Assignment 3

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Development of Real-Time Systems

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Introduction

In this assignment we will focus a bit more on the theoretical side. We will have a look at verifying real-time system by using the cyclic structured construct handled in the course and a simulation environment to automatically schedule a full timeline. The main purpose of the assignment is to expose the student to several ways of planning and verifying a real-time system in practice.

1- Theory assignment

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. The following three task sets should be used:

1- T1(15, 1, 14) T2(20, 2, 26) T3(22, 3)
2- T1(4, 1) T2(5, 2, 7) T3(20, 5)
3- T1(5, 0.1) T2(7, 1) T3(12, 6) T4(45, 9)

1.1 Report 1

1.1 1st set of tasks

This report shows the results with the first data:

T1(15,1,14) T2(20,2,26) T3(22,3)

- Requirement 1:
  The task with the largest execution time is T3. Therefore, the Frame size is:
  Frame size (f) ≥ 3
- Requirement 2:
  The candidates that divide the hyper period, H, evenly are:
  f = {22, 20, 15, 11, 10, 5, 4, 3, 2, 1}
- Requirement 3:

$$2f - gcd(Pi, f) \leq Di$$

	T1	T2	T3
22	44-1	14	
20	40-5	14	
15	30-15	14	
10	20-5	14	
5	10-5<=14	10-5<= 26	10-1<= 22

- Results:

The optimal frame size that fulfils the requirements is f= 5.

1.2 2nd set of tasks

This shows the results with the second data:

T1 (4; 1) T2 (5; 2; 7) T3 (20; 5)

- Requirement 1:

  The task with the largest execution time is T3. Therefore, the Frame size is:
  Frame size (f) ≥ 5

- Requirement 2:

  The candidates that divide the hyper period, H, evenly are:
  f = {20, 10, 5, 4, 2, 1}

- Requirement 3:

$$2f - gcd(Pi, f) \leq Di$$

	T1	T2	T3
20	40 - 4≤4		
10	20 - 2 ≤4		
5	10 - 1 ≤ 44		
4	8 - 4 ≤ 4	8 -1≤7	8 - 4 ≤20

- Results:

  The frame size is 4 but is violating the requirement so the jobs from T3 whose execution time is 5 must be split into equal parts.

1.3 3rd set of tasks

This shows the results with the second data:

T1 (5, 0.1) T2 (7, 1) T3 (12, 6) T4 (45, 9)

- Requirement 1:

  The task with the largest execution time is T3. Therefore, the Frame size is:
  $(f) \geq 9$

- Requirement 2:

  The candidates that divide the hyper period, H, evenly are:
  f = {45, 15, 12, 9, 7, 6, 5, 4, 3, 2, 1}

- Requirement 3:

$$2f - gcd(Pi, f) \leq Di$$

	T1	T2	T3	T4
45	90 - 5≤5			
15	30 - 5≤5			
12	24 - 1≤5			
9	18 - 1≤5			

7	14 - 1≤5			
6	12 - 1≤5			
5	10 - 5≤5	10 - 1≤7		
4	8 - 1≤5			
3	6 - 1≤5	6 - 1≤7	6 - 3≤12	6 - 3≤45

- Results:

The largest frame size that satisfies requirement three is 3 as seen in Table 3. Since T3 and T4 have an execution times of 6 and 9 respectively, this implies that T3 execution will be in two stages and so the first execution will be 3 and its next execution will be 3 after which it completes. For T4, its execution will be in three stages and so the first execution will be 3, its second execution will be 3 and last execution time frame will be 3 after which it completes.

2- Simulation assignment

1.2 Report 2

Input the tasks T1 (2, 0.5), T2 (3, 1.2), T3 (6, 0.5) and the RM scheduler into the SimSo simulator

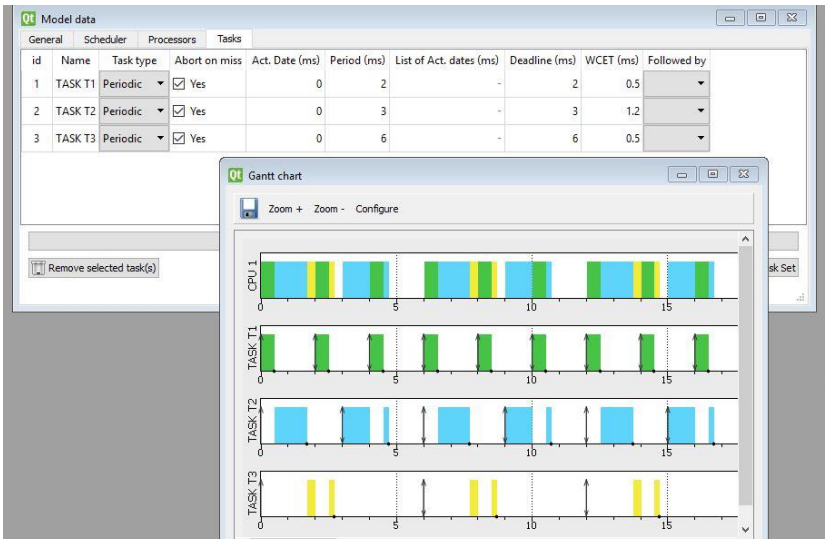

Figure1: the SimSo simulation of the RM scheduler

- **What is the utilization factor of the system and what is the value for Urm(3)**

$$Urm = \frac{0.5}{2} + \frac{1.2}{3} + \frac{0.5}{6} \sim 0.73$$

$$Urm(3) = \frac{0.5}{6} = \frac{1}{12} \sim 0.083$$

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

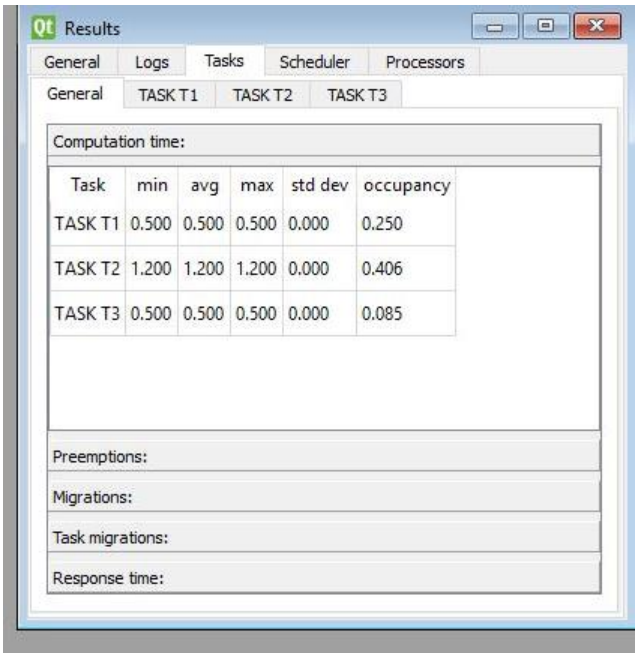

Figure2: the minimum, maximum and average response time of all tasks

- **Is any task missing the deadline? Which task? Where?**
  Yes, T1, T1 should be stop executing at time 2 but it starts after T2 terminated and interrupted T3 which after time and that happened because the T2 take too long to execute so it made T1 pass the deadline.

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

  Yes, we can use the EDF scheduler instead, so the scheduler will execute the tasks according to deadline so it can't missed as follows:

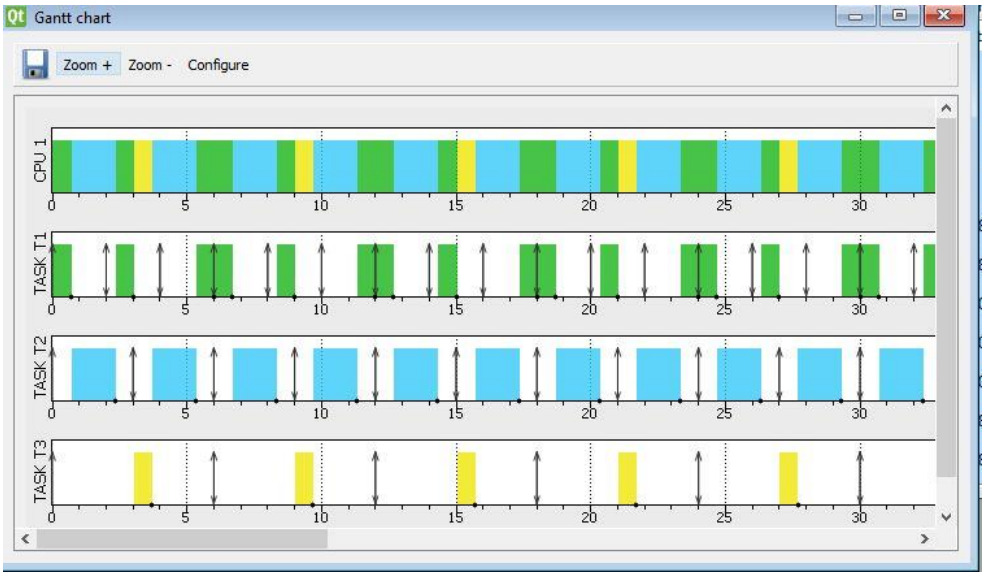

Figure3: EDF scheduling of the above tasks

1.3 Report 3

Input the tasks T1 (2, 0.5, 1.9) T2 (5, 2) T3 (1, 0.1, 0.5) T4 (10, 5, 20) and the EDF scheduler into the SimSo simulator

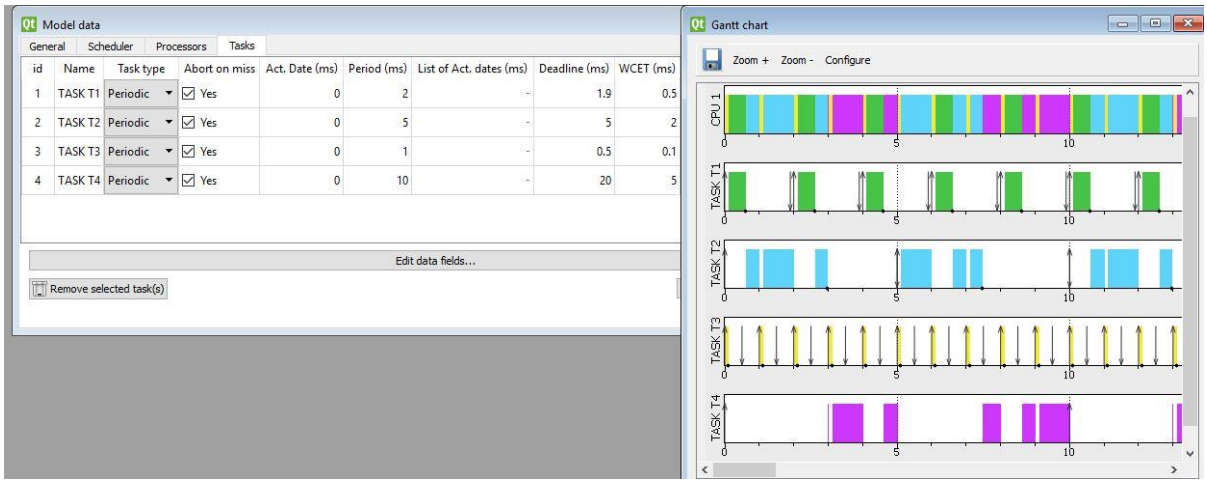

Figure4: SimSo simulation of the EDF scheduler

- **What is the utilization factor of the system and what is the value for Urm(4)**

  $Urm = \frac{0.5}{2} + \frac{2}{5} + \frac{0.1}{1} + \frac{5}{10} = \frac{12.5}{10} \sim 1.25$

  $Urm(4) = \frac{5}{10} = 0.5$

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

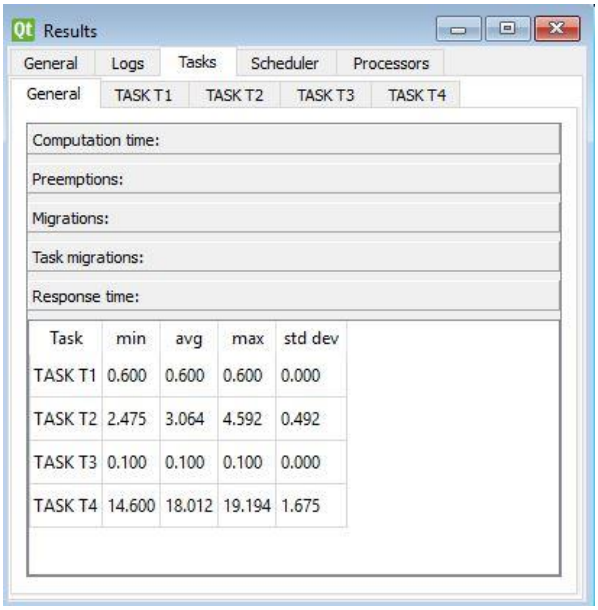

Figure5: the minimum/maximum/average response time of all tasks

- **Is any task missing the deadline? Which task? Where?**

  Yes, T4, as follows:

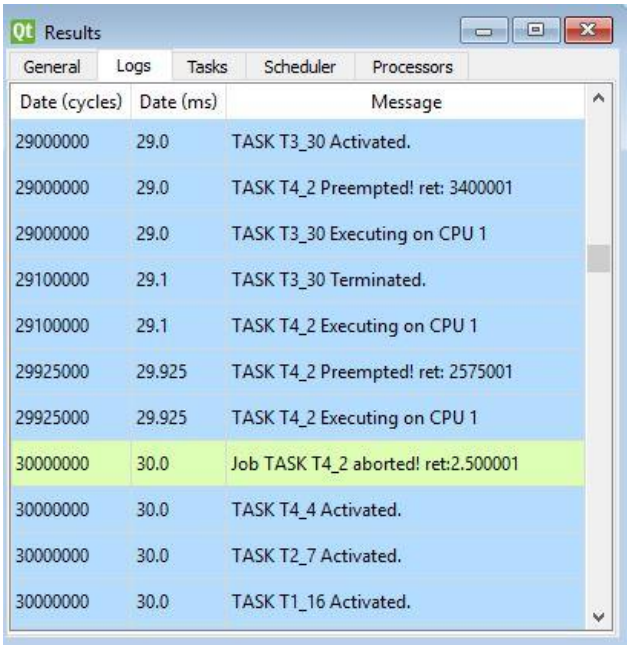

Figure6: T4 missing the deadline

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

We should then use two processors.