Computer Organization and Architecture

5 Decimal Arithmetic

Tongwei Ren

Sep. 24, 2019

NANJING UNIVERSITY

Review

- ALU, full adder, serial carry adder, carry look ahead adder

- Integer arithmetic operations

  - Addition

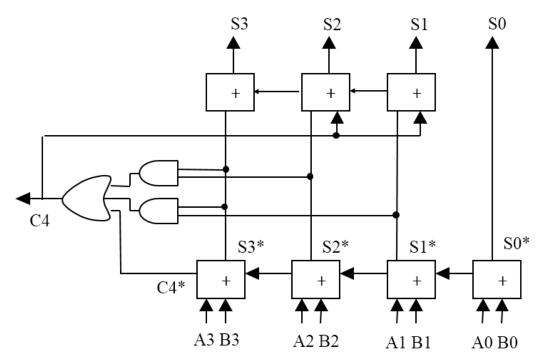 - Subtraction

  - Multiplication

  - Division

Addition

25 + 31 = 56

```
  0010 0101
+ 0011 0001
_____
  0101 0110
```

25 + 39 = 64

```
  0010 0101
+ 0011 1001
_____
  0101 1110
+      0110
_____
  0110 0100
```

28 + 39 = 67

```
  0010 1000
+ 0011 1001
_____
  0101 0001
+         1
       0110
_____
  0110 0111
```

98 + 79 = 177

```
       1001 1000
+      0111 1001
_____
       0000 0001
+ 1       1
       0110 0110
_____
  0001 0111 0111
```

Addition (cont.)

- Implementation
    - When it is in the value range [10, 19], the result requires to be adjusted

Subtraction

- How?
  - Add "complement":

    $N_1 - N_2 = N_1 + (10^n - N_2)$

- Calculating complement
  - "Invert" each digit, and add 1 on the last digit

- "Invert" digits
  - Invert each bit, and add "1010"
  - Add "0110", and invert each bit

Digit	Inversion	Digit	Inversion
0000	1001	0001	1000
0010	0111	0011	0110
0100	0101	0101	0100
0110	0011	0111	0010
1000	0001	1001	0000

Subtraction (cont.)

309 - 125 = 184

```
     0011 0000 1001
  +  1000 0111 0101
  ───────────────────
     1011 0111 1110
  +  0110      0110
  ───────────────────
  1  0001 1000 0100
```

125 - 309 = -184

```
     0001 0010 0101
  +  0110 1001 0001
  ───────────────────
     0111 1011 0110
  +       0110
  ───────────────────
     1000 0001 0110
              │
              ▼
  -  0001 1000 0100
```

Summary

- Decimal arithmetic operations
  - Addition
  - Subtraction

Thank You

rentw@nju.edu.en