

Operating System Design

Homework:

- Operating System Review 3
Chapter 8 to 12

NAME:
STUDENT ID:
DATE:

Questions

- 1) Consider a logical address space of 64 pages of 1024 words each, mapped onto a physical memory of 32 frames.

a. How many bits are there in the logical address?

- The logical address requires 6 bits for page numbering since $2^6 = 64$.
- The logical address requires 10 bits of offsets to store $1024 = 2^{10}$ words.
 \Rightarrow the logical address requires 16 bits in total.

b. How many bits are there in the physical address?

32 frames $\Rightarrow 2^5$.
10 bits of offset $\rightarrow 2^{10}$ } $\Rightarrow 2^{15}$

- 2) What is the purpose of paging the page tables?

In certain situations the page tables could become large enough that by paging the page tables, one could simplify the memory allocation problem (to ensure that everything is allocated as fixed size pages as opposed to variable-sized chunks) and also enable the swapping of portions of page table that are not currently used.

- 3) Under what circumstances do page faults occur? Describe the actions taken by the operating system when a page fault occurs.

A page fault occurs when an access to a page that has not been brought into main memory takes place. The operating system verifies the memory access, aborting the program if it is invalid. If it is valid, a free frame is located & I/O is requested to read the needed page into the free frame. Upon completion of I/O, the process table & page table are updated & the instruction is restarted.

- 4) Which of the following programming techniques and structures are "good" for a demand-paged environment? Which are "not good"? Explain your answers.

- a. Stack
- b. Hashed Symbol Table
- c. Sequential Search
- d. Pure code
- e. Indirection

Demand-paging is good in techniques or data structure which reference data in the same vicinity (i.e. hit ratio on the same page is high), e.g. sequential access to an array versus random access.

The following techniques & data structures are good: a, c, d
but the following are not so good: b, e

- 5) Does the working set model of page allocation support global or local replacement of frames? Explain.

The working set model supports local page replacement.

A process is provided with enough frames for its working set, and page replacement is done from those frames.

However, the working set may change overtime, expand or shrink, depending on its needs. This mechanism allows the process to get more frame, indirectly from other process (but not necessary).

Thus it is very close to global replacement mechanism.

- 6) Consider a demand-paged computer system where the Operating System is expected to support multiprogramming. The system was recently measured to determine utilization of CPU and the paging disk. For the measurements below, which measurement shows thrashing, which measurement shows an increase in multiprogramming is needed, which measurement shows the computer system is being utilized effectively.

- CPU utilization 13 percent; disk utilization 97 percent
 - CPU utilization 87 percent; disk utilization 3 percent
 - CPU utilization 13 percent; disk utilization 3 percent
- System is thrashing, the degree of multiprogramming should decrease.
 System is efficiently utilized, CPU is being kept busy. The degree of multiprogramming should stay the same.
 System is under utilized, the CPU is not getting enough work. The degree of multiprogramming should increase.

- 7) Describe what causes thrashing to occur in an Operating System. What technique can be used to minimize the possibility of thrashing.

Thrashing is when a process is busy swapping pages in and out, the cause is when the page-fault rate is very high due to process does not have "enough" pages.

To minimize the possibility of thrashing, the degree of multiprogramming should be reduced.

- 8) 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.

Complete the diagram. How many page faults would occur for the LRU replacement algorithms, assuming four frames? Show work, similar to Figure 9.15 in textbook.

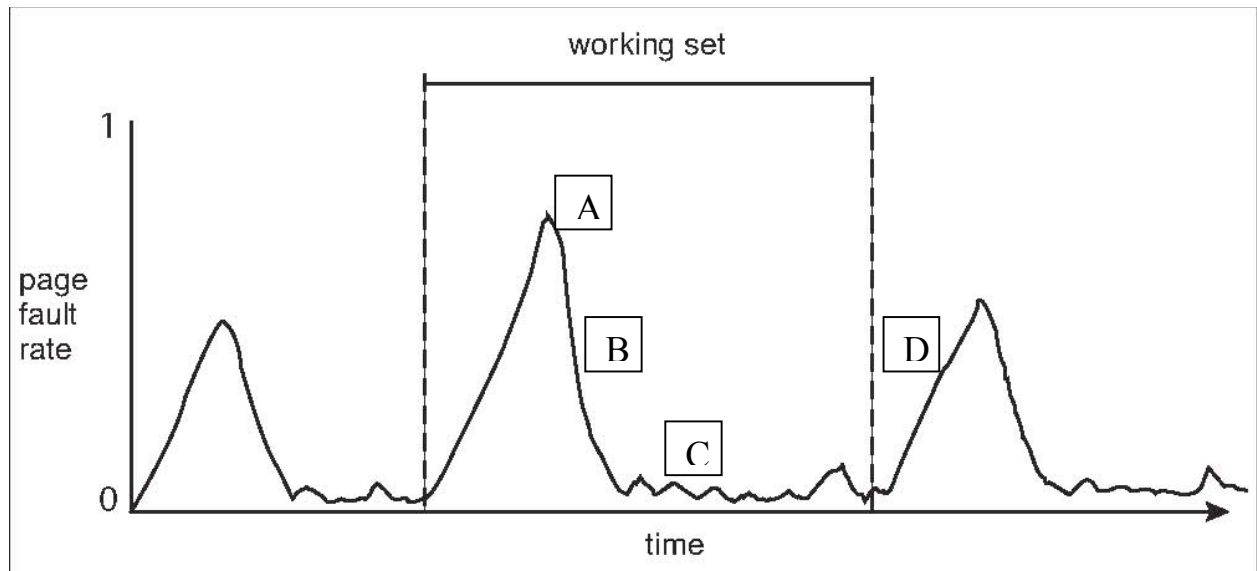
1	2	3	4	2	1	5	6	2	1	2	3	7	6	3	2	1	2	3	6
1	1	1	1	1	1	1	1	1	1	1	1	6	6	6	6	6	6	6	6
-	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
-	-	3	3	3	3	5	5	5	5	3	3	3	3	3	3	3	3	3	3
-	-	-	4	4	4	4	6	6	6	6	7	7	7	7	1	1	1	1	1
F	F	F	F			F	F			F	F	F		F					

10 page faults would occur for LRU replacement algo

- 9) The Memory Management techniques for paging and segmentation, was an improvement over requiring the process image to reside in contiguous memory, but paging and segmentation still required the process image to reside in physical memory. With Virtual Memory, the process image no longer has to reside in physical memory, just the pages that are currently used. Explain why the entire process image does not need to reside in physical memory for the process to execute.

When a process is loaded into memory, it is allocated an address space. Under virtual memory, this address space contains all virtual addresses, which will be translated to real physical addresses for use. The translation occurs all the time. Because (a) all addresses are virtual, and (b) most process does not need to use all of its variables, or functions all the time, therefore the operating system just needs to load, or if the process image is in physical memory. If a process tries to access an address that is not inside physical memory, the OS will load or swap the content from the disk into physical memory for the process to access.

- 10) The diagram belows shows the Page Fault Rate in relationship to time in a Working Set Model. What is the significance of the following points in the diagram.



- A) Peak in Page Fault Rate : begin of Demand Paging in new Locality.
- B) Working Set of new Locality is loading in progress into Mem, PF rate decreases.
- C) Most pages for new locality are in physical frame.
- D) Demand Paging in next Locality.

11) User space and the Linux Kernel space are in different segments in physical memory. What type of memory allocation scheme is used by the Linux Kernel?

Memory Segmentation : kernel code , kernel data , user code , task state , & default local descriptor table

12) Consider a system that supports the file allocation strategies of contiguous, linked, and indexed allocation. What type of file would be best utilized by each of the file allocation strategies?

a) Contiguous Strategy:

b) Linked Strategy:

c) Indexed Strategy:

13) Explain how the VFS layer allows an operating system to support multiple types of file systems easily.

- 14) What are the advantages of the variant of linked allocation that uses a FAT to chain together the blocks of a file?
- 15) None of the disk-scheduling disciplines, except FCFS, is truly fair (starvation may occur). Explain why this assertion is true for SSTF, SCAN, and CSCAN.