generation microprocessors had 8-bit data registers. 8 bits were called bytes. By using the byte as a basic unit of data it means that 16, 32, and 64-bit addresses fit exactly in an integer number of bytes (which is, of course, why we choose these address widths). If an address were 34 bits wide in a byte-oriented world, then it would require a 40-bit word of 5 bytes to store the address with 6 bits unused.

More importantly, a byte is 8, bits which is 2^3 and that fits well in a binary word. Another reason for employing an 8-bit byte is that it allows 2^6 = 256 different characters which fit in well with the extended ASCII character set.

I sometime wonder whether the basic unit of data in a computer should have been 12 bits. That would permit a wider range of representation using the basic unit (1 in 2³² = 4,096) which would have provided for (a) greater precision in simple calculations and (b) a greater ability to encode alphabets. Moreover, a 12-bit unit would allow a feasible address in simple control applications (4K locations), whereas an 8-bit unit has to be used to create a 16-bit address.

5. Calculations are to be performed to a precision of 0.001%. How many bits does this require?

SOLUTION

A precision of 0.001% is one part in 100,000. The nearest power of two above this value is 2¹⁷. Therefore, 17 bits are required.

- 6. What are the decimal equivalents of the following values (assume positional notation and unsigned integer formats):
 - a. 11001100₂
 - b. 11001100₁
 - c. 11001100.
 - d. 11001100.

SOLUTION

- a. 11001100, 1 × 2° + 1 × 2° + 1 × 2° + 1 × 2° = 4 + 8 + 64 + 128 = 204
- b. 11001100, $1 \times 3^2 + 1 \times 3^3 + 1 \times 3^6 + 1 \times 3^7 = 2.952$
- c. 11001100_4 $1 \times 4^2 + 1 \times 4^3 + 1 \times 4^6 + 1 \times 4^7 = 20,560$
- d. 11001100, $1 \times (-2)^2 + 1 \times (-2)^3 + 1 \times (-2)^6 + 1 \times (-2)^7 = 4 8 + 64 128 = -68$
- 7. Why do we have octal and hexadecimal arithmetic?

SOLUTION

Computers operate with base 2 arithmetic. However, it is difficult for people to handle binary numbers (for example 298₁₀ is 100101010₂) because binary numbers involve long strings of bits and we are not good at remembering long sequences. Hexadecimal arithmetic has 16 digits from 0 to F representing 4 binary bits. Therefore, a binary number can be easily represented in hexadecimal form by replacing each four bits by a hexadecimal character. For example, 298₂₀ is 12A₂₀ (easier for people to remember than 000100101010).

Octal arithmetic uses base 8 with the digits 0 to 7. Each octal digit replaces three bits. It has the same advantage as hexadecimal numbers; for example the binary number 111101011 is 753 in octal. However, octal arithmetic is hardly used today.

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Karin Nielsen-Saines

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