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CPSC 380

Homework #4

Part IV –Storage Management

1. None of the disk-scheduling disciplines, except FCFS, is truly fair (starvation may occur). (6 pts)
   1. Explain why this assertion is true.

New requests for the track over which the head currently is can theoretically arrive as soon as the requests are being serviced.

* 1. Describe a way to modify algorithms such as SCAN to ensure fairness.

All requests can be “aged” so that if a request reaches some predetermined age it can be forced to the top of the queue.

* 1. Explain why fairness is an important goal in a time-sharing

Fairness is important to ensure that response times are not too long.

1. Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4999. The drive is currently serving a request at cylinder 2150, and the previous request was at cylinder 1805. The queue of pending requests, in FIFO order, is:

2069, 1212, 2296, 2800, 544, 1618, 356, 1523, 4965, 3681

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? (10 pts)

1. FCFS

Order: 2150, 2069, 1212, 2296, 2800, 544, 1618, 356, 1523, 4965, 3681

Total movement: 81 + 857 + 1084 + 504 + 2256 + 1074 + 1262 + 1167 + 3433 + 1275 = 12993

1. SSTF

Order: 2150, 2069, 2296, 2800, 3681, 4965, 1618, 1523, 1212, 544, 356

Total movement: 81 + 227 + 504 + 881 + 1275 + 3338 + 95 + 311 + 668 + 188 = 7568

1. SCAN

Order: 2150, 2296, 2800, 3681, 4956, (4999), 2069, 1618, 1523, 1212, 544, 356

Total movement: 146 + 504 + 881 + 1275 + 43 + 2930 + 451 + 95 + 311 + 668 + 188 = 7492

1. LOOK

Order: 2150, 2296, 2800, 3681, 4956, 2069, 1618, 1523, 1212, 544, 356

Total Movement: 146 + 504 + 881 + 1275 + 2887 + 451 + 95 + 311 + 668 + 188 = 7406

1. C-SCAN

Order: 2150, 2296, 2800, 3681, 4956, (4999), (0), 356, 544, 1212, 1523, 1618, 2069

Total movement: 146 + 504 + 881 + 1275 + 43 + 4999 + 356 + 188 + 668 + 311 + 95 + 451 = 9917

1. The reliability of a hard-disk drive is typically described in terms of a quantity called *mean time between failures* (*MTBF*). Although this quantity is called a “time,” the MTBF actually is measured in drive-hours per failure. (3 pts)
   1. If a system contains 1000 drives, each of which has a 750,000-hourMTBF, which of the following best describes how often a drive failure will occur in that disk farm: once per thousand years, once per century, once per decade, once per year, once per month, once per week, once per day, once per hour, once per minute, or once per second?

750000/1000 = 750 hrs/failure = once per month

1. Discuss the reasons why the operating system might require accurate information on how blocks are stored on a disk. How could the operating system improve file system performance with this knowledge? (4 pts)

While allocating blocks for a file, the operating system could allocate blocks that are close together on the disk if it had more information regarding the physical location of the blocks on the disk. In particular, it could allocate a block of data and then allocate the second block of data in the same cylinder but on a different surface at a rotationally optimal place so that the access to the next block could be made with minimal cost.

1. Provide examples of applications that typically access files according to sequential and random-access methods. (4 pts)

Sequential: applications that access documents successively (word processors, video players, etc.)

Random: applications that access documents arbitrarily (databases, video editors, etc.)

1. Give an example of an application that could benefit from operating system support for random access to indexed files. (3 pts)

A database so that files are searched for by their pointer. If the file is found, it’s contents will be fetched.

1. Some systems provide file sharing by maintaining a single copy of a file; other systems maintain several copies, one for each of the users sharing the file. Discuss the relative merits of each approach. (4 pts)

Single Copy: there is a chance that several concurrent updates to a file may result in the user obtaining incorrect information

Several Copies: there is a larger space requirement and copies may not be consistent with each other

1. Consider a system where free space is kept in a free-space list. (4 pts)
   1. Suppose that the pointer to the free-space list is lost. Can the system reconstruct the free-space list? Explain your answer.

In order to reconstruct the free-space list, it would be necessary to perform “garbage collection.” This would mean that the entire directory needs to be searched to determine which pages are already allocated, unallocated pages should be relinked as free-space.

* 1. Consider a file system similar to the one used by UNIX with indexed allocation. How many disk I/O operations might be required to read the contents of a small local file at */a/b/c*? Assume that none of the disk blocks is currently being cached.

The free-space list pointer could be stored on the disk, possibly in several places.

1. Some file systems allow disk storage to be allocated at different levels of granularity. For instance, a file system could allocate 4 KB of disk space as a single 4-KB block or as eight 512-byte blocks. How could we take advantage of this flexibility to improve performance? What modifications would have to be made to the free-space management scheme in order to support this feature? (4 pts)

The advantage of this scheme is that it would decrease internal fragmentation. Assuming a file is 5KB, it could be allocated a 4KB block and two contiguous 512-byte blocks. In addition to maintaining a bitmap of free blocks, one would also have to maintain extra state regarding which of the subblocks are currently being used inside a block. The allocator would then have to examine this extra state to allocate subblocks and coalesce the subblocks to obtain the larger block when all of the subblocks become free.

1. Consider a file system that uses inodes to represent files. Disk blocks are 8-KB in size and a pointer to a disk block requires 4 bytes. This file system has 12 direct disk blocks, plus single, double, and triple indirect disk blocks. What is the maximum size of a file that can be stored in this file system? (3pts)

(12\*8 KB) + (2048\*8 KB) + (2048\*2048\*8 KB) + (2048\*2048\*2048\*8 KB) = 64 TB

1. Discuss how performance optimizations for file systems might result in difficulties in maintaining the consistency of the systems in the event of computer crashes. (4 pts)

The biggest difficult is delayed updates of data and metadata. Updates can be delayed in hope that the same data might be updated in the future or that the updated data might be temporary or might be deleted in the near future. However, if the system were to crash without having committed the delayed updates, then the consistency of the file system is destroyed.