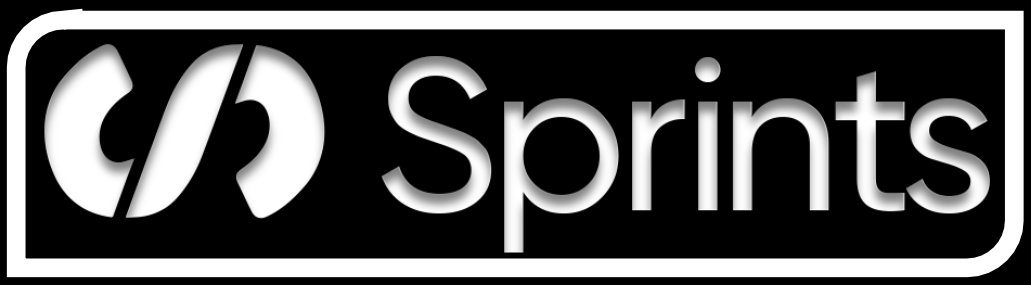

EDF Scheduler Project

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Project Description

The EDF Scheduler project aims to implement an Earliest Deadline First (EDF) scheduling algorithm using FreeRTOS. The EDF scheduler is a dynamic priority-based preemptive scheduling policy commonly used in real-time systems. This project involves implementing the necessary changes outlined in a provided thesis, creating tasks with specific criteria, verifying the system implementation, and optionally enhancing the functionality of the scheduler.

Requirements

The following requirements must be fulfilled to successfully complete the EDF scheduler implementation project:

- Read the provided thesis, specifically Chapter 2: "FreeRTOS Task Scheduling" and Chapter 3: "EDF Scheduler."
- Implement the changes mentioned in Chapter 3.2.2: "Implementation in FreeRTOS." The changes should be made in the tasks.c source file.
- Implement any missing changes not mentioned in the thesis:
- Modify the prvIdleTask function to ensure the idle task always has the farthest deadline.
- In the xTaskIncrementTick function, calculate the new task deadline and insert it in the correct position in the EDF ready list for every tick increment.
- Modify the preemption mechanism in the xTaskIncrementTick function, so that a task with a sooner deadline preempts a task with a larger deadline.
- Implement four tasks using the EDF scheduler. The tasks and their criteria are as follows:
    - Task 1: "Button_1_Monitor," Periodicity: 50ms, Deadline: 50ms.
    - Task 2: "Button_2_Monitor," Periodicity: 50ms, Deadline: 50ms.
    - Task 3: "Periodic_Transmitter," Periodicity: 100ms, Deadline: 100ms.
    - Task 4: "Uart_Receiver," Periodicity: 20ms, Deadline: 20ms.
    - Add two additional tasks to simulate a heavier load:
    - Task 5: "Load_1_Simulation," Periodicity: 10ms, Deadline: 10ms, Execution time: 5ms.
    - Task 6: "Load_2_Simulation," Periodicity: 100ms, Deadline: 100ms, Execution time: 12ms.

- Implement all the tasks mentioned above in the same main.c source file.

Tasks

Task id	Periodicity	Execution time (ms)
T1_Button_1_Monitor	50	0.0144
T2_Button_2_Monitor	50	0.0144
T3_Periodic_Transmitter	100	0.013
T4_Uart_Receiver	20	0.0246
T5_ Load_1_Simulation	10	5
T6_Load_2_Simulation	100	12

The following table is shown the tasks with each (Periodicity, Deadline, Busy time)

Hyper period

Hyper period = LCM (tasks periodicity) =LCM (100,20,10,50) = 100

Task id	Periodicity	Deadline	Busy time (E*(P/H)) (ms)
T1_Button_1_Monitor	50	50	0.0288
T2_Button_2_Monitor	50	50	0.0288
T3_Periodic_Transmitter	100	100	0.01308
T4_Uart_Receiver	20	20	0.0984
T5_ Load_1_Simulation	10	10	25
T6_Load_2_Simulation	100	100	12
Total			37.169

CPU Load

CPU load = (Total busy time / Hyper period)

CPU load = [(13*2) (0.014*2) +0.013+(5*0.0132) +(5*10)+12]/100

= 62.831%

URM Calculation

Task id	Periodicity	Execution time	U
T1_Button_1_Monitor	50	0.0144	0.0144/50
T2_Button_2_Monitor	50	0.0144	0.0144/50
T3_Periodic_Transmitter	100	0.013	0.013/100
T4_Uart_Receiver	20	0.0246	0.0246/20
T5_ Load_1_Simulation	10	5	5/10
T6_Load_2_Simulation	100	12	12/100
Total			0.6219

$$U=\sum_{i=1}^{n}\frac{C_i}{P_i} \leq n(2^{\frac{1}{n}}-1)$$

U = 0.6219 (62.19%)

URM= $n\left(2^{\frac{1}{n}}-1\right) = 6\left(2^{\frac{1}{6}}-1\right)$ = 0.7347 (73.47%)

U ? URM→ U < URM

Time demand Calculation

$$w(t)=e_i + \sum_{k=1}^{i-1} \left\lceil \frac{t}{p_k} \right\rceil e_k \quad for\ 0 < t \leq p_i$$

Task1

$$w(20) = 0.0144 + \left\lceil \frac{20}{10} \right\rceil * 5 + \left\lceil \frac{20}{20} \right\rceil * 0.0137 = 10.0281$$

$$w(25) = 0.0144 + \left\lceil \frac{20}{10} \right\rceil * 5 + \left\lceil \frac{20}{20} \right\rceil * 0.0137 = 12.53$$

$$w(40) = 0.0144 + \left\lceil \frac{40}{10} \right\rceil * 5 + \left\lceil \frac{40}{20} \right\rceil * 0.0137 = 20.0418$$

$$w(50) = 0.0144 + \left\lceil \frac{50}{10} \right\rceil * 5 + \left\lceil \frac{50}{20} \right\rceil * 0.0137 = 25.04$$

: - w(50) < 50 , T1 is schedulable

Task2

$$w(20) = 0.0144 + \left\lceil \frac{20}{10} \right\rceil * 5 + \left\lceil \frac{20}{20} \right\rceil * 0.0137 = 10.0281$$

$$w(25) = 0.0144 + \left\lceil \frac{20}{10} \right\rceil * 5 + \left\lceil \frac{20}{20} \right\rceil * 0.0137 = 12.53$$

$$w(40) = 0.0144 + \left\lceil \frac{40}{10} \right\rceil * 5 + \left\lceil \frac{40}{20} \right\rceil * 0.0137 = 20.0418$$

$$w(50) = 0.0144 + \left\lceil \frac{50}{10} \right\rceil * 5 + \left\lceil \frac{50}{20} \right\rceil * 0.0137 = 25.04$$

: - w(50) < 50 , T2 is schedulable

Task3

$$w(50) = 0.013 + \left\lceil \frac{50}{10} \right\rceil * 5 + \left\lceil \frac{50}{20} \right\rceil * 0.0137 + \left\lceil \frac{50}{50} \right\rceil * 0.014 + \left\lceil \frac{50}{50} \right\rceil * 0.014 = 25.07$$

$$w(70) = 0.013 + \left\lceil \frac{70}{10} \right\rceil * 5 + \left\lceil \frac{70}{20} \right\rceil * 0.0137 + \left\lceil \frac{70}{50} \right\rceil * 0.014 + \left\lceil \frac{70}{50} \right\rceil * 0.014 = 35.1$$

$$w(90) = 0.013 + \left\lceil \frac{90}{10} \right\rceil * 5 + \left\lceil \frac{90}{20} \right\rceil * 0.0137 + \left\lceil \frac{90}{50} \right\rceil * 0.014 + \left\lceil \frac{90}{50} \right\rceil * 0.014 = 45.125$$

$$w(100) = 0.013 + \left\lceil \frac{100}{10} \right\rceil * 5 + \left\lceil \frac{100}{20} \right\rceil * 0.0137 + \left\lceil \frac{100}{50} \right\rceil * 0.014 + \left\lceil \frac{100}{50} \right\rceil * 0.014 = 50.1375$$

: - w(100) < 100 , T3 is schedulable

Task4

$$w(10) = 0.013 + \left\lceil \frac{10}{10} \right\rceil * 5 = 5.013$$

$$w(20) = 0.013 + \left\lceil \frac{20}{10} \right\rceil * 5 = 10.013$$

: - w(20) < 20 , T4 is schedulable

Task5

$$w(1) = 5 + 0 = 5$$

$$w(2) = 5 + 0 = 5$$

$$w(5) = 5 + 0 = 5$$

: - w(5) < 5 , T4 is schedulable

Task6

$$w(50) = 12 + \left\lceil \frac{50}{10} \right\rceil * 5 + \left\lceil \frac{50}{20} \right\rceil * 0.0137 + \left\lceil \frac{50}{50} \right\rceil * 0.014 + \left\lceil \frac{50}{50} \right\rceil * 0.014 = 25.07$$

$$w(70) = 12 + \left\lceil \frac{70}{10} \right\rceil * 5 + \left\lceil \frac{70}{20} \right\rceil * 0.0137 + \left\lceil \frac{70}{50} \right\rceil * 0.014 + \left\lceil \frac{70}{50} \right\rceil * 0.014 = 35.1$$

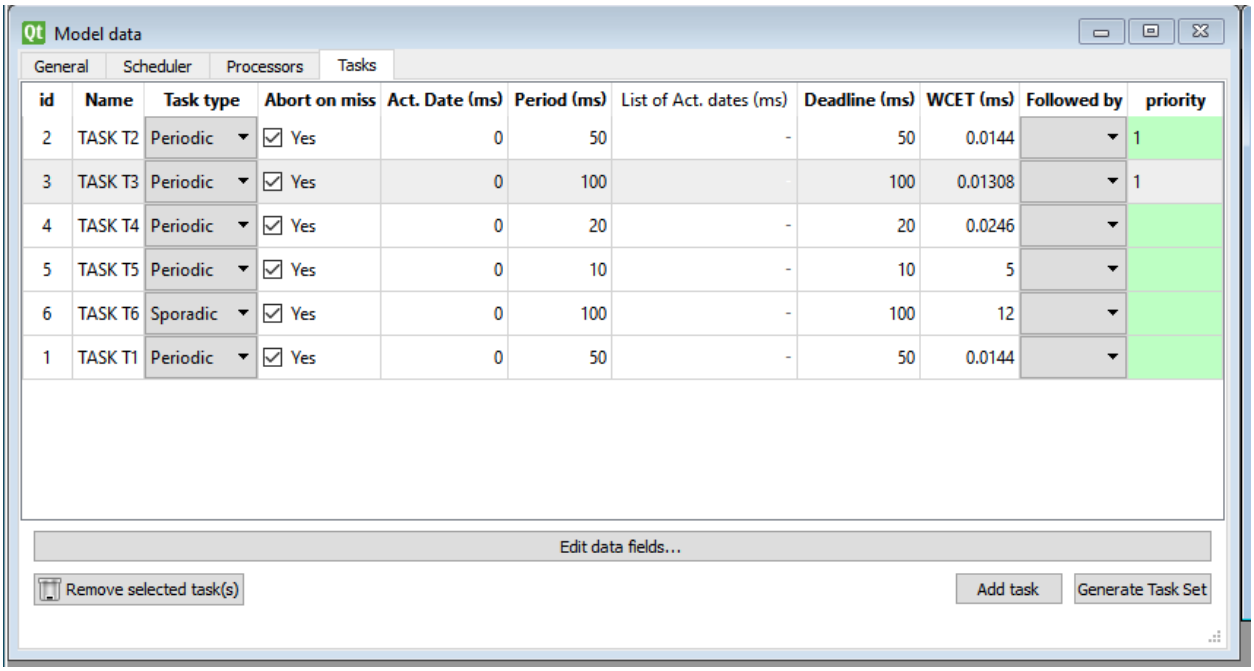
$$w(90) = 12 + \left\lceil \frac{90}{10} \right\rceil * 5 + \left\lceil \frac{90}{20} \right\rceil * 0.0137 + \left\lceil \frac{90}{50} \right\rceil * 0.014 + \left\lceil \frac{90}{50} \right\rceil * 0.014 = 5.112$$

$$w(100) = 12 + \left\lceil \frac{100}{10} \right\rceil * 5 + \left\lceil \frac{100}{20} \right\rceil * 0.0137 + \left\lceil \frac{100}{50} \right\rceil * 0.014 + \left\lceil \frac{100}{50} \right\rceil * 0.014 = 62.12$$

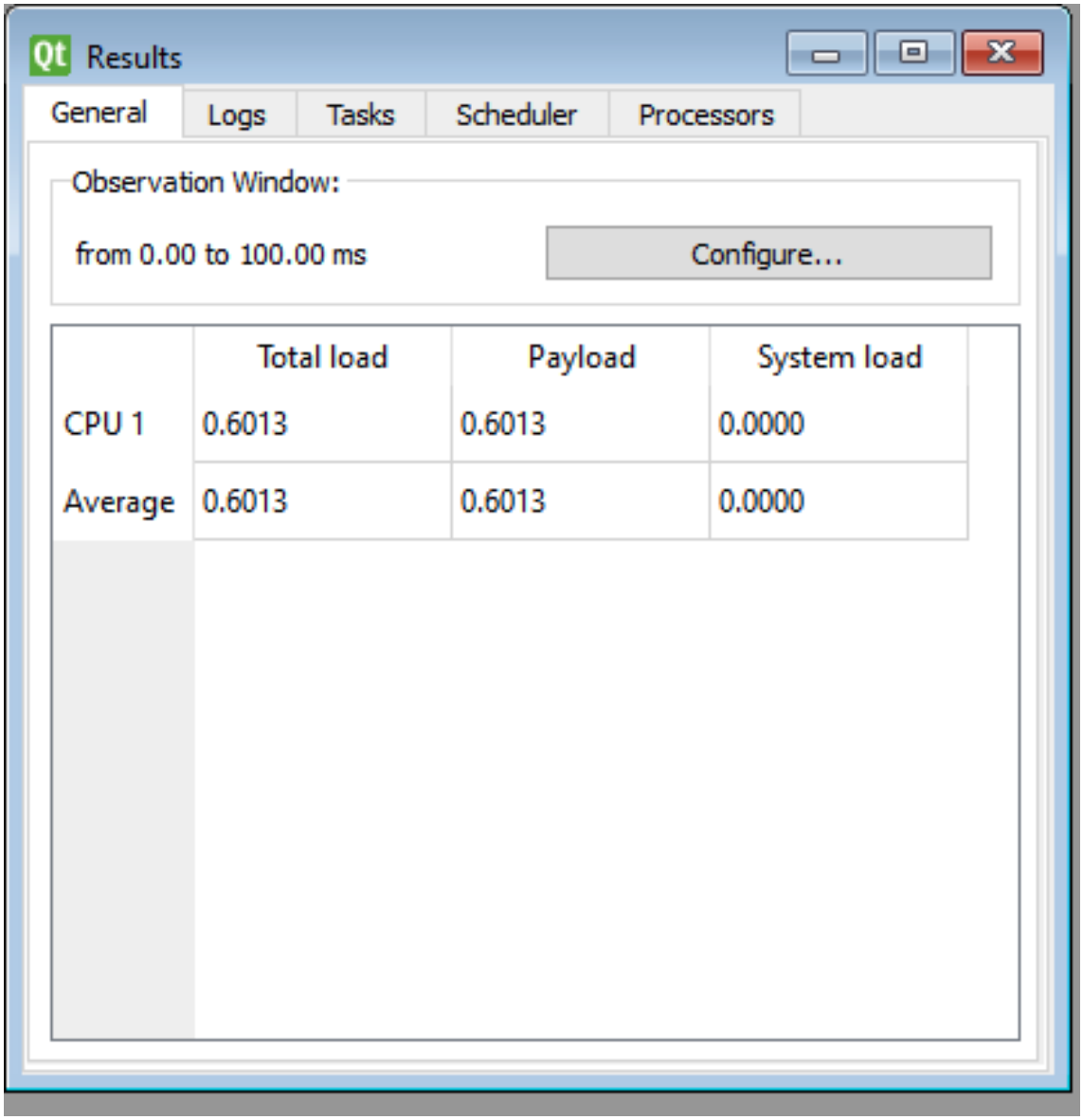
: - *w(100) < 100 , T6 is schedulable*

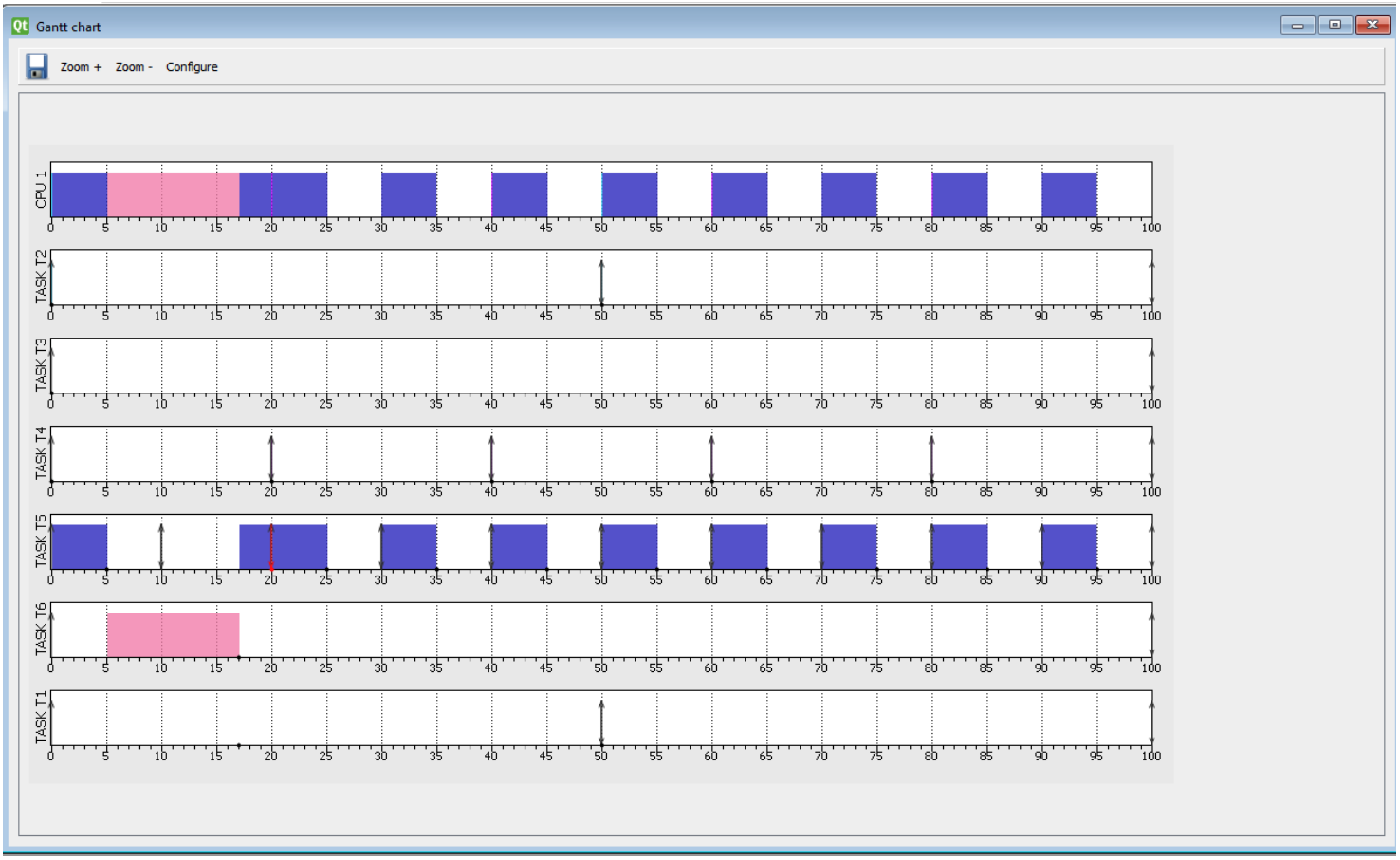
NB: After we made URM calculation and Time demand calculation on this task , we noticed that the two calculations leading to the same result that the system is schedulable

Simulation on SimSo



id	Name	Task type	Abort on miss	Act. Date (ms)	Period (ms)	List of Act. dates (ms)	Deadline (ms)	WCET (ms)	Followed by	priority
2	TASK T2	Periodic	Yes	0	50	-	50	0.0144		1
3	TASK T3	Periodic	Yes	0	100	-	100	0.01308		1
4	TASK T4	Periodic	Yes	0	20	-	20	0.0246		
5	TASK T5	Periodic	Yes	0	10	-	10	5		
6	TASK T6	Sporadic	Yes	0	100	-	100	12		
1	TASK T1	Periodic	Yes	0	50	-	50	0.0144		


Results
General
Logs
Tasks
Scheduler
Processors
Observation Window:
from 0.00 to 100.00 ms
Configure...
Total load
Payload
System load
CPU 1
0.6013
0.6013
0.0000
Average
0.6013
0.6013
0.0000


Gantt chart
Zoom +
Zoom -
Configure
CPU 1
TASK T2
TASK T3
TASK T4
TASK T5
TASK T6
TASK T1
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100