

# Operating Systems Lab

## Assignment 3

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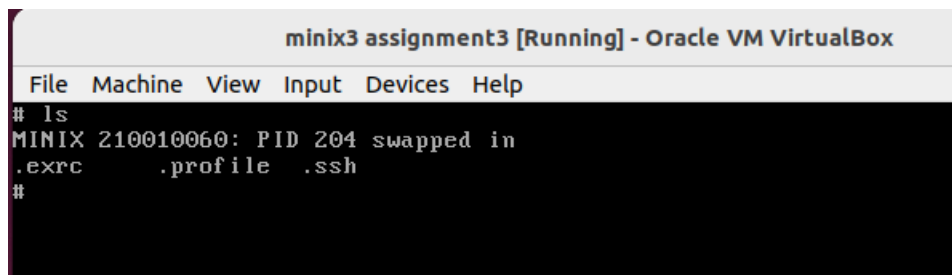
### Part 1

The file `schedule.c` in `minix/servers/sched` is modified by adding the following code lines in the method `schedule_process()`:

```
if(rmp->priority >= USERQ)
{
    printf("MINIX 210010060: PID %d swapped in\n", _ENDPOINT_P(rmp->endpoint));
}
```

The if statement checks if the priority of the process is greater than equal to the `USER_Q`(which is defined in `minix/include/minix/config.h`) .

Also, a `run.sh` is provided which copies `schedule.c` to its location(`minix/servers/sched/`) and builds the src.



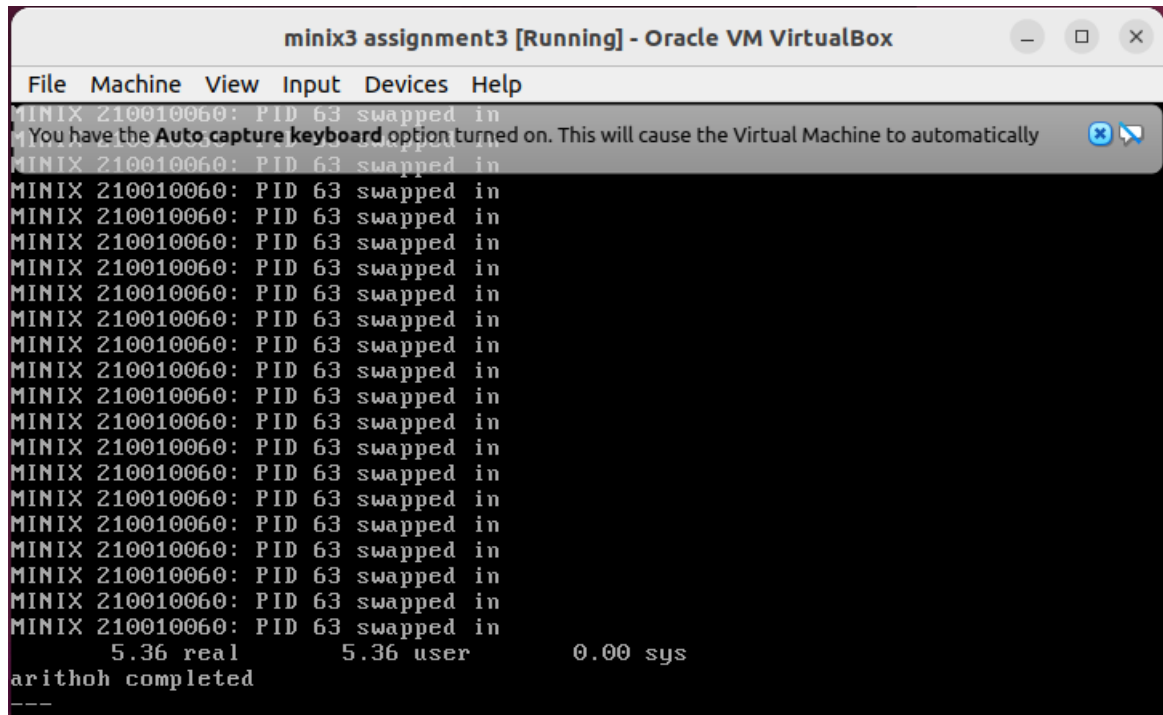
```
minix3 assignment3 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
# ls
MINIX 210010060: PID 204 swapped in
.exrc      .profile  .ssh
#
```

### Part 2

Individual Benchmarks

## 1) arithoh.sh

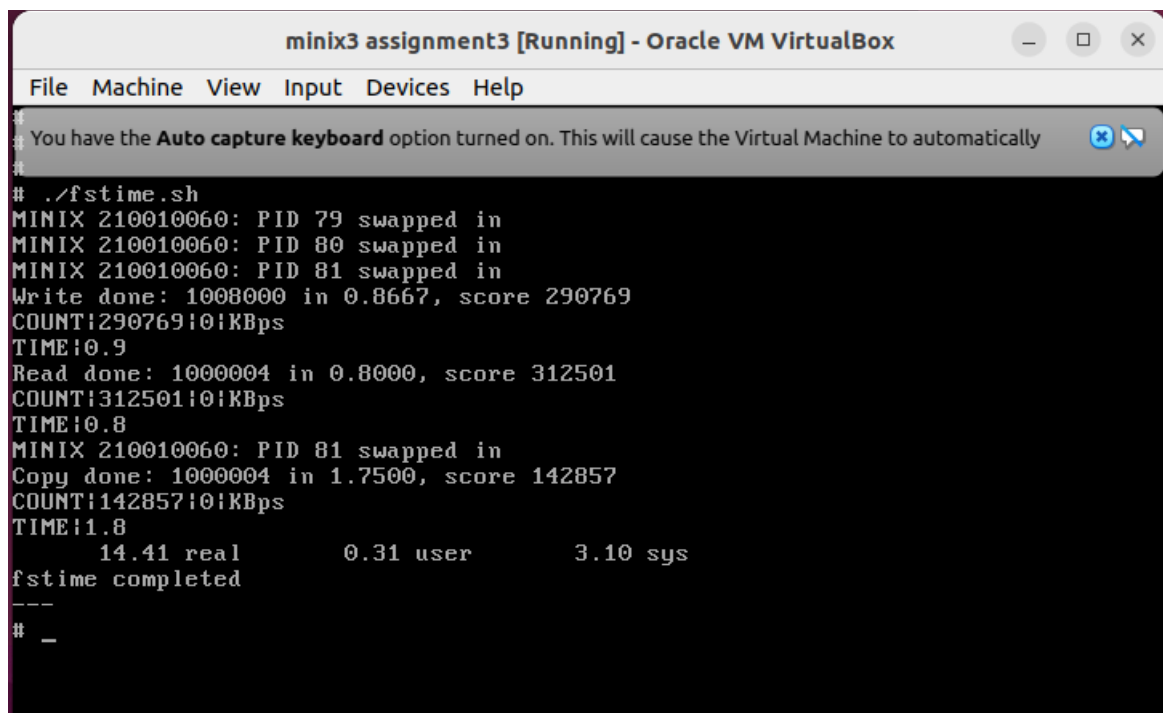
- It is observed that no system time is used. The entire process is run in user mode as they are CPU intensive processes.



```
minix3 assignment3 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
MINIX 210010060: PID 63 swapped in
MINIX 210010060: PID 63 swapped in
MINIX 210010060: PID 63 swapped in
MINIX 210010060: PID 63 swapped in
MINIX 210010060: PID 63 swapped in
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MINIX 210010060: PID 63 swapped in
MINIX 210010060: PID 63 swapped in
MINIX 210010060: PID 63 swapped in
MINIX 210010060: PID 63 swapped in
5.36 real      5.36 user      0.00 sys
arithoh completed
---
```

## 2) fstime.sh

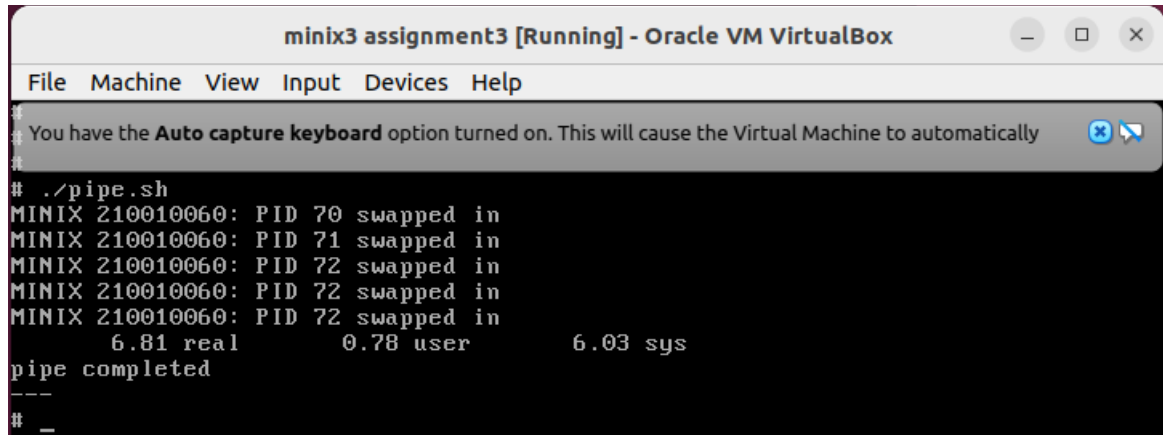
- The real time is high as compared to user and system time because the process consists of several calls to time, date, sleep, etc.
- It is an IO bound process.



```
minix3 assignment3 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
# You have the Auto capture keyboard option turned on. This will cause the Virtual Machine to automatically
#
# ./fstime.sh
MINIX 210010060: PID 79 swapped in
MINIX 210010060: PID 80 swapped in
MINIX 210010060: PID 81 swapped in
Write done: 1008000 in 0.8667, score 290769
COUNT:290769:0:KBps
TIME:0.9
Read done: 1000004 in 0.8000, score 312501
COUNT:312501:0:KBps
TIME:0.8
MINIX 210010060: PID 81 swapped in
Copy done: 1000004 in 1.7500, score 142857
COUNT:142857:0:KBps
TIME:1.8
14.41 real      0.31 user      3.10 sys
fstime completed
---
# _
```

### 3) pipe.sh

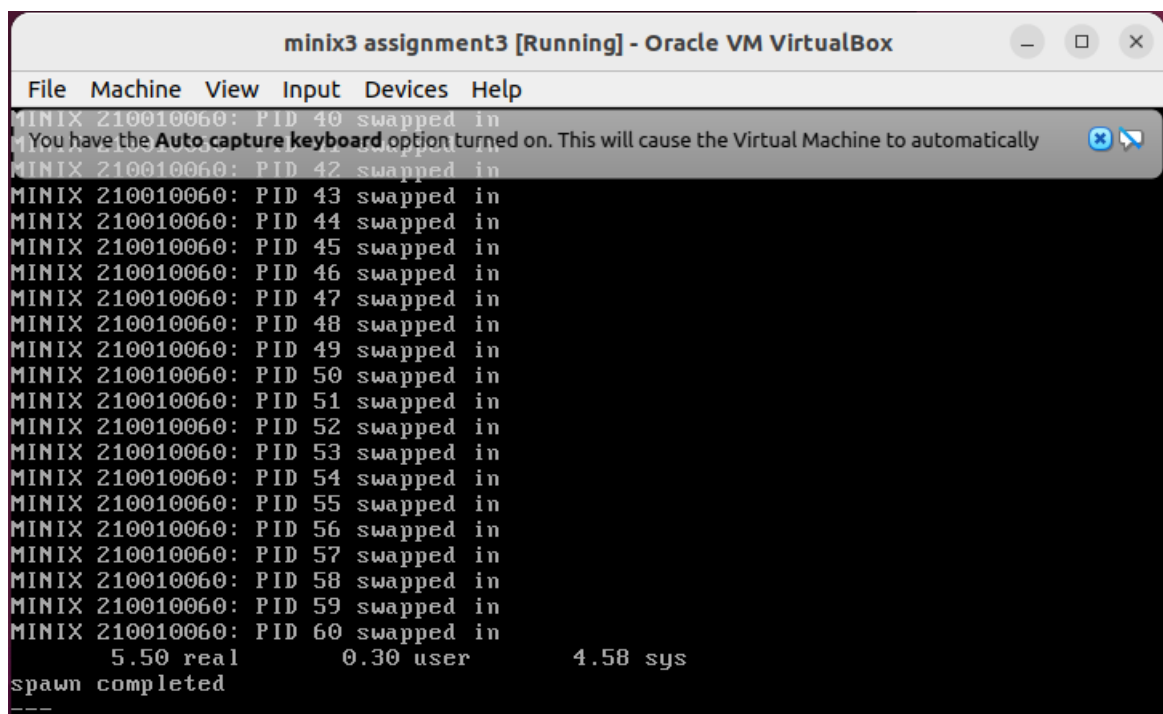
- This benchmark mostly consists of system calls, hence mostly run in kernel mode.
- It is an IO bound process and involves repeated reads and writes to a pipe.



```
minix3 assignment3 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
You have the Auto capture keyboard option turned on. This will cause the Virtual Machine to automatically
# ./pipe.sh
MINIX 210010060: PID 70 swapped in
MINIX 210010060: PID 71 swapped in
MINIX 210010060: PID 72 swapped in
MINIX 210010060: PID 72 swapped in
MINIX 210010060: PID 72 swapped in
        6.81 real          0.78 user          6.03 sys
pipe completed
---
# _
```

### 4) spawn.sh

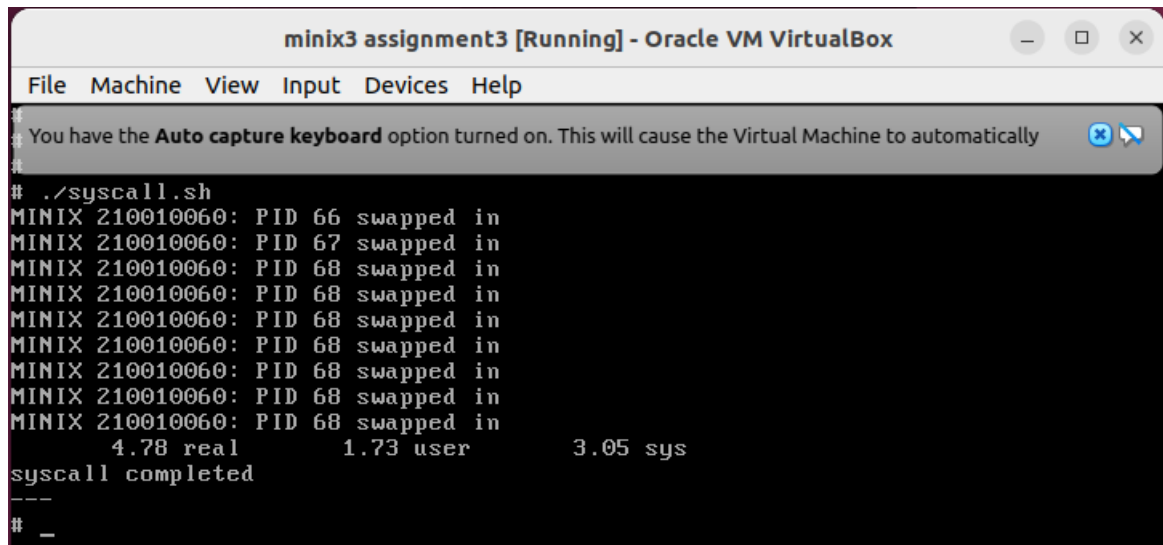
- This benchmark mostly consists of system calls, hence mostly run in kernel mode.
- It goes through 100002 iterations where it forks, and immediately reaps the child it created.
- The memory-bandwidth and process creation mechanism is tested in this benchmark.



```
minix3 assignment3 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
You have the Auto capture keyboard option turned on. This will cause the Virtual Machine to automatically
MINIX 210010060: PID 40 swapped in
MINIX 210010060: PID 42 swapped in
MINIX 210010060: PID 43 swapped in
MINIX 210010060: PID 44 swapped in
MINIX 210010060: PID 45 swapped in
MINIX 210010060: PID 46 swapped in
MINIX 210010060: PID 47 swapped in
MINIX 210010060: PID 48 swapped in
MINIX 210010060: PID 49 swapped in
MINIX 210010060: PID 50 swapped in
MINIX 210010060: PID 51 swapped in
MINIX 210010060: PID 52 swapped in
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MINIX 210010060: PID 56 swapped in
MINIX 210010060: PID 57 swapped in
MINIX 210010060: PID 58 swapped in
MINIX 210010060: PID 59 swapped in
MINIX 210010060: PID 60 swapped in
        5.50 real          0.30 user          4.58 sys
spawn completed
---
```

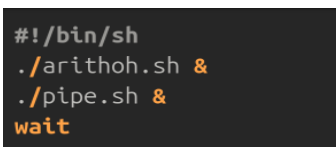
#### 5) syscall.sh

- This benchmark mostly consists of system calls, hence mostly run in kernel mode.
- It does system calls and deals with file operators.



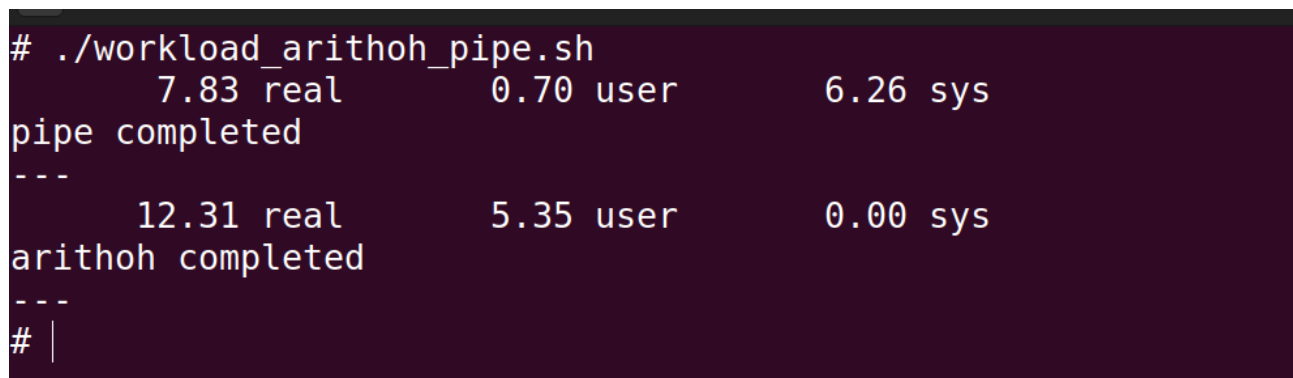
```
minix3 assignment3 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
You have the Auto capture keyboard option turned on. This will cause the Virtual Machine to automatically
# ./syscall.sh
MINIX 210010060: PID 66 swapped in
MINIX 210010060: PID 67 swapped in
MINIX 210010060: PID 68 swapped in
MINIX 210010060: PID 68 swapped in
MINIX 210010060: PID 68 swapped in
MINIX 210010060: PID 68 swapped in
MINIX 210010060: PID 68 swapped in
MINIX 210010060: PID 68 swapped in
MINIX 210010060: PID 68 swapped in
MINIX 210010060: PID 68 swapped in
4.78 real 1.73 user 3.05 sys
syscall completed
---
```

#### 6) Workload mix of arithoh.sh and pipe.sh



```
#!/bin/sh
./arithoh.sh &
./pipe.sh &
wait
```

- It is observed that pipe completes its execution before arithoh as pipe consists of IO bound processes which have highest priority as compared to arithmetic operations.

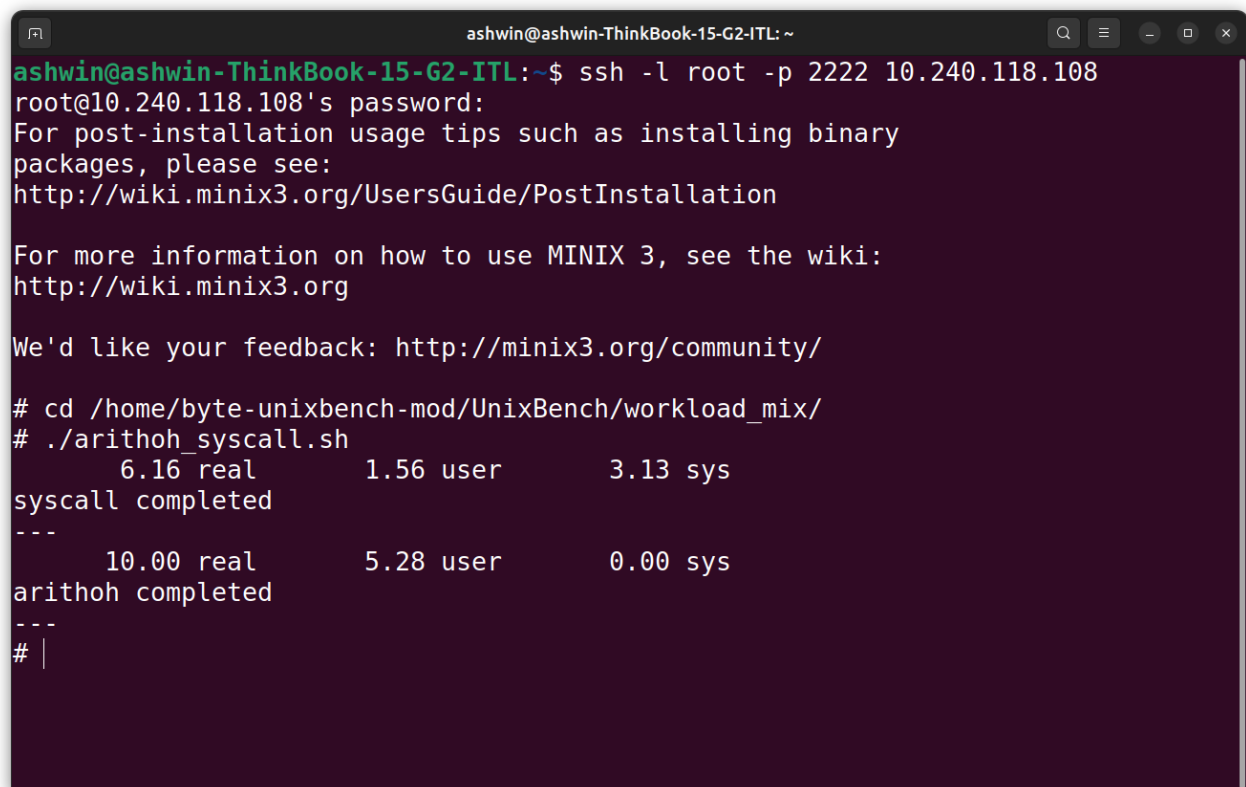


```
# ./workload_arithoh_pipe.sh
7.83 real 0.70 user 6.26 sys
pipe completed
---
12.31 real 5.35 user 0.00 sys
arithoh completed
---
```

## 7) Workload mix of arithoh.sh and syscall.sh

```
#!/bin/sh
./arithoh.sh &
./syscall.sh &
wait
```

- It is observed that syscall completes its execution before arithoh as syscall consists of IO bound processes which have highest priority as compared to arithmetic operations.



A terminal window titled 'ashwin@ashwin-ThinkBook-15-G2-ITL: ~' showing the execution of a workload mix script. The user connects via SSH to a root user on 10.240.118.108. After displaying some introductory text, the user runs 'cd /home/byte-unixbench-mod/UnixBench/workload\_mix/' and then './arithoh\_syscall.sh'. The output shows timing results for 'syscall completed' and 'arithoh completed'.

```
ashwin@ashwin-ThinkBook-15-G2-ITL: ~$ ssh -l root -p 2222 10.240.118.108
root@10.240.118.108's password:
For post-installation usage tips such as installing binary
packages, please see:
http://wiki.minix3.org/UsersGuide/PostInstallation

For more information on how to use MINIX 3, see the wiki:
http://wiki.minix3.org

We'd like your feedback: http://minix3.org/community/

# cd /home/byte-unixbench-mod/UnixBench/workload_mix/
# ./arithoh_syscall.sh
        6.16 real          1.56 user          3.13 sys
syscall completed
---
       10.00 real          5.28 user          0.00 sys
arithoh completed
---
# |
```