

# Real-Time Scheduling – TD 2

## IMC4-1RT

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### Notations

$\Psi = \{\tau_1, \dots, \tau_n\}$  is a set of  $n$  real-time periodic tasks each one characterized by  $\tau_i = (C_i, D_i, T_i)$  where  $C_i$  is its worst case execution time (WCET),  $D_i$  its relative deadline and  $T_i$  its period.

$\Phi = \{J_1, \dots, J_m\}$  is a set of  $m$  aperiodic tasks, each task  $J_i$  characterized by  $(r_i, C_i)$  which are respectively its release date and its worst case execution time.

## 1 Synchronisation Protocols

Let us consider the system described in table 1, schedule with a preemptive fixed priority scheduler.

Task	release	wcet	deadline	period	Priority
$\tau_1$	4	$1 + 2(\text{Blue}) + 5(\text{Yellow}) + 1$	20	20	16
$\tau_2$	2	$1 + 2(\text{Blue}) + 1$	20	20	14
$\tau_3$	0	$1 + 5(\text{Yellow}) + 1$	20	20	12

TABLE 1 – system  $S4_\tau$

1. draw and explain execution with PIP
2. draw and explain execution with PCE
3. draw and explain execution with PCP

## 2 Aperiodic Tasks

Let us consider  $\Psi = \{(1, 5, 5), (2, 8, 8)\}$  :

1. is  $\Psi$  schedulable with RM ?

We now want to add a Polling Server in the system :

2. Give the maximal load for the server  $U_s$  to keep the system verifying the sufficient load condition with RM. Deduce three values for  $C_s$  respectively when  $T_s = 4$ ,  $T_s = 7$  and  $T_s = 10$ .
3. For the case  $T = 7$ , draw the schedule obtained on interval  $[0, 20]$  for aperiodic tasks :  $\{J_1 = (2, 3), J_2 = (7, 2), J_3 = (9, 1)\}$ .
4. (bonus) same for  $T_s = 4$  and  $T_s = 10$ .

Instead of the Polling Server, we want to use now a Deferrable Server :

5. Compute the maximal utilization load  $U_s = C_s/P_s$  we can use for the server.

6. Deduce its minimal period (an integer) to obtain a capacity of 2 time units.
7. draw the schedule obtained on interval  $[0, 25]$  with the same tasks as question 3.
8. (bonus) same with a capacity of 1.
9. Are response times better for aperiodic? Comment.
10. Draw on interval  $[0, 25]$  the schedule we obtain with a *slack stealer*.
11. Are response times better for aperiodic? Comment.

### 3 Precedence Constraints

1. draw the DAG of precedences corresponding to :  $J_1 \rightarrow J_3$ ,  $J_2 \rightarrow J_3$ ,  $J_2 \rightarrow J_4$ ,  $J_3 \rightarrow J_5$ ,  $J_3 \rightarrow J_6$ ,  $J_4 \rightarrow J_6$ ,  $J_4 \rightarrow J_7$ . The following tabular give us the parameters of the tasks. Compute the new wake up values and deadline in order to schedule the system with EDF

	$J_1$	$J_2$	$J_3$	$J_4$	$J_5$	$J_6$	$J_7$
$C_i$	2	3	3	5	1	2	5
$d_i$	13	15	25	9	20	17	22
$r_i$	0	1	12	0	10	0	0

2. (bonus) Draw the obtain schedule. Are the constraints satisfied?