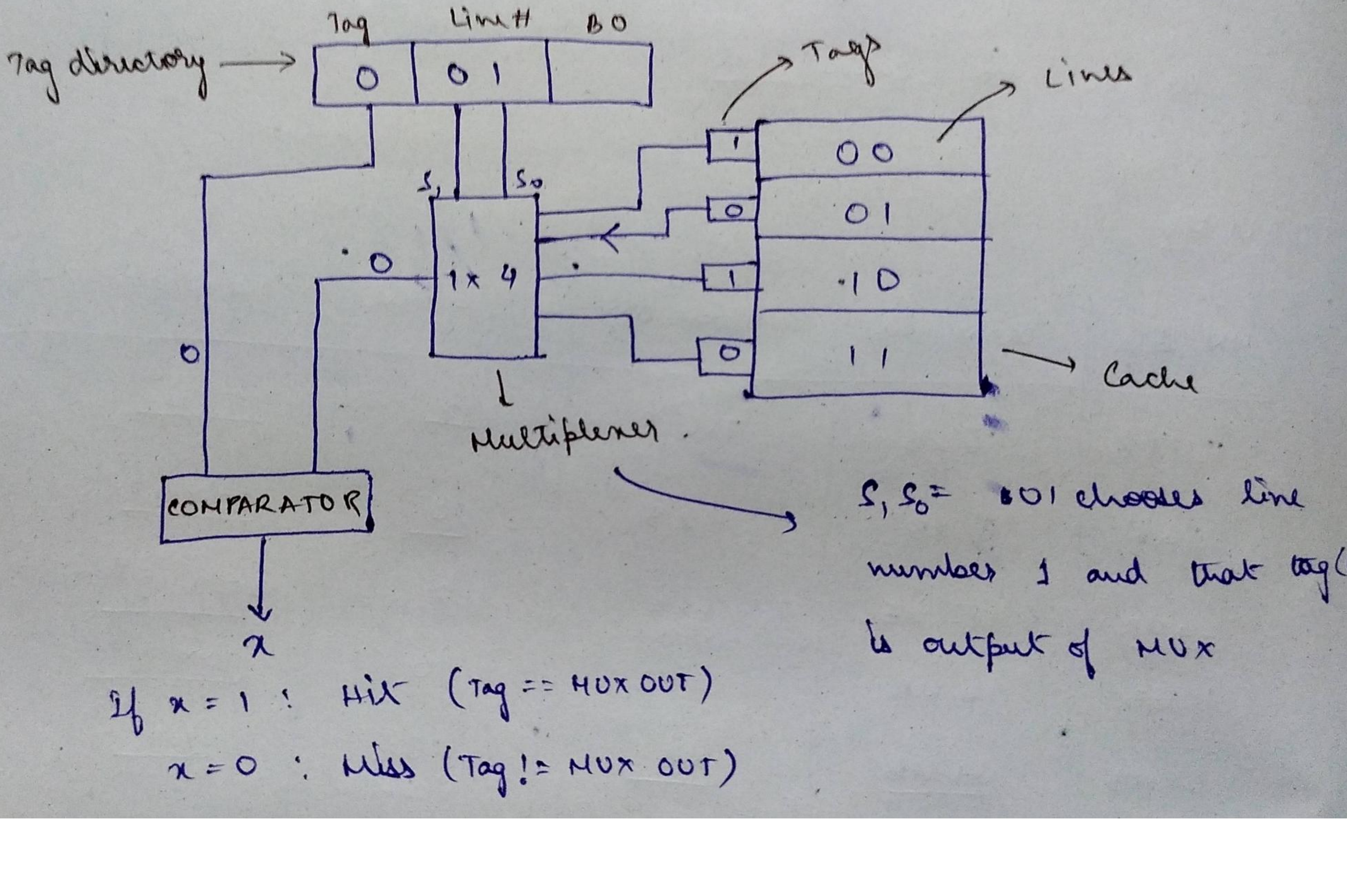
DIRECT MAPPING IMPLEMENTATION



(A) If number of tag bits is 2 then we need to have two multiplexers.

For K tag bits, # MUX = K.
No. of comparator required is 1. (K bit comparator)

(*) Hit / Miss Latency = MUX delay + COMPARATOR delay

Q. If MM = 1GB, cache size = 1MB,

comparator delay = 10 K ns (K = # tag bits)

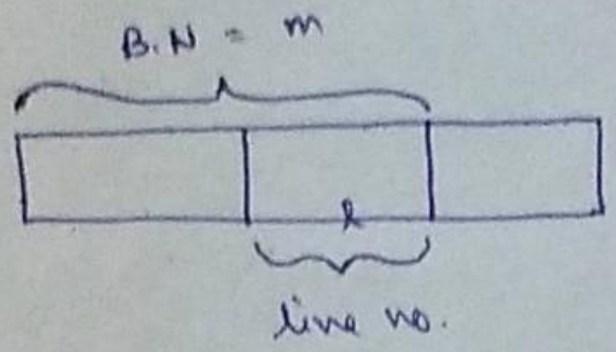
Hit latency = ?

→ # tag bits = $\log_2 2^{10}$ = 10

Comp. delay = 100 ns

So, hit latency = 100 ns. Ans

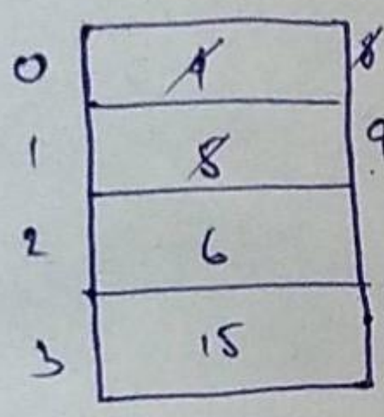
Disadvantage of Direct Mapping



Blocks = 2^m

lines = 2^l

(*) Position of x^{th} block of main memory in a cache containing 'l' lines is $(x \% 2^l)$ = line number.



5, c, 4, 8, 9, 12, 15, 20 ...

It does not use the free space. This is called **conflict miss**

(*) If there is not space & left then it is called **capacity miss**.

ASSOCIATIVE MAPPING

In associative mapping any byte from a block of MM can go to any line of cache.

So here [# bits in tag = $\log_2$ (Blocks) = # lines]

In this case for searching an element we need to compare it with all bytes in cache.

So, we use & n comparators where n = # lines.

If any comparator produce 1 then it is a 'Hit'.

Q. Given, Main memory size = 32 GB

Block size = 32 KB

Propagation delay of comparator = 10K ns (K = # tag bits)

Propagation delay of OR GATE = 10 ns

Hit latency = ?

→ # Tag bits = $\log_2 \left(\frac{2^{35}}{2^{15}} \right)$ = 20

comparator = 20.

Total delay by comparators = 20 × 10 ns

= 200 ns.

Hit latency = (200 + 10) = 210 ns

Q.	MM Size	Cache Size	Block Size	Tag Size	Tag directory Size	# Comp.
a)	128 MB	512 KB	1KB	17	17×2^9	512
b)	16 GB	NA	4KB	10	NA	NA
c)	64MB	NA	64 KB	10	NA	NA
d)	NA	512KB	NA	7	NA	NA

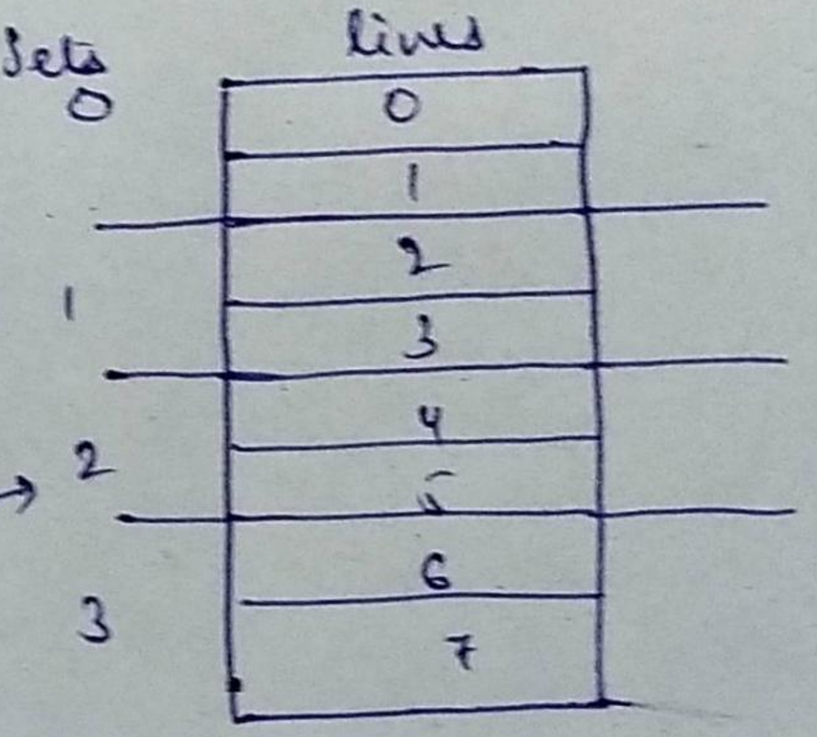
SET ASSOCIATIVE MAPPING

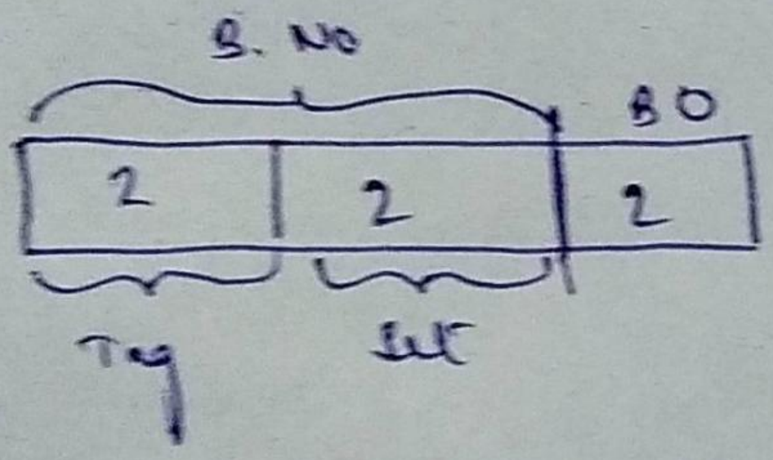
Let MM = 64B, CS = 32B, BS = 4B.

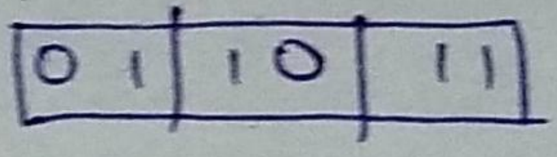
1 set size = 2 lines (also called 2 way set associative)

→ # lines = $\frac{CS}{BS}$ = 8

set = $\frac{\text{\# lines}}{\text{set size}}$ = $\frac{8}{2}$ = 4.





So given any address 

, so here only two comparators will be required rather than 8.

∴ Size of each comparator = 2 bytes (# Tag bytes).