Development of Real-Time Systems
Assignment 3

Elyasin Shaladi

July 4, 2016

Contents

1 Theory assignment

The following part of assignment is a purely theoretical task that requires no additional tools. The task is to find the largest possible frame size for the cyclic structured scheduler by following requirements 1,2 and 3 for finding the largest frame size.

1.1 Task set 1 — T1(15, 1, 14) T2(20, 2, 26) T3(22, 3)

Task	p_i	e_i	D_i
Task 1	15	1	14
Task 2	20	2	26
Task 3	22	3	22

1.1.1 Requirement 1

f must be greater or equal than the longest execution time, i.e. $f \geq 3$

1.1.2 Requirement 2

f must evenly divide the hyperperiod H. The hyperperiod H is the least common multiple of all the periods in the task set, which are 15, 20 and 22. This means $H = 660$.
Therefore possible values for f are: $f \in \{1, 2, 3, 4, 5, 6, 10, 11, 15, 22\}$

1.1.3 Requirement 3

The frame size f has to fulfill the following requirement $\forall i : 2 * f - gcd(p_i, f) \leq D_i$
This requirement does not hold for $10 \leq f \leq 22$.
However this requirement holds for $1 \leq f \leq 6$ and thus $f = 6$ is the largest possible frame size.
For $f = 6$ all three requirements are met.

1.2 Task set 2 — T1(4, 1) T2(5, 2, 7) T3(20, 5)

Task	p_i	e_i	D_i
Task 1	4	1	4
Task 2	5	2	7
Task 3	20	5	20

1.2.1 Requirement 1

f must be greater or equal than the longest execution time, i.e. $f \geq 5$

1.2.2 Requirement 2

f must evenly divide the hyperperiod H. The hyperperiod H is the least common multiple of all the periods in the task set, which are 4, 5 and 20. This means $H = 20$.
Therefore possible values for f are: $f \in \{1, 2, 4, 5, 10, 20\}$

1.2.3 Requirement 3

The frame size f has to fulfill the following requirement $\forall i : 2*f - gcd(p_i, f) \leq D_i$
This requirement does not hold for $5 \leq f \leq 20$.
However this requirement holds for $1 \leq f \leq 4$ and thus $f = 4$ is the largest possible frame size.

However, $f = 4$ does not fulfill the requirement 1. Therefore Task 3, which has an execution time of 5, has to be sliced into sub jobs as suggested in the lecture.

1.3 Task set 3 — T1(5, 0.1) T2(7, 1) T3(12, 6) T4(45, 9)

Task	p_i	e_i	D_i
Task 1	5	0.1	5
Task 2	7	1	7
Task 3	12	6	12
Task 4	45	9	45

1.3.1 Requirement 1

f must be greater or equal than the longest execution time, i.e. $f \geq 9$

1.3.2 Requirement 2

f must evenly divide the hyperperiod H. The hyperperiod H is the least common multiple of all the periods in the task set, which are 5, 7, 12 and 45. This means $H = 1260$.
Therefore possible values for f are: $f \in \{1, 2, 3, 4, 5, 6, 7, 9, 12, 15, 45\}$

1.3.3 Requirement 3

The frame size f has to fulfill the following requirement $\forall i : 2*f - gcd(p_i, f) \leq D_i$
This requirement does not hold for $4 \leq f \leq 45$.
However this requirement holds for $1 \leq f \leq 3$ and thus $f = 3$ is the largest possible frame size.

However, $f = 3$ does not fulfill the requirement 1. Therefore Task 3, which has an execution time of 6, and Task 4, which has an execution time of 9, have to be sliced into sub jobs as suggested in the lecture.

2 Simulation assignment

The assignment is to use a real-time simulator to verify feasibility of a set of tasks.

2.1 Simulation 1 — RM Scheduler

Task	p_i	e_i	D_i
Task 1	2	0.5	2
Task 2	3	1.2	3
Task 3	6	0.5	6

2.1.1 What is the utilization factor of the system and what is the value for Urm(3)?

The utilization U is 0.741 according to SimSo (CPU total load).
Although according to the formula learned in the lecture the value is 0.733, but this does not change the feasibility test conclusion.
The value for $U_{rm}(3)$ is 0.780.

Since $U \leq U_{rm}(3)$ the system is guaranteed feasible.

2.1.2 What is the minimum/maximum/average response time of all tasks?

Task	min	avg	max
Task 1	0.5	0.5	0.5
Task 2	1.7	1.7	1.7
Task 3	2.7	2.7	2.7

2.1.3 Is any task missing the deadline? Which task? Where?

No deadline is missed in this schedule.

2.1.4 If a deadline is missed, could it be avoided by changing the scheduler?

No deadline is missed in this schedule.

2.2 Simulation 2 — EDF Scheduler

Task	p_i	e_i	D_i
Task 1	2	0.5	1.9
Task 2	5	2	5
Task 3	1	0.1	0.5
Task 4	10	5	20

2.2.1 What is the utilization factor of the system and what is the value for Urm(3)?

The utilization U is 1 according to SimSo (CPU total load).
Although according to the formula learned in the lecture the value is 1.25.

The value for $U_{rm}(4)$ is 0.757. Although I dont see the utility of calculating U_{rm}, because

1. the scheduler is not an RM scheduler and
2. the utilization is greater than 1, so the system is not feasible anyway.

2.2.2 What is the minimum/maximum/average response time of all tasks?

Task	*min*	*avg*	*max*
Task 1	0.6	0.6	0.6
Task 2	2.8	3.1	3.4
Task 3	0.1	0.1	0.1
Task 4	20	20	20

2.2.3 Is any task missing the deadline? Which task? Where?

Task 4 meets the first deadline ($t = 20$), but misses all subsequent deadlines ($t = 30, 40, 50, 60, 70, 80, 90, 100$)

2.2.4 If a deadline is missed, could it be avoided by changing the scheduler?

No, I tried the available schedulers that we know from the class: RM (Rate Monotonic, FP Fixed Priority and EDF Earliest Deadline First) and none of them was feasible.
This is consistent with the finding that the utilization U is greater than 1 and thus the system is guaranteed not feasible.
I also found (in a research paper) that the EDF scheduling algorithm is optimal. I.e. if a real-time task set cannot be scheduled by EDF, then this task set cannot be scheduled by any algorithm.