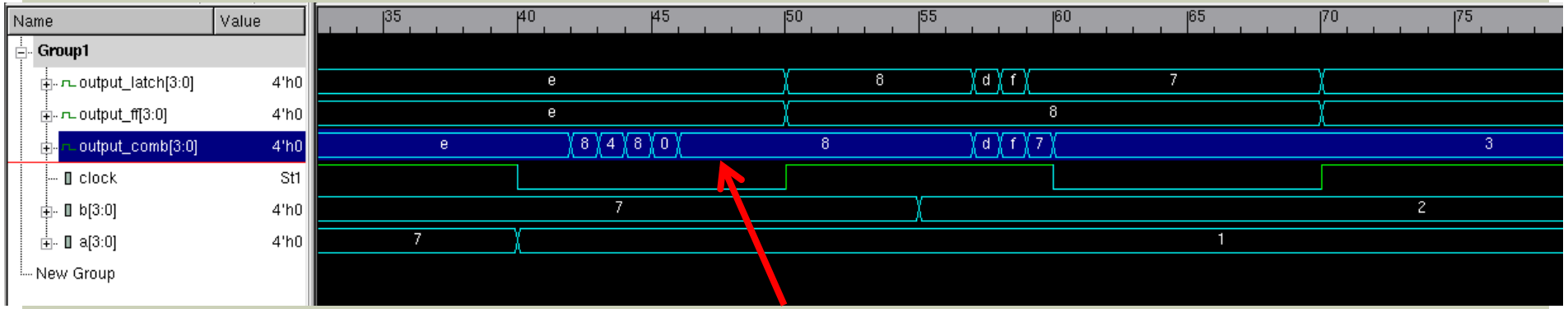
- Let's zoom in on the interesting part.



There's propagation delay before the adder even starts to change values.

AN EXAMPLE OF WHY THIS MATTERS

- Let's zoom in on the interesting part.



The value stabilizes

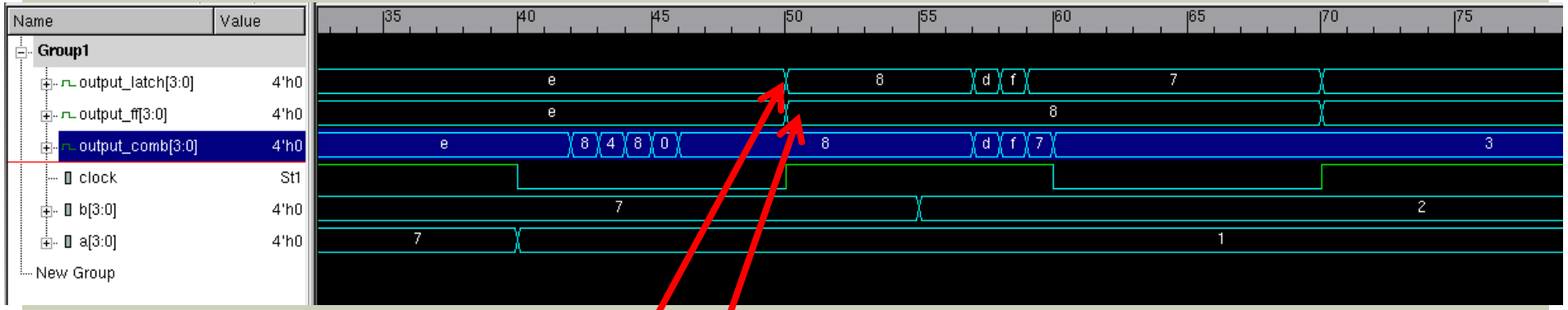
AN EXAMPLE OF WHY THIS MATTERS

- Let's zoom in on the interesting part.

The next clock edge comes along

AN EXAMPLE OF WHY THIS MATTERS

- Let's zoom in on the interesting part.

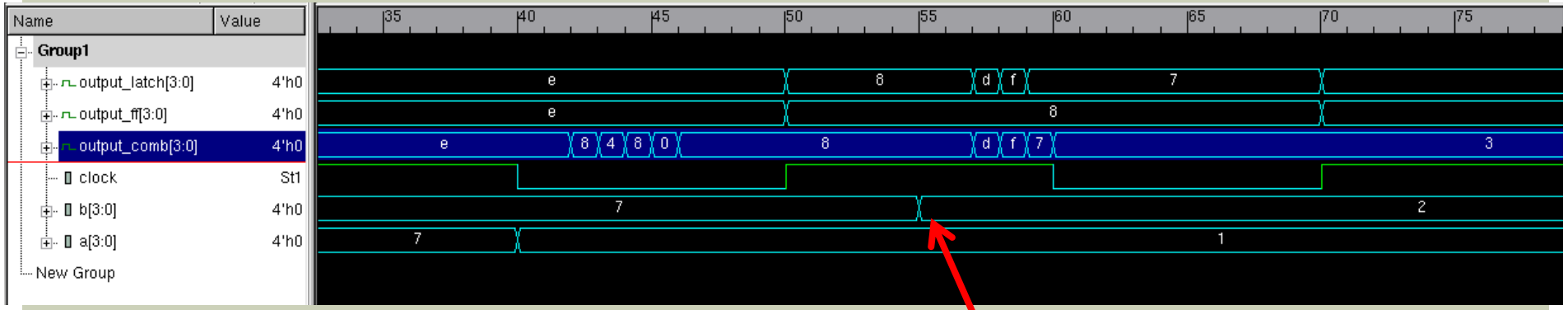


The latch opens up
(and shows new value)

The flip-flop grabs new value.

AN EXAMPLE OF WHY THIS MATTERS

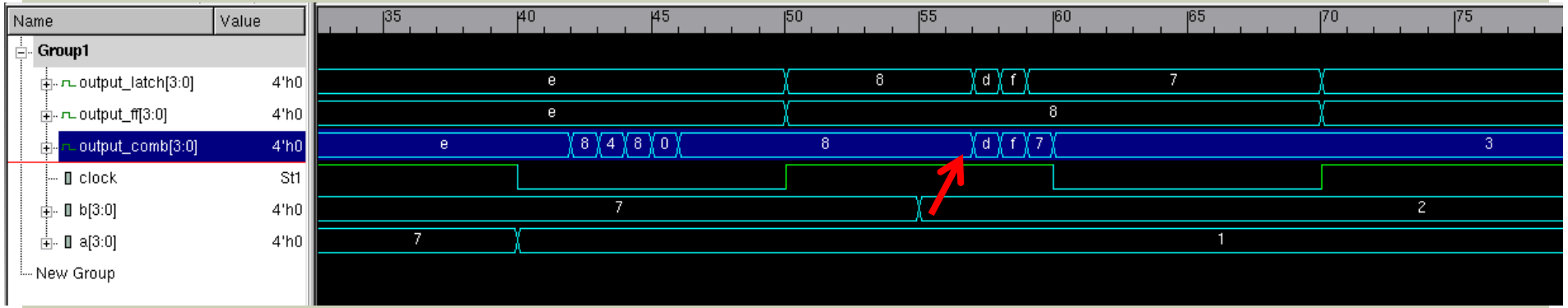
- Let's zoom in on the interesting part.



B changes now,
while the clock is still high.

AN EXAMPLE OF WHY THIS MATTERS

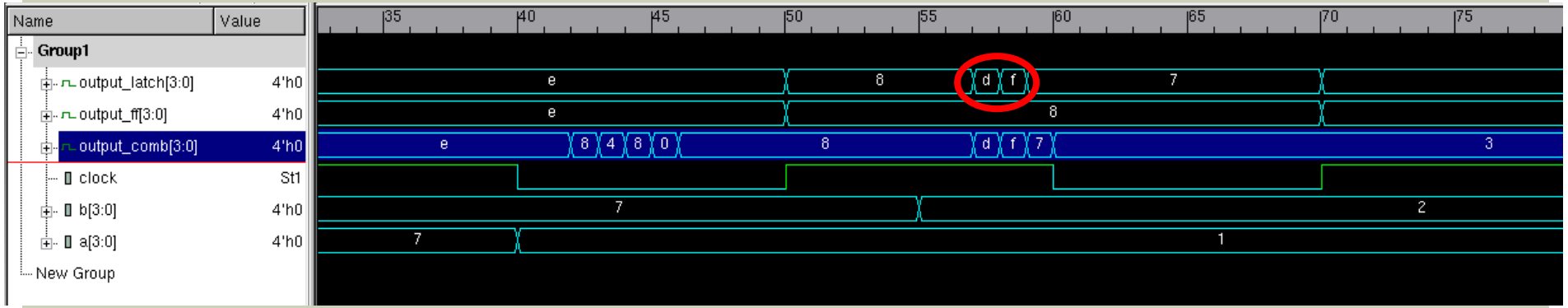
- Let's zoom in on the interesting part.



Again, there's propagation delay before the adder starts to change.

AN EXAMPLE OF WHY THIS MATTERS

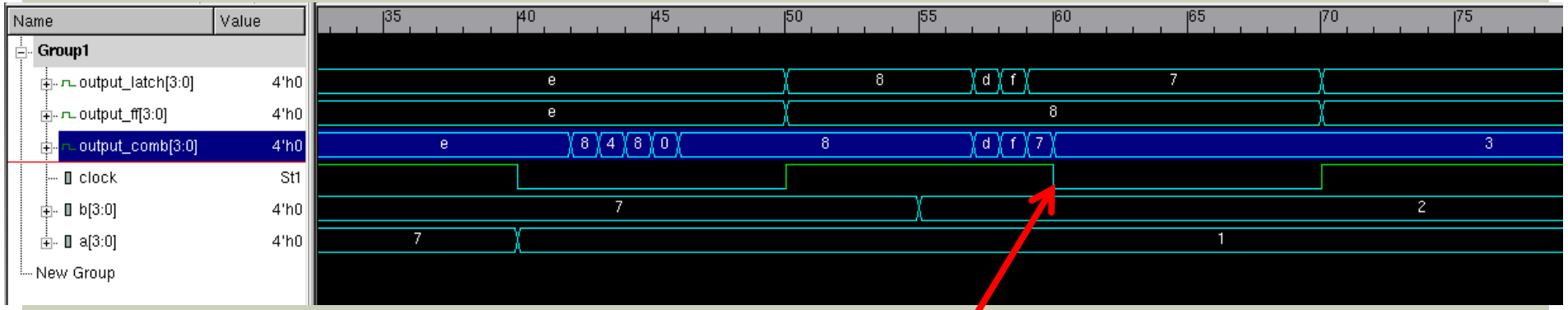
- Let's zoom in on the interesting part.



The value in the latch changes too!

AN EXAMPLE OF WHY THIS MATTERS

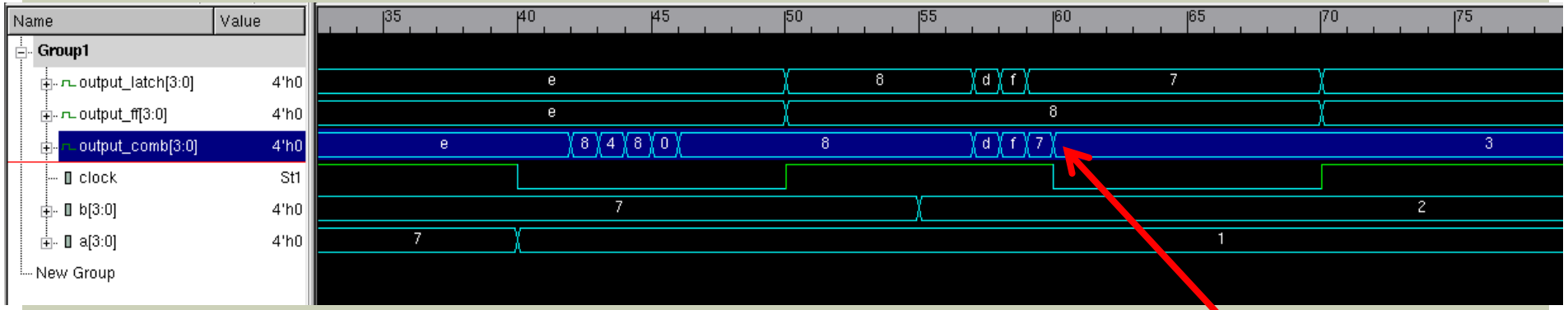
- Let's zoom in on the interesting part.



The next falling edge comes along

AN EXAMPLE OF WHY THIS MATTERS

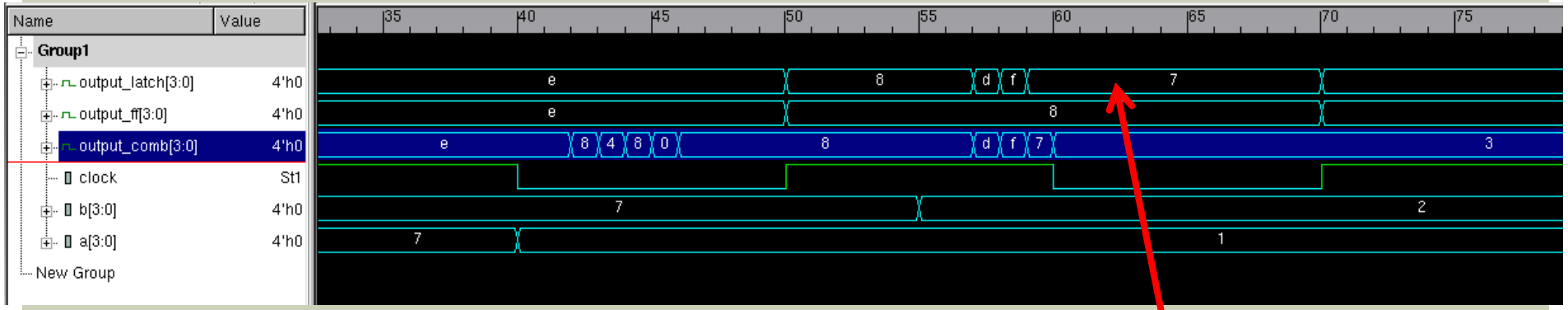
- Let's zoom in on the interesting part.



The adder stabilizes.

AN EXAMPLE OF WHY THIS MATTERS

- Let's zoom in on the interesting part.



The latch locked with the wrong value!