Name: _____

Instructions

There are three (3) questions on the exam. You may find questions that could have several answers and require an explanation or a justification. As we've said, many answers in storage systems are "It depends!". In these cases, we are more interested in your justification, so make sure you're clear. Good luck!

If you have several calculations leading to a single answer, please place a ☐ box around your answer ☐.

Problem 1 : Short answer. [63 points]

(a) Identify two benefits of frequent checkpointing in a journaling file system?

(b) Some file systems use disk space allocation policies that place large files toward the beginning of the LBN space. Why would they do this?

(c) Most disk drives maintain a cache, even though the block cache in most systems' main memory has much larger capacity. Why?

(d) Project 1 involved direct access to the raw disk interface rather than use of the file system. Why not use the file system interface instead?

(e) Most file systems keep multiple copies of the "superblock" on the disk. By doing so, what disk-level problem are they protecting against?

(f) It is difficult, in most systems, to perform disk request scheduling that simultaneously considers low-level positioning costs (e.g., Shortest-Positioning-Time-First) and high-level priorities among requests (e.g., because they were generated by applications of differing importance). Explain why.

(g) Would you expect a secondary (non-clustered) B-Tree index to perform better or worse than a primary (clustered) index? Why?

(h) Explain why soft updates does not provide the semantics most naturally desired for RENAME operations that move a file from one directory to another.

(i) Web sites that sell disk drives usually report their capacity (in GBs) and their rotation speed (in RPMs). Why should someone buying a disk not expect the 15000 RPM disk to be twice as fast as the 7200 RPM disk?

time
(ms)

2

1

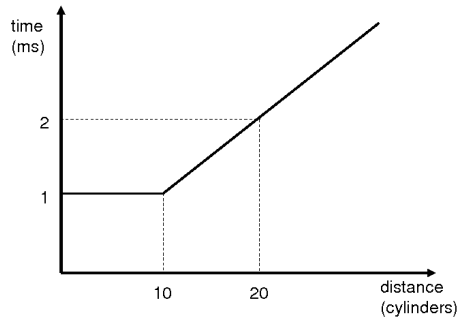10   20   distance
(cylinders)

Figure 1: Disk Seek Curve

Problem 2 : Optimizing Disk Access Patterns . [13 points]

Consider a disk with the following characteristics:

- 10000 RPM

- Single zone with 700 sectors per track

- The seek curve shown in Figure 1.

(a) Compute the time it takes to read a directory and ten single-block files contained within it, assuming that all data and metadata are stored in the same cylinder group (of exactly 10 cylinders in size) and that no two inodes are in the same inode block.

(b) Which component of disk access time dominates the time in (a)?

Problem 3 : Short design questions. [24 points]

(a) In an LFS implementation, it is important to identify the last log segment written upon recovering from a crash. Assuming a static order in which the segments should be used, explain one approach a system could use to do this.

(b) You are considering the use of a secondary index on the main table in your database. Identify one performance benefit and one performance penalty associated with the choice.

(c) Most file systems use write-back caching, which decouples application performance from disk access times for writes. At some point, however, modified data is written out to disk. Identify two reasons for generation of such disk writes.

Problem 4 : Instructor trivia. [up to 2 bonus points]

(a) Timmy will be dressing up as a football player for Halloween, with the winged helmut of daddy's favorite football team. Which team is it?

(b) Identify at least one "term" coined in 18-746 this term to refer to a desirable or undesirable system property. What have we used it to mean?

(c) Which team won the Greece vs. USA semifinal match in the 2006 basketball world championship? Bonus on bonus: associate the instructor and TA with the appropriate country of origin, from among the teams involved.

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