Place Values

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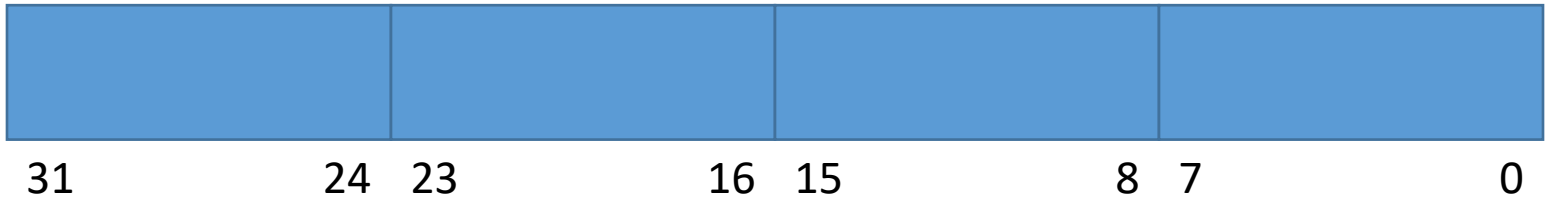
Value of Bits in Word

- 32-bit Word



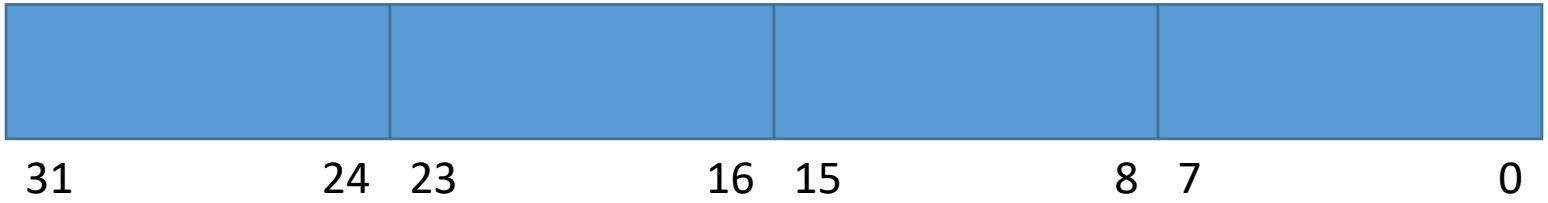
- Value of bit 0 is $2^0 = 1$
- Value of bit 1 is $2^1 = 2$
- Value of bit 2 is $2^2 = 4$

  …
- Value of bit 7 is $2^7 = 128$

  …
- Value of bit 31 is $2^{31} = 2{,}147{,}483{,}648$

Numbering Bits in Word

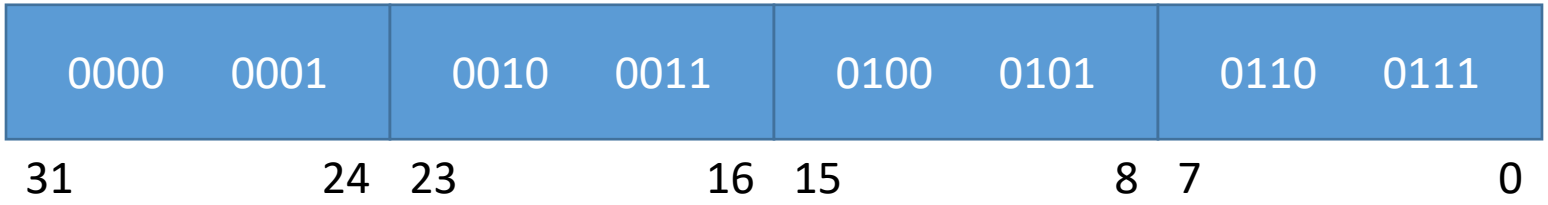
- 32-bit Word



- We number bit positions from least significant bit (LSB) to most significant bit (MSB) beginning with 0

Expressing Integral Values in Binary (Base 2)

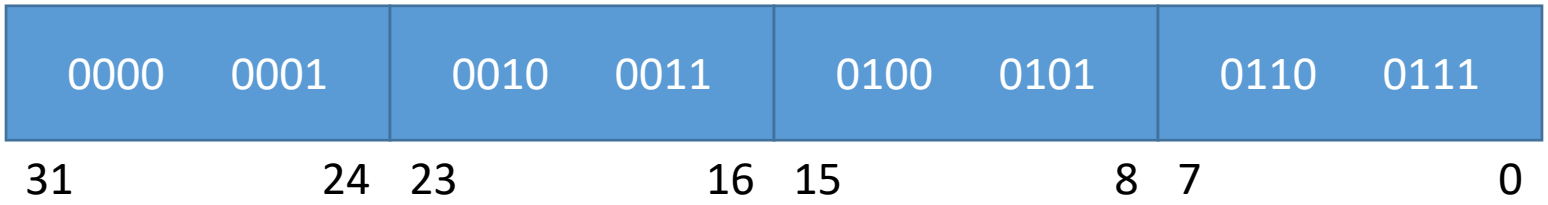
- 32-bit Word



- In binary as $00000001001000110100010101100111_2$
  - Difficult to read in binary because there are so many bits
  - Bit is a contraction of *binary digit*
- Groups of eight bits are generally referred to as a byte
- Groups of four bits are generally referred to as a nibble

Expressing Integral Values in Octal (Base 8)

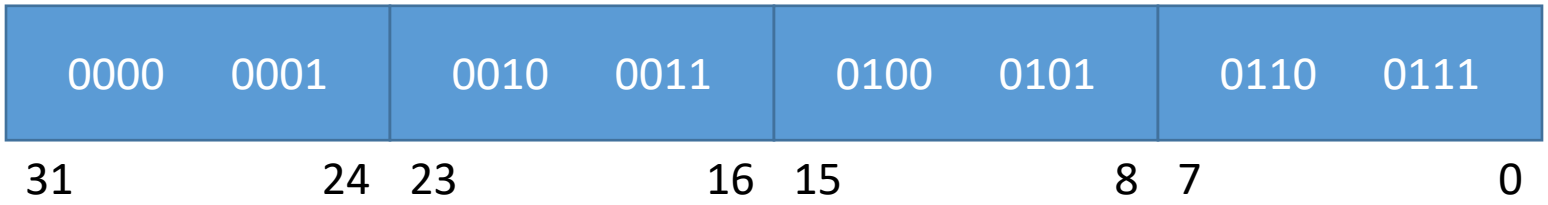
- 32-bit Word



- In octal as 00110642547_8
  - Use groups of three bits per octal digit starting at the LSB
  - Difficult to read because octal does not groups bits in nibbles or bytes
  - Also, 32 (the word size) is not evenly divisible by 3 (bits per octal digit)

Expressing Integral Values in Hexadecimal (Base 16)

- 32-bit Word



- Hexadecimal digits are 0 to 9 followed by A to F
- In hexadecimal as 01234567_{16}
  - Use groups of four bits per hexadecimal digit
  - Nicely aligns with nibble and byte boundaries

Value of Hexadecimal Digits

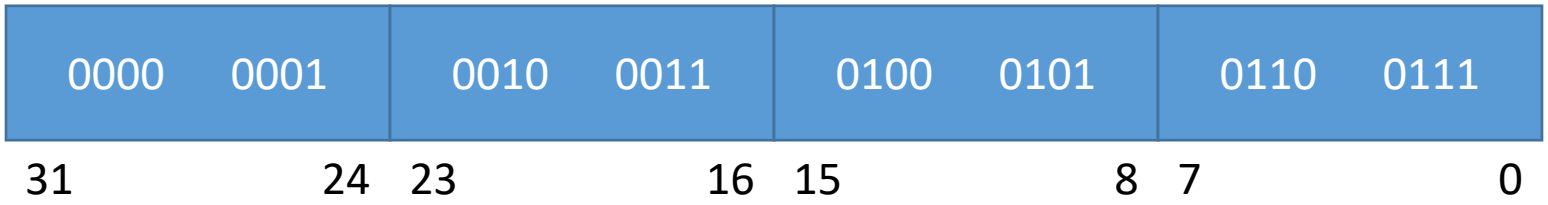
Hex	Binary	Decimal
0	0000	0
…	…	…
9	1001	9
A or a	1010	10
B or b	1011	11
C or c	1100	12
D or d	1101	13
E or e	1110	14
F or f	1111	15

Observation about Hexadecimal Numbers

- Hexadecimal is often the preferred representation for writing large integer values

Expressing Integral Values in Decimal (Base 10)

- 32-bit Word



- In decimal as 19088743_{10}
  - Doesn't align with any bit boundaries
  - Requires computation to convert to decimal from bits and vice versa
- So, 19088743 = 0x01234567 = 00110642547

Prefixes for Powers of Two

- 1K (Kilo) = 2^{10}
- 1M (Mega) = 2^{20}
- 1G (Giga) = 2^{30}
- 1T (Tera) = 2^{40}
- 1P (Peta) = 2^{50}
- 1E (Exa) = 2^{60}
- 1Z (Zetta) = 2^{70}
- 1Y (Yotta) = 2^{80}