EECS 343: Homework 4

I/O and File Systems - Solutions

Fall 2014

Important Dates

Out: November 22, 2014.

Due: December 3, 2014, 11:59PM CDT.

Submitting your assignment: Please use the course submission site. There is a link to it from the class site. **Submit only ASCII text files.**

Problems

1. Discuss at least two advantages and one disadvantage of Memory-mapped I/O.

   Answer: *Advantages: no special instructions, so you can write device drivers in C; no special protection mechanisms, just don't put the part of the address space containing the control registers in any user's virtual address space; every instruction that can reference memory can reference control registers. Disadvantages: hardware has to allow disabling caching at some level since caching device control registers is not good; the machine has to tell if a reference is for memory or a device.*

2. Disk requests come in to the disk driver for cylinders 10, 22, 20, 2, 40, 6 and 38, in that order. A seek takes 6 msec per cylinder moved. How much seek time is needed for the following algorithms. In all cases, the arm is initially at cylinder 20.

   (a) FCFS:
   (b) SSTF:
   (c) C-SCAN (initially moving upward and cylinders range within [0,40]):
   (d) C-LOOK: (initially moving upward):

   (a) FCFS: *10 + 12 + 2 + 18 + 38+ 34 + 32 = 146 cylinders = 876msec.*
   (b) SSTF: *0 + 2 + 12 + 4 + 4 + 36 + 2 = 60 cylinders = 360msec.*
   (c) C-SCAN (initially moving upward and cylinders range within [0,40]): *0 + 2 + 16 + 2 + 40 + 2 + 4 + 4 = 70 cylinders = 420msec.*
   (d) C-LOOK: (initially moving upward): *0 + 2 + 16 + 2 + 38 + 4 + 4 = 66 cylinders = 396msec.*

3. Free disk space can be kept track of using a free list or a bitmap. Disk addresses require D bits. For a disk with B blocks, F of which are free, state the condition under which the free list uses less space than the bitmap. For D of 16 bits, express your answer as a percentage of the disk space that must be free.

Answer: *The bitmap requires B bits. The free list requires DF bits. The free list requires fewer bits if $DF < B$. Alternatively, the free list is shorter if $F/B < 1/D$, where F/B is the fraction of blocks free. For 16-bit disk addresses, the free list is shorter if 6% or less of the disk is free.*

4. How does the Fast File System try to optimize storage utilization and file system performance over the traditional UNIX file system? Briefly explain your answer.

Answer: *Larger block sizes for performance, two block sizes for disk utilization, clustering of i-nodes and blocks in cylinder groups for performance.*

5. List and briefly discuss at least two of the observations that motivated the work on Log-Structured File systems.

Answer: *Memory sizes were growing, so one could cache more in memory and disk traffic would increasingly consist of writes; a growing gap between random and sequential I/O performance as transfer bandwidth increases 10x faster than seek and rotational costs decreases; existing file systems perform poorly on many common workloads, as file systems employed a large number of writes to create files, for instance; file systems were not RAID-aware with a lot of small writes*