Automotive Door Control System Design

Fully Dynamic Design

Egypt FWD – Advanced Embedded Systems

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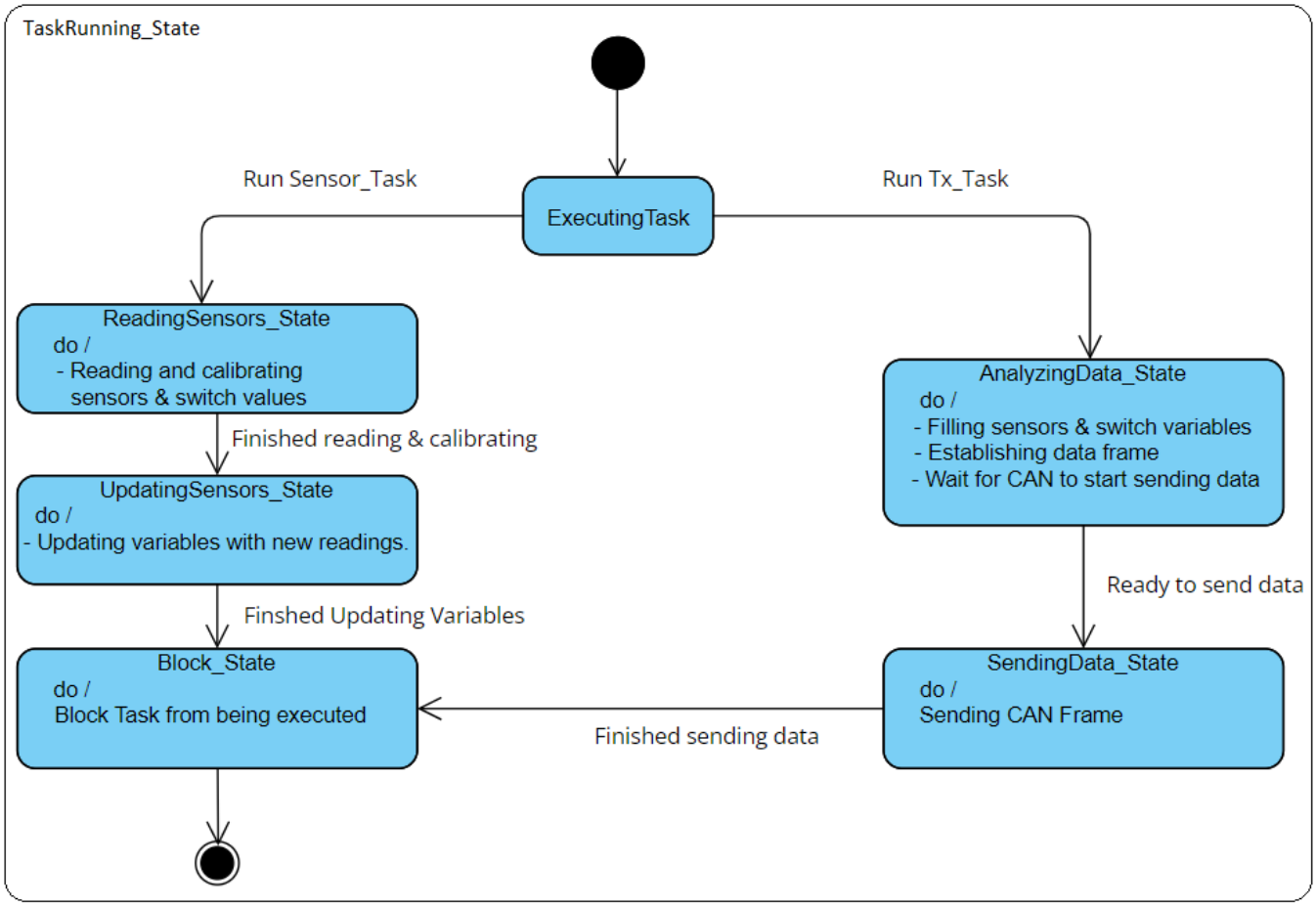
I. ECU 1:

a. **State Machine Diagram For Each ECU 1 Component**:

As ECU 1 uses RTOS, For any running task “TaskRunning_State” we can consider ECU 1 RTOS tasks as two types, first, tasks dealing with sensors and light switch which described in state diagram as “Run Sensor_Task”.

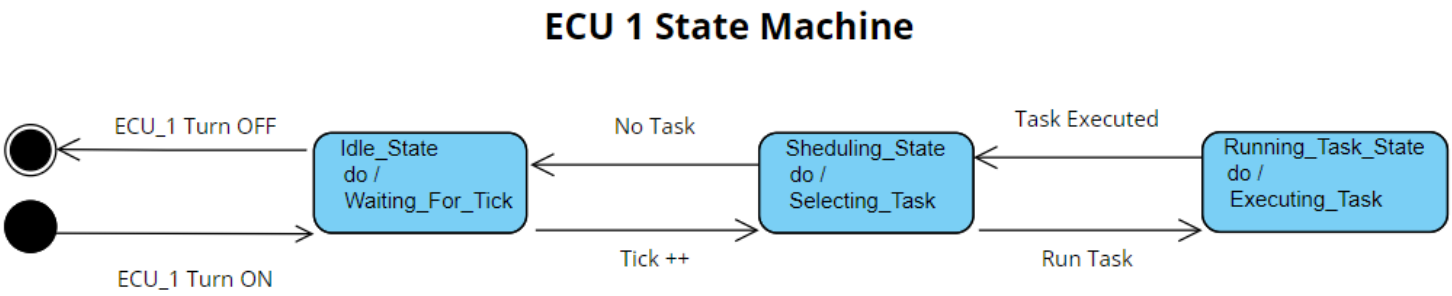
Another type is sending tasks which described in state diagram as “Run Tx_Task”.

ECU1 Components State Machine

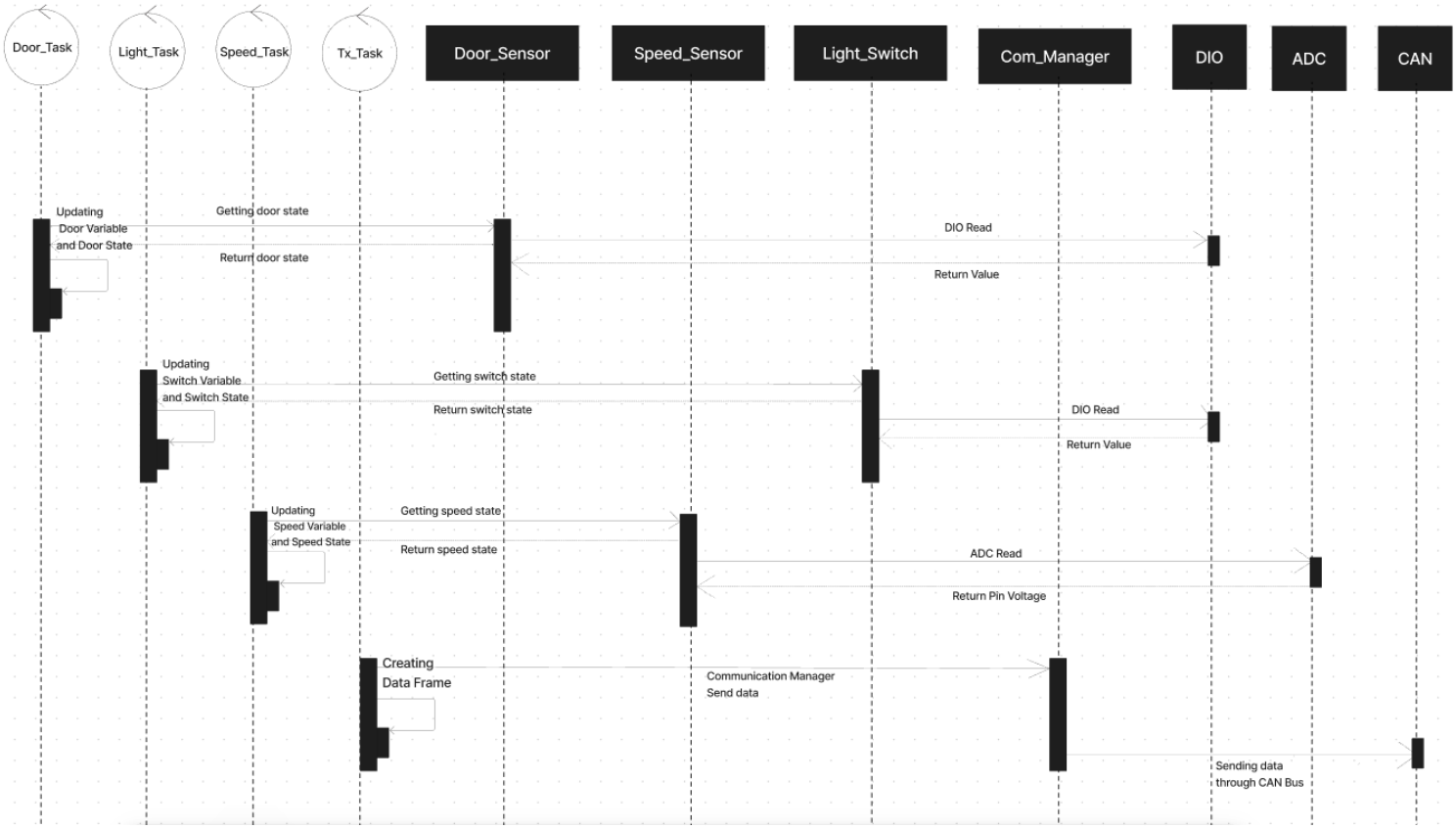


b. **State Machine Diagram For The ECU 1 Operation**:

As described in state machine diagram RTOS scheduling and handles all tasks.

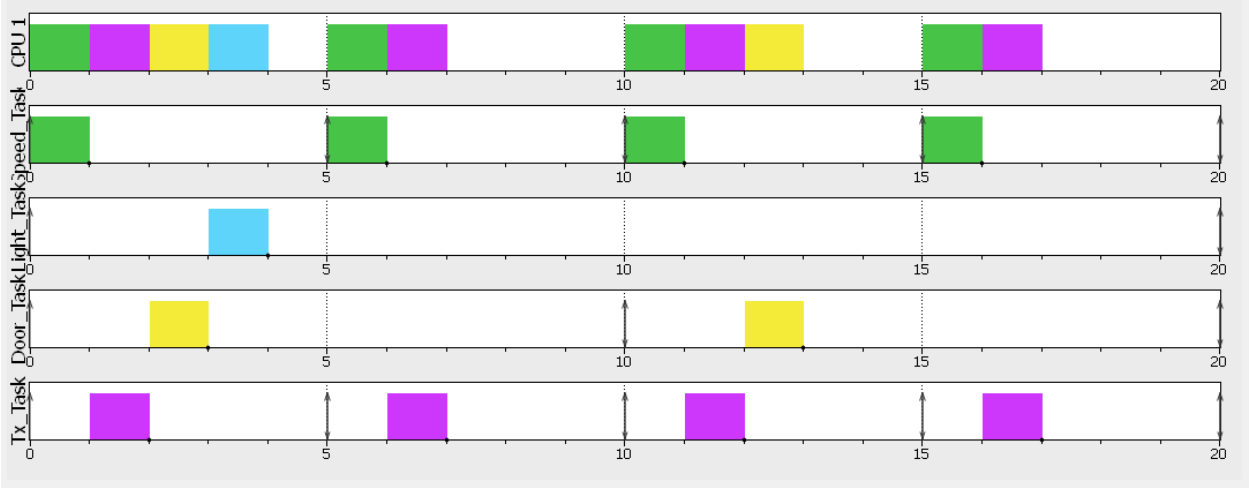


c. **Sequence Diagram For The ECU 1**:



d. CPU load for the ECU 1:

Using Simso (assuming execution time of all tasks is 1 ms)



Observation Window:

from 0.00 to 20.00 ms

	Total load	Payload	System load
CPU 1	0.5500	0.5500	0.0000
Average	0.5500	0.5500	0.0000

CPU Load = 55%

Also we can calculate it manually,

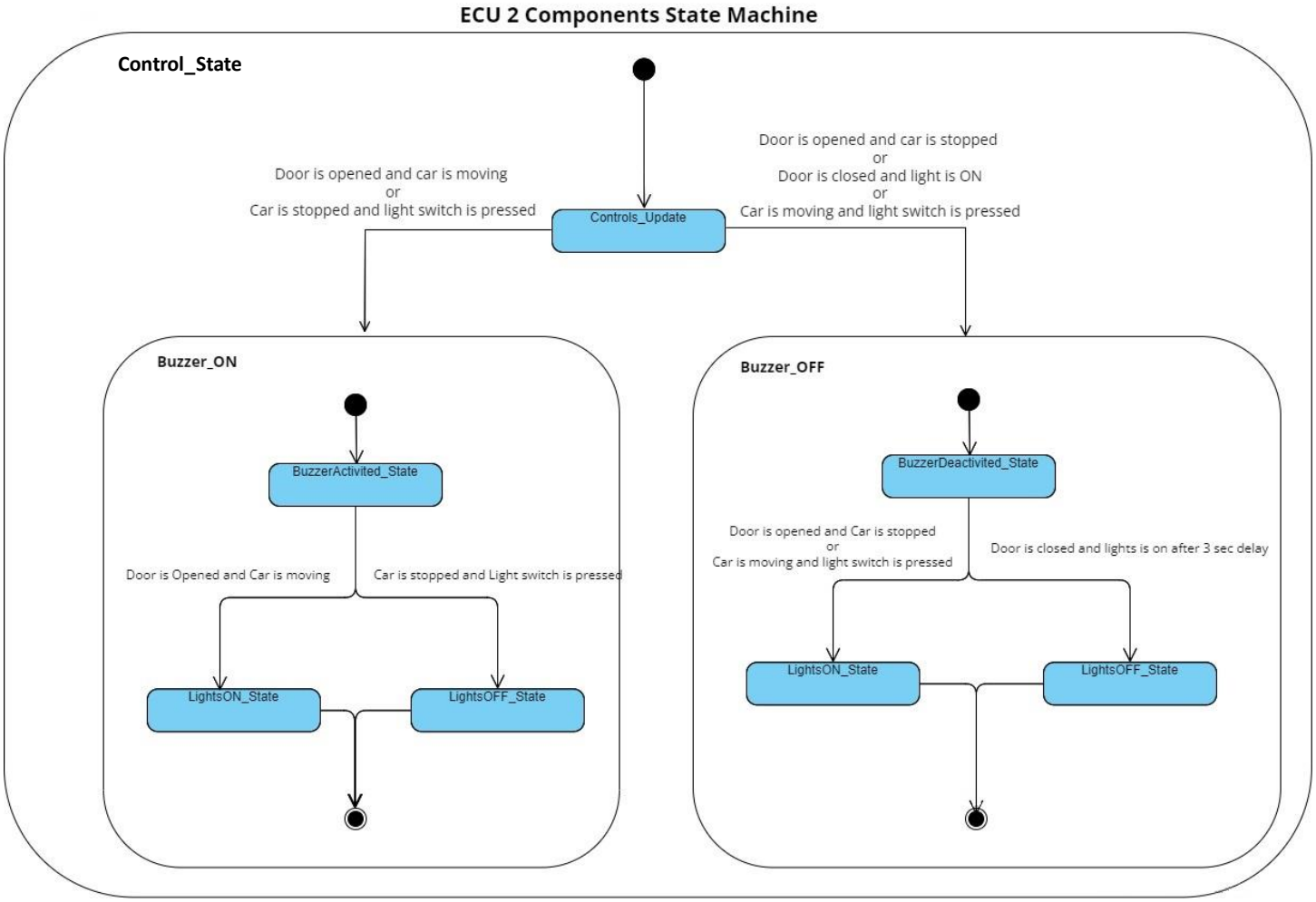
As we know, Door_Task Periodicity is 10ms, Speed_Task Periodicity is 5ms, Light_Task Periodicity is 20ms ,Tx_Task Periodicity is 5ms & Hyperperiod is 20 ms.

CPU Load = (1*1 + 4*1 + 2*1 + 4*1) / 20 = 0.55 = **55%**

II. ECU 2:

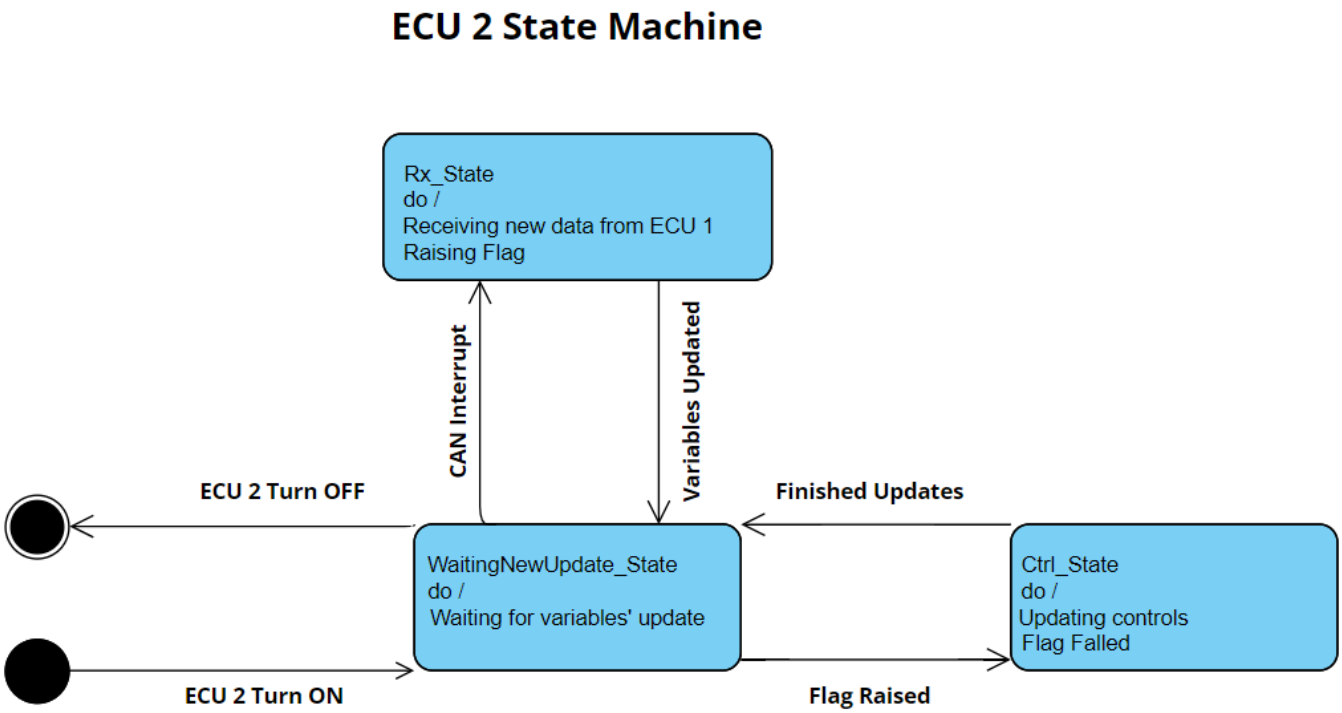
a. State Machine Diagram For Each ECU 2 Component:

control_state controls RL, LF, and Buzzer, based on data received from CAN Bus, according to a specific logic (described on the state machine diagram).

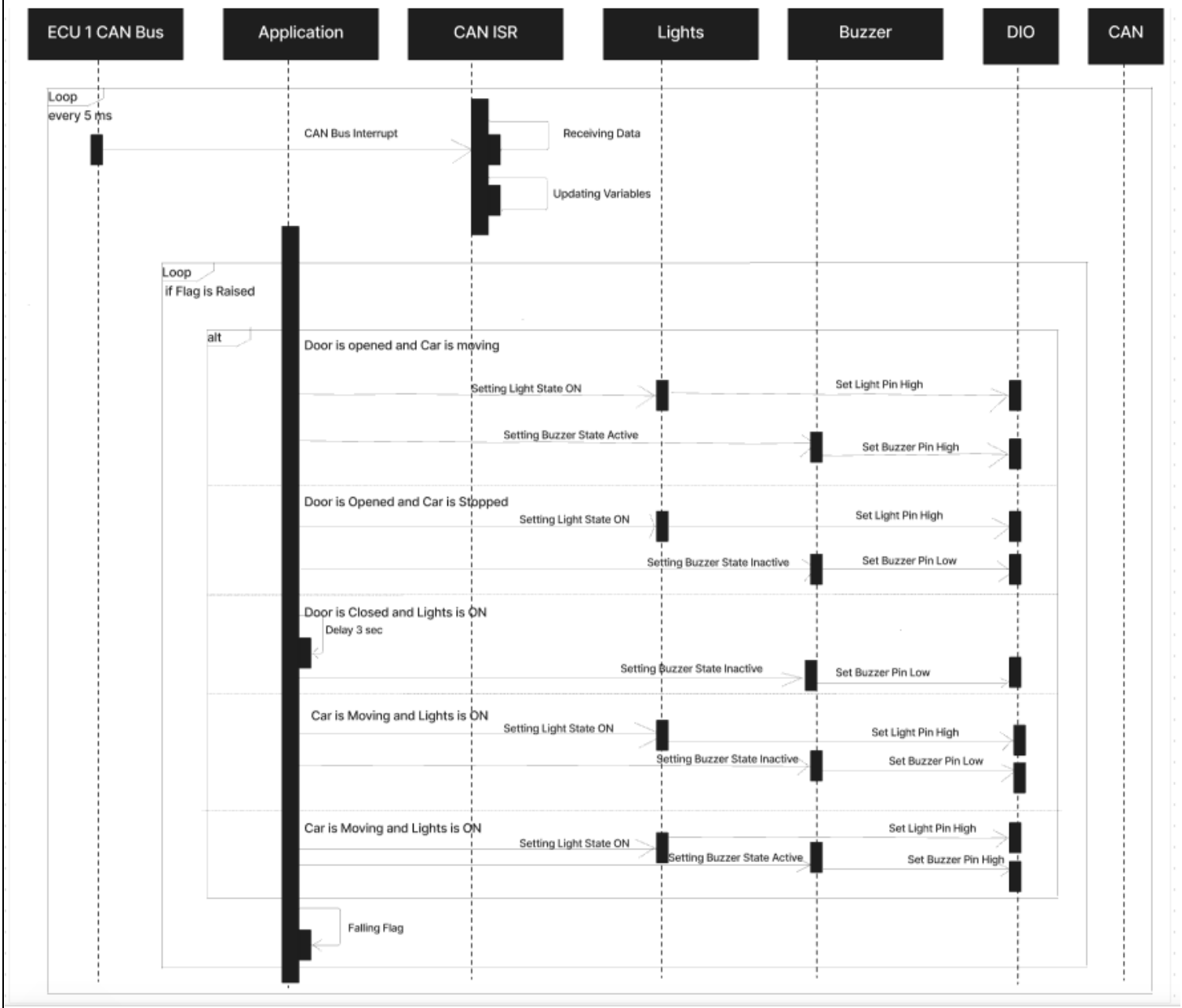


b. State Machine Diagram For The ECU 2 Operation:

ECU 2 runs Event Triggerd OS, as it triggered by receiving sensors & switch states from ECU 1 through CAN Bus, then taking actions based on received values.



c. Sequence Diagram For ECU 2:



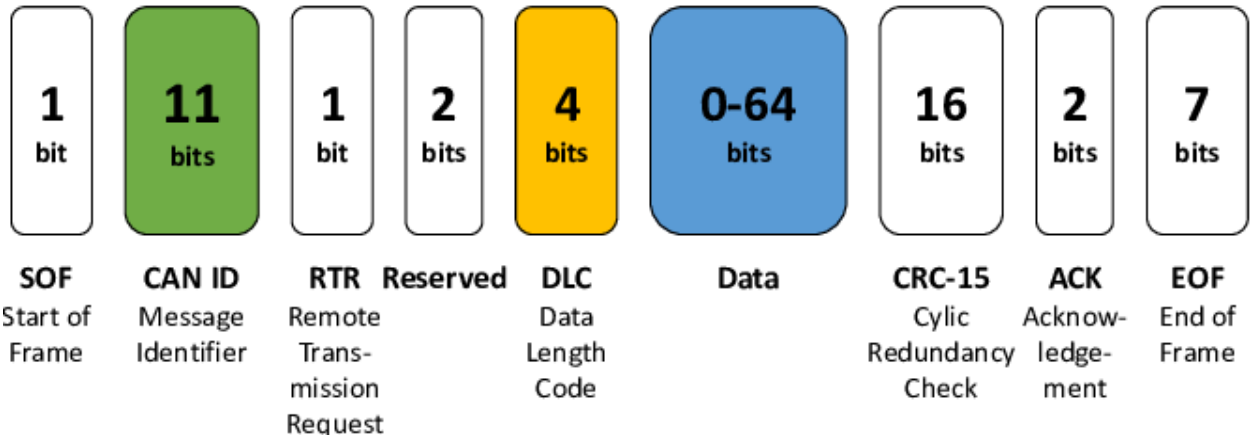
d. <u>CPU load for the ECU 2:</u>

By Assuming:

Rx_Task execution time is 1 ms, Control_Task execution time is 2 ms, Hyperperiod is 5 ms [as Tx_Task (From ECU1) periodicity is 5 ms].

CPU Load = [(1*2 + 1*1) / 5] = 0.6 = **60%**

III. System Bus Load:



As Tx_Task Periodicity is 5 ms,

(Message Rate) Num of messages per second = 200 message / sec.

Assuming our message is 8 bit, so total width of CAN Frame = 111 bits.

Total number of bits send through CAN Bus in 1 sec = 200*111 = 22200 bits/sec

Assuming CAN Bus baud rate = 125 kbits/sec

So, time required for bit to be send = 1/(125*1024) = 7.8 uS

Time to send whole frame = 7.8 uS * 22200 = 173.4 ms

From perious results, Bus load in 1 sec = 0.1734 * 100 = **17.3 %**