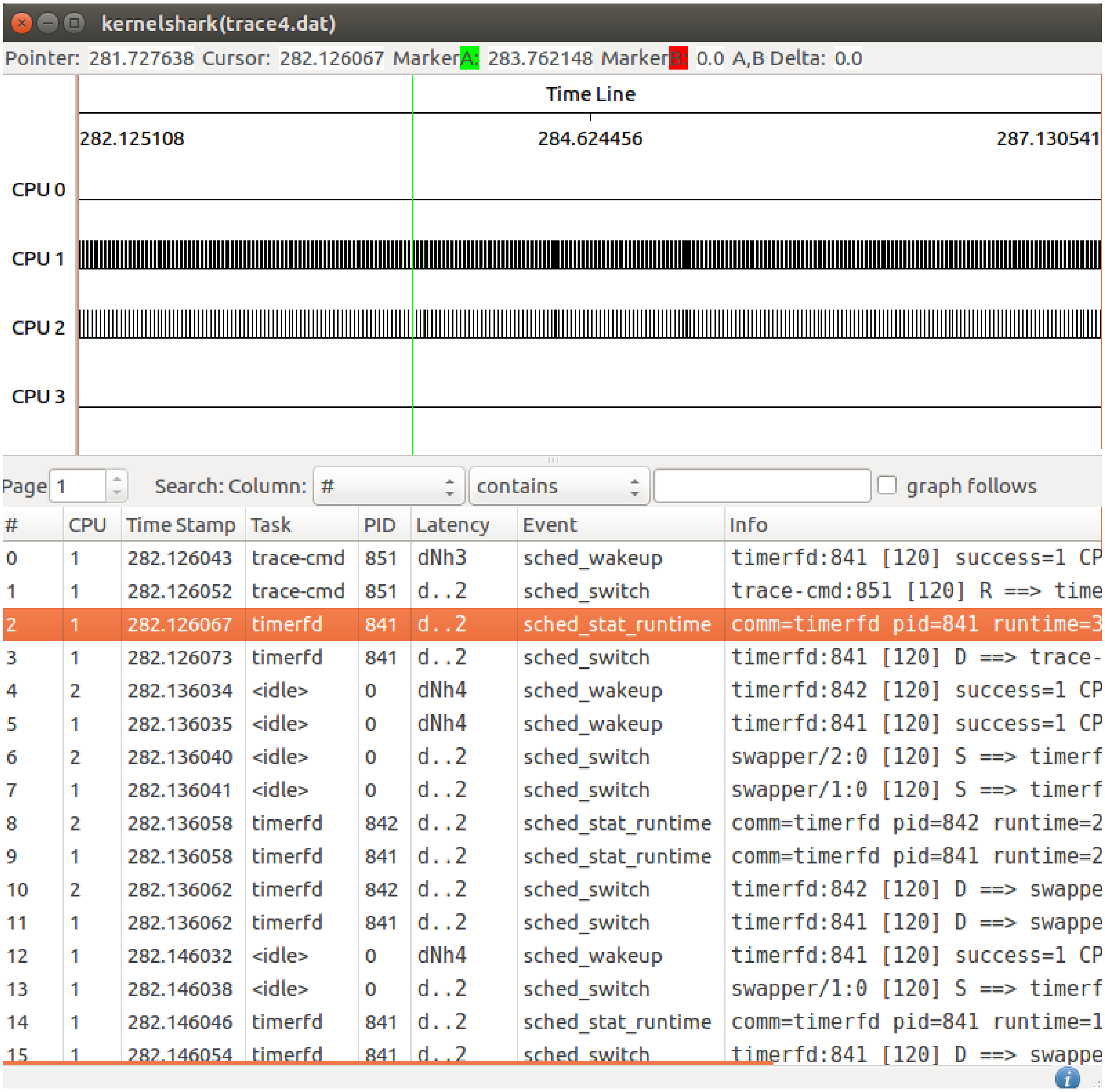
EE255 Real-Time Embedded Systems
HW Project #2 Writeup

Team05 (Jinwei Zhang & Uriel Escobar)

4.6.1. Screenshots of trace of sample application *timerfd* in kernelshark tool.



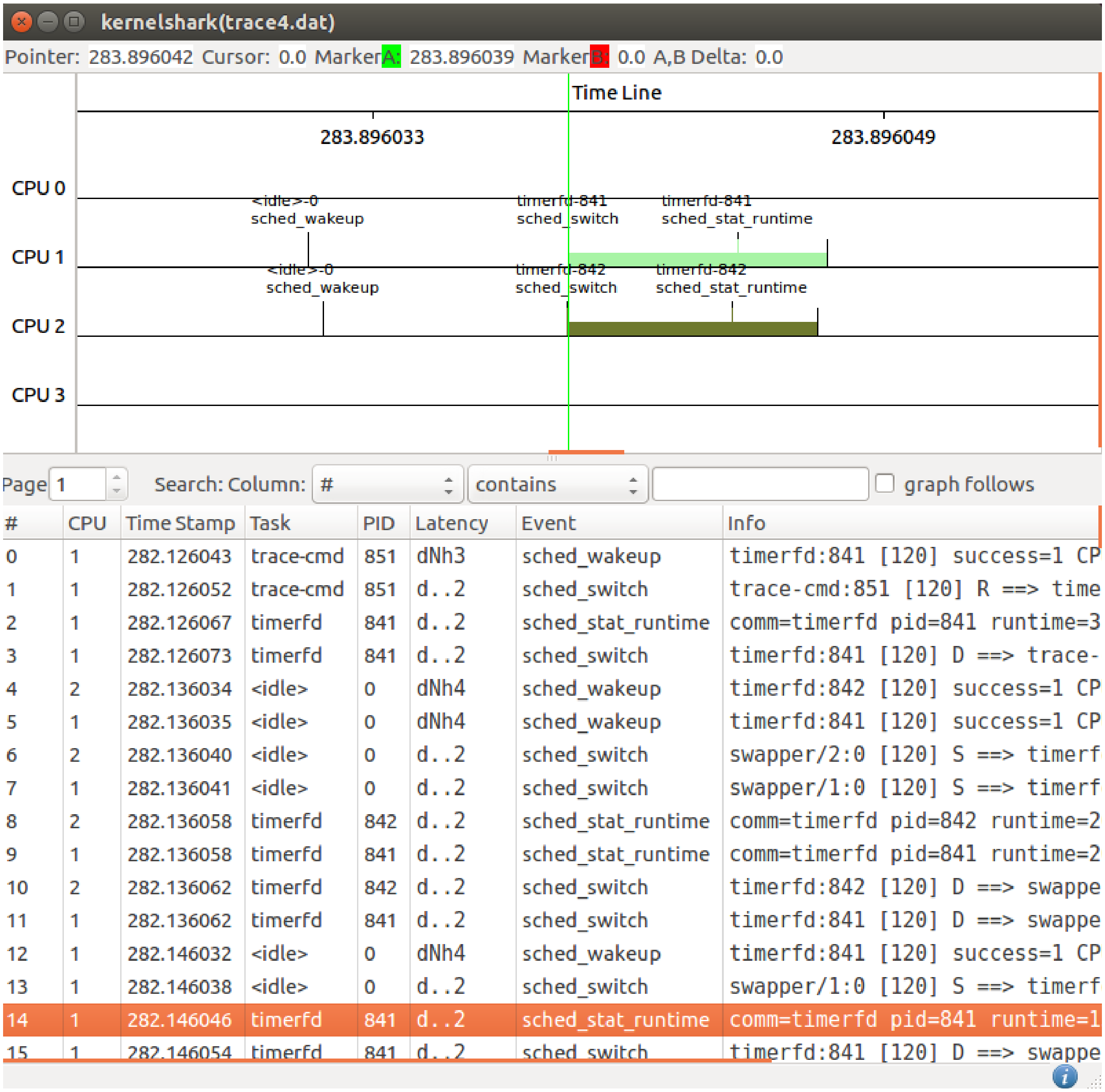
kernelshark(trace4.dat)

Pointer: 281.727638 Cursor: 282.126067 MarkerA: 283.762148 MarkerB: 0.0 A,B Delta: 0.0

Page 1 Search: Column: # contains □ graph follows

#	CPU	Time Stamp	Task	PID	Latency	Event	Info
0	1	282.126043	trace-cmd	851	dNh3	sched_wakeup	timerfd:841 [120] success=1 CP
1	1	282.126052	trace-cmd	851	d..2	sched_switch	trace-cmd:851 [120] R ==> time
2	1	282.126067	timerfd	841	d..2	sched_stat_runtime	comm=timerfd pid=841 runtime=3
3	1	282.126073	timerfd	841	d..2	sched_switch	timerfd:841 [120] D ==> trace-
4	2	282.136034	<idle>	0	dNh4	sched_wakeup	timerfd:842 [120] success=1 CP
5	1	282.136035	<idle>	0	dNh4	sched_wakeup	timerfd:841 [120] success=1 CP
6	2	282.136040	<idle>	0	d..2	sched_switch	swapper/2:0 [120] S ==> timerf
7	1	282.136041	<idle>	0	d..2	sched_switch	swapper/1:0 [120] S ==> timerf
8	2	282.136058	timerfd	842	d..2	sched_stat_runtime	comm=timerfd pid=842 runtime=2
9	1	282.136058	timerfd	841	d..2	sched_stat_runtime	comm=timerfd pid=841 runtime=2
10	2	282.136062	timerfd	842	d..2	sched_switch	timerfd:842 [120] D ==> swappe
11	1	282.136062	timerfd	841	d..2	sched_switch	timerfd:841 [120] D ==> swappe
12	1	282.146032	<idle>	0	dNh4	sched_wakeup	timerfd:841 [120] success=1 CP
13	1	282.146038	<idle>	0	d..2	sched_switch	swapper/1:0 [120] S ==> timerf
14	1	282.146046	timerfd	841	d..2	sched_stat_runtime	comm=timerfd pid=841 runtime=1
15	1	282.146054	timerfd	841	d..2	sched_switch	timerfd:841 [120] D ==> swappe

When room in into the execution section of the sample application,



Pointer: 283.896042 Cursor: 0.0 Marker A: 283.896039 Marker B: 0.0 A,B Delta: 0.0

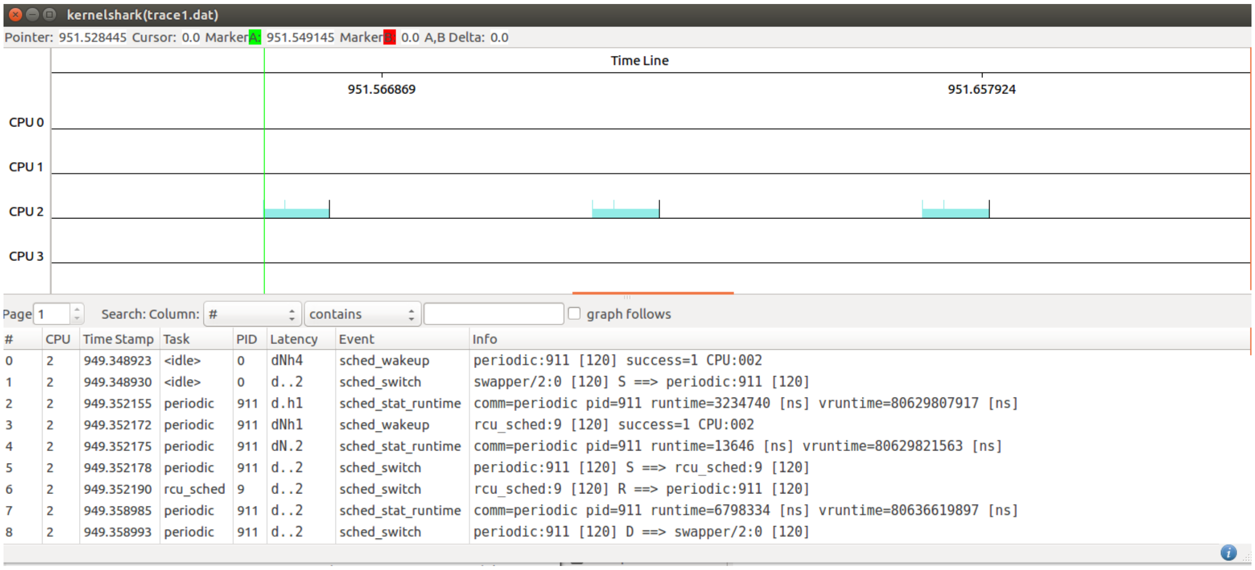
Page 1 Search: Column: # contains ☐ graph follows

#	CPU	Time Stamp	Task	PID	Latency	Event	Info
0	1	282.126043	trace-cmd	851	dNh3	sched_wakeup	timerfd:841 [120] success=1 CP
1	1	282.126052	trace-cmd	851	d..2	sched_switch	trace-cmd:851 [120] R ==> time
2	1	282.126067	timerfd	841	d..2	sched_stat_runtime	comm=timerfd pid=841 runtime=3
3	1	282.126073	timerfd	841	d..2	sched_switch	timerfd:841 [120] D ==> trace-
4	2	282.136034	<idle>	0	dNh4	sched_wakeup	timerfd:842 [120] success=1 CP
5	1	282.136035	<idle>	0	dNh4	sched_wakeup	timerfd:841 [120] success=1 CP
6	2	282.136040	<idle>	0	d..2	sched_switch	swapper/2:0 [120] S ==> timerf
7	1	282.136041	<idle>	0	d..2	sched_switch	swapper/1:0 [120] S ==> timerf
8	2	282.136058	timerfd	842	d..2	sched_stat_runtime	comm=timerfd pid=842 runtime=2
9	1	282.136058	timerfd	841	d..2	sched_stat_runtime	comm=timerfd pid=841 runtime=2
10	2	282.136062	timerfd	842	d..2	sched_switch	timerfd:842 [120] D ==> swappe
11	1	282.136062	timerfd	841	d..2	sched_switch	timerfd:841 [120] D ==> swappe
12	1	282.146032	<idle>	0	dNh4	sched_wakeup	timerfd:841 [120] success=1 CP
13	1	282.146038	<idle>	0	d..2	sched_switch	swapper/1:0 [120] S ==> timerf
14	1	282.146046	timerfd	841	d..2	sched_stat_runtime	comm=timerfd pid=841 runtime=1
15	1	282.146054	timerfd	841	d..2	sched_switch	timerfd:841 [120] D ==> swappe

4.6.2. Below are the screenshots of the traces of our periodic program (periodic.c) from kernelshark.

Instance 1):

CPUID	PID	Start exe time/ period (sec)	End exe time/ period (sec)	End time of Period (sec)	Execution time C (ms)	Period T (ms)
2	911	951.548928	951.558955	951.598928	10	50



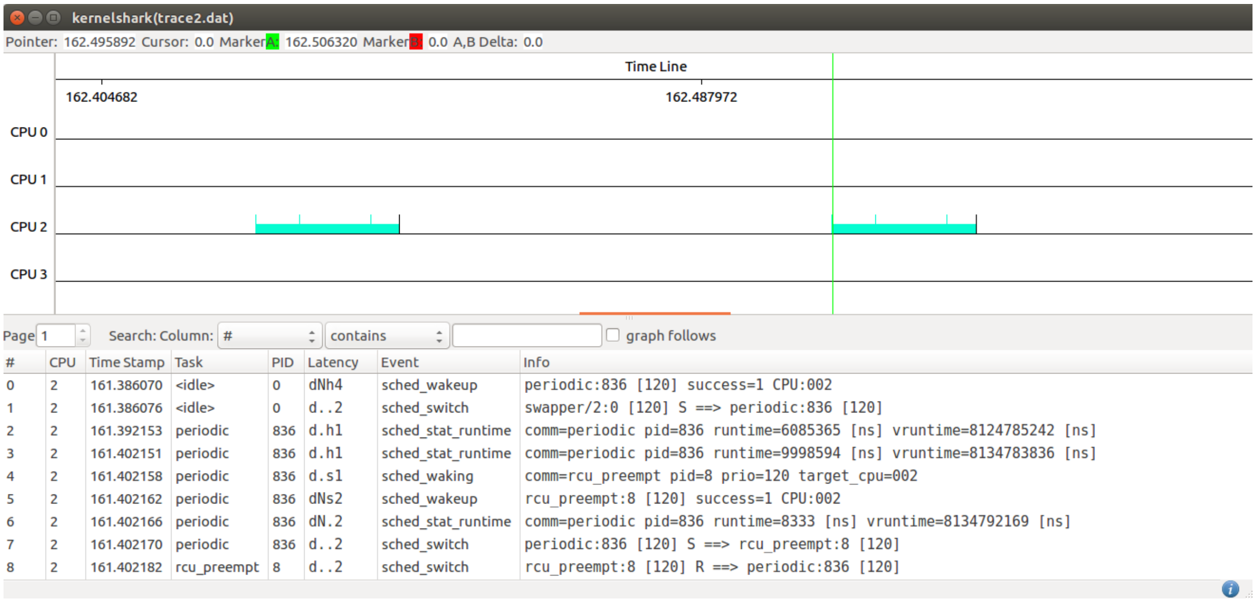
Pointer: 951.528445 Cursor: 0.0 MarkerA: 951.549145 MarkerB: 0.0 A,B Delta: 0.0

Page 1 Search: Column: # contains □ graph follows

#	CPU	Time Stamp	Task	PID	Latency	Event	Info
0	2	949.348923	<idle>	0	dNh4	sched_wakeup	periodic:911 [120] success=1 CPU:002
1	2	949.348930	<idle>	0	d..2	sched_switch	swapper/2:0 [120] S ==> periodic:911 [120]
2	2	949.352155	periodic	911	d.h1	sched_stat_runtime	comm=periodic pid=911 runtime=3234740 [ns] vruntime=80629807917 [ns]
3	2	949.352172	periodic	911	dNh1	sched_wakeup	rcu_sched:9 [120] success=1 CPU:002
4	2	949.352175	periodic	911	dN.2	sched_stat_runtime	comm=periodic pid=911 runtime=13646 [ns] vruntime=80629821563 [ns]
5	2	949.352178	periodic	911	d..2	sched_switch	periodic:911 [120] S ==> rcu_sched:9 [120]
6	2	949.352190	rcu_sched	9	d..2	sched_switch	rcu_sched:9 [120] R ==> periodic:911 [120]
7	2	949.358985	periodic	911	d..2	sched_stat_runtime	comm=periodic pid=911 runtime=6798334 [ns] vruntime=80636619897 [ns]
8	2	949.358993	periodic	911	d..2	sched_switch	periodic:911 [120] D ==> swapper/2:0 [120]

Instance 2):

CPUID	PID	Start exe time/ period (sec)	End exe time/ period (sec)	End time of Period (sec)	Execution time C (ms)	Period T (ms)
2	836	162.426076	162.446114	162.5060	20	80



kernelshark(trace2.dat)

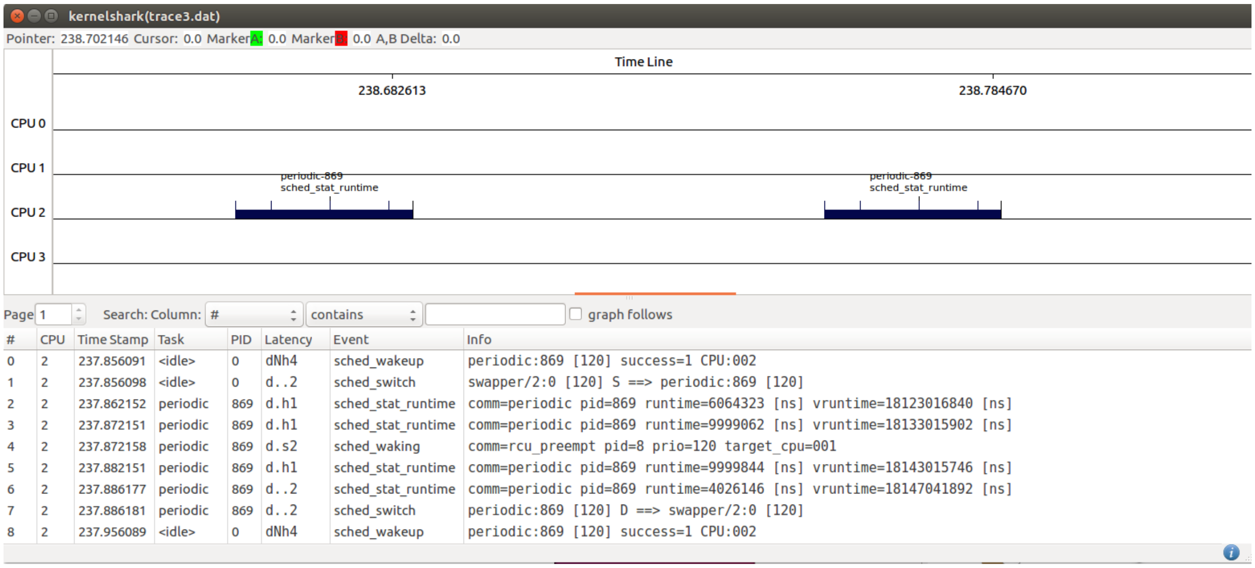
Pointer: 162.495892 Cursor: 0.0 MarkerA: 162.506320 MarkerB: 0.0 A,B Delta: 0.0

Page 1 Search: Column: # contains □ graph follows

#	CPU	Time Stamp	Task	PID	Latency	Event	Info
0	2	161.386070	<idle>	0	dNh4	sched_wakeup	periodic:836 [120] success=1 CPU:002
1	2	161.386076	<idle>	0	d..2	sched_switch	swapper/2:0 [120] S ==> periodic:836 [120]
2	2	161.392153	periodic	836	d.h1	sched_stat_runtime	comm=periodic pid=836 runtime=6085365 [ns] vruntime=8124785242 [ns]
3	2	161.402151	periodic	836	d.h1	sched_stat_runtime	comm=periodic pid=836 runtime=9998594 [ns] vruntime=8134783836 [ns]
4	2	161.402158	periodic	836	d.s1	sched_waking	comm=rcu_preempt pid=8 prio=120 target_cpu=002
5	2	161.402162	periodic	836	dNs2	sched_wakeup	rcu_preempt:8 [120] success=1 CPU:002
6	2	161.402166	periodic	836	dN.2	sched_stat_runtime	comm=periodic pid=836 runtime=8333 [ns] vruntime=8134792169 [ns]
7	2	161.402170	periodic	836	d..2	sched_switch	periodic:836 [120] S ==> rcu_preempt:8 [120]
8	2	161.402182	rcu_preempt	8	d..2	sched_switch	rcu_preempt:8 [120] R ==> periodic:836 [120]

Instance 3):

CPUID	PID	Start exe time/ period (sec)	End exe time/ period (sec)	End time of Period (sec)	Execution time C (ms)	Period T (ms)
2	869	238.656097	238.686144	238.756097	30	100



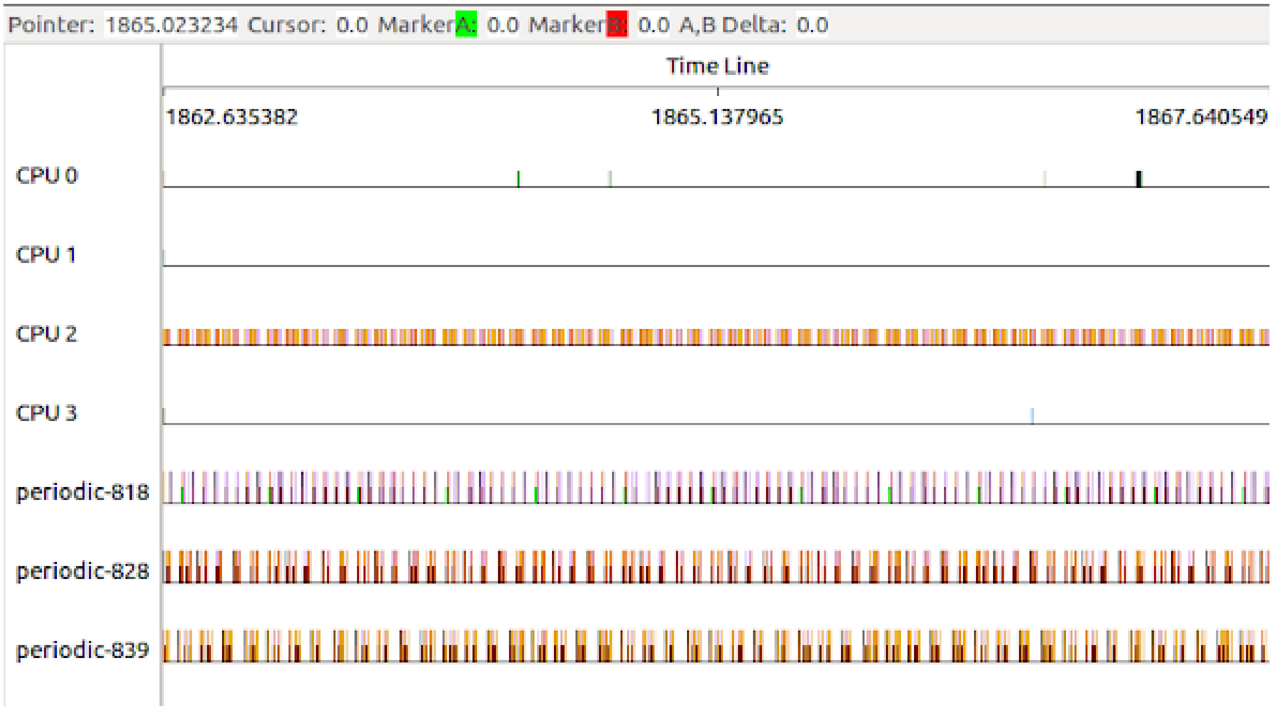
kernelshark(trace3.dat)

Pointer: 238.702146 Cursor: 0.0 MarkerA: 0.0 MarkerB: 0.0 A,B Delta: 0.0

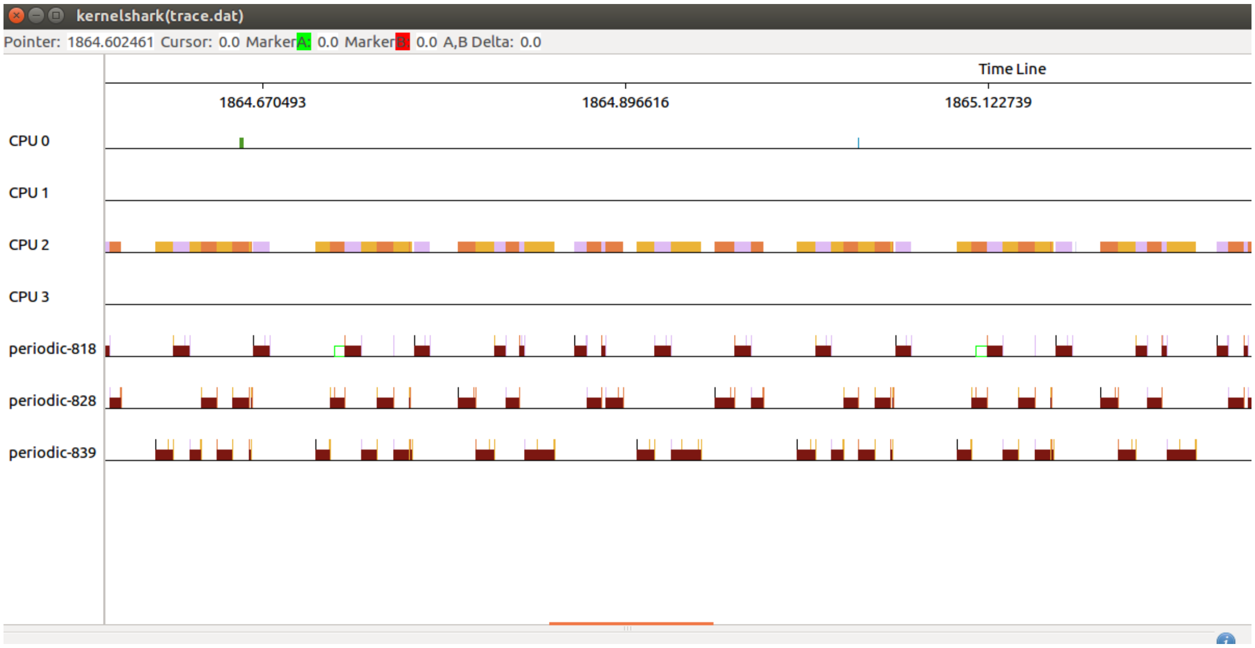
Page 1 Search: Column: # contains □ graph follows

#	CPU	Time Stamp	Task	PID	Latency	Event	Info
0	2	237.856091	<idle>	0	dNh4	sched_wakeup	periodic:869 [120] success=1 CPU:002
1	2	237.856098	<idle>	0	d..2	sched_switch	swapper/2:0 [120] S ==> periodic:869 [120]
2	2	237.862152	periodic	869	d.h1	sched_stat_runtime	comm=periodic pid=869 runtime=6064323 [ns] vruntime=18123016840 [ns]
3	2	237.872151	periodic	869	d.h1	sched_stat_runtime	comm=periodic pid=869 runtime=9999062 [ns] vruntime=18133015902 [ns]
4	2	237.872158	periodic	869	d.s2	sched_waking	comm=rcu_preempt pid=8 prio=120 target_cpu=001
5	2	237.882151	periodic	869	d.h1	sched_stat_runtime	comm=periodic pid=869 runtime=9999844 [ns] vruntime=18143015746 [ns]
6	2	237.886177	periodic	869	d..2	sched_stat_runtime	comm=periodic pid=869 runtime=4026146 [ns] vruntime=18147041892 [ns]
7	2	237.886181	periodic	869	d..2	sched_switch	periodic:869 [120] D ==> swapper/2:0 [120]
8	2	237.956089	<idle>	0	dNh4	sched_wakeup	periodic:869 [120] success=1 CPU:002

All three at same time.



Pointer: 1865.023234 Cursor: 0.0 MarkerA: 0.0 MarkerB: 0.0 A,B Delta: 0.0



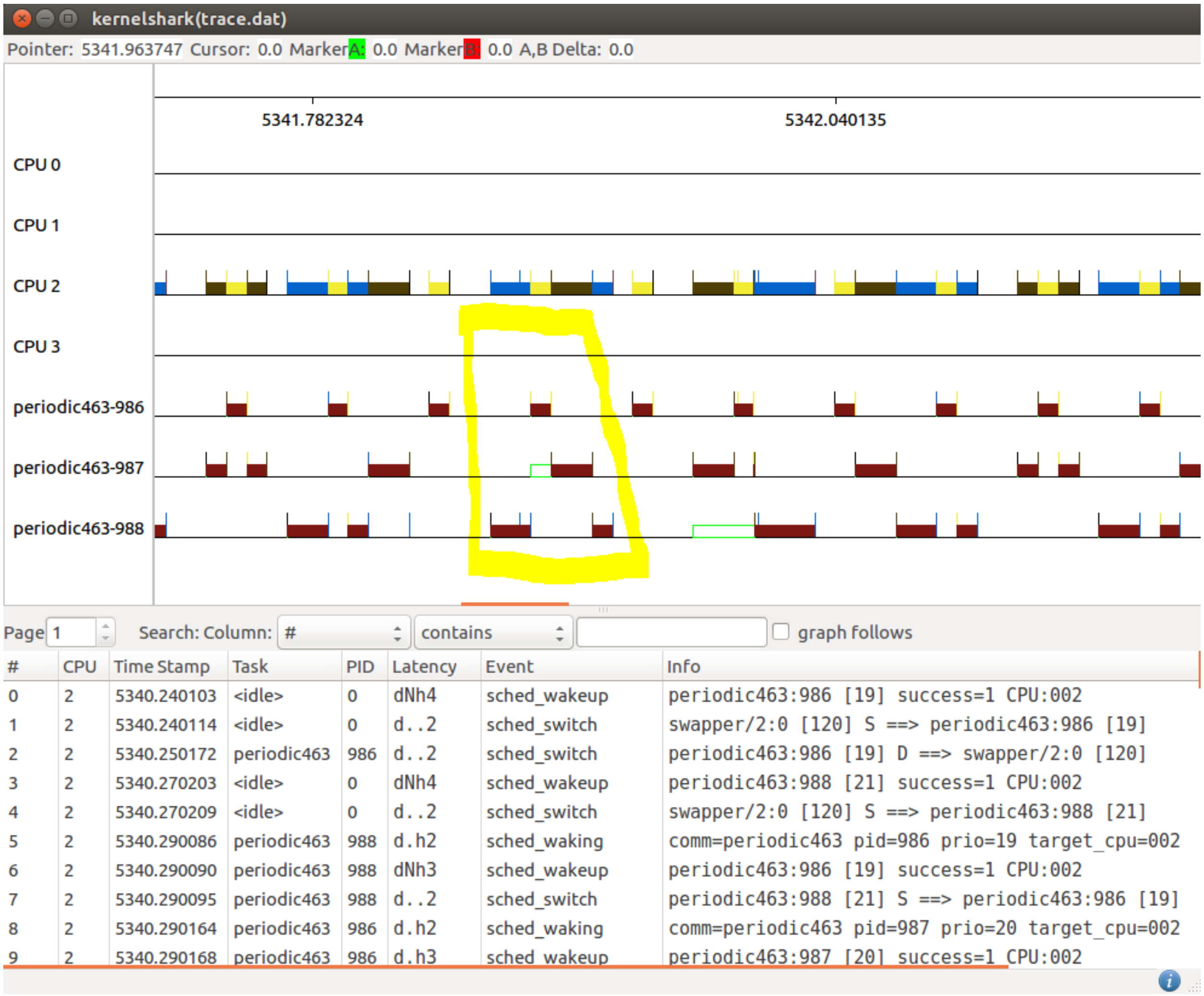
kernelshark(trace.dat)

Pointer: 1864.602461 Cursor: 0.0 MarkerA: 0.0 MarkerB: 0.0 A,B Delta: 0.0

As we can see there is a lot of process switching. It some what looks like its in a round robin fashion but not exactly. We can see that there is not priority scheduling as not one thread preempts another consistently

4.6.3 Task sets are running with real-time priorities respectively under SCHED_FIFO policy.

We can observe the preemptions among the three tasks. Task 1, 2, 3 have pid numbers of 986, 987 and 988. As demonstrated in the yellow box, the task 3 came first and has been executed firstly. In the middle of task 3, it is preempted by task 1, who has the highest priority. Task 2 arrived after task 1 started but before task 1 finished, task 2 was also preempted by task 1. Then task 1 completed and task 2 can run, while task 3 was still holding. Later when task 2 finishes task 3 can resume and run to end.



Pointer: 5341.963747 Cursor: 0.0 MarkerA: 0.0 MarkerB: 0.0 A,B Delta: 0.0

Page 1 Search: Column: # contains □ graph follows

#	CPU	Time Stamp	Task	PID	Latency	Event	Info
0	2	5340.240103	<idle>	0	dNh4	sched_wakeup	periodic463:986 [19] success=1 CPU:002
1	2	5340.240114	<idle>	0	d..2	sched_switch	swapper/2:0 [120] S ==> periodic463:986 [19]
2	2	5340.250172	periodic463	986	d..2	sched_switch	periodic463:986 [19] D ==> swapper/2:0 [120]
3	2	5340.270203	<idle>	0	dNh4	sched_wakeup	periodic463:988 [21] success=1 CPU:002
4	2	5340.270209	<idle>	0	d..2	sched_switch	swapper/2:0 [120] S ==> periodic463:988 [21]
5	2	5340.290086	periodic463	988	d.h2	sched_waking	comm=periodic463 pid=986 prio=19 target_cpu=002
6	2	5340.290090	periodic463	988	dNh3	sched_wakeup	periodic463:986 [19] success=1 CPU:002
7	2	5340.290095	periodic463	988	d..2	sched_switch	periodic463:988 [21] S ==> periodic463:986 [19]
8	2	5340.290164	periodic463	986	d.h2	sched_waking	comm=periodic463 pid=987 prio=20 target_cpu=002
9	2	5340.290168	periodic463	986	d.h3	sched_wakeup	periodic463:987 [20] success=1 CPU:002