Problem Solving Techniques 문제해결

Jinkyu Lee

Dept. of Computer Science and Engineering,
Sungkyunkwan University (SKKU)

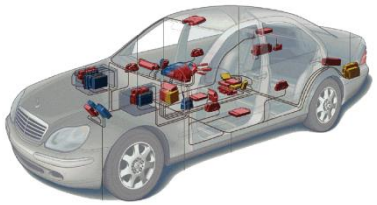
Contents

- Real-time systems
- Real-time scheduling problem

Real-time Systems

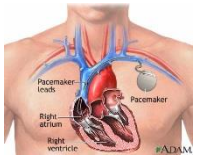
- Systems that operate with time constraints (deadlines)
  - Important to produce accurate results before deadlines

Automotive



Avionics

Medical Devices



Robots

Military

Smartphones

Multimedia

Factory Automation

Real-Time Systems

- Definition
  - Systems whose correctness depend on their temporal aspects as well as their functional aspects
- Performance measure
  - Timeliness on timing constraints (deadlines)
  - Speed/average case performance are less significant.
- Key property
  - Predictability on timing constraints

Real-time Systems

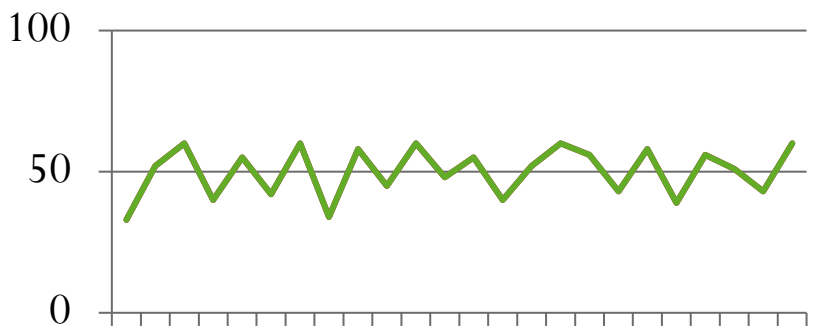
- Misconceptions about real-time systems
- Real-time ≠ fast
  - Rather predictable than fast
  - “A man drowned in a river with an average depth of 20 centimeters”

Real-time Systems

- Example

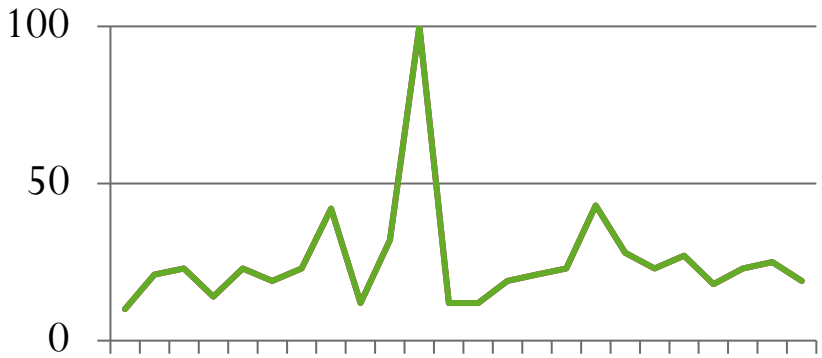
Web Server

response time (avg=50,max=60)

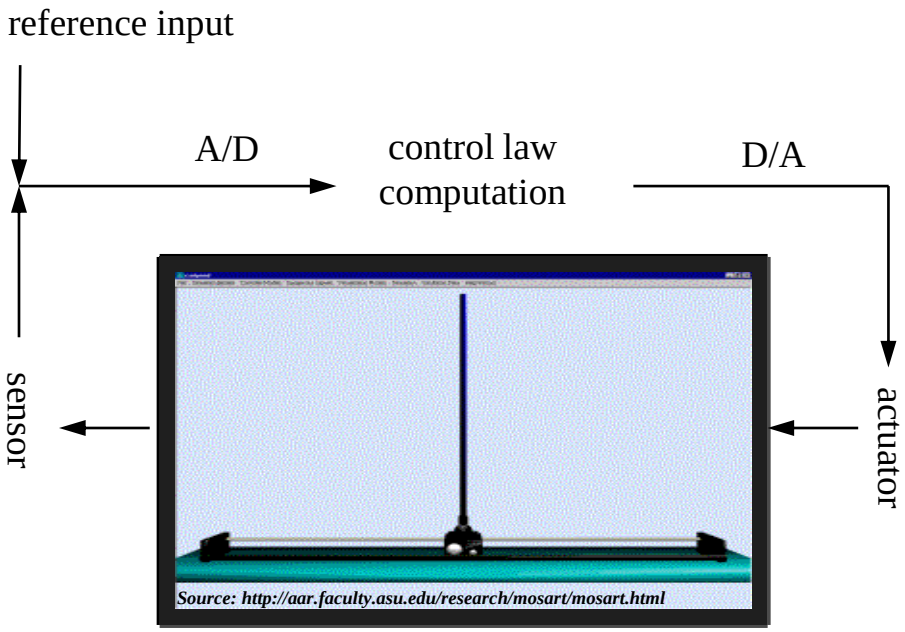


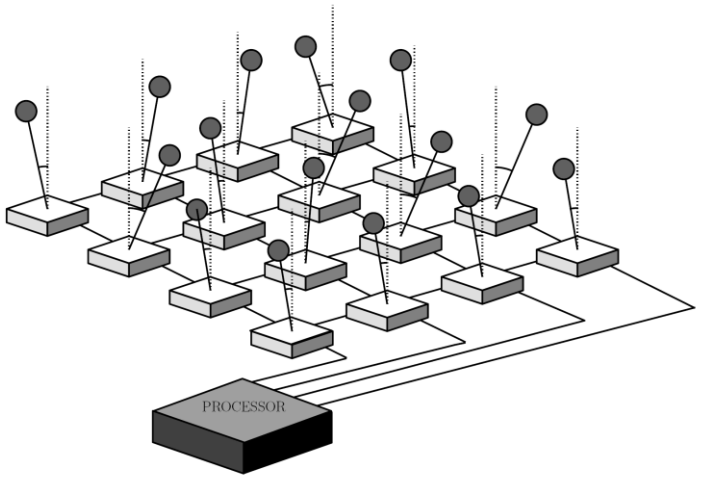
Autonomous Vehicle Driving

response time (avg=25,max=100)

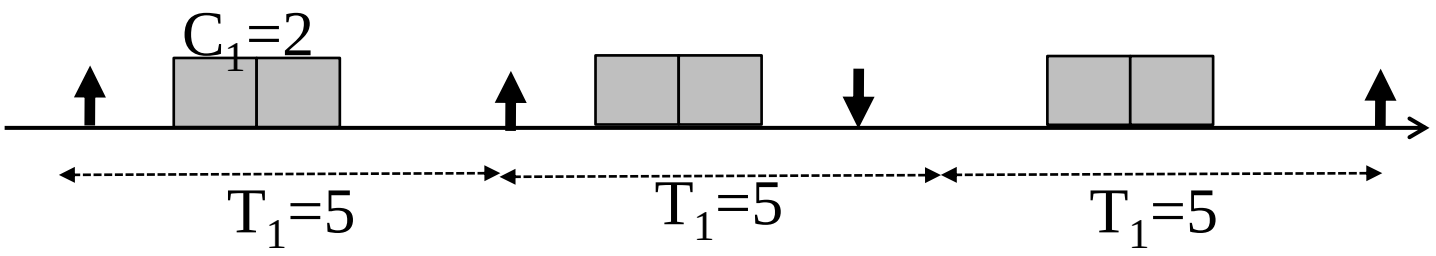


Real-Time Task



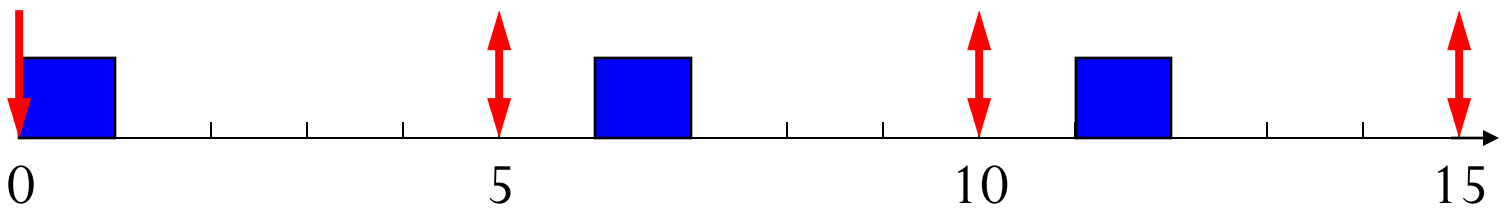


A job of Task 1



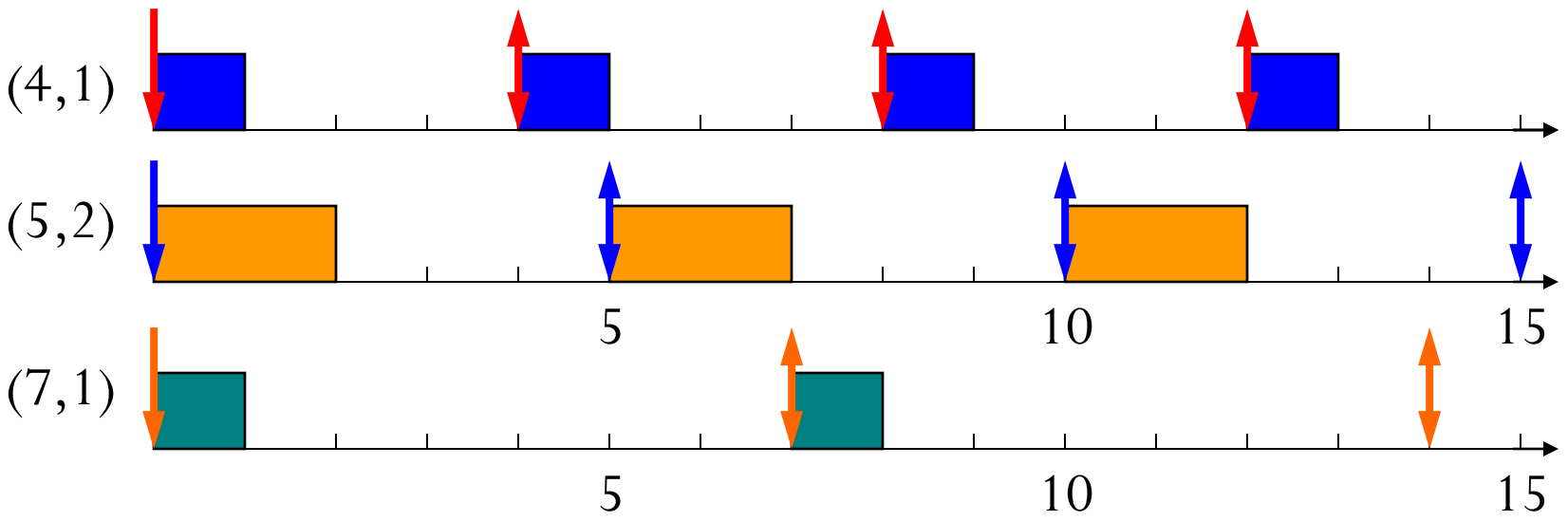
Real-Time Task

- Task : a sequence of series of jobs
  - Periodic task (T,C)
    - Its jobs repeat regularly
    - Period T = inter-release time ($0 < T$)
    - Execution time C = maximum execution time ($0 < C \leq T$)
    - Utilization U = C/T



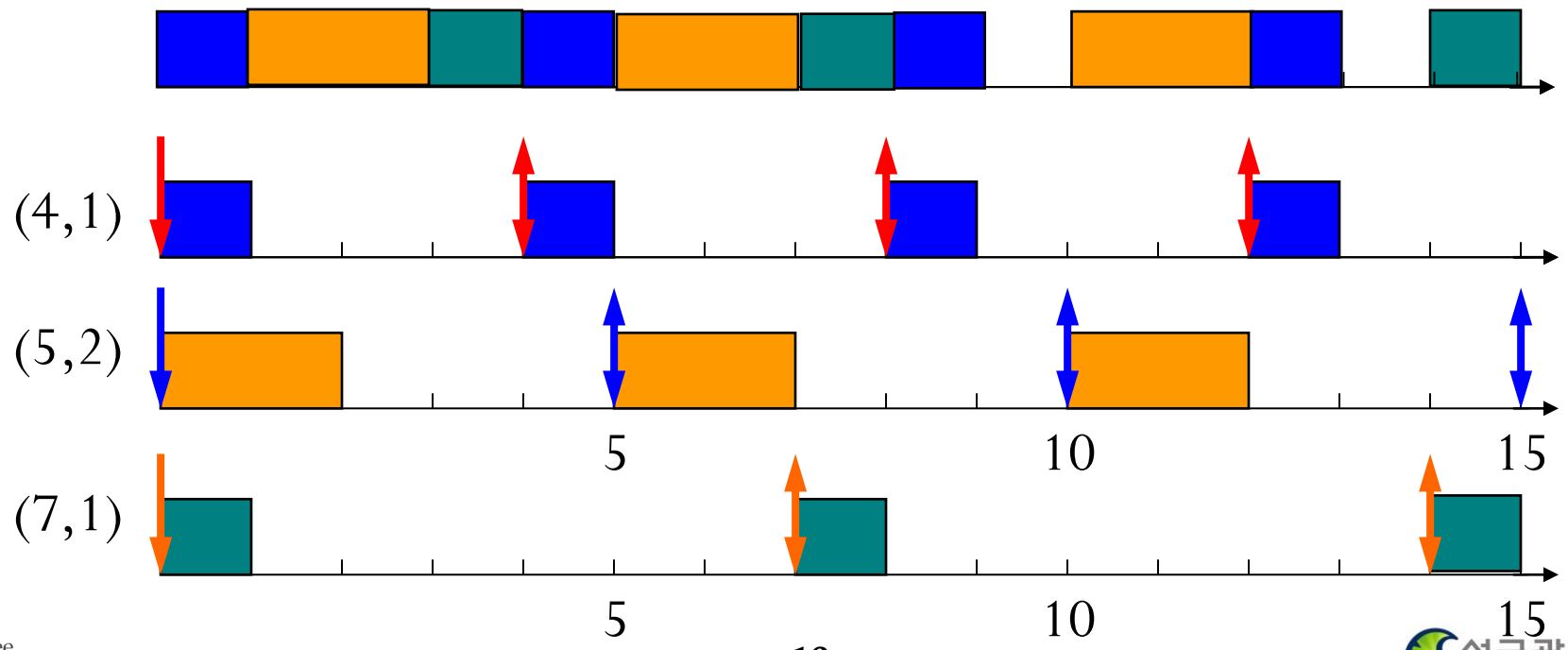
Real-Time Scheduling Problem

- You have n real-time tasks with its period and execution time.
  - For example, in the figure, you have three tasks: Task 1 with its period 4 and execution time 1, Task 2 with its period 5 and execution time 2, and Task 3 with its period 7 and execution time 1.
  - Suppose that a task with a short period has a higher priority.



Real-Time Scheduling Problem

- You have n real-time tasks with its period and execution time.
  - For example, in the figure, you have three tasks: Task 1 with its period 4 and execution time 1, Task 2 with its period 5 and execution time 2, and Task 3 with its period 7 and execution time 1.
  - Suppose that a task with a short period has a higher priority.
  - Here is a sample schedule



Real-Time Scheduling Problem

- You have n real-time tasks with its period and execution time.
  - For example, in the figure, you have three tasks: Task 1 with its period 4 and execution time 1, Task 2 with its period 5 and execution time 2, and Task 3 with its period 7 and execution time 1.
  - Suppose that a task with a short period has a higher priority.
  - Make a condition that checks whether a given task set never miss their job deadlines.

Solution: Real-Time Scheduling Problem

- Calculate the worst-case response time, the maximum duration between the release time and the completion time of each task.

- Task 1(4,1), Task 2(5,2), Task 3(7,1)
  - The worst-case response time of Task 1: 1
  - The worst-case response time of Task 2: ?
  - The worst-case response time of Task 3: ?

Solution: Real-Time Scheduling Problem

- Calculate the worst-case response time, the maximum duration between the release time and the completion time of each task.

- Task 1(4,1), Task 2(5,2), Task 3(7,1)
  - The worst-case response time of Task 1: 1
  - The worst-case response time of Task 2: ?
  - The worst-case response time of Task 3: ?

$$a_{n+1} = C_i + \sum_{j=1}^{i-1} \left\lceil \frac{a_n}{T_j} \right\rceil C_j \quad \text{where} \quad a_0 = \sum_{j=1}^{i} C_j$$

Solution: Real-Time Scheduling Problem

- Calculate the worst-case response time, the maximum duration between the release time and the completion time of each task.

- Task 1(100,40), Task 2(150,40), Task 3(350,100)
  - The worst-case response time of Task 1: 40
  - The worst-case response time of Task 2: ?
  - The worst-case response time of Task 3: ?

$$a_{n+1} = C_i + \sum_{j=1}^{i-1} \left\lceil \frac{a_n}{T_j} \right\rceil C_j \quad \text{where} \quad a_0 = \sum_{j=1}^{i} C_j$$

Solution: Real-Time Scheduling Problem

- Calculate the worst-case response time, the maximum duration between the release time and the completion time of each task.

- Task 1(100,40), Task 2(150,40), Task 3(350,100)
  - The worst-case response time of Task 1: 40
  - The worst-case response time of Task 2: 80
  - The worst-case response time of Task 3: ?

$$a_{n+1} = C_i + \sum_{j=1}^{i-1} \left\lceil \frac{a_n}{T_j} \right\rceil C_j \quad \text{where} \quad a_0 = \sum_{j=1}^{i} C_j$$