

# Block Two: The Information Layer

Yangtao Ge

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## 1 Chapter 2: Binary Value and Number System

### Abstract

This chapter describes binary values – the way in which computer **hardware** represents and manages information. It also puts the binary value in all number system.

### 1.1 Number and Computing

Some definitions of Numbers:

- Number: A unit of an abstract mathematical system subject to the laws of arithmetic (succession, addition and multiplication).
- Natural number: The number **0** and any number obtained by repeatedly adding to 1 to 1.
- Negative number: A value less than zero and with a sign opposite to its **positive counterpart**
- Rational number: An integer or the quotient of two integers (division by zero included)

## 1.2 Positional Notation

Some definitions of Base:

- Base: The foundational value of a number system, which dictates **number digits** and the **value of digit Position**
- Positional notation: A way of expressing number in different base system in a following way:

$$d_n * R^{n-1} + d_{n-1} * R^{n-2} + ... + d_2 * R + d_1 \quad (1)$$

where **Base-R** has  $n$  digits and  $d_i$  represents the digit in the  $i$ th position

Watch out the digit in a number. e.g. 2074 does not have base **less than Base-8** because digit 7 is used here.

**2 digits** is needed to represent the base value. e.g. 10 is ten in decimal. 10 is eight in base 8. 10 is two in binary.

Carry and borrow system is also applied to other base system. However, the value represented binary these carries and borrows means the **value of the base**.

All power of 2 number system can be transfered to **binary**, then to **decimal**. Examples are as follows:

count every 4 digits for Hex

$$1010110 = 101(5) \text{ \& } 0110(6)$$

count every three digits for Oct

$$101010111100 = 101(5) \text{ \& } 010(2) \text{ \& } 111(7) \text{ \& } 100(4)$$

Algorithm for Base 10 to Other Bases is as follows:

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WHILE (the quotient is not zero):  
    Divide the decimal number by the new base  
    Make the remainder the next digit to the left in the answer  
    Replace the decimal number with the quotient
```

This algorithm shows that:

- The production of new number is **from right to left**
- Quotient is repeatedly used, remainder is the **answer**

some definitions about bit:

- binary digit: A digit in the **binary number** system
- bit: Binary digit
- byte: **Eight** binary digits
- word: A group of one or more bytes  
*the number of bits in a word = word length of the computer*

## 2 Chapter 3: Data Representation