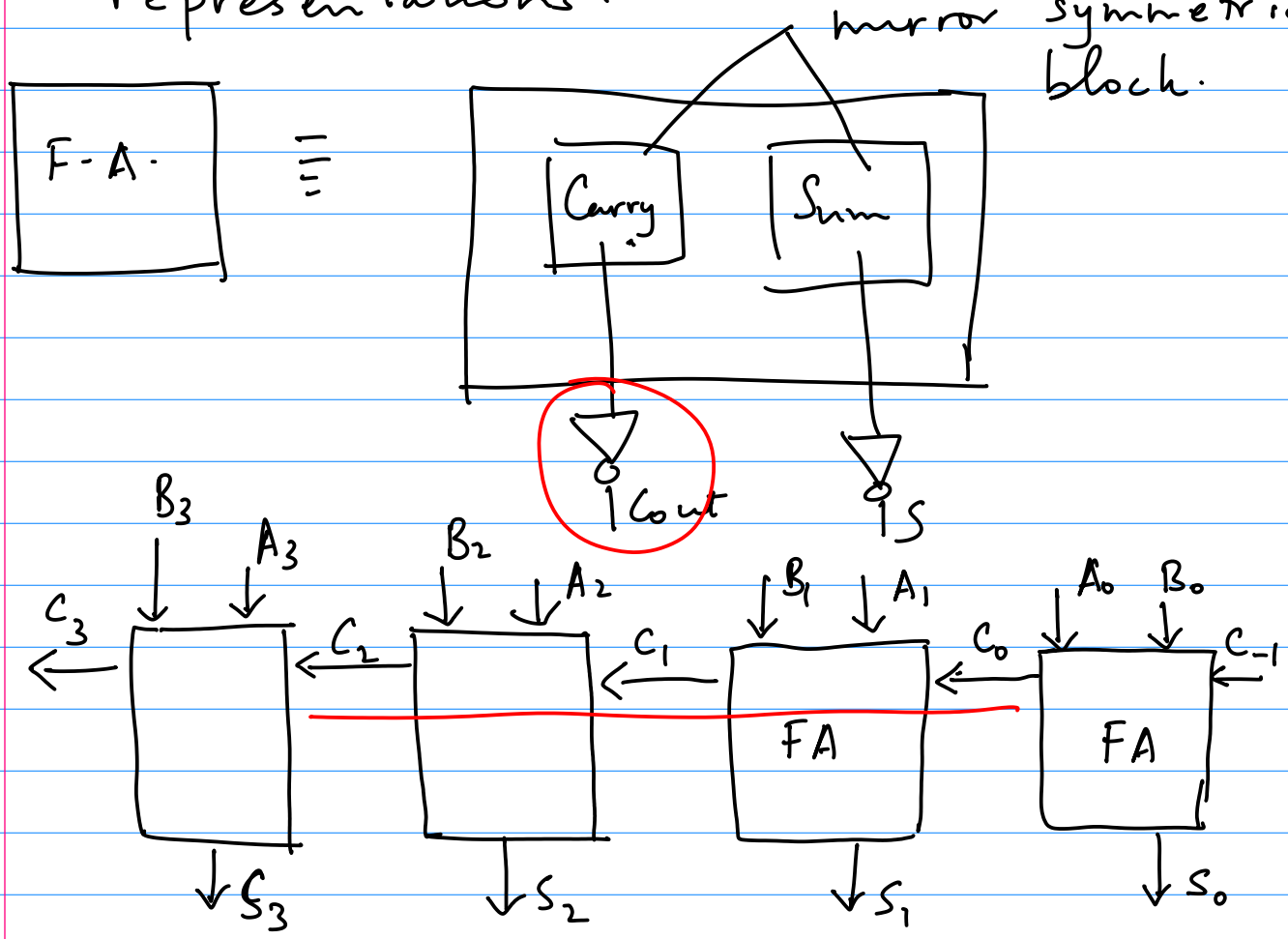
$$S(A, B, C_{in}) = ABC_{in} + \overline{C_{out}}(A + B + C_{in})$$

$$C_{out}(A, B, C_{in}) = AB + C_{in}(A + B)$$

$$\begin{cases} \overline{S}(A, B, C_{in}) = S(\overline{A}, \overline{B}, \overline{C_{in}}) \\ \overline{C_{out}}(A, B, C_{in}) = C_{out}(\overline{A}, \overline{B}, \overline{C_{in}}) \end{cases}$$

↳ Use this to get mirror symmetric representations.



t_{inv} : 1 unit

t_{cout} : 3 + 1

t_{sum} : 4 + 1

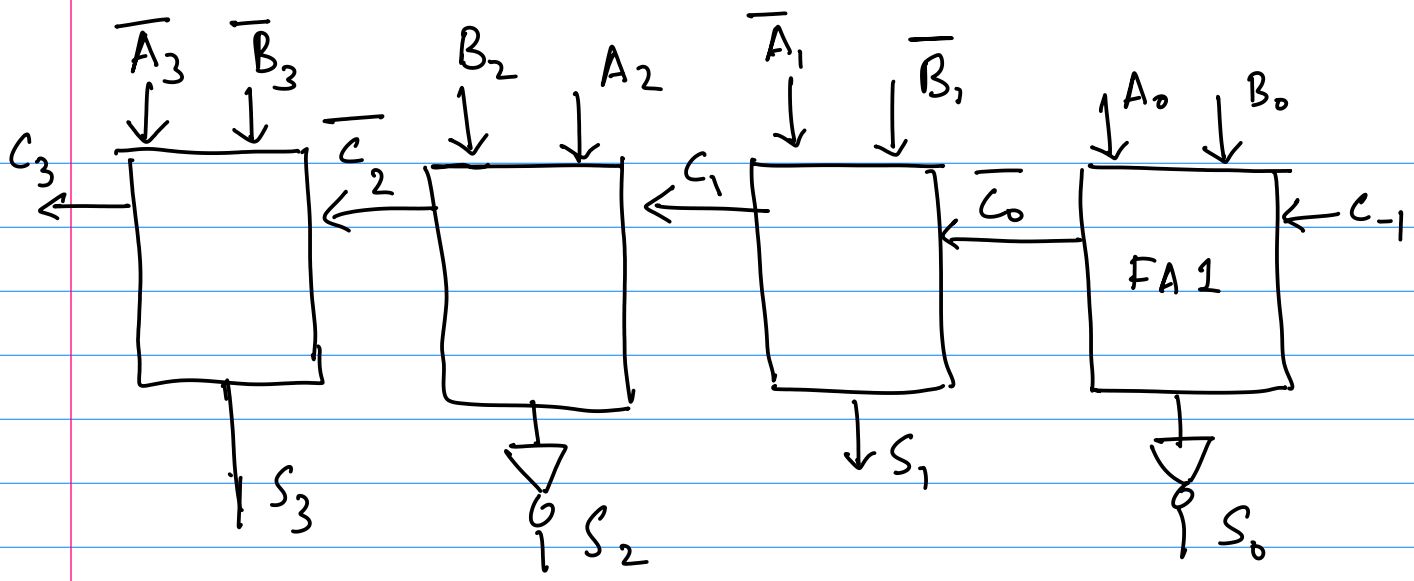
$t = 0$; A_i, B_i, $(i = 0, \ldots 3)$, C_{-1}

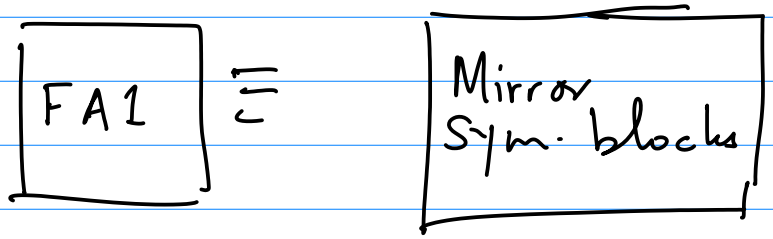
C_0 : $t = 4$ C_1 : $t = 8$

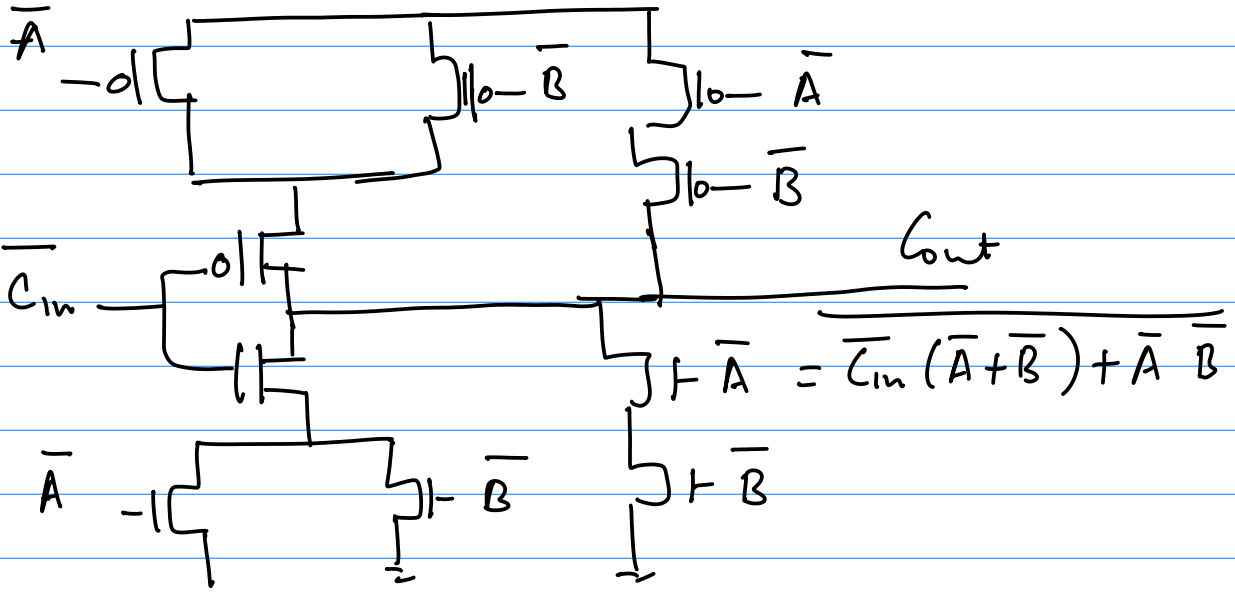
S_0 = $t = 5$ S_1 . $t = 9$

C_2 : $t = 12$ C_3 : 16

S_2 : $t = 13$ S_3 : 17







$\overline{C_{out}} = \overline{C_{in}}(\overline{A}+\overline{B}) + \overline{A}\,\overline{B}$

S_3: 13, C_3: 12

Critical path: Carry path.

Can put extra processing in inputs; optimise carry path for speed.

$C_{out}(A, B, C_{in}) = \Sigma(3, 5, 6, 7)$

011, 101, 110, 111

$A \oplus B = 1$; $C_{in} = 1$; $A, B = 1$; $C_{in} = X$

$G = AB$ (Generate)

$P = A \oplus B = A\bar{B} + \bar{A}B$

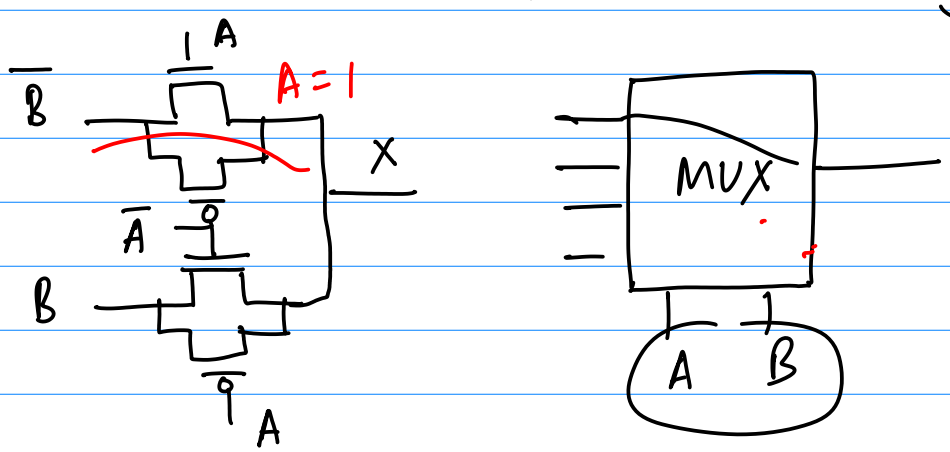
$C_{out} = G + PC_{in}$

$= \bar{P}A + PC_{in} \rightarrow$

$\bar{P} = \bar{A}\bar{B} + AB$

Implementation with transmission gates

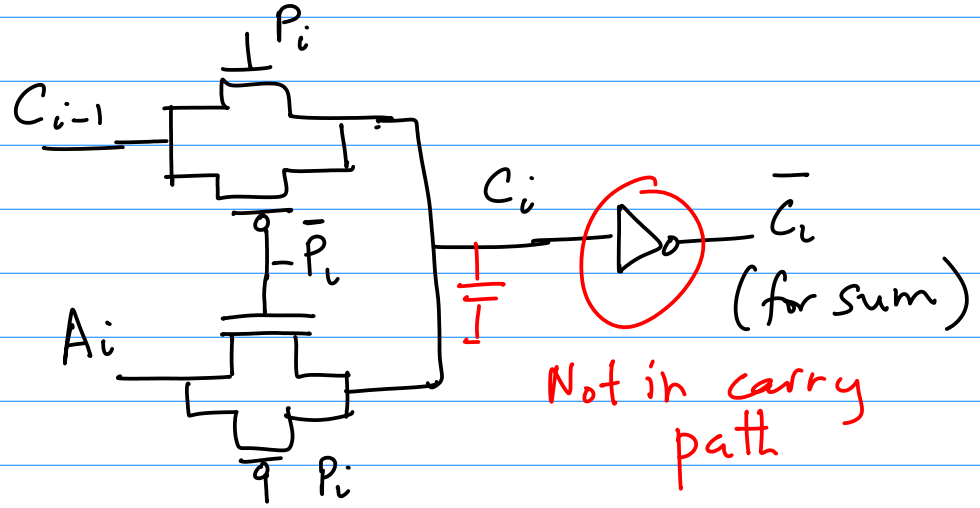
$A \oplus B$



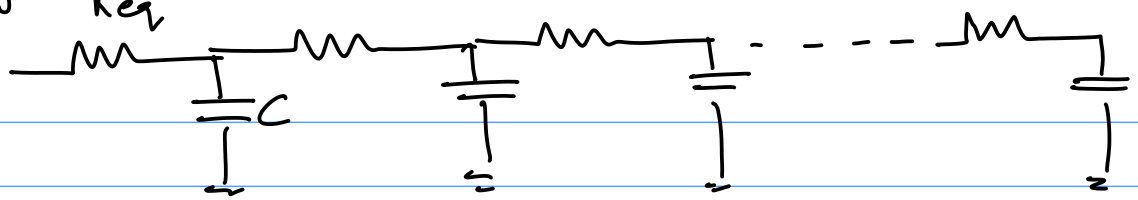
$S = P \oplus C_{in} = P\bar{C}_{in} + \bar{P}C_{in}$

$t = 0$; A_i, B_i

$t = 2$ P_i $\forall i$



Carry: Req

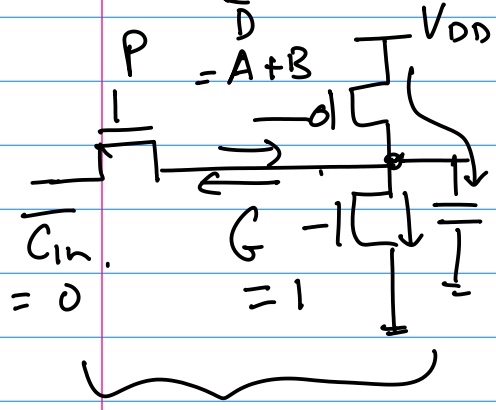


Can get very slow unless buffers are placed appropriately. (Delay $\propto N^2$ without buffers)

$P = A \oplus B$

$G = AB$: carry generate

$D = \bar{A}\,\bar{B}$: carry kill.



$\overline{C_{out}} = \Sigma(0, 1, 2, 4)$

$A, B = 0$ $\quad C_{in} = 0$

$P = 1$

$A, B = 1$ ✓

$C_{in} = 1$ ✓

A or $B = 1$