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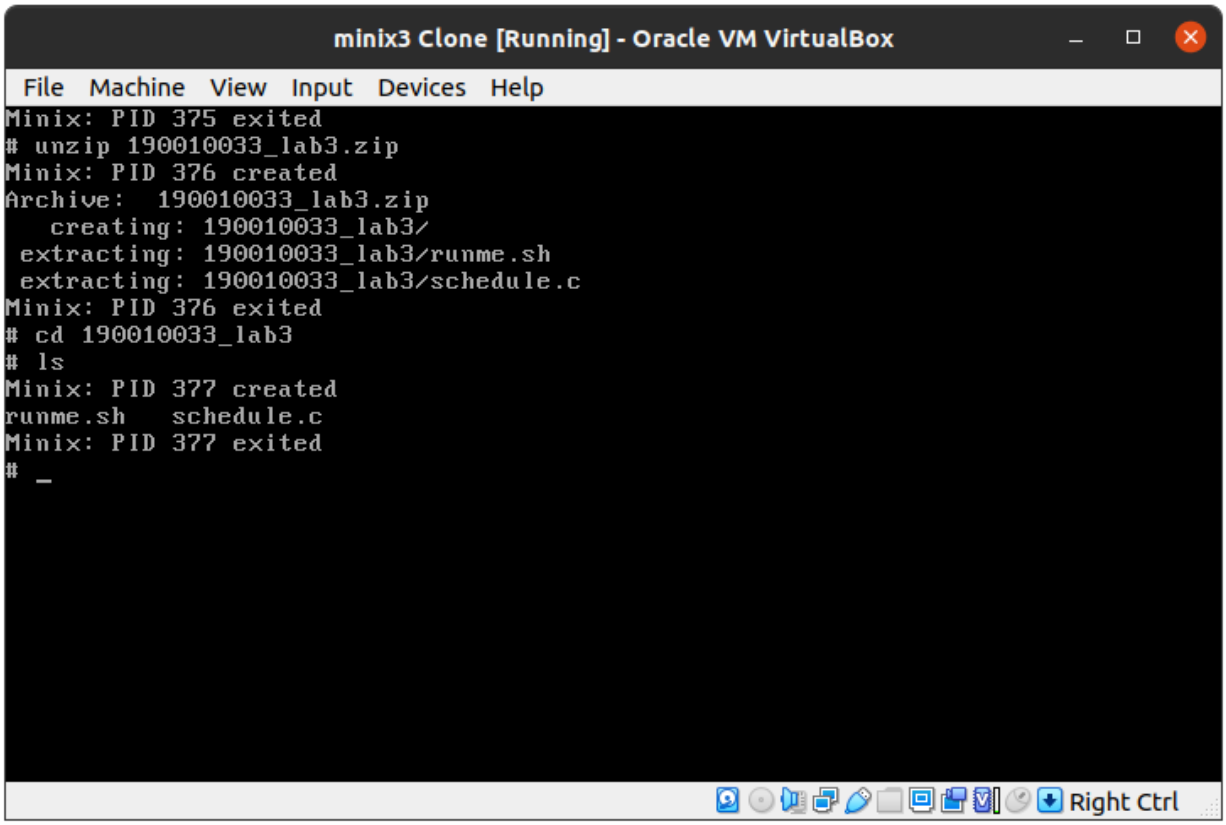
12/01/2022

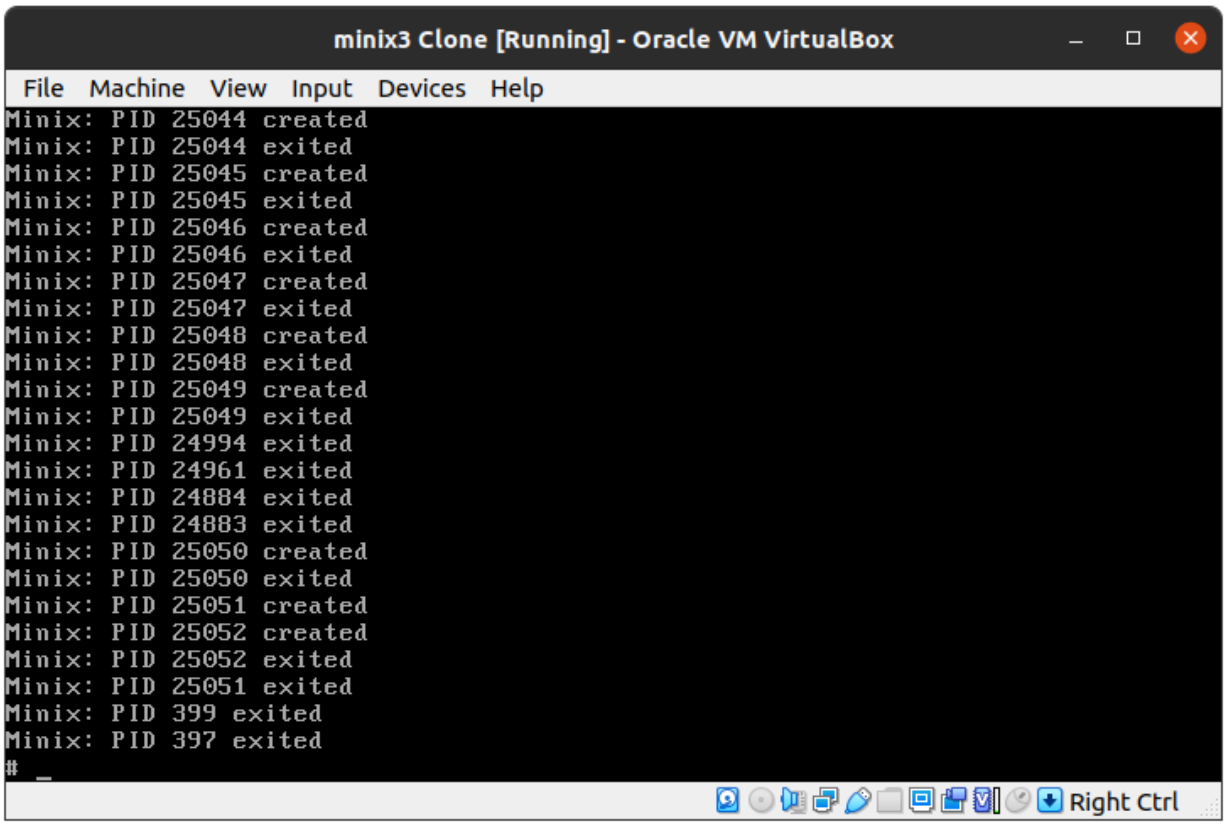
OS LAB: ASSIGNMENT - 3

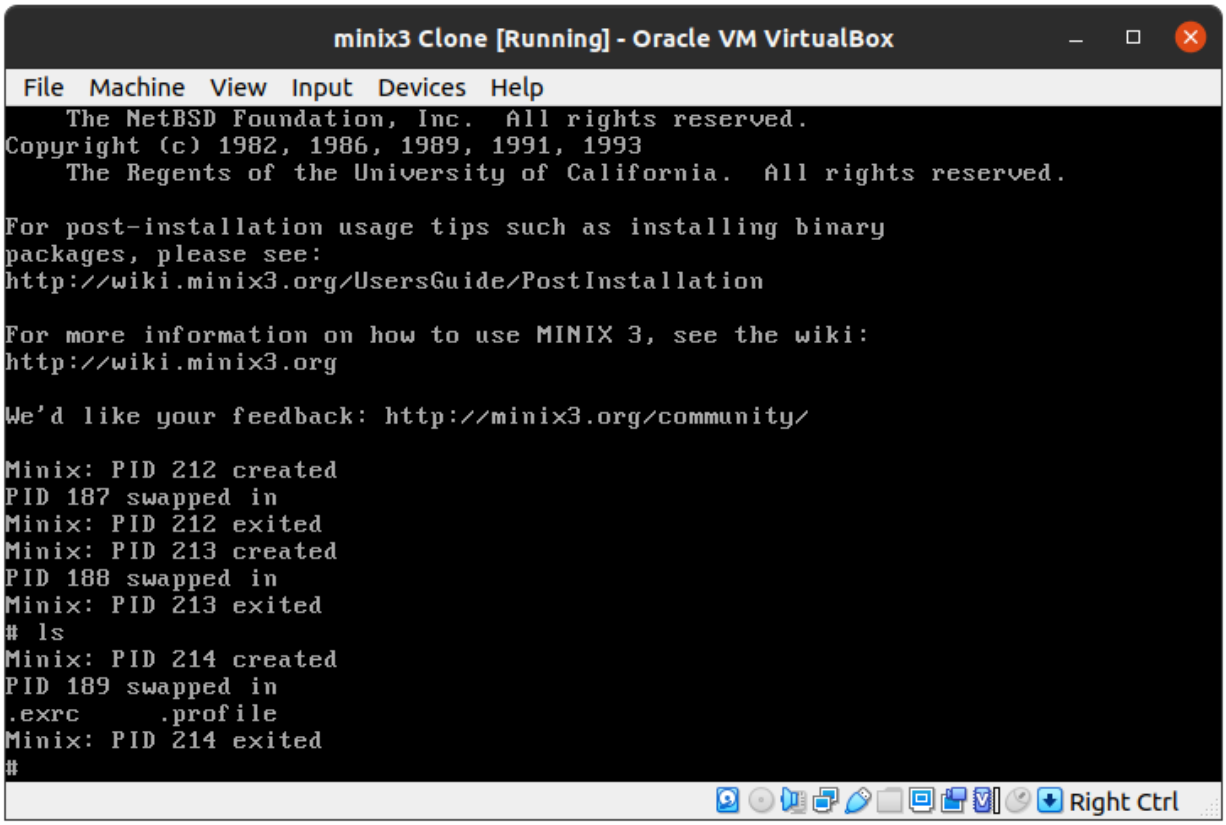
1 Part I

Here, we were supposed to modify the Minix3 source code such that the string “PID <pid> swapped in” is printed, whenever a user-level process is brought in by the scheduler.



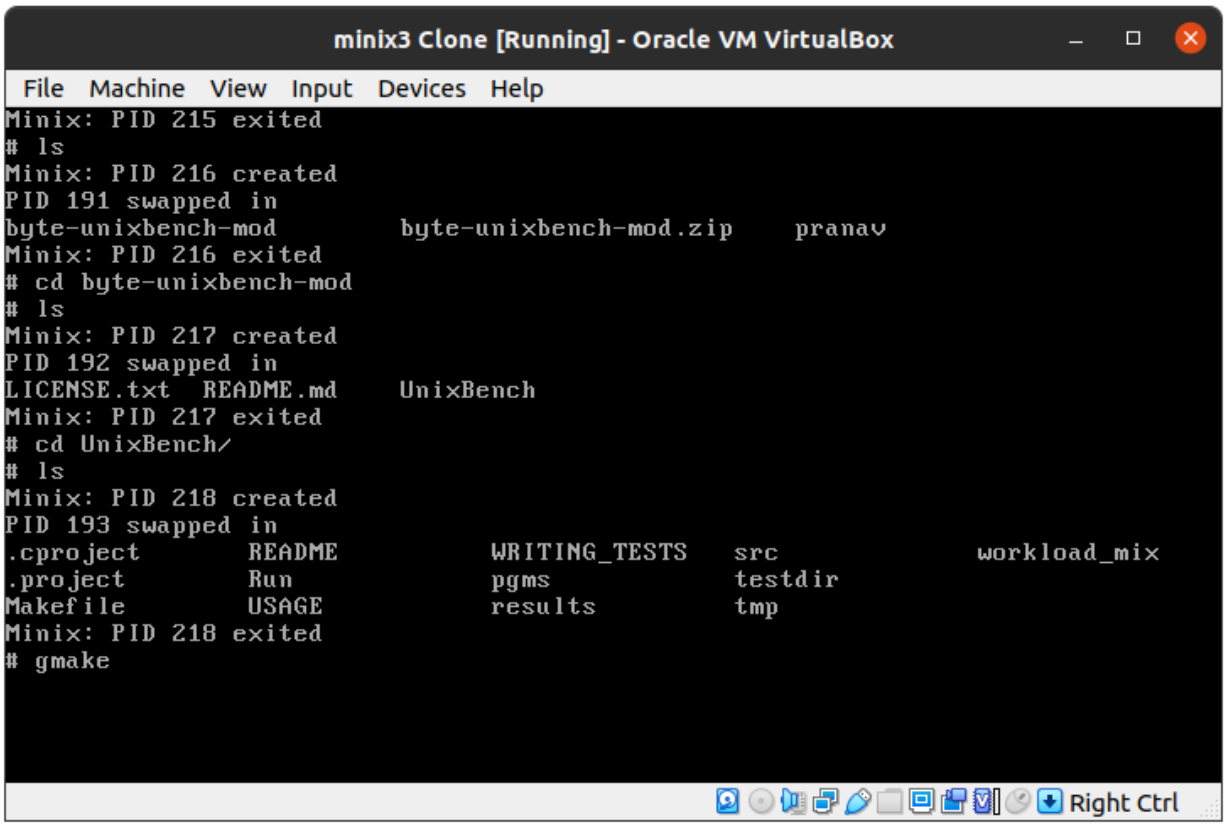
Below image shows the result after successful execution of runme.sh file. And also the image following it shows the result after rebooting the system (printing ‘PID <PID> swapped in’ for user-level processes’).


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Minix: PID 25044 created
Minix: PID 25044 exited
Minix: PID 25045 created
Minix: PID 25045 exited
Minix: PID 25046 created
Minix: PID 25046 exited
Minix: PID 25047 created
Minix: PID 25047 exited
Minix: PID 25048 created
Minix: PID 25048 exited
Minix: PID 25049 created
Minix: PID 25049 exited
Minix: PID 24994 exited
Minix: PID 24961 exited
Minix: PID 24884 exited
Minix: PID 24883 exited
Minix: PID 25050 created
Minix: PID 25050 exited
Minix: PID 25051 created
Minix: PID 25052 created
Minix: PID 25052 exited
Minix: PID 25051 exited
Minix: PID 399 exited
Minix: PID 397 exited
_
Right Ctrl


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
The NetBSD Foundation, Inc. All rights reserved.
Copyright (c) 1982, 1986, 1989, 1991, 1993
The Regents of the University of California. All rights reserved.
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/
Minix: PID 212 created
PID 187 swapped in
Minix: PID 212 exited
Minix: PID 213 created
PID 188 swapped in
Minix: PID 213 exited
ls
Minix: PID 214 created
PID 189 swapped in
.exrc .profile
Minix: PID 214 exited
#
Right Ctrl

2 Part II

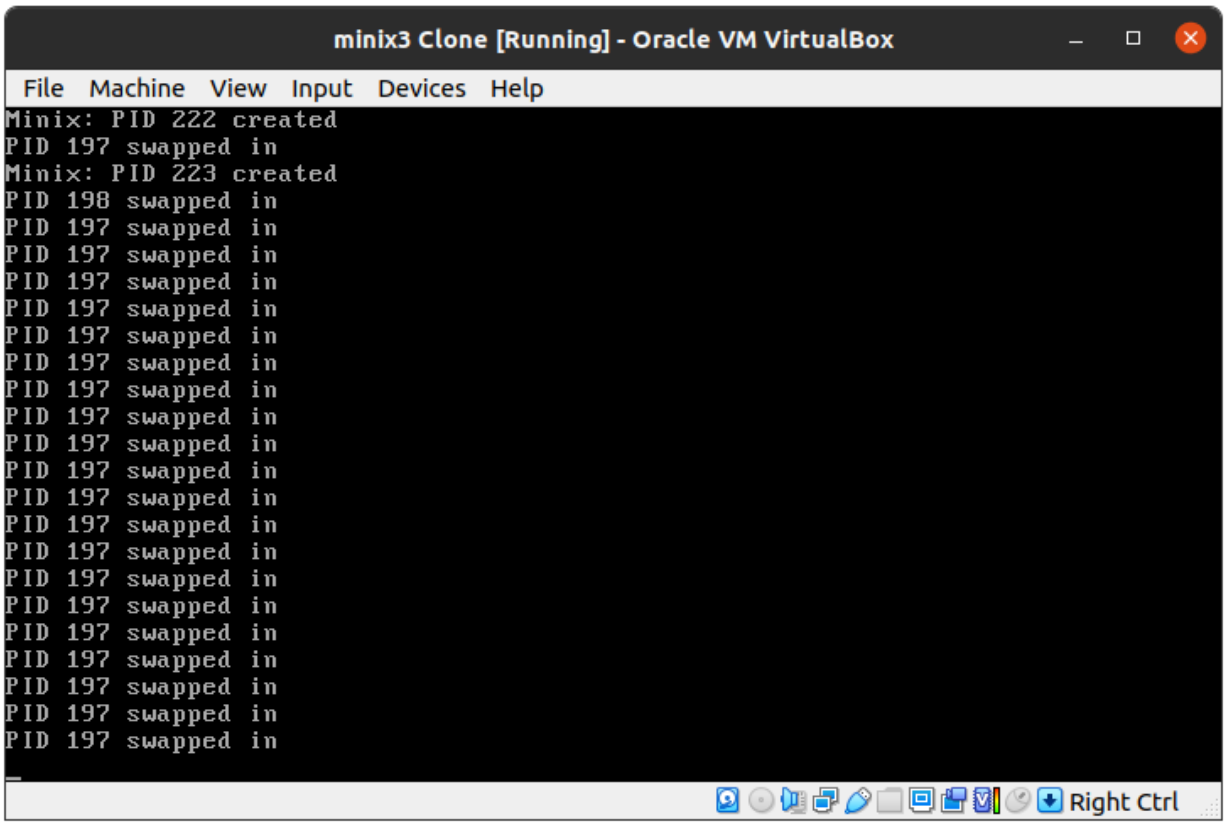
Run the command “gmake” to build the benchmarks in the Minix3 VM.



Some UnixBench/workload_mix tweaks were made with the UnixBench Benchmark Suite in order to examine the behavior of the scheduler by looking at the sequence of PID printouts when these workloads were performed. In the subsections that follow, we'll look at four distinct workload combinations to see how they're run.

2.1 workload_mix1.sh

In this shell script, 2 scripts arithoh.sh & fstime.sh are used as follows:
#!/bin/sh
./arithoh.sh & #CPU intensive
./fstime.sh & #I/O bound
wait


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Minix: PID 222 created
PID 197 swapped in
Minix: PID 223 created
PID 198 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
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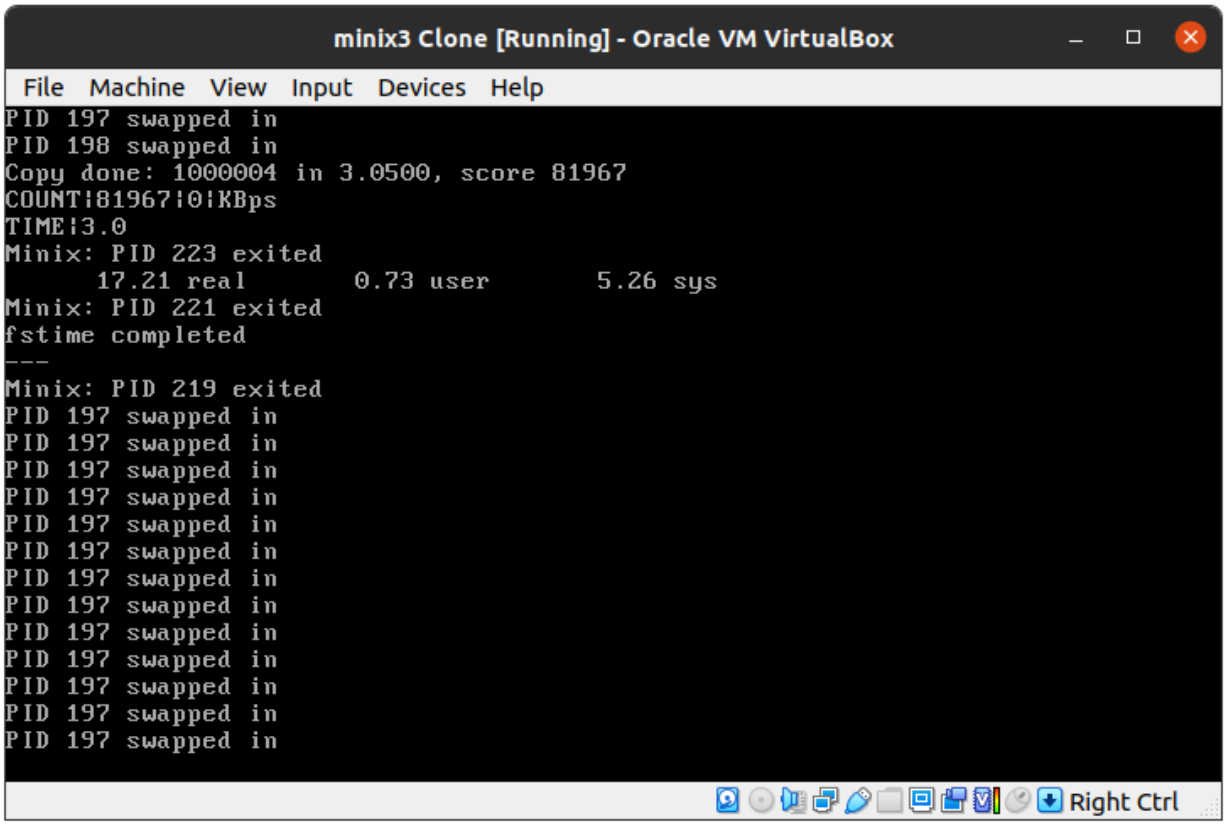
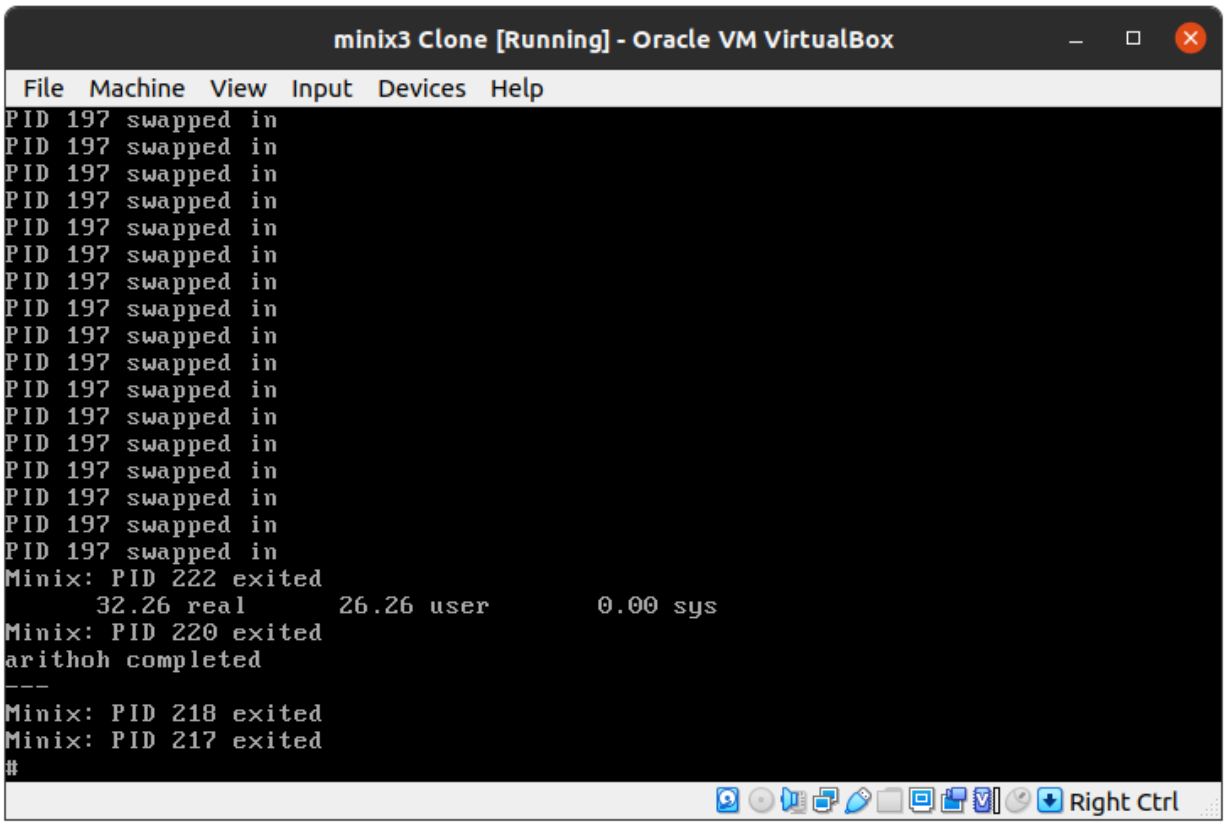
PID 197 swapped in
Right Ctrl


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PID 197 swapped in
PID 198 swapped in
Copy done: 1000004 in 3.0500, score 81967
COUNT¦81967¦0¦KBps
TIME¦3.0
Minix: PID 223 exited
17.21 real 0.73 user 5.26 sys
Minix: PID 221 exited
fstime completed

Minix: PID 219 exited
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
PID 197 swapped in
Right Ctrl

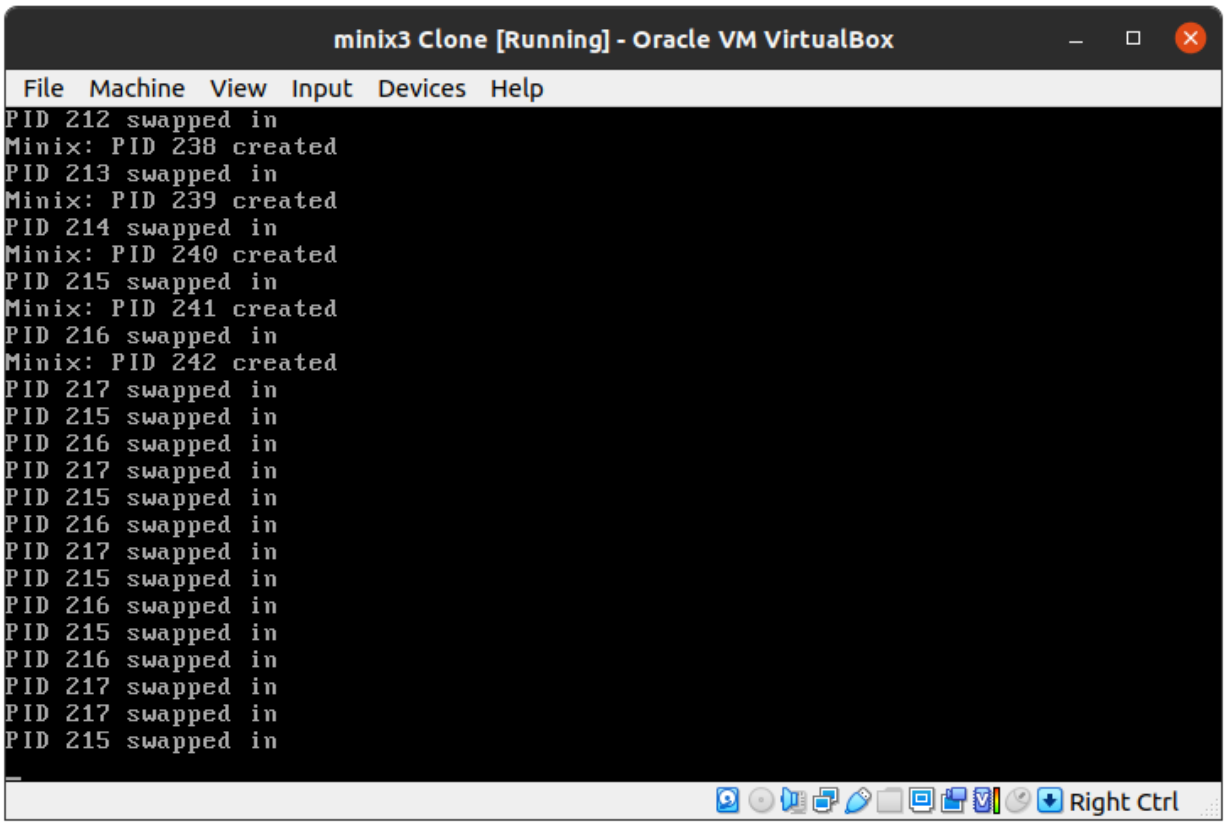


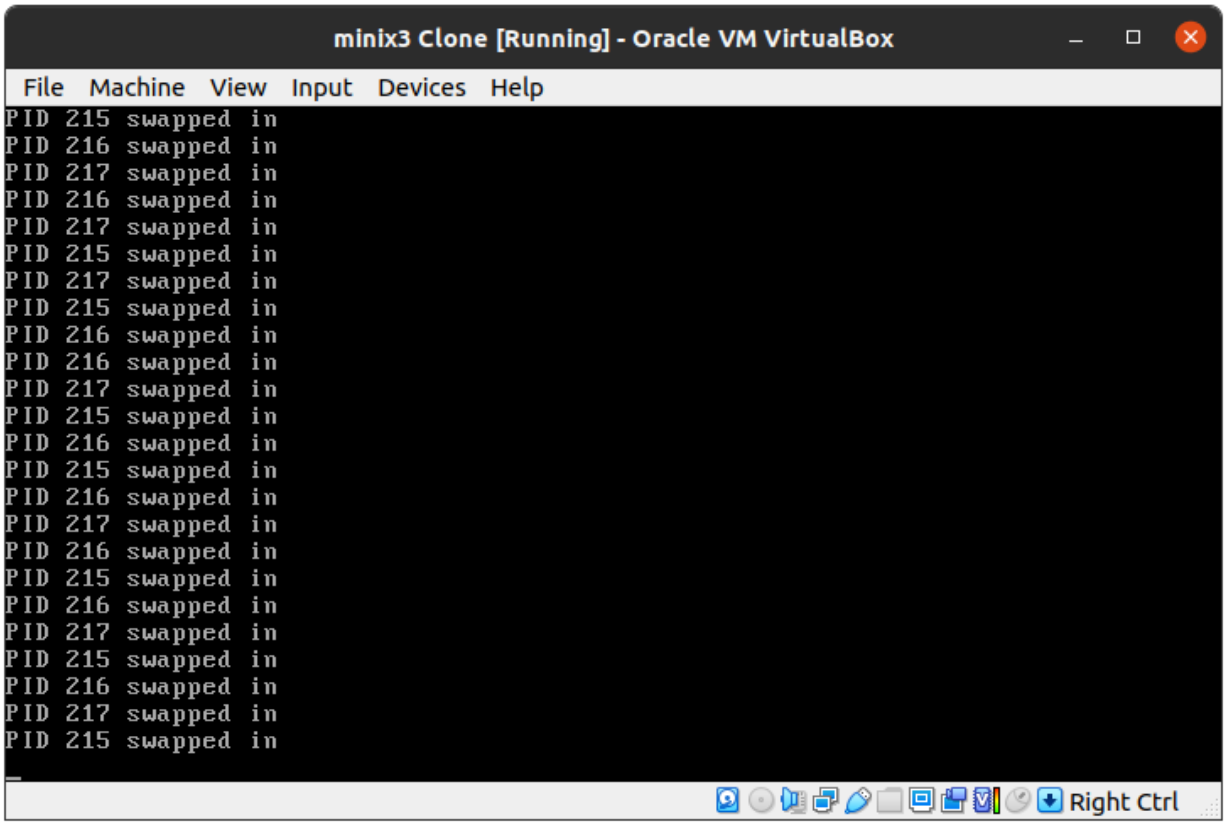
An instance of file arithoh.sh and an instance of file fstime.sh are executed in workload_mix1.sh. The arithoh.sh instructions are clearly computationally intensive, but the fstime.sh instructions are I/O constrained. Only the "PID <PID> swapped in" statements corresponding to arithoh.sh are printed as fstime.sh waits for its I/O operations to complete, as seen in above images.
PID 197 belongs to arithoh.sh, while PID 198 belongs to fstime.sh. So, PID 197 process is scheduled, and PID process 198 is waiting for an input; in the meantime, arithoh.sh is scheduled, and the processor is being used for CPU heavy operations. When fstime.sh gets input with PID 198, it is scheduled and the procedure is finished. Finally, the next 197 PID tasks will be scheduled till it is done.

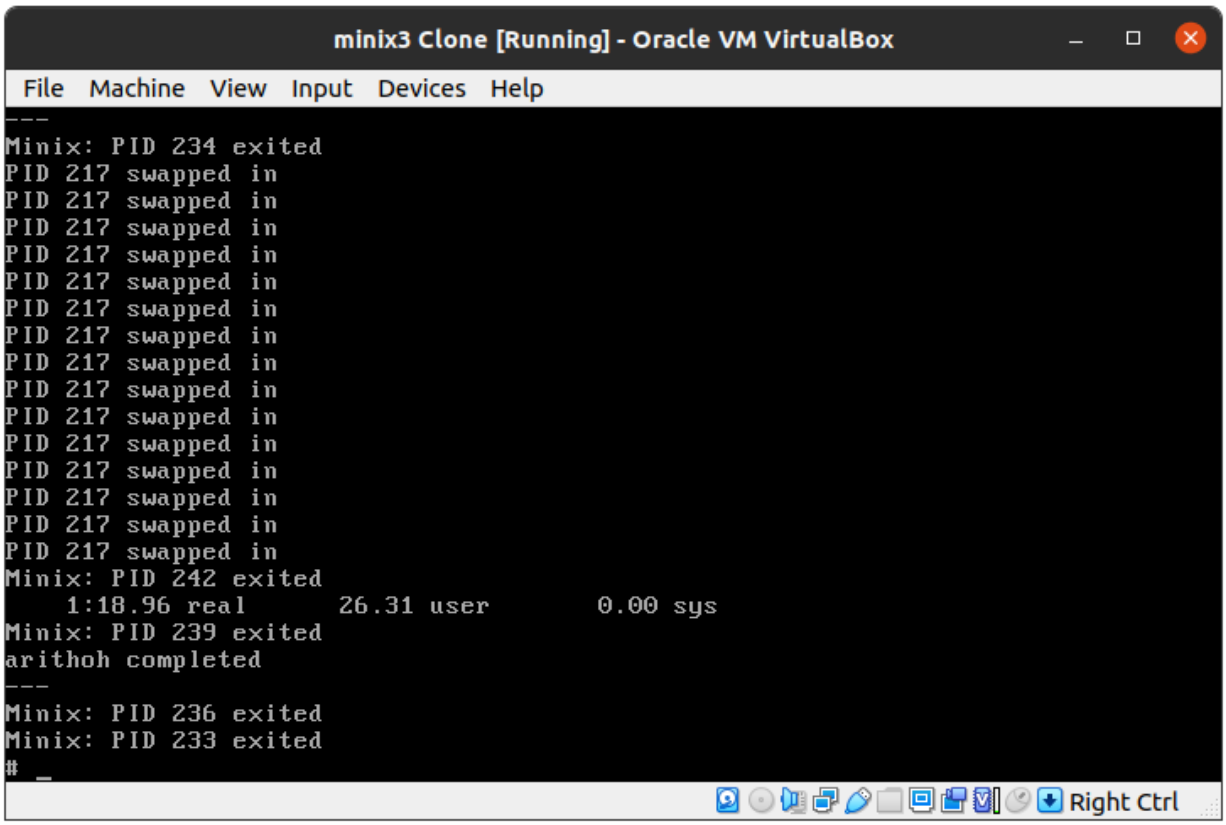
2.2 workload_mix2.sh

In this shell script, only script arithoh.sh is used as follows:

```
#!/bin/sh
./arithoh.sh & #CPU intensive
./arithoh.sh & #CPU intensive
./arithoh.sh & #CPU intensive
wait
```


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PID 212 swapped in
Minix: PID 238 created
PID 213 swapped in
Minix: PID 239 created
PID 214 swapped in
Minix: PID 240 created
PID 215 swapped in
Minix: PID 241 created
PID 216 swapped in
Minix: PID 242 created
PID 217 swapped in
PID 215 swapped in
PID 216 swapped in
PID 217 swapped in
PID 215 swapped in
PID 216 swapped in
PID 217 swapped in
PID 215 swapped in
PID 216 swapped in
PID 215 swapped in
PID 216 swapped in
PID 217 swapped in
PID 217 swapped in
PID 215 swapped in
Right Ctrl


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PID 215 swapped in
PID 216 swapped in
PID 217 swapped in
PID 216 swapped in
PID 217 swapped in
PID 215 swapped in
PID 217 swapped in
PID 215 swapped in
PID 216 swapped in
PID 216 swapped in
PID 217 swapped in
PID 215 swapped in
PID 216 swapped in
PID 215 swapped in
PID 216 swapped in
PID 217 swapped in
PID 216 swapped in
PID 215 swapped in
PID 216 swapped in
PID 217 swapped in
PID 215 swapped in
PID 216 swapped in
PID 217 swapped in
PID 215 swapped in
Right Ctrl

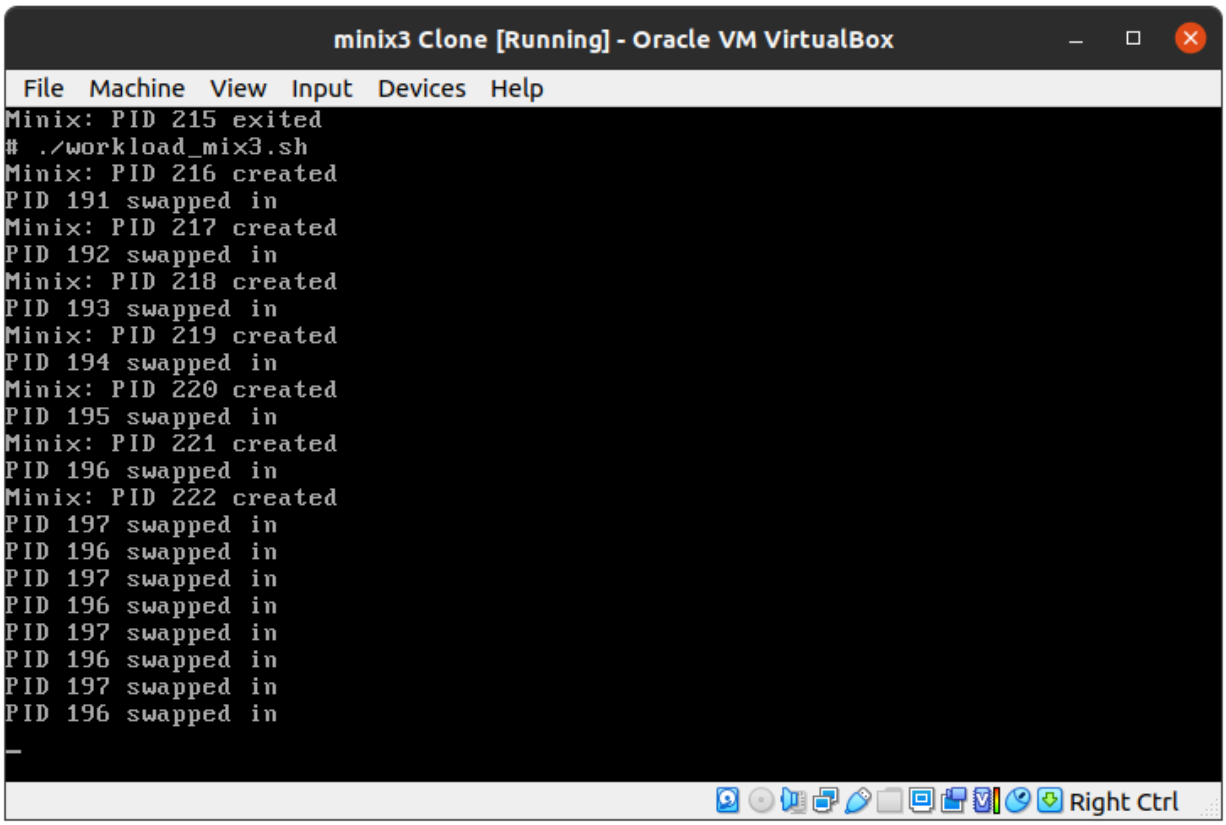


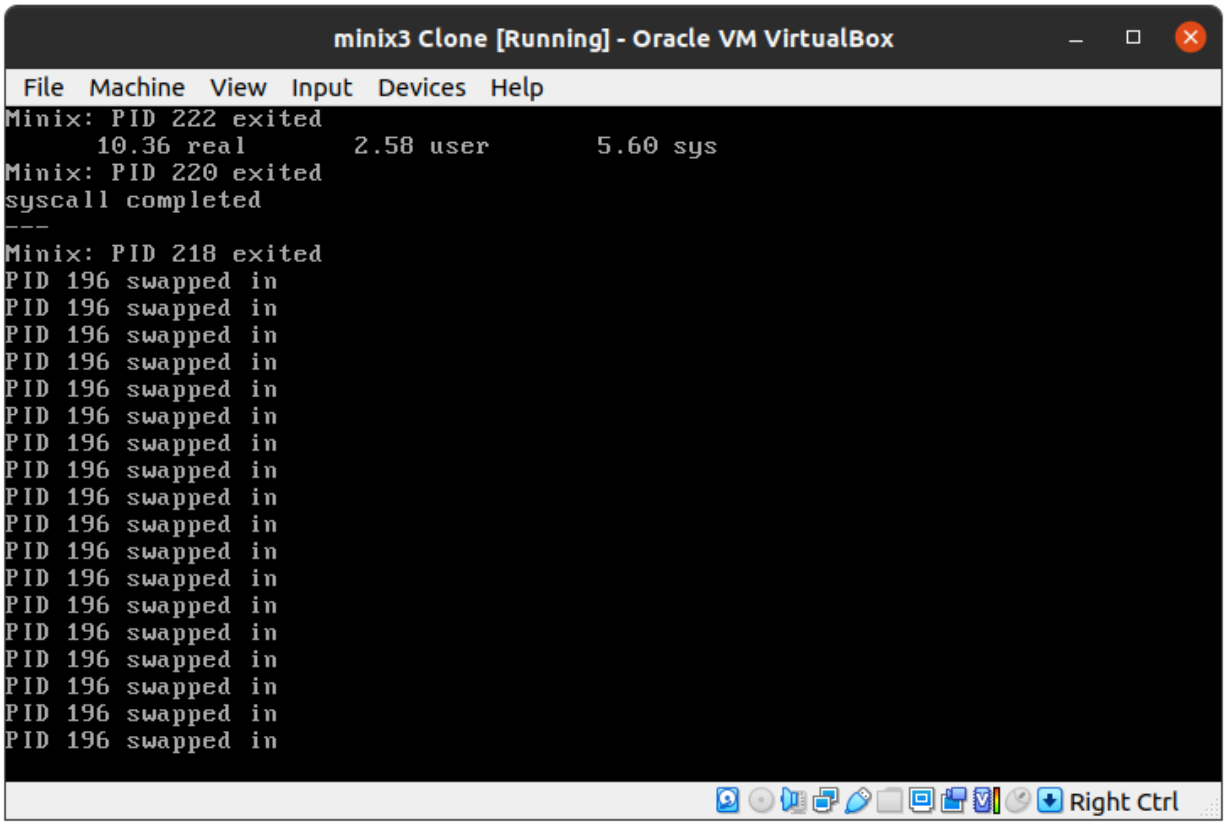
Here the first arithoh.sh has a PID of 215, the second arithoh.sh has a PID of 216, and the last arithoh.sh has a PID of 217. Clearly, if numerous instances of arithoh.sh are performed, each of which is CPU intensive in nature, as in this workload, they are scheduled alternately.
Above images shows that process PID 215,216,217 corresponds to three workload instances in arithoh.sh that are alternately scheduled till they are completed.

2.3 workload_mix3.sh

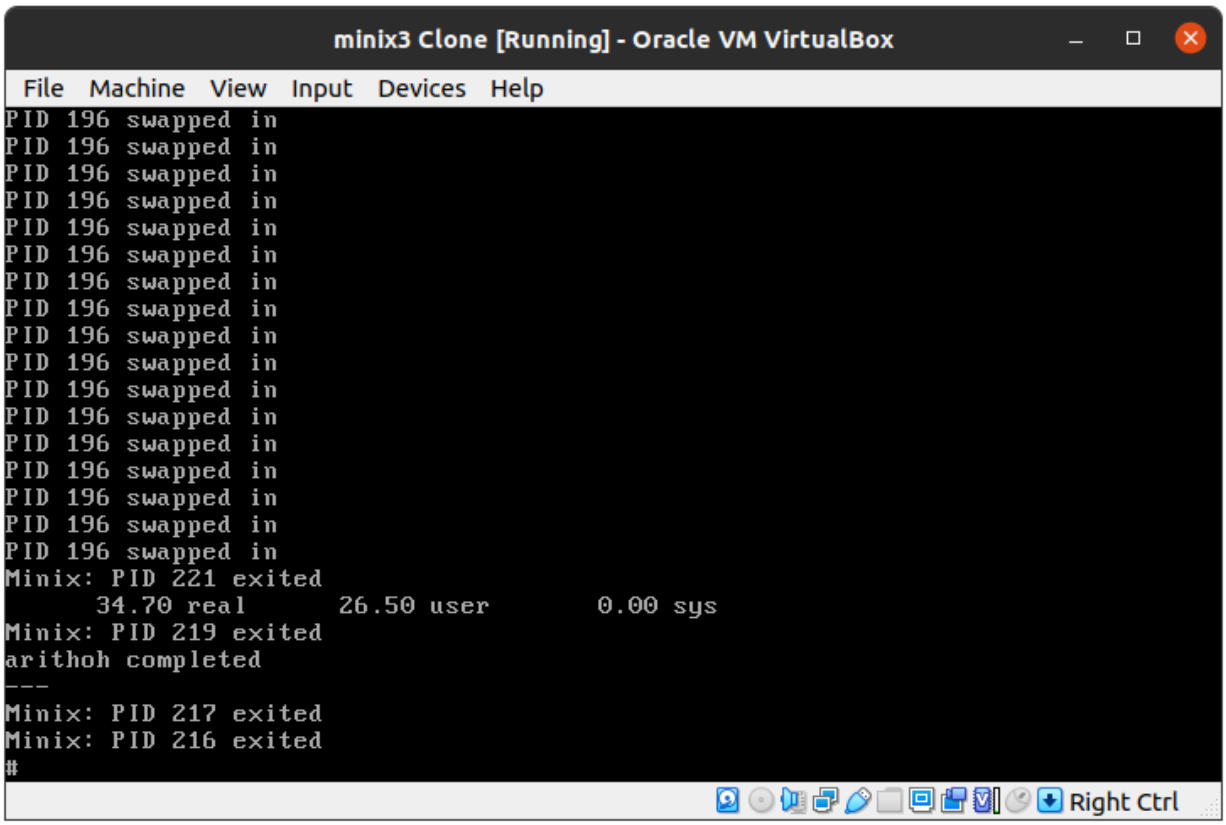
In this shell script, 2 scripts arithoh.sh, syscall.sh are used as follows:
#!/bin/sh
./arithoh.sh & #CPU intensive
./syscall.sh & #Faster
wait

PID 196 is assigned to arithoh.sh, whereas PID 197 is assigned to syscall.sh. According to the literature, arithoh.sh and syscall.sh are two separate types of CPU intensive processes. images below shows that at the start of the execution, both are alternately scheduled based on their intensiveness, and that syscall.sh with PID 197, which is less CPU intensive than arithoh.sh, is completed first. At the conclusion, arithoh.sh is set to run until it is totally done.


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Minix: PID 215 exited
./workload_mix3.sh
Minix: PID 216 created
PID 191 swapped in
Minix: PID 217 created
PID 192 swapped in
Minix: PID 218 created
PID 193 swapped in
Minix: PID 219 created
PID 194 swapped in
Minix: PID 220 created
PID 195 swapped in
Minix: PID 221 created
PID 196 swapped in
Minix: PID 222 created
PID 197 swapped in
PID 196 swapped in
PID 197 swapped in
PID 196 swapped in
PID 197 swapped in
PID 196 swapped in
PID 197 swapped in
PID 196 swapped in
Right Ctrl


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Minix: PID 222 exited
10.36 real 2.58 user 5.60 sys
Minix: PID 220 exited
syscall completed

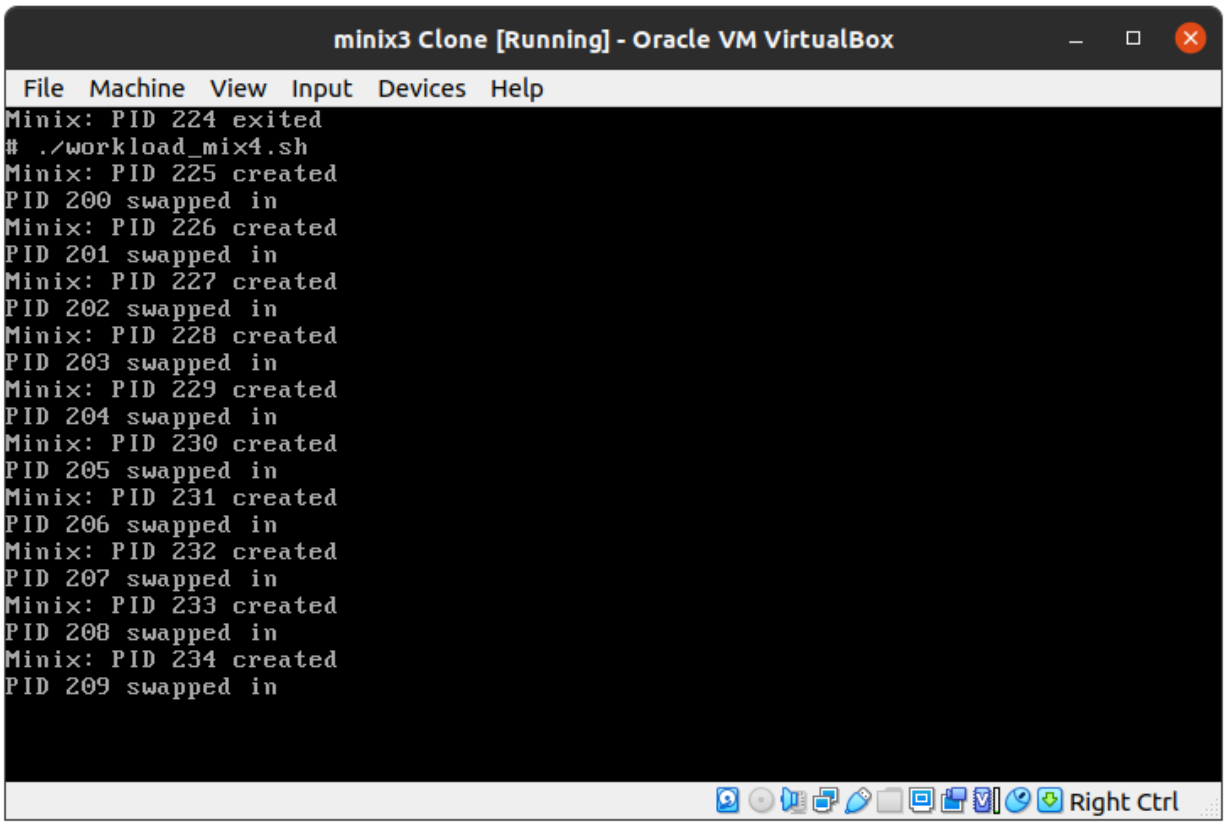
Minix: PID 218 exited
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
PID 196 swapped in
Right Ctrl

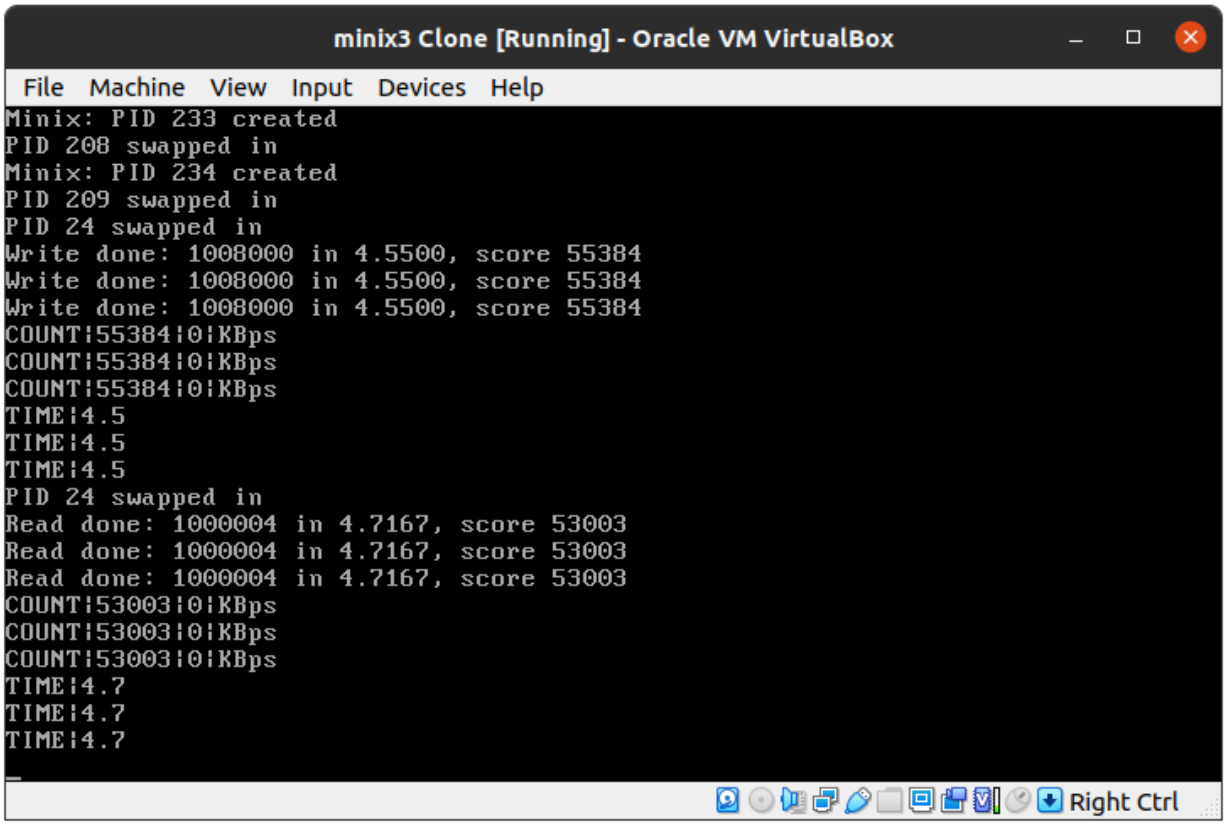


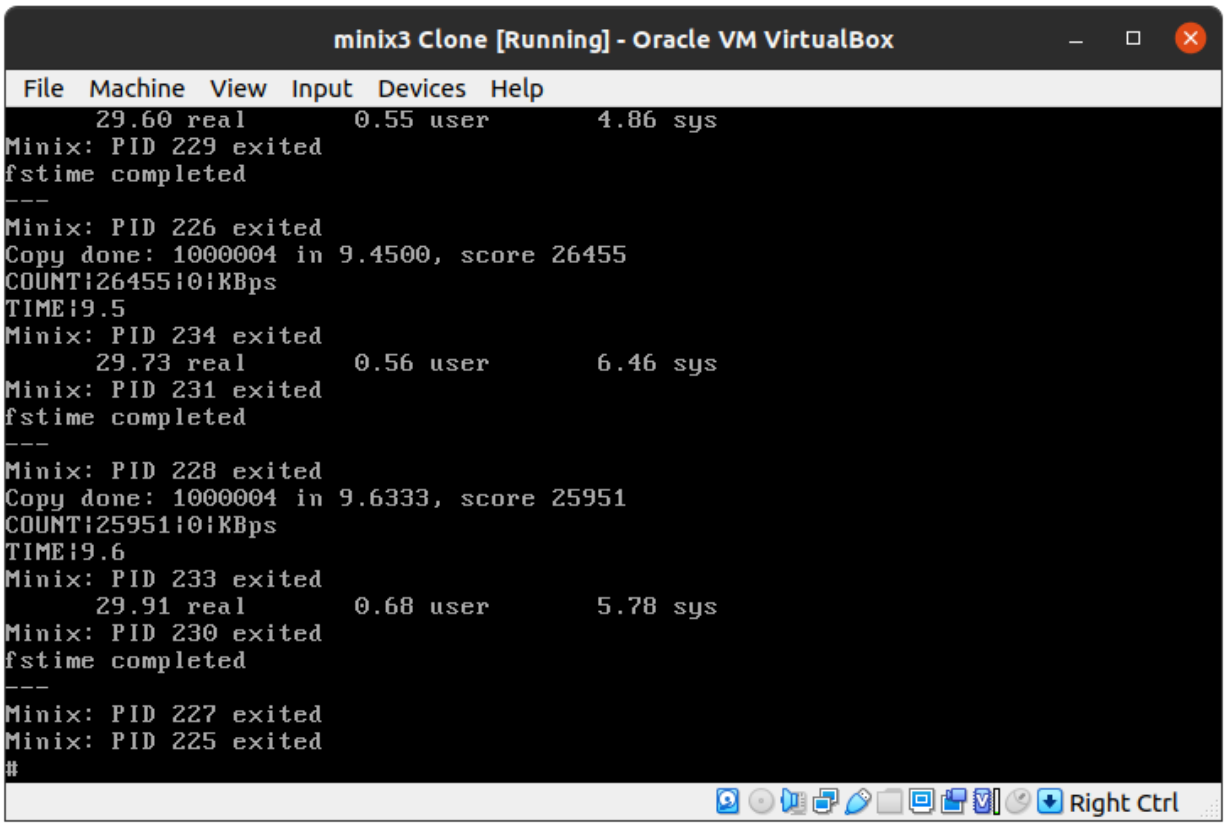
2.4 workload_mix4.sh

In this shell script, script fstime.sh is used as follows:
#!/bin/sh
./fstime.sh & #I/O bound
./fstime.sh & #I/O bound
./fstime.sh & #I/O bound
wait

Below images show three identical fstime.sh workloads with PID 206, 207, and 208. All three are input/output (I/O) processes that are awaiting input. When a process gets input, it is scheduled and completed ahead of time. Processes are planned and then completed in the same way, in the sequence of incoming inputs.


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Minix: PID 224 exited
./workload_mix4.sh
Minix: PID 225 created
PID 200 swapped in
Minix: PID 226 created
PID 201 swapped in
Minix: PID 227 created
PID 202 swapped in
Minix: PID 228 created
PID 203 swapped in
Minix: PID 229 created
PID 204 swapped in
Minix: PID 230 created
PID 205 swapped in
Minix: PID 231 created
PID 206 swapped in
Minix: PID 232 created
PID 207 swapped in
Minix: PID 233 created
PID 208 swapped in
Minix: PID 234 created
PID 209 swapped in
Right Ctrl


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Minix: PID 233 created
PID 208 swapped in
Minix: PID 234 created
PID 209 swapped in
PID 24 swapped in
Write done: 1008000 in 4.5500, score 55384
Write done: 1008000 in 4.5500, score 55384
Write done: 1008000 in 4.5500, score 55384
COUNT¦55384¦0¦KBps
COUNT¦55384¦0¦KBps
COUNT¦55384¦0¦KBps
TIME¦4.5
TIME¦4.5
TIME¦4.5
PID 24 swapped in
Read done: 1000004 in 4.7167, score 53003
Read done: 1000004 in 4.7167, score 53003
Read done: 1000004 in 4.7167, score 53003
COUNT¦53003¦0¦KBps
COUNT¦53003¦0¦KBps
COUNT¦53003¦0¦KBps
TIME¦4.7
TIME¦4.7
TIME¦4.7
Right Ctrl


minix3 Clone [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
29.60 real 0.55 user 4.86 sys
Minix: PID 229 exited
fstime completed

Minix: PID 226 exited
Copy done: 1000004 in 9.4500, score 26455
COUNT|26455|0|KBps
TIME|9.5
Minix: PID 234 exited
29.73 real 0.56 user 6.46 sys
Minix: PID 231 exited
fstime completed

Minix: PID 228 exited
Copy done: 1000004 in 9.6333, score 25951
COUNT|25951|0|KBps
TIME|9.6
Minix: PID 233 exited
29.91 real 0.68 user 5.78 sys
Minix: PID 230 exited
fstime completed

Minix: PID 227 exited
Minix: PID 225 exited
#
Right Ctrl