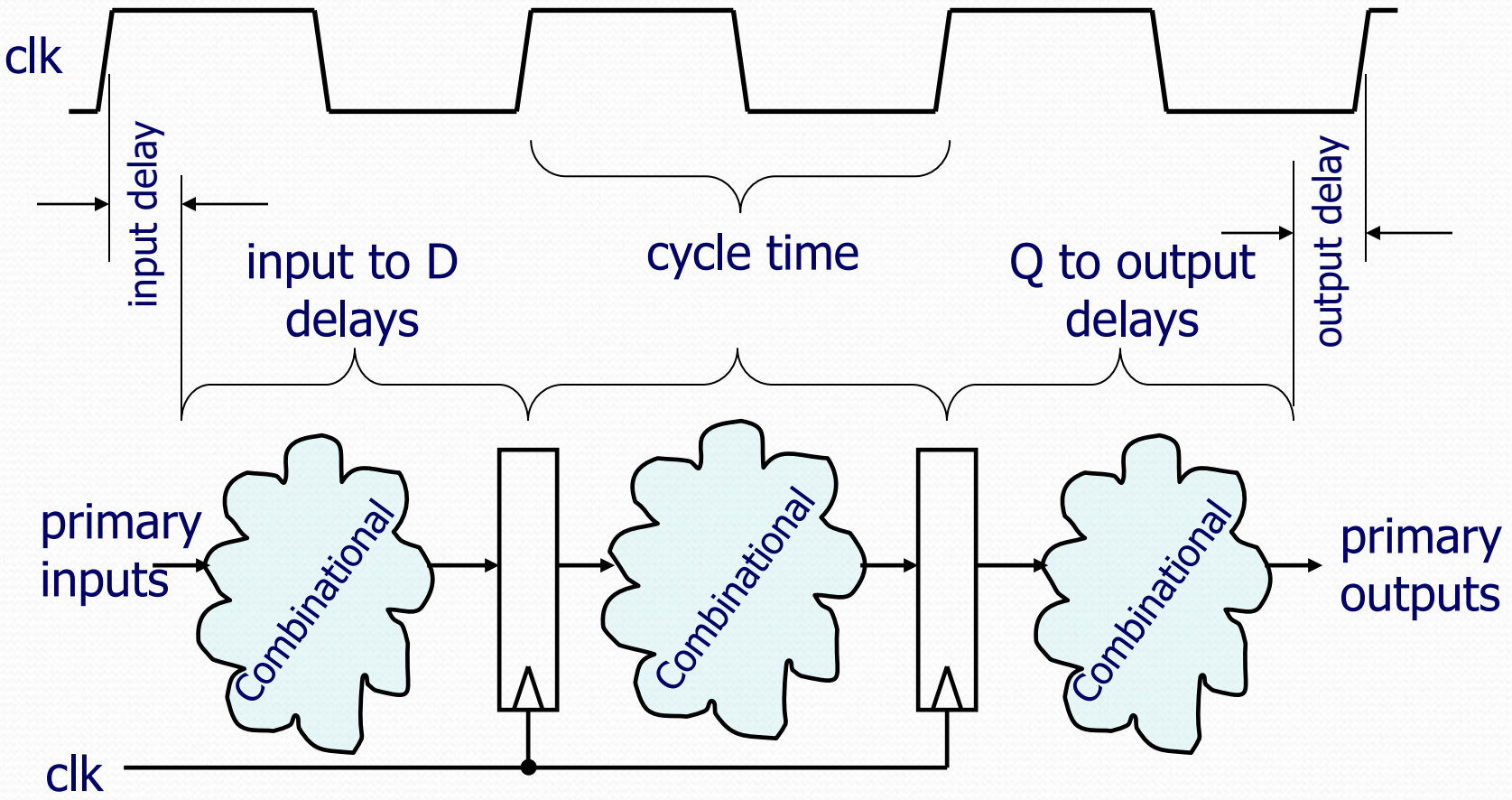
WARNING: There is a little snarkyness in the following slides.

It almost like they were written by a bitter old man who is prejudice against his students. Prejudice in the sense he is pre-judging them. Assuming they will screw up simple static timing analysis questions they encounter on the final.

Prove that you are smarter than all previous classes and you understand STA. If you know the definitions it is really just a matter of simple arithmetic.

Static Timing Analysis

(we have flops…and combinational logic…this stuff is not hard, it just simple arithmetic



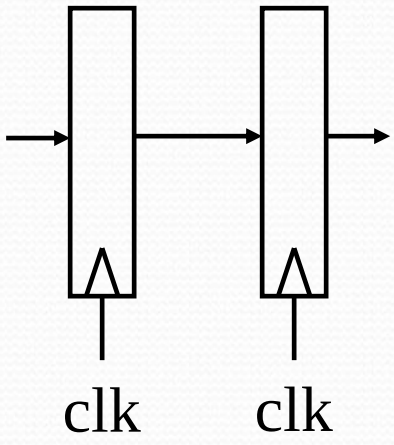
Know your definitions.

- **clk2q** delay ➔ The delay from an active edge of clock *(positive edge in our case)* to when the output *(Q output*) is known valid. The name tells you what it is…how hard is that to remember?

- **setup** time ➔ The amount of time the D input of a flop needs to be valid prior to the active edge of clock (*positive edge in our case*). Is not 352 a pre-req for this course? You already knew this right?

Know your definitions.

- **hold** time ➔ The minimum amount of time the D input of a flop has to be held after the active edge of clock. If the D input changes prior to this time there is the danger that the flop will capture the new value the D input is becoming, not the value it was just prior to the clock edge. OK…this one is a little trickier to understand…still it is not that hard of a concept.



Back to back flops is the worst case topology for hold time (min delay). Do you want the signal at the first flop to go through both flops in one clock edge?

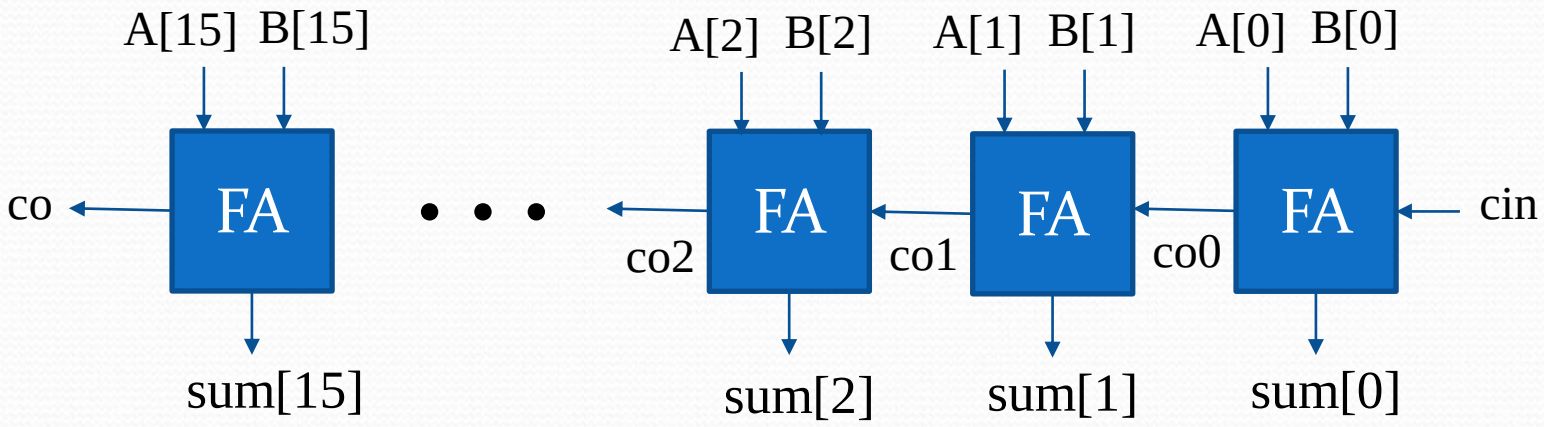
if (clk2q > T_{HOLD}) we are golden

(what about clock skew?)

Know your definitions.

- max path ➔ The worst case (maximum) amount of time it takes to propagate from an input of a combinational block of logic to the output. This can be vector dependent.

16-bit Ripple Carry Adder

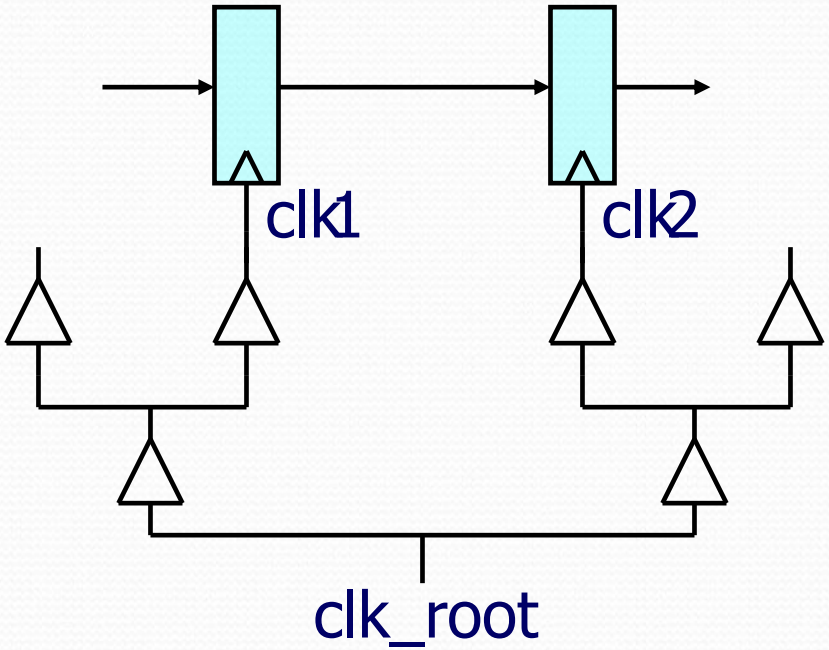



```
Consider the delay for inputs:
A[15:0] = 16'hAAAA;
B[15:0] = 16'h5555;
cin = 1'b0;
```

```
Consider the delay for inputs:
A[15:0] = 16'hAAAA;
B[15:0] = 16'h5555;
cin = 1'b1;
```

Know your definitions.

- min path ➔ The minimum amount of time it takes to propagate from an input of a combinational block of logic to the output.

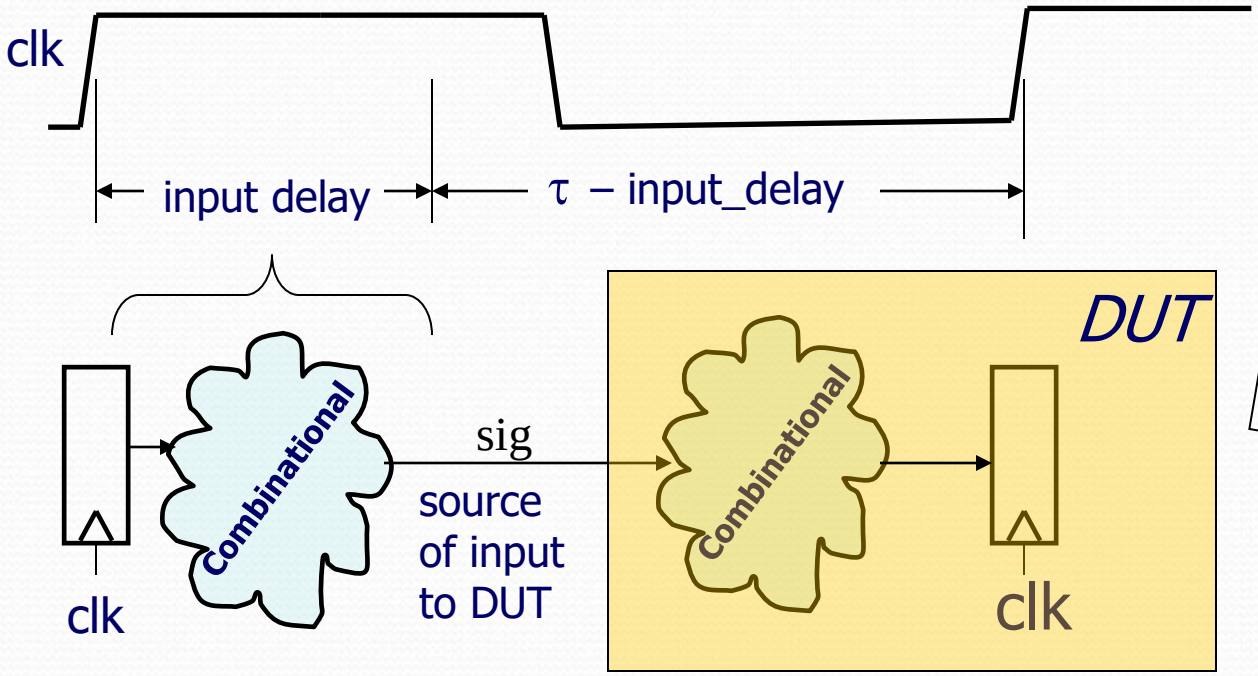


Clock skew ➔ try as hard as you might…it is impossible to distribute a clock to 100k+ flops on chip and have the clock arrive precisely at the same time to all the flops.

There is uncertainty (*a +/- margin*) in a clocks arrival time.

Know your definitions.

- Remember how Synopsys defines input delay

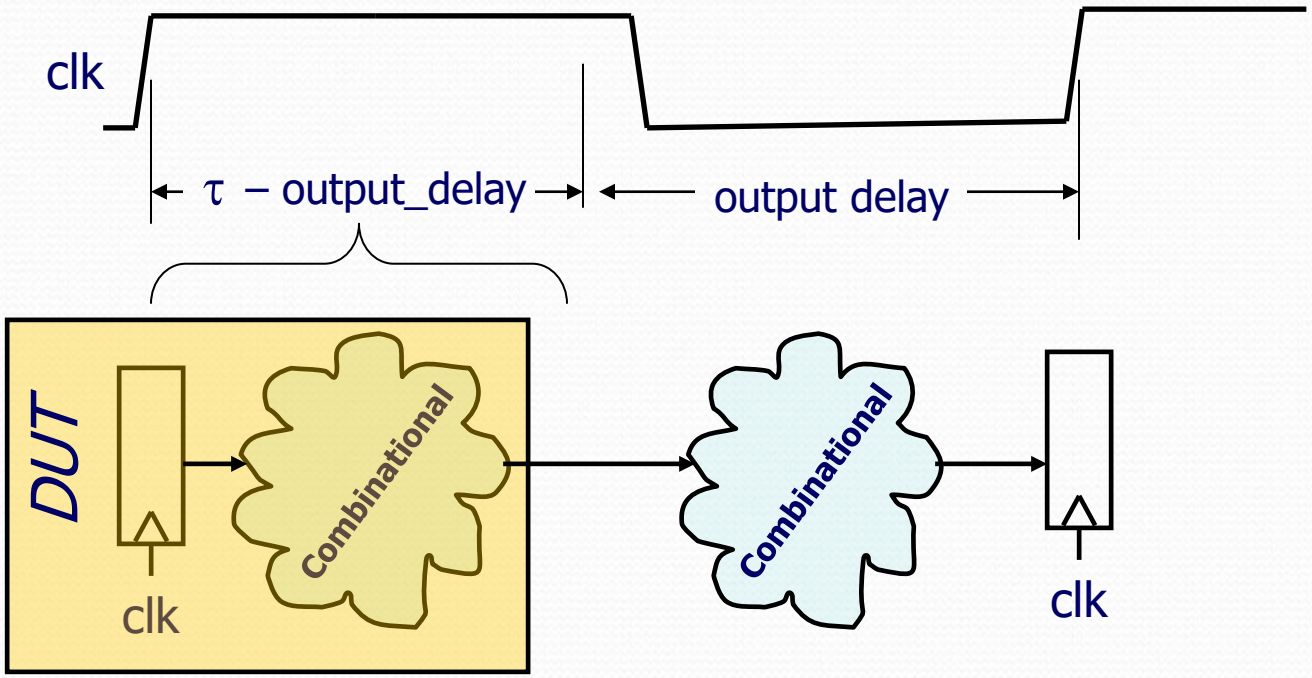


Its not about you *(how much time you need)*. Its about how much time the block providing your signals stole from you.

input delay is specified as time after the clock edge (of prior clock cycle) that the input to the DUT is valid.

Know your definitions.

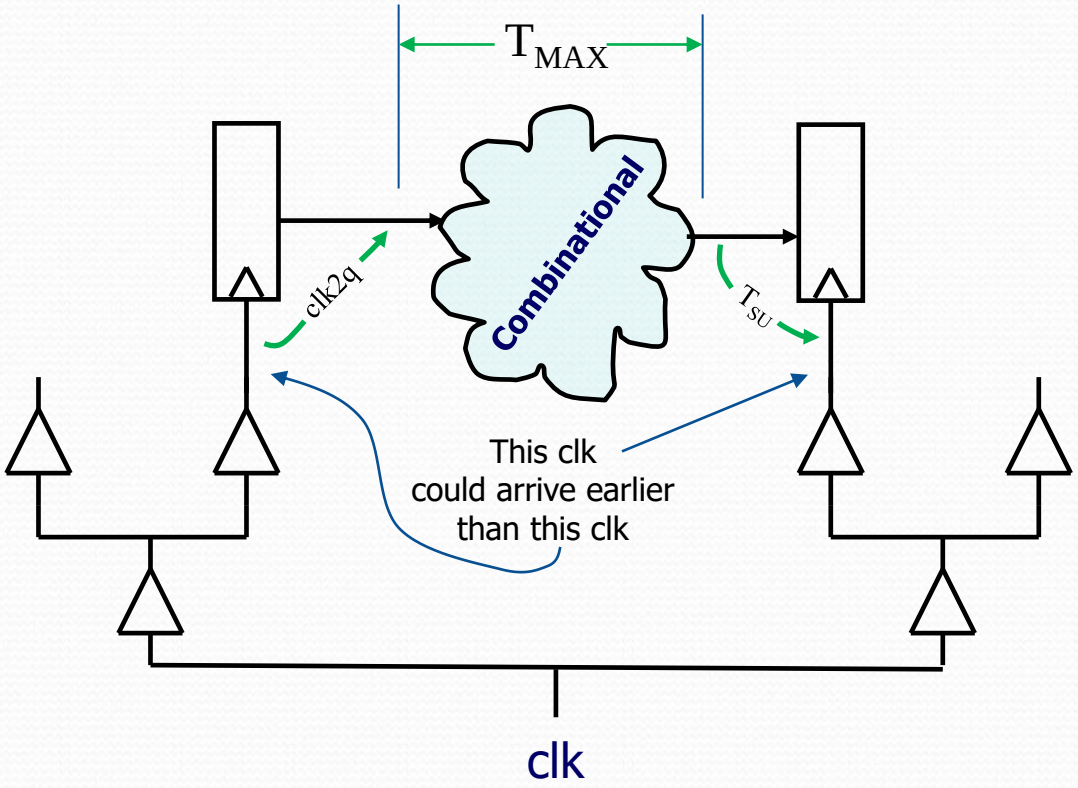
- Remember how Synopsys defines output delay



output delay is specified as time prior to next rising edge that the output has to be valid.

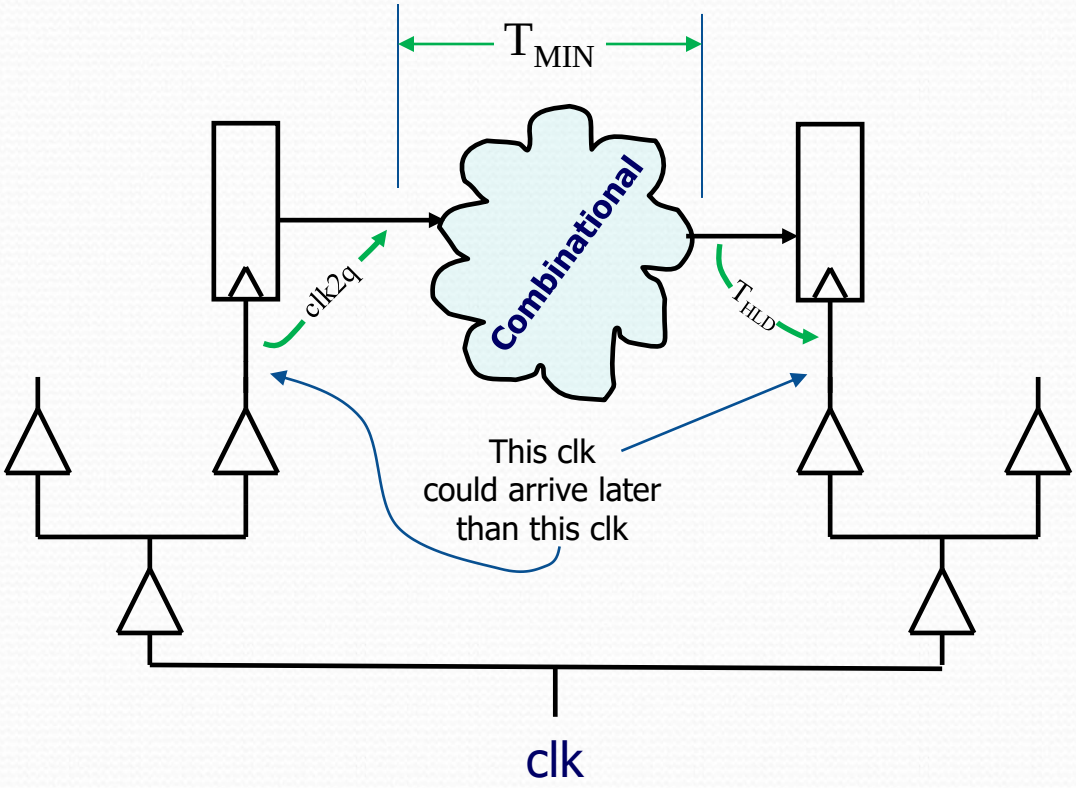
When Considering Max Delay *(Is my circuit fast enough?)*

It called clock **uncertainty**. What does that imply? Yeah that's right **+** or **-** we don't know. As engineers we always assume the worst case.



$$MaxDelaySlack = ClockPeriod - clk2q - T_{MAX} - T_{SU} - clkSkew$$

When Considering Min Delay *(Is my circuit too fast. I am going to have a shoot through problem)*



$$\text{MinDelaySlack} = \text{clk2q} + T_{MIN} - T_{HLD} - \text{clkSkew}$$

I suspect you will write these formulas down on your cheatsheet for the final. But really you should not need to. If you know the definitions these formulas are self evident.

Static Timing Analysis Practice

There is quiz for practice, it does not count for anything.

Some of the questions are a bit tricky *(more tricky than you will encounter on the final)*. This is your practice time. Feel free to discuss it with neighbors as you are taking the quiz. The point here is for you to learn/understand.