Tutorial #4

CSE 321a: Computer Organization (I)
Third Year, Computer and Systems Engineering

Prob. (4.2):
A two-way set-associative cache has lines of 16 bytes and a total size of 8 Kbytes. The 64-Mbyte main memory is byte addressable.
Show the format of main memory addresses.

Word size = 1 byte (byte addressable)
Word field (W) = lg(# of words in block) = lg(16) = 4 bits
Set field (S) = lg(# of sets in cache) = lg(cache size / set size) = lg(8 K/16 * 2) = 8 bits
Tag field (T) = address field – (s+w) = lg(64 M) – (4+8) = 14 bits

T=14	S=8	W=4

Prob. (4.11):
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.

Address size= 32 bits
Word size = 1byte (bit level)
Line size = block size = 64 bytes. → L=6 , W=6
T=A-(L+W) = 20

a. Direct Mapped:

T=20	L=6	W=6

Addressable units = $2^A=2^{32}$ = 4G bytes

#MM blocks= MM size / Block size = 4G/64 = 64M blocks
Cache lines = 2^{L} =2^{6} = 64 Lines
Tag size = 20 bits

b. Associative:

T=26	W=6

Addressable units = 2^{T+W} =2^{32} = 4G bytes
#MM blocks= 2^{T} =2^{26} = 64M blocks
Cache lines = undetermined but if use the same cache it will be = 64 Lines
Tag size = 26 bits

c. 4 way set associative:

T=9	S=17	W=6

K=4
# Addressable units = 4G bytes
#MM blocks= 2^{T+S}=2^{26} = 64M blocks
Lines per set = k = 4 lines
Cache sets = cache size/set size =4k/4*64 =128K sets
Cache lines = # cache sets * # lines per set
= 128k * 4 = 512 K lines
Tag size = 9 bits