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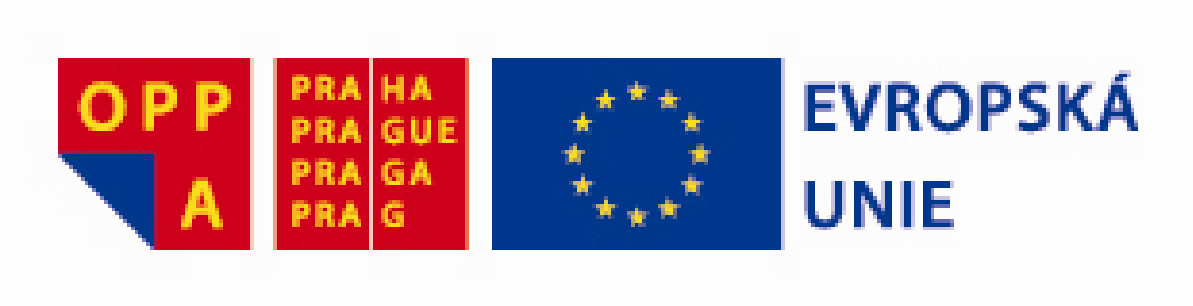

Evropský sociální fond
Praha & EU: Investujeme do vaší budoucnosti

Department of Distributed and Dependable Systems D3S

Embedded and Real-time Systems

Response Time Analysis – Additions

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Response Time Analysis with Jitter

- So far we assumed that tasks are released at the exactly at beginning of a period
- What about if it is not so
  - For example due to inaccurate timer

- Release Jitter
  - the difference between the earliest and the latest time a task could be released relative to the start of the period

$$J_i = J_i^{max} - J_i^{min}$$

Response Time Analysis with Jitter

- May cause missed deadlines

Task	T	D	C	R
A	30	20	10	10
B	1000	25	15	25

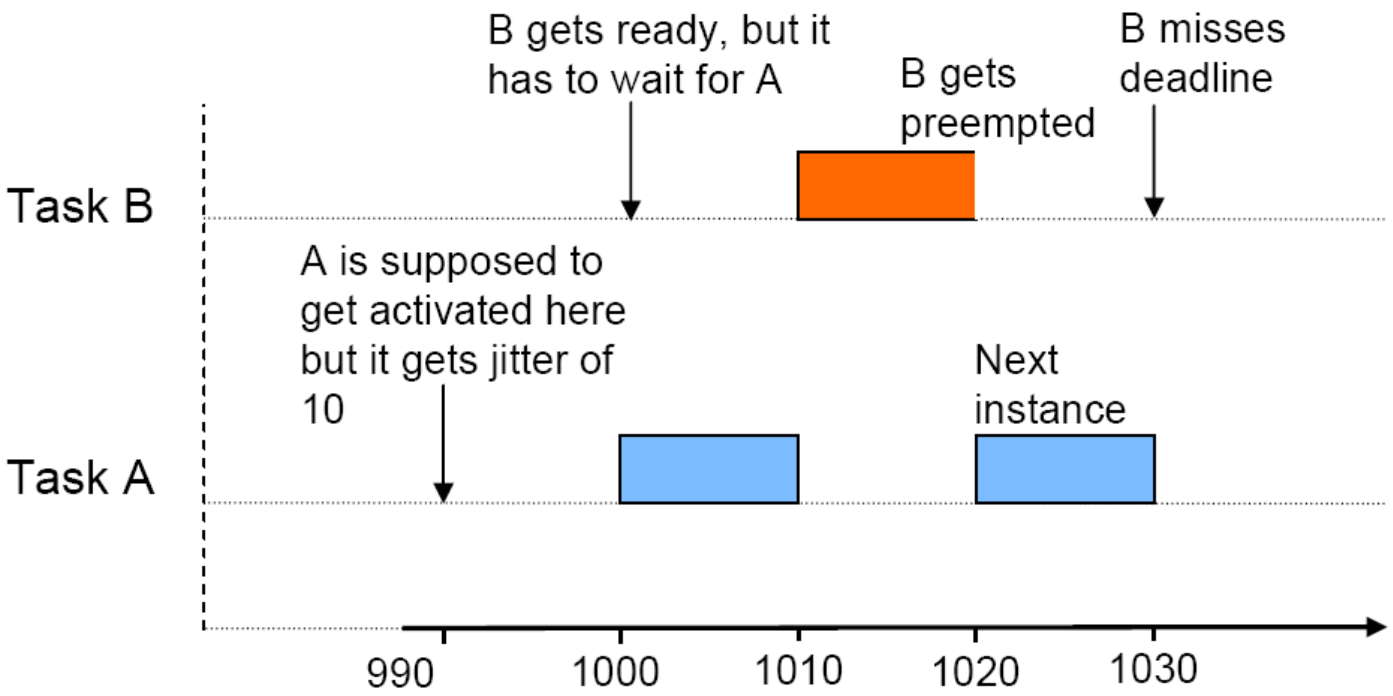

Fig. from Issovic, D.:Real-time systems, basic course

Response Time Analysis with Jitter

- How many times task τ_2 may be preempted by τ_1?
  - n times if $R_2 > (n-1)T_1 - J_1$
  - Thus we need the biggest n satisfying condition

$$\frac{R_2 + J_1}{T_1} > n - 1$$

  - That is:

$$n = \left\lceil \frac{R_2 + J_1}{T_1} \right\rceil$$

  - Resulting into:

$$R_i^{n+1} = C_i + B_i + \sum_{j=1}^{i-1} \left\lceil \frac{R_i^n + J_j}{T_j} \right\rceil C_j$$

Response Time Analysis with Jitter

- Now, we have to account for jitter of the actual task τ_i

$$w_i^{n+1} = C_i + B_i + \sum_{j=1}^{i-1} \left\lceil \frac{w_i^n + J_j}{T_j} \right\rceil C_j$$

$$R_i = J_i^{max} + \mathrm{w_i}$$

- w_i is the time taken for the task to complete once it has been released (i.e. a preemption window)

Response Time Analysis with System Overhead

- So far we assumed zero scheduling costs
- What brings the overhead?
  - Every preemption can result in two context switches (C_{sw})
  - Timer clock tick (C_{clk}) – can be modeled as high-priority task
- Time to move a task from waiting to ready queue (C_q)

$$w_i^{n+1} = C_i + 2C_{sw} + B_i + \sum_{j=1}^{i-1} \left\lceil \frac{w_i^n + J_j}{T_j} \right\rceil \left(C_j + 2C_{sw}\right) + \sum_{\forall k \in all\_tasks} \left\lceil \frac{w_i^n}{T_k} \right\rceil C_q + \left\lceil \frac{w_i^n}{T_{clk}} \right\rceil C_{clk}$$