VLSI Design Flow: RTL To GDS (NPTEL Course)

Tutorial 9

Objective: To gain a hands-on experience on Power Analysis using OpenSTA

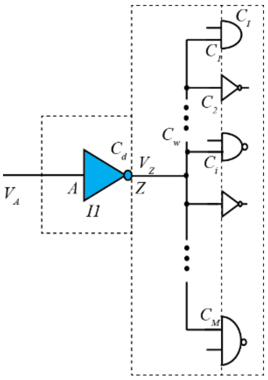
Requirements:

- **OpenSTA**: The installation and how to run OpenSTA is described in Tutorial 7. Please refer to it if you do not have OpenSTA installed on your machine.
- **Files:**
    - Design file: test.v
    - OpenSTA script file: test.tcl
    - SDC file: test.sdc
    - Technology library: toy.lib

  All the above files are available on the NPTEL website as study material for Week 9

Concepts:

From Lecture 29 (Power Analysis):



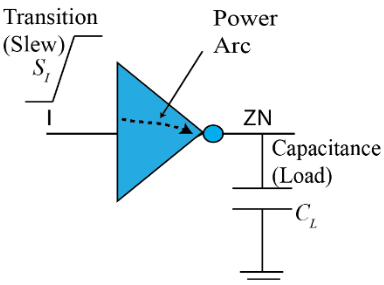
$$P_{tot} = C_L V_{DD}^2 \alpha f_{clk} + V_{DD} I_{SC} + V_{DD} I_{leak}$$

where $V_{DD} = supply\ voltage,\ C_L = \ load\ capacitance, f_{clk} = frequency\ of\ the\ clock\ in\ the\ circuit,\ \alpha = activity\ of\ the\ signal$

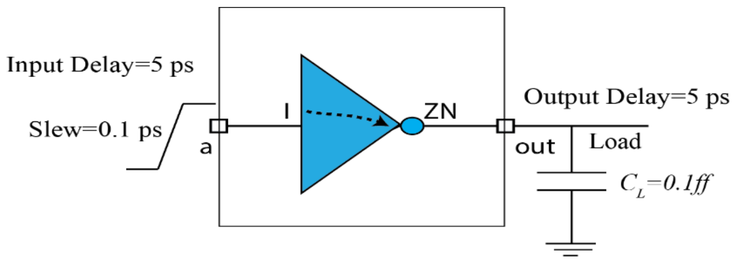
Energy dissipated in one cycle of 0→1→0 transition:

$$E_{dyn} = C_d V_{DD}^2 + V_{DD} I_{SC} \tau_{SC} + (C_w + C_I) V_{DD}^2 = E_{int} + E_{ext}$$

Non-linear Power Model (NLPM)



Experiment: Run OpenSTA and examine how Power Analysis is done by the tool.



Internal Power Computation:

From toy.lib:

Fall Transition:

	C=0.1ff	C=100ff
Tr=0.1ps	1	2
Tr=100ps	3	4

Rise Transition:

	C=0.1ff	C=100ff
Tr=0.1ps	2	4
Tr=100ps	6	10

From small.v and small.sdc:

Average energy consumed per transition=$\frac{1+2}{2} = 1.5\ fJ = 1.5 \times 10^{-15} J$

Clock Period = 1000 ps

No. of clock cycles per second = $\frac{1}{1000 \times 10^{-12}} = 10^9$

Activity = number of transitions per clock cycle=0.1

No. of transitions per second =0.1×10^9

Internal power =$Energy\ per\ transition\ \times number\ of\ transition\ per\ second$

$= 1.5 \times 10^{-15} \times 0.1 \times 10^9 = 1.5 \times 10^{-7}\ W$

Switching Power Computation:

Load = $C = 0.1ff$

Voltage = 1 V

Energy dissipated in one transition = $\frac{1}{2}CV^2 = 0.5 \times 0.1 \times 10^{-15} \times 1^2 = 5 \times 10^{-17}$ J

No. of transitions per second =0.1×10^9

Switching power= $Energy\ per\ transition\ \times number\ of\ transition\ per\ second$

$$= 5 \times 10^{-17} \times 0.1 \times 10^9 = 5 \times 10^{-9}\ W$$

Leakage Power: From toy.lib $150 \times 10^{-12} = 1.5 \times 10^{-10}\ W$