Circuit Timing

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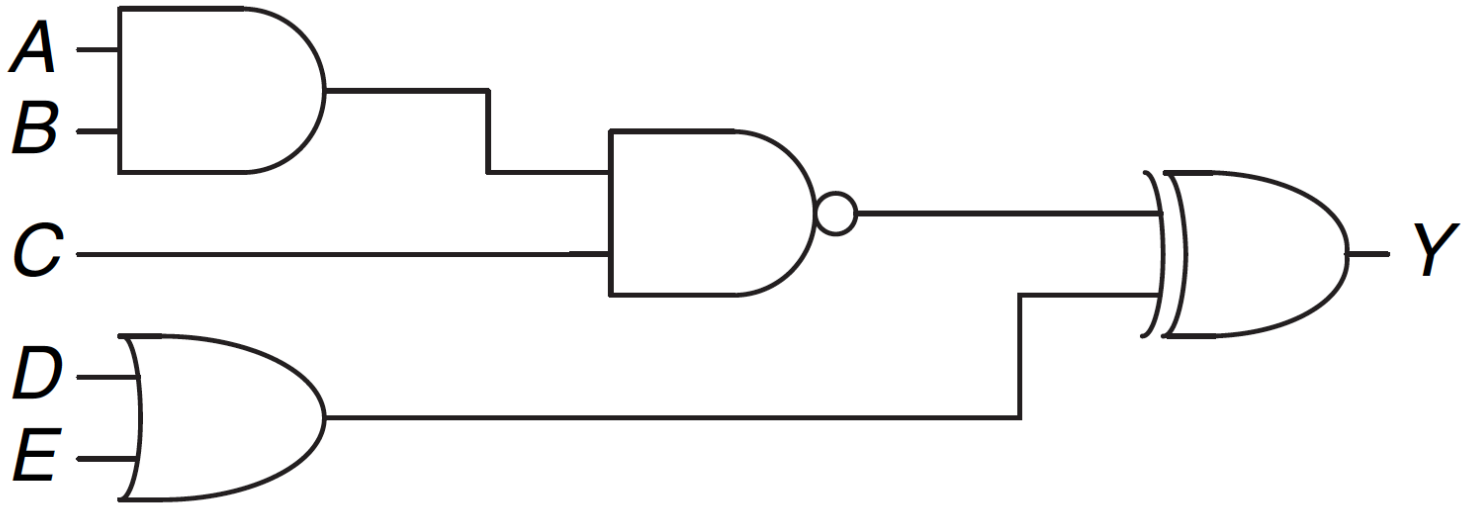
Key Idea

Information does not propagate through a circuit instantaneously.

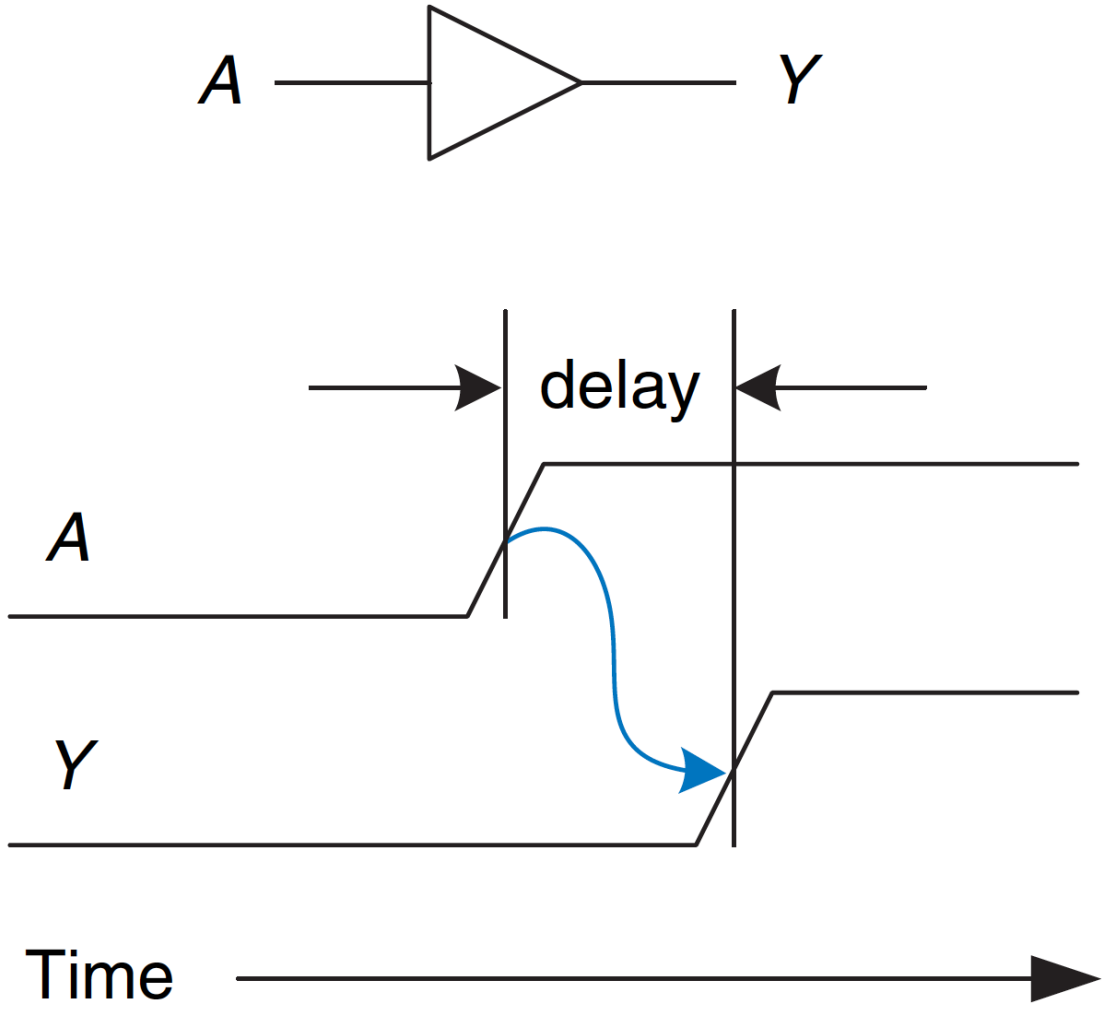
Factors such as the speed of light, temperature, and physical configuration influence execution time.



Delay

Time between inputs changing and a circuit responding.

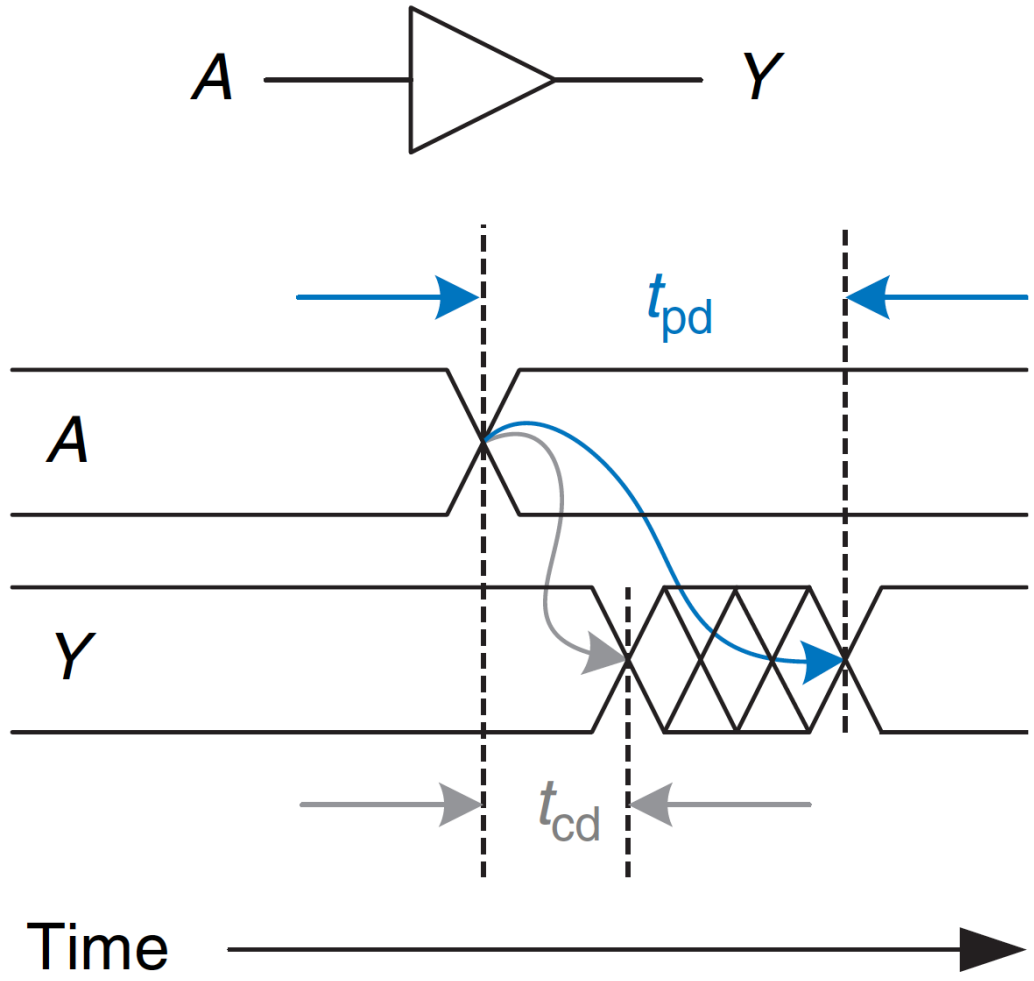
Starts at the 50% point.



Propagation Delay

Maximum time from when an input changes until the output(s) reach their final value.

t_{pd}

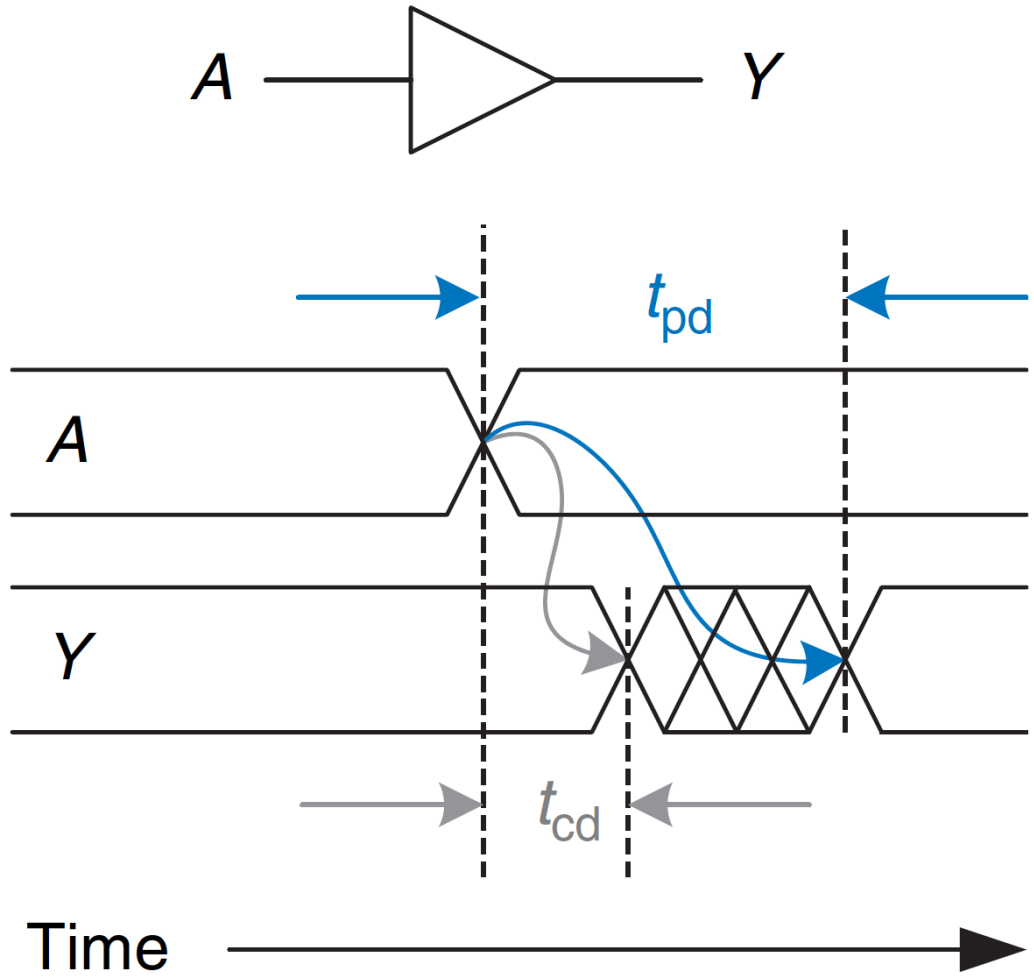


Contamination Delay

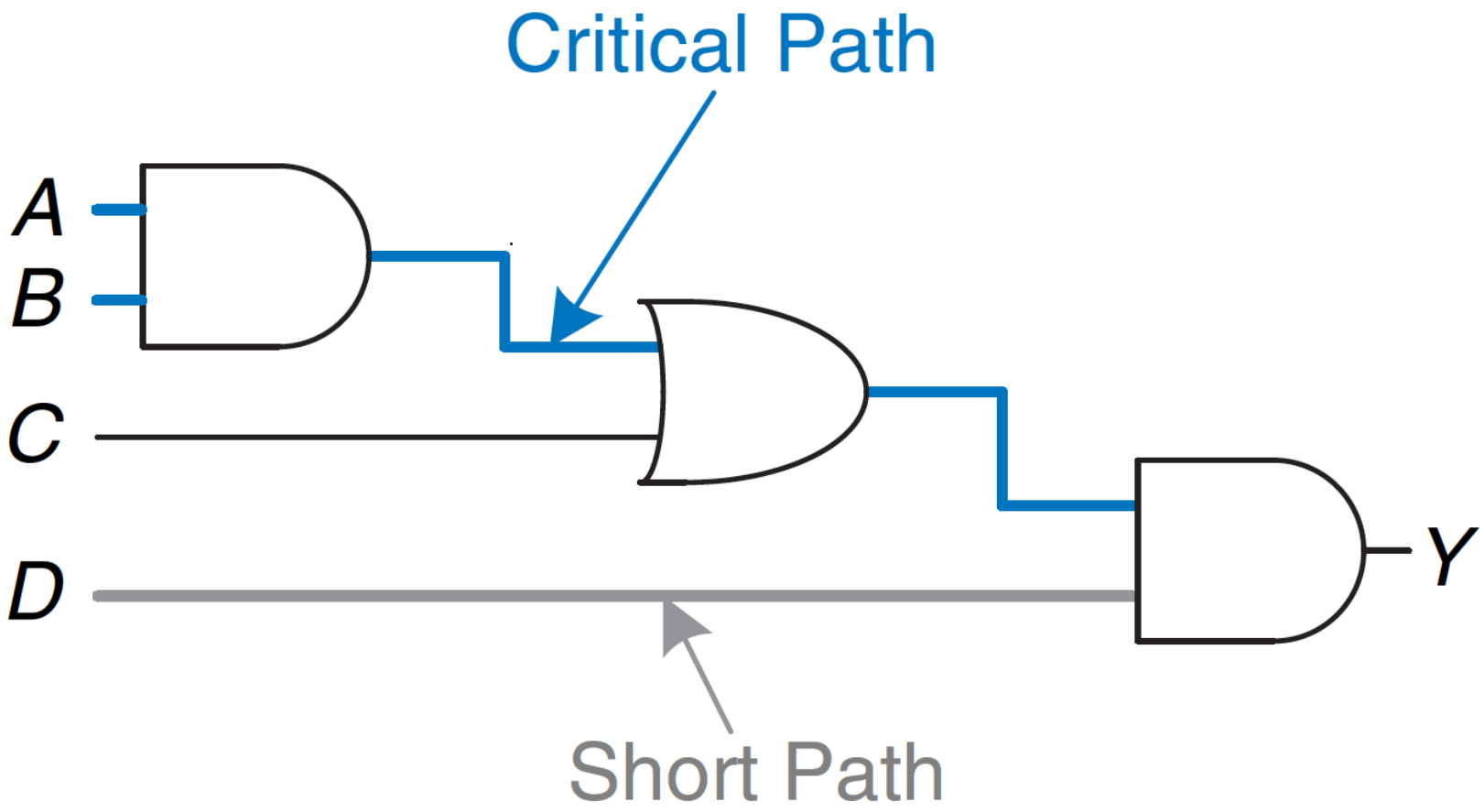
Minimum time from when an input changes until any output starts to change its value.

t_{cd}

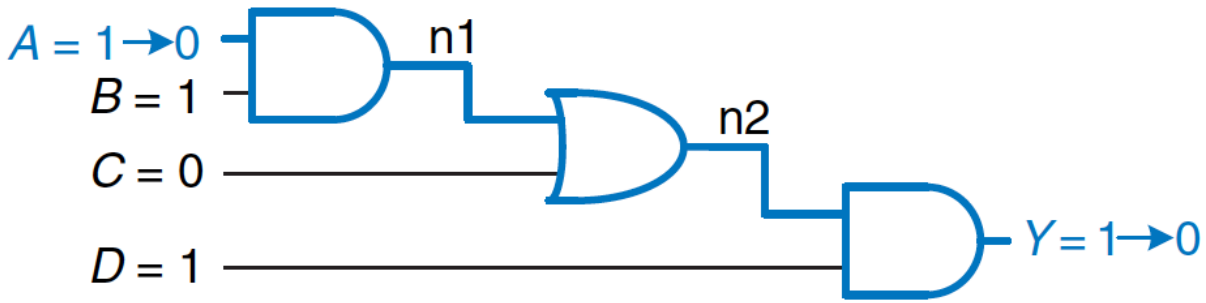
Generally refer to propagation delay when discussing delay in the general sense.

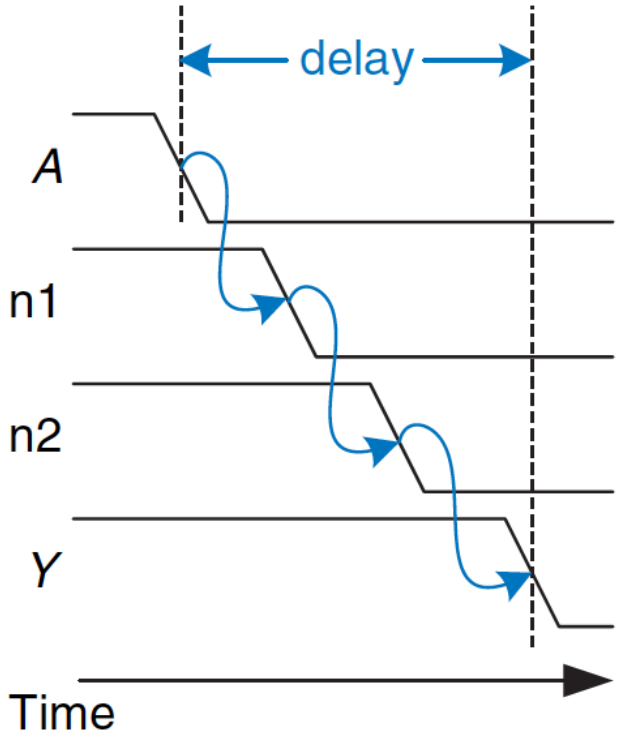


Terminology

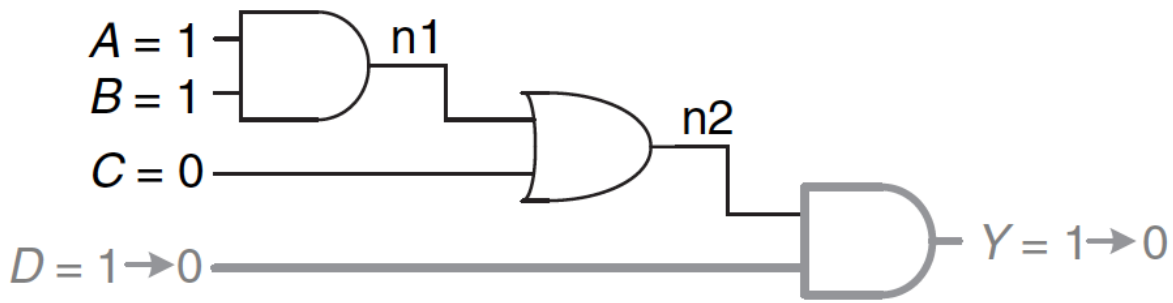


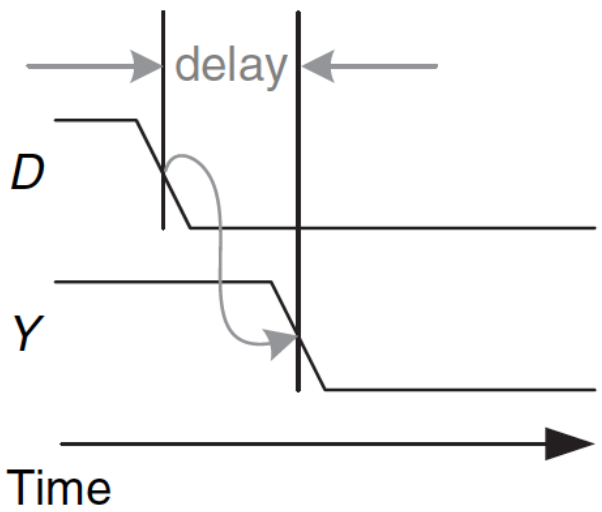
Critical Path





Short Path





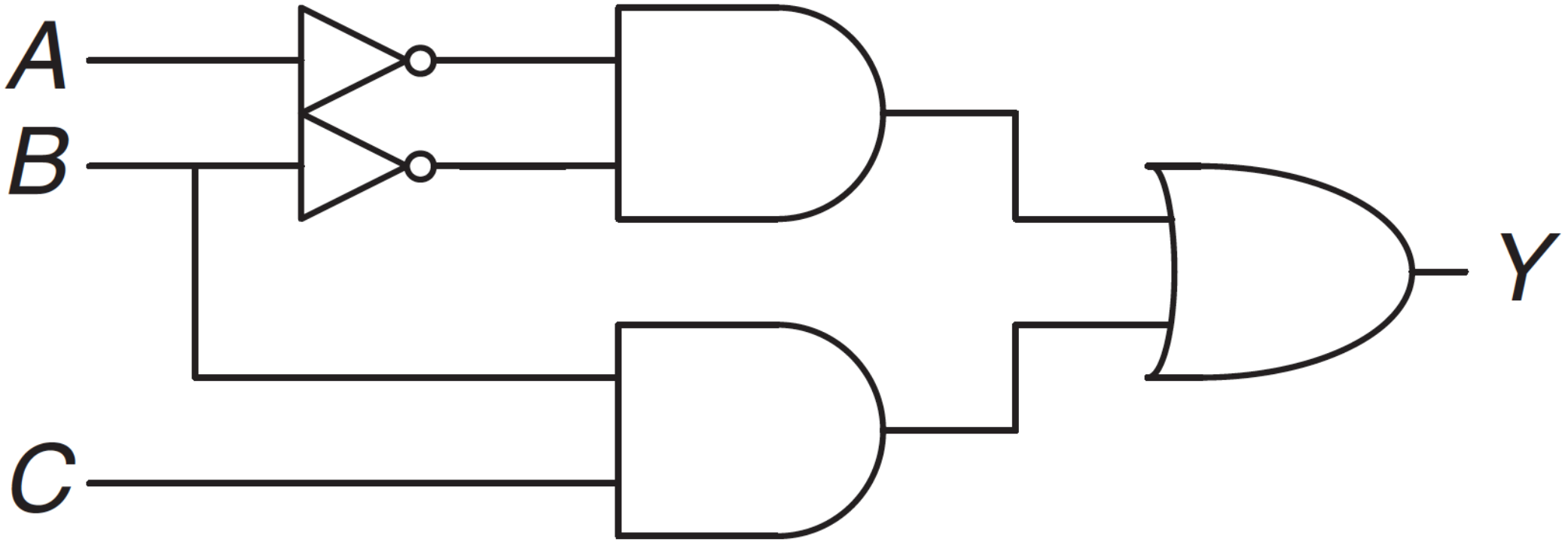
Glitches

aka hazards

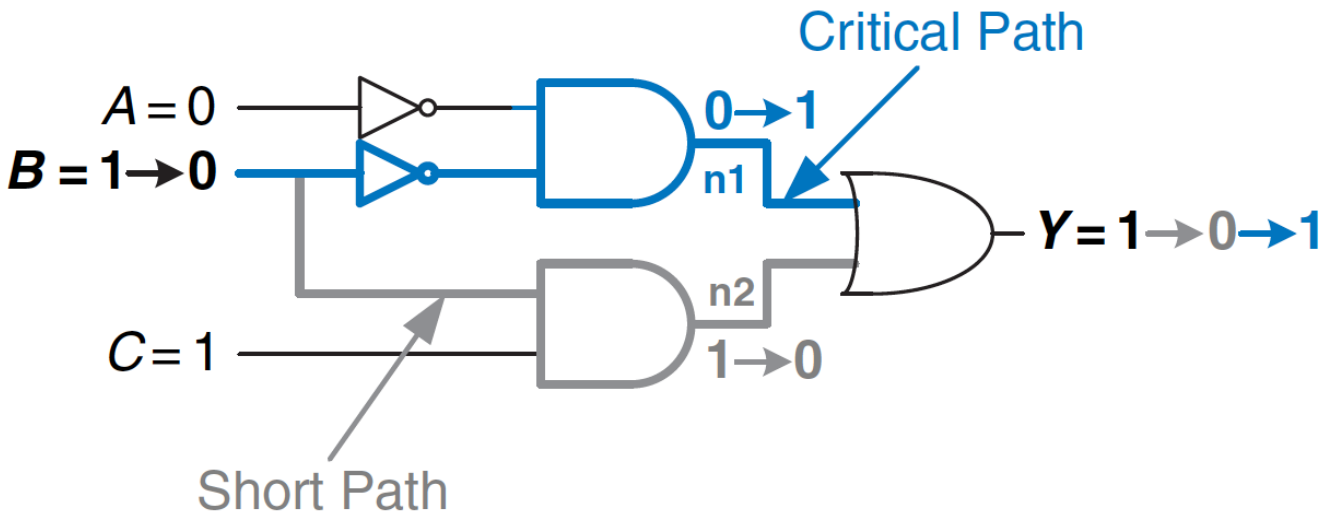
Key: A circuit may output different values until settling into the final state

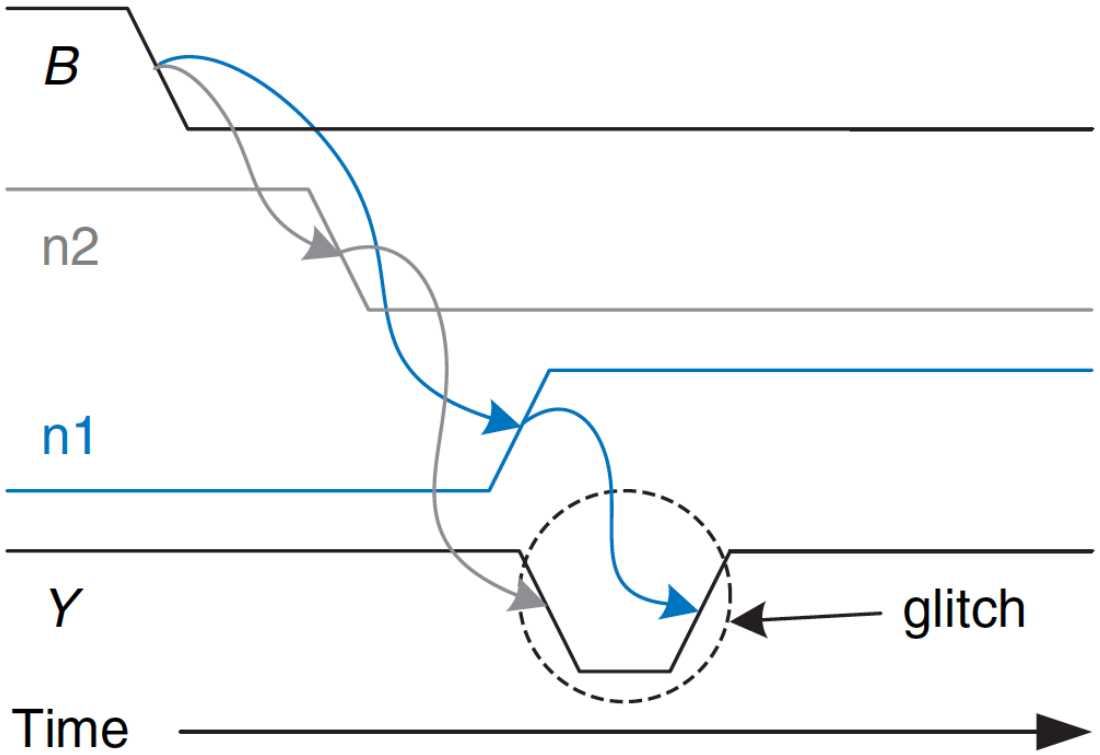
Depends on the length of the paths each input makes through a circuit

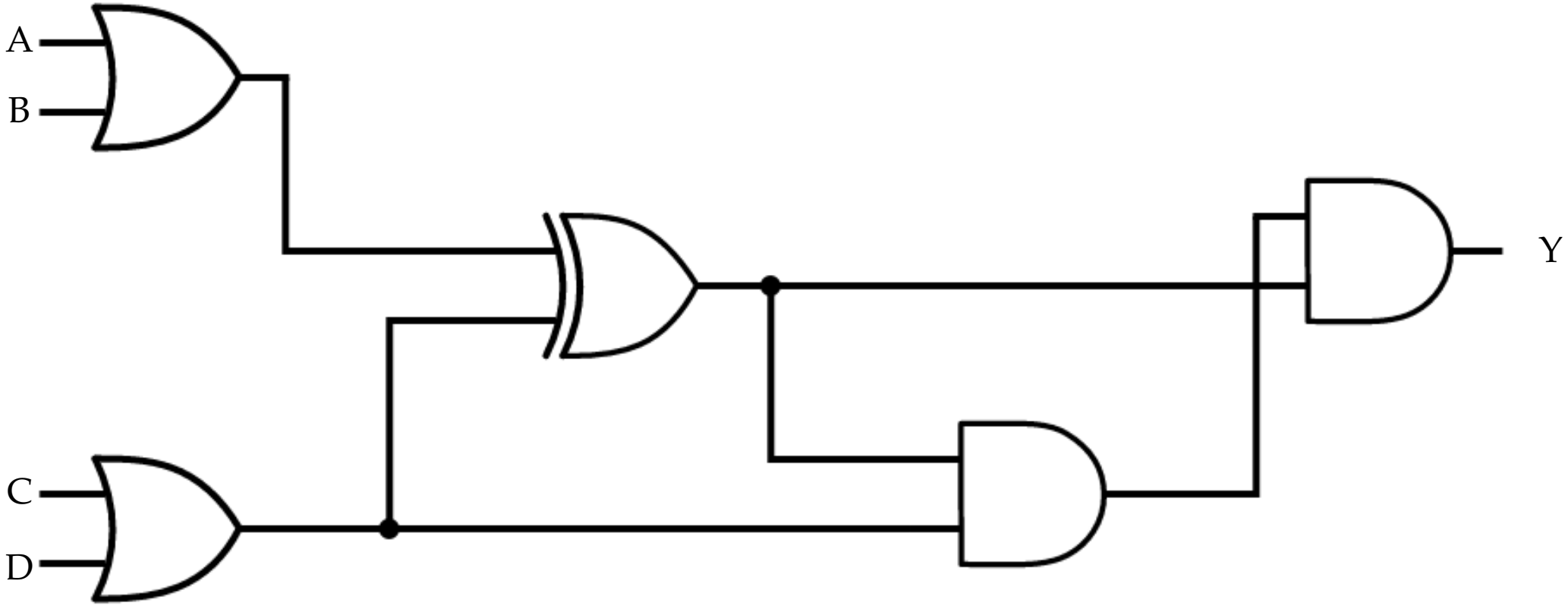
Key: Must wait for propagation delay to elapse.



Glitch is possible in this circuit.
What happens to Y as we change the inputs from (A=0, B=1, C=1) to (A=0, B=0, C=1)?


Critical Path
A = 0
B = 1→0
0→1
n1
Y = 1→0→1
n2
1→0
C = 1
Short Path


B
n2
n1
Y
glitch
Time



What is the critical path of this circuit?
(There may be more than one if they have equal lengths)

What is the short path?

Summary

Propagation from inputs to outputs is not instantaneous

We assume all delays occur in gates (not on wires)

Critical path is slowest route through circuit – delay along critical path is **propagation delay**

If we sample circuit after changing inputs but before propagation delay has occurred, *we can get the wrong answer*