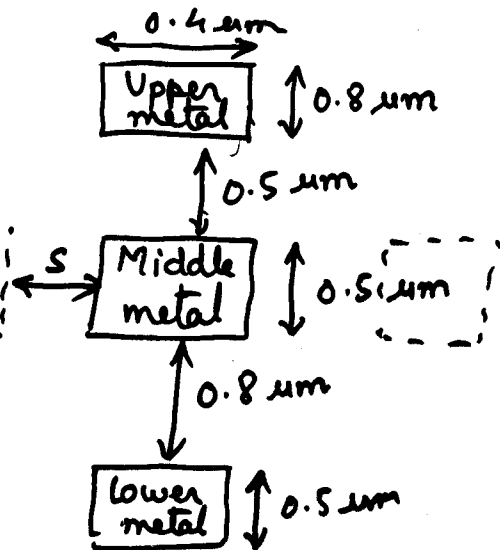


Interconnect Capacitance



$$\underline{W = 0.4 \mu\text{m}}$$

I. Upper metal

a) closely spaced ($s = 0.4 \mu\text{m}$)

$$T = 0.8 \mu\text{m}$$

$$H = 0.5 \mu\text{m}$$

$$\begin{aligned} C_{\text{int}} &= 2\overset{\checkmark}{C}_A + 2\overset{\checkmark}{C}_L + 2\overset{\times}{C}_F \\ &= 2(0.03) + 2(0.07) + 0 \\ &= 0.2 \text{ fF}/\mu\text{m}. \end{aligned}$$

b) Widely spaced ($s = 4 \mu\text{m}$)

$$\begin{aligned} C_{\text{int}} &= 2\overset{\checkmark}{C}_A + 2\overset{\times}{C}_L + 2\overset{\checkmark}{C}_F \\ &= 2(0.03) + 0 + 2(0.025) \\ &\cong 0.1 \text{ fF}/\mu\text{m}. \end{aligned}$$

Upper metal

$$C_A = 0.035 \left(\frac{0.4 \mu\text{m}}{0.5 \mu\text{m}} \right)$$

$$\cong 0.03$$

$$C_L = 0.035 \left(\frac{0.8 \mu\text{m}}{0.4 \mu\text{m}} \right) \cong 0.07$$

$$C_F = 0.035 \ln \left(1 + \frac{0.8}{0.5} \right)$$

$$\cong 0.025$$

II. Lower metal

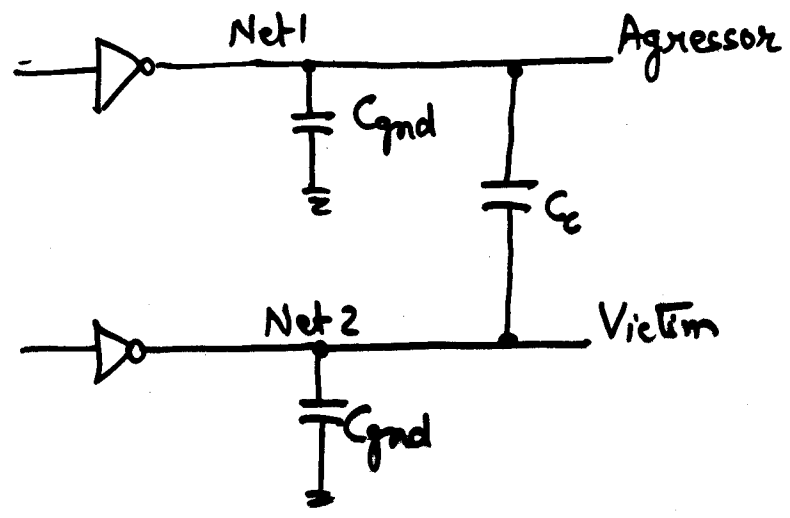
a) closely spaced. ($s = 0.4 \mu\text{m}$)

$$\begin{aligned} C_{\text{int}} &= 2\overset{\checkmark}{C}_A + 2\overset{\checkmark}{C}_L + 2\overset{\times}{C}_F \\ &= 2(0.015) + 2(0.035) + 0 \\ &= 0.1 \text{ fF}/\mu\text{m} \end{aligned}$$

b) Widely spaced
($s = 4 \mu\text{m}$)

$$\begin{aligned} C_{\text{int}} &= 2\overset{\checkmark}{C}_A + 2\overset{\times}{C}_L + 2\overset{\checkmark}{C}_F \\ &= 2(0.015) + 0 + 2(0.025) \\ &\cong 0.1 \text{ fF}/\mu\text{m}. \end{aligned}$$

Coupling effects on delay



Effective C_c of Net 2

Condition

$C_{gnd} + C_c$

Agressor is not switching.

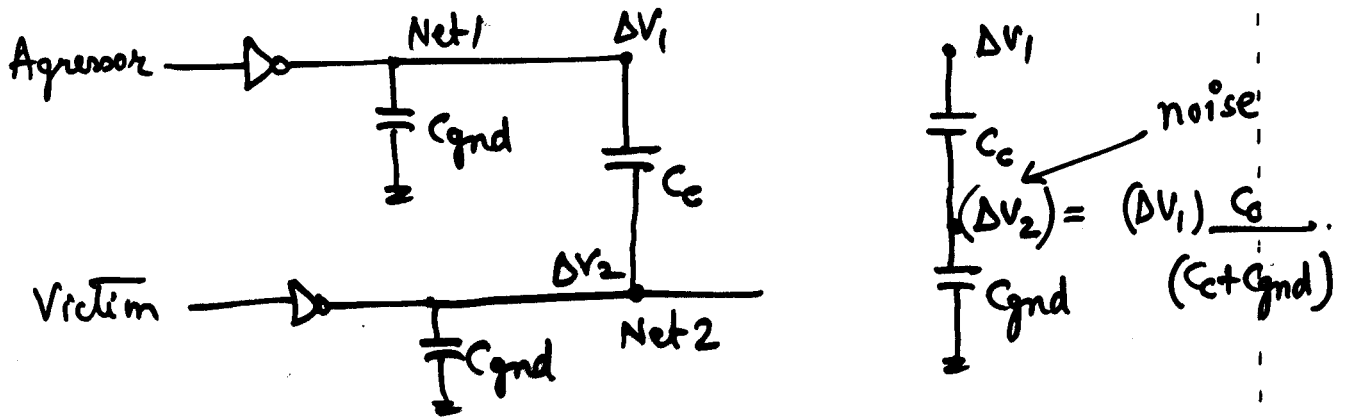
C_{gnd}

Agressor and Victim switch in the same direction.

$C_{gnd} + 2C_c$

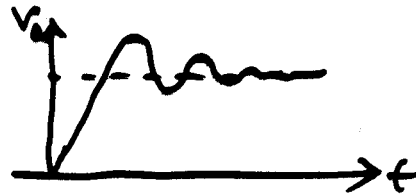
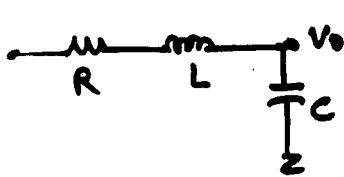
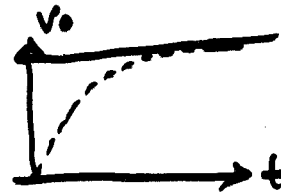
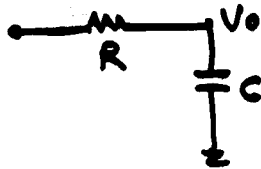
Agressor and victim switch opposite.

Capacitive noise or Crosstalk



Interconnect Inductance

$$V = L \left(\frac{di}{dt} \right)$$



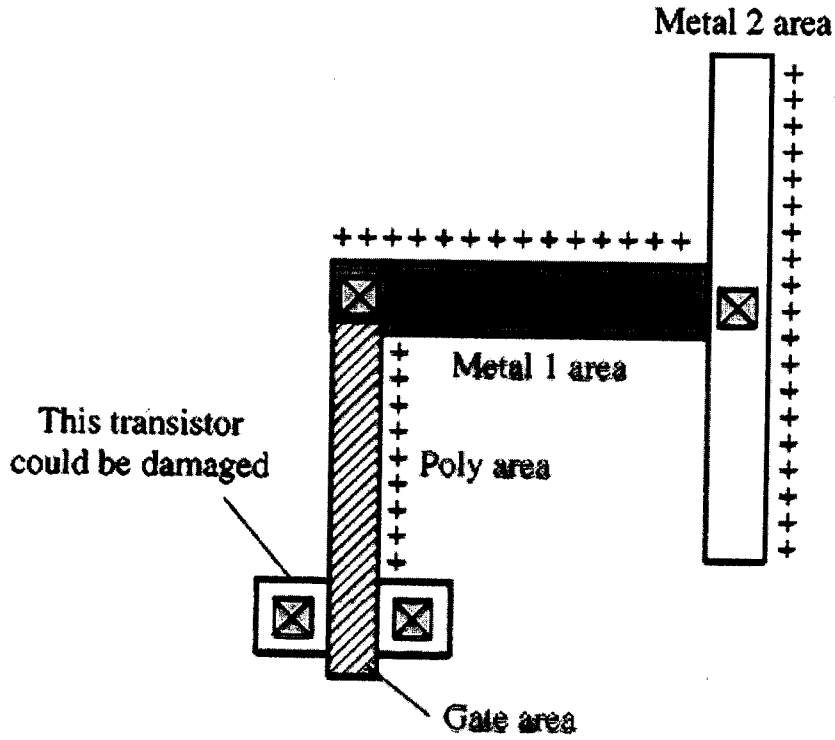
rise time

$$\frac{t_r}{2\sqrt{L_{int}C_{int}}} < l < \frac{2}{R_{int}} \sqrt{\frac{L_{int}}{C_{int}}}$$

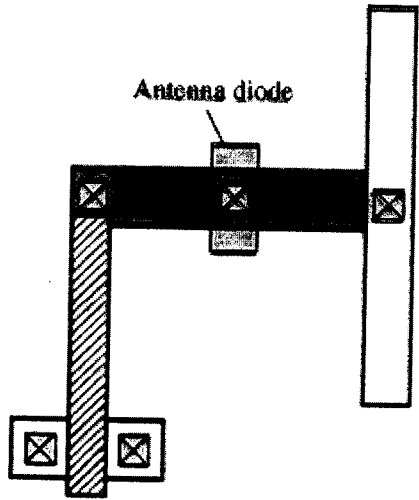
length of the wire

Antenna Effects

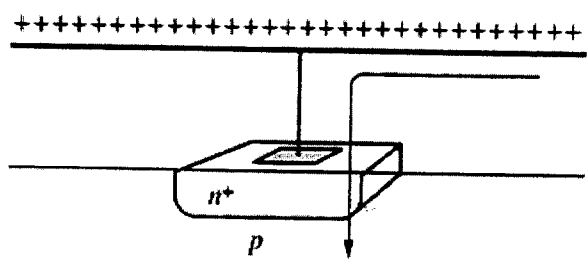
Antenna effects during IC fabrication:



Solution 1 - Antenna diodes to discharge the metal lines:

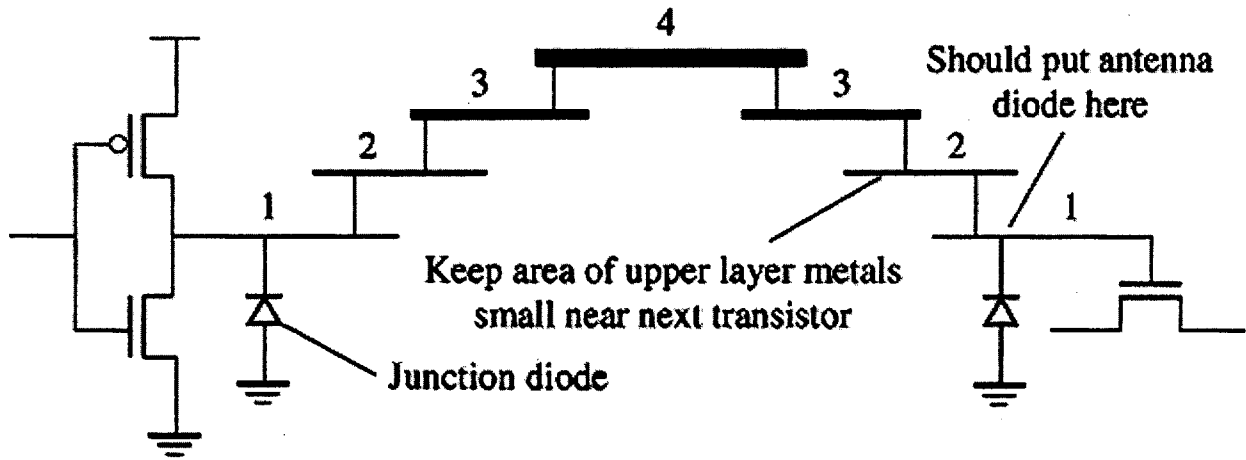


(a)

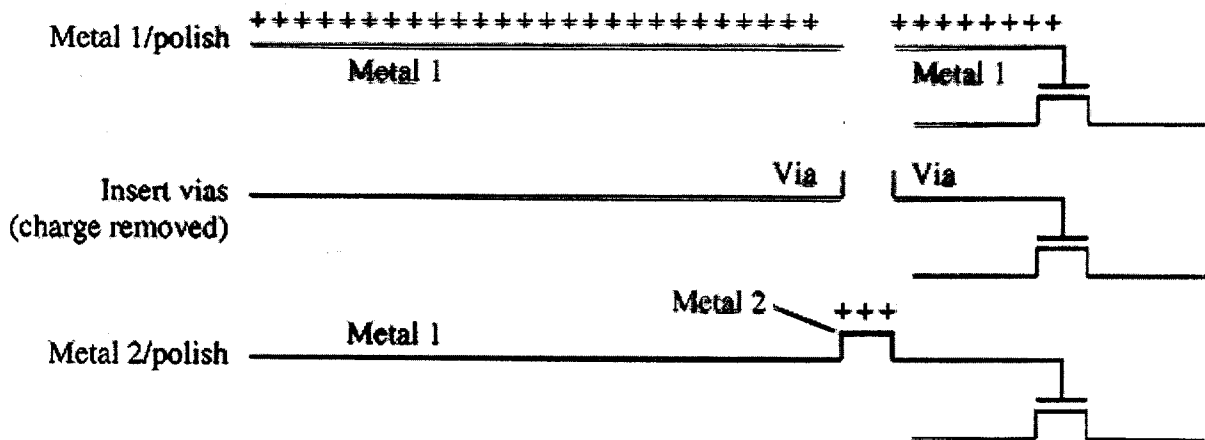


(b)

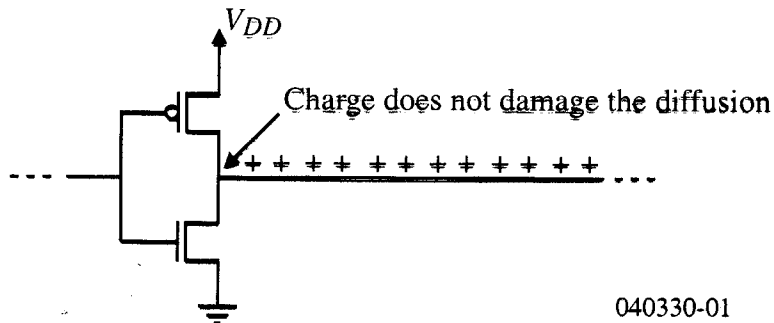
Solution 1 – Proper placement of the antenna diodes.



Solution 2 – Metal line jogs to avoid antenna effects.



Solution 3 – Insert buffers which will also reduce the delay.



Signal transmission is now only in one direction.