



1 Verifying tasks

- T₁: Button_1_Monitor (P=50, C=0.012, D=50).
- T₂: Button_2_Monitor (P=50, C=0.012, D=50).
- T₃: Periodic_Transmitter (P=100, C=0.013, D=100).
- T₄: Uart_Receiver (P=20, C=0.012, D=20).
- T₅: Load_1_Simulation (P=10, C=5, D=10).
- T₆: Load_2_Simulation (P=100, C=12, D=100).

2 Hyper Period

The hyper period is the least common multiplier of all tasks' periodicities, $H = 100 \text{ ms}$.

3 Calculating CPU load

CPU load or Utilization (U) is the percentage of time of executing tasks in the hyper period to the hyper period.

3.1 Analytical method

$$U = \frac{\sum_{i=1}^n \left(\frac{H}{P_i} \right) \times C_i}{H}$$

$$= \frac{\left(\frac{100}{50} \right) \times 0.012 + \left(\frac{100}{50} \right) \times 0.012 + \left(\frac{100}{100} \right) \times 0.013 + \left(\frac{100}{20} \right) \times 0.012 + \left(\frac{100}{10} \right) \times 5 + \left(\frac{100}{100} \right) \times 12}{100}$$

$$= 0.62121 = 62.121\%$$

3.2 Offline simulation method using SimSo

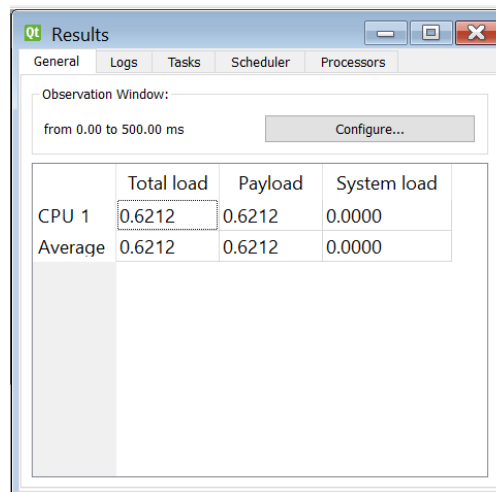


Figure 3-1 CPU load in SimSo



4 Schedulability checking

Assuming the given set of tasks is scheduled using a fixed priority rate-monotonic scheduler then the verifying tasks' priorities will be:

$$p_1 = 2$$

$$p_2 = 2$$

$$p_3 = 1$$

$$p_4 = 3$$

$$p_5 = 4$$

$$p_6 = 1$$

4.1 Utilization rate-monotonic URM method

$$URM = n \left(2^{\left(\frac{1}{n}\right)} - 1 \right) = 6 \left(2^{\left(\frac{1}{6}\right)} - 1 \right) = .73477 = 73.477\%$$

$$U = \sum_{i=1}^n \frac{C_i}{P_i} = \frac{0.012}{50} + \frac{0.012}{50} + \frac{0.013}{50} + \frac{0.012}{20} + \frac{5}{10} + \frac{12}{100} = 0.62134 = 62.134\%$$

As $U < URM$ and $U < 100\%$ then these tasks are guaranteed schedulable.

4.2 Time demand method

Tasks are checked in order depending on their priorities. The time required for each task is calculated from $W_i(t) = C_i + \sum_{k=1}^i \left(\frac{t}{P_i} \right) \times C_i$ as t is the deadline of this task.

4.2.1 T₅ checking

T₅: (P=10, C=5, D=10).

Time required = 10.

Time provided: $W_5(10) = 5 + 0 = 5 < 10$ (schedulable).

4.2.2 T₄ checking

T₄: (P=20, C=0.012, D=20).

Time required = 20.

Time provided: $W_4(20) = 0.012 + \left(\frac{20}{10} \right) \times 5 = 10.012 < 20$ (schedulable).

4.2.3 T₁ and T₂ checking

T₁: (P=50, C=0.012, D=50).

T₂: (P=50, C=0.012, D=50).

As both tasks have the same deadline then we can't predict which one will execute first but as both of them has the same execution time so if the last executed one of them is schedulable whatever each one is the first and each is the last then both of them are schedulable.

$$W_{1,2}(50) = 0.012 + \left(\frac{50}{10}\right) * 5 + \left(\frac{50}{20}\right) * 0.012 + \left(\frac{50}{50}\right) * 0.012 = 25.06 < 50 \text{ (schedulable)}.$$

4.2.4 T₃ and T₆ checking

T₃: (P=100, C=0.013, D=100).

T₆: (P=100, C=12, D=100).

As both tasks have the same deadline then we can't predict which one will execute first and the two tasks have different execution times so every task will be treated to be the last executed one as a worst-case scenario.

$$W_3(100) = 0.013 + \left(\frac{100}{10}\right) * 5 + \left(\frac{100}{20}\right) * 0.012 + \left(\frac{100}{50}\right) * 0.012 + \left(\frac{100}{50}\right) * 0.012 + \left(\frac{100}{100}\right) * 0.012 = 62.108 < 100 \text{ (schedulable)}.$$

$$W_6(100) = 12 + \left(\frac{100}{10}\right) * 5 + \left(\frac{100}{20}\right) * 0.012 + \left(\frac{100}{50}\right) * 0.012 + \left(\frac{100}{50}\right) * 0.012 + \left(\frac{100}{100}\right) * 0.013 = 62.108 < 100 \text{ (schedulable)}.$$

4.3 Comment

The analytical results are the same as SimSo results as all tasks meet their deadlines.

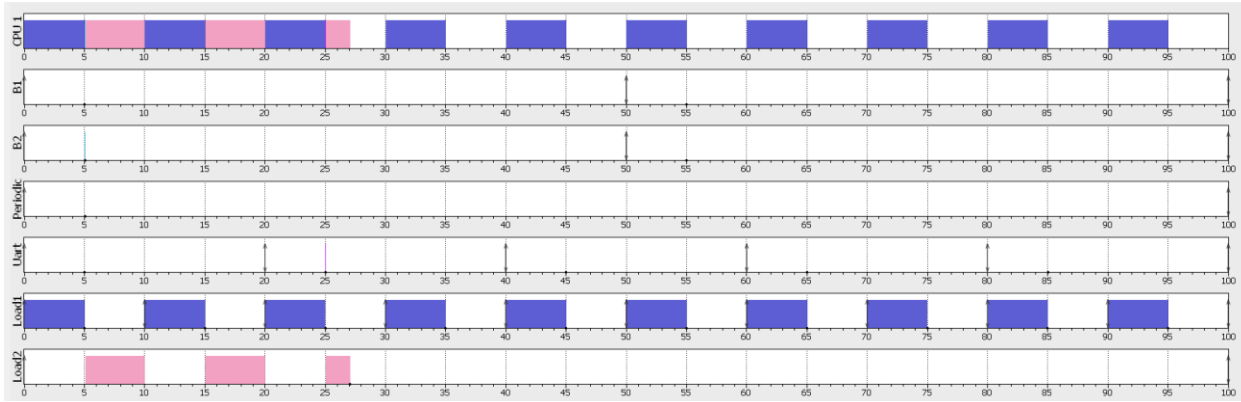


Figure 4-1 A hyper period with no deadline missing in SimSo

5 Offline simulation v.s implemented scheduler

In this section, we will compare the Gant chart generated by SimSo and the tasks' tracing generated by the logic analyzer for the implemented scheduler for the same set of tasks mentioned in the first section.

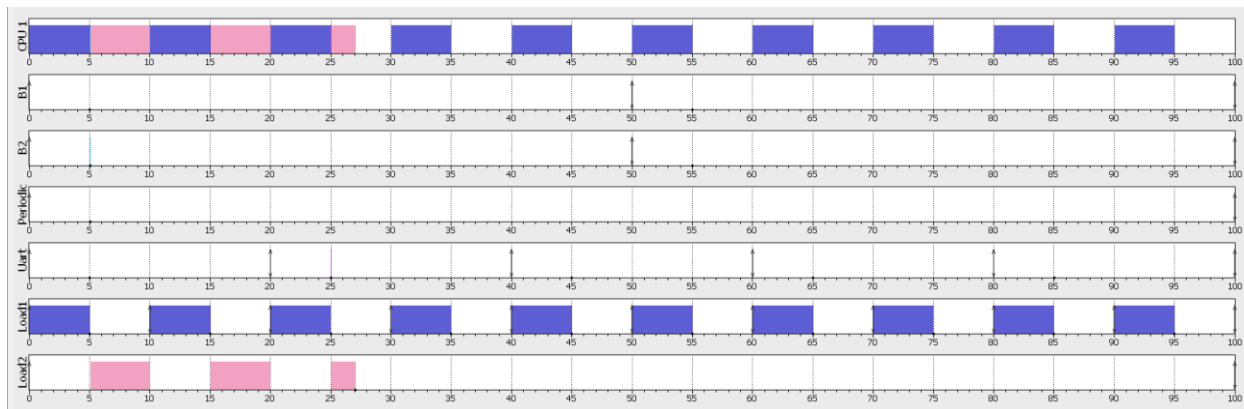


Figure 5-2 SimSo hyper period Gant chart

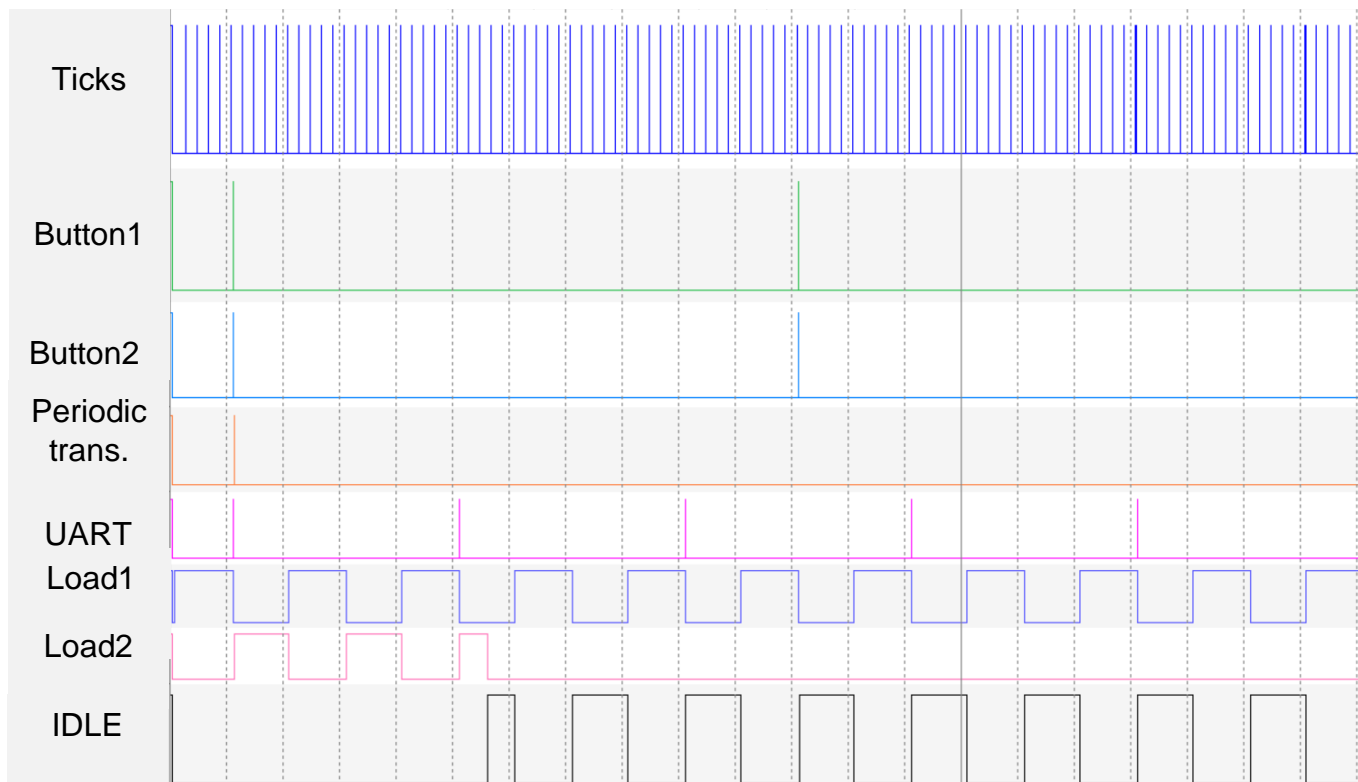


Figure 5-1 logic analyzer tracing for a hyper period

As shown that the two charts are identical except for the first four tasks because their execution time is very small compared with other tasks so they are not visualized clearly in SimSo but if we zoomed in at for example tick five we will be able to compare between the two charts.

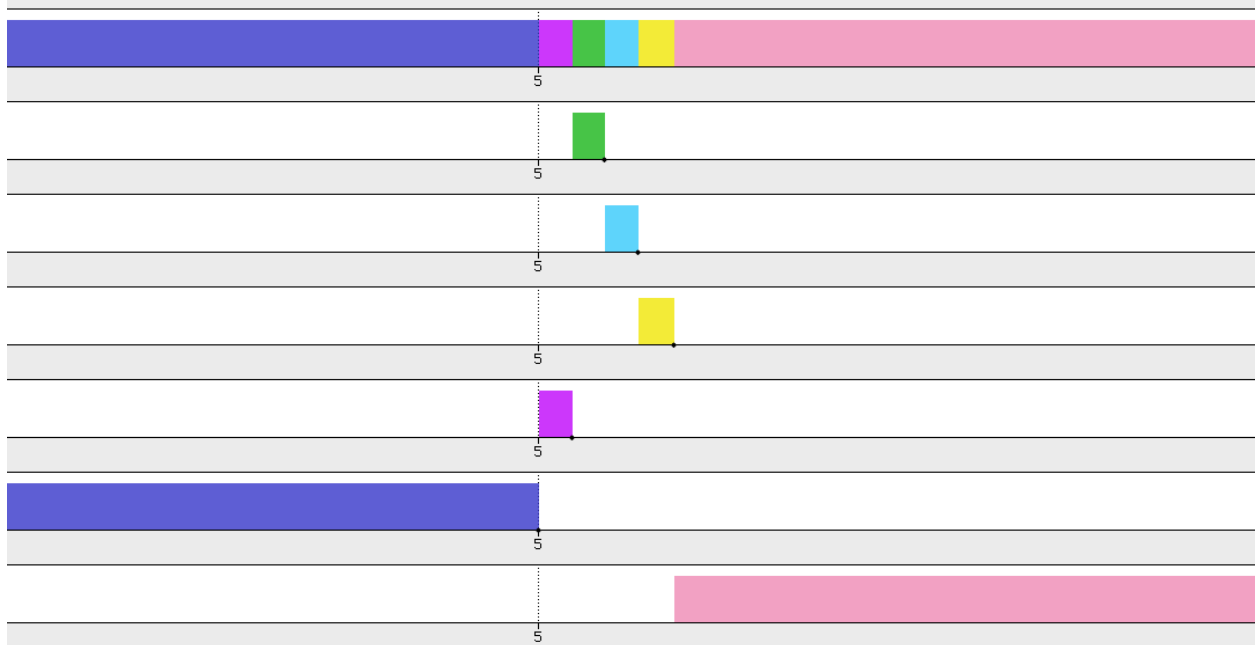


Figure 5-4 SimSo Zooming in tick 5

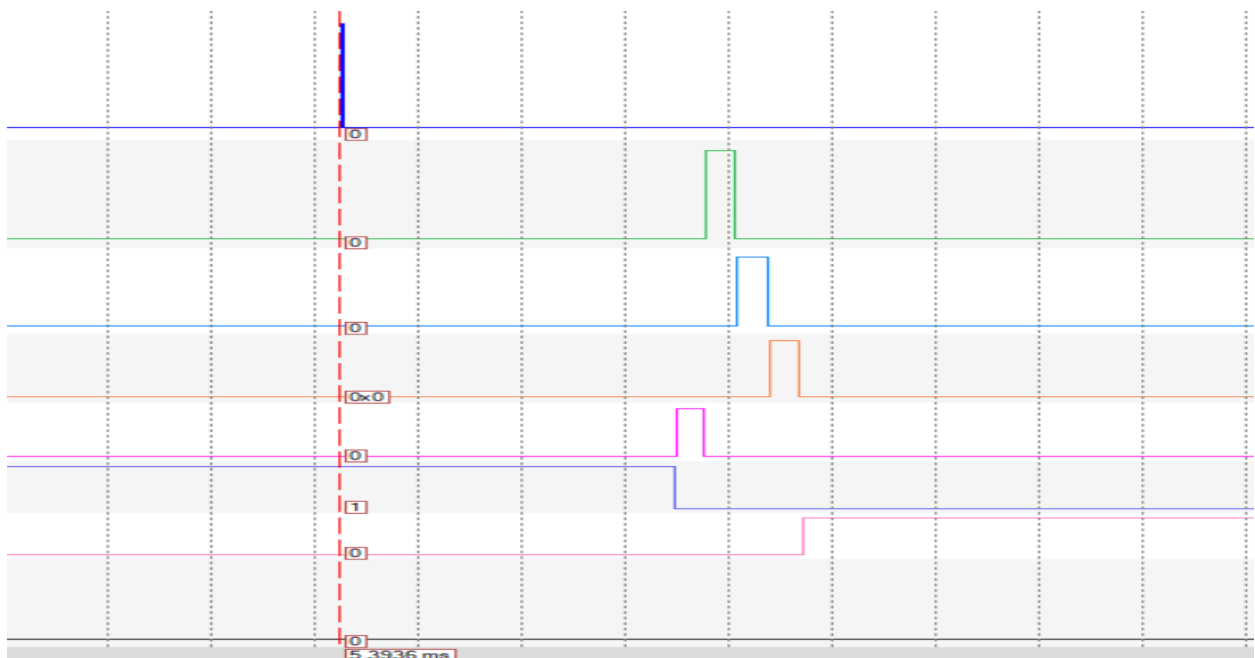


Figure 5-3 Logic analyzer zooming in tick 5



Now we can see that both charts are completely identical and the EDF scheduler is implemented successfully, and all tasks behave as expected.