# CS342 Operating Systems
# Project 1

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# 1    Introduction

The producer program prints M characters, and the consumer program scans M characters at a time. The intercepting shell program was used to execute these programs at the same time. Normal and tapped modes were tested for different M values. In tapped mode, different values were used for the number of bytes read and written at a time (N).

# 2    Results

The tables below show the execution times in microseconds (µs) for the normal mode and tapped mode for different values of M (the total number of characters). Each table for the tapped mode correspond to a different number for N, which is the number of bytes read and written at a time.

**Normal Mode**

| M (Characters) | Time (µs) |
|---|---|
| 10 | 74,161 |
| 100 | 42,131 |
| 250 | 41,385 |
| 500 | 51,114 |
| 1,000 | 47,237 |
| 5,000 | 48,473 |
| 10,000 | 52,496 |
| 20,000 | 48,955 |
| 50,000 | 64,421 |

**Tapped Mode, 1-Byte**

| M (Characters) | Time (µs) |
|---|---|
| 10 | 107,297 |
| 100 | 74,028 |
| 250 | 75,521 |
| 500 | 92,648 |
| 1,000 | 104,624 |
| 5,000 | 270,947 |
| 10,000 | 580,082 |
| 20,000 | 803,159 |
| 50,000 | 1,723,962 |

**Tapped Mode, 2-Byte**

| M (Characters) | Time (µs) |
|---|---|
| 10 | 113,890 |
| 100 | 58,571 |
| 250 | 64,583 |
| 500 | 65,789 |
| 1,000 | 94,314 |
| 5,000 | 167,924 |
| 10,000 | 235,743 |
| 20,000 | 426,612 |
| 50,000 | 1,166,299 |

**Tapped Mode, 4-Byte**

| M (Characters) | Time (µs) |
|---|---|
| 10 | 108,308 |
| 100 | 64,248 |
| 250 | 57,066 |
| 500 | 65,574 |
| 1,000 | 63,467 |
| 5,000 | 117,800 |
| 10,000 | 168,002 |
| 20,000 | 244,926 |
| 50,000 | 567,299 |

### Tapped Mode, 8-Byte

| M (Characters) | Time (µs) |
|---|---|
| 10 | 108,507 |
| 100 | 54,782 |
| 250 | 63,724 |
| 500 | 82,318 |
| 1,000 | 59,280 |
| 5,000 | 82,186 |
| 10,000 | 114,674 |
| 20,000 | 174,893 |
| 50,000 | 277,726 |

### Tapped Mode, 16-Byte

| M (Characters) | Time (µs) |
|---|---|
| 10 | 116,600 |
| 100 | 64,522 |
| 250 | 63,823 |
| 500 | 59,147 |
| 1,000 | 64,604 |
| 5,000 | 69,805 |
| 10,000 | 83,151 |
| 20,000 | 104,290 |
| 50,000 | 488,338 |

### Tapped Mode, 32-Byte

| M (Characters) | Time (µs) |
|---|---|
| 10 | 112,359 |
| 100 | 65,225 |
| 250 | 67,817 |
| 500 | 81,504 |
| 1,000 | 72,875 |
| 5,000 | 73,139 |
| 10,000 | 84,530 |
| 20,000 | 79,894 |
| 50,000 | 167,230 |

### Tapped Mode, 64-Byte

| M (Characters) | Time (µs) |
|---|---|
| 10 | 117,740 |
| 100 | 65,495 |
| 250 | 71,956 |
| 500 | 59,986 |
| 1,000 | 68,932 |
| 5,000 | 68,450 |
| 10,000 | 73,801 |
| 20,000 | 72,370 |
| 50,000 | 93,797 |

### Tapped Mode, 128-Byte

| M (Characters) | Time (µs) |
|---|---|
| 10 | 119,280 |
| 100 | 43,277 |
| 250 | 58,388 |
| 500 | 74,265 |
| 1,000 | 63,451 |
| 5,000 | 68,356 |
| 10,000 | 71,341 |
| 20,000 | 81,152 |
| 50,000 | 78,018 |

### Tapped Mode, 256-Byte

| M (Characters) | Time (µs) |
|---|---|
| 10 | 110,451 |
| 100 | 74,681 |
| 250 | 62,192 |
| 500 | 70,347 |
| 1,000 | 66,626 |
| 5,000 | 59,218 |
| 10,000 | 67,361 |
| 20,000 | 61,075 |
| 50,000 | 80,010 |

**Tapped Mode, 512-Byte**

| M (Characters) | Time (µs) |
|---|---|
| 10 | 113,518 |
| 100 | 63,383 |
| 250 | 75,619 |
| 500 | 75,419 |
| 1,000 | 82,126 |
| 5,000 | 72,570 |
| 10,000 | 74,889 |
| 20,000 | 60,102 |
| 50,000 | 84,219 |

**Tapped Mode, 1024-Byte**

| M (Characters) | Time (µs) |
|---|---|
| 10 | 103,505 |
| 100 | 56,142 |
| 250 | 77,009 |
| 500 | 62,110 |
| 1,000 | 59,625 |
| 5,000 | 73,186 |
| 10,000 | 70,225 |
| 20,000 | 60,325 |
| 50,000 | 69,817 |

**Tapped Mode, 2048-Byte**

| M (Characters) | Time (µs) |
|---|---|
| 10 | 100,880 |
| 100 | 57,690 |
| 250 | 70,665 |
| 500 | 63,053 |
| 1,000 | 68,362 |
| 5,000 | 50,004 |
| 10,000 | 75,057 |
| 20,000 | 79,027 |
| 50,000 | 72,226 |

**Tapped Mode, 4096-Byte**

| M (Characters) | Time (µs) |
|---|---|
| 10 | 115,605 |
| 100 | 60,826 |
| 250 | 71,086 |
| 500 | 63,097 |
| 1,000 | 62,197 |
| 5,000 | 58,123 |
| 10,000 | 56,882 |
| 20,000 | 64,941 |
| 50,000 | 67,217 |

# 3    Analysis

The graph in the next page shows the execution times in microseconds (µs) for the normal and tapped modes for different values of M (the number of characters). In the normal mode, changing the M value did not affect the execution time significantly because the characters were sent directly using one pipe.

In the tapped mode, when the number of bytes read and written at a time (N) was 1 and 2, the execution time was longer than all other trials. When N was larger than 2, the execution time decreased for all M values. As the number of bytes (N) read and written from one pipe to the other increased, the execution time decreased because of the fewer read and write operations than that for a small N. For some large values of N, such as 1024, 2048, 4096 in the graph, the execution times do not change significantly for various M values because the operations' computational cost was similar. When different N values are compared for the same M values, as N increased, the execution time generally decreased.

The normal mode had a faster execution time than the tapped mode because the first program's output was sent directly using only one pipe. In the tapped mode, operations for memory allocation were needed to write into and read from the pipe. Additionally, the read and write operations used in the tapped mode increased the execution time compared to the normal mode. In cases where N was large, execution time was similar to normal mode. As a conclusion, the tapped mode should be chosen with large N values. Otherwise, the normal mode should be chosen for pipe commands.

Time for Producer to Output and Consumer to Input