Cache Memory

- Cache Memory mapping technique means how data is copied/mapped from MM to CM
- Mapping Technique:
- **Direct Mapping:**
- In this mapping, MM blocks are copied to a fixed block of CM, but once at a time
- Let, CM block no.=C_b
- MM block no. = M_b
- Number of blocks in CM = C
- Number of blocks in MM = M
- CM block no. = (MM block no.)mod (Number of blocks in CM)

$C_b = M_b \mod C$

Cache Memory

- Suppose,
- Main memory size = 512 * 8 [512 bytes means it contains 512 words and each word is 8 bit]
- Cache memory size = 64 * 8 [64 bytes means it contains 64 words and each word is 8 bit]
- Block size =4 words
- So, number of MM blocks = (Total MM words)/Block size=512/4= 128 blocks
- Number of CM blocks = (Total CM words)/Block size=64/4=16 blocks
- So, CM block no. = 0 mod 16 = 0
- 16 mod 16=0 and so on

Cache Memory

- Number of MM blocks in one block of CM = (Number of MM blocks)/(Number of CM blocks)
- = 128/16 = 8
- Block size = 4 words
- If there are 512 words in MM then there will be 512 locations
- Thus, MM address =512 =2^9 bits
- So, Each MM address will be 9 bits
- **MM address is divided into 3 parts:**

Tag bit =3	Block bit=4	Word bit=2

- Index bit = Block bit + Word bit
- **Tag bit** indicates Number of MM blocks in each CM blocks
- **Block bit** indicates Number of CM blocks

Cache Memory

- **Associative mapping in Cache Memory:**
- In associative mapping, MM blocks are copied into any block of CM
- Let, MM size is = 512 X 8 (512 words and 8 word size)
- CM size is = 63 X8 (64 words and 8 word size)
- Block size = 4
- So, Number of MM blocks = 512/4 = 128 blocks
- Number of CM blocks = 64/4 = 16
- Thus, number of MM blocks in one block of CM = 128 = 2^7
- MM size = 512 = 2^9 ; Thus, MM address bits = 9
- **Main Memory address format:**

Tag bit = 7	Word bit =2

Cache Memory

- **Set Associative Mapping**:
- It is a combination of **direct mapping and associative mapping**
- Set Associative Mapping = Direct Mapping + Associative Mapping
- In this method, CM is divided into sets:
- Set = Group of Blocks
- Block = Group of Words
- CM set no. = (MM block no.) mod (Number of sets in CM)
- Number of sets in CM = (Number of CM blocks)/Set size
- Number of blocks in CM = (Number of words in CM) / Block size
- Number of blocks in MM = (Number of words in MM) / Block size

Cache Memory

- Let Set size=2 (Two way set associative)
- Block size = 4 words
- Main memory size 512x8
- CM size =64x8
- Number of MM blocks = 512/4=128 blocks
- Number of CM blocks = 64/4 16 blocks
- Number of sets in CM = 16/2 = 8 sets = 2^3
- CM set number:

0 mod 8=0 8 mod 8=0 16 mod 8=0	1 mod 8=1 9 mod 8=1 17 mod 8=1	2 mod 8=2 10 mod 8=2 18 mod 8=2

Cache Memory(Set associative mapping)

Set 0	Tag bit	B_0	Tag bit	B_8
Set 0	Tag bit	B_1	Tag bit	B_9
Set 0	Tag bit	B_2	Tag bit	B_{10}
Set 0	Tag bit	B_3	Tag bit	B_{11}
Set 0	Tag bit	B_4	Tag bit	B_{12}
Set 0	Tag bit	B_5	Tag bit	B_{13}
Set 0	Tag bit	B_6	Tag bit	B_{14}
Set 0	Tag bit	B_7	Tag bit	B_{15}

Cache Memory: 64x8

Block 0
Block 1
Block 2
Block 3
Block 4
Block 8
Block 9
.....
.....
Block 126
Block 127

Main Memory: 512x8

Cache Memory

- **Number of MM blocks in one set of CM = (Number of MM blocks)/(Number of CM Sets)**

  (2 at a time) = 128/8 = 16 = 2^4

Main Memory Address format:

Tag = 4 bit	Set = 3 bit	Word = 2 bit

Index bit = Set bit + Word bit = 3 + 2 = 5 bits

Each word in CM:

Cache Size = $2^{\text{index bit}}$ X(tag1+data1+tag2+data2)

= 2^5 x(4+8+4+8)

= 32x24 =768 bytes