Cache Mapping

There are three different types of mapping used for the purpose of cache memory which are as follows.

(i) Direct Mapping (ii) Associative Mapping
(iii) Set-Associative Mapping

Direct Mapping :- This is the simplest technique of mapping in which each block of main memory maps into only one possible cache line. In direct mapping, we assign each memory block to a specific line in the cache. The specific line in the cache can be assigned using following formula;

$i = j \text{ modulo } m$, where

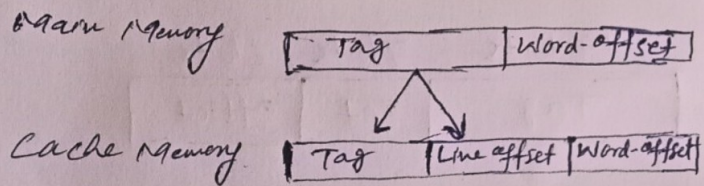
i = cache line number

j = main memory block number

m = number of lines in the cache.

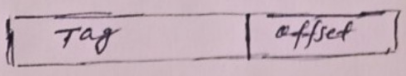
For purpose of cache access, each main memory address can be viewed as consisting of three fields. The least significant 'w' bits identify a unique word or byte within a block of main memory. The remaining s-bits specify one of the blocks of main memory.

The cache logic interprets these 's' bits as a tag of 's-r' bits (most significant portion) and a line field of 'r' bits. These 'r' bits identifies one of the $m = 2^r$ lines of the cache.



Associative Mapping :-

In this type of mapping, any block of main memory can go into any line of the cache. This means that the word id bits are used to identify which word in the block is needed, but the tag becomes all of the remaining bits. This enables the placement of any word at any place in the cache memory.



Set Associative Mapping :-

Set associative mapping is a mixture of direct and associative mapping. The cache lines are grouped into sets. The number of lines in a set can vary from 2 to 16. A portion of the address is used to specify which set will hold an address. The data can be stored in any of the lines in the set.

For example,

Assume we have 32 bits addresses, 32 KB of cache and 64 byte lines.

$$\therefore \text{No. of cache line } (N) = \frac{\text{cache size}}{\text{line size}} = \frac{32\,KB}{64} = 512$$

Suppose, 4 way set associative,

$$\text{Number of sets} = \frac{512}{4} = 128$$

$$\text{Set bits} = \log_2(128) = 7$$

$$\text{offset bits} = 6 \text{ bits} \quad (\because 2^6 = 64)$$

$\therefore$