Real-time operating systems project

Implementing EDF scheduler based on FREE RTOS

Name: Hady Emad Mohamed

Email: hady_emad@outlook.com

Analytical calculations:

Task	Task period	Task maximum execution time
Button 1	50ms	18us
Button 2	50ms	18us
Periodic Transmitter	100ms	20us
UART	20ms	63us
Load 1	10ms	5ms
Load 2	100ms	12ms

1. System hyper period = 100 ms

2. CPU Load = $\frac{\sum Task\ Execution\ Time}{\sum Task\ Period}$

$$= \frac{18}{50000} + \frac{18}{50000} + \frac{20}{100000} + \frac{63}{20000} + \frac{5}{10} + \frac{12}{100}$$

= 62.4%

3. System schedulablity

   - URM analysis:

   $URM = n\ [\ 2^{\frac{1}{n}} - 1]$ = 0.735
   U = 0.624

   Since $U < URM$

   Then system is guaranteed schedulable using URM method

- Time demand analysis

Task	**Task priority in case of RM scheduling**	**Periodicity**	**Task maximum execution time (ms)**
Load 1	4	10	5
UART	3	20	0.063
Button 1	2	50	0.018
Button 2	2	50	0.018
Load 2	1	100	12
Periodic transmitter	1	100	0.02

Time demand analysis equation: $W_i(t) = e_i + \sum_{k=1}^{i-1}[\frac{t}{P_k}]e_k$

For Load 1: $W(10) = 5$, P = 10

Then W < P, Load 1 task is schedulable

For UART: $W(20) = 0.063 + \frac{20}{10} \times 5 = 10.063$, P =20

Then W < P, UART task is schedulable

For Button 1: $W(50) = 0.018 + ceil(\frac{50}{20}) \times 0.063 + \frac{50}{10} \times 5 = 25.207$, P =50

Then W < P, Button 1 task is schedulable

For Button 2: $W(50) = 0.018 + 0.018 + ceil(\frac{50}{20}) \times 0.063 + \frac{50}{10} \times 5 = 25.225$, P =50

Then W < P, Button 2 task is schedulable

For Load 2: $W(100) = 12 + \frac{100}{50} \times 0.018 + \frac{100}{50} \times 0.018 + \frac{100}{20} \times 0.063 + \frac{100}{10} \times 5 = 62.387$, P = 100

Then W < P, Load 2 task is schedulable

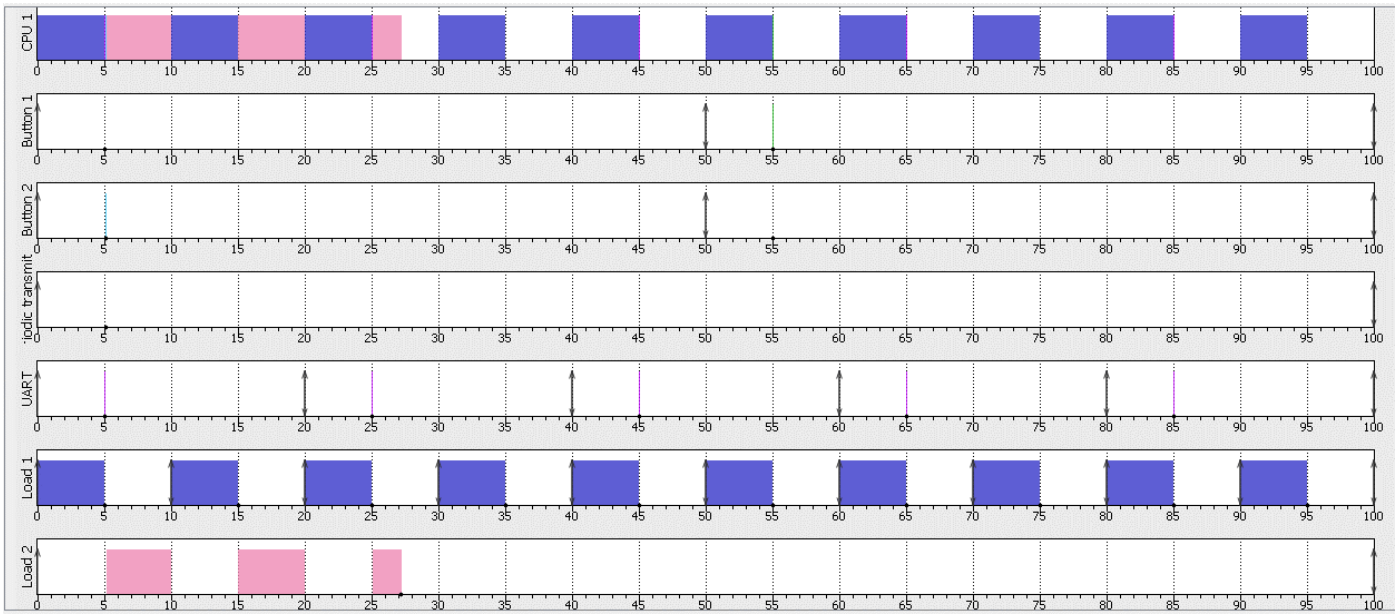
For Periodic transmitter: $W(100) = 0.02 + 12 + \frac{100}{50} \times 0.018 + \frac{100}{50} \times 0.018 + \frac{100}{20} \times 0.063 + \frac{100}{10} \times 5 = 62.407$, P = 100

Then W < P, Periodic transmitter task is schedulable

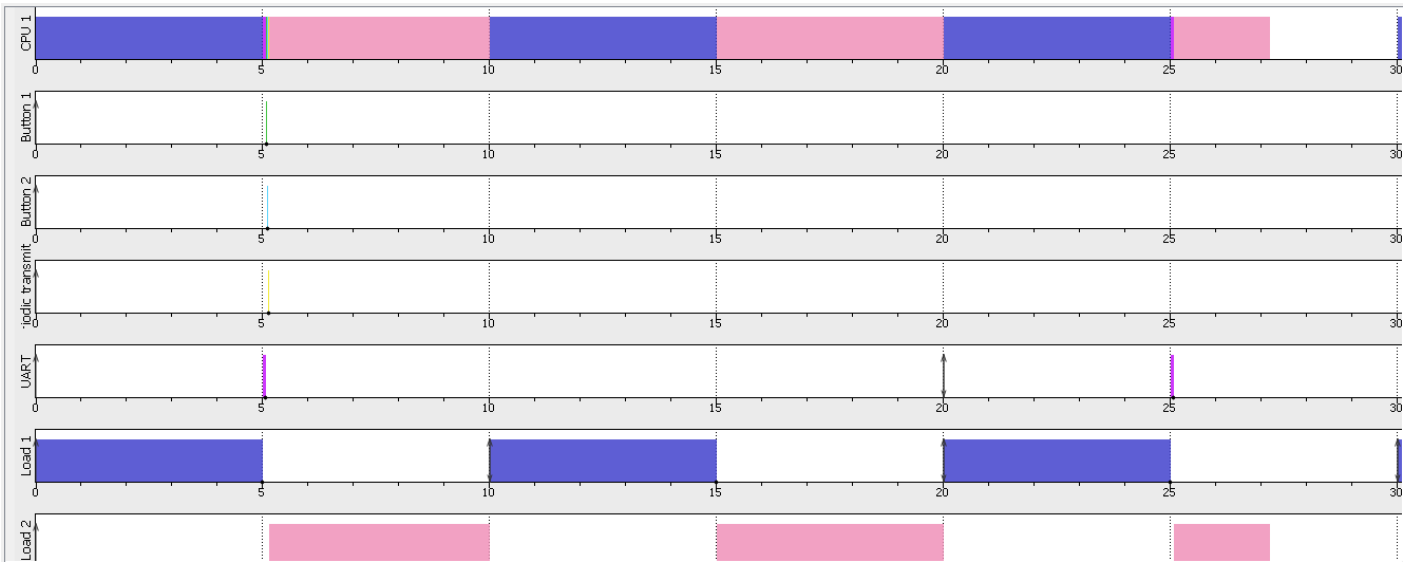
Then using time demand analysis all tasks are schedulable

Simso offline simulator:

- Fixed priority rate monotonic scheduling



- Another zoomed view so button 1, button 2 and periodic transmitter tasks can be seen



Keil simulation:

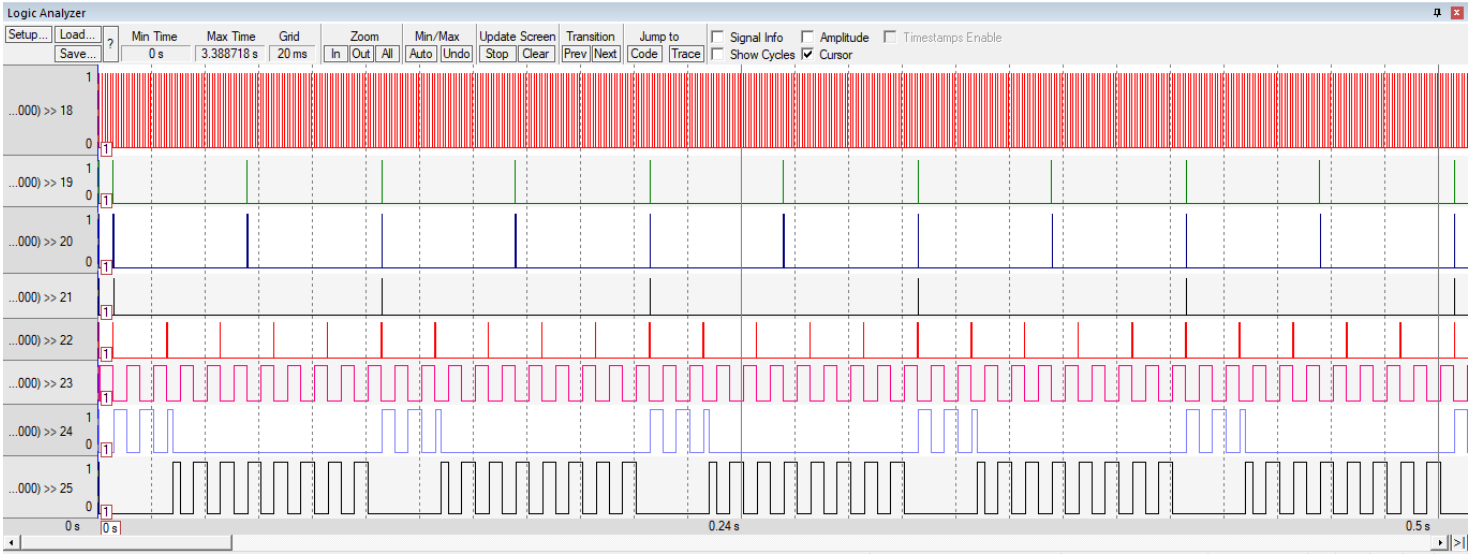
1. CPU time and load, and all tasks time

Watch 1

Name	Value	Type
system_time	3385416	int
cpu_load	62	int
Button_1_total_time	0x00000378	int
Button_2_total_time	0x00000395	int
Periodic_total_time	0x00000274	int
UART_total_time	0x00000FC2	int
Load_1_total_time	0x0019EC58	int
Load_2_total_time	0x00064537	int
<Enter expression>		

Timer is prescaled so that each tick corresponds to 1 microsecond, so all the shown times are in microseconds

2. Tasks, tick hook and idle task plotted on logic analyzer



- Signal 1: Tick hook
- Signal 2: Button 1 task
- Signal 3: Button 2 task
- Signal 4: Periodic transmitter task

- Signal 5: UART task
- Signal 6: Load 1 task
- Signal 7: Load 2 task
- Signal 8: Idle task

Results of all analysis is as expected and matches the manual analytical calculations