

Operation Systems Lab 3 (210010032)

Part 1:

Modified file schedule.c in usr/src/minix/servers/sched by inserting print statement inside schedule_process function. As follows.

```
if (rmp->priority >= USER_Q){  
    printf("Minix 210010032 : PID %d swapped in\n", _ENDPOINT_P(rmp->endpoint));  
}
```

The condition `rmp->priority >= USER_Q` is written to ensure that we print only user level processes when it is scheduled.

Part 2:

The task is to run several workmixes of different benchmarks like aritho, fstime, syscall, spawn and pipe.

fstime and pipe seem to be I/O bound. Aritho, syscall and spawn are CPU bound.

1. CPU usage of aritho

PID	USERNAME	PRI	NICE	SIZE	STATE	TIME	CPU	COMMAND
275	root	15	0	708K	RUN	0:03	99.46%	arithoh
-1	root	0		2802K		0:00	0.22%	kernel
9	root	1	0	180K		0:00	0.10%	tty
7	root	5	0	1204K		0:06	0.08%	vfs
11	root	2	0	5052K		0:00	0.05%	vm
40	root	7	0	1208K	RUN	0:00	0.02%	procfs
252	root	7	0	596K		0:00	0.01%	top
49	service	5	0	8204K		0:00	0.01%	mfs
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
174	root	7	0	312K		0:00	0.01%	syslogd
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

2. CPU usage of fstime

PID	USERNAME	PRI	NICE	SIZE	STATE	TIME	CPU	COMMAND
7	root	5	0	1204K		0:10	17.15%	vfs
-1	root	0		2802K		0:00	12.73%	kernel
76	service	5	0	4748K		0:06	9.21%	mfs
284	root	7	0	712K	RUN	0:00	2.93%	fstime
11	root	2	0	5072K		0:00	0.08%	vm
40	root	7	0	1208K	RUN	0:00	0.07%	procfs
252	root	7	0	596K		0:00	0.04%	top
79	root	7	0	200K		0:00	0.02%	devman
49	service	5	0	8204K		0:00	0.02%	mfs
107	root	7	0	188K		0:00	0.01%	devmand
5	root	4	0	596K		0:00	0.01%	pm
139	service	7	0	1152K		0:00	0.00%	inet
248	root	7	0	2468K		0:00	0.00%	sshd
143	service	7	0	204K		0:00	0.00%	pty
134	root	7	0	112K		0:00	0.00%	lance

3. CPU usage of syscall

PID	USERNAME	PRI	NICE	SIZE	STATE	TIME	CPU	COMMAND
7	root	5	0	1204K		0:12	37.16%	vfs
-1	root	0		2802K		0:00	27.01%	kernel
287	root	9	0	708K	RUN	0:00	23.55%	syscall
5	root	4	0	596K		0:00	12.13%	pm
11	root	2	0	5072K		0:00	0.05%	vm
9	root	1	0	180K		0:00	0.02%	tty
40	root	7	0	1208K	RUN	0:00	0.02%	procfs
252	root	7	0	596K		0:00	0.01%	top
49	service	5	0	8204K		0:00	0.01%	mfs
79	root	7	0	200K		0:00	0.01%	devman
107	root	7	0	188K		0:00	0.01%	devmand
139	service	7	0	1152K		0:00	0.00%	inet
174	root	7	0	312K		0:00	0.00%	syslogd
248	root	7	0	2468K		0:00	0.00%	sshd
143	service	7	0	204K		0:00	0.00%	pty

4. CPU usage of pipe

PID	USERNAME	PRI	NICE	SIZE	STATE	TIME	CPU	COMMAND
7	root	5	0	1204K		0:15	48.81%	vfs
-1	root	0		2802K		0:00	28.18%	kernel
12	service	5	0	560K		0:00	15.66%	pfs
290	root	7	0	708K	RUN	0:00	7.14%	pipe
11	root	2	0	5072K		0:00	0.09%	vm
40	root	7	0	1208K	RUN	0:00	0.04%	procfs
252	root	7	0	596K		0:00	0.03%	top
49	service	5	0	8204K		0:00	0.01%	mfs
79	root	7	0	200K		0:00	0.01%	devman
5	root	4	0	596K		0:01	0.01%	pm
107	root	7	0	188K		0:00	0.01%	devmand
139	service	7	0	1152K		0:00	0.00%	inet
143	service	7	0	204K		0:00	0.00%	pty
248	root	7	0	2468K		0:00	0.00%	sshd
134	root	7	0	112K		0:00	0.00%	lance

5. CPU usage of spawn

PID	USERNAME	PRI	NICE	SIZE	STATE	TIME	CPU	COMMAND
9	root	1	0	180K		0:01	64.17%	tty
-1	root	0		2802K		0:00	13.10%	kernel
11	root	2	0	5136K		0:00	2.18%	vm
7	root	5	0	1204K		0:18	1.02%	vfs
5	root	4	0	596K		0:01	0.79%	pm
155	service	2	0	148K		0:00	0.71%	log
174	root	7	0	312K	RUN	0:00	0.48%	syslogd
6	root	4	0	48K		0:00	0.40%	sched
73	service	5	0	11328K		0:00	0.19%	mfs
293	root	7	0	708K		0:00	0.14%	spawn
40	root	7	0	1208K	RUN	0:00	0.07%	procfs
139	service	7	0	1152K		0:00	0.07%	inet
147	root	7	0	544K		0:00	0.05%	uds
252	root	7	0	596K		0:00	0.05%	top
49	service	5	0	8204K		0:00	0.03%	mfs

6. workload_mix1.sh

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

CPU usage:

PID	USERNAME	PRI	NICE	SIZE	STATE	TIME	CPU	COMMAND
10339	root	15	0	712K	RUN	0:04	60.51%	arithoh
7	root	5	0	1204K		0:28	15.95%	vfs
-1	root	0		2802K		0:00	11.81%	kernel
76	service	5	0	4772K		0:13	8.81%	mfs
10340	root	7	0	716K	RUN	0:00	2.72%	fstime
9	root	1	0	180K		0:13	0.06%	tty
11	root	2	0	5364K		0:01	0.05%	vm
40	root	7	0	1208K	RUN	0:00	0.02%	procfs
252	root	7	0	596K		0:00	0.01%	top
49	service	5	0	8204K		0:00	0.01%	mfs
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		0:01	0.01%	pm
174	root	7	0	312K		0:00	0.00%	syslogd
139	service	7	0	1152K		0:00	0.00%	inet

Here process 68 is that of fstime, 67 if of aritho. 67 runs many times since it is CPU intensive while process with PID 68 (fstime) waits until it gets input, since it is I/O bound process.

[illegible]

7. workload mix2

```
#!/bin/sh
./arithoh.sh &
./arithoh.sh &
./arithoh.sh &
Wait
```

CPU usage:

PID	USERNAME	PRI	NICE	SIZE	STATE	TIME	CPU	COMMAND
10373	root	12	0	712K	RUN	0:01	34.74%	arithoh
10374	root	12	0	712K	RUN	0:01	32.41%	arithoh
10371	root	13	0	712K	RUN	0:01	32.41%	arithoh
-1	root	0		2802K		0:00	0.12%	kernel
9	root	1	0	180K		0:13	0.10%	tty
7	root	5	0	1204K		0:33	0.07%	vfs
11	root	2	0	5432K		0:01	0.05%	vm
40	root	7	0	1208K	RUN	0:00	0.02%	procfs
252	root	7	0	596K		0:00	0.02%	top
49	service	5	0	8204K		0:00	0.01%	mfs
79	root	7	0	200K		0:00	0.01%	devman
107	root	7	0	188K		0:00	0.01%	devmand
174	root	7	0	312K		0:00	0.01%	syslogd
5	root	4	0	596K		0:01	0.01%	pm
139	service	7	0	1152K		0:00	0.00%	inet


```

Minix 210010032 : PID 78 swapped in
Minix 210010032 : PID 77 swapped in
Minix 210010032 : PID 78 swapped in
Minix 210010032 : PID 75 swapped in
Minix 210010032 : PID 77 swapped in
Minix 210010032 : PID 78 swapped in
Minix 210010032 : PID 75 swapped in
Minix 210010032 : PID 77 swapped in
Minix 210010032 : PID 78 swapped in
Minix 210010032 : PID 75 swapped in
Minix 210010032 : PID 77 swapped in
Minix 210010032 : PID 78 swapped in
Minix 210010032 : PID 75 swapped in
Minix 210010032 : PID 77 swapped in
Minix 210010032 : PID 78 swapped in
Minix 210010032 : PID 75 swapped in

```

These 3 processes with PIDs 75,77 and 78 are all three different aritho processes. This is highly CPU intensive and interval between swaps is very less, since other process enters queue after current process spends considerable amount of time in queue.

8. workload_mix3

```

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

```

CPU usage:

PID	USERNAME	PRI	NICE	SIZE	STATE	TIME	CPU	COMMAND
7	root	5	0	1204K		0:34	29.50%	vfs
10408	root	11	0	712K	RUN	0:01	21.28%	arithoh
-1	root	0		2802K		0:00	20.97%	kernel
10409	root	10	0	712K	RUN	0:01	18.83%	syscall
5	root	4	0	596K		0:02	9.26%	pm
11	root	2	0	5368K		0:01	0.05%	vm
9	root	1	0	180K		0:13	0.04%	tty
40	root	7	0	1208K	RUN	0:00	0.02%	procfs
252	root	7	0	596K		0:00	0.01%	top
49	service	5	0	8204K		0:00	0.01%	mfs
79	root	7	0	200K		0:00	0.01%	devman
107	root	7	0	188K		0:00	0.01%	devmand
174	root	7	0	312K		0:00	0.00%	syslogd
139	service	7	0	1152K		0:00	0.00%	inet
73	service	5	0	13780K		0:00	0.00%	mfs

```
Minix 210010032 : PID 138 swapped in  
Minix 210010032 : PID 137 swapped in  
Minix 210010032 : PID 138 swapped in  
Minix 210010032 : PID 137 swapped in  
Minix 210010032 : PID 138 swapped in  
Minix 210010032 : PID 137 swapped in  
Minix 210010032 : PID 138 swapped in  
Minix 210010032 : PID 137 swapped in  
Minix 210010032 : PID 137 swapped in  
Minix 210010032 : PID 138 swapped in  
Minix 210010032 : PID 138 swapped in  
Minix 210010032 : PID 137 swapped in
```

Syscall is also CPU bound process like aritho. Hence both are in queue one after the other. But it is to be noted that syscall is less CPU intensive than aritho. Hence aritho is scheduled towards the end.