CS 4/53201, Operating Systems, Spring 2006

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Take Home Assignment#3

All problem and page numbers refer to your text book (6th Edition, OS Concepts, Silberschartz).

1. (Problem 9.5) Given memory partitions of 100KB, 500KB, 200KB, 300KB, and 600KB (in order), how could each of the first-fit, best-fit, and worst-fit algorithms place processes of 212KB, 417KB, 112KB, and 426KB (in order)? Which algorithm makes the most efficient use of memory?

2. (Problem 9.10) Consider a paging system with the page table stored in memory.

    a. If a memory reference takes 200 nanoseconds, how long does a paged memory reference take?
    b. If we add TLBs, and 75 percent of all page-table references are found in the TLBs, what is the effective memory reference time? (Assume that finding a page-table entry in the TLBs takes zero time, if the entry is there.)

3. (Problem 9-16) Consider the following segment table:

Segment	Base	Length
0	219	600
1	2300	14
2	90	100
3	1327	580
4	1952	96

    What are the physical addresses for the following logical addresses?
    a. 0430
    b. 110
    c. 2500
    d. 3400
    e. 4112

4. (Problem 10-8) An operating system supports a paged virtual memory, using a central processor with a cycle time of 1 microsecond. It costs an additional 1 microsecond to access a page other than the current one. Pages have 1,000 words, and the paging device is a drum that rotates at 3,000 revolutions per minute and transfer one million words per second. The following statistical measurements were obtained from the system:
    - One percent of all instructions executed accessed a page other than the current page.
    - Of the instruction that accessed another page, 80 percent accessed a page already in memory.
    - When a new page was required, the replaced page was modified 50 percent of the time.

Calculate the effective instruction time on this system, assuming that the system is running one process only, and that the processor is idle during drum transfers.

5. (Problem 10-9) Consider a demand-paging system with the following time-measureed utilizations:

CPU utilization	20%
Paging disk	97.7%
Other I/O devices	5%

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

a. Install a feaster 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 hard disks.
g. Add prepaging to the page-fetch system
h. Insrease the page size

6. (Problem 10-11) Consider the following page-reference string:

1,2,3,4,2,1,5,6,2,1,2,3,7,6,3,2,1,2,3,6.

How many page faults would occur for the following replacement algorithms, assuming one, two, three, four, five, six, or seven frames? Remember that all frames are initially empty, so your first unique pages will all cost one fault each.

- LRU replacement
- FIFO replacement
- Optimal replacement

7. (Problem 12-1) Consider a file currently consisting of 100 blocks. Assume that the FCB (and the index block, in the case of indexed allocation) is already in memory. Calculate how many disk I/O operations are required for contiguous, linked, and indexed (single-level) allocation strategies, if, for one block, the following conditions hold. In the contiguous-allocation case, assume that there is no room to grow in the beginning, but room to grow in the end. Assume that the block information to be added is stored in memory.

a. The block is added at the beginning
b. The block is added in the middle
c. The block is added at the end
d. The block is removed from beginning
e. The block is removed from middle
f. The block is removed from the end

8. (Problem 12-6) Consider a file system on a disk that has both logical and physicl block sizes of 512 bytes. Assume that the information about each file is already in memory. For each of the three allocation strategies (contiguous, linked, and indexed), answer these questions:

a. How is the logical-to-physical address mapping accomplished in this system? (For the indexed allocation, assume that a file is always less than 512 blocks long.)

b. If we are currently at logical block 10 (the last block accessed was block 10) and want to access logical block 4, how many physical blocks must be read from the disk?

9. (Problem 14-2) Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4999. The drive is currently serving a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order, is

   86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130.

   Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests for each of the following disk-scheduling algorithms?
   a. FCFS
   b. SSTF
   c. SCAN
   d. LOOK
   e. C-SCAN
   f. C-LOOK

10. (Problem 14-26) It is sometimes said that tape is a sequential-access medium, whereas magnetic disk is a random-access medium. In fact, the suitability of a storage device for random access depends on the transfer size. The term *streaming transfer rate* denotes the data rate for a transfer underway, excluding the effect of access latency. By contrast, the *effective transfer rate* is the ratio of total bytes per total seconds, including overhead time such as the access latency.

    Suppose that, in a computer, the level-2 cache has an access latency of 8 nanoseconds and a streaming transfer rate of 800MB per second, the main memory have an access latency of 60 nanoseconds and a streaming transfer rate of 80MB per second, the magnetic disk have an access latency of 15 millisecond and a streaming transfer rate of 5MB per second, and a tape drive has an access latency 0f 60 seconds and a streaming transfer rate of 2MB per second.
    a. Random access causes the effective transfer rate of a device to decrease, because no data are transferred during the access time. For the disk described, what is the effective transfer rate if a steaming transfer of 512 bytes, 8KB, 1 MB, and 16MB follows an average access?
    b. The utilization of a device is the ratio of effective transfer rate to straming transfer rate. Calculate the utilization of the disk drive for random access that performs transfers in each of the four sizes given in part a.
    c. Suppose that a utilization of 25 percent (or higher) is considered acceptable. Using the performance figures given, compute the smallest transfer size for disk that gives acceptable utilization.
    d. Complete the following sentence: A disk is a random-access device for transfers larger than _____ bytes, and is a sequential–access device for smaller transfers.
    e. Compute the minimum transfer sizes that give acceptable utilization for cache, memory, and tape.
    f. When is a tape a random-access device, and when is it a sequential-access device?