CS & IT ENGINEERING

COMPUTER ORGANIZATION AND ARCHITECTURE

Cache Organization

Lecture No.- 3

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Recap of Previous Lecture

Topic Cache Memory

Topic Average Memory Access Time

Topic Cache Write

Topics to be Covered

Topic Cache Write

Topic Cache Mapping

Topic : Cache Write or Write Propagation

1. Write Through
2. Write Back

Topic : T_{avg} in Write Through Cache

$T_{avg\ read} = H * t_{cm} + (1-H)\, t_{mm}$ ← default (simultaneous)

Hier.

$= H * t_{cm} + (1-H)(t_{cm} + t_{mm})$

$T_{avg\ write} = \max(t_{cm}, t_{mm}) = t_{mm}$

T_{avg} = fraction of read operation * $t_{avg\ read}$ + fraction of write operation * $t_{avg\ write}$

Effective hit rate = fraction of read * Hit ratio of read

[MCQ]

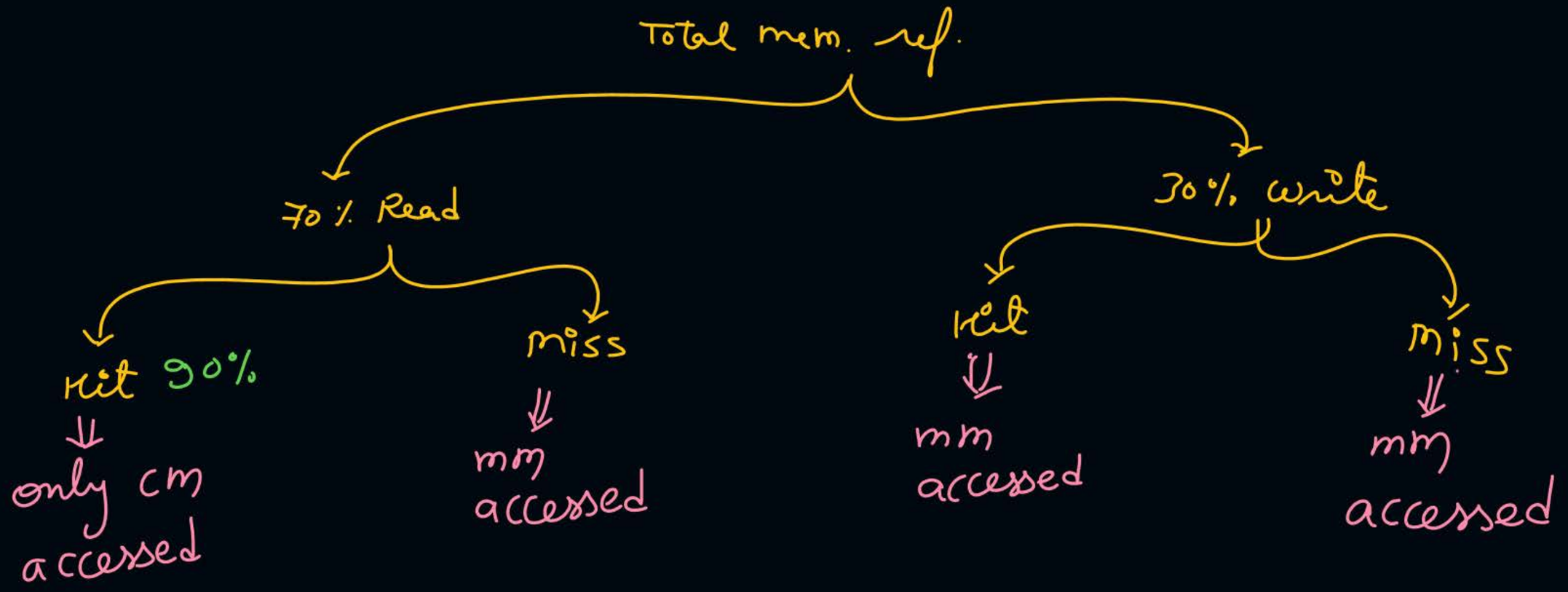
#Q. A system has a write through cache with access time of 100ns and hit ratio of 90%. The main memory access time is 1000ns. The 70% of memory references are for read operations.

A. Average memory access time for read operations only $= 0.9 * 100 + 0.1 * 1000 = 190$ ns

B. Average memory access time for write operations only = 1000 ns

C. Average memory access time for read-write operations both
↳ $0.7 * 190 + 0.3 * 1000 = 433$ ns

D. Effective Hit ratio $= 0.7 * 0.9$
$= 0.63$ or 63%


Total mem. ref.
70% Read
30% write
Hit 90%
only cm accessed
Miss
mm accessed
Hit
mm accessed
Miss
mm accessed

Topic : T_{avg} in Write Back Cache

Pending

[NAT]

#Q. The memory access time is 2 nanosecond for a read operation with a hit in cache, 5 nanoseconds for a read operation with a miss in cache, 4 nanoseconds for a write operation with a hit in cache and 10 nanoseconds for a write operation with a miss in cache. Execution of a sequence of instructions involves 70 memory operand read operations and 30 memory operand write operations. The cache hit- ratio is 0.9. The average memory access time (in nanoseconds) in executing the sequence of instructions is?

	Read	write
hit	2ns	4ns
miss	5ns	10 ns

$T_{avg\ read} = (0.9 * 2) + (0.1 * 5) = 2.3$ ns

$T_{avg\ write} = (0.9 * 4ns + 0.1 * 10) = 4.6$ ns

Total mem. references = 70 + 30 = 100

Read = $\frac{70}{100} = 0.7$

write = $\frac{30}{100} = 0.3$

$t_{avg} = (0.7 * 2.3\,ns) + (0.3 * 4.6\,ns)$

$= 2.99\,ns$

Topic : Write Allocate vs No Write Allocate

Write Allocate: → with write back cache by default

The missed block is loaded in cache on a write miss.

No Write Allocate: → with write through by default

The block is modified in the main memory and not loaded into the cache.

Topic : Write Through with No Write Allocate

Read

Hit

CPU reads required content from cache

Miss

CPU reads required content from mm.
CPU copies missed block from mm to cache, and if any block is replaced from cache then it is just removed from cache. No write back needed.

Write

Hit

CPU performs write operation in cache and mm simultaneously

Miss

CPU performs write operation in mm and <u>does not</u> bring block to cache.

Topic : Write Back with Write Allocate

Read

Hit

CPU reads required content from cache

miss

CPU reads required content from mm.
CPU copies missed block from mm to cache, and
A block is replaced from cache; then write it back to main memory if it is a modified block.

write

Hit

CPU performs write in cache

miss

CPU brings missed block from mm to cache, then perform write in cache.
If any block is replaced from cache then write it back to mm if it is a modified block.

[NAT]

14.00.

#Q. Size of data sent to main memory from CPU:

1. For write hit, when a write through cache is used?
2. For write miss, when a write through cache is used?
3. For write hit, when a write back cache is used?
4. For write miss, when a write back cache is used?

[MCQ]

H.W.

#Q. Size of data sent from main memory to cache:

1. For write hit, when a write through cache is used?
2. For write miss, when a write through cache is used?
3. For write hit, when a write back cache is used?
4. For write miss, when a write back cache is used?

2 mins Summary

Topic Cache Write

Topic Cache Mapping

Happy Learning

THANK - YOU