

Ministry of Communications
and Information Technology

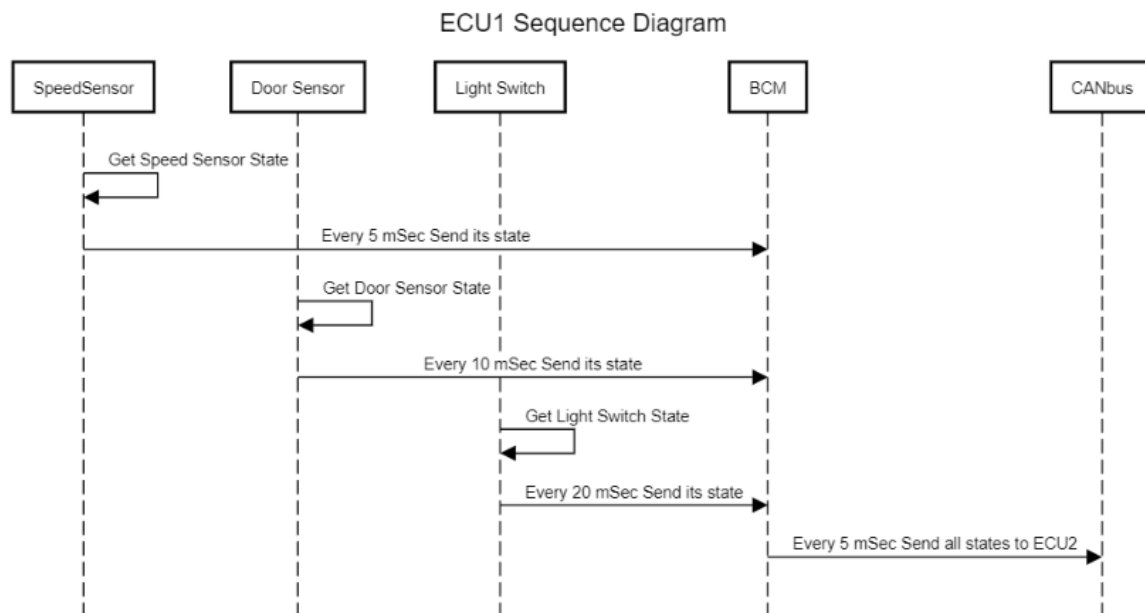


egypt
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مستقبلنا رقمي

Dynamic Design for Microcontrollers

By: Ahmed Sayed

- **ECU1 Sequence Diagram (<https://sequencediagram.org/>)**

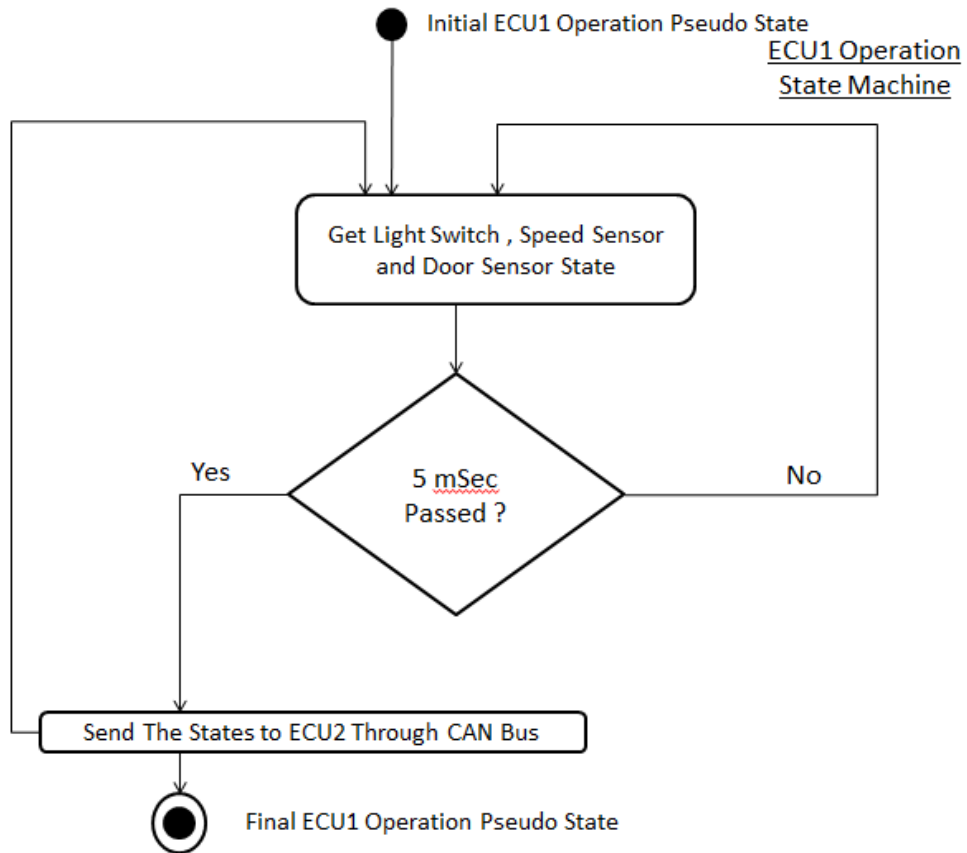


Code For Generating this Sequence Diagram :

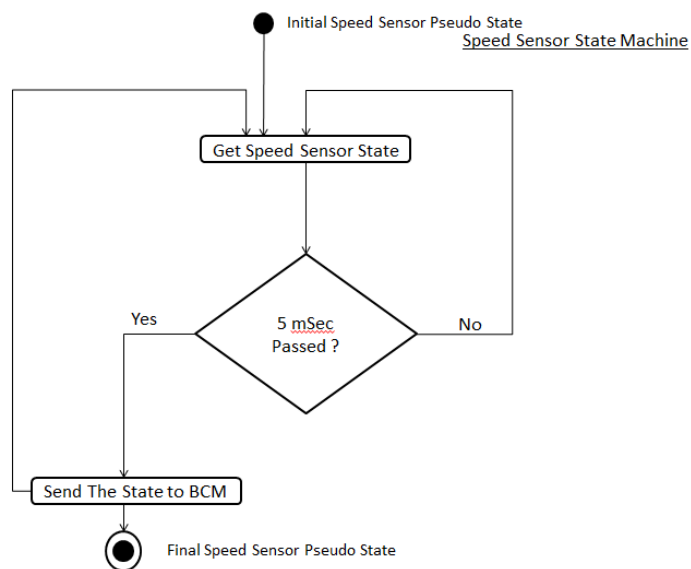
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title ECU1 Sequence Diagram
participant SpeedSensor
participant Door Sensor
participant Light Switch
participant BCM
participant CANbus
SpeedSensor->>SpeedSensor: Get Speed Sensor State
SpeedSensor->>BCM: Every 5 mSec Send its state
Door Sensor->>Door Sensor: Get Door Sensor State
Door Sensor->>BCM: Every 10 mSec Send its state
Light Switch->>Light Switch : Get Light Switch State
Light Switch->>BCM: Every 20 mSec Send its state
BCM->>CANbus: Every 5 mSec Send all states to ECU2
  
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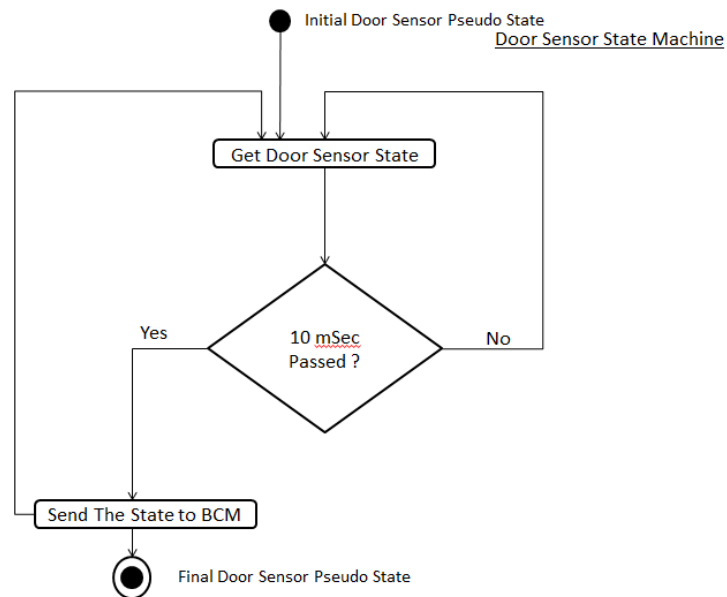
- ECU1 State Machine Operation



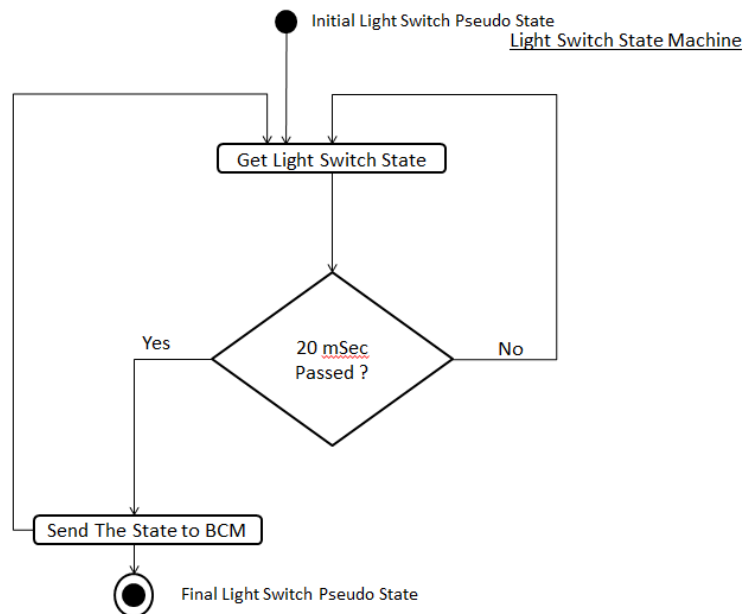
- State Machine For Speed Sensor



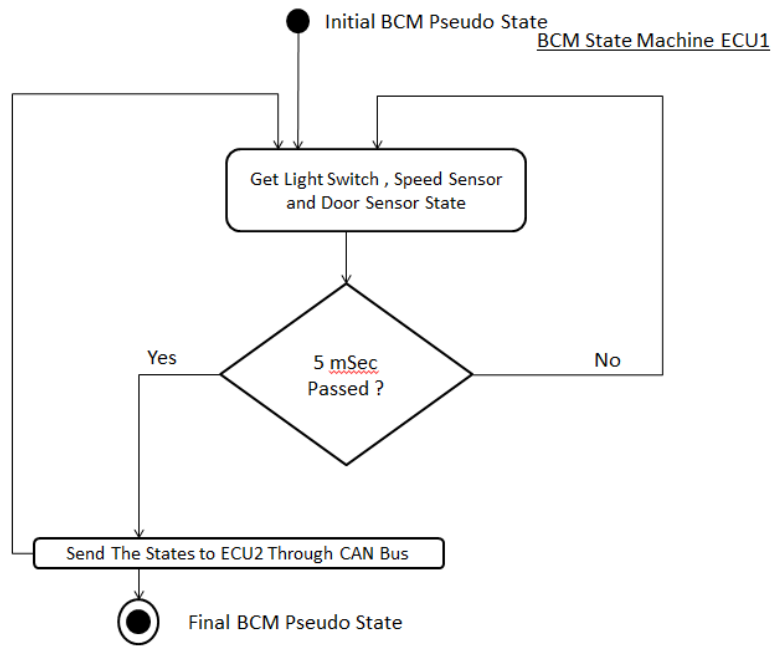
- State Machine For Door Sensor



- State Machine For Light Switch Sensor



- State Machine For Basic Communication Module



- Calculate CPU load for the ECU1

Hyperperiod = 20msec

Assumption Every Task Execution Time = 1 msec

Speed Sensor Task Execution Time = 4msec

Door Sensor Task Execution Time = 2msec

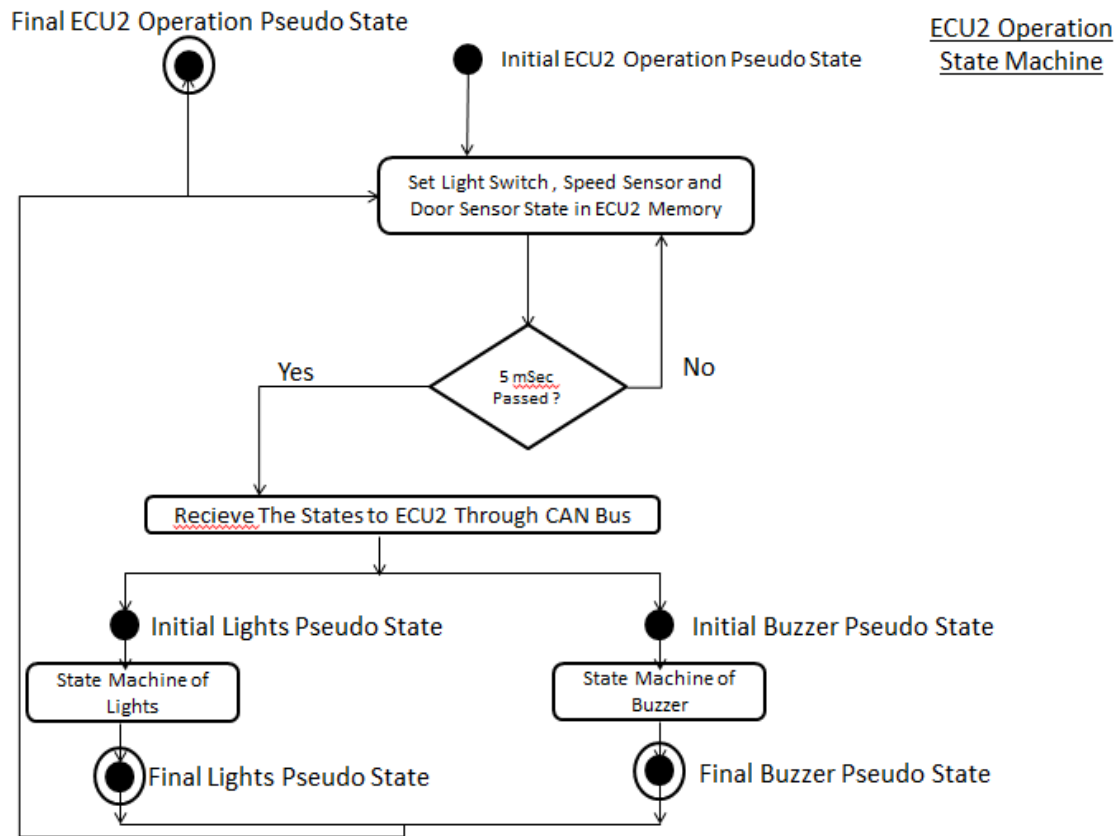
Light Switch Task Execution Time = 1msec

BCM Task Execution Time = 4msec

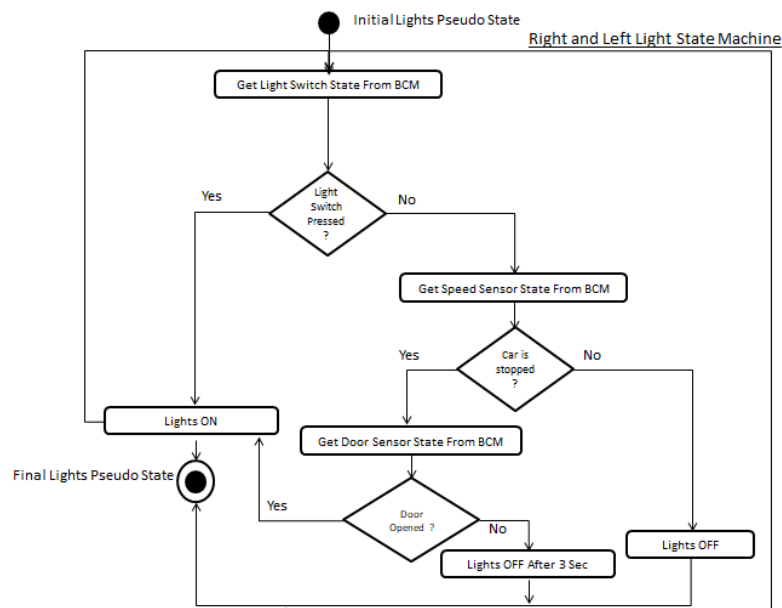
Cpu Load of ECU1 = Execution Time of All Tasks / Hyperperiod

$$= (4+2+1+4)/20 * 100\% = 55\%$$

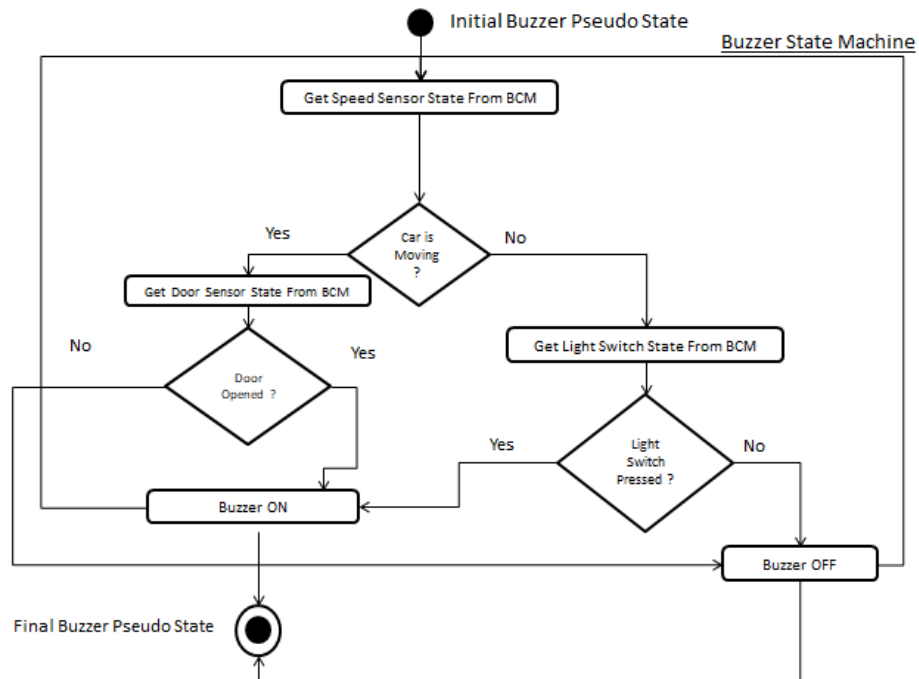
- ECU2 State Machine Operation



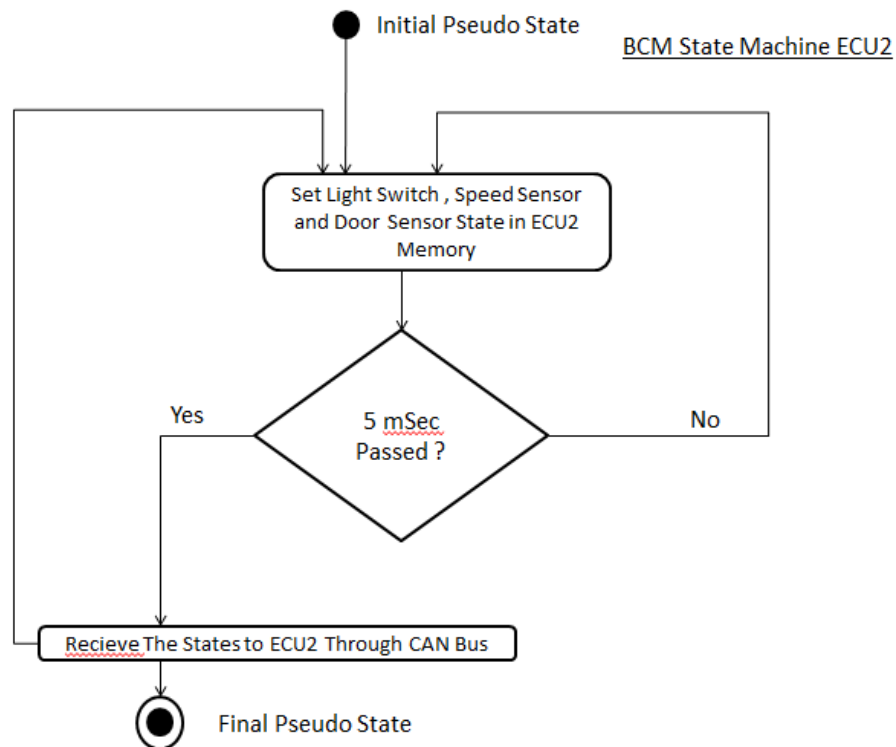
- State Machine For Right Light and Left Light



- State Machine For Buzzer



- State Machine For Basic Communication Module



- **Calculate CPU load for the ECU2**

Hyperperiod = 20msec

Assumption Every Task Execution Time Except BCM Task = 1.5 msec

Buzzer Task Execution Time = $1.5 * 4 = 6$ msec

Right Light And Left Light Task Execution Time = $1.5 * 4 = 6$ msec

BCM Task Execution Time = $4 * 1 = 4$ msec

Cpu Load of ECU2 = Execution Time of All Tasks / Hyperperiod

$$= (4+6+6)/20 * 100\% = 80\%$$

- **ECU2 Sequence Diagram (<https://sequencediagram.org/>)**

Code For Generating this Sequence Diagram :

title ECU2 Sequence Diagram

participant CANbus

participant BCM

participant Right Light and Left Light

participant Buzzer

CANbus->>BCM:Every 5 mSec Send all states to ECU2

BCM->>Right Light and Left Light:Get Light Switch State\nIs Light Switch Pressed ?

Right Light and Left Light->>Right Light and Left Light:Light Switch is pressed\nLights are Turned On

BCM->>Right Light and Left Light:Light Switch is not pressed\nGet Speed Sensor State\nIs Car Stopped ?

Right Light and Left Light->>Right Light and Left Light:Light Switch is not pressed\nCar is stopped\nLights are Turned Off

BCM->>Right Light and Left Light:Light Switch is not Pressed\nCar is stopped\nGet Door Sensor State\nIs Door Opened ?

Right Light and Left Light->>Right Light and Left Light:Light Switch is not Pressed\nCar is stopped\nDoor is Opened\nLights are Turned On

Right Light and Left Light->>Right Light and Left Light:Light Switch is not Pressed\nCar is stopped\nDoor is Closed\nWait 3 sec

Right Light and Left Light->>Right Light and Left Light:Light Switch is not Pressed\nCar is stopped\nDoor is Closed\nLights are Turned off

BCM->>Buzzer:Get Speed Sensor State\nIs Car Stopped?

BCM->>Buzzer:Car is running\nGet Door Sensor State\nIs Door Opened?

Buzzer->>Buzzer:Car is running\nDoor is opened\nBuzzer Turned on

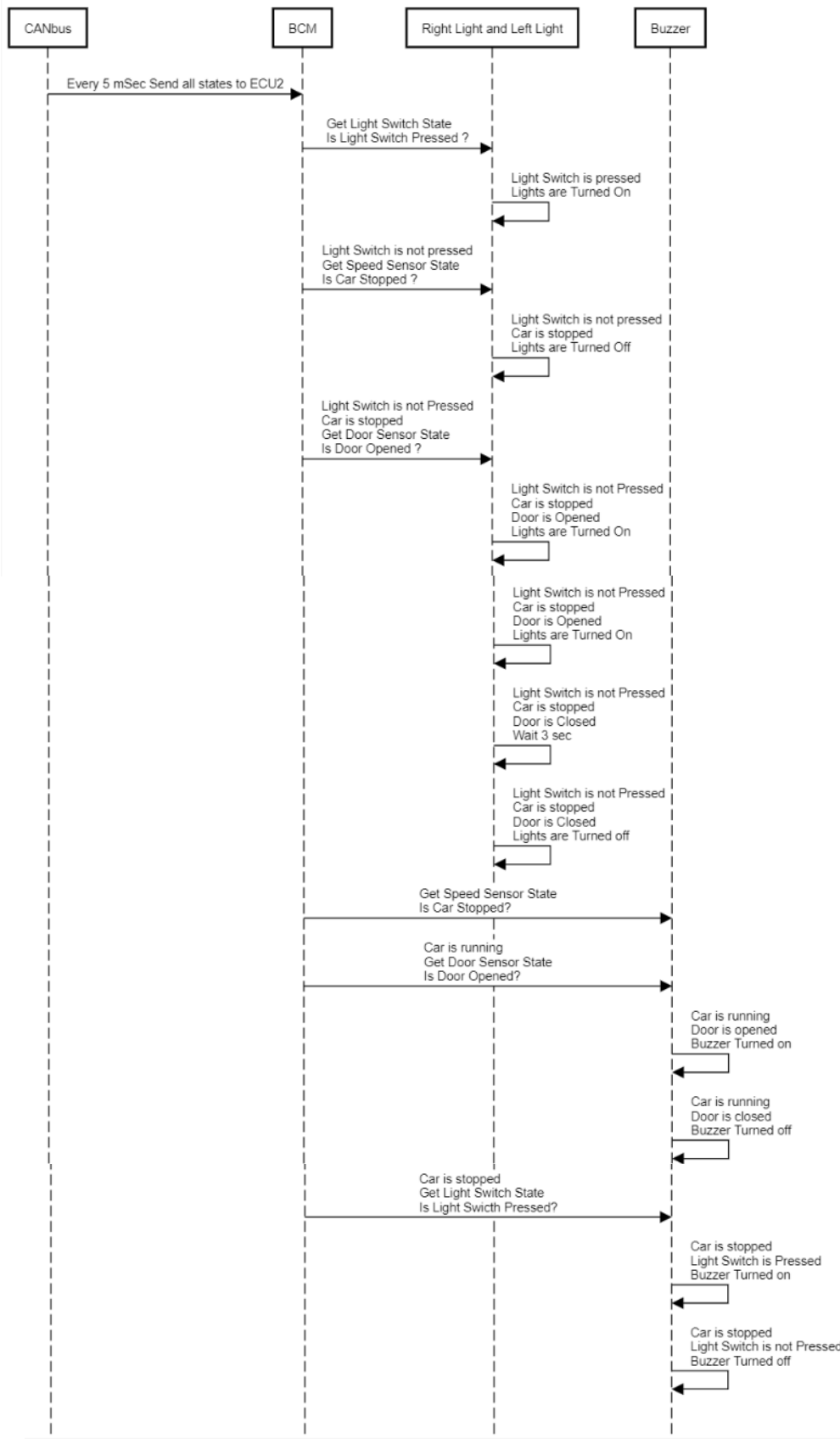
Buzzer->>Buzzer:Car is running\nDoor is closed\nBuzzer Turned off

BCM->>Buzzer:Car is stopped\nGet Light Switch State\nIs Light Switch Pressed?

Buzzer->>Buzzer:Car is stopped\nLight Switch is Pressed\nBuzzer Turned on

Buzzer->>Buzzer:Car is stopped\nLight Switch is not Pressed\nBuzzer Turned off

ECU2 Sequence Diagram



- **Calculate Bus Load**

Hyperperiod = 20msec

Assumption BCM Task = 1 msec

BCM of ECU1 Sending Task Execution Time = $1 \times 4 = 4$ msec

BCM of ECU2 Receiving Task Execution Time = $1 \times 4 = 4$ msec

Bus Load = Execution Time of All Tasks / Hyperperiod = $8/20 \times 100\% = 40\%$