CSCI 350 Digital Logic and Computer organization
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Assignment 7 Due April 23, 2020

1. You are given a main memory of 256MB and a 64KB cache. Give the following values:
    a. For a direct cache of 16 bytes per line:
        - Address length of main memory (in bits)
        - Block size
        - Number of lines in cache
        - Number of blocks in memory
        - Tag size (in bits)
    b. For an associative cache:
        - Number of lines in cache
        - Tag size (in bits)
    c. For a 4-way set associative cache:
        - Number of sets in cache
        - Tag size (in bits)

2. For the main memory and each of the cache organizations of problem 1 above, and assuming the line or set bits values are represented in the leftmost bits of an address, give the tag, set or line, and byte values (in hex) associated with each of the following memory addresses (in hex):
    a. 1234567
    b. 4444444
    c. ABCDEFE

3. Problem 26 on page 340 of your textbook.

Assignment 7

Shefali E.

#1 Main Memory = 256 MB = 2^{28} byte

Cache = 64 KB = 2^{16} byte 1 word = 1 byte = 2^1

(a) bytes per line = 16 of direct cache = 2^4

Address length of main memory (in bits)

28 bits, leftmost 27 bits would represent a word address

2^{27} words

Block size

2^4

# of lines in cache

$2^{16} / 16 = 12$ lines

2^{4+1} 2^{11}

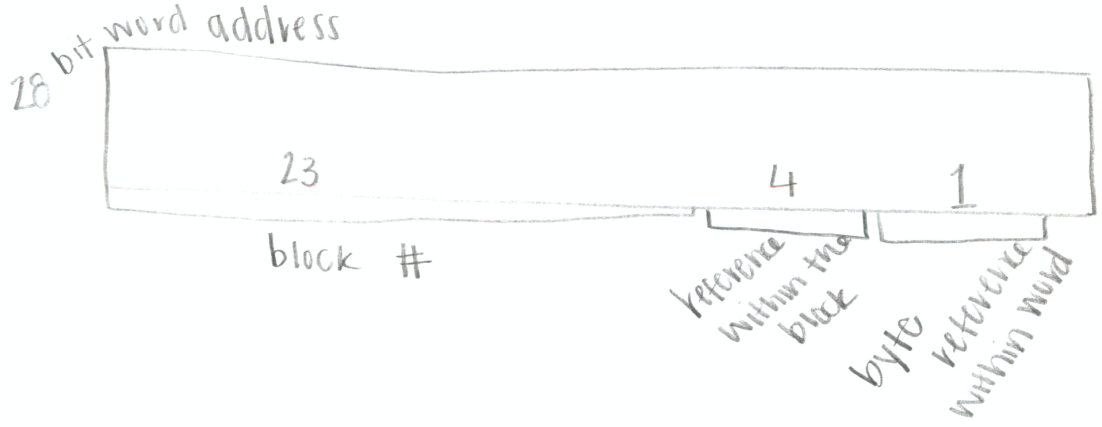
# of blocks in memory

$2^{27} - 2^4 = 2^{23}$ blocks

tag size (in bits)

line value size = 11 bits

$2^{23} \div 2^{11} = 2^{12}$ memory blocks → 12 bits



(B) Associative Cache

Main mem = 256 MB = 2^{28} byte

Cache = 64 kb = 2^{16} byte

1word = 21 byte

line = 16 = 2^4 byte

# of lines in cache

$2^{16} / 2^{4+1} = 2^{11}$ lines

line value size = 11 bits

tag size $\rightarrow$ # of bits needed to specify a block

23 bits

(C) For a 4-way set associative cache

lines per set = $4 = 2^2$

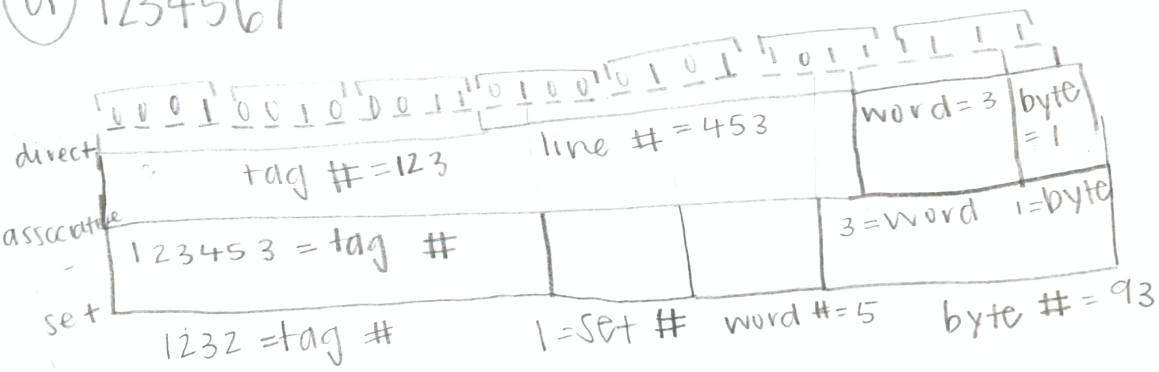
$2^{11} \div 2^2 = 2^9$ sets

$2^{23} \div 2^9 = 2^{14}$ blocks per set

tag size = 14 bits

#2

(a) 1234567



(b) 44444444

tag # = 444
line # = 442
word = 2
byte = 0

associative tag # = 44442
word = 2
byte = 0

set tag # = 44441
set = 1
word = 1
byte = 20

(c) ABCDEFE

direct
- tag = ABC
- line = DE7
- word = F
- byte = 0

associative
- tag = ABCDE7
- word = F
- byte = 0

set tag
- tag # = ABC3
- set = 7
- word = B
- byte = F2

#26 2 level cache

60% of memory hits on 1st level

35% of memory hits on 2nd level

5% miss

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access times

5nsec, 15 nsec, 60 nsec

what are the times for the level 2 cache? memory start counting at the moment it is known that they are needed. what is the average access time?

average access time = .6 (5 nanosec x (.35(15 nsec)) + .05(60 nsec) = 18.75 nsec