CIS 452 - Operating Systems Concepts

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Images taken from Silberschatz book

Approximating LRU (Additional Reference Bits)

LRU replacement is effective replacement policy, but expensive to implement

Typically do not have hardware support for full LRU, such as counter

Many systems offer single **reference bit** per page

Reference bit initialized to 0 when page is loaded in and set to 1 when page is accessed (read or write)

Single bit gives OS some info about use, but nothing about order

True LRU is impossible to implement efficiently with just reference bit

Various approximate LRU schemes will be considered

Additional-reference-bits LRU uses reference bit and OS intervention to approximate counter-based LRU

OS keeps additional counter data associated with each page

At fixed time intervals (e.g., every 100 milliseconds), OS updates counter by shifting refernce bit into most-significant bit of counter

Before:

Reference	Counter
0	10010011
0	01100010
1	00010100

After:

Reference	Counter
0	01001001
0	00110001
0	10001010

Higher counter values indicate more recent use

Lowest number is LRU

It is possible to have a tie

Ties can be broken with another method, such as FIFO

This looks like counter-based LRU with less granular counter

However, there is a substantial implementation difference

Reference bit set automatically by hardware, but OS responsible for updating counter

We see that it is possible to approximate LRU with minimal hardware, but there is a cost in terms of both accuracy and efficiency

Other approximations will be considered in future lecture