

Embedded OS Implementation, Fall 2021

Project #1 (due Nov. 10, 2021 (Wednesday) 13:00)

[PART I] Task Control Block Linked List

Objective:

Following the previous homework (HW1), please add some code to the μ C/OS-II scheduler in the kernel level to observe the operations of the task control block (TCB) and TCB linked list.

※ The TCB address is dynamic.

The output results are shown below:

```
OSTick    created, Thread ID 22576
Task[ 63] created, TCB Address 009BF640
-----After TCB[63] being linked-----
Previous TCB point to address 00000000
Current  TCB point to address 009BF640
Next     TCB point to address 00000000

Task[  1] created, TCB Address 009BF698
-----After TCB[1] being linked-----
Previous TCB point to address 00000000
Current  TCB point to address 009BF698
Next     TCB point to address 009BF640

Task[  2] created, TCB Address 009BF6F0
-----After TCB[2] being linked-----
Previous TCB point to address 00000000
Current  TCB point to address 009BF6F0
Next     TCB point to address 009BF698

===== TCB linked list =====
Task   Prev_TCB_addr  TCB_addr  Next_TCB_addr
2      00000000        009BF6F0   009BF698
1      009BF6F0        009BF698   009BF640
63     009BF698        009BF640   00000000
```

[PART II] RM Scheduler Implementation

Objective:

To implement the Rate Monotonic (RM) scheduler for periodic tasks and observe the scheduling behaviors.

Problem Definition:

Implement the following three task sets of periodic tasks. Add necessary code to the μ C/OS-II scheduler in the kernel level to observe how the task suffers from the scheduler. We give the files for the parameter of the task.

Periodic Task Set = $\{\tau_{ID} (ID, \text{arrival time}, \text{execution time}, \text{period})\}$

Example Task Set 1 = $\{\tau_1 (1, 0, 2, 4), \tau_2 (2, 0, 3, 8)\}$

Example Task Set 2 = $\{\tau_1 (1, 0, 6, 15), \tau_2 (2, 0, 3, 6)\}$

Example Task Set 3 = $\{\tau_1 (1, 1, 1, 5), \tau_2 (2, 0, 8, 15), \tau_3 (3, 2, 2, 10)\}$

※ The priority of the task is set according to the RM scheduling rules.

The input file format:

Task ID	Arrive Time	Execution Time	Task Periodic
##	##	##	##

Example of task set file 1:

TaskSet.txt - Notepad				
File	Edit	Format	View	Help
1	0	2	4	
2	0	3	8	

Evaluation:

The output format:

Tick	Event	CurrentTask ID	NextTask ID	Response Time	# of ContextSwitch	Preemption Time
##	Preemption	task(ID)(job number)	task(ID)(job number)			
##	Completion	task(ID)(job number)	task(ID)(job number)	##	##	##
##	MissDeadline	task(ID)(job number)	-----			

✂ If the task is Idle Task, print “*task(priority)*”.

The output results of Task Set 1:

TaskSet 1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$\tau_1(1, 0, 2, 4)$	0				1					2				3				4			5				6				7		
$\tau_2(2, 0, 3, 8)$	0									1								2							3						
Result(RM)	0	0		1		0			2	1		3	1		4	2		5	2		6	3			7						

Tick	Event	CurrentTask ID	NextTask ID	ResponseTime	# of ContextSwitch	PreemptionTime
2	Completion	task(1)(0)	task(2)(0)	2	1	0
4	Preemption	task(2)(0)	task(1)(1)			
6	Completion	task(1)(1)	task(2)(0)	2	2	0
7	Completion	task(2)(0)	task(63)	7	4	2
8	Preemption	task(63)	task(1)(2)			
10	Completion	task(1)(2)	task(2)(1)	2	2	0
12	Preemption	task(2)(1)	task(1)(3)			
14	Completion	task(1)(3)	task(2)(1)	2	2	0
15	Completion	task(2)(1)	task(63)	7	4	2
16	Preemption	task(63)	task(1)(4)			
18	Completion	task(1)(4)	task(2)(2)	2	2	0
20	Preemption	task(2)(2)	task(1)(5)			
22	Completion	task(1)(5)	task(2)(2)	2	2	0
23	Completion	task(2)(2)	task(63)	7	4	2
24	Preemption	task(63)	task(1)(6)			
26	Completion	task(1)(6)	task(2)(3)	2	2	0
28	Preemption	task(2)(3)	task(1)(7)			
30	Completion	task(1)(7)	task(2)(3)	2	2	0

The output results of Task Set 2:

TaskSet 2	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$\tau_1(1, 0, 6, 15)$	0																1														
$\tau_2(2, 0, 3, 6)$	0							1						2						3						4					
Result(RM)	0			0			1			0			2			1			3			1			4						

Tick	Event	CurrentTask ID	NextTask ID	ResponseTime	# of ContextSwitch	PreemptionTime
3	Completion	task(2)(0)	task(1)(0)	3	1	0
6	Preemption	task(1)(0)	task(2)(1)			
9	Completion	task(2)(1)	task(1)(0)	3	2	0
12	Completion	task(1)(0)	task(2)(2)	12	4	3
15	Completion	task(2)(2)	task(1)(1)	3	2	0
18	Preemption	task(1)(1)	task(2)(3)			
21	Completion	task(2)(3)	task(1)(1)	3	2	0
24	Completion	task(1)(1)	task(2)(4)	9	4	3
27	Completion	task(2)(4)	task(63)	3	2	0
30	Preemption	task(63)	task(2)(5)			

The output results of Task Set 3:

TaskSet 3	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$\tau_1(1, 1, 1, 5)$			0					1					2					3					4						5		
$\tau_2(2, 0, 8, 15)$	0																1														
$\tau_3(3, 2, 2, 10)$			0										1										2								
Result(RM)	0	0	0		0		1	0				2	1		0	1	3	1				4	2		1		5	1			

Tick	Event	CurrentTask ID	NextTask ID	ResponseTime	# of ContextSwitch	PreemptionTime
1	Preemption	task(2)(0)	task(1)(0)			
2	Completion	task(1)(0)	task(3)(0)	1	2	0
4	Completion	task(3)(0)	task(2)(0)	2	2	0
6	Preemption	task(2)(0)	task(1)(1)			
7	Completion	task(1)(1)	task(2)(0)	1	2	0
11	Preemption	task(2)(0)	task(1)(2)			
12	Completion	task(1)(2)	task(3)(1)	1	2	0
14	Completion	task(3)(1)	task(2)(0)	2	2	0
15	Completion	task(2)(0)	task(2)(1)	15	6	7
16	Preemption	task(2)(1)	task(1)(3)			
17	Completion	task(1)(3)	task(2)(1)	1	2	0
21	Preemption	task(2)(1)	task(1)(4)			
22	Completion	task(1)(4)	task(3)(2)	1	2	0
24	Completion	task(3)(2)	task(2)(1)	2	2	0
26	Preemption	task(2)(1)	task(1)(5)			
27	Completion	task(1)(5)	task(2)(1)	1	2	0
28	Completion	task(2)(1)	task(63)	13	7	5
30	Preemption	task(63)	task(2)(2)			

[Bonus] Miss Deadline Handling

Objective:

Implement the RM scheduler for periodic tasks, and handle the miss deadline behaviors.

Problem Definition:

Implement and describe how to handle the deadline missing situation under RM.

Example Task Set 4 = $\{\tau_1(1, 1, 2, 6), \tau_2(2, 0, 6, 15), \tau_3(3, 2, 3, 10)\}$

✂ The priority of the task is set according to the RM scheduling rules.

Credit:

[PART I] Task Control Block Linked List [20%]

- The screenshot results. (10%)
- A report that describes your implementation (please attach the screenshot of the code and **MARK** the modified part). (10%)

[PART II] RM Scheduler Implementation [80%]

- The correctness of schedule results of examples. Note the testing task set might not be the same as the given example task set. (40%)
- A report that describes your implementation (please attach the screenshot of the code and **MARK** the modified part). (40%)

[Bonus I] Miss Deadline Handling [10%]

- The correctness of schedule results of examples. Note the testing task set might not be the same as the given example task set. (5%)
- Implement and describe how to handle the deadline missing situation under RM. (5%)

※ **You must modify the source code!**

※ **Standard input and output filenames in the project are necessary for the checker. Please check the file names before submitting.**

```
#define INPUT_FILE_NAME "./TaskSet.txt"
#define OUTPUT_FILE_NAME "./Output.txt"
```

※ **Please set the system end time as 30 seconds in this project.**

```
#define SYSTEM_END_TIME 30
```

※ **We will use **different task sets** to verification your code.**

※ **When the current task is completed, the completion information shall be printed even there is one task missing its deadline.**

Project submit:

Submit to Moodle.

Submit deadline: Nov. 10, 2021 (Wednesday) 13:00

File name format: RTOS_Myyyddxxx_PA1.zip

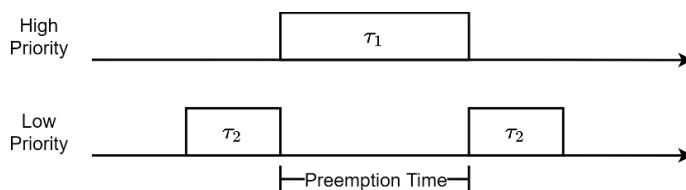
RTOS_Myyyddxxx_PA1.zip includes (The tree structure of files is shown as hints):

- The report (RTOS_Myyyddxxx_PA1.pdf).
- Folder with the executable μ C/OS-II project (RTOS_Myyyddxxx_PA1).

※ Plagiarizing is strictly prohibited.

Hints:

1. Preemption time is introduced in multiple tasking.



2. If your project size is too large for uploading, you can try to delete the “.vs” or the “Debug” folders.

<< Micrium_Win32_Kernel > Microsoft > Windows > Kernel > OS2 > VS				
Name	Date modified	Type	Size	
.vs	10/25/2021 4:01 PM	File folder		
Debug	10/25/2021 4:01 PM	File folder		
OS2.sln	9/29/2017 1:57 PM	Visual Studio Solu...	2 KB	
OS2.vcxproj	10/25/2021 4:01 PM	VC++ Project	10 KB	
OS2.vcxproj.filters	9/1/2017 2:33 PM	VC++ Project Filte...	10 KB	
OS2.vcxproj.user	9/1/2017 2:33 PM	Per-User Project O...	1 KB	

3. RTOS_Myyyddxxx_PA1.zip include files as follow:

```
C:.\
|  RTOS_Myyyddxxx_PA1.pdf
|
|---RTOS_Myyyddxxx_PA1
|   |  ReadMe.txt
|   |
|   |---Micrium
|   |   |---Software
|   |   |   |---uC-CPU
|   |   |   |   |  cpu_cache.h
|   |   |   |   |  cpu_core.c
|   |   |   |   |  cpu_core.h
|   |   |   |   |  cpu_def.h
|   |   |   |   |
|   |   |   |   |---Win32
|   |   |   |   |   |---Visual_Studio
|   |   |   |   |   |   |  cpu.h
|   |   |   |   |   |   |  cpu_c.c
|   |   |   |   |
|   |   |   |---uC-LIB
|   |   |   |   |  lib_ascii.c
|   |   |   |   |  lib_ascii.h
|   |   |   |   |  lib_def.h
|   |   |   |   |  lib_math.c
|   |   |   |   |  lib_math.h
|   |   |   |   |  lib_mem.c
|   |   |   |   |  lib_mem.h
|   |   |   |   |  lib_str.c
|   |   |   |   |  lib_str.h
|   |   |   |
|   |   |   |---uCOS-II
|   |   |   |   |---Ports
|   |   |   |   |   |---Win32
|   |   |   |   |   |   |---Visual Studio
|   |   |   |   |   |   |   |  os_cpu.h
|   |   |   |   |   |   |   |  os_cpu_c.c
|   |   |   |   |
|   |   |   |   |---Source
|   |   |   |   |   |  os.h
|   |   |   |   |   |  os_cfg_r.h
|   |   |   |   |   |  os_core.c
|   |   |   |   |   |  os_dbg_r.c
|   |   |   |   |   |  os_flag.c
|   |   |   |   |   |  os_mbox.c
|   |   |   |   |   |  os_mem.c
|   |   |   |   |   |  os_mutex.c
|   |   |   |   |   |  os_q.c
|   |   |   |   |   |  os_sem.c
|   |   |   |   |   |  os_task.c
|   |   |   |   |   |  os_time.c
|   |   |   |   |   |  os_tmr.c
|   |   |   |   |   |  os_trace.h
|   |   |   |   |   |  ucos_ii.c
|   |   |   |   |   |  ucos_ii.h
```

```
|---Microsoft
|   |---BSP
|   |   |---Windows
|   |   |   |  bsp_cpu.c
|   |   |
|   |   |---Windows
|   |   |   |---Kernel
|   |   |   |   |  app_cfg.h
|   |   |   |   |  cpu_cfg.h
|   |   |   |   |  lib_cfg.h
|   |   |   |
|   |   |   |---OS2
|   |   |   |   |  app_hooks.c
|   |   |   |   |  main.c
|   |   |   |   |  os_cfg.h
|   |   |   |
|   |   |   |---VS
|   |   |   |   |  OS2.sln
|   |   |   |   |  OS2.vcxproj
|   |   |   |   |  OS2.vcxproj.filters
|   |   |   |   |  OS2.vcxproj.user
```