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11/30/22

ECE357

PSET 5

2)

a) Ideally, true LRU behavior would be achieved if the page frames carried a time value that indicated the total time of inactivity, resulting in a list of all page frames ordered by their time of inactivity. The page with greatest time of inactivity would be elected for use, thus satisfying perfect LRU. For the method outlined in the lecture notes which uses PTE “A” bits and the PFRA algorithm, it does not achieve true LRU behavior, but it comes close. During normal operation, hypoactive pages are moved from active to inactive, clearing the “ACCESSED” bit and keeping a reference bit to track the previous state. During a PFRA scan, if the page is not active and the reference bit indicates the page was already inactive, the page frame is moved to the tail of the inactive list. When more page frames are required, pages from the top of the inactive page list are moved to the active list and PTE bit set. Although it accomplishes the task, it isn’t LRU because the page frames moved from inactive to active aren’t necessarily the least recently used, they just happened to be on the top of list of unused page frames.

b) A radix tree is a forward mapping method that is commonly used to hold pointers to struct pages. It allows for faster lookup for files and contains 64 pointers to struct pages within a file, or NULL. By using this address_space data structure, we can find the page descriptor for a given offset in a memory mapped file. The kernel determines a struct page's position in memory by determining whether a struct page exists given an offset within a mmap file. During paging-in, the kernel consults the radix-64 tree when there is a special case or fault, in which case the mmap region is established with MAP_ANONYMOUS | MAP_SHARED.

c) vm_area_structs should be examined, specifically the virtual address space descriptor field, to determine whether the faulting virtual address violated memory region permissions by checking the vm_flags.

d) The PTE “dirty” bit. Once triggered, a write-back to backing storage begins where the page is unmapped and reclaimed in the free list.