

→ Adder: 3-types

- 1) Serial adder
- 2) Parallel adder
- 3) Look ahead Carry Adder

1) Serial adder → 4-bit adder

↳ Slowest adder X

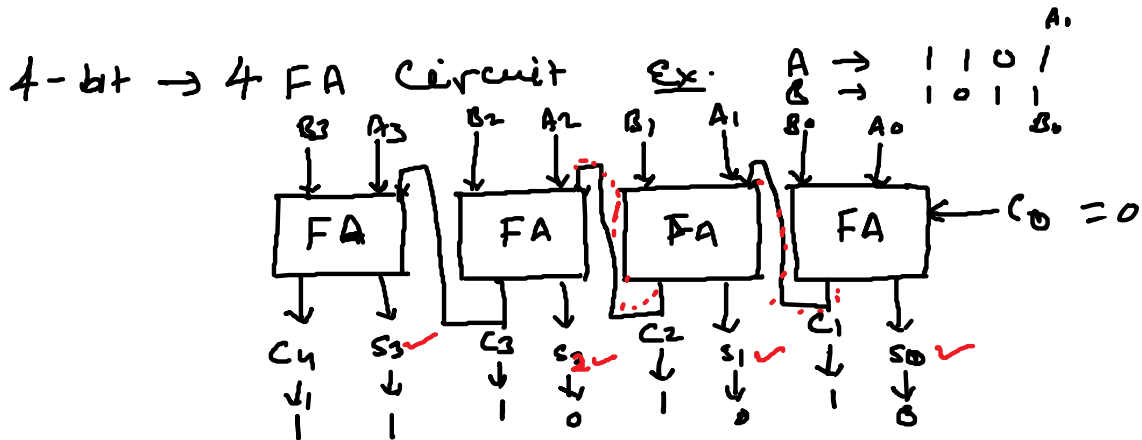


Very slow adder

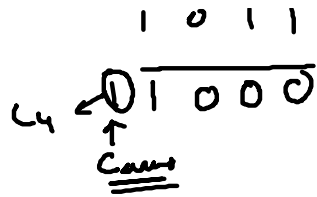
2) Parallel adder → 4-bit

↳ 4-FA Circuit  
or

1HA + 3FA Circuit



$$\begin{array}{r} A_3 \ A_2 \ A_1 \ A_0 \qquad B_3 \ B_2 \ B_1 \ B_0 \\ 1 \ 1 \ 0 \ 1 \qquad + \ 1 \ 0 \ 1 \ 1 \\ \hline C_3 \ C_2 \ C_1 \\ \textcircled{1} \ \textcircled{1} \ \textcircled{1} \\ + \ 1 \ 1 \ 0 \ 1 \\ \hline \end{array}$$



→ Parallel Adder → Ripple Carry Adder

Carry → serially propagating

Sum → parallel propagation

→ As compare to serial Adder → faster

→ How carry can be take out parallel ?

Delay

$$T_{\text{delay}} = 2n t_{pd}$$

Here

$T_{\text{delay}}$  = Total or overall delay

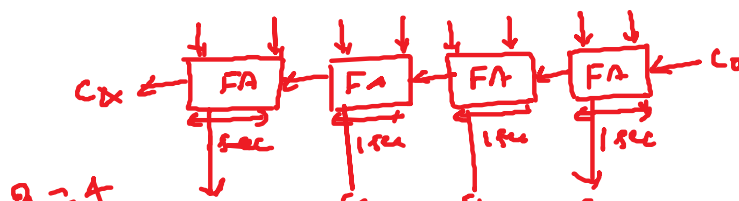
$n$  = no. of bits / blocks

$t_{pd}$  = Each block delay

Ex

4-bit adder

$$t_{pd} = 1 \mu$$



$$9 = 4 \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$$

$$s_3 \quad s_2 \quad s_1 \quad s_0$$

$$\text{Sum} = 1 \underline{\underline{\mu\text{e}}}$$

$$\text{Carry} = 4 \text{ sec.}$$

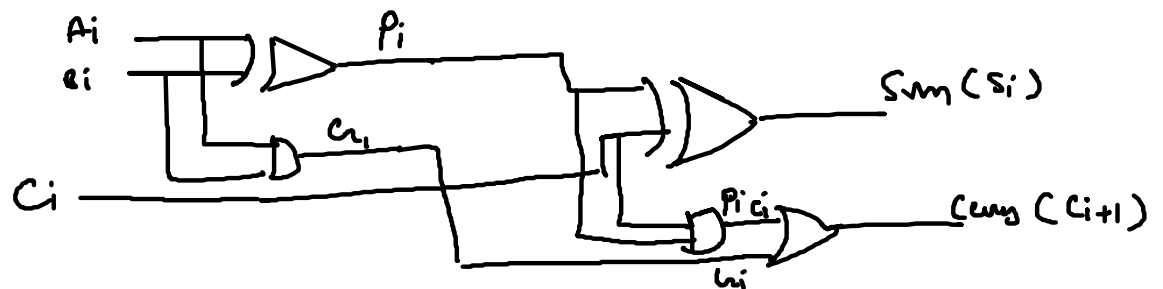
$$T_{\text{delay}} = 2 \times 4 \times 1 = \underline{\underline{8 \text{ sec}}}$$

→ Look Ahead Carry Adder :- (LACA)

→ PA → Carry propagation delay

→ If No. of bits ↑ speed of operation ↓

→ LACA ✓



$P_i \rightarrow$  Propagation

$G_i \rightarrow$  generation

$$P_i = A_i \oplus B_i$$

$$G_i = A_i B_i$$

$$S_i = P_i \oplus C_i$$

$$C_{i+1} = P_i C_i + G_i$$

→ 4-bit LACA

$$A_3 \quad A_2 \quad A_1 \quad A_0$$

$$B_3 \quad B_2 \quad B_1 \quad B_0$$

$$P_0 = A_0 \oplus B_0$$

$$P_1 = A_1 \oplus B_1$$

$$P_2 = A_2 \oplus B_2$$

$$u_0 = A_0 B_0$$

$$u_1 = A_1 B_1$$

$$u_2 = A_2 B_2$$

$$u_3 = A_3 B_3$$

$$S_0 = P_0 \oplus C_0 \checkmark$$

$$S_1 = P_1 \oplus C_1 \checkmark$$

$$S_2 = P_2 \oplus C_2 \checkmark$$

$$S_3 = P_3 \oplus C_3 \checkmark$$

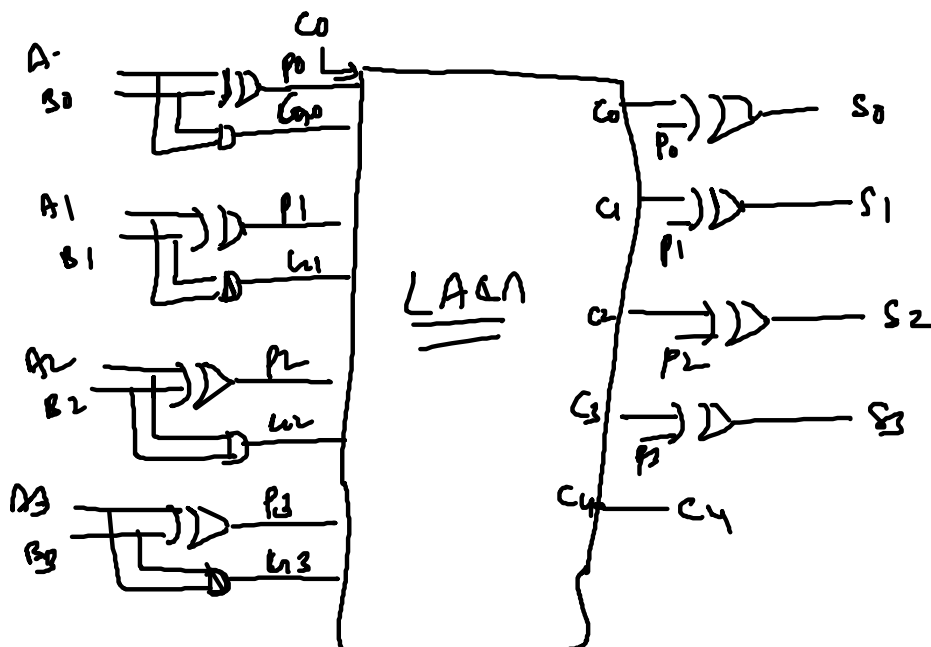
→ Carry  $C_{i+1} = P_i C_i + u_i \quad \{ i = 0, 1, 2, 3 \}$

$$C_1 = P_0 C_0 + u_0 \quad \{ i = 0 \}$$

$$C_2 = P_1 C_1 + u_1 = P_1 P_0 C_0 + P_1 u_0 + u_1 \quad \{ i = 1 \}$$

$$C_3 = P_2 C_2 + u_2 = P_2 P_1 P_0 C_0 + P_2 P_1 u_0 + P_2 u_1 + u_2 \quad \{ i = 2 \}$$

$$C_4 = P_3 C_3 + u_3 = P_3 P_2 P_1 P_0 C_0 + P_3 P_2 P_1 u_0 + P_3 P_2 u_1 + P_3 u_2 + u_3 \quad \{ i = 3 \}$$



LACA

$$\boxed{T_{\text{avg}} = 2 t_{pd}}$$

Very faster than

Ex

$$t_{pd} = 1 \text{ sec}$$

$$\boxed{T_{\text{avg}} = 2 \text{ sec}}$$