

Lab3 Report

210010054

Suyash Gaurav

Part 1: Scheduler Swapping

- The goal is to print a specific message indicating the roll number and process ID (PID) whenever user-level process is scheduled.
- In the scheduled.c file within the minix/servers/sched directory, the schedule_process() function has been modified to include a print statement when the priority of a process is greater than or equal to the USER_Q.

```
327     if(rmp->priority >= USER_Q){  
328         printf("Minix 210010054: PID %d swapped in\n", _ENDPOINT_P(rmp->endpoint));  
329     }
```

- USER_Q indicates the minimum priority for a process to be considered a user-level process.
- A script file “run.sh” is submitted in the zip files which copies the modified source files and build the system.

```
# ls  
Minix 210010054: PID 321 created  
Minix 210010054: PID 62 swapped in  
log.txt minix  
Minix 210010054: PID 321 exited
```

Process created, swapped in, and exited

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Part 2: Benchmarks Analysis

About UnixBench

- UnixBench is a benchmark suite designed to assess the performance of Unix-like systems. It includes tests for CPU, memory, disk, and system call performance.

Some Commands:

- **‘time’ command:** The time command in Minix3 can be used to measure the execution time of a command or script. It has three different time measurements:
 - **Real-Time:** It provides the total time the process takes to complete, including time spent waiting for resources.
 - **User Time:** It represents the CPU time spent executing the process in user mode, indicating the actual computation performed by the application.
 - **System Time:** It represents the CPU time spent in the kernel or system mode, indicating the overhead related to system calls and kernel-level activities.

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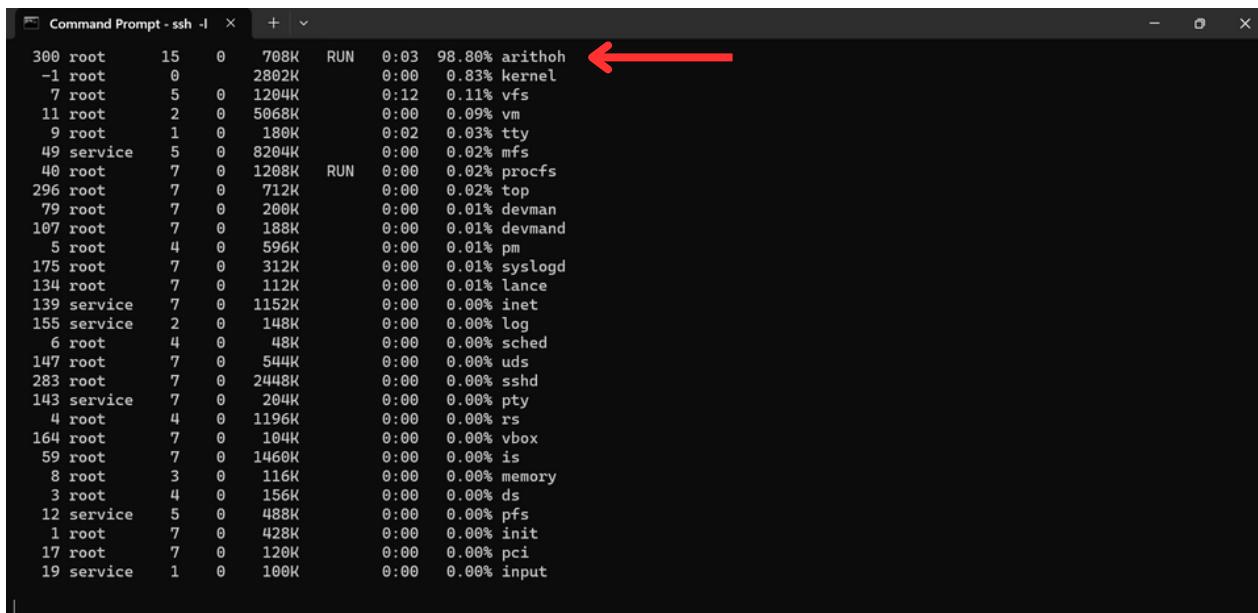
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- **'top' command:** It is used to monitor CPU usage in real-time.

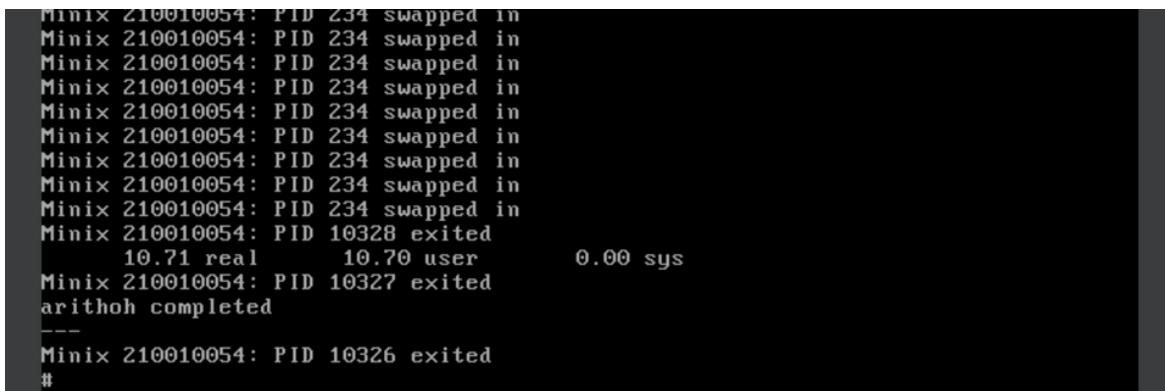
Running benchmarks:

- **arithoh:** As shown in the screenshot attached, it is consuming so much amount of CPU, and it is taking a long time to complete. This may be because of many arithmetic operations to perform. Thus, it is a CPU-bound process.



PID	User	Priority	VSize	RSS	State	CPUTime	PCPU	Name
300	root	15	0	708K	RUN	0:03	98.80%	arithoh
-1	root	0	0	2802K		0:00	0.83%	kernel
7	root	5	0	1204K		0:12	0.11%	vfs
11	root	2	0	5068K		0:00	0.09%	vm
9	root	1	0	180K		0:02	0.03%	tty
49	service	5	0	8204K		0:00	0.02%	mfss
40	root	7	0	1208K	RUN	0:00	0.02%	procfs
296	root	7	0	712K		0:00	0.02%	top
79	root	7	0	200K		0:00	0.01%	devman
107	root	7	0	188K		0:00	0.01%	devmand
5	root	4	0	596K		0:00	0.01%	pm
175	root	7	0	312K		0:00	0.01%	syslogd
134	root	7	0	112K		0:00	0.01%	lance
139	service	7	0	1152K		0:00	0.00%	inet
155	service	2	0	148K		0:00	0.00%	log
6	root	4	0	48K		0:00	0.00%	sched
147	root	7	0	544K		0:00	0.00%	uds
283	root	7	0	2448K		0:00	0.00%	sshd
143	service	7	0	204K		0:00	0.00%	pty
4	root	4	0	1196K		0:00	0.00%	rs
164	root	7	0	104K		0:00	0.00%	vbox
59	root	7	0	1460K		0:00	0.00%	is
8	root	3	0	116K		0:00	0.00%	memory
3	root	4	0	156K		0:00	0.00%	ds
12	service	5	0	488K		0:00	0.00%	pfs
1	root	7	0	428K		0:00	0.00%	init
17	root	7	0	120K		0:00	0.00%	pci
19	service	1	0	100K		0:00	0.00%	input

CPU usage of arithoh



```
Minix 210010054: PID 234 swapped in
Minix 210010054: PID 10328 exited
    10.71 real      10.70 user      0.00 sys
Minix 210010054: PID 10327 exited
arithoh completed
---
Minix 210010054: PID 10326 exited
#
```

arithoh completion time

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- **fstime:** As shown in the screenshot attached, it consumes relatively less amount of CPU and its real-time is relatively higher than that of arithoh. This may be because of many I/O operations to perform. Thus, it is a I/O bound process.

PID	User	Time	Memory	Real	CPU %	Process
7	root	0:16	1204K	0:00	36.17%	vfs
-1	root	0:00	2802K	0:00	34.36%	kernel
76	service	0:10	4708K	0:00	21.71%	mfs
314	root	0:00	740K	0:00	5.92%	fstime ←
11	root	0:00	5068K	0:00	0.08%	vm
40	root	0:00	1208K	0:00	0.02%	procfs
308	root	0:00	712K	0:00	0.02%	top
49	service	0:00	8204K	0:00	0.02%	mfs
79	root	0:00	200K	0:00	0.01%	devman
107	root	0:00	188K	0:00	0.01%	devmand
9	root	0:02	180K	0:02	0.01%	tty
5	root	0:00	596K	0:00	0.01%	pm
134	root	0:00	112K	0:00	0.01%	lance
283	root	0:00	2448K	0:00	0.00%	sshd
139	service	0:00	1152K	0:00	0.00%	inet
143	service	0:00	204K	0:00	0.00%	pty
175	root	0:00	312K	0:00	0.00%	syslogd
4	root	0:00	1196K	0:00	0.00%	rs
164	root	0:00	104K	0:00	0.00%	vbox
6	root	0:00	48K	0:00	0.00%	sched
155	service	0:00	148K	0:00	0.00%	log
147	root	0:00	544K	0:00	0.00%	uds
118	service	0:00	132K	0:00	0.00%	random
8	root	0:00	116K	0:00	0.00%	memory
3	root	0:00	156K	0:00	0.00%	ds
12	service	0:00	488K	0:00	0.00%	pfs
1	root	0:00	428K	0:00	0.00%	init
17	root	0:00	120K	0:00	0.00%	pci

CPU usage of fstime

```
# ./fstime.sh
Minix 210010054: PID 318 created
Minix 210010054: PID 67 swapped in
Minix 210010054: PID 319 created
Minix 210010054: PID 68 swapped in
Minix 210010054: PID 320 created
Minix 210010054: PID 69 swapped in
Write done: 1008000 in 0.9667, score 260689
COUNT:260689!0!KBps
TIME:1.0
Read done: 1000004 in 0.9333, score 267858
COUNT:267858!0!KBps
TIME:0.9
Minix 210010054: PID 69 swapped in
Copy done: 1000004 in 2.1000, score 119048
COUNT:119048!0!KBps
TIME:2.1
Minix 210010054: PID 320 exited
  15.08 real      0.36 user      3.66 sys
Minix 210010054: PID 319 exited
fstime completed
```

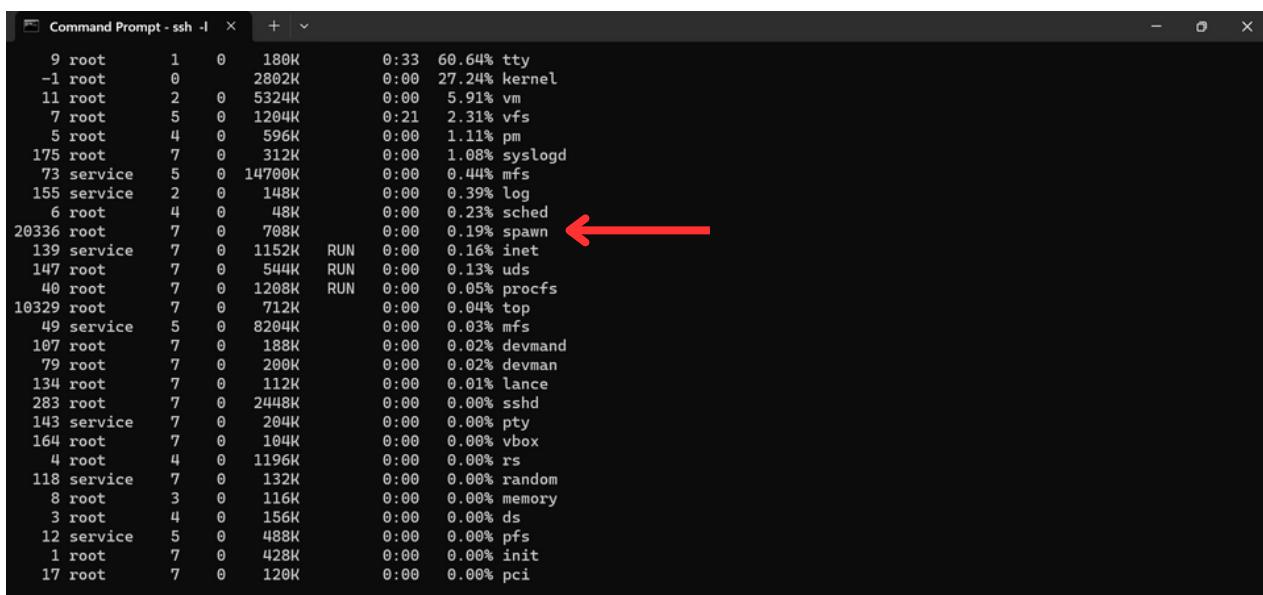
fstime completion time

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- **spawn:** It repeatedly forks child processes and immediately exits them. The time spent in these system calls contributes to sys time. The benchmark is designed to be a CPU-bound process, as it involves creating and terminating processes rapidly. Also it has high real and system time.



```
Command Prompt - ssh -l x + v
9 root 1 0 180K 0:33 60.64% tty
-1 root 0 2862K 0:00 27.24% kernel
11 root 2 0 5324K 0:00 5.91% vm
7 root 5 0 1264K 0:21 2.31% vfs
5 root 4 0 596K 0:00 1.11% pm
175 root 7 0 312K 0:00 1.08% syslogd
73 service 5 0 14760K 0:00 0.44% mfs
155 service 2 0 148K 0:00 0.39% log
6 root 4 0 48K 0:00 0.23% sched
20336 root 7 0 708K 0:00 0.19% spawn ←
139 service 7 0 1152K RUN 0:00 0.16% inet
147 root 7 0 544K RUN 0:00 0.13% uds
40 root 7 0 1268K RUN 0:00 0.05% procfs
10329 root 7 0 712K 0:00 0.04% top
49 service 5 0 8204K 0:00 0.03% mfs
107 root 7 0 188K 0:00 0.02% devman
79 root 7 0 200K 0:00 0.02% devman
134 root 7 0 112K 0:00 0.01% lance
283 root 7 0 2448K 0:00 0.00% sshd
143 service 7 0 204K 0:00 0.00% pty
164 root 7 0 104K 0:00 0.00% vbox
4 root 4 0 1196K 0:00 0.00% rs
118 service 7 0 132K 0:00 0.00% random
8 root 3 0 116K 0:00 0.00% memory
3 root 4 0 156K 0:00 0.00% ds
12 service 5 0 488K 0:00 0.00% pfs
1 root 7 0 428K 0:00 0.00% init
17 root 7 0 120K 0:00 0.00% pci
```

CPU usage of spawn

```
Minix 210010054: PID 165 swapped in
Minix 210010054: PID 379 exited
Minix 210010054: PID 380 created
Minix 210010054: PID 166 swapped in
Minix 210010054: PID 380 exited
Minix 210010054: PID 381 created
Minix 210010054: PID 167 swapped in
Minix 210010054: PID 381 exited
Minix 210010054: PID 20336 exited
    13.48 real          0.00 user          9.66 sys
Minix 210010054: PID 20335 exited
spawn completed
---
Minix 210010054: PID 20334 exited
```

spawn completion time

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- **pipe:** The program performs a loop with 1,000,000 iterations (iter), during which it repeatedly writes data to the write end of the pipe (pvec[1]) and reads data from the read end of the pipe (pvec[0]). More sys-time indicates involvement in kernel level activities. Thus, it appears to be a I/O bound process.

7	root	5	0	1204K	0:29	47.39% vfs
-1	root	0	0	2802K	0:00	32.77% kernel
12	service	5	0	488K	0:03	13.92% pfs
10397	root	8	0	708K	RUN	0:00 5.69% pipe
11	root	2	0	5408K	0:00	0.09% vn
49	service	5	0	8204K	0:00	0.03% mfs
40	root	7	0	1208K	RUN	0:00 0.03% procfs
10388	root	7	0	712K	0:00	0.02% top
79	root	7	0	200K	0:00	0.01% devman
107	root	7	0	188K	0:00	0.01% devmand
9	root	1	0	180K	0:54	0.01% tty
5	root	4	0	596K	0:00	0.01% pm
134	root	7	0	112K	0:00	0.00% lance
139	service	7	0	1152K	0:00	0.00% inet
283	root	7	0	2448K	0:00	0.00% sshd
143	service	7	0	204K	0:00	0.00% pty
175	root	7	0	312K	0:00	0.00% syslogd
4	root	4	0	1196K	0:00	0.00% rs
164	root	7	0	104K	0:00	0.00% vbox
155	service	2	0	148K	0:00	0.00% log
6	root	4	0	48K	0:00	0.00% sched
147	root	7	0	544K	0:00	0.00% uds
118	service	7	0	132K	0:00	0.00% random
8	root	3	0	116K	0:00	0.00% memory
3	root	4	0	156K	0:00	0.00% ds
1	root	7	0	428K	0:00	0.00% init
17	root	7	0	120K	0:00	0.00% pci
19	service	1	0	100K	0:00	0.00% input

CPU usage of pipe

```
# ./pipe.sh
Minix 210010054: PID 10395 created
Minix 210010054: PID 201 swapped in
Minix 210010054: PID 10396 created
Minix 210010054: PID 202 swapped in
Minix 210010054: PID 10397 created
Minix 210010054: PID 203 swapped in
Minix 210010054: PID 203 swapped in
Minix 210010054: PID 203 swapped in
Minix 210010054: PID 10397 exited
    7.91 real          0.61 user          7.25 sys
Minix 210010054: PID 10396 exited
pipe completed
---
Minix 210010054: PID 10395 exited
```

pipe completion time

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- **syscall:** It performs various system calls like *close*, *getpid*, *getuid*, and *umask* in a loop for 1,000,000 iterations. It primarily measures the efficiency of system call execution rather than just CPU-bound computations. The high sys time suggests the involvement of system calls, indicating that the benchmark is more focused on system-level operations than user-level computations.

-1	root	0	2802K	0:00	35.96%	kernel
7	root	5	0 1204K	0:35	35.29%	vfs
10405	root	8	0 708K	RUN	0:01	17.97% syscall
5	root	4	0 596K		0:01	10.54% pm
11	root	2	0 5412K		0:00	0.11% vm
49	service	5	0 8204K		0:00	0.03% mfs
40	root	7	0 1208K	RUN	0:00	0.02% procfs
10398	root	7	0 712K		0:00	0.02% top
9	root	1	0 180K		0:54	0.02% tty
79	root	7	0 200K		0:00	0.01% devman
107	root	7	0 188K		0:00	0.01% devmand
134	root	7	0 112K		0:00	0.01% lance
139	service	7	0 1152K		0:00	0.00% inet
283	root	7	0 2448K		0:00	0.00% sshd
175	root	7	0 312K		0:00	0.00% syslogd
143	service	7	0 204K		0:00	0.00% pty
4	root	4	0 1196K		0:00	0.00% rs
155	service	2	0 148K		0:00	0.00% log
6	root	4	0 48K		0:00	0.00% sched
164	root	7	0 104K		0:00	0.00% vbox
179	root	7	0 228K		0:00	0.00% nonamed
147	root	7	0 544K		0:00	0.00% uds
59	root	7	0 1460K		0:00	0.00% is
8	root	3	0 116K		0:00	0.00% memory
3	root	4	0 156K		0:00	0.00% ds
12	service	5	0 488K		0:04	0.00% pfs
1	root	7	0 428K		0:00	0.00% init
17	root	7	0 120K		0:00	0.00% pci

CPU usage of syscall

```
# ./syscall.sh
Minix 210010054: PID 10403 created
Minix 210010054: PID 209 swapped in
Minix 210010054: PID 10404 created
Minix 210010054: PID 210 swapped in
Minix 210010054: PID 10405 created
Minix 210010054: PID 211 swapped in
Minix 210010054: PID 10405 exited
      5.55 real        1.88 user        3.65 sys
Minix 210010054: PID 10404 exited
syscall completed
---
```

syscall completion time

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Some workload mixtures

• arithoh and fstime:

arithoh being CPU-bound and
fstime being a I/O bound process.
We observe that arithoh swaps
occur when fstime waits for I/O.

```
workload_mix1.sh > workload_mix1.sh
1 #!/bin/sh
2 ./arithoh.sh &
3 ./fstime.sh &
4 wait
```

```
Command Prompt - ssh -l
load averages: 0.19, 0.02, 0.08
54 processes: 2 running, 52 sleeping
main memory: 1048124K total, 996796K free, 227044K cached
CPU states: 72.91% user, 16.46% system, 10.63% kernel, 0.00% idle
CPU time displayed ('t' to cycle): user ; sort order ('o' to cycle): cpu

PID USERNAME PRI NICE SIZE STATE TIME CPU COMMAND
18435 root 15 0 712K RUN 0:04 70.95% arithoh ←
 7 root 5 0 1264K 0:44 10.68% vfs
-1 root 0 2802K 0:00 10.63% kernel
76 service 5 0 4748K 0:19 5.65% mfs
18436 root 7 0 744K 0:00 1.89% fstime ←
11 root 2 0 5512K 0:00 0.07% vm
9 root 1 0 180K 0:55 0.04% tty
49 service 5 0 8204K 0:00 0.02% mfs
40 root 7 0 1288K RUN 0:00 0.01% procfs
32 service 7 0 188K 0:02 0.01% at_wini
10398 root 7 0 712K 0:00 0.01% top
187 root 7 0 188K 0:00 0.01% devmand
79 root 7 0 280K 0:00 0.01% devman
5 root 4 0 596K 0:02 0.01% pm
175 root 7 0 312K 0:00 0.00% syslogd
73 service 5 0 18696K 0:00 0.00% mfs
134 root 7 0 112K 0:01 0.00% lance
139 service 7 0 1152K 0:00 0.00% inet
155 service 2 0 148K 0:00 0.00% log
283 root 7 0 2448K 0:00 0.00% sshd
6 root 4 0 48K 0:00 0.00% sched
147 root 7 0 544K 0:00 0.00% uds
143 service 7 0 204K 0:00 0.00% pty
4 root 4 0 1196K 0:00 0.00% rs
164 root 7 0 104K 0:00 0.00% vbox
59 root 7 0 1460K 0:00 0.00% is
8 root 3 0 116K 0:00 0.00% memory
3 root 4 0 156K 0:00 0.00% ds
```

```
Minix 210010054: PID 241 swapped in
Minix 210010054: PID 10435 exited
    7.21 real      6.63 user      0.01 sys
Minix 210010054: PID 10433 exited
arithoh completed
---
Minix 210010054: PID 10431 exited
Read done: 1000004 in 0.5000, score 500001
COUNT:500001:0:KBps
TIME:0.5
Copy done: 1000004 in 1.1167, score 223881
COUNT:223881:0:KBps
TIME:1.1
Minix 210010054: PID 10436 exited
    13.45 real      0.30 user      1.91 sys
Minix 210010054: PID 10434 exited
fstime completed
---
Minix 210010054: PID 10432 exited
[1] Done          ./arithoh.sh
```

arithoh & fstime completion time

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• **fstime & syscall:**

Now I have run fstime (I/O process) and syscall to observe the swaps. In this case, the kernel activities parts of the syscall code swap in when fstime waits for I/O.

```
workload_mix2.sh X
210010054_lab3_part2 > workload_mix2.sh
1 #!/bin/sh
2 ./fstime.sh &
3 ./syscall.sh &
4 wait
```

```
Command Prompt - ssh -i X + v
Load averages: 0.37, 0.11, 0.03
54 processes: 2 running, 52 sleeping
main memory: 1048124K total, 997112K free, 996796K contig free, 22708K cached
CPU states: 12.14% user, 51.42% system, 36.45% kernel, 0.00% idle
CPU time displayed ('t' to cycle): user ; sort order ('o' to cycle): cpu

PID USERNAME PRI NICE SIZE STATE TIME CPU COMMAND
-1 root 0 2802K 0:00 36.45% kernel
7 root 5 0 1204K 0:58 36.00% vfs
76 service 5 0 4748K 0:22 10.10% mfs
10455 root 11 0 712K RUN 0:01 8.64% syscall
5 root 4 0 596K 0:05 5.11% pm
10456 root 7 0 744K 0:00 3.42% fstime ←
11 root 2 0 5512K 0:00 0.11% vm
9 root 1 0 180K 0:55 0.04% tty
40 root 7 0 1208K RUN 0:00 0.03% procfs
49 service 5 0 8204K 0:00 0.02% mfs
32 service 7 0 188K 0:02 0.02% at_wini
10398 root 7 0 712K 0:00 0.02% top
79 root 7 0 290K 0:00 0.02% devman
107 root 7 0 188K 0:00 0.02% demandad
134 root 7 0 112K 0:01 0.00% lance
139 service 7 0 1152K 0:00 0.00% inet
73 service 5 0 18100K 0:00 0.00% mfs
283 root 7 0 2448K 0:00 0.00% sshd
143 service 7 0 264K 0:00 0.00% pty
175 root 7 0 312K 0:00 0.00% syslogd
4 root 4 0 1196K 0:00 0.00% rs
164 root 7 0 104K 0:00 0.00% vbox
155 service 2 0 148K 0:00 0.00% log
6 root 4 0 48K 0:00 0.00% sched
147 root 7 0 544K 0:00 0.00% uds
118 service 7 0 132K 0:00 0.00% random
8 root 3 0 116K 0:00 0.00% memory
```

```
COUNT:260689:0:KBps
TIME:1.0
Minix 210010054: PID 37 swapped in
Minix 210010054: PID 37 swapped in
Minix 210010054: PID 10455 exited
    6.51 real      1.75 user      3.76 sys
Minix 210010054: PID 10453 exited
syscall completed
---
Minix 210010054: PID 10451 exited
Read done: 1000004 in 0.9333, score 267858
COUNT:267858:0:KBps
TIME:0.9
Minix 210010054: PID 38 swapped in
Copy done: 1000004 in 2.0000, score 125000
COUNT:125000:0:KBps
TIME:2.0
Minix 210010054: PID 10456 exited
    14.96 real      0.23 user      3.68 sys
Minix 210010054: PID 10454 exited
fstime completed
---
Minix 210010054: PID 10452 exited
[1] Done          ./syscall.sh
```

fstime & syscall completion time

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• arithoh & syscall:

Now I have run arithoh(CPU bound process) and syscall to observe the swaps. In this case, both are mainly CPU bound process, thus they are swapping alternatively.

```
workload_mix3.sh X  
210010054_lab3_part2 > workload_mix3.sh  
1 #!/bin/sh  
2 ./arithoh.sh &  
3 ./syscall.sh &  
4 wait
```

```
Command Prompt - ssh -l x + v  
load averages: 0.30, 0.22, 0.11  
54 processes: 3 running, 51 sleeping  
main memory: 1048124K total, 997132K free, 996796K contig free, 22716K cached  
CPU states: 24.25% user, 28.47% system, 23.12% kernel, 24.16% idle  
CPU time displayed ('t' to cycle): user ; sort order ('o' to cycle): cpu  


| PID   | USERNAME | PRI | NICE | SIZE   | STATE | TIME | CPU    | COMMAND |
|-------|----------|-----|------|--------|-------|------|--------|---------|
| -1    | root     | 0   | 0    | 2802K  | RUN   | 0:00 | 23.12% | kernel  |
| 7     | root     | 5   | 0    | 1204K  | RUN   | 1:06 | 21.77% | vfs     |
| 10479 | root     | 8   | 0    | 712K   | RUN   | 0:00 | 13.26% | arithoh |
| 10480 | root     | 8   | 0    | 712K   | RUN   | 0:00 | 10.75% | syscall |
| 5     | root     | 4   | 0    | 596K   | RUN   | 0:07 | 6.49%  | pm      |
| 9     | root     | 1   | 0    | 180K   | RUN   | 0:55 | 0.19%  | tty     |
| 11    | root     | 2   | 0    | 5512K  | RUN   | 0:00 | 0.13%  | vn      |
| 49    | service  | 5   | 0    | 8204K  | RUN   | 0:00 | 0.02%  | mfs     |
| 48    | root     | 7   | 0    | 1208K  | RUN   | 0:00 | 0.02%  | procfs  |
| 10398 | root     | 7   | 0    | 712K   | RUN   | 0:00 | 0.02%  | top     |
| 79    | root     | 7   | 0    | 200K   | RUN   | 0:00 | 0.01%  | devman  |
| 107   | root     | 7   | 0    | 188K   | RUN   | 0:00 | 0.01%  | demand  |
| 73    | service  | 5   | 0    | 18108K | RUN   | 0:00 | 0.01%  | mfs     |
| 175   | root     | 7   | 0    | 312K   | RUN   | 0:00 | 0.00%  | syslogd |
| 134   | root     | 7   | 0    | 112K   | RUN   | 0:01 | 0.00%  | lance   |
| 10475 | root     | 7   | 0    | 476K   | RUN   | 0:00 | 0.00%  | sh      |
| 139   | service  | 7   | 0    | 1152K  | RUN   | 0:00 | 0.00%  | inet    |
| 76    | service  | 5   | 0    | 4748K  | RUN   | 0:34 | 0.00%  | mfs     |
| 10476 | root     | 7   | 0    | 476K   | RUN   | 0:00 | 0.00%  | sh      |
| 283   | root     | 7   | 0    | 24448K | RUN   | 0:00 | 0.00%  | sshd    |
| 155   | service  | 2   | 0    | 148K   | RUN   | 0:00 | 0.00%  | log     |
| 208   | root     | 7   | 0    | 552K   | RUN   | 0:00 | 0.00%  | sh      |
| 10477 | root     | 7   | 0    | 132K   | RUN   | 0:00 | 0.00%  | time    |
| 10478 | root     | 7   | 0    | 132K   | RUN   | 0:00 | 0.00%  | time    |
| 6     | root     | 4   | 0    | 48K    | RUN   | 0:00 | 0.00%  | sched   |
| 143   | service  | 7   | 0    | 204K   | RUN   | 0:00 | 0.00%  | pty     |
| 21    | service  | 1   | 0    | 52K    | RUN   | 0:00 | 0.00%  | pckbd   |


```

```
# ./arithoh.sh & ./syscall.sh  
Minix 210010054: PID 10481 created  
Minix 210010054: PID 63 swapped in  
Minix 210010054: PID 10482 created  
Minix 210010054: PID 64 swapped in  
Minix 210010054: PID 10483 created  
Minix 210010054: PID 65 swapped in  
Minix 210010054: PID 10484 created  
Minix 210010054: PID 66 swapped in  
Minix 210010054: PID 10485 created  
Minix 210010054: PID 67 swapped in  
Minix 210010054: PID 10486 created  
Minix 210010054: PID 68 swapped in  
Minix 210010054: PID 67 swapped in  
Minix 210010054: PID 68 swapped in  
Minix 210010054: PID 67 swapped in  
Minix 210010054: PID 68 swapped in  
Minix 210010054: PID 67 swapped in
```

arithoh & syscall swapping

Lab3 Report

210010054

Suyash Gaurav

• repeated arithoh:

Now I have run repeated arithoh which is a CPU bound process. Following are the observations:

```
workload_mix4.sh > workload_mix4.sh
1  #!/bin/sh
2  ./arithoh.sh &
3  ./arithoh.sh &
4  ./arithoh.sh &
5  wait
```

```
load averages: 0.38, 0.15, 0.14
57 processes: 4 running, 53 sleeping
main memory: 1048124K total, 996900K free, 996796K contig free, 22720K cached
CPU states: 98.81% user, 0.32% system, 0.86% kernel, 0.00% idle
CPU time displayed ('t' to cycle): user ; sort order ('o' to cycle): cpu

PID USERNAME PRI NICE SIZE STATE TIME CPU COMMAND
10494 root 15 0 712K RUN 0:02 37.44% arithoh ←
10493 root 15 0 712K RUN 0:02 32.22% arithoh ←
10495 root 15 0 712K RUN 0:02 28.95% arithoh ←
-1 root 0 2802K 0:00 0.86% kernel ←
9 root 1 0 180K 0:55 0.15% tty ←
7 root 5 0 1204K 1:11 0.12% vfs ←
11 root 2 0 5576K 0:00 0.11% vm ←
49 service 5 0 8204K 0:00 0.03% mfs ←
40 root 7 0 1208K RUN 0:00 0.03% procfs ←
10398 root 7 0 712K 0:00 0.02% top ←
107 root 7 0 188K 0:00 0.02% devmand ←
79 root 7 0 200K 0:00 0.02% devman ←
5 root 4 0 596K 0:09 0.01% pm ←
175 root 7 0 312K 0:00 0.01% syslogd ←
134 root 7 0 112K 0:01 0.00% lance ←
139 service 7 0 1152K 0:00 0.00% inet ←
73 service 5 0 18112K 0:00 0.00% mfs ←
6 root 4 0 48K 0:00 0.00% sched ←
155 service 2 0 148K 0:00 0.00% log ←
283 root 7 0 2448K 0:00 0.00% sshd ←
147 root 7 0 544K 0:00 0.00% uds ←
143 service 7 0 204K 0:00 0.00% pty ←
4 root 4 0 1196K 0:00 0.00% rs ←
164 root 7 0 104K 0:00 0.00% vbox ←
118 service 7 0 132K 0:00 0.00% random ←
8 root 3 0 116K 0:00 0.00% memory ←
3 root 4 0 156K 0:00 0.00% ds ←
```

```
Minix 210010054: PID 10492 exited
arithoh completed
---
Minix 210010054: PID 10489 exited
# Minix 210010054: PID 75 swapped in
Minix 210010054: PID 76 swapped in
Minix 210010054: PID 76 swapped in
Minix 210010054: PID 75 swapped in
Minix 210010054: PID 76 swapped in
Minix 210010054: PID 10493 exited
    30.41 real      10.33 user      0.00 sys
Minix 210010054: PID 10490 exited
arithoh completed
---
Minix 210010054: PID 10487 exited
Minix 210010054: PID 10494 exited
    30.55 real      9.95 user      0.00 sys
Minix 210010054: PID 10491 exited
arithoh completed
---
Minix 210010054: PID 10488 exited
```

repeated arithoh swapping

Lab3 Report

210010054

Suyash Gaurav

• repeated fstime:

Now I have run repeated fstime which is a I/O bound process. Following are the observations:

```
workload_mix5.sh > workload_mix5.sh
1 #!/bin/sh
2 ./fstime.sh &
3 ./fstime.sh &
4 ./fstime.sh &
5 wait
```

```
load averages: 0.18, 0.03, 0.14
57 processes: 1 running, 56 sleeping
main memory: 1048124K total, 996800K free, 996796K contig free, 22732K cached
CPU states: 5.43% user, 49.22% system, 33.26% kernel, 12.08% idle
CPU time displayed ('t' to cycle): user ; sort order ('o' to cycle): cpu

PID USERNAME PRI NICE SIZE STATE TIME CPU COMMAND
-1 root 0 2802K 0:00 33.26% kernel
  7 root 5 0 1204K 1:13 30.46% vfs
  76 service 6 0 4748K 0:25 18.46% mfs
10504 root 7 0 744K 0:00 1.76% fstime ←
10503 root 7 0 744K 0:00 1.74% fstime ←
10502 root 7 0 744K 0:00 1.67% fstime ←
  9 root 1 0 180K 0:56 0.21% tty
  11 root 2 0 5580K 0:00 0.14% vm
  40 root 7 0 1208K RUN 0:00 0.04% procfs
  49 service 5 0 8204K 0:00 0.04% mfs
10398 root 7 0 712K 0:00 0.03% top
  32 service 7 0 188K 0:02 0.03% at_wini
  79 root 7 0 200K 0:00 0.02% devman
  107 root 7 0 188K 0:00 0.02% devmand
  5 root 4 0 596K 0:09 0.01% pm
134 root 7 0 112K 0:01 0.01% lance
  73 service 5 0 18124K 0:00 0.00% mfs
  283 root 7 0 2448K 0:00 0.00% sshd
  139 service 7 0 1152K 0:00 0.00% inet
  143 service 7 0 204K 0:00 0.00% pty
  4 root 4 0 1196K 0:00 0.00% rs
  164 root 7 0 104K 0:00 0.00% vbox
  179 root 7 0 228K 0:00 0.00% nonamed
  59 root 7 0 1460K 0:00 0.00% is
  6 root 4 0 48K 0:00 0.00% sched
  8 root 3 0 116K 0:00 0.00% memory
  3 root 4 0 156K 0:00 0.00% ds
```

```
Minix 210010054: PID 10511 created
Minix 210010054: PID 94 swapped in
Minix 210010054: PID 10512 created
Minix 210010054: PID 95 swapped in
Minix 210010054: PID 10513 created
Minix 210010054: PID 96 swapped in
^[[DSWrite done: 1008000 in 3.1667, score 79578
Write done: 1008000 in 3.1667, score 79578
Write done: 1008000 in 3.1667, score 79578
COUNT:79578|0|KBps
COUNT:79578|0|KBps
COUNT:79578|0|KBps
TIME:3.2
TIME:3.2
TIME:3.2
Read done: 1000004 in 2.8833, score 86705
Read done: 1000004 in 2.8833, score 86705
Read done: 1000004 in 2.8833, score 86705
COUNT:86705|0|KBps
COUNT:86705|0|KBps
COUNT:86705|0|KBps
TIME:2.9
TIME:2.9
TIME:2.9
```

repeated fstime swapping

Lab3 Report

210010054

Suyash Gaurav

• repeated syscall:

Now I have run repeated syscall. It will flood with many system calls, thus increase in sys-time. Following are the observations:

```
workload_mix6.sh > workload_mix6.sh
1 #!/bin/sh
2 ./syscall.sh &
3 ./syscall.sh &
4 ./syscall.sh &
5 wait
```

```
load averages: 0.23, 0.04, 0.09
57 processes: 4 running, 53 sleeping
main memory: 1048124K total, 996880K free, 996796K contig free, 22740K cached
CPU states: 20.58% user, 44.43% system, 34.99% kernel, 0.00% idle
CPU time displayed ('t' to cycle): user ; sort order ('o' to cycle): cpu

PID USERNAME PRI NICE SIZE STATE TIME CPU COMMAND
-1 root 0 2802K 0:00 34.99% kernel
7 root 5 0 1204K 1:26 34.12% vfs
5 root 4 0 596K 0:10 10.13% pm
10523 root 8 0 712K RUN 0:00 6.96% syscall ←
10522 root 8 0 712K RUN 0:00 6.80% syscall ←
10521 root 8 0 712K RUN 0:00 6.73% syscall ←
11 root 2 0 5580K 0:00 0.10% vm
9 root 1 0 180K 0:56 0.04% tty
40 root 7 0 1208K RUN 0:00 0.03% procfs
10398 root 7 0 712K 0:00 0.03% top
49 service 5 0 8204K 0:00 0.02% mfs
79 root 7 0 200K 0:00 0.02% devman
187 root 7 0 188K 0:00 0.01% devmand
134 root 7 0 112K 0:01 0.01% lance
139 service 7 0 1152K 0:00 0.00% inet
175 root 7 0 312K 0:00 0.00% syslogd
283 root 7 0 2448K 0:00 0.00% sshd
73 service 5 0 18128K 0:00 0.00% mfs
143 service 7 0 204K 0:00 0.00% pty
155 service 2 0 148K 0:00 0.00% log
6 root 4 0 48K 0:00 0.00% sched
147 root 7 0 544K 0:00 0.00% uds
164 root 7 0 104K 0:00 0.00% vbox
4 root 4 0 1196K 0:00 0.00% rs
179 root 7 0 228K 0:00 0.00% nonamed
8 root 3 0 116K 0:00 0.00% memory
3 root 4 0 156K 0:00 0.00% ds
```

```
Minix 210010054: PID 106 swapped in
Minix 210010054: PID 104 swapped in
Minix 210010054: PID 104 swapped in
Minix 210010054: PID 105 swapped in
Minix 210010054: PID 106 swapped in
Minix 210010054: PID 10521 exited
    15.15 real      1.96 user      3.30 sys
Minix 210010054: PID 10518 exited
syscall completed
---
Minix 210010054: PID 10515 exited
Minix 210010054: PID 10523 exited
    15.20 real      1.65 user      3.20 sys
Minix 210010054: PID 10520 exited
syscall completed
---
Minix 210010054: PID 10517 exited
[1] Done          ./syscall.sh
# Minix 210010054: PID 10522 exited
    15.21 real      1.70 user      3.36 sys
Minix 210010054: PID 10519 exited
syscall completed
---
```

repeated syscall swapping