

Chapter 08: The Memory System

Lesson 04:

Replacement, Inclusion, Write-back and write-through policies

Objective

- Learn the concepts of hit, miss, replacement, and inclusion
- Write through and write back policies

Hit and Miss rates

Hit and Miss

- Occurrence of Hit— in a level when the address that an operation references is found in that level of the memory hierarchy
- Otherwise, a Miss

Replacement

Action on a miss

- A block of data containing the address of the miss is brought into the level
- As a program runs, the level will fill up with data and run out of free space to put blocks in
- Eviction— When this happens, a block must be removed from the level to make room for the new block

Replacement

- Eviction or replacement— The removal of a block of data from a level to make room for a new block of data
- Replacement policy— The method by which the system selects a block to be removed

Inclusion

Inclusion Property

- To simplify evicting data blocks from a level, many memory systems maintain a property called *inclusion*, in which the presence of an address in a given level of the memory system guarantees that the address is present in all lower levels of the memory system

Inclusion Property

- Suppose a program block is in cache, then it is also in the main memory as well as secondary memory
- Suppose a program block is in main memory, then it is also in the secondary memory

Write-back system

Write-back System

- Data that is written is placed only in the top level of the hierarchy
- When the block containing the data is evicted from that level, the written data is copied into the next level down in the hierarchy, and so on

Dirty and Clean Blocks

- Blocks containing data that has been written are called dirty, to distinguish them from clean blocks, which have not been modified

Implementing write-back system

- Much easier if they maintain inclusion
- Never necessary to evict a block from a level to make room for data being written back from a higher level

Write-through system

Write Through memory system

- Copy written data into each level of the memory hierarchy when a write occurs
- Different write policies (write-back and write through) in the systems for different levels in the hierarchy
- Write-through policy for caches and write-back policy for main memories

Example

- Not uncommon for computers to have write-through caches and write-back main memories
- Basis of the decision about whether to make a level in the hierarchy write back or write through—based on a tradeoff between bandwidth and complexity

Bandwidth in Write-back system

Bandwidth

- Higher bandwidth in Write-back systems
- Don't require each level of the hierarchy to be accessed on every write, but they are more complex than write-through systems
- Necessary to keep track of which blocks in a level have been written since they were brought into the level in write back

Summary

We Learnt

- Concepts of replacement, inclusion and write back Policies
- Write-through caches
- Write-back main memory

End of Lesson 04 on
**Replacement, Inclusion, Write-back and
write- through policies**