

Assignment 3

Coursera: "Development of real time systems" by EIT

Theory assignment:

The theory assignment is based upon finding the highest frame size for different sets of tasks, for a scheduler of type: Cyclic structured.

For this type of scheduler we have to meet 3 main requirements in order to determine the largest frame size:

- **1st requirement:** $f \geq \text{largest execution time.}$
- **2nd requirement:** The f candidates must divide the hyperperiod evenly.
- **3rd requirement:** The chosen frame size must meet the following equation $\rightarrow 2*f - \text{GCD}(f, \pi) \leq d_i$

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

1st req. : $f \geq 3$

2nd req.; $f = \{22, 20, 15, 11, 10, 5, 4, 3, 2, 1\}$

3rd req.:

f	T(15,1,14)	T2(20,2,26)	T3(22,3)
22	$2*22 - 1 \leq 14$		
20	$2*20 - 5 \leq 14$		
15	$2*15 - 15 \leq 14$		
11	$2*11 - 1 \leq 14$		
10	$2*10 - 5 \leq 14$		
5	$2*5 - 5 \leq 14$	$2*5 - 5 \leq 26$	$2*5 - 1 \leq 22$

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Fig 1: 3rd requirement for task set 1

As you can see, I used a green color to indicate that the condition was met, and red when was not. This gives us that **the largest frame size for this set task is 5**. Which also meets 1st requirement.

Task set 2: $T1(4, 1)$ $T2(5, 2, 7)$ $T3(20, 5)$

1st req. : $f \geq 5$

2nd req.; $f = \{20, 10, 8, 5, 4, 2, 1\}$

3rd req.:

f	T(4,1)	T2(5,2,7)	T3(20,5)
20	$2*20 - 4 \leq 4$		
10	$2*10 - 2 \leq 4$		
8	$2*8 - 4 \leq 4$		
5	$2*5 - 1 \leq 4$		
4	$2*4 - 4 \leq 4$	$2*4 - 1 \leq 7$	$2*4 - 4 \leq 20$

Fig 2: 3rd requirement for task set 2

For $f=4$, we don't meet 1st requirement. As we can see, T3 has an execution time of 5, so what we can do is to split T3:

$$T3(20,5) \Rightarrow T3'(20,3) + T4(20,2)$$

Then we have:

f	T(4,1)	T2(5,2,7)	T3'(20,3)	T4(20,2)
4	$2*4 - 4 \leq 4$	$2*4 - 1 \leq 7$	$2*4 - 4 \leq 20$	$2*4 - 4 \leq 20$

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Which meets all the three requirements, and therefore: **the largest frame size for this set task is 4**

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

1st req. : $f \geq 9$

2nd req.; $f = \{45, 15, 12, 5, 4, 2, 1\}$

3rd req.:

f	T(5,0.1)	T2(7,1)	T3(12,6)	T4(45,9)
45	$2*45 - 15 \leq 5$			
15	$2*15 - 5 \leq 5$			
12	$2*12 - 1 \leq 5$			
5	$2*5 - 5 \leq 5$	$2*5 - 1 \leq 7$		
4	$2*4 - 1 \leq 5$			
2	$2*2 - 1 \leq 5$	$2*2 - 1 \leq 7$	$2*2 - 2 \leq 12$	$2*2 - 1 \leq 45$

Fig 3: 3rd requirement for task set 3

For $f=2$, we don't meet 1st requirement. As we can see, T3 has an execution time of 6, and T4 of 9. So what we can do is to split both tasks:

$$T3(12,6) \Rightarrow T3'(12,2) + T5(12,2) + T6(12,2)$$

$$T4(45,9) \Rightarrow T4'(45,2) + T7(45,2) + T8(45,2) + T9(45,1)$$

The 3rd requirement is easily verified as it's the same than for T3 and T4. Which meets all three requirements, and therefore: **the largest frame size for this set task is 2.**

Simulation assignment:

Task set 1:

For first set task we have:

- *What is the utilization factor of the system and what is the value for $U_{rm}(3)$?*

$$U \sim 0,9 \text{ and: } U_{rm}(3) = 3(2^{1/3} - 1) \sim 0,78$$

Since $U < U_{rm} < 1$ the test doesn't guarantee feasibility.

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

The average and max response time are the same for task set 1, as can be appreciated in *fig.5*



Fig 4: Scheduling simulation for set task 1

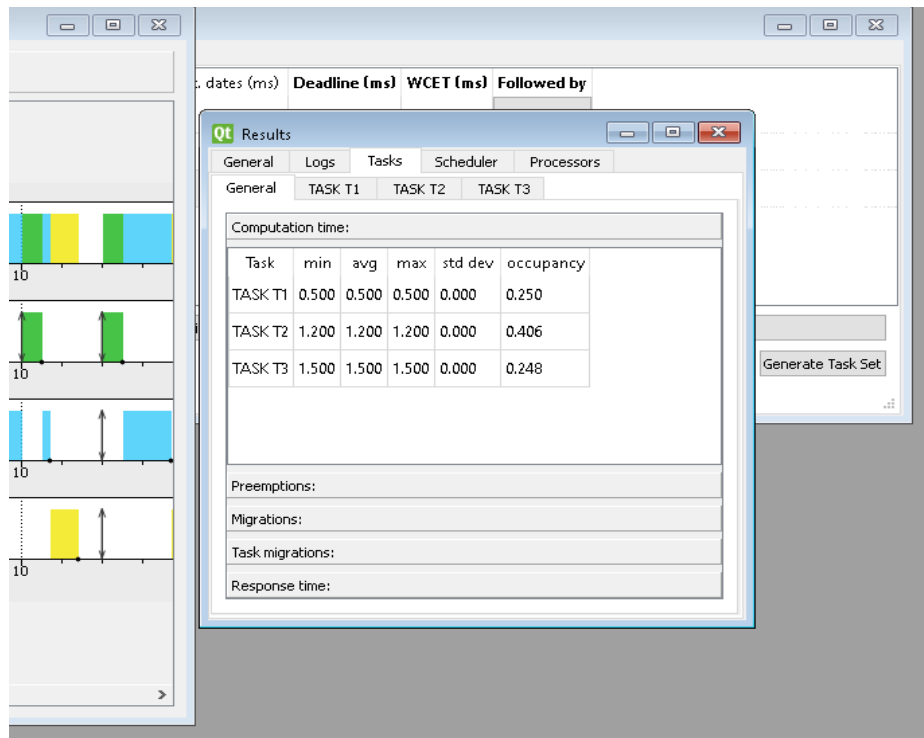


Fig 5: Numerical results for tasks in simulation for task set 1

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

None of the tasks misses a deadline. As you can see in fig.4

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

Yes, as the total utilization is less than one.

Task set 2:

For the second set task we have:

- ***What is the utilization factor of the system and what is the value for $U_{rm}(4)$?***

$U=1$ and the RM test cannot be applied to an EDF scheduler.

- *What is the minimum/maximum/average response time of all tasks?*
The average and max response time are the same for task set 2, as can be appreciated in *fig.7*

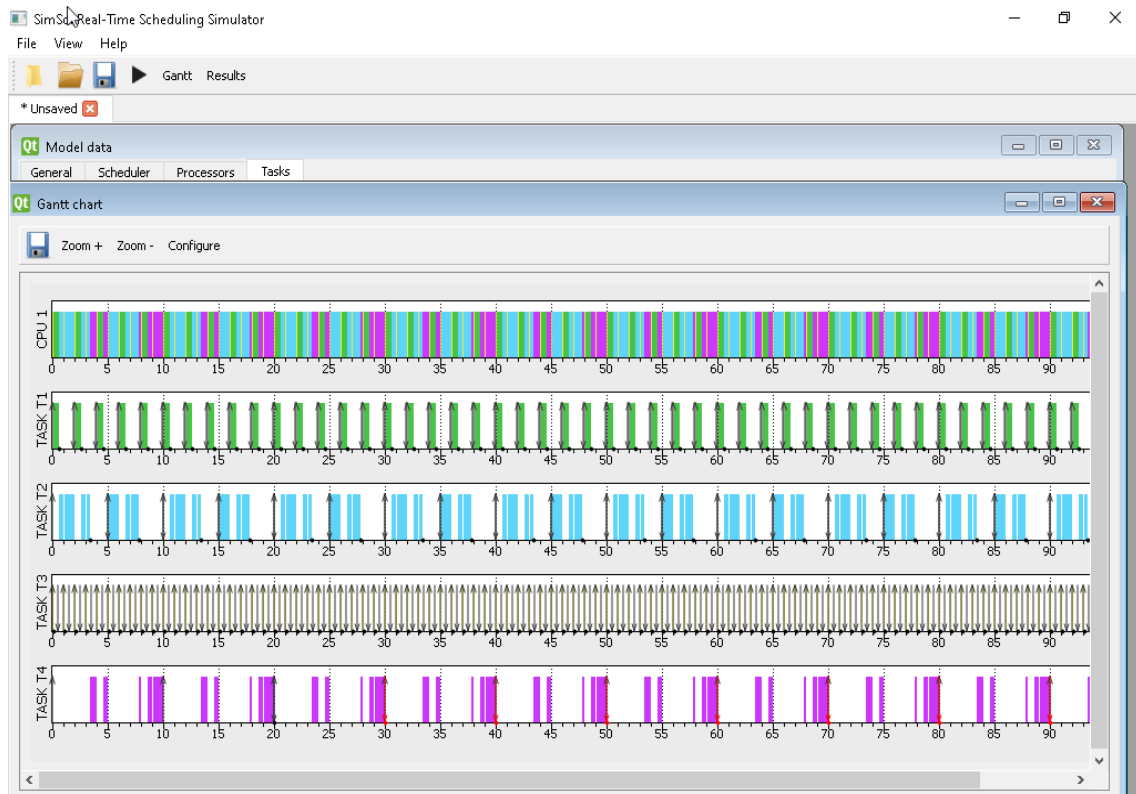


Fig 6: Scheduling simulation for set task 2

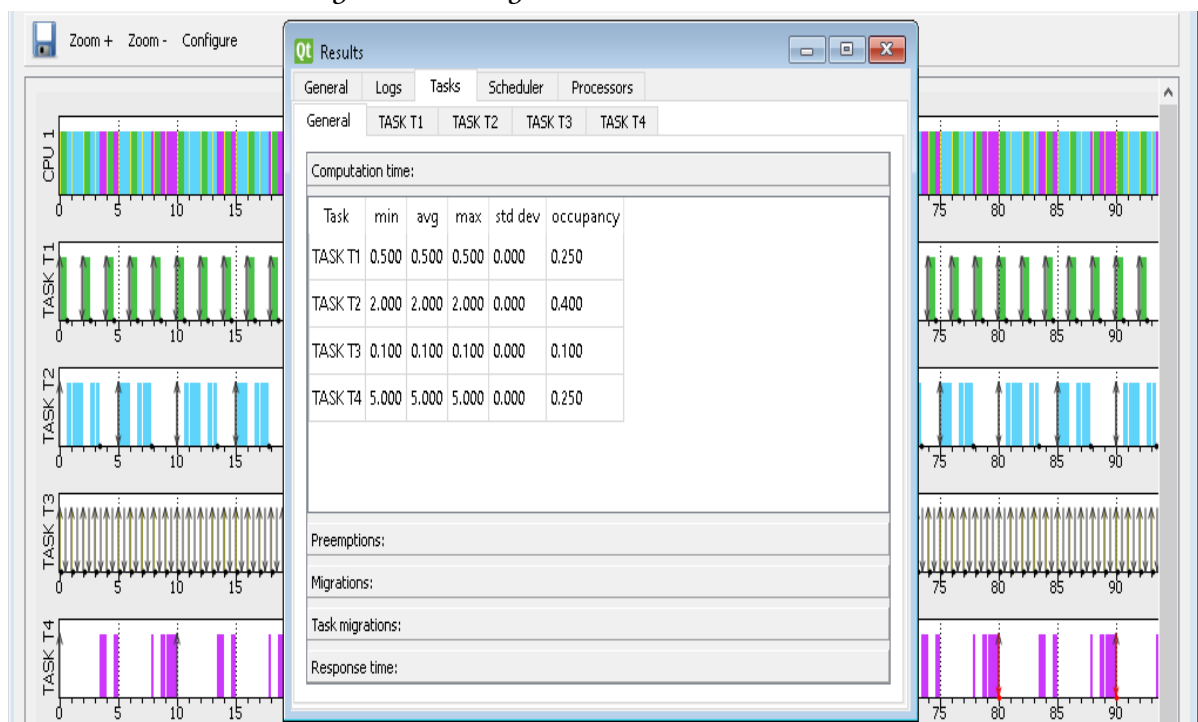


Fig 7: Scheduling simulation for set task 2

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

Yes, TASK4 is missing deadlines 30,40,50,60,70,80,90 and so on. As you can see in *fig.4*

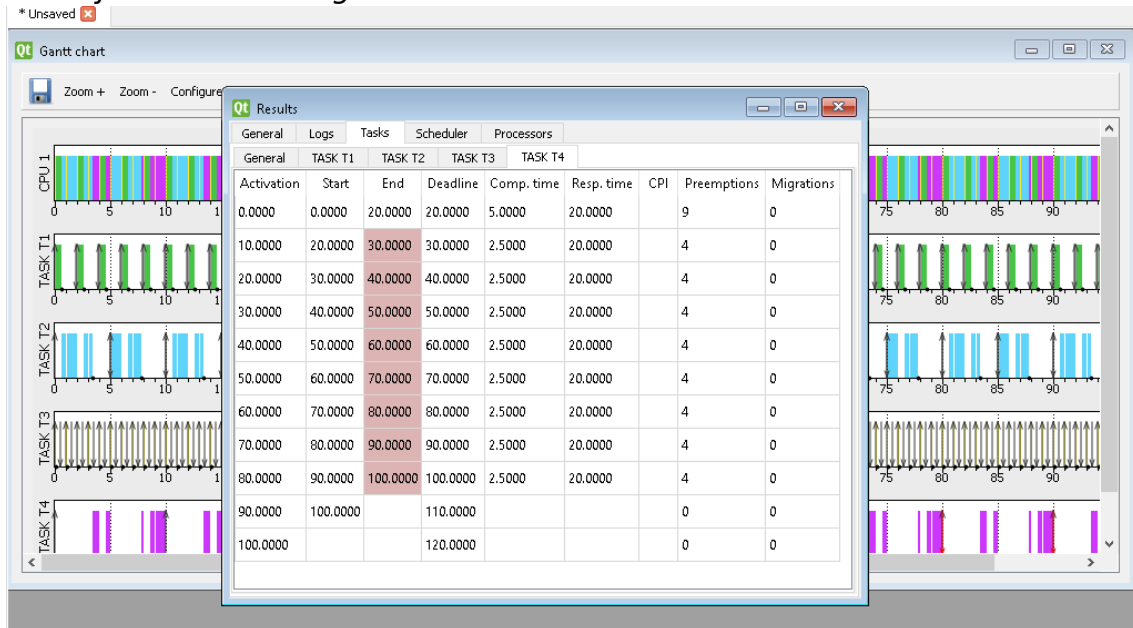


Fig 8: TASK 4 time specifications

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

No, as the EDF scheduler is already using 100% of the CPU. ($U = 1$)