Alexandria University
Faculty of Engineering
Computer and Systems Engineering Dept.

Subject: Operating Systems
Sheet 8

Memory Management

7.1 MEMORY MANAGEMENT REQUIREMENTS

1. Why is the capability to relocate processes desirable?

2. What are the distinctions among logical, relative, and physical addresses?

7.2 MEMORY PARTITIONING

3. What is the difference between internal and external fragmentation?

4. Consider a fixed partitioning scheme with equal-size partitions of 2^{16} bytes and a total main memory size of 2^{24} bytes. A process table is maintained that includes a pointer to a partition for each resident process. How many bits are required for the pointer?

5. Another placement algorithm for dynamic partitioning is referred to as worst-fit. In this case, the largest free block of memory is used for bringing in a process. Discuss the pros and cons of this method compared to first-, next-, and best-fit.

6. A dynamic partitioning scheme is being used, and the following is the memory configuration at a given point in time:
The shaded areas are allocated blocks; the white areas are free blocks. The next three memory requests are for 40M, 20M, and 10M. Indicate the starting address for each of the three blocks using the following placement algorithms:

20M | 20M | 40M | 60M | 20M | 10M | 60M | 40M | 20M | 30M | 40M | 40M
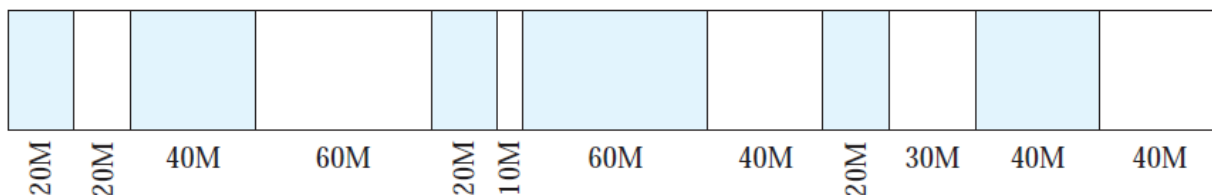
   a. First-fit.
   b. Best-fit.
   c. Next-fit. Assume the most recently added block is at the beginning of memory.
   d. Worst-fit.

7. This diagram shows an example of memory configuration under dynamic partitioning after a number of placement and swapping-out operations have been carried out. Addresses go from left to right; gray areas indicate blocks occupied by processes; white areas indicate free memory blocks. The last process placed is 2-Mbyte and is marked with an X. Only one process was swapped out after that.

| 4M | | 1M | X | 5M | | 8M | | 2M | 4M | | 3M | |
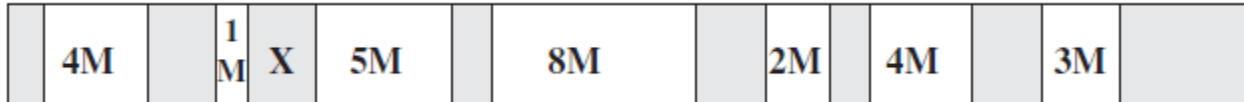
      a. What was the maximum size of the swapped-out process?
      b. What was the size of the free block just before it was partitioned by X?
      c. A new 3-Mbyte allocation request must be satisfied next. Indicate the intervals of memory where a partition will be created for the new process under the following four placement algorithms: best-fit, first-fit, next-fit, and worst-fit. For each algorithm, draw a horizontal segment under the memory strip and label it clearly.

8. A 1-Mbyte block of memory is allocated using the buddy system.
      a. Show the results of the following sequence in a figure similar to Figure 7.6:
         Request 70; Request 35; Request 80; Return A; Request 60; Return B; Return D; Return C.
      b. Show the binary tree representation following Return B.

9. Consider a buddy system in which a particular block under the current allocation has an address of 011011110000.
      a. If the block is of size 4, what is the binary address of its buddy?
      b. If the block is of size 16, what is the binary address of its buddy?

7.3 PAGING

10. Consider a simple paging system with the following parameters: 2^{32} bytes of physical memory; page size of 2^{10} bytes; 2^{16} pages of logical address space.
      a. How many bits are in a logical address?
      b. How many bytes in a frame?
      c. How many bits in the physical address specify the frame?
      d. How many entries in the page table?
      e. How many bits in each page table entry?

11. A logical address a in a paging system is equivalent to a pair (p, w), in which p is a page number and w is a byte number within the page. Let z be the number of bytes in a page. Find algebraic equations that show p and w as functions of z and a.

7.4 SEGMENTATION

12. Consider a simple segmentation system that has the following segment table:

Starting Address	Length (bytes)
660	248
1752	422
222	198
996	604

For each of the following logical addresses, determine the physical address or indicate if a segment fault occurs:
   a. 0, 198
   b. 2, 156
   c. 1, 530
   d. 3, 444
   e. 0, 222

General questions

13. Consider a system with a 16KB memory. The sequence of processes loaded in and leaving the memory are given in the following.
   P1 7K loaded
   P2 4K loaded
   P1 terminated and returned the memory space
   P3 3K loaded
   P4 6K loaded
   Give the memory map showing the allocated portion and the free portion after the end of the sequence (if a process cannot be loaded, indicate that) for the following placement algorithms. Also, indicate the internal/external fragmentations.
   a. first fit
   b. best fit
   c. buddy
   d. simple paging (assume that each page is of size 2K)