In-class problems on File Systems
COP 6600 Spring 2015

1. Assume a file system that uses a "contiguous" disk allocation strategy. Assume that there is a file on the disk that is 5 disk blocks long. Describe the steps, including any disk read or write operations, required by the operating system to delete the 3rd block of the file.

2. Assume a file system that uses a contiguous disk allocation strategy. Assume that there is a file that is 10 disk blocks long (starting block is 1, ending block is 10) and that the file's descriptor information is already in main memory.
    1. If we want to access information on block 6 of the file, how many blocks must be read from the disk? Explain why.
    2. The same questions but assume that the file system uses a linked disk allocation strategy.
    3. The same question but assume that the file system uses an index node (i-node) allocation strategy.

3. Contiguous allocation of files leads to disk fragmentation, as mentioned in class. Is this internal fragmentation or external fragmentation? Make an analogy with another component of an operating system.

4. 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 conditions under which the free list uses less space than the bitmap. For D having the value 16 bits, express your answer as a percentage of the disk space that must be free.

5. It has been suggested that the first part of a UNIX file be kept in the same disk block as its i-node. What good would this do?

6. Two computer scientists, Carolyn and Elinor, are having a discussion about i-nodes. Carolyn maintains that memories have gotten so large and so cheap that when a file is opened, it is simpler and faster just to fetch a new copy of the i-node into the i-node table, rather than search the entire table to see if it is already there. Elinor disagrees. Who is right and why? (Support your answer clearly.)

7. Which of the following conditions would likely represent a serious problem with a file system (Justify answer for each.)
    a) A write to a data block that contains no on-disk inodes pointing at it.
    b) A write to a data block that contains multiple on-disk inodes pointing at it.
    c) A write to a data block that is marked as free in the on-disk bitmap.

8. Given a BSD Unix Fast File System that needs to support two types of workloads:
    - Workload A – Contains sequential access to many small files in the same directory.
    - Workload B – Contains sequential access to a few very large files in different directories.

   For each workload, describe the effect of the following changes in disk technology (be sure to estimate how significant the change would be):

   a) A disk with twice the number of heads and platters.
   b) A disk that spins twice as fast.
   c) A disk with twice as many sectors per track.

9. a) Is it possible with the BSD fast file system to have blocks from two different files in the same cylinder group?
   b) How about files from two different directories in the same cylinder group?

   Justify your answers. If it is possible, describe what conditions would be necessary to make it occur.

10. fsck is the Unix file system crash recovery program. For each of the following fsck error messages, what do you believe fsck has seen in the crashed file system to generate the error message:
    a) File's inode link count is 1 should be 2.
    b) Free bitmap entry for block 3323 is 0, should be 1 (allocated).
    c) Cylinder group 4 - free block count is incorrect.

11. What would be the implications of setting the log size of a write-ahead logging file system to a very small size (say just a few blocks). Consider both reliability and performance issues.

12. Assume you have a file system that uses write-ahead logging. (a) Is it ever possible to have more bytes written to the log than are written to the data portion (i.e., the non-log portion) of the disk? (b) Is it ever possible to have more bytes read from the log than are read from the data portion of the disk? Justify your answers.