☆ **Adder** – Area & Delay → Depends on structure

↓

key factor

⇒ (Carry forwarding)

∴ Trade-off between area(power) & speed.

: Ripple Carry Adder
Carry Bypass Adder
Carry Select Adder
Sparse Tree Adder
Manchaster Adder

(Integer) Signed 2's complement, unsigned, ..

↳ [FA]–[FA]–[FA]–[HA] (4 bit case)

⇑ Use P.G.K for carry forwarding

(Fixed Point) (fast addition)

Integer	.	fractional
+ I	.	F

① ~~Just~~ like adding two integers

× [ ] . [ ]
[ ] . [ ]

① multiplying 2 integers
② & consider position of the radix point

(Floating point) (fast multiplication)

Exponent	.	Mantissa
+ Exponent	.	Mantissa

① Match exponent
② Add Mantissa

× [ ] . [ ]
[ ] . [ ]

① ~~Ad~~ Multiply Mantissas
② Add exponents

(ex) 1.0110101 × 2^1011

⇒ [0] [+1011] [0110 |]

sign 1bit, -127–128, 8bits (start from -127), 23 bits ⇒ 32 bits

Adder

1. Truth Table → 2. Arithematic → 3. Logic

a → Adder → c
b →

a + b	⇒ c
0 1	1
1 0	1
0 0	0
1 1	0 + carry → Need to conside rt!

C_I

a → Adder → Sum
b →
C_o

a b C_I	Sum C_o
0 0 0	0 0
1 0 0	1 0
0 1 0	1 0
1 1 0	0 1
0 0 1	0 1
1 0 1	0 1
0 1 1	0 1
1 1 1	1 1

carryoutchip

$C_o = (A \cap B \cap C^c) \cup (A^c \cap B \cap C) \cup (A \cap B^c \cap C) \cup (A \cap B \cap C)$

$= (A \cap B \cap C^c) \cup (A^c \cap B \cap C) \cup (A \cap C) \cap (B^c \cup B)$

$= A \cap ((B \cap C^c) \cup C) \cup (A^c \cap B \cap C)$

$B \cup C$

$= A \cap (B \cup C) \cup (A^c \cap B \cap C)$

$= (A \cap B) \cup (A \cap C) \cup (A^c \cap B \cap C)$

$= B \cap (A \cup (A^c \cap C)) \cup (A \cap C)$

$= B \cap (A \cup C) \cup (A \cap C)$

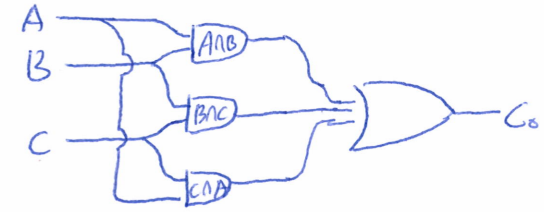
$C_o = (A \cap B) \cup (B \cap C) \cup (C \cap A)$

↓

Make a logic gate circuit !!

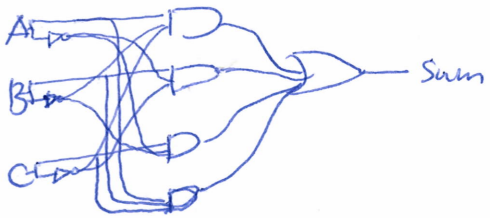
Gates : { AND (⊐), OR (⇒), NOT (▷○) }

⇒

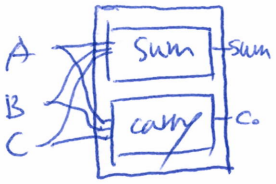


Sum chip

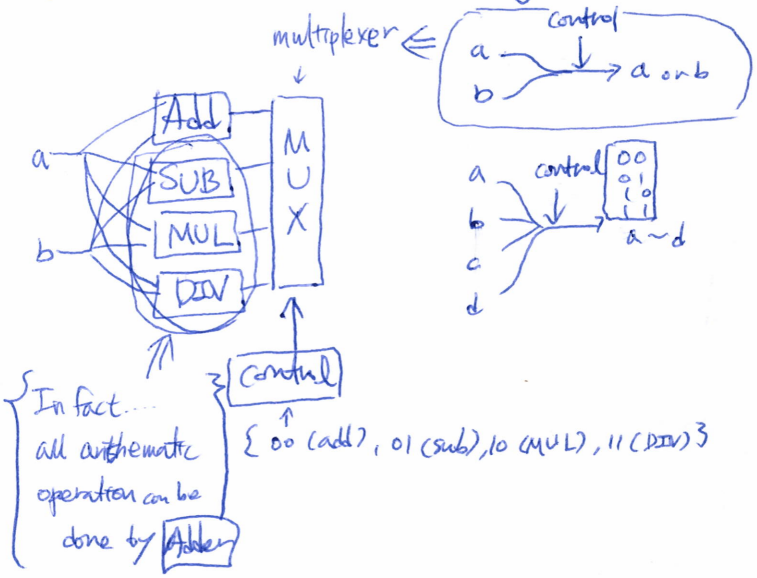
$Sum = (A \cap B^c \cap C^c) \cup (A^c \cap B \cap C^c) \cup (A^c \cap B^c \cap C) \cup (A \cap B \cap C)$

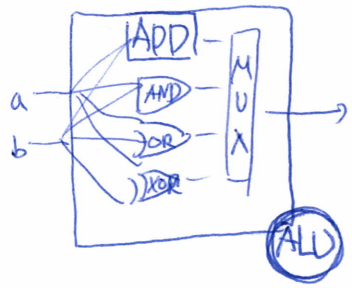


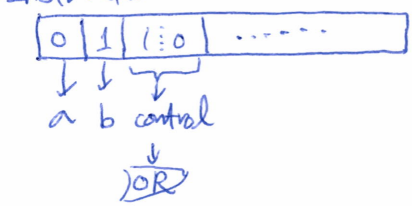
∴ Adder chip ⇒



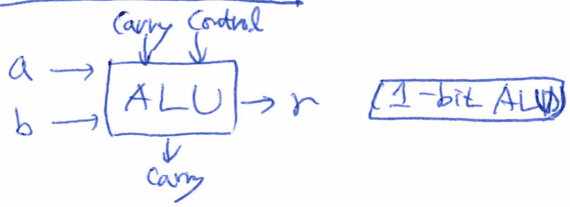
ALU (Arithematic Logic Unit)

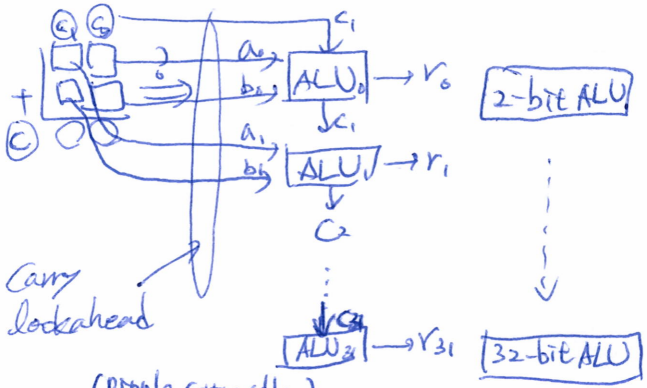






32-bit ALU





(Ripple carry adder)
⇒ this structure needs 32 times (energy/time)

∴ Carry look-ahead !
(goal ; all r_i & c_i are calculated at the same clock!!)

MUL