Scheduling Algorithm and Analysis

EDF

(Module 28)

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Priority-Driven Scheduling of Periodic Tasks

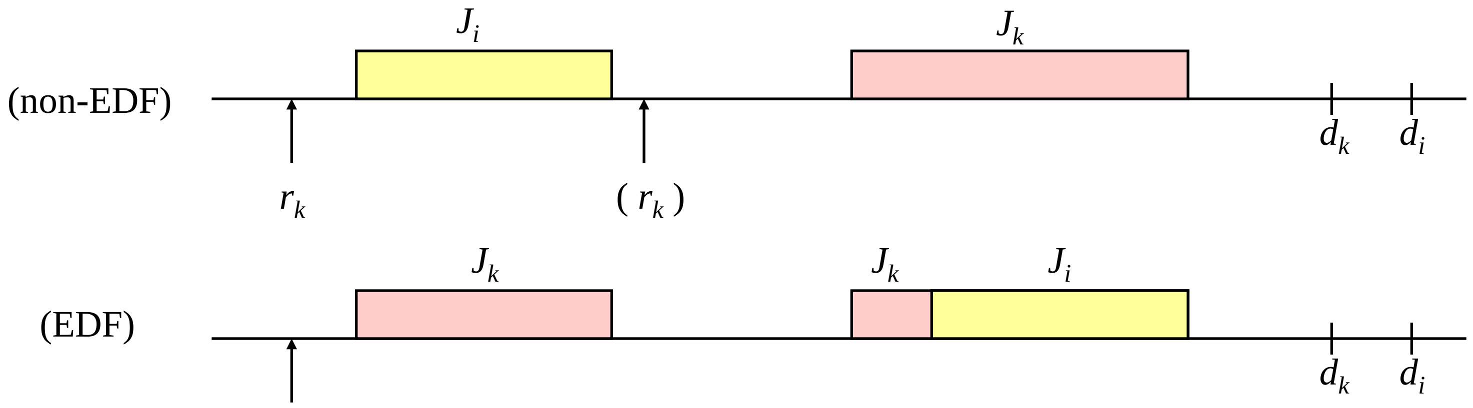
- **Why priority-driven scheduling**
  - use priority to represent urgency
  - easy implementation of scheduler (compare priorities and dispatch tasks)
  - tasks can be added or removed easily
  - no direct control of execution instance
- **How can we analyze the schedulability if we don't know when a task is to be executed**
- **Let's begin a deterministic case in one processor**
  - independent periodic tasks
  - deadline = period
  - preemptable
  - no overhead for context switch

Priority-Driven Schedules

- **Assign priority when jobs arrive**
  - static -- all jobs of a task have a fixed priority
  - dynamic -- different priorities to individual tasks of a task
  - relative priorities don't change while jobs are waiting
- **Static priority schedules**
  - Rate-monotonic -- the smaller a task period, the higher its priority
  - Deadline-monotonic – if deadline ≠ period, the smaller a task's deadline (relative), the higher its priority
- **Dynamic priority schedules**
  - EDF -- earliest deadline (absolute) first
- **Schedulable utilization:**
  - a scheduling algorithm can feasibly schedule any sets of priority tasks if the total utilization is equal to or less than the schedulable utilization of the algorithm

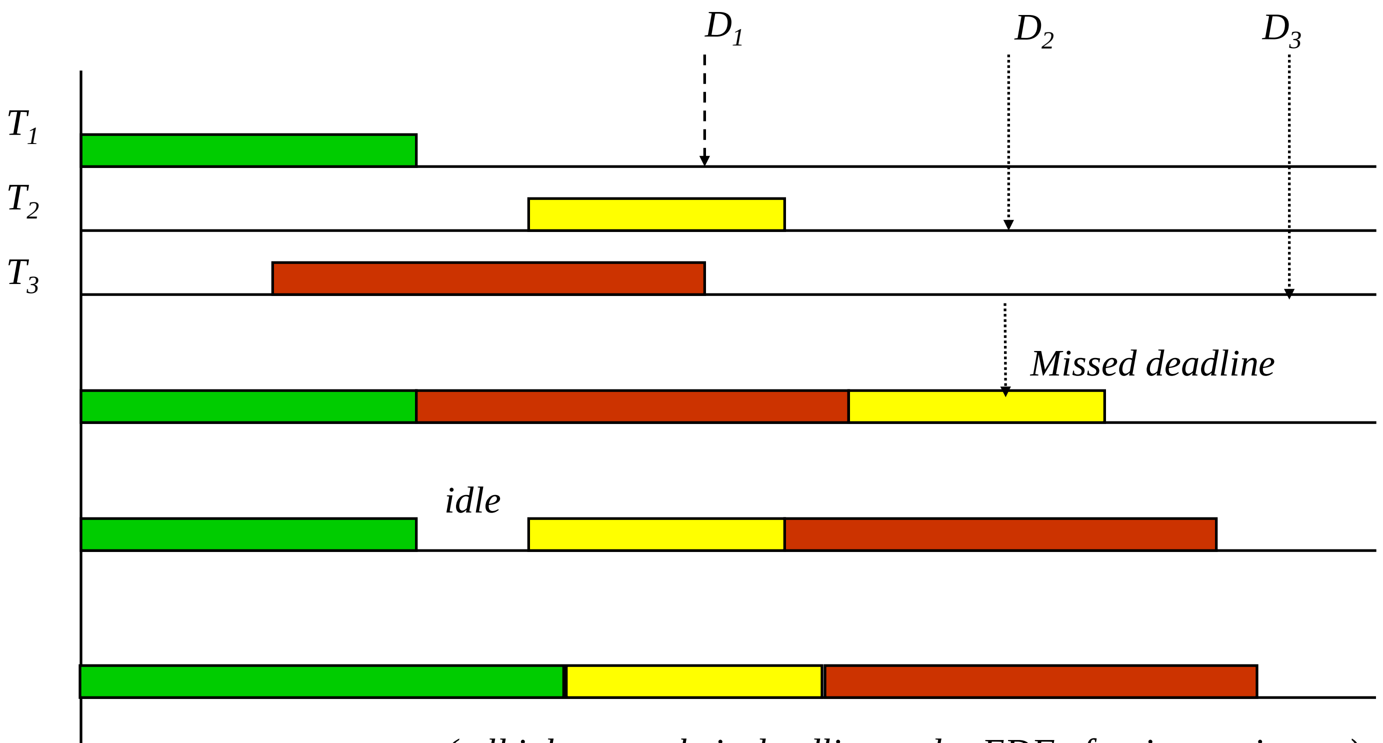
Earliest-deadline First (EDF) Schedule

- **Priority preemptive scheduling**
  - a job with earliest (absolute) deadline has the highest priority
  - does not require the knowledge of execution time
- **Optimal if**
  - single processor, no resource contention, preemption
  - why it is optimal: assume a feasible schedule



Non-optimality of EDF

- Non-preemptive or multiple processors
- scheduling anomaly --- the schedule fails after we reduce job execution times



(all jobs meet their deadline under EDF after increasing e_1)

EDF Schedule

- **A optimal algorithm under single processor and preemptable tasks**
- **How do we know a set of periodic tasks are schedulable under EDF ?**
- **If we know the schedulable utilization *SU* of EDF, then any sets of tasks are schedulable when $U \leq SU$**
- **Theorem: A set of n periodic tasks can be scheduled by EDF iff**

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

- **This schedulability utilization is no long true if *deadline* < *period*.**

Example of EDF Schedule

- **A digital robot with EDF schedule**
  - control loop: $e_c \leq$ 8ms at 100Hz
  - BIST: $e_b \leq$ 50ms
  - given

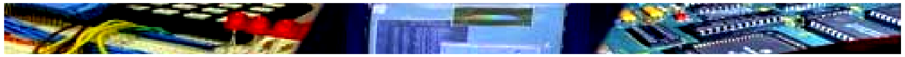
$$u_c + u_b = \frac{8}{10} + \frac{50}{p_b} \leq 1$$

  - BIST can be done every 250ms

- **Add a telemetry task to send and receive messages with *$e_t \leq$ 15ms***
  - if BIST is done every 1000ms
  - given

$$u_c + u_b = \frac{8}{10} + \frac{50}{1000} + \frac{15}{D_t} \leq 1$$

  - the telemetry task can have a relative deadline of 100ms
  - sending or receiving must be separated at least 100ms



Supplementary Slides

On-line vs. Off-line Scheduling

- ***Off-line scheduling:*** **the schedule is computed off-line and is based on the knowledge of the release times and execution times of all jobs.**
  - For deterministic systems: with fixed set of functions and job characteristics does not vary or vary only slightly.
- ***On-line scheduling:*** **a scheduler makes each scheduling decision without knowledge about the jobs that will be released in the future.**
  - there is no optimal on-line schedule if jobs are non-preemptive
  - when a job is released, the system can serve it or wait for the future jobs