



Bài tập về Cache của Kiến trúc máy tính và hợp ngữ

Kiến trúc máy tính _ hợp ngữ (Trường Đại học Sư phạm Kỹ thuật Thành phố Hồ Chí Minh)

Bài Tập Bộ Nhớ Cache

1. A set-associative cache consists of 64 lines, or slots, divided into four-line sets. Main memory contains 4K blocks of 128 words each. Show the format of main memory addresses.

64line, bộ nhớ chính: 512KB;



shubhamjoshi033

Virtuoso • 989 answers • 2.3M people helped

Number of sets = $64/4 = 16$

=> The cache is divided into $16 (= 2^4)$ sets

Therefore, 4 bits are needed to identify the set number.

Main memory consists of $4K = 2^{12}$ blocks.

Therefore, the set + tag lengths must be 12 bits

tag length = $12 - 4 = 8$

Each block contains 128 words = 2^7 words

Therefore, 7 bits are needed to specify the word field

So the main memory can be represented as

TAG	SET	WORD
8	4	7

2. A two-way set-associative cache has lines of 16 bytes and a total size of 8 kbytes. The 64Mbyte main memory is byte addressable. Show the format of main memory addresses.

16B line: kích thước 8KB; Bộ nhớ chính L 64MB

2 Bộ đệm ẩn kết hợp hai chiều có các dòng 16 byte và tổng kích thước là 8 Kbyte. Bộ nhớ chính 64-Mbyte có thể định địa chỉ theo byte. Hiển thị định dạng của địa chỉ bộ nhớ chính.

Có tổng cộng $8 \text{ kbyte} / 16 \text{ byte} = 512$ dòng trong bộ nhớ cache. Như vậy bộ nhớ đệm bao gồm 256 bộ, mỗi bộ 2 dòng. Do đó cần 8 bit để xác định số bộ. Đối với bộ nhớ chính 64-Mbyte, địa chỉ 26-bit là cần thiết.

Answer:

There are a total of $8 \text{ kbytes} / 16 \text{ bytes} = 512$ lines in the cache. Thus the cache consists of 256 sets of 2 lines each. Therefore 8 bits are needed to identify the set number. For the 64-Mbyte main memory, a 26-bit address is needed.

$$8 * 2^{10} / 16 = 2^3 * 2^{10} / 2^4 = 2^9 \Rightarrow s = 9;$$

$$b = 2 \Rightarrow t = 2^8 * 2^{20} - 2^9 - 2^2 = 17;$$

3. For the hexadecimal main memory addresses 111111, 666666, BBBB, show the following information, in hexadecimal format:

- Tag, Line, and Word values for a direct-mapped cache, using the format of Figure 4.10
- Tag and Word values for an associative cache, using the format of Figure 4.12
- Tag, Set, and Word values for a two-way set-associative cache, using the format of Figure 4.15

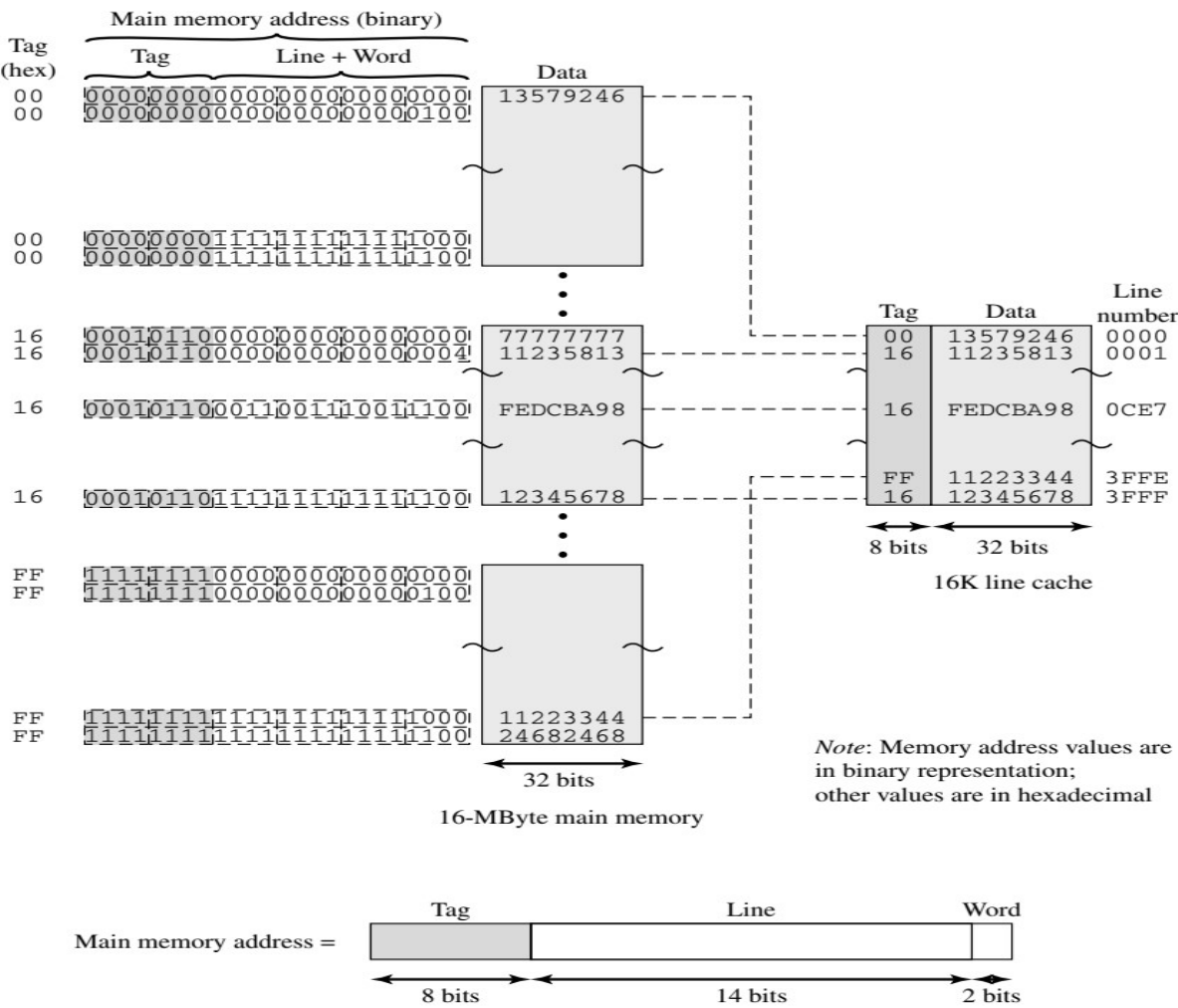


Figure-10

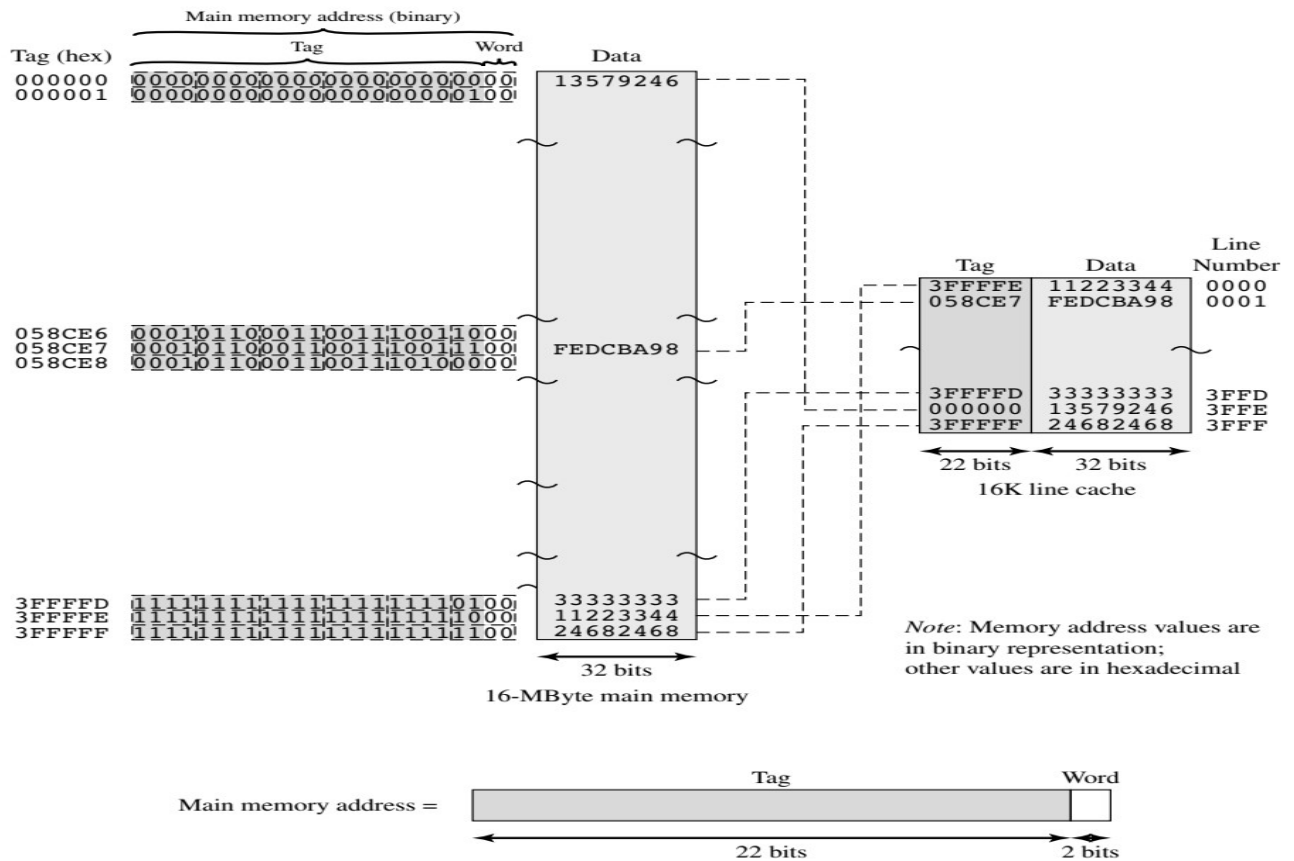


Figure- 12

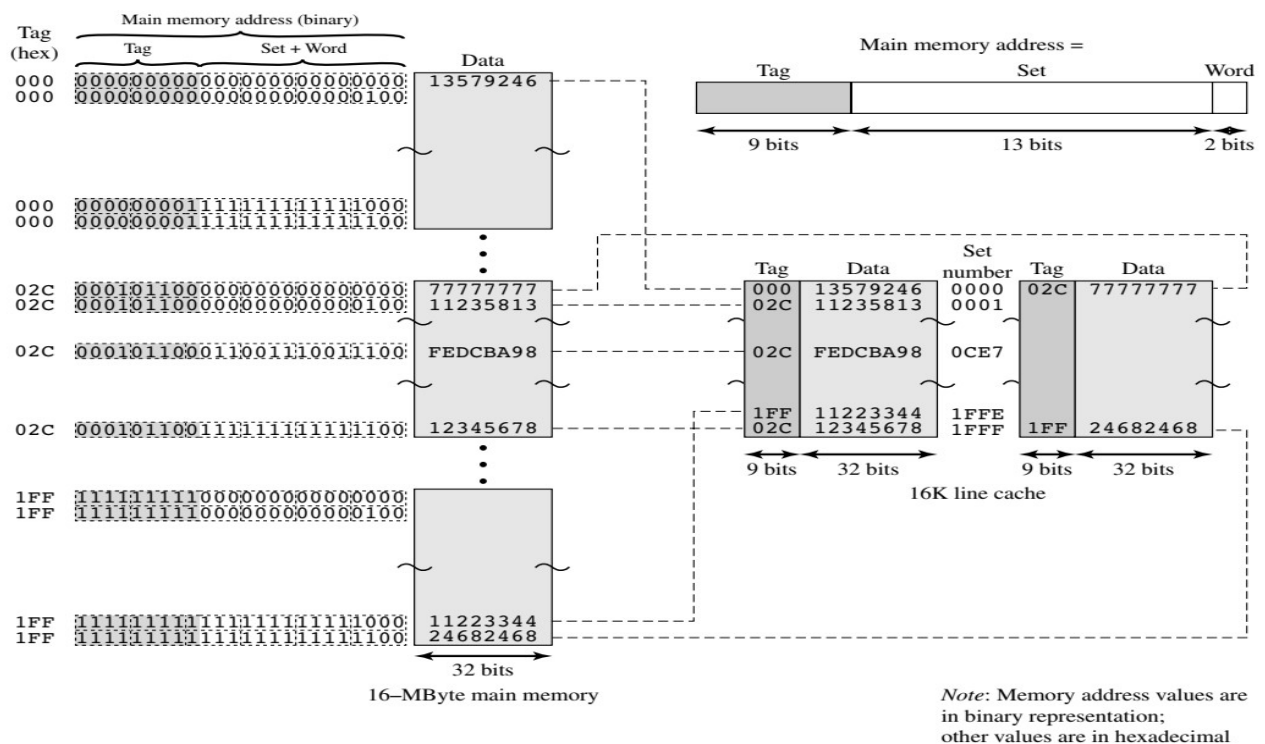


Figure 4.15 Two-Way Set Associative Mapping Example

4. List the following values:

- For the direct cache example of Figure 4.10: address length, number of addressable units, block size, number of blocks in main memory, number of lines in cache, size of tag

- b. For the associative cache example of Figure 4.12: address length, number of addressable units, block size, number of blocks in main memory, number of lines in cache, size of tag
 - c. For the two-way set-associative cache example of Figure 4.15: address length, number of addressable units, block size, number of blocks in main memory, number of lines in set, number of sets, number of lines in cache, size of tag
5. Consider a 32-bit microprocessor that has an on-chip 16-KByte four-way set-associative cache. Assume that the cache has a line size of four 32-bit words. Draw a block diagram of this cache showing its organization and how the different address fields are used to determine a cache hit/miss. Where in the cache is the word from memory location ABCDE8F8 mapped?
6. Given the following specifications for an external cache memory: four-way set associative; line size of two 16-bit words; able to accommodate a total of 4K 32-bit words from main memory; used with a 16-bit processor that issues 24-bit addresses. Design the cache structure with all pertinent information and show how it interprets the processor's addresses.
7. The Intel 80486 has an on-chip, unified cache. It contains 8 KBytes and has a four-way setassociative organization and a block length of four 32-bit words. The cache is organized into 128 sets. There is a single "line valid bit" and three bits, B0, B1, and B2 (the "LRU" bits), per line. On a cache miss, the 80486 reads a 16-byte line from main memory in a bus memory read burst. Draw a simplified diagram of the cache and show how the different fields of the address are interpreted.
8. Consider a machine with a byte addressable main memory of 2^{16} bytes and block size of 8 bytes. Assume that a direct mapped cache consisting of 32 lines is used with this machine.
 - a. How is a 16-bit memory address divided into tag, line number, and byte number?
 - b. Into what line would bytes with each of the following addresses be stored?
 0001 0001 0001 1011
 1100 0011 0011 0100
 1101 0000 0001 1101
 1010 1010 1010 1010
 - c. Suppose the byte with address 0001 1010 0001 1010 is stored in the cache. What are the addresses of the other bytes stored along with it?
 - d. How many total bytes of memory can be stored in the cache?
 - e. Why is the tag also stored in the cache?
9. A set-associative cache has a block size of four 16-bit words and a set size of 2. The cache can accommodate a total of 4096 words. The main memory size that is cacheable is 64K 32 bits. Design the cache structure and show how the processor's addresses are interpreted.
10. Consider a memory system that uses a 32-bit address to address at the byte level, plus a cache that uses a 64-byte line size.

- a. Assume a direct mapped cache with a tag field in the address of 20 bits. Show the address format and determine the following parameters: number of addressable units, number of blocks in main memory, number of lines in cache, size of tag.
 - b. Assume an associative cache. Show the address format and determine the following parameters: number of addressable units, number of blocks in main memory, number of lines in cache, size of tag.
 - c. Assume a four-way set-associative cache with a tag field in the address of 9 bits. Show the address format and determine the following parameters: number of addressable units, number of blocks in main memory, number of lines in set, number of sets in cache, number of lines in cache, size of tag.
- 11.** Consider a computer with the following characteristics: total of 1Mbyte of main memory; word size of 1 byte; block size of 16 bytes; and cache size of 64 Kbytes.
- a. For the main memory addresses of F0010, 01234, and CABBE, give the corresponding tag, cache line address, and word offsets for a direct-mapped cache.
 - b. Give any two main memory addresses with different tags that map to the same cache slot for a direct-mapped cache.
 - c. For the main memory addresses of F0010 and CABBE, give the corresponding tag and offset values for a fully-associative cache.
 - d. For the main memory addresses of F0010 and CABBE, give the corresponding tag, cache set, and offset values for a two-way set-associative cache.
- 12.**