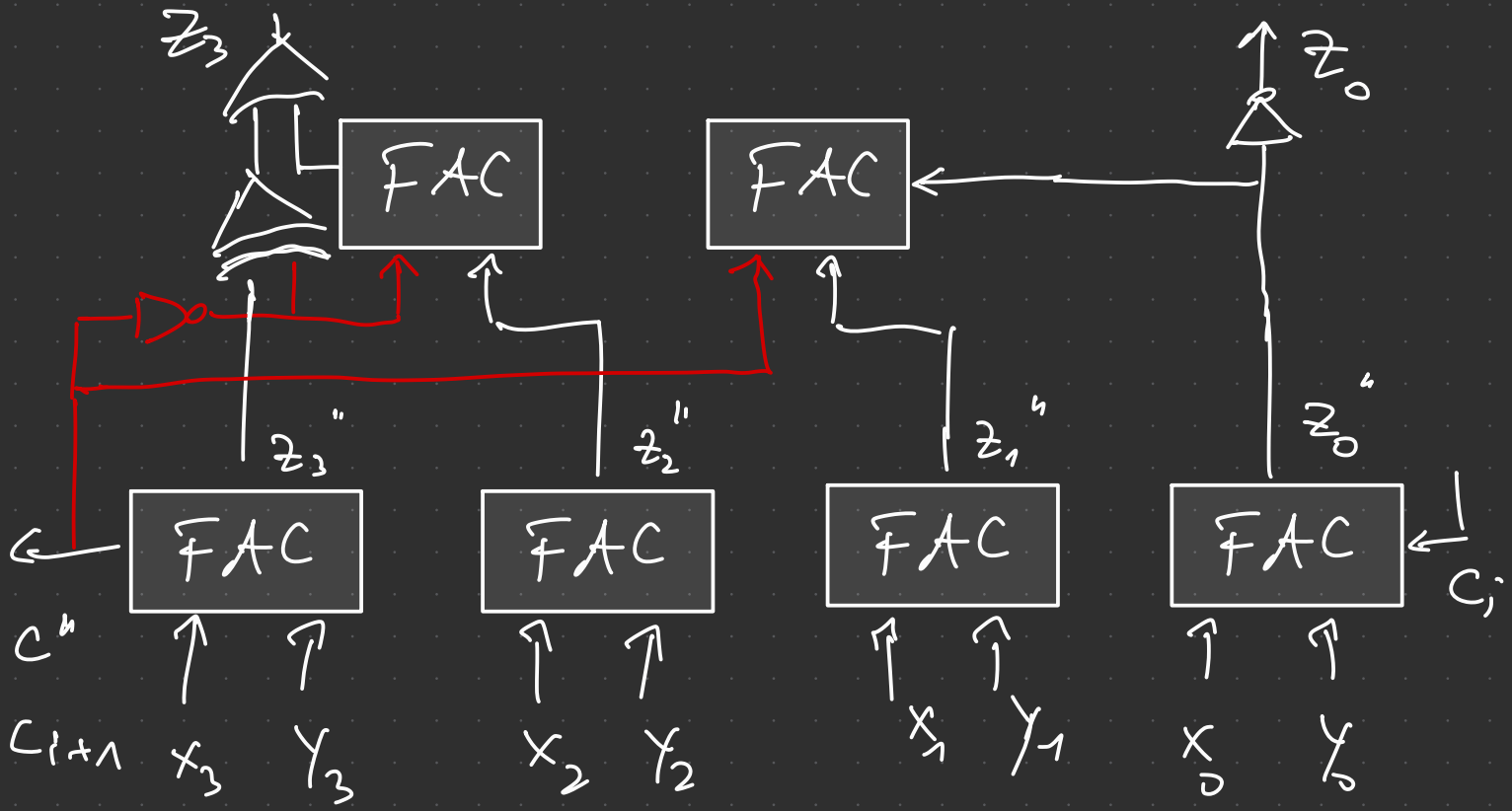
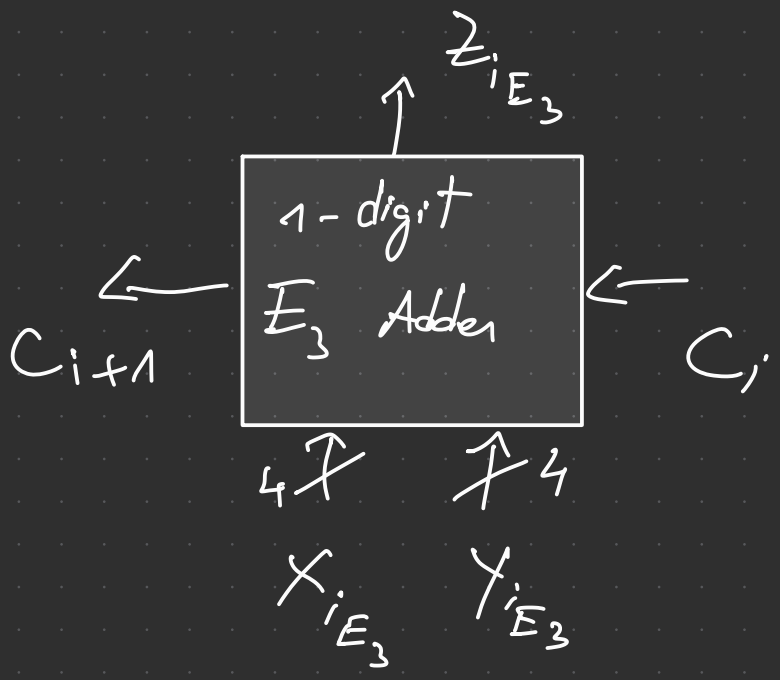
Sumator tetradă exces de 3





$497 + 485 = 982$

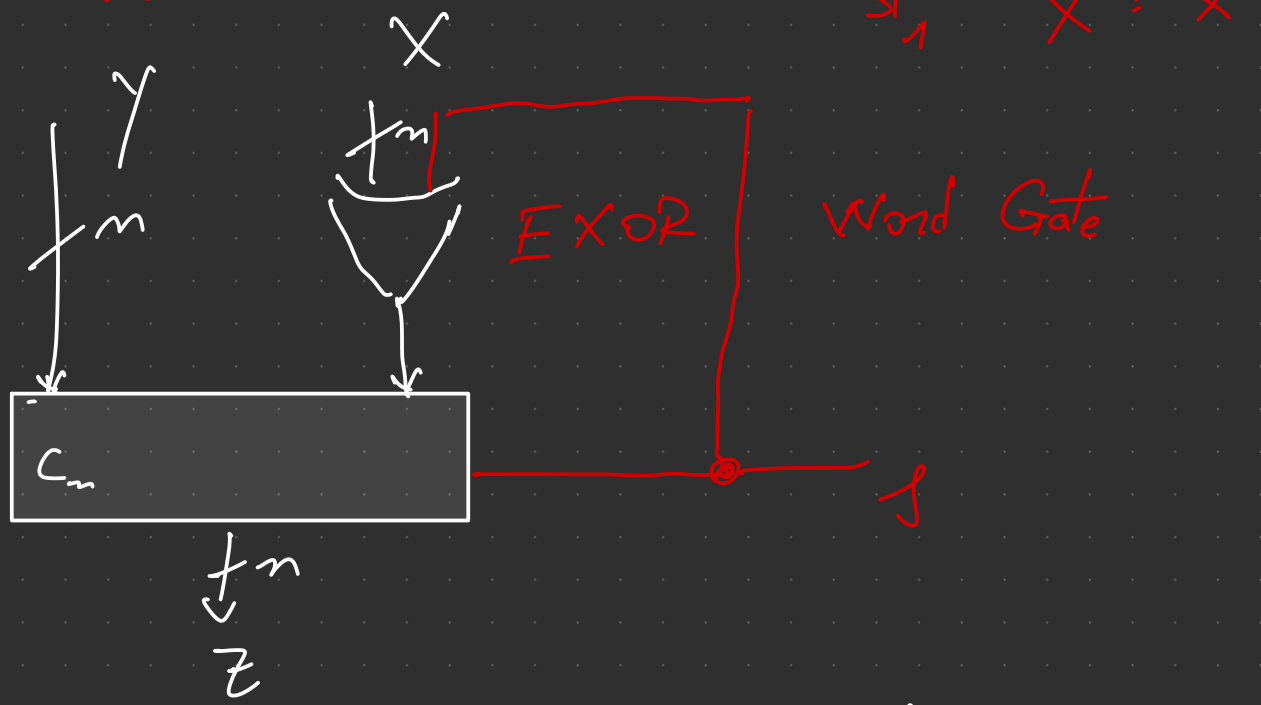
1 1 1	0111	1100	1010	E_3
	0111	1011	1000	
	01111	11000	10010	+
	1101	0011	0011	
	1100	1011	0101	
	9_{E_3}	8_{E_3}	$2_{Zm\ E_3}$	

Scăzătoare serială

$Z = Y - X$ (A) $Y - X = Y + (-X)$

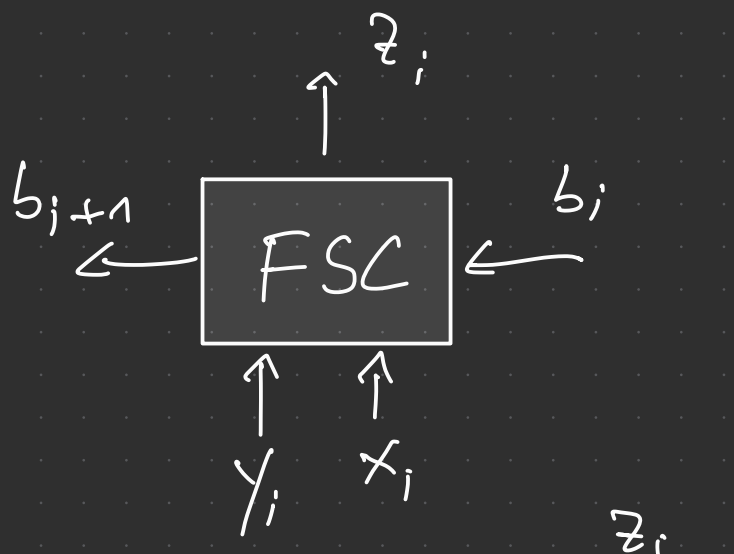
Adder Subtractor

$x^*: 1 \to \overline{x}$, $0 \to x$ ($x^* = x$, $x^* = \overline{x}$)



J: 0: $Z = Y + X + 0 = Y + X$

1: $Z = Y + \overline{X} + 1 = Y - X$ (C_2)



$$y_i - x_i - b_i \begin{cases} z_i \\ z_{i+1} \end{cases}$$

y_i	x_i	b_i	z_i	b_{i+1}
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

$$z_i = y_i \oplus x_i \oplus b_i$$

$$b_{i+1} = \overline{y_i}\, x_i + \overline{y_i}\, b_i + x_i b_i$$

Scăzător BCD

$x^{(k)}, y^{(k)}$ — k-digit BCD 8421 number

$z^{(k)} = y^{(k)} - x^{(k)}$

x_i = BCD digit $\quad x_i = x_3 x_2 x_1 x_0$

↳ $\overline{x_i}^*$ — 9's complement of x_i

$$\overline{x_i}^* = 9 - x_i$$

$$\overline{X^{*(k)}} = \overline{X^*_{n-1}}\ \overline{X^*_{n-2}} \cdots \overline{X^*_0}$$

$$= \underbrace{9\,9\,9 \ldots 9}_{k} - x_{k-1}\, x_{k-2} \cdots x_0$$

$$\boxed{\overline{X}^{*(k)} = 10^k - 1 - X^{(k)}}$$

$$Z^{(k)} = \left(Y^{(k)} - X^{(k)}\right) \bmod 10^4$$

$$= \left(Y^{(k)} + \underbrace{10^k - 1 - X^{(k)}}_{X^{*(k)}} + 1\right) \bmod 10^k$$

$$Z^{(k)} = \left(Y^{(k)} + \overline{X}^{*(k)} + 1\right) \bmod 10^k$$

$X_i = x_3\, x_2\, x_1\, x_0 \qquad \overline{X_i}^* = 9 - X_i = x_3^*\, x_2^*\, x_1^*\, x_0^*$

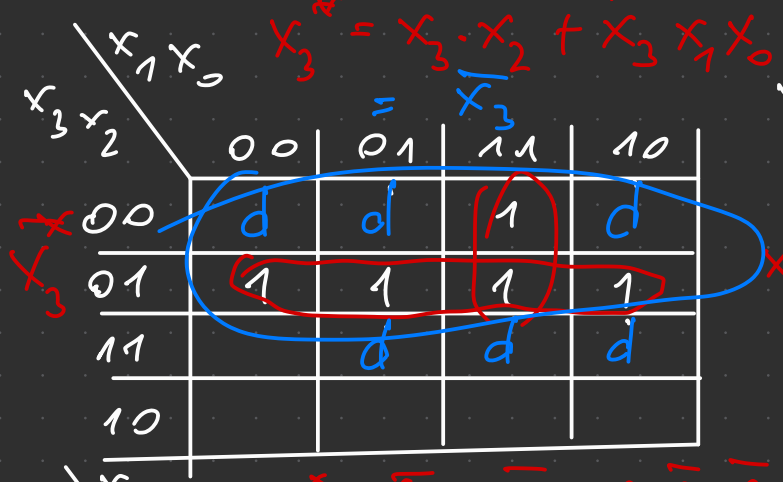
$$\begin{cases} x_3^* = \overline{x_3 + x_2 + x_1} \\ x_2^* = x_2 \oplus x_1 \\ x_1^* = x_1 \\ x_0^* = \overline{x_0} \end{cases}$$

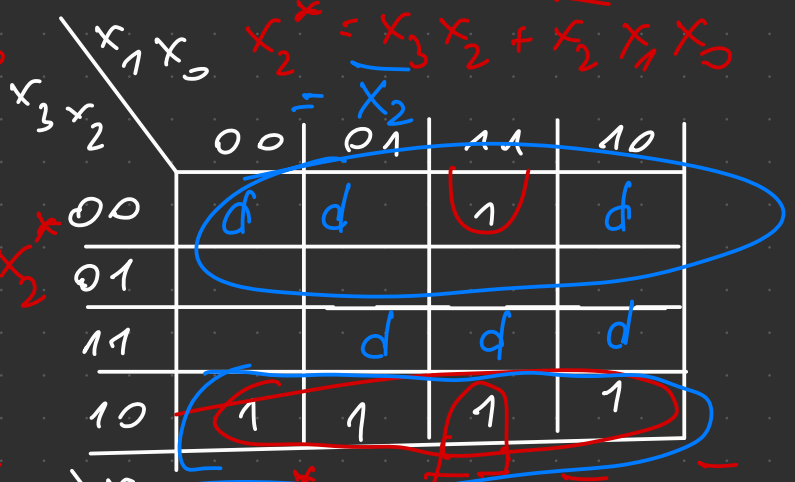
$$\begin{array}{r} 803- \\ 279 \\ \hline 524 \end{array} \qquad \begin{array}{r} 803+ \\ 720 \\ \hline 524 \end{array}$$

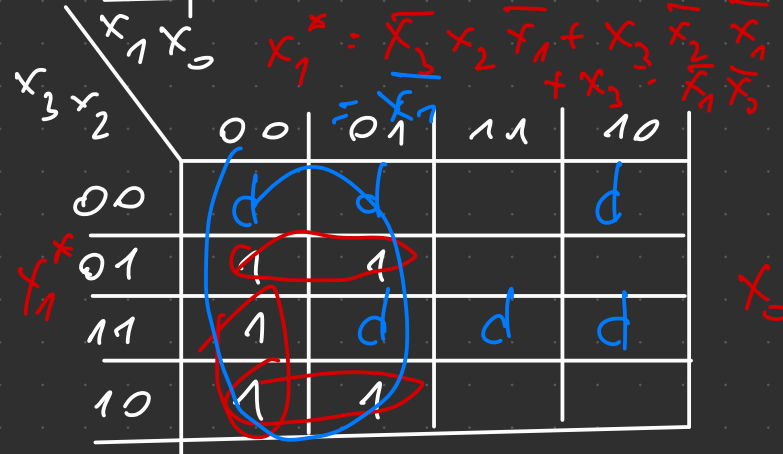
$$\begin{array}{r} 999- \\ 279 \\ \hline 720 \end{array}$$

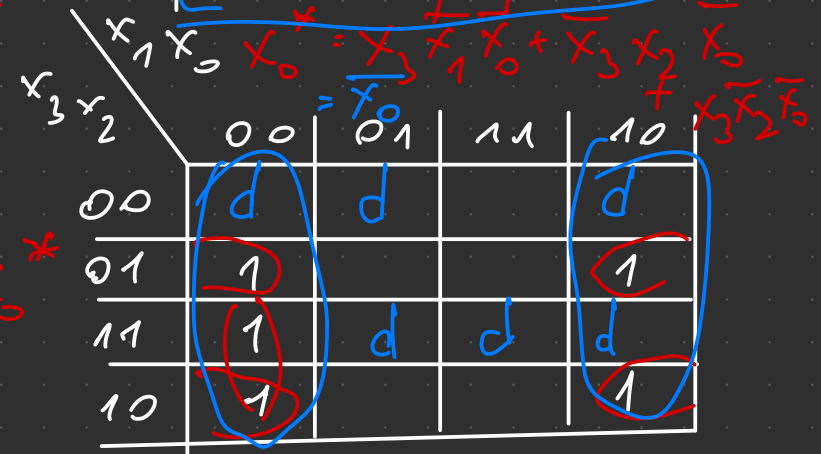
pf. $\overline{E}_3$ → modificare tabel complement de 9

	x_3	x_2	x_1	x_0	x_3^*	x_2^*	x_1^*	x_0^*
0	0	0	0	1	1	1	0	0
1	0	0	1	0	1	0	1	1
2	0	0	1	1	1	0	0	0
3	0	0	1	1	1	0	0	1
4	0	1	0	0	1	0	0	0
5	0	1	0	1	0	1	1	1
6	0	1	1	0	0	1	1	0
7	0	1	1	1	0	1	0	1
8	1	0	0	0	0	1	0	0
9	1	0	0	1	0	0	1	1









Calcul paralel a sumei

Carry Look-Ahead — pur teoretic

F-CLA

- semnale propagate / generate

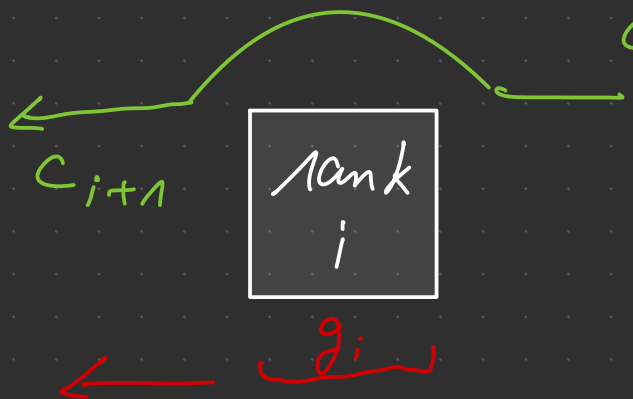
$$g_i = x_i \cdot y_i \rightarrow 1\Phi$$

$$p_i = x_i + y_i \rightarrow 1\Phi$$

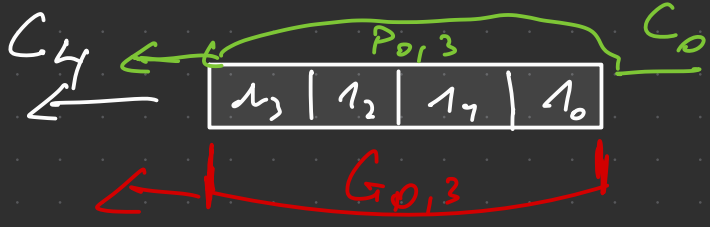
$$c_4 = g_3 + p_3 c_3$$

$$c_4 = \underbrace{g_3 + p_3 g_2 + p_3 p_2 g_1 + p_3 p_2 p_1 g_0}_{G_{0,3}} + \underbrace{p_3 p_2 p_1 p_0}_{P_{0,3}} c_0$$

$$\boxed{c_{i+1} = g_i + p_i c_i}$$



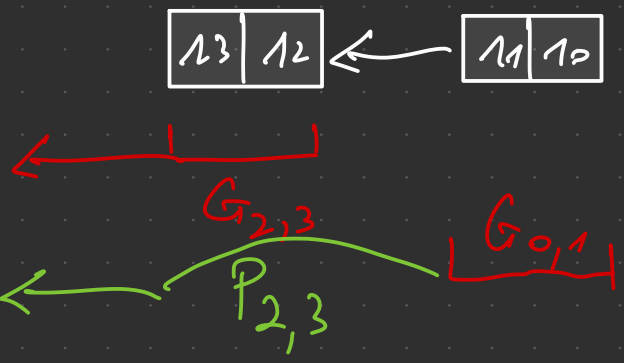
$$c_4 = G_{0,3} + P_{0,3} \cdot c_0$$



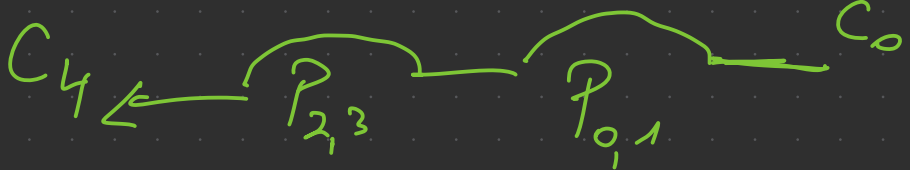
→ variabile de generare la nivel de bloc

$$C_4 = \underbrace{g_3}_{G_{2,3}} + \underbrace{p_3}_{P_{2,3}} \cdot \underbrace{g_2}_{G_{0,1}} + \underbrace{p_3 p_2}_{P_{2,3}} \cdot \underbrace{(g_1 + p_1 g_0)}_{P_{0,1}} + p_3 p_2 p_1 p_0 \, c_0$$

$G_{0,3}$



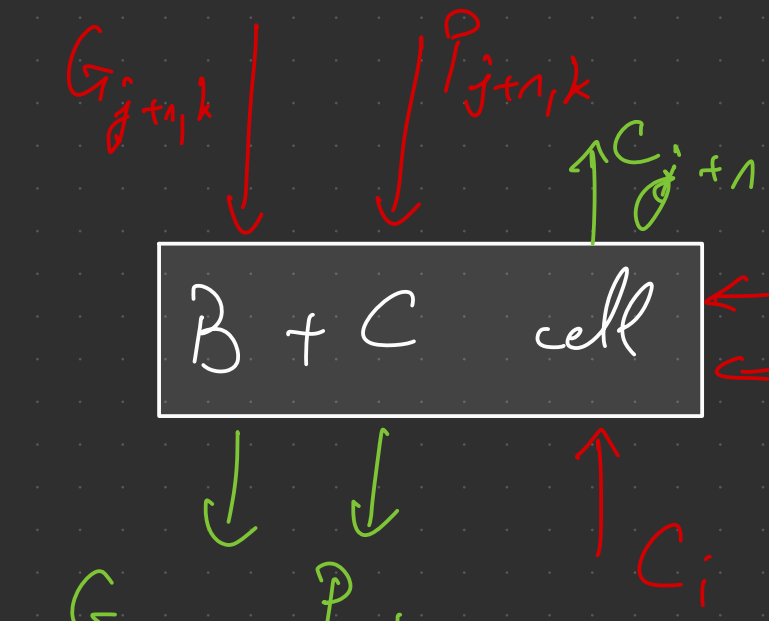
$P_{0,3}$



$$C_{j+1} = G_{i,j} + P_{i,j} \cdot C_i \qquad \forall i \le j$$

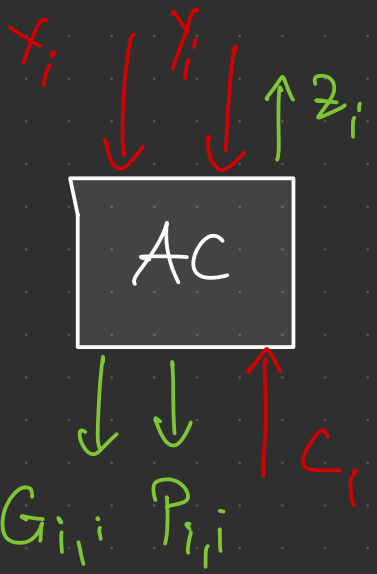
$$G_{i,k} = G_{j+1,k} + P_{j+1,k} \cdot G_{i,j} \qquad \forall i \le j < k$$

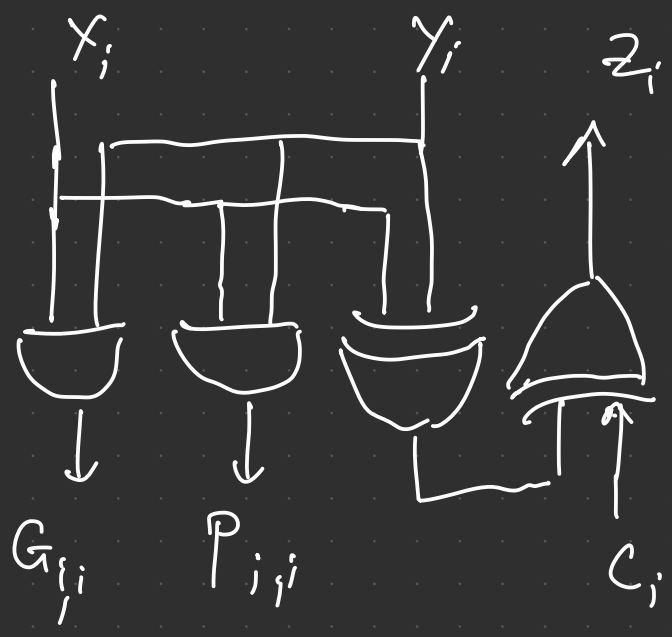
$$P_{i,k} = P_{j+1,k} \cdot P_{i,j} \qquad \forall i \le j < k$$



B → bloc

C → carry





Arhitectura CLA pe 4 biți

pt AC cell

$G_{i,i}$, $P_{i,i}$ → 1d

z_i → Δ_{C_i} + 2d

pt. B+C cell

Δ

$$\Delta_{ML-CLA-4} = 9\Delta - 2\lceil \log_2 n \rceil d$$

Cout

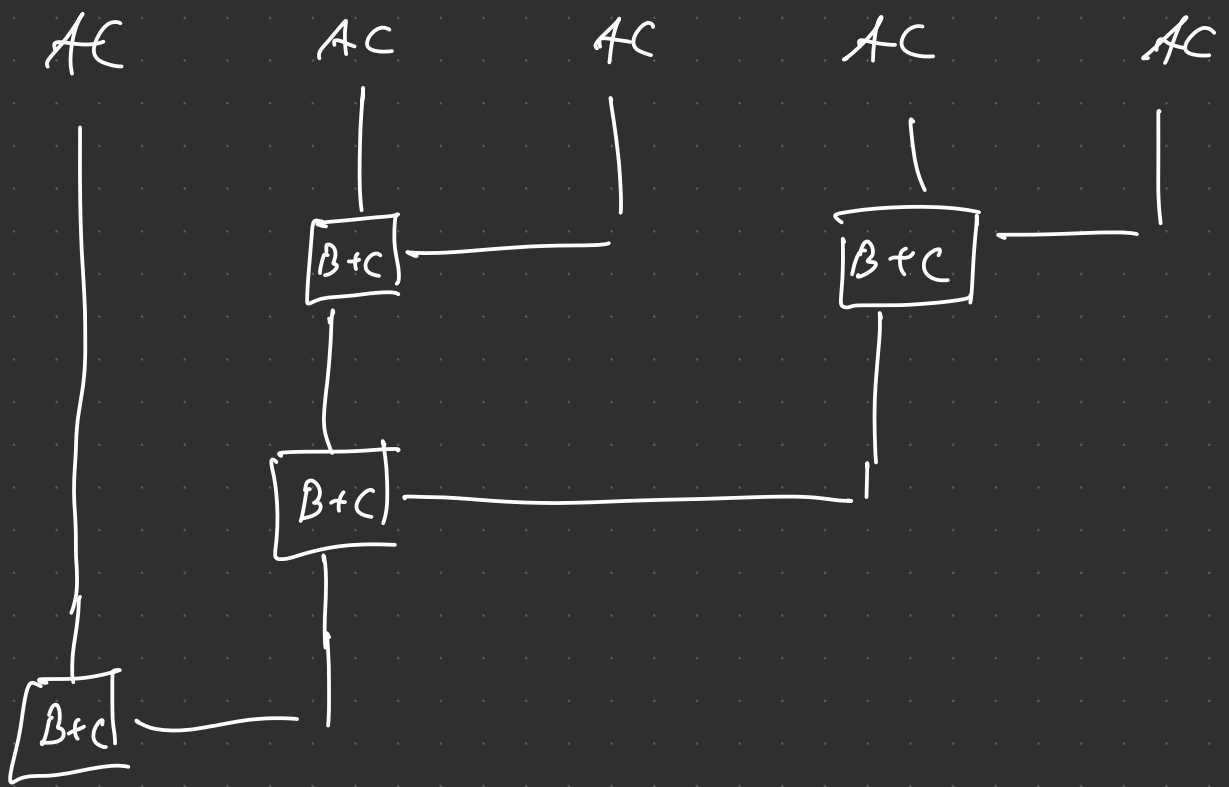
1) $\Delta_{ML-CLA-n} = \underbrace{1d}_{G_{ii}, P_{ii}} + 2\underbrace{\lceil \log_2 n \rceil}_{\text{niveles } B+C} d + \underbrace{2d}_{C_{out}}$

ML -> multi level

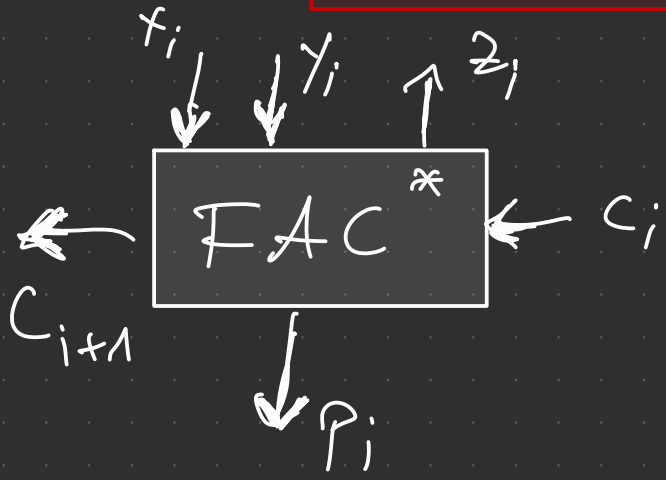
$= \left(2\lceil \log_2 n \rceil + 3\right) d$

2) $\Delta_{ML-CLA-n} = \left(4\lceil \log_2 n \rceil + 1\right) d$

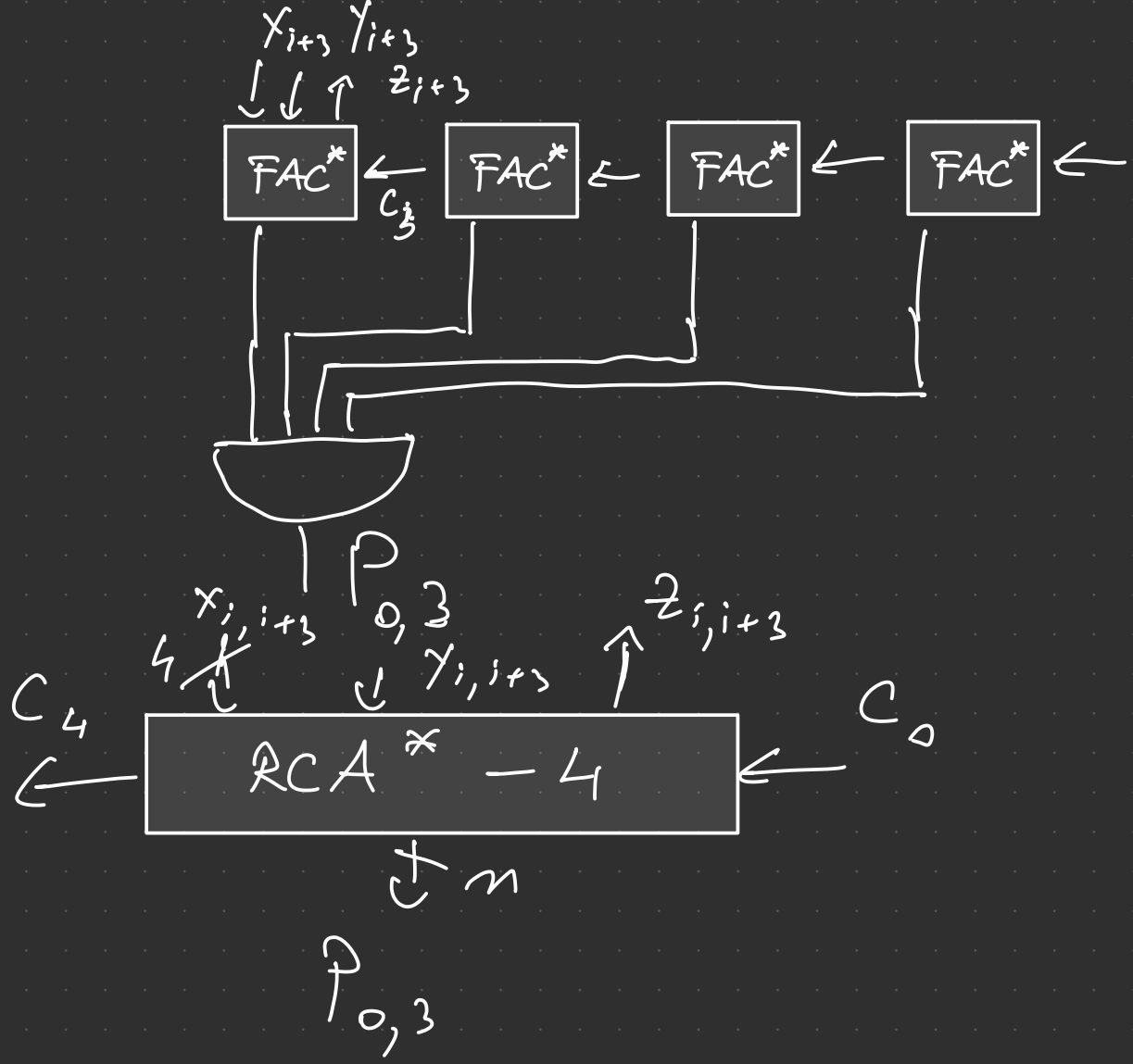
$1d + \left(2\lceil \log_2 n \rceil - 1\right) d + 2\lceil \log_2 n \rceil d + 2d$



Sumator Carry Skip



$$\begin{cases} p_i = x_i + y_i \\ z_i = x_i \oplus y_i \oplus c_i \\ c_{i+1} = x_i \cdot y_i + x_i \cdot c_i + y_i \cdot c_i \end{cases}$$



CMOS pre-discharge

→ toate semnalele carry vor fi predescărcate (val. 0) înainte de calcul

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16 biți