HO CHI MINH UNIVERSITY OF TECHNOLOGY
FACULTY OF COMPUTER SCIENCE AND ENGINEERING

SIMPLE OPERATING SYSTEM IMPLEMENTATION
WITH
PROCESS SCHEDULING AND MEMORY MANAGEMENT SIMULATION

Instructor
Le Thanh Van
Tran Van Hoai

I. WORKLOAD

Name	Student ID	Class	Contribution
Bành Vĩ Khang	2153423	CC03	45%
Vương Hồng Lĩnh	2152728	CC03	50%
Trịnh Hoàng Duy	2152473	CC01	5%

II. QUESTION

- **QUESTION 1: What is the advantage of using priority queue in comparison with other scheduling algorithms you have learned?**

  The relative importance of each process can be precisely defined beforehand allowing the cpu to choose processes based on their importance and it is easier to manage the queue while processing.

- **QUESTION 2: In this simple OS, we implement a design of multiple memory segments or memory areas in source code declaration. What is the advantage of the proposed design of multiple segments?**

  The multiple memory segments design allows many processes to share data easily, different areas can be used for stack, code, heap or data, easier to manage the size of each area like stack or heap as we can manage how many segments will be used in each area.It extends the address ability of a processor, for example, giving an addressing capability of 1 MB, with segmentation it only requires 16 bit registers, otherwise it needs 20 bit registers. It also allows processes to work independently of each other.

- **QUESTION 3: What will happen if we divide the address to more than 2-levels in the paging memory management system?**

  This approach is known as multi-level paging or hierarchical paging, where the page number is divided into multiple levels, and each level contains a smaller number of entries. Each level of the page table points to the next level of the page table until the final level points to the physical page frame, reducing the size of the page table.

- **QUESTION 4: What is the advantage and disadvantage of segmentation with paging?**

  Advantage: It does not cause external fragmentation. It's also easier to manage memory allocation and the algorithm is simpler

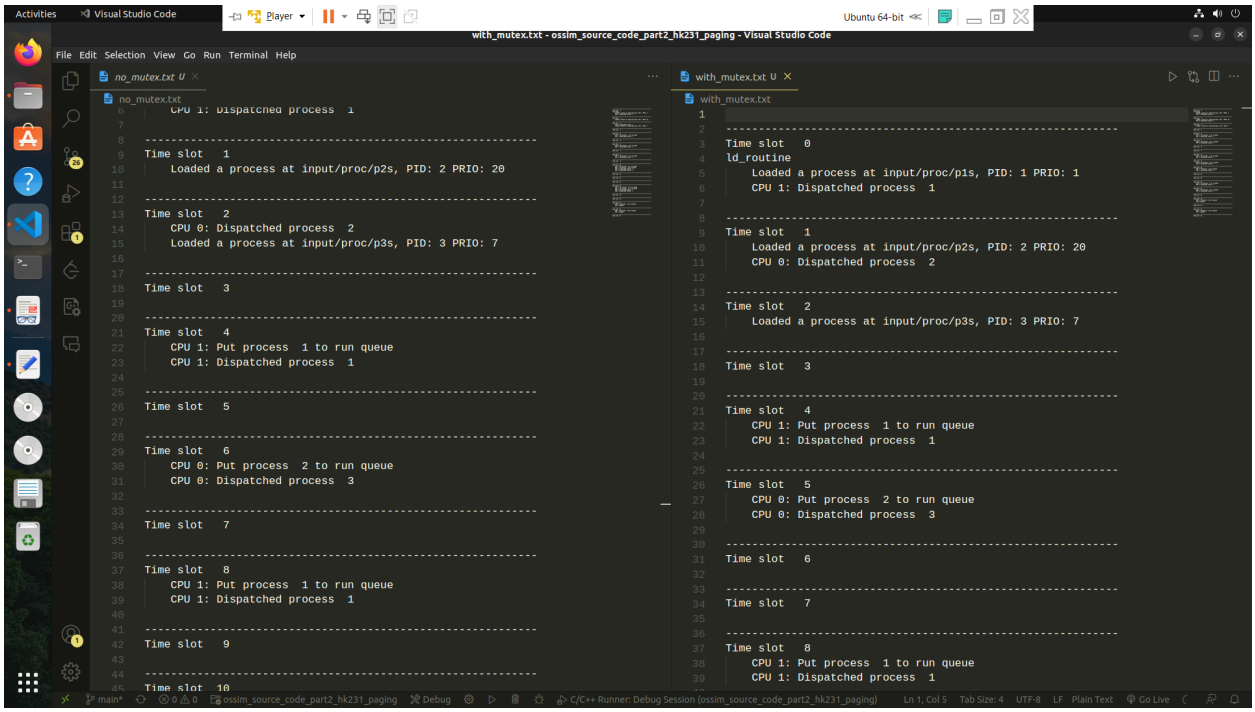
  Disadvantage: It can cause internal fragmentation, require more hardware resources, may increase memory access time, leading to increasing complexity. It also require memory to store the page table

- **QUESTION 5: What will happen if the synchronization is not handled in your simple OS? Illustrate by example the problem of your simple OS if you have any.**

  The major problem is race condition. Normally, without synchronization, when both cpus are running at the same time, a single variable which stores the remaining time left of

each process will be accessed by both cpus, leading to race condition. Thankfully, in our code we store each remaining time of different processes in another array outside of the process, avoiding race condition entirely, so even if the synchronization is not handled in our simple OS it would still work.

Running input “sched” with 2 cpus, without mutex and with mutex, respectively:



III. RESULTS

1. Scheduling:

Take input os_sched_0 as an example, we have the following time slot table:

J22

	A	B	C	D	E	F	G	H	I
1									
2	Process	PID	Priority	Arrival time		Burst time			
3	s0	1	1	0		15			
4	s1	2	3	4		7			
5									
6	Time	0	1	2	3	4	5	6	7
7	PID		1				1		
8					1				
9									
10	Time	8	9	10	11	12	13	14	15
11	PID	1			1				
12			1				1		
13									
14	Time	16	17	18	19	20	21	22	23
15	PID	2				2			**
16		*		2					
17									
18		*Process with PID 1 has stopped							
19		**Process with PID 2 has stopped							

2. Memory management:

At the end of each time slot, we add a line title RAM to show the status of the RAM after each time slot, only meaningful value will be shown (value different from 0).

```
----------------------------------------------------------
-
Time slot   0
ld_routine
    Loaded a process at input/proc/p0s, PID: 1 PRIO: 0
RAM:
    CPU 0: Dispatched process  1

----------------------------------------------------------
-
Time slot   1

----------------------------------------------------------
-
```

```
Time slot   2
    Loaded a process at input/proc/p1s, PID: 2 PRIO: 15
RAM:

------------------------------------------------------------
-
Time slot   3
    CPU 1: Dispatched process  2
    Loaded a process at input/proc/p1s, PID: 3 PRIO: 0
RAM:

------------------------------------------------------------
-
Time slot   4
    Loaded a process at input/proc/p1s, PID: 4 PRIO: 0
RAM:

------------------------------------------------------------
-
Time slot   5
write region=1 offset=20 value=100
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004

------------------------------------------------------------
-
Time slot   6
    CPU 0: Put process  1 to run queue
    CPU 0: Dispatched process  3

------------------------------------------------------------
-
Time slot   7

------------------------------------------------------------
-
Time slot   8

------------------------------------------------------------
```

```
-
Time slot   9
    CPU 1: Put process  2 to run queue
    CPU 1: Dispatched process  4

-------------------------------------------------------------
-
Time slot  10

-------------------------------------------------------------
-
Time slot  11

-------------------------------------------------------------
-
Time slot  12
    CPU 0: Put process  3 to run queue
    CPU 0: Dispatched process  1
read region=1 offset=20 value=100
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004
RAM content: 100
-------------------------------------------------------------
-
Time slot  13
write region=2 offset=20 value=102
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004
RAM content: 100
-------------------------------------------------------------
-
Time slot  14
read region=2 offset=20 value=102
print_pgtbl: 0 - 1280
00000000: 80000001
```

```
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004
RAM content: 102
------------------------------------------------------------
-
Time slot  15
    CPU 1: Put process  4 to run queue
    CPU 1: Dispatched process  3
write region=3 offset=20 value=103
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004
RAM content: 102
------------------------------------------------------------
-
Time slot  16
    CPU 0: Processed  1 has finished
    CPU 0: Dispatched process  4

------------------------------------------------------------
-
Time slot  17

------------------------------------------------------------
-
Time slot  18

------------------------------------------------------------
-
Time slot  19
    CPU 1: Processed  3 has finished
    CPU 1: Dispatched process  2

------------------------------------------------------------
-
Time slot  20
    CPU 0: Processed  4 has finished
    CPU 0 stopped
```

```
------------------------------------------------------------
-
Time slot   21

------------------------------------------------------------
-
Time slot   22

------------------------------------------------------------
-
Time slot   23
    CPU 1: Processed  2 has finished
    CPU 1 stopped

------------------------------------------------------------
-
Time slot   24
```

3. Result

Scheduling functionality test by with input “sched_0”

```
------------------------------------------------------------
Time slot   0
ld_routine
      Loaded a process at input/proc/s0, PID: 1 PRIO: 1
      CPU 1: Dispatched process  1

------------------------------------------------------------
Time slot   1

------------------------------------------------------------
Time slot   2
```

```
      CPU 1: Put process  1 to run queue
      CPU 1: Dispatched process  1

------------------------------------------------------------
Time slot   3

------------------------------------------------------------
Time slot   4
      Loaded a process at input/proc/s1, PID: 2 PRIO: 3
      CPU 0: Dispatched process  2
      CPU 1: Put process  1 to run queue
      CPU 1: Dispatched process  1

------------------------------------------------------------
Time slot   5

------------------------------------------------------------
Time slot   6
      CPU 0: Put process  2 to run queue
      CPU 0: Dispatched process  2
      CPU 1: Put process  1 to run queue
      CPU 1: Dispatched process  1

------------------------------------------------------------
Time slot   7

------------------------------------------------------------
Time slot   8
      CPU 0: Put process  2 to run queue
      CPU 0: Dispatched process  2
      CPU 1: Put process  1 to run queue
      CPU 1: Dispatched process  1

------------------------------------------------------------
Time slot   9

------------------------------------------------------------
Time slot  10
      CPU 0: Put process  2 to run queue
      CPU 1: Put process  1 to run queue
      CPU 1: Dispatched process  1
      CPU 0: Dispatched process  2
```

```
------------------------------------------------------------
Time slot   11
      CPU 0: Processed  2 has finished
      CPU 0 stopped

------------------------------------------------------------
Time slot   12
      CPU 1: Put process  1 to run queue
      CPU 1: Dispatched process  1

------------------------------------------------------------
Time slot   13

------------------------------------------------------------
Time slot   14
      CPU 1: Put process  1 to run queue
      CPU 1: Dispatched process  1

------------------------------------------------------------
Time slot   15
      CPU 1: Processed  1 has finished
      CPU 1 stopped

------------------------------------------------------------
Time slot   16
```

- **Paging**

  Paging functionality test result with input “os_0_mlq_paging”

```
------------------------------------------------------------
-
Time slot   0
ld_routine
      Loaded a process at input/proc/p0s, PID: 1 PRIO: 0
      CPU 0: Dispatched process  1

------------------------------------------------------------
-
Time slot   1
```

```
-------------------------------------------------------------
-
Time slot   2
      Loaded a process at input/proc/p1s, PID: 2 PRIO: 15

-------------------------------------------------------------
-
Time slot   3
      CPU 1: Dispatched process  2
      Loaded a process at input/proc/p1s, PID: 3 PRIO: 0

-------------------------------------------------------------
-
Time slot   4
      Loaded a process at input/proc/p1s, PID: 4 PRIO: 0

-------------------------------------------------------------
-
Time slot   5
write region=1 offset=20 value=100
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004

-------------------------------------------------------------
-
Time slot   6
      CPU 0: Put process  1 to run queue
      CPU 0: Dispatched process  3

-------------------------------------------------------------
-
Time slot   7

-------------------------------------------------------------
-
Time slot   8

-------------------------------------------------------------
-
```

```
Time slot   9
      CPU 1: Put process  2 to run queue
      CPU 1: Dispatched process  4

------------------------------------------------------------
-
Time slot  10

------------------------------------------------------------
-
Time slot  11

------------------------------------------------------------
-
Time slot  12
      CPU 0: Put process  3 to run queue
      CPU 0: Dispatched process  1
read region=1 offset=20 value=100
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004

------------------------------------------------------------
-
Time slot  13
write region=2 offset=20 value=102
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004

------------------------------------------------------------
-
Time slot  14
read region=2 offset=20 value=102
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
```

```
00000008: 80000003
00000012: 80000003
00000016: 80000004

------------------------------------------------------------
-
Time slot  15
write region=3 offset=20 value=103
print_pgtbl: 0 - 1280
00000000: 80000001
00000004: 80000001
00000008: 80000003
00000012: 80000003
00000016: 80000004
      CPU 1: Put process  4 to run queue
      CPU 1: Dispatched process  3

------------------------------------------------------------
-
Time slot  16
      CPU 0: Processed  1 has finished
      CPU 0: Dispatched process  4

------------------------------------------------------------
-
Time slot  17

------------------------------------------------------------
-
Time slot  18

------------------------------------------------------------
-
Time slot  19
      CPU 1: Processed  3 has finished
      CPU 1: Dispatched process  2

------------------------------------------------------------
-
Time slot  20
      CPU 0: Processed  4 has finished
      CPU 0 stopped
```

```
------------------------------------------------------------
-
Time slot  21

------------------------------------------------------------
-
Time slot  22

------------------------------------------------------------
-
Time slot  23
      CPU 1: Processed  2 has finished
      CPU 1 stopped

------------------------------------------------------------
-
Time slot  24
```

IV. REFERENCES

1. *"Operating System Concepts and Design" by Milan Milenkovic*
2. *“operating-system-concepts-10th-Copy” by Peter Baer Galvin*