

CS 414 – Multimedia Systems Design  
Lecture 32 –  
Process Management (Part 1)

Klara Nahrstedt  
Spring 2008



# Outline

- MP4 is out, Start early
- Deadline April 30
  - Finalists will preview their solutions (grading) on April 29, 4-6pm in 0216 SC
  - All non-finalists groups will be graded on April 30 3 -5pm, 0216 SC
  - Competition will be on April 30, between 5-7, 0216 SC
  - Judged by CEO of Pavlov company, and possibly by Thompson company representative
  - Exact rules, scenarios of the competition will be posted next Monday.
- All should come, pizza and 1,2,3<sup>rd</sup> prizes of the competition will be provided between 6:30-7pm on April 30 in 0216 SC



# Real-time Processing Requirements

- Need to process continuous multimedia data
  - Processing occurs in **predetermined**, usually periodic intervals
  - Processing must be completed by certain **deadlines**
- Need RT process manager
  - Perform **admission control**
  - Determine **schedule**
  - Perform **reservation**
  - Schedule to **give processing guarantees**



# RT Processing Requirements

- Main Problem: **How to find a feasible schedule?**
- Conflicting Goals/Problems:
- **How do we schedule multimedia (RT) processes so that**
  1. non-RT processes do not starve when RT process is running
  2. RT process is not subject to priority inversion

# Model in RT Scheduling

- Task (Process) – schedulable unit

- Task characterized by

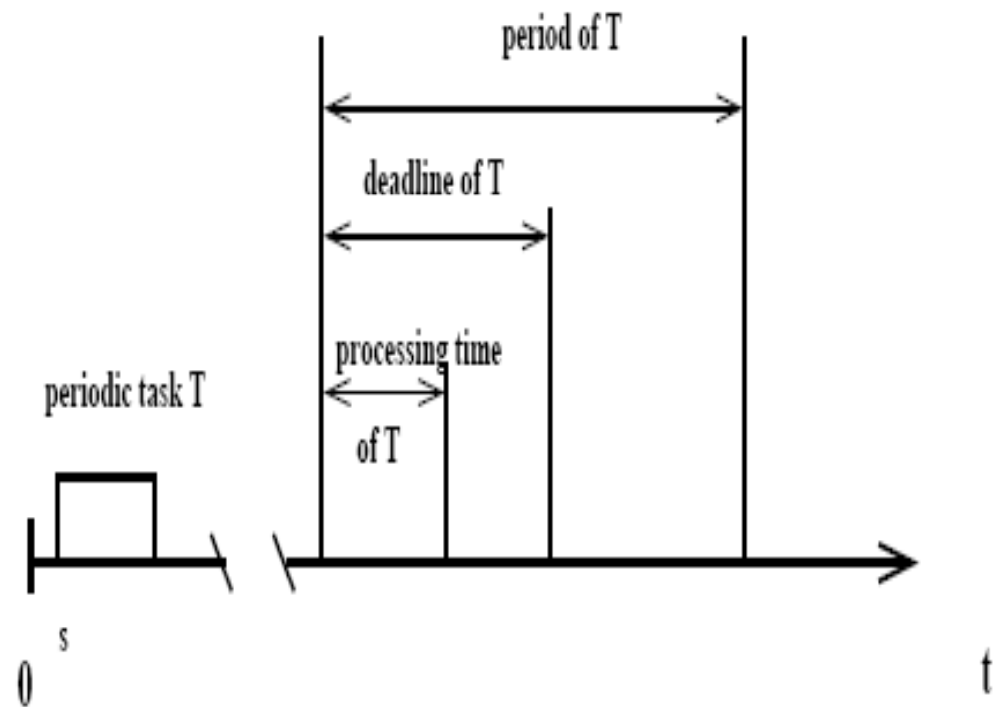
- Timing constraints**
- Resource requirements

- Assumptions

- Periodic tasks without precedence relations**

- Time constraints

- $s$  – task starting point
- $e$  – task processing time
- $d$  – task deadline
- $p$  – task period





# Model of RT Scheduling

- Congestion avoidance deadline
  - If period at  $(k-1)$  step is equal to ready (start) time of period  $k$
- Tasks: preemptive vs. non-preemptive
- Main goal of RT Scheduling:
  - find feasible schedule of all periodic tasks so that newly arriving task and all previous admitted tasks finish processing in every period according to their deadline



# Model of RT Scheduling

- Must have **Schedulability (Admission) Test** for RT tasks
- What is the performance metric for RT tasks?
  - **Guarantee ratio** := number of guaranteed tasks/total number of tasks
  - **Process utilization (U):**

$$U = \sum_{i=1}^n \frac{e_i}{p_i}$$




# Scheduling Policies of RT Tasks

- Rate- Monotonic Scheduling (RMS)
  - Designed/proved by C.L. Liu and Layland 1973
  - Policy: task with highest rate has highest priority
  - Static and optimal, priority-driven
    - **Optimal** means that there no other static algorithm that is able to schedule a RT task which can't be scheduled by RMS algorithm
    - Assumptions:
      - Tasks are periodic
      - Each task must complete before next request
      - All tasks are independent
      - Run-time of each task request is constant
      - Any non-periodic task has no required deadline



# Example of RMS

process 1:   
high priority

process 2:   
lower priority

preemptive 

non-preemptive 

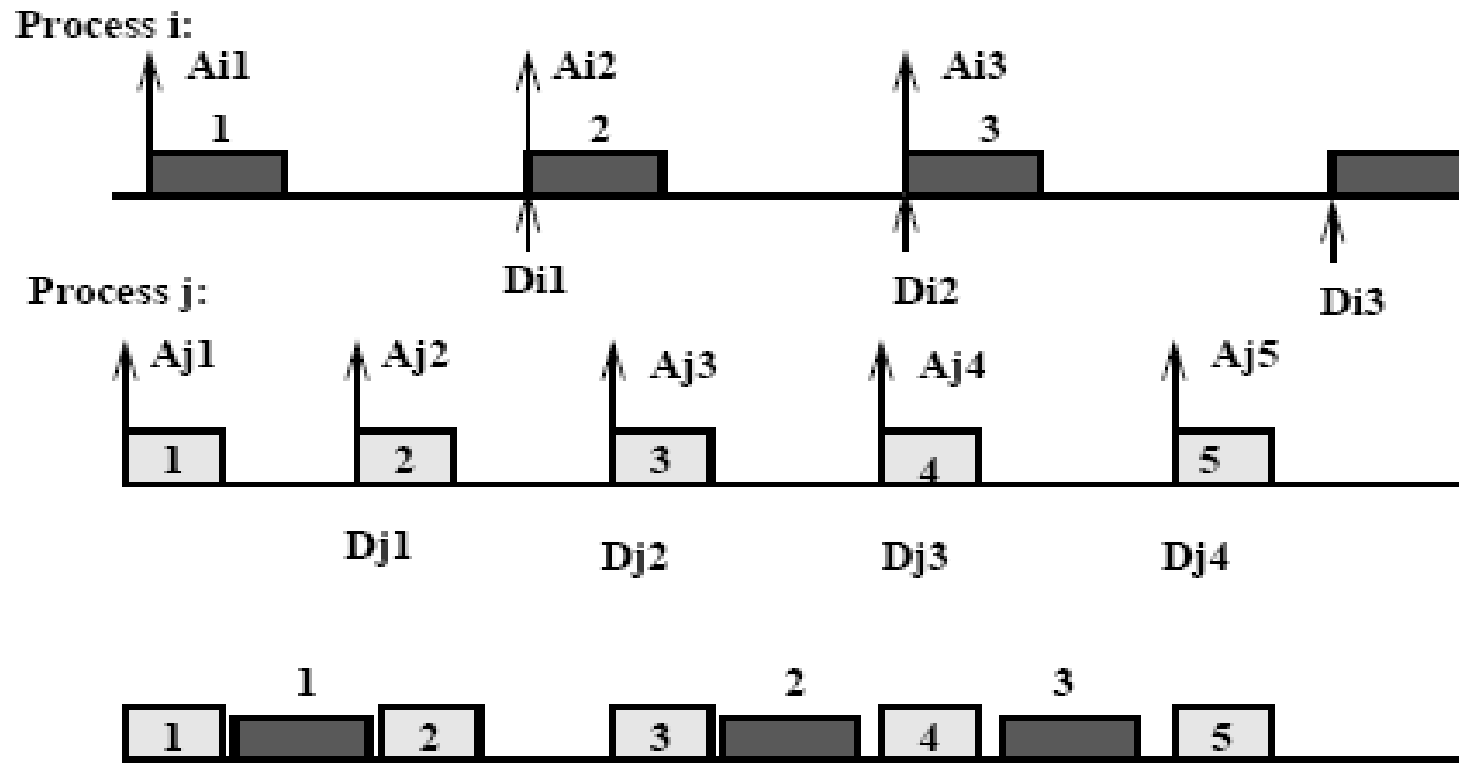
=> Relative Stream priority is fixed



# Scheduling Policies for RT Tasks

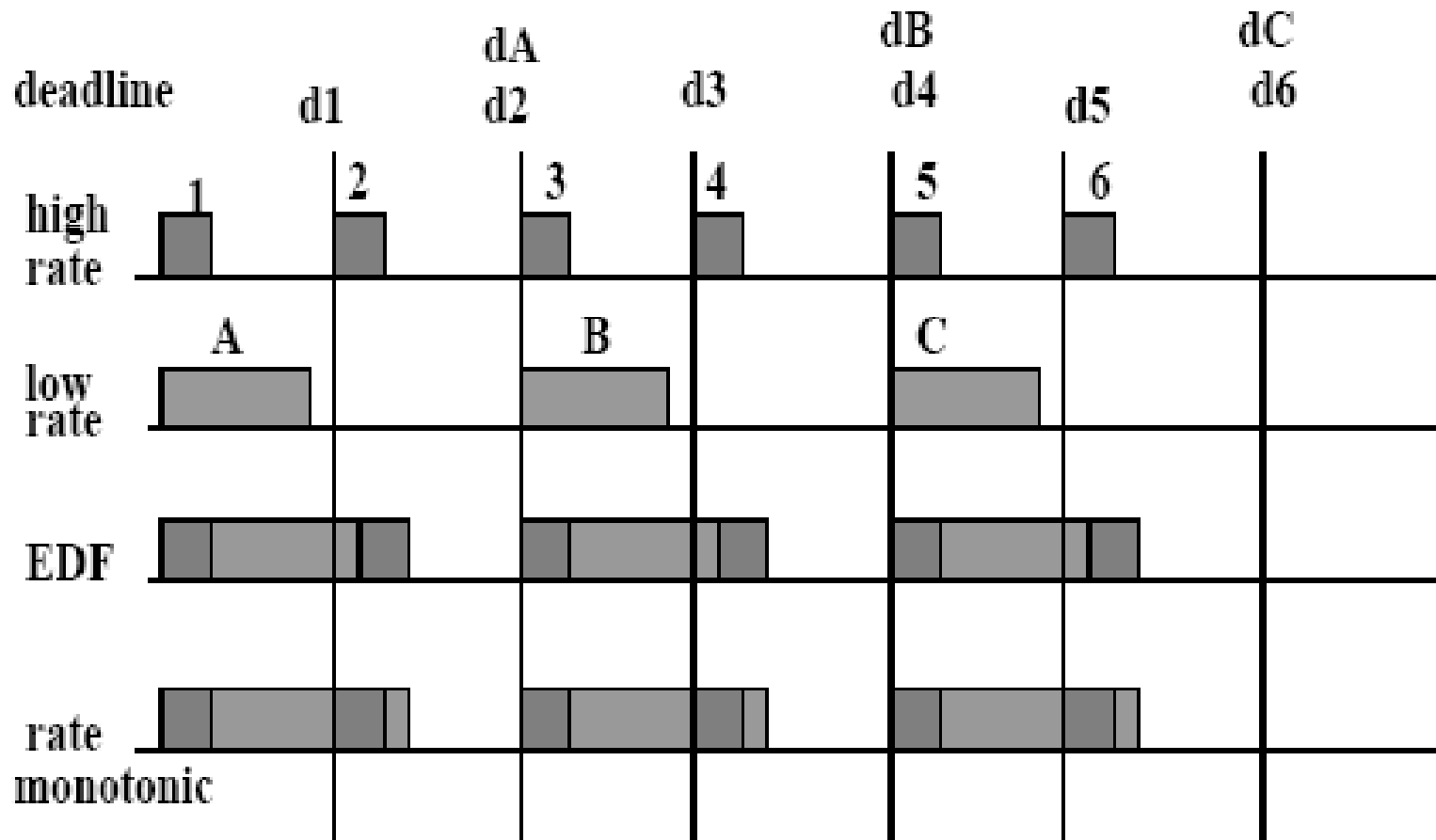
- Earliest Deadline First (EDF) Policy
  - Optimal dynamic algorithm
  - Produces valid schedule if one exists
  - Complexity  $O(n^2)$
  - Upper bound of process utilization 100%
  - Policy: task with earliest deadline has highest priority

# Example of EDF



Both streams scheduled according to their deadlines

# Comparison between RMS and EDF





# Admission Control (for preemptive tasks)

- Schedulability test for RMS

$$U \leq \ln 2 \quad \sum_{i=1}^n \frac{e_i}{p_i} \leq \ln 2$$

- Schedulability test for EDF

$$U \leq 1 \quad \sum_{i=1}^n \frac{e_i}{p_i} \leq 1$$



# Example

- Consider the following preemptive RT tasks and their characteristics
  - T1:  $p_1 = 50\text{ms}$ ,  $e_1 = 10\text{ms}$
  - T2:  $p_2 = 100\text{ms}$ ,  $e_2 = 20\text{ms}$
  - T3:  $p_3 = 200\text{ms}$ ,  $e_3 = 50\text{ms}$
  - T4:  $p_4 = 100\text{ms}$ ,  $e_4 = 20\text{ms}$
- Are these tasks schedulable via RMS?
  - If yes, what is the feasible schedule?
- Are these tasks schedulable via EDF?
  - If yes, what is the feasible schedule?



# Conclusion

- RMS and EDF are basic policies for real-time scheduling systems
- For multimedia systems, soft-real-time scheduling (SRT) concepts needed, connecting reservation-based and adaption-based SRT
- Next lecture – we look at DSRT system that shows implementation of hybrid SRT systems