Unsigned integers.

Wallace tree multiplier
- Booth's method
- CSA
- CLA

Booth's Algorithm.

Signed multiplicand.

n (✓) Multiplicand
× ( ) multiplier
n

. . . . .

← 2n →

Integer Unit.

Operations: add, sub, mul, div.

Operands: Signed unsigned.

Sizes: 8, 16, 32, 64. ✓

unsigned short int w, x, y, z;

y = w * x;

ADD	16	W	X	Y

operation ↑ size. OP1 OP2 destination.

int A, B, C, D

C = A - B

SUB	32	A	B	C

D = A * B.

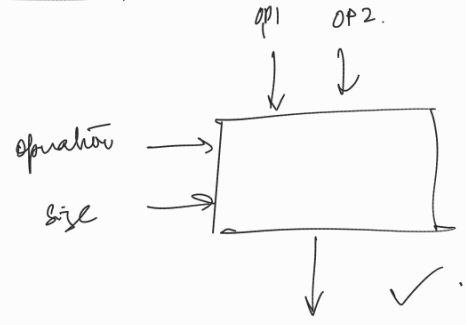
IMUL	32	A	B	D

sign.

z = w * x

MUL	16	W	X	Z

unsigned



✓

Real valued numbers.

n-bit representation.

Unsigned: 0 to $2^n - 1$

Signed: -2^{n-1} to $2^{n-1} - 1$

n = 4 → Range → -8 to +7.

64 bits.

unsigned: 0 to $2^{64}-1$

signed: -2^{63} to $2^{63}-1$

$\downarrow$

$\approx -10^{19}$ to 10^{19}

① motivation: extend the range

② motivation: Obvious.

Range

Resolution → integers (1)

Fixed point representation.

37.75

integer fraction.

i digits for integer
f digits for fraction.

37.75

i = 2

f = 2.

Smallest 00.01

Resolution: 10^{-f}

Largest 99.99

Range

100.00 → 10^{i}

− 00.01 → 10^{-f}

99.99 → $10^{i} - 10^{-f}$

Binary

i bits for integer
f bit for the fraction.

2^{-f} → resolution/precision.

$2^{i} - 2^{-f}$ → largest value

64 bit

i = 20
f = 44.

Resolution → 2^{-44} → 10^{-13}

Range → $[2^{20} - 2^{-44}]$ → 10^{6}

decimal to binary.

21.375

Repeated division.

2 | 21	
2 | 10	1
2 | 5	0
2 | 2	1
2 | 1	0
	1

backward.

10101

integer.

0.375 × 2

0	75
1	5
1	0
0	

0.75 × 2
0.5 × 2
0 × 2

forward.

Repeated multiplication.

011

10101.011

integer

Trade-off between Range & Resolution.

Goal: realize the flexible tradeoff.

Scientific Notation.

$X = 325.178$

Mantissa

Exponent

325.178×10^0

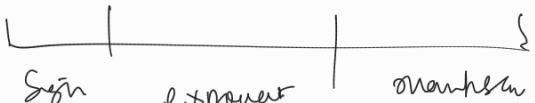
radix

32.5178×10^1

3.25178×10^2

325.178×10^{-1}

3257.8×10^{-2}



Normalize representation

only one nonzero digit to the left of the decimal point

IEEE