Class Test 4 **Date: September 4, 2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Department of Computer Science and Engineering

January 2023 CSE 313: Operating System

Time: 30 minutes **Marks: 20**

Student Name: _____ Student No: _____

The following commands have been executed in a file system with 8KB blocks and 4byte block-numbers.

```
$ cp f.txt /a/b.txt
$ ln -s /a/b.txt /p/q/r.txt
```

The disk spec is as follows:

Capacity	2 TB
Rotation speed	8,000 RPM
Max seek time	18 ms
Max transfer rate	120 MB/s
Platters	2
Sector size	1 KB
Cache	16 MB

1. In the first command, how many data blocks will be allocated for `/a/b.txt` if `f.txt` is of size 1GB? Assume an inode points to 12 data-blocks, 1 indirect pointer and 1 double-indirect pointer. (3)

Ans. No. of pointers that can be stored in a data block $= \frac{8\times 2^{10}}{4} = 2^{11}$

No. of data blocks used by `/a/b.txt`

$$
\begin{aligned}
&= \frac{1 \times 2^{30}}{8 \times 2^{10}} && \text{[for data]} \\
&+ \left\lceil \frac{\frac{1\times 2^{30}}{8\times 2^{10}} - 12}{2^{11}} \right\rceil && \text{[for indirect pointers]} \\
&+1 && \text{[for double-indirect pointer]} \\
&= 2^{17} + 2^6 + 1 \\
&= 131137
\end{aligned}
$$

2. Write down the sequence of read-writes in the file system for the second command. (7)

Ans.

data bitmap	inode bitmap	root inode	p inode	q inode	r inode	root data	p data	q data	r data
		read							
						read			
			read						
							read		
				read					
								read	
	read								
	write								
					read				
read									
write									
									read
									write
								write	
					write				
				write					

3. Assuming that switching block types (e.g. super-block, inode-table, data-block etc.) incurs additional disk-arm positioning, how much time will it take (on average) to execute the second command in VSFS with and without buffering? Mention any assumptions that you make to solve this. (10)

Ans.

Average disk-arm positioning time, $T_{position,avg} = T_{seek,avg} + T_{rotate,avg} = \frac{60\times 1000}{2\times 8000} ms + \frac{18}{3} ms = 9.75ms$

Max rotation time, $T_{rotate,max} = \frac{60\times 1000}{8000} ms = 7.5ms$

Transfer time for one block, $T_{transfer} = \frac{8\times 1000}{120\times 2^{10}} ms = 0.065ms$

Sequence of read/writes to each block type: 1(inode) + 1(data) + 1(inode) + 1(data) + 1(inode) + 1(data) + 2(bitmap) + 1(inode) + 2(bitmap) + 3(data) + 2(inode)

Assumptions: *The assumptions can differe and the subsequent answers change accordingly.*

- bitmap is in one block
- inodes are in one block
- data for each file are in separate blocks and one block for each file
- read and write cannot be done at the same time, full rotation needed to write after read in same block

Without buffering:

$=6 \times (T_{position,avg} + T_{transfer})$	1 inode, 1 data, 1 inode, 1 data, 1 inode, 1 data
$+T_{position,avg} + T_{rotate,max} + 2 \times T_{transfer}$	2 bitmap
$+T_{position,avg} + T_{transfer}$	1 inode
$+T_{position,avg} + T_{rotate,max} + 2 \times T_{transfer}$	2 bitmap
$+T_{position,avg} + T_{rotate,max} + 3 \times T_{transfer}$	3 data
$+T_{position,avg} + T_{rotate,max} + T_{transfer}$	2 inode

With buffering:

$=3 \times T_{position,avg} + 6 \times T_{transfer}$	read 6 blocks of 3 block type
$+3 \times T_{rotate,max} + 4 \times T_{transfer}$	write 4 blocks of 3 block type