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ECE 460: Computer Operating Systems
Professor Jeff Hakner
Problem Set 1: System Calls, Error Checking and Reporting

Hardware: (using lscpu command)

Architecture: i686
CPU op-mode(s):   32-bit, 64-bit
Byte Order: Little Endian
CPU(s):   2
On-line CPU(s) list: 0,1
Thread(s) per core: 1
Core(s) per socket: 2
Socket(s):   1
Vendor ID: GenuineIntel
CPU family: 6
Model: 15
Stepping: 13
CPU MHz: 1601.000
BogoMIPS: 3191.19
L1d cache: 32K
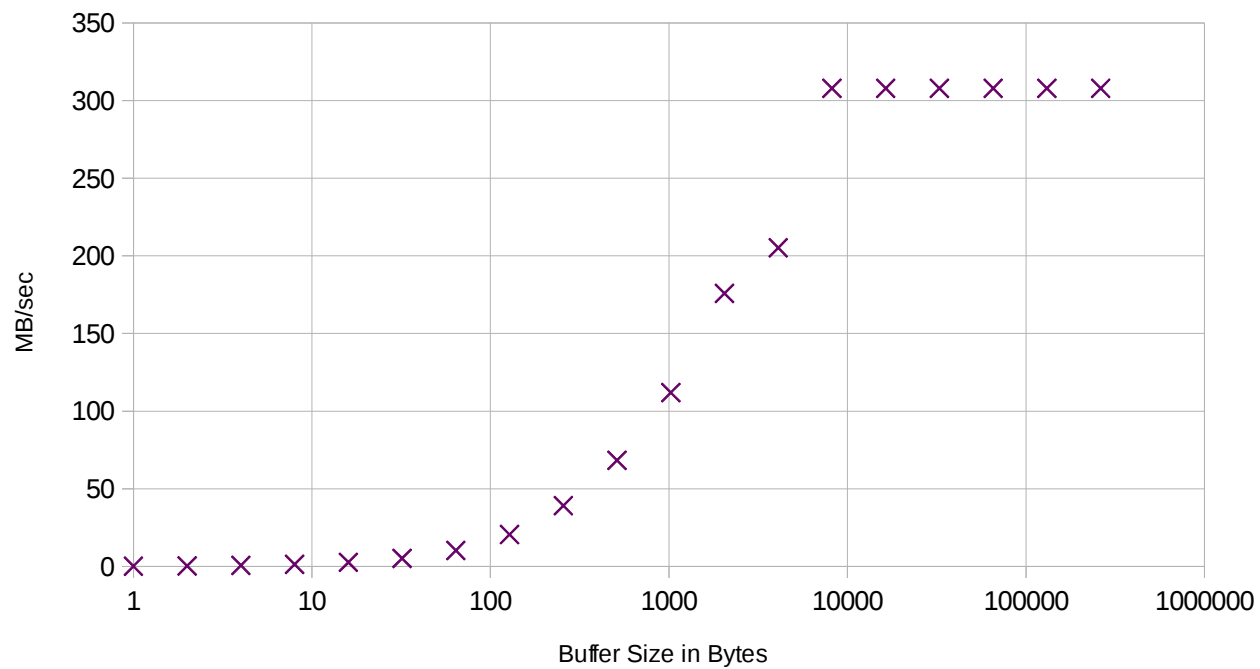L1i cache: 32K
L2 cache: 2048K

Operating System: (using uname -mrs)
Linux 3.13.0-37-generic i686

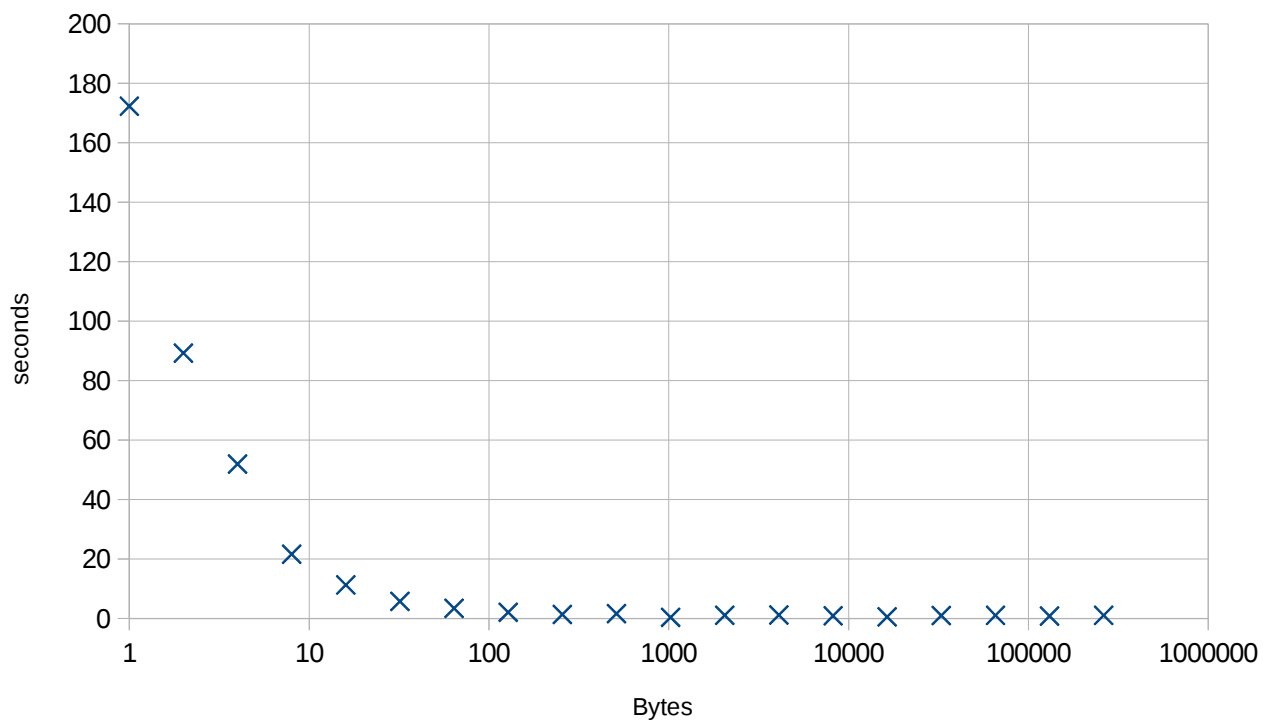1) **Experimenting with different read/write buffer sizes**
A shell script was written to automate data collection for various buffer sizes. 4 text files of sizes: 1.1 MB, 23.5 MB, 914 Bytes, and 592 Bytes were used as the input files (Total: 24.6 MB). The files were concatenated to a file called "out" within the same directory as the program. The following is the output data:
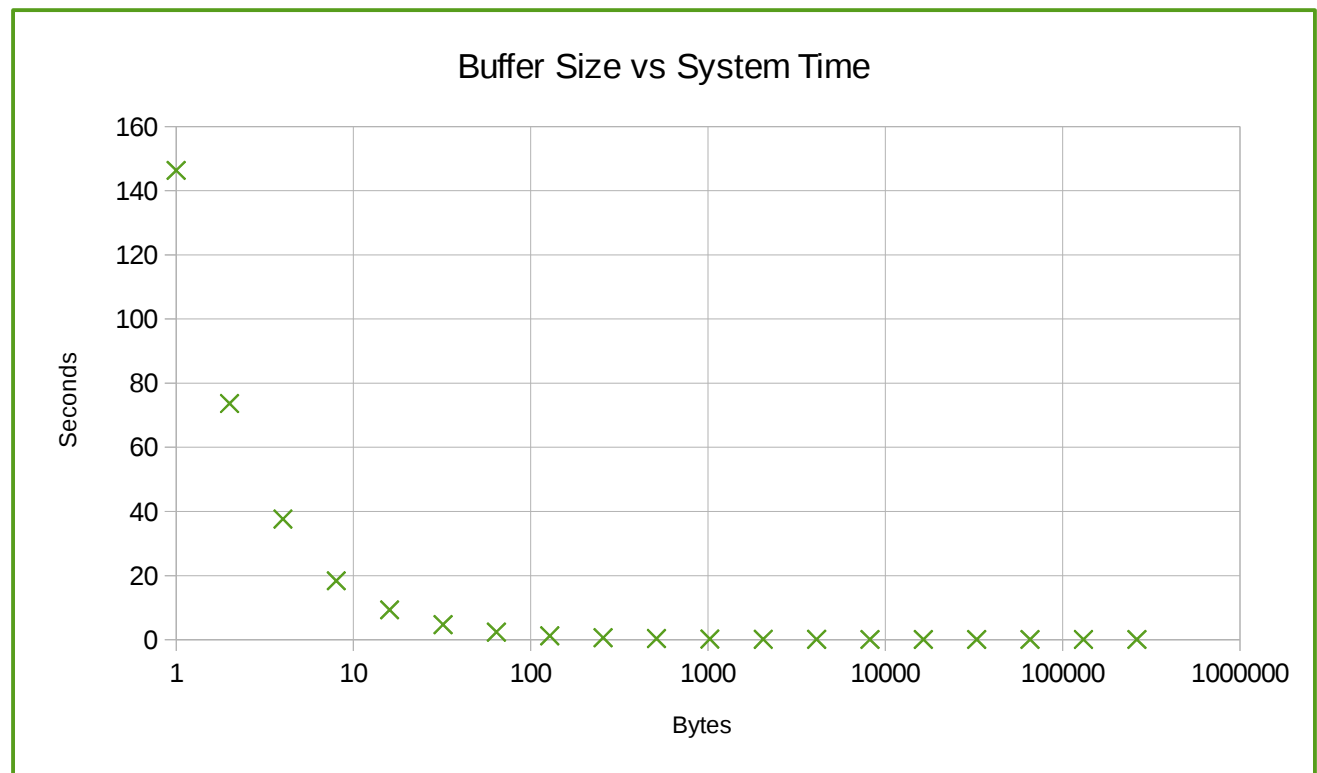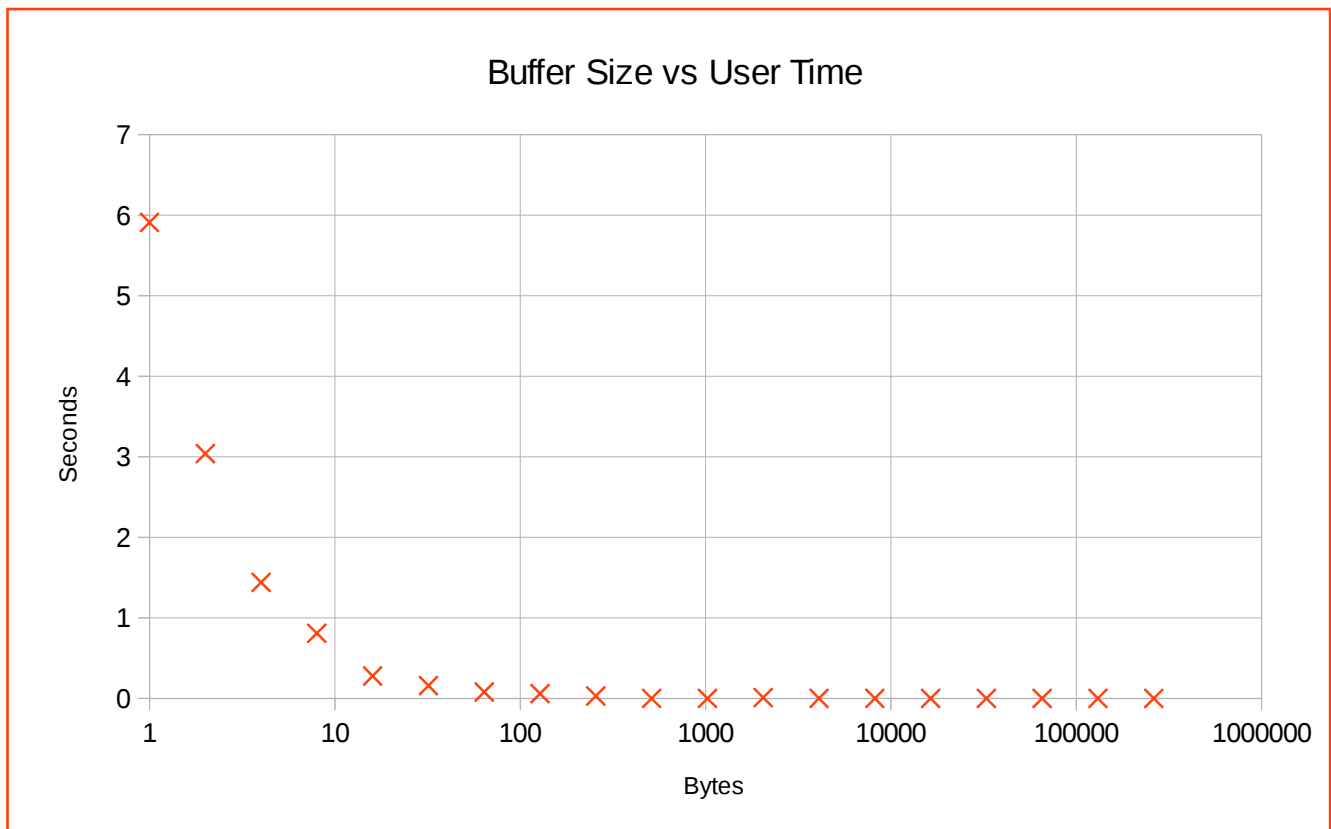
Buffer Size (bytes)	Real (sec)	User (sec)	System (sec)	System Throughput (MB/s)
1	172.29	5.91	146.34	0.17
2	89.30	3.04	73.67	0.33
4	51.96	1.44	37.62	0.65
8	21.65	0.81	18.38	1.34
16	11.28	0.28	9.32	2.64
32	5.80	0.16	4.71	5.23
64	3.42	0.08	2.38	10.35
128	2.13	0.06	1.20	20.52
256	1.36	0.03	0.63	39.09
512	1.66	0.00	0.36	68.41
1024	0.43	0.00	0.22	111.94
2048	1.11	0.01	0.14	175.90
4096	1.22	0.00	0.12	205.22
8192	0.95	0.00	0.08	307.83
16384	0.53	0.00	0.08	307.83
32768	1.04	0.00	0.08	307.83
65536	1.06	0.00	0.08	307.83
131072	0.81	0.00	0.08	307.83
262144	1.06	0.00	0.08	307.83

System Throughput for copycat

Buffer Size vs Real Time

Buffer Size vs User Time

Buffer Size vs System Time

2) **Discuss experimental results**

It was observed that as the buffer size doubled, the corresponding system time was approximately halved. As the first plot shows, the system throughput (total input size/system size) very

nearly doubles as buffer size doubles. The user time and real time also dramatically decreased as the buffer size increased. Furthermore, the system time monotonically decreased whereas for large buffer sizes, the user time and real time would slightly increase. Using buffer sizes of 4096 bytes and higher yielded user times that were recorded as 0.00 seconds by the time command. Although the real time generally decreased, there were instances when using a larger buffer size didn't correspond to a lower real time. However, these instances weren't particularly significant. Finally, it was noted that after 8192 bytes, the system time didn't continue to decrease significantly for each doubling of the buffer size. In addition, the system throughput essentially remained constant. Since the time command only returned up to 2 decimal places, it can only be assumed that any changes to the system time and system throughput were less than a tenth of a second.

The reason why the buffer size has such a dramatic impact on performance time is due to the expense associated with making system calls. Smaller buffer sizes mean more system calls per file. A large buffer size requires fewer system calls, thus decreasing execution time

3) **Sample Run Screenshots**
copycat with no options and no input files copies input to output

copycat with no options and specified valid input files concatenates files and writes to screen

copycat with multiple "-"s for reading from stdin

```
                                     Terminal
george@george-Vostro-1400 ~/Desktop/ECE460/PS1 - System Calls, Error Checking and Reporting $ ./copycat - Stallman1.txt - Stallman2.txt
WRITING TO STDIN THE FIRST TIME
WRITING TO STDIN THE FIRST TIME
This is Stallman1.txt.
Richard Stallman has a URL tatooed on the left side of his chest where you can
download his genetic code.When Richard Stallman runs /bin/false, it returns "true".
Behind Richard Stallman's beard there is another fist, to code faster.Richard
Stallman's uptime is over 53 years. And counting up. When Richard Stallman uses
floats, there are no rounding errors Some people say M-x psychoanalyse-pinhead is a
merely a program. Others say M-x psychoanalyse-pinhead *is* Richard Stallman. All I
know is, Richard Stallman is The Stig. When Richard Stallman executes ps -e, you show
up. When Richard Stallman counted his fingers as a kid, he always started with 0.
Richard Stallman's brain accepts UNIX commands. Richard Stallman's brain compiles and
runs C code.There is no chin under Richard Stallman' beard. There's only another beard.
Recursively. Richard Stallman can touch MC Hammer.
WRITING TO STDIN THE SECOND TIME
WRITING TO STDIN THE SECOND TIME
This is Stallman2.txt
Richard Stallman's first words were in binary. When they couldn't understand
him, he wrote a parser. Richard Stallman can make infinite loops end.Global
warming is caused by Richard Stallman's rage towards non-free software.
Whenever someone writes a "Hello, world" program, Richard Stallman says "Hello"
back. Every day Richard Stallman finds at least fifteen things in the world to
rage about. You can read his findings here: http://stallman.org/archives/polnotes.html.
Richard Stallman is the one who trims Chuck Norris beard. And he does it freely, of course.
george@george-Vostro-1400 ~/Desktop/ECE460/PS1 - System Calls, Error Checking and Reporting $ []
```

copycat concatenating 2 text files and stdin to output file on a USB

```
                                     Terminal
george-Vostro-1400 PS1 - System Calls, Error Checking and Reporting # ./copycat -b 32 -o /media/george/51BE-FB95/out.txt Stallman1.txt - Stallman2.txt
I'M WRITING TO MY FLASHDRIVE FROM STDIN!!!!!
george-Vostro-1400 PS1 - System Calls, Error Checking and Reporting # cat /media/george/51BE-FB95/out.txt
This is Stallman1.txt.
Richard Stallman has a URL tatooed on the left side of his chest where you can
download his genetic code.When Richard Stallman runs /bin/false, it returns "true".
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george-Vostro-1400 PS1 - System Calls, Error Checking and Reporting # []
```

copycat handling a write() error when writing to a USB that is suddenly removed

```
                                     Terminal
george-Vostro-1400 PS1 - System Calls, Error Checking and Reporting # ./copycat -o /media/george/E41C-9A61/out.txt Classics
copycat: Can't write to file Classics: Input/output error
george-Vostro-1400 PS1 - System Calls, Error Checking and Reporting # []
```

copycat handling error when passing in an input file that doesn't exist (a read() error)

```
                                     Terminal
george@george-Vostro-1400 ~/Desktop/ECE460/PS1 - System Calls, Error Checking and Reporting $ ./copycat -b 4 -o out no_such_file.txt
copycat: Can't open file no_such_file.txt for reading: No such file or directory
george@george-Vostro-1400 ~/Desktop/ECE460/PS1 - System Calls, Error Checking and Reporting $ []
```

copycat handling bad buffer size: copycat switches to unbuffered mode if given a bad buffer size

```
george@george-Vostro-1400 ~/Desktop/ECE460/PS1 - System Calls, Error Checking and Reporting $ ./copycat -b -4 Stallman1.txt Stallman2.txt
copycat: Invalid buffer size. Using unbuffered mode...
This is Stallman1.txt.
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george@george-Vostro-1400 ~/Desktop/ECE460/PS1 - System Calls, Error Checking and Reporting $ []
```