

Operating systems Homework Assignment

Chapter 10 Virtual Memory

9.1 (2 points) A certain computer provides its users with a virtual-memory space of 2^{36} bytes. The computer has 2^{30} bytes of physical memory. The virtual memory is implemented by paging, and the page size is 4096 bytes.

A user process generates the virtual address 13126533. Explain how the system establishes the corresponding physical location. Calculate the Physical address. Distinguish between software and hardware operations.

9.2 (2 points) Assume we have a demand-paged memory. The page table is held in registers. It takes 3 milliseconds to service a page fault if an empty page is available or the replaced page is not modified, and 10 milliseconds if the replaced page is modified. Memory access time is 50 nanoseconds. Assume that the page to be replaced is modified 70 percent of the time. What is the maximum acceptable page-fault rate for an effective access time of no more than 120 nanoseconds?

9.3 (3 points for correct answer, 7 points for steps) Consider the following page reference string: 7, 2, 2, 4, 1, 2, 3, 0, 6, 6, 5, 0, 7, 2, 7, 0, 0, 4, 7, 7

Assuming demand paging with three frames, how many page faults would occur for the following replacement algorithms?

- LRU replacement
- FIFO replacement
- Optimal replacement

9.4 (2 points for correct answer and 3 points for calculation steps) The following page table is for a system with 16-bit virtual and physical addresses and with 4,096-byte pages. The reference bit is set to 1 when the page has been referenced. Periodically, a thread zeroes out all values of the reference bit. A dash for a page frame indicates the page is not in memory. The page-replacement algorithm is localized LRU, and all numbers are provided in decimal.

Page	Page Frame	Reference Bit
0	7	0
1	–	0
2	14	0
3	13	0
4	15	0
5	8	0
6	0	0
7	–	0
8	4	0
9	5	0
10	–	0

11	1	0
12	9	0
13	3	0
14	–	0
15	2	0

a. Convert the following virtual addresses (in hexadecimal) to the equivalent physical addresses. You may provide answers in either hexadecimal or decimal. Also set the reference bit for the appropriate entry in the page table.

- 0xE13C
- 0x5A97
- 0x59D8
- 0x1002
- 0xCCB1

b. Using the above addresses as a guide, provide an example of a logical address (in hexadecimal) that results in a page fault.

c. From what set of page frames will the LRU page-replacement algorithm choose in resolving a page fault?

9.27 (2 points) Consider a demand-paging system with the following time-measured utilizations:

CPU utilization 25%

Paging disk 98.7%

Other I/O devices 6%

For each of the following, say whether it will (or is likely to) improve CPU utilization. Explain your answers.

- a. Install a faster CPU.
- b. Install a bigger paging disk.
- c. Increase the degree of multiprogramming.
- d. Decrease the degree of multiprogramming.
- e. Install more main memory.
- f. Install a faster hard disk or multiple controllers with multiple harddisks.
- g. Add prepaging to the page fetch algorithms.
- h. Increase the page size.