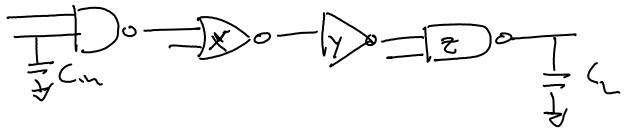
Logical Effort

Monday, March 08, 2010
09:04

TA Stuff

Midterm 3/15/2010 : 7-9PM

→ 1 handwritten cheat sheet



$$D = \sum_{i=1}^{N} D_i = \sum_{i}^{N} PD_i + \sum_{i}^{N} \underbrace{LE_i \cdot FO_i}_{SE_i \text{ (Stage Effort)}}$$

$$\text{Path Effort} = \prod_{i=1}^{N} SE_i = \underbrace{\prod_{i=1}^{N} LE_i}_{\text{path logical effort}} \cdot \underbrace{\prod_{i=1}^{N} FO_i}_{\frac{C_L}{C_{in}}}$$

(PE)

aka path electrical effort $\frac{C_{out}}{C_{in}}$

Recall that for a chain of buffers, $f = \sqrt[N]{F}$

$$\Rightarrow SE^* = \sqrt[N]{PE}$$

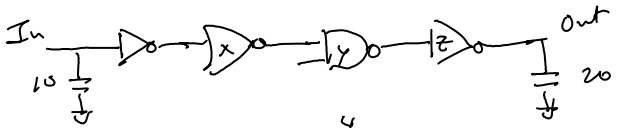
$$LE_i \cdot FO_i = SE^*$$

$$LE_i \cdot \frac{C_{gate,i+1}}{C_{gate,i}} = SE^*$$

$$C_{gate,i+1} = \frac{SE^*}{LE_i} \cdot C_{gate,i}$$

$$C_{gate,i} = \frac{LE_i}{SE^*} \cdot C_{gate,i+1}$$

Example 1



$$PE = \prod_{i=1}^{4} SE = \left(1 \cdot \frac{X}{10}\right) \cdot \left(\frac{5}{3} \cdot \frac{Y}{X}\right) \cdot \left(\frac{4}{3} \cdot \frac{Z}{Y}\right) \cdot \left(1 \cdot \frac{20}{Z}\right)$$

$$= \frac{40}{9} \qquad N = 4$$

$$\Rightarrow SE^* = \sqrt[4]{\frac{40}{9}} \approx 1.45$$

$LE_{inv} \cdot FO_{inv} = 1.45$

$1 \cdot \frac{x}{18} = 1.45 \Rightarrow x = 14.5$

$LE_{nor} \cdot FO_{nor} = 1.45$

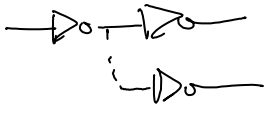
$\frac{5}{3} \cdot \frac{y}{14.5} = 1.45 \Rightarrow y = 12.7$

$LE_{NAND} \cdot FO_{NAND} = 1.45$

$\frac{4}{3} \cdot \frac{z}{12.7} = 1.45 \Rightarrow z = 13.8$

$D = N_a SE^* + \sum_{i=1}^{N} PD_i$

Branching Effort

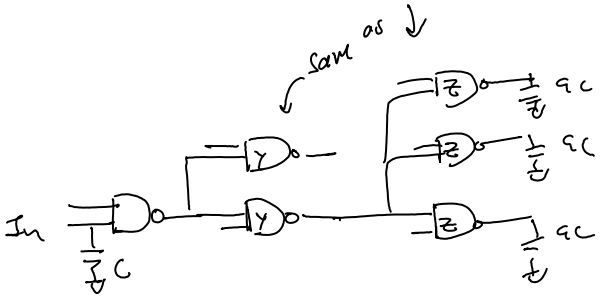


$b_i = \frac{Con\text{-}path - Coff\ path}{Con\ path}$

$PE = \prod_{i=0}^{N} LE_i \cdot FO_i \cdot b_i$

$SE^* = \sqrt[N]{PE}$

Example #2



$PE = \frac{4}{3}\frac{y}{C} \cdot \left(\frac{y+y}{y}\right) \cdot \frac{4}{3} \cdot \frac{z}{y}\left(\frac{z+z+z}{z}\right) \cdot \frac{4}{3} \cdot \frac{qC}{z} \cdot 1$

$PE = 128 \qquad SE^* = \sqrt[3]{128} = 5$

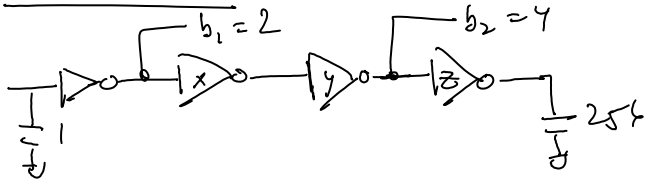
$\frac{4}{3} \cdot \frac{y}{C} \cdot 2 = 5 \Rightarrow y = \frac{15}{8}C$

$\frac{4}{3} \cdot \frac{z}{\frac{15}{8}C} \cdot 3 = 5 \Rightarrow z = \frac{5 \cdot 15}{32} \cdot C = \frac{75}{32}C$

And now we have our sizes.

Do plug & chug

Practice Quiz



find x, y, z to minimize delay

$$PE = \left(1 \cdot \frac{x}{1} \cdot 2\right) \cdot \left(1 \cdot \frac{y}{x}\right) \cdot \left(1 \cdot \frac{z}{y} \cdot 4\right) \cdot \left(1 \cdot \frac{256}{z}\right)$$

$$PE = 2 \cdot 4 \cdot 256 = 512 \cdot 4 = 1024 \cdot 2 = 2048$$

$$\Rightarrow SE^* = \sqrt[4]{2048} \approx 6.73$$

$$1 \cdot \frac{x}{1} \cdot 2 = 6.73 \Rightarrow x = 3.37$$

$$1 \cdot \frac{y}{3.37} = 6.73 \Rightarrow y = 22.68$$

$$1 \cdot \frac{z}{22.68} \cdot 4 = 6.73 \Rightarrow z = 38.16$$