**Operating System - Assignment - 5**

***Q.1 Name one advantage of hard links over symbolic links and one advantage of symbolic links over hard links.***

**Answer:**

Hard links do not require any additional disk space, just a counter in the inode to keep track of how many there are. On the other hand, symbolic links need space to store the name of the file pointed to it. Symbolic links can point to files on other machines, even over the internet. Hard links are restricted to pointing to files within their own partition.

***Q.2 One way to use contiguous allocation of disk and not suffer from holes is to compact the disk every time a file is removed. Since all files are contiguous, copying a file requires a seek and rotational delay to read the file, followed by the transfer at full speed. Writing the file back requires the same work. Assuming a seek time of 5 msec, a rotational delay of 4msec, a transfer rate of 8MB/sec and an average file size of 8KB, how long does it take to read a file into main memory then write it back to the disk at a new location?***

***Using these numbers, how long would it take to compact half of a 16GB disk?***

**Answer:**

It takes 9 msec to start the transfer (due to 5msec seek and 4msec rotation delay).

To read 213 bytes (8KB) at the transfer rate of 223 bytes/sec (8MB/sec) requires 2−10 sec (0.977msec).

Hence the total time to seek, rotate and transfer is 9.977msec.

Writing back takes another 9.977msec.

Thus copying an average file takes 19.954msec.

To compact half of a 16GB disk would involve copying 8GB of storage, which is 220 files. At 19.954 msec per file, this takes 20,923 seconds, which is 5.8 hours.

Clearly, compacting the disk after every file removal is not a great idea.

***Ques 3: The beginning of the free space bitmap looks like this after the disk partition is first formatted: 1000 0000 0000 0000 (the first block is used by the root directory). The system always searches for free blocks starting at the lowest numbered block, so after writing a file A which uses 6 blocks, the bitmap looks like this: 1111 1110 0000 0000. Show the bitmap after each of the following additional actions:***

***(a) File B is written, using 5 blocks.***

***(b) File A is deleted.***

***(c) File C is written, using 8 blocks.***

***(d) File B is deleted.***

**Answer:**

(a) 1111 1111 1111 0000

(b) 1000 0001 1111 0000

(c) 1111 1111 1111 1100

(d) 1111 1110 0000 1100

***Ques 4: Consider a disk that has 10 data blocks starting from block 14 through 23. Let there be***

***2 files on the disk: f1 and f2. The directory structure lists that the first data blocks of f1 and f2 are respectively 22 and 16. Given the FAT table entries as below, what are the data blocks allotted to f1 and f2?***

***(14,18); (15,17); (16,23); (17,21); (18,20); (19,15); (20, −1); (21, −1); (22,19); (23,14).***

***In the above notation, (x, y) indicates that the value stored in table entry x points to data block y.***

**Answer:**   
The blocks allotted to f1 are: 22, 19, 15, 17, 21.

The blocks allotted to f2 are: 16, 23, 14, 18, 20.