

---

# ***Scheduling Algorithm and Analysis***

## ***Case Study (Module 37)***

*Yann-Hang Lee  
Arizona State University  
yhlee@asu.edu  
(480) 727-7507*

*Summer 2014*



# Linux Scheduling Pthread Attributes

## □ 3 scheduling classes set by `sched_setscheduler()`

- ❖ `SCHED_FIFO` and `SCHED_RR` (Round-robin) are real-time classes
- ❖ `SCHED_OTHER` is for the rest (time-sharing)

## □ *Pthread\_attr*

```
pthread_attr_init(&attr);
```

```
pthread_attr_setschedpolicy(&attr, SCHED_FIFO);
```

```
pthread_attr_getschedparam(&attr, &param);
```

```
param.sched_priority = prio;
```

```
pthread_attr_setschedparam(&attr, &param);
```

```
err = pthread_create(&thrd->handler, &attr, thread_routine, (void *)thrd);
```

## □ `Schedule()` in `kernel/sched.c` implements the scheduler and is called when

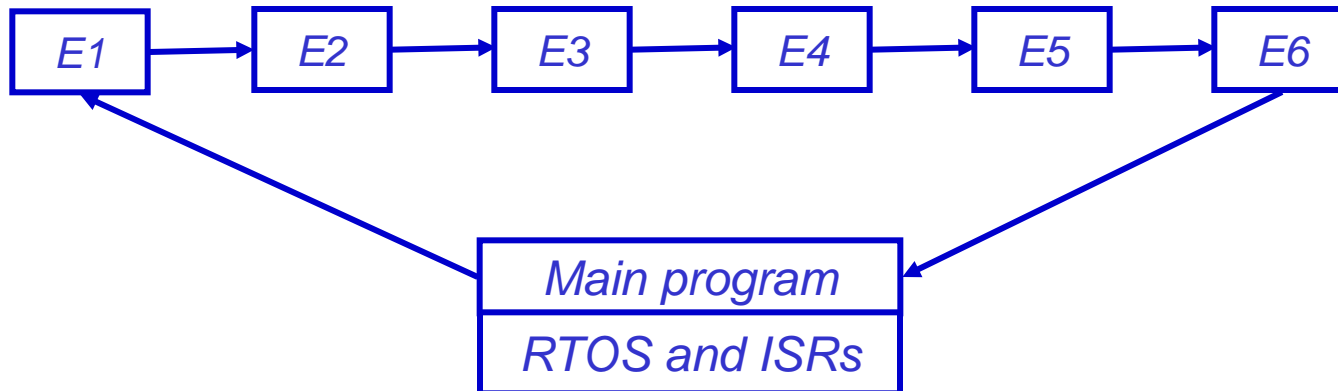
- ❖ Blocking call (sleep)
- ❖ After every `ret_from_sys_call` or interrupt if `need_resched` is on



# Case Study

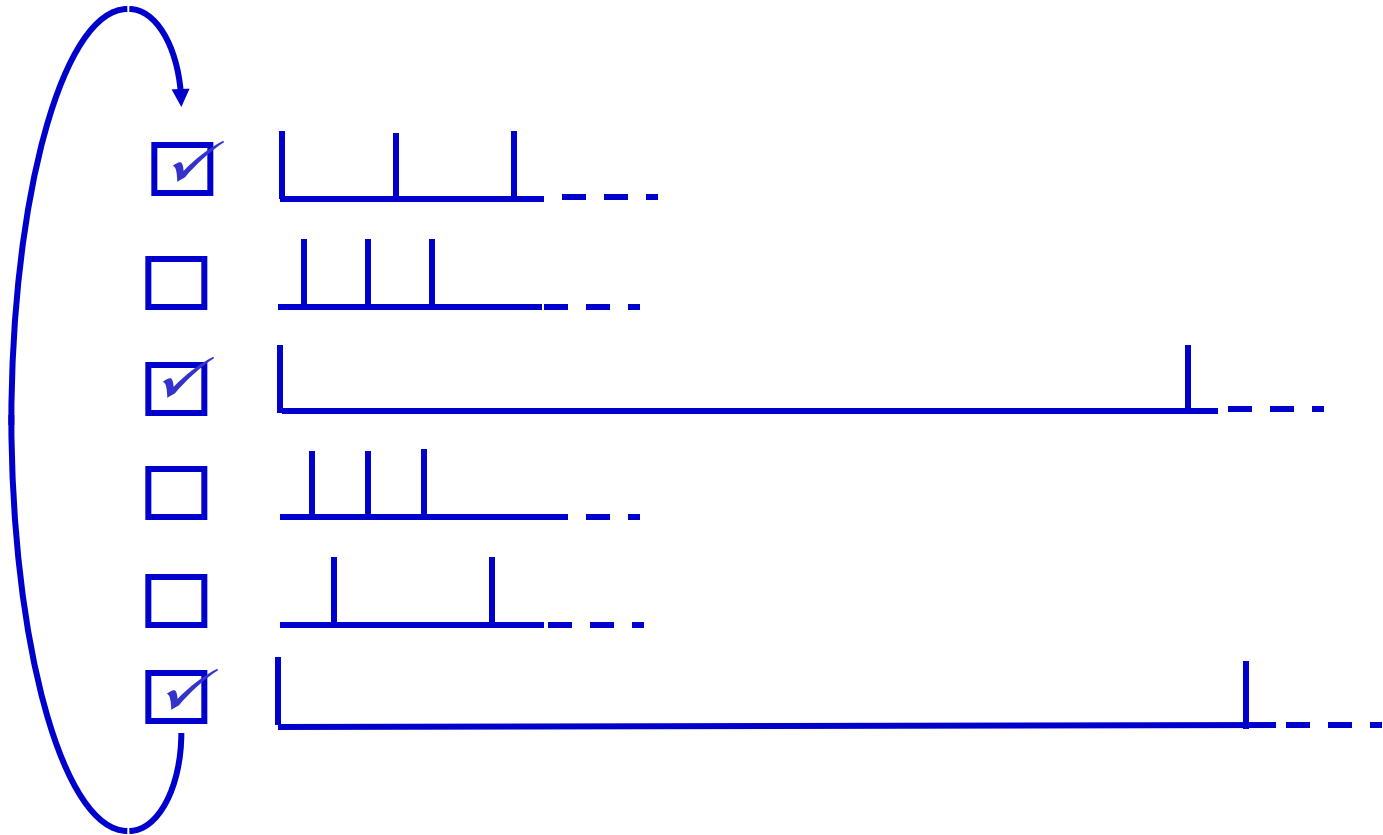
## □ The target system responds to 6 events

- ❖ each event is processed by an ISR and an application routine
- ❖ ISRs are nonpreemption and set up event ready flags
- ❖ Main program checks ready flags in round-robin manner
  - if flag is set, calls the application routing



# Scheduling Discipline

*wait for signals*



# Task Data

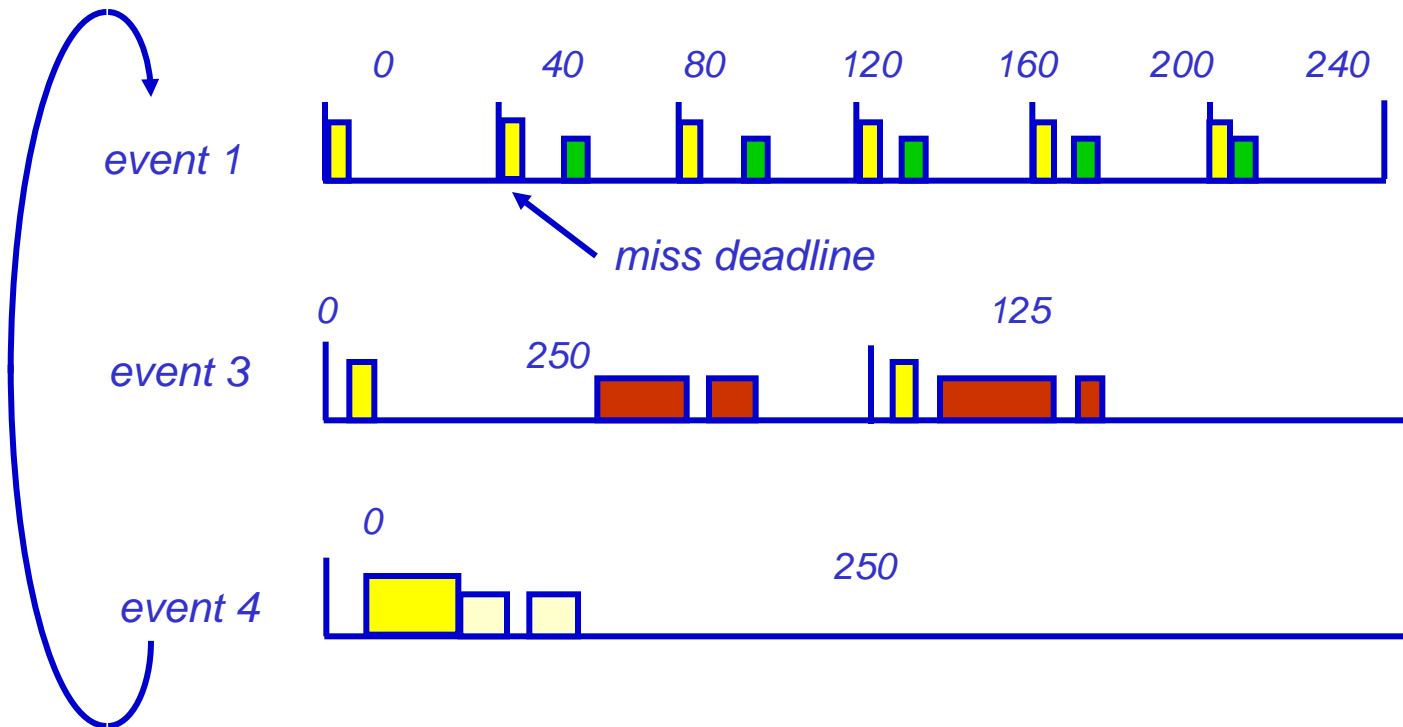
	$C_i$	$C_a$	$C$	$T$	$U$
event 1	2.0	0.5	2.5	40	0.063
event 2	7.5	8.5	16	75	0.213
event 3	6.0	0.6	6.6	125	0.053
event 4	21.0	27.0	48.0	250	0.192
event 5	5.0	24.0	29.0	1050	0.028
event 6	3.0	1.0	4.0	4000	0.001
total					0.550

□ The total utilization is only 55% in the worst-case



# A Possible Scenario

- ❑ Examine a possible scenario of event 1, 3 and 4
- ❑ The main program just checked the flag for event 3 and then three interrupts arrives



# Applying RMA in the Case Study

Event	Period	Preempt {Hn}	Execute	Preempt {H1}	total (f <sub>i</sub> )
E1a	40		0.013		
E2a	75		0.113		
E3a	125		0.005		
E4a	250	0.198	0.108	0.254	0.56
E5a	1050		0.023		
E6a	4000		0.0003		

$$E4a = \left( \frac{2.0}{40} + \frac{7.5}{75} + \frac{6}{125} \right) + \frac{27}{250} + \left( \frac{0.5 + 8.5 + 0.6 + 24 + 1 + 21 + 5 + 3}{250} \right)$$

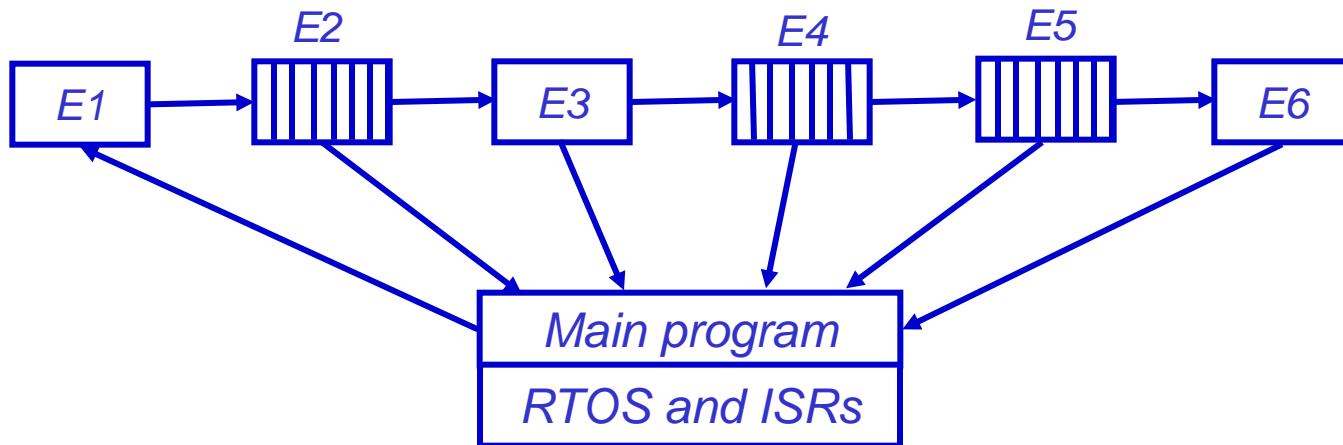
$$= 0.56$$

□ **Event 4 application is schedulable ( $f_4 < 69\%$ )**



# Improving Response Times

- ❑ **Process events in RM order**
  - ❖ go back to the main loop after completing an application routine
- ❑ **Streamlined ISR**
  - ❖ move the work done in ISR to application routines
- ❑ **Preemptable services**





# Analysis After Improvements

	$C_i$	$C_a$	$C$	$T$	$U$
event 1	2.0	0.5	2.5	40	0.063
event 2	1.5	14.5(1.7)	16	75	0.213
event 3	6.0	0.6	6.6	125	0.053
event 4	6.5	41.5(4.5)	48	250	0.192
event 5	5.0	24(3.9)	29	1050	0.028
event 6	3.0	1.0	4.0	4000	0.001
total					0.550

$$E2a \quad f_{2a} = \left( \frac{2.5}{40} \right) + \frac{14.5}{75} + \left( \frac{4.5 + 1.5 + 6.0 + 6.5 + 5 + 3.0}{75} \right) = 0.609$$

*Is it scheduable?*



---

# Supplementary Slides

