

Scheduling Algorithms (2)

Real-Time and Embedded Systems (M)

Tutorial 3

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Tutorial Outline

- Review of problem set 2
- Review of lectures
- Worked examples
- Question & answer

Review of Problem Set 2

- Question 1: A system consists of three independent, preemptable, periodic tasks: $T_1 = (3, 1)$, $T_2 = (5, 2)$, and $T_3 = (10, 3)$
 - Construct an earliest deadline first schedule of this system in the interval $[0, 30)$. Label any missed deadlines.
 - Construct a rate-monotonic schedule for this system in the interval $[0, 30)$. Label any missed deadlines.
 - Suppose we want to reduce the execution time of the task with period 3 in order to make the system schedulable according to the EDF algorithm. What is the minimum reduction needed for the system to be schedulable?

Review of Problem Set 2

- Question 2: A system contains five independent preemptable periodic tasks with utilization of $u_1 = 0.8$, $u_2 = u_3 = u_4 = u_5 = 0.01$. Can these tasks be scheduled using a rate monotonic algorithm? Explain your answer.

Review of Problem Set 2

- Question 3: Consider a system of periodic tasks $T_1 = (6, 1)$, $T_2 = (10, 2)$, and $T_3 = (18, 2)$ that are to be scheduled and executed according to a structured cyclic schedule with fixed frame size. What is an appropriate frame size?

Review of Lectures

- Aperiodic and sporadic jobs
 - Assumptions, definitions and system model
- Simple approaches
 - Background, interrupt-driven and polled execution
 - Periodic servers
- Bandwidth-preserving servers
 - Deferrable server
 - Sporadic server
 - Constant utilization servers
 - Total bandwidth servers
 - Weighted fair queuing servers
- Scheduling sporadic jobs

Key Learning Outcomes

- Understanding of how aperiodic jobs can be scheduled using a bandwidth preserving server task
- Understanding of various types of bandwidth preserving server, trade-offs in their design, schedulability of the various types of server
- Understanding of how to accept and schedule sporadic jobs

Example (1a)

- Consider a system with three periodic tasks:
 - $T_1 = (6, 1)$
 - $T_2 = (10, 1)$
 - $T_3 = (14, 3)$
- What does an EDF schedule for this system look like?

Example (1b)

- Consider a system with three periodic tasks:
 - $T_1 = (6, 1)$
 - $T_2 = (10, 1)$
 - $T_3 = (14, 3)$
- A deferrable server with period 4 and budget (execution time) 1 is added. Is the system schedulable?

Example (1c)

- Consider a system with three periodic tasks:
 - $T_1 = (6, 1)$
 - $T_2 = (10, 1)$
 - $T_3 = (14, 3)$
- A deferrable server with period 4 and budget (execution time) 1 is added. Is the system schedulable?
- An aperiodic task arrives with $r_A = 6$ and $e_A = 2$. What does the schedule look like? How does the budget of the server vary?

Example (2)

- Consider a system of three periodic tasks $T_1 = (3, 1)$, $T_2 = (4, 0.5)$ and $T_3 = (10, 2)$. The system must support three aperiodic jobs:
 - A_1 which is released at time 0.5
 - A_2 which is released at time 12.25,
 - A_3 which is released at time 17

The aperiodic jobs execute for 0.75 units of time. The system is scheduled using RM, with a simple sporadic server $T_s = (5, 0.5)$ supporting the aperiodic jobs.

- Simulate the system for sufficient time to show how the aperiodic tasks are scheduled. Calculate the response times for each of the aperiodic tasks.

Summary

- Should understand how to evaluate the schedules for various types of server
- Should understand how to demonstrate correctness of a system with aperiodic or sporadic tasks scheduled using a bandwidth preserving server
- Any Further Questions?