

第七次作业

9.4 A certain computer provides its users with a virtual-memory space of 2^{32} bytes. The computer has 2^{18} bytes of physical memory. The virtual memory is implemented by paging, and the page size is 4,096 bytes. A user process generates the virtual address 11123456H. Explain how the system establishes the corresponding physical location. Distinguish between software and hardware operations.

解：

虚拟地址 11123456H 转换为二进制为：

$$11123456_{(H)} = 0001\ 0001\ 0001\ 0010\ 0011\ 0100\ 0101\ 0110_{(2)}$$

分页大小：

$$4096 = 2^{12}$$

则地址后 12 位为位移量，即 0100 0101 0110；

除位移量外的前 20 位为页号，即 0001 0001 0001 0010 0011；

寻找页号对应的块号，内存地址即为块号+位移量，对应的物理位置在该块的起始位置向后偏移位移量。

9.10 Consider a demand-paging system with the following time-measured 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.

- Install a faster CPU.**
- Install a bigger paging disk.**
- Increase the degree of multiprogramming.**
- Decrease the degree of multiprogramming.**
- Install more main memory.**

- f. Install a faster hard disk or multiple controllers with multiple hard disks.**
- g. Add pre-paging to the page-fetch algorithms.**
- h. Increase the page size.**

解：

在此需求分页系统中，CPU 利用率仅为 20%，而分页磁盘利用率达到了 97.7%，表明系统的分页开销很大，花费大量时间处理缺页，读取磁盘内的页并将其调入内存。

- a. 更快的 CPU 速度不能提升 CPU 利用率；
- b. 更大的分页磁盘不能提升 CPU 利用率；
- c. 增加多道程序不能提升 CPU 利用率；
- d. 降低多道程序可以提高 CPU 利用率，因为降低多道程度可以减少缺页中断；
- e. 更多主存可以提升 CPU 利用率，因为内存中可以存储更多的页，减少页置换；
- f. 安装更快的硬盘或具有多个硬盘的多个控制器可以提升 CPU 利用率，因为读磁盘的速度更快，处理缺页的速度更快；
- g. 为页面获取算法添加预调页可以减少缺页，从而提升 CPU 利用率；
- h. 增加页面大小可以减少页置换，提升 CPU 利用率。

9.13 A page-replacement algorithm should minimize the number of page faults. We can achieve this minimization by distributing heavily used pages evenly over all of memory, rather than having them compete for a small number of page frames. We can associate with each page frame a counter of the number of pages associated with that frame. Then, to replace a page, we can search for the page frame with the smallest counter.

- a. Define a page-replacement algorithm using this basic idea. Specifically address these problems:
 - 1. What the initial value of the counters is
 - 2. When counters are increased
 - 3. When counters are decreased

4. How the page to be replaced is selected

b. How many page faults occur for your algorithm for the following reference string, with four page frames?

1,2,3,4,5,3,4,1,6,7,8,7,8,9,7,8,9,5,4,5,4,2.

c. What is the minimum number of page faults for an optimal page-replacement strategy for the reference string in part b with four page frames?

解:

a.利用题目所述的页置换思想，计数器的初始值为 0；当新页与当前页帧关联时，计数器加 1；当与当前页帧关联的页不再需要时，计数器减 1；页置换时，选择计数器值最小的页帧，相同值时采用 FIFO 算法。

b.

1	2	3	4	5	3	4	1	6	7	8	7	8	9	7	8	9	5	4	5	4	2
1	1	1	1	5	5	5	5	5	5	8	8	8	8	8	8	8	8	4	4	4	4
1				2			1			2							1	2			
	2	2	2	2	2	2	1	1	1	1	1	1	9	9	9	9	9	9	9	9	9
	1						2						3								
		3	3	3	3	3	3	6	6	6	6	6	6	6	6	6	5	5	5	5	5
		1						2									3				
			4	4	4	4	4	4	7	7	7	7	7	7	7	7	7	7	7	7	2
			1						2										1		2
x	x	x	x	x			x	x	x	x			x				x	x			x

共发生 13 次缺页中断，9 次页置换。

c.针对本例最佳的页置换算法如下：

1	2	3	4	5	3	4	1	6	7	8	7	8	9	7	8	9	5	4	5	4	2
1	1	1	1	1	1	1	1	6	7	7	7	7	7	7	7	7	5	5	5	5	5
	2	2	2	5	5	5	5	5	5	5	5	5	9	9	9	9	9	9	9	9	9
		3	3	3	3	3	3	3	3	8	8	8	8	8	8	8	8	8	8	8	8
			4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
x	x	x	x	x				x	x	x			x				x				x

共 11 次缺页中断，7 次页置换。