

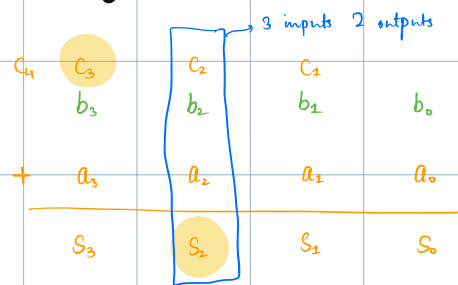
2024/09/30 - Digital Circuits - Week 10

Arithmetic

addition, multiplication, division

subtraction

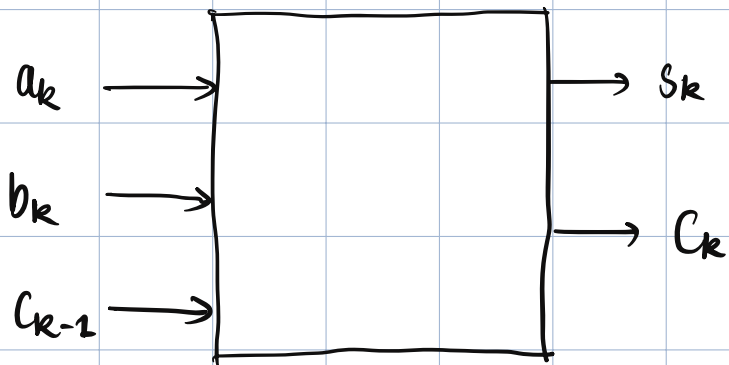
adding 2 4-bit numbers



C_{k-1}	b_k	a_k	S_k	C_k
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

b, a	00	01	11	10
C_k				
0	0	0	1	0
1	0	1	1	1

$$ab + ca + cb$$



Find $S_k(a_k, b_k, C_{k-1})$

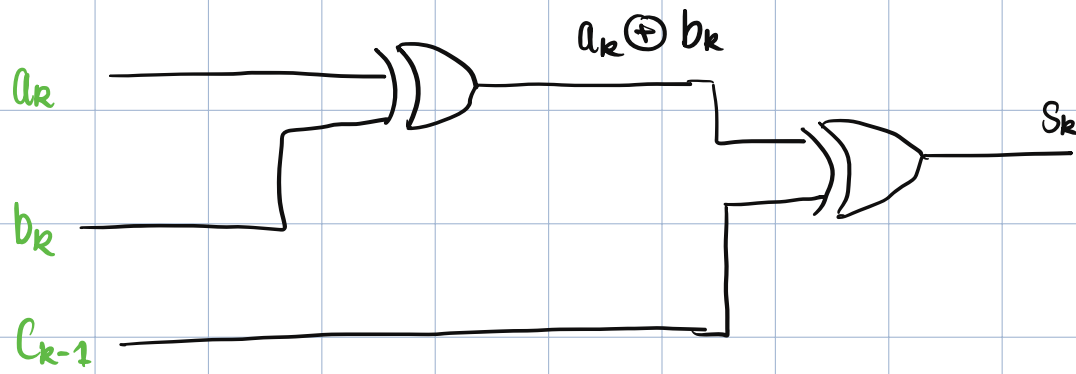
$C_k(a_k, b_k, C_{k-1})$

$$S_k = a_k \oplus b_k \oplus C_{k-1}$$

$$C_k = a_k b_k + C_{k-1} a_k + C_{k-1} b_k$$

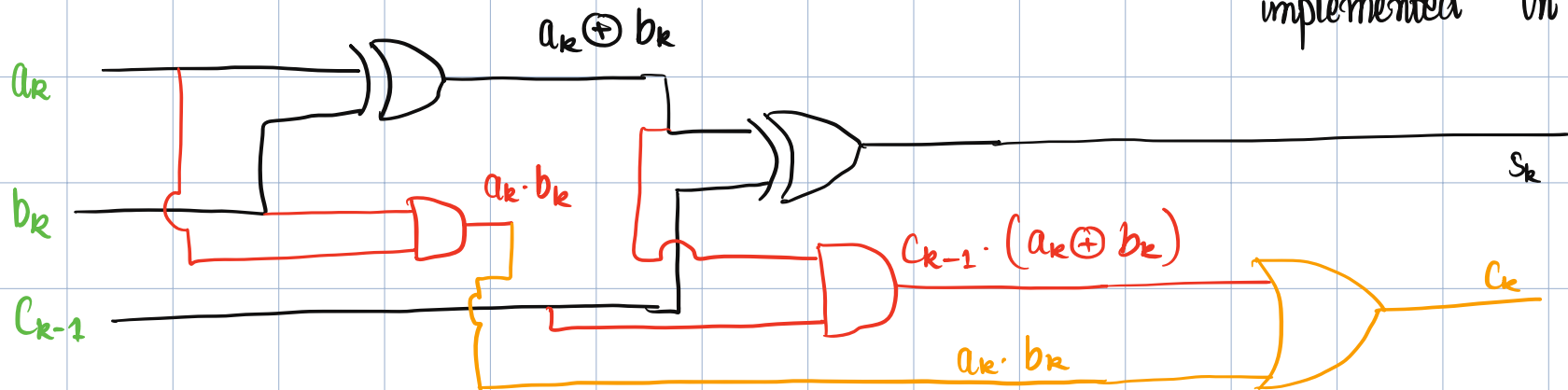
$$= a_k b_k + C_{k-1} \cdot (a_k \oplus b_k)$$

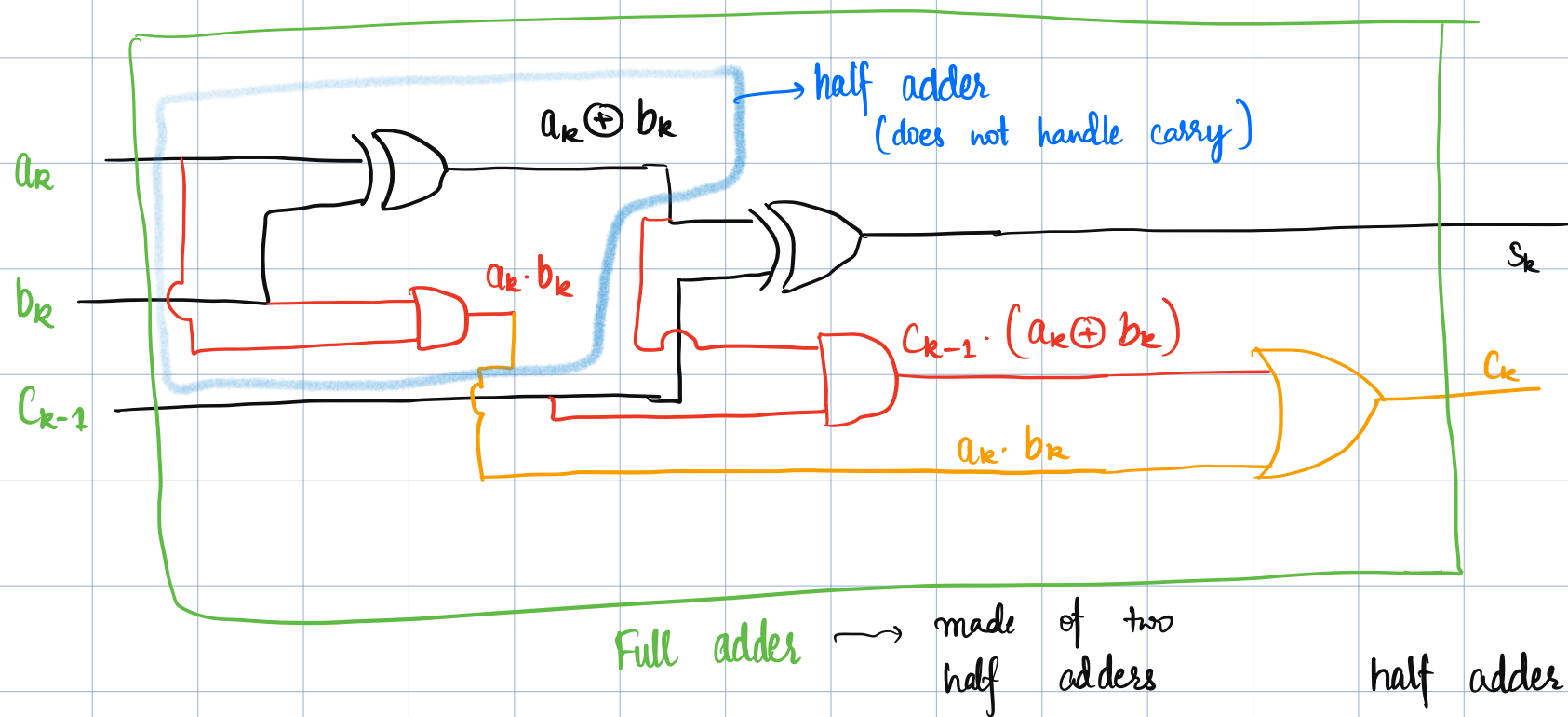
both 'xor' and 'or' work



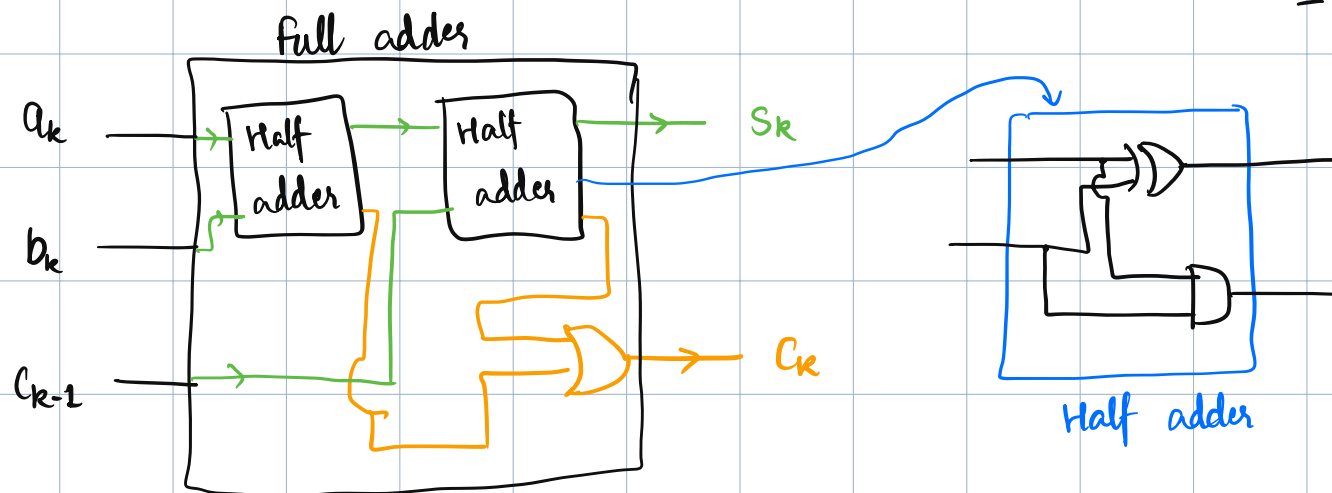
$$C_k = a_k b_k + c_{k-1} a_k + c_{k-1} b_k$$

$$= a_k a_k + c_{k-1} \cdot (a_k \oplus b_k) \rightarrow \text{better choice } (a_k \oplus b_k \text{ is already implemented in } S_k)$$





half adder
= 1 xor +
1 and gate

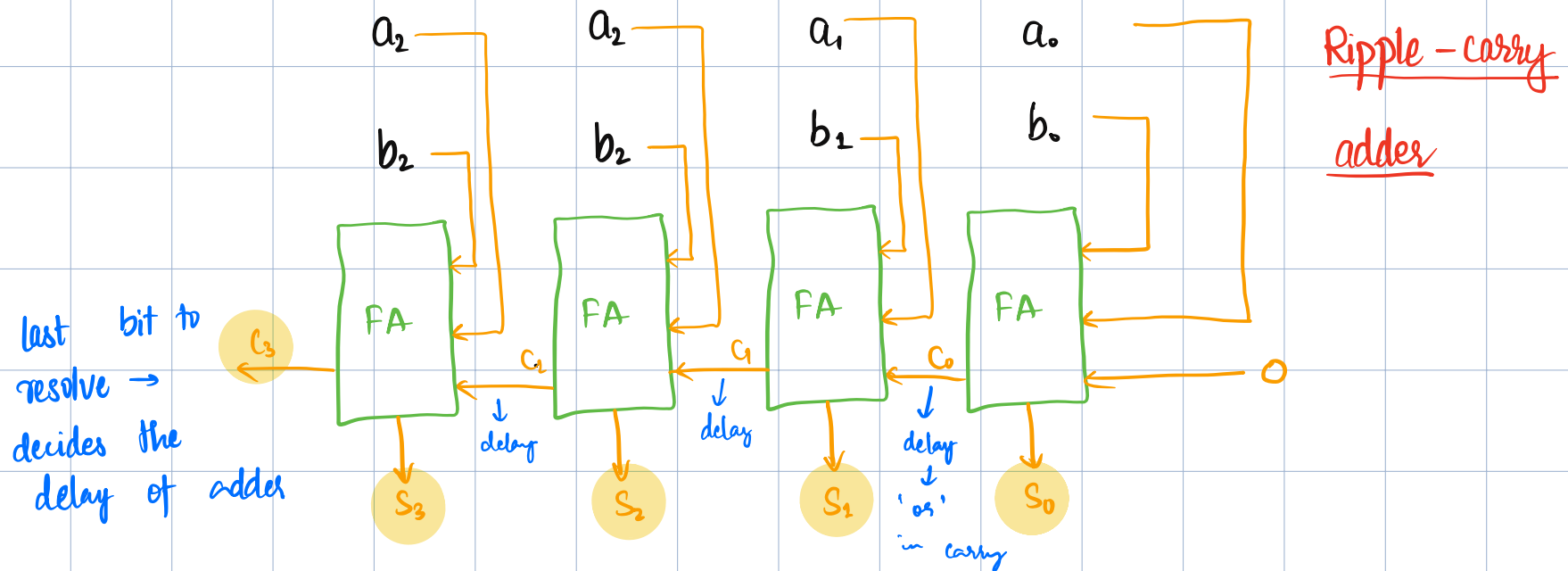


Ex: 4-bit adder \rightsquigarrow by default, assume that 5th bit is also needed.

*You cannot send all four bits at once.

Solutions:

- Time multiplexing
- Have 4 full adders



- Assume τ = delay for each gate

total delay (4-bit)

\downarrow
 12τ

