

Operating System – Homework Assignment #5

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1. What is the difference between a hard link and symbolic link? Give an advantage of each one.

Hard link uses the same inode of the target file, namely they are the same files; however, symbolic link is just like a shortcut who create a new inode and point to the original inode of the same target file.

When it comes to the advantage of both, the hard link has no space and time cost compared to the other one, and it would not worry about the original file will be removed when the target file of hard link is removed, since it is “the file itself”. Nevertheless, the soft link could be able to link to another directory of file and even link to the file of another disk across the file system, which the hard link can’t do.

2. A disk has 4000 cylinders, each with 8 tracks of 512 blocks. A seek take 1 msec per cylinder moved. If no attempt is made to put the blocks of a file close to each other, two blocks that are logically consecutive (i.e., follow one another in the file) will require an average seek, which takes 5 msec. If, however, the operating system makes an attempt to cluster related blocks, the mean interblock distance can be reduced to 2 cylinders and the seek time reduce to 100 microsec. How long does it take to read a 100 block file in both cases, if the rotational latency is 0 msec and transfer time is 20 microsec per block?

For NON-optimal algorithm: $(5+10+0.02) * 100 = 1502\text{ms}$

For optimal algorithm: $(0.1*2+10+0.02) * 100 = 1022\text{ms}$

3. 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 all frames are initially empty, so your first unique pages will all cost one fault each.

- a. LRU replacement

Frame	1	2	3	4	5	6	7
LRU	20	18	15	10	8	7	7

- b. Optimal replacement

Frame	1	2	3	4	5	6	7
Optimal	20	15	11	8	7	7	7

4. Consider a file currently consisting of 100 blocks. Assume that the file control block (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 there is room to grow in the end. Assume that the block information to be added is stored in memory.
- The block is added at the beginning.
 - The block is added at the middle.
 - The block is added at the end.
 - The block is removed from the beginning.
 - The block is removed from the middle.

	Contiguous	Linked	Indexed
a	201	1	1
b	101	52	1
c	1	3	1
d	198	1	0
e	98	52	0

5. 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 4096 bytes. A user process generates the virtual address 11123456. Explain how the system establishes the corresponding physical location. Distinguish between software and hardware operations.

Since the page size is 4096 bytes = 2^{12} , and the page table size would be the rest of 2^{20} = 1048576 bytes, where the total virtual memory space is 2^{32} = 4294967296.

Assuming 11123456 is in HEX, which is equal to “0x11123456”, the virtual address in binary form is “0b0001 0001 0001 0010 0011 0100 0101 0110”. Therefore, the low-order 12 bits (0100 0101 0110) are used as the displacement into the page, while the rest (0001 0001 0001 0010 0011) are used as the displacement into the page table.

Assuming 11123456 is in DECIMAL, the virtual address in binary form is “0b0000 0000 1010 1001 1011 1011 0000 0000”. Therefore, the low-order 12 bits (1011 0000 0000) are used as the displacement into the page, while the rest (0000 0000 1010 1001 1011) are used as the displacement into the page table.

Distinguish between software and hardware operation: the hardware part handles the address translation dynamically. and the software part takes care of page I/ O.