History of Computer Arithmetic, Part Deux

Caleb Jurgensen and Mason Wilde

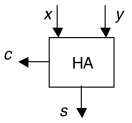
Integer Representation

- Base 2 Representation (aka radix-2)
- 2's Complement Representation
- How to represent decimals?
  - Fixed Point
    - (01101.1 = $2^3+2^2+2^0+2^{-1}$=13.5)
  - Floating Point

Addition/Subtraction

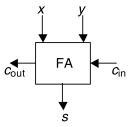
- Addition of two bits is a combination of logical AND and exclusive OR (XOR)
- Half adder vs. Full adder
- Ripple-carry adder
- Subtraction performed the same way we do it by hand.
- Carry-lookahead adder

Inputs		Outputs	
x	y	c	s
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

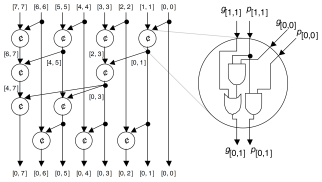


Half-Adder

Inputs			Outputs	
x	y	c_{in}	c_{out}	s
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1



Full-Adder



Brent-Kung lookahead carry network (8-digit)

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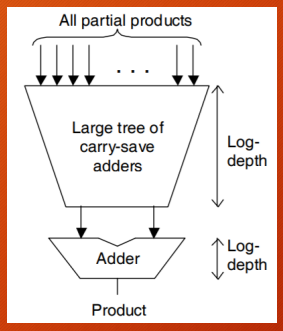
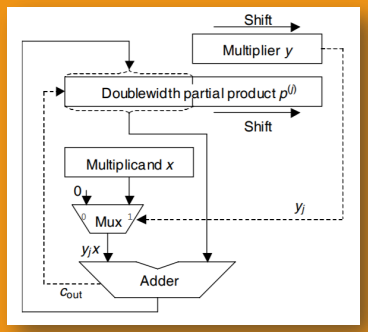
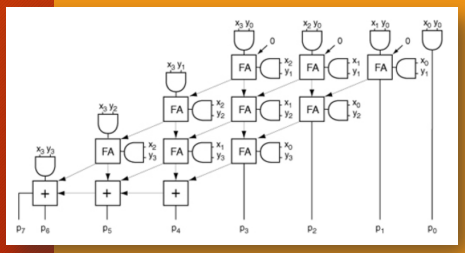
- Minecraft adds redstone dust

Multiplication

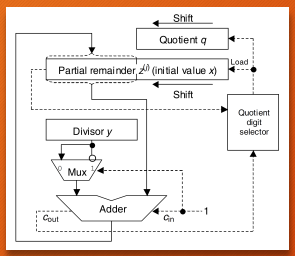
- Shift Add Multiplication
  - Software (Booth's Algorithm)
  - Hardware
- Array Multiplier
- Tree Multiplier
  - Full or Partial-tree
  - Dadda and Wallace Tree







Division



- Basic dividers carry out a variant of the binary-division-by-hand method
  - Aka shift subtract division
  - Can be sped up with higher-radix
- Faster Division Methods
  - Restoring division
  - Non-restoring division
  - SRT division
  - Newton-Raphson division
  - Goldschmidt division

Sources

- https://www.ece.ucsb.edu/~parhami/pubs_folder/parh02-arith-encycl-infosys.pdf
- https://en.wikipedia.org/wiki/Two%27s_complement#History
- https://en.wikipedia.org/wiki/Ones%27_complement
- http://www-inst.eecs.berkeley.edu/~cs61c/sp06/handout/fixedpt.html

Questions?

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