COSC 450 Operating System Mini-Test #4

11/12/24

Name:_____.

1. An operating system commonly uses two methods to track free blocks: the linked list and the bitmap. Let's say a block size is 4-KB and 64-bit disk block number in a file system.

a. (1.5 pt.) How many maximum blocks are needed for keep track 2TB secondary memory such as HDD with linked list?

- Size of Each block =4×2^{10} Byte = $8 \times 4 \times 2^{10}$ bits = 2^{15} bits
- One block can keep = size of block/size of a block address = 2^{15} bits / 64 bits =2^{15} / 2^{6} = 2^{9} -1 = 511 block information
- Total # of blocks in the secondary memory = size of secondary memory / block size
  = 2TB / 4KB blocks =2×2^{40} / 4×2^{10}
  = 2^{41} / 2^{12}= 2^{29} blocks
- # of blocks need to keep track of free blocks = 2^{29} blocks /511 = 1,050,628.007
  ∴ 1,050,629 blocks

b. (1.5 pt.) How many blocks are needed for keep track of 2TB secondary memory with bitmap?

- Total # of blocks in the disk = 2^{29} blocks
- Need 2^{29} bits for bit map= 2^{29} bit = 2^{29}/ 8 Byte= 2^{29} / 2^{3} = 2^{26} Byte
- # of blocks need for bitmap = 2^{26} / (4×2^{10}) = 2^{26} / 2^{12} = 2^{14} blocks

c. (1 pt.) What is the maximum size of secondary memory supported by the operating system?

- Since this system use 64 bit disk block number, this system support 2^{64} blocks
- Maximum disk size = maximum # of block supported $\times$ one block size =
  =$2^{64} \times 4 \times 2^{10}$ Byte =256×2^{70} = 32 ZB (Zibi)

2. (1 pt.) Linux-like systems use i-nodes to manage the file system. File attributes and block addresses are stored within the i-node. A limitation with i-nodes is that, if each i-node can store only a fixed number of disk addresses, it becomes problematic when a file grows beyond this limit. One solution is to reserve the last disk address not for a data block but for the address of a block that contains additional block addresses.

For example, if an i-node can store 10 direct addresses, each taking up 16 bytes, and the block size is 2 KB, what would be the maximum file size if the file uses an i-node and one extra block to store additional addresses?

Sol) since 1 block is 2KB, and 16 Byte per block address, it can save $2 \times 2^{10} / 16 = 2^{11}/2^4 = 2^7$ = 128 block information

Total = 128 +10 = 138 block information.

Since a block size is 2KB, largest file will be 2KB × 138 =276 KB

3. (1 pt.) What are pieces of information is typically stored in the directory for a file in each of allocation scheme?

a. Contiguous allocation – File name, first block number and number of blocks used

b. Linked allocation scheme – File name, First block number

c. I-node allocation scheme – File name, i-node number

4. (1 pt.) About Log-Structured File System

a. Log-Structured File system can be apply based on the assumption. What is this assumption? files are cached in the RAM when it is opened.

b. Linux use i-node for saving blocks information for a file. To open a file, operating system checks the directory for the file to get i-node number. Since i-nodes are located in special location, operating system does not need search for i-node. In LSF (Log-Structured File) system, i-node is not located in specific location. Express the detailed steps to read a file with file name in an i-node scheme

- In LSF, each i-node is not at a fixed location; they are written to the log.
- LFS uses a data structure called an i-node map to maintain the current location of each i-node.
- Opening a file consists of using the map to locate the i-node for the file.

5. (2 pt.) The Unix system has an algorithm for performing logical dumps. A logical dump begins at one or more specified directories and recursively dumps all files and directories within them that have changed since a specified base date. Please explain in detail how the logical dump algorithm can be implemented by constructing a specific data structure. Additionally, describe how the values in this data structure are initialized.

Sol) The algorithm needs to maintain a bitmap with a size matching the number of i-nodes currently used by active files. The bitmap values are initialized in two phases:

- Phase one - For each modified file, its i-node is marked in the bitmap. Each directory is also marked and recursively inspected.
- Phase two - unmarking any directories that have no modified files or directories in them or under them.

6. (1 pt.) A system use bit-map to keep track of free-blocks. Let' say a block size is 8KB. The system use 2^{14} blocks for bit-map. What is the total secondary memory (disk) size? (MB or GB)

Size of bit-map = $8 \times 2^{10} \times 2^{14}$ byte = 8×2^{24} Byte = $8 \times 8 \times 2^{24}$ bit. = 2^{30} bits
There are 2^{30} blocks
Total disk size = # of block $\times$ one block size= $2^{30} \times 8 \times 2^{10} = 8 \times 2^{40}$ = 8 TB