technische universität dortmund
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# Real-Time Systems (SS 2014)

## Exercise 5: Real-Time Calculus and Communications

### Discussion Date: 25, June, 2014

**Exercise 5.1**

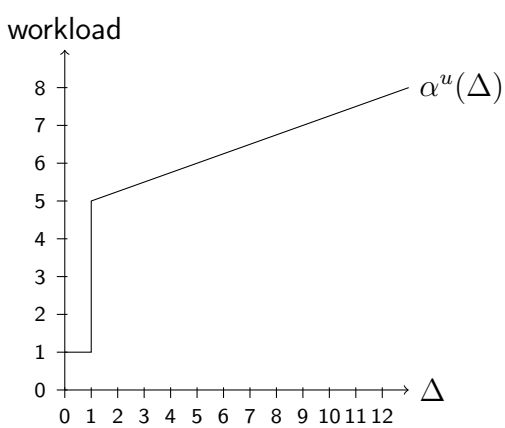
(a) Mr. Smart wants to define the feasibility of his design as follows: "the system is feasible if $\alpha^u(\Delta) \leq \beta^l(\Delta)$ for any $\Delta \geq 0$", where $\alpha$ and $\beta$ are arrival curve and service curve, respectively. Is this a reasonable definition?

(b) How to derive the arrival curves from a set of given traces of events? How to derive the service curves from a set of traces of services?

(c) What are the limitations of using Greedy Processing Components (GPC) in Real-Time Calculus (RTC)? How to perform schedulability analysis for fixed-priority scheduling based on GPCs? For fixed-priority scheduling, what are the similarity and difference of worst-case response time analysis in RTC to and from the time-demand schedulability tests for sporadic real-time tasks with arbitrary deadlines?

(d) In the lecture, we have discussed about the possibility to generate jitters by sending messages immediately at the end of computation task. How can we resolve the jitter problem due to the variant response times of a sporadic task?

**Exercise 5.2**




Is the arrival curve in the left correct? Is it tight? If yes, why? If not, how to make it tighter?

**Exercise 5.3**

Consider the following case with four sporadic messaging tasks on a CAN. Suppose that the worst-case transmission time of a message is at most 200 $\mu$s. Each sporadic messaging task sends only one message per job.

| symbol | identifier | minimum inter-arrival time and relative deadline ($\mu$s) |
|---|---|---|
| A | 00000000001 | 500 |
| B | 00000001011 | 800 |
| C | 00000001111 | 2000 |
| D | 00000000110 | 1400 |

Can a message of a task be sent before its relative deadline? If not, evaluate whether there exists a feasible schedule to send the messages for these tasks (without changing the timing parameters) on the CAN.

**Exercise 5.4**

Given a flexible TDMA defined as follows: $< \bar{c}, (t_1, s_2), (t_2, s_2), \ldots, (t_k, s_k) >$, in which $\bar{c}$ is the cycle length, $t_i$ is the $i$-th offset of the starting time in a cycle and $s_i$ is the slot length of the $i$-th slot. Suppose that the flexible TDMA is feasible, i.e., $t_i + s_i < t_{i+1}$ for $i = 1, 2, \ldots k-1$ and $t_k + s_k \leq \bar{c}$, $t_i \geq 0, \forall i$, $s_i > 0, \forall i$. How to calculate the service curve of this flexible TDMA to serve an application?

**Exercise 5.5**

How do we handle non-preemptiveness for the schedulability tests by using fixed-priority scheduling under TDMA? That is, the TDMA slots are shared by a set of tasks scheduled by using fixed-priority scheduling. How can we handle the minimum slice length under TDMA, i.e., each frame has a fixed-length, and must be sent within one time slot?