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Pre-class Assign,ment #16

Relevant Materials:
OSPP textbook, chapter 9, sections 9.6-9.8
chapter 9 slides

1. Define the following terms:

- demand paging: Using address translation hardware to run a process without all of its memory physically present. When the process references a missing page, the hardware traps to the kernel, which brings the page into memory from disk.
- page fault: A hardware trap to the operating system kernel when a process references a virtual address with an invalid page table entry.
- dirty bit: A status bit in a page table recording whether the contents of the page have been modified relative to what is stored on disk.
- use bit (a.k.a. reference bit): A status bit in a page table entry recording whether the page has been recently referenced.
- clock algorithm: A method for identifying a not recently used page to evict. The algorithm sweeps through each page frame: if the page use bit is set, it is cleared; if the use bit is not set, the page is reclaimed.

2. List the nine actions in section 9.6.2 that the operating system must perform to handle a page fault. (Assume that the operating system has already identified or obtained an empty page.)

TLB miss 10ns
Page table exception 1 pico second
Convert virtual address to file offset 5ns
Disk block read 10ms
Disk interrupt 1 pico second
Page table update 5ns
Resume process 1 pico second
TLB miss 10ns
Page table fetch 100ns

3. Give the appropriate SI prefix for the amount of seconds it takes to handle a page fault and then resume execution for the thread that experienced the fault. That is, does it take on the order of nanoseconds, microseconds, milliseconds, seconds, kiloseconds, etc., to handle a page fault from the time of its occurrence to the time that the execution of the faulting instruction is resumed or restarted. Explain why you picked that particular SI prefix in enough detail that you demonstrate your knowledge of the timing for each of the nine actions you listed in question 2 above.

In the worst case scenario there could could be two TLB misses and the system could possibly have to retrieve data manually from a disk which is usually measured on the order of milliseconds and the other steps wouldn't break this magnitude of measurement.

4. How is the core map used when a page is chosen for replacement?

Allows the operating system to find the page table entries that point to the page that has been chosen for replacement; these entries must be invalidated.

5. Why is there an advantage to choosing a clean (or empty) page to replace instead of a dirty page?

Avoids an extra disk transfer to copy back a modified page to disk before it is overwritten by the new page.

6. Why does the textbook say that the use bit in a page table entry residing in a page table in memory is set by hardware on a TLB miss instead of being set on every instruction fetch and/or data read/write to that page?

To prevent a page table update on every access to a page.

7. If all pages have their use bit set, to which policy does the on-demand clock algorithm degenerate?

The policy will default to FIFO.