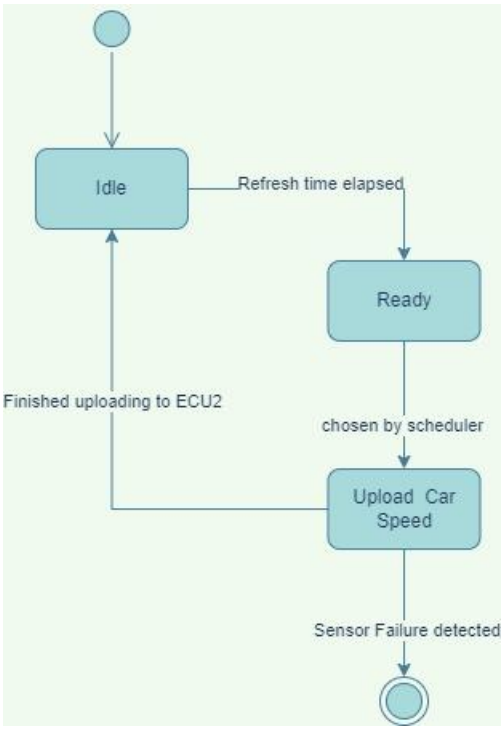
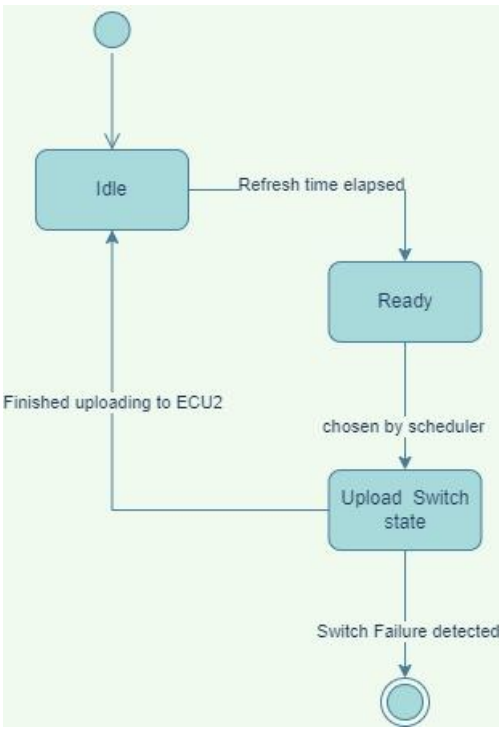
Embedded Software Engineering
Dynamic Design

ECU1:
Modules_state_Machines:

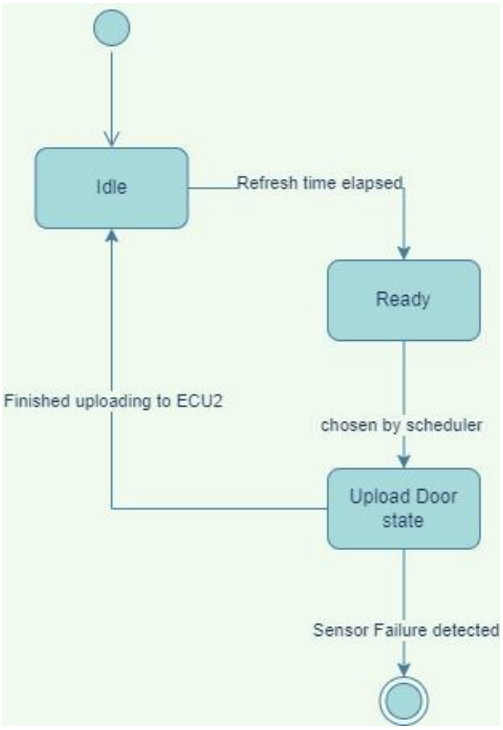
1.Speed_sensor_State_Machine:



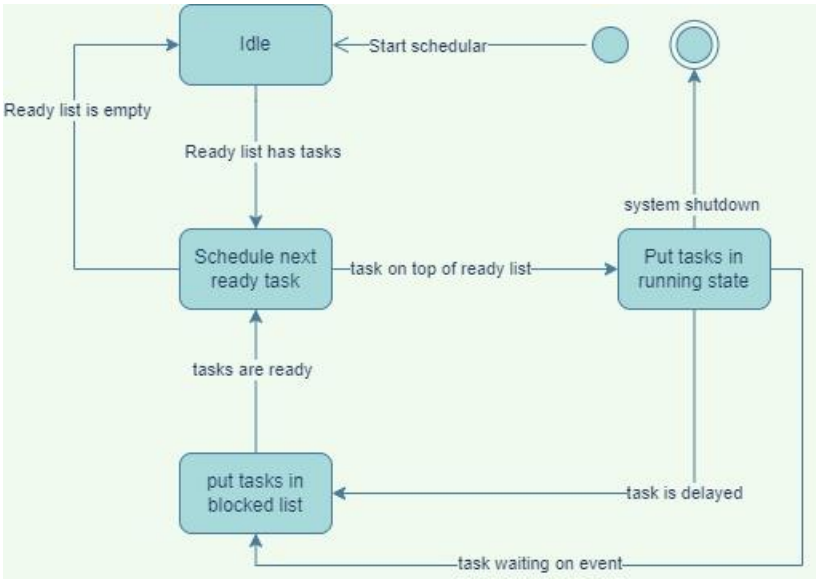
2.Switch_State_Machine:



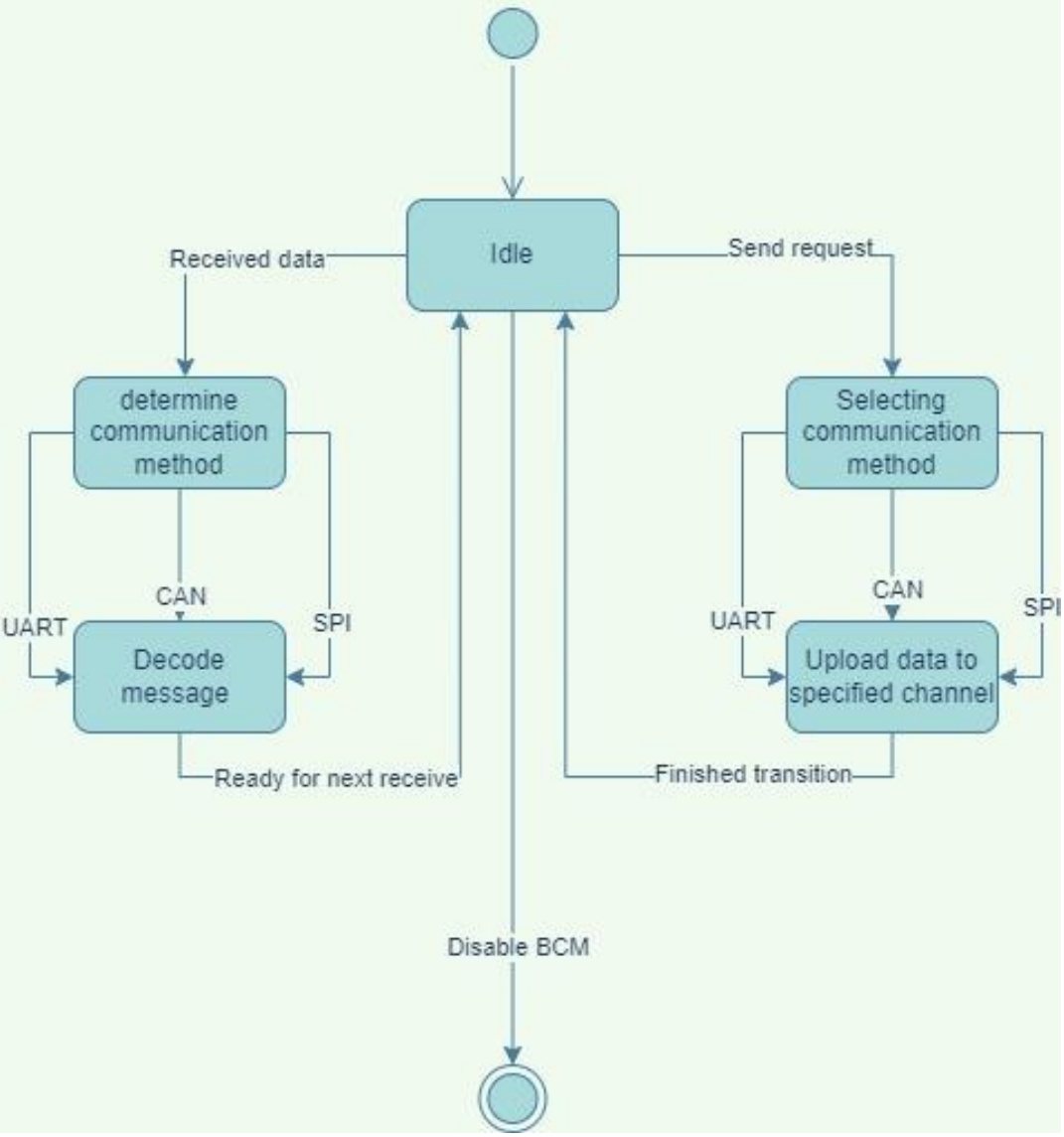
3.Door_sensor_State_Machine:



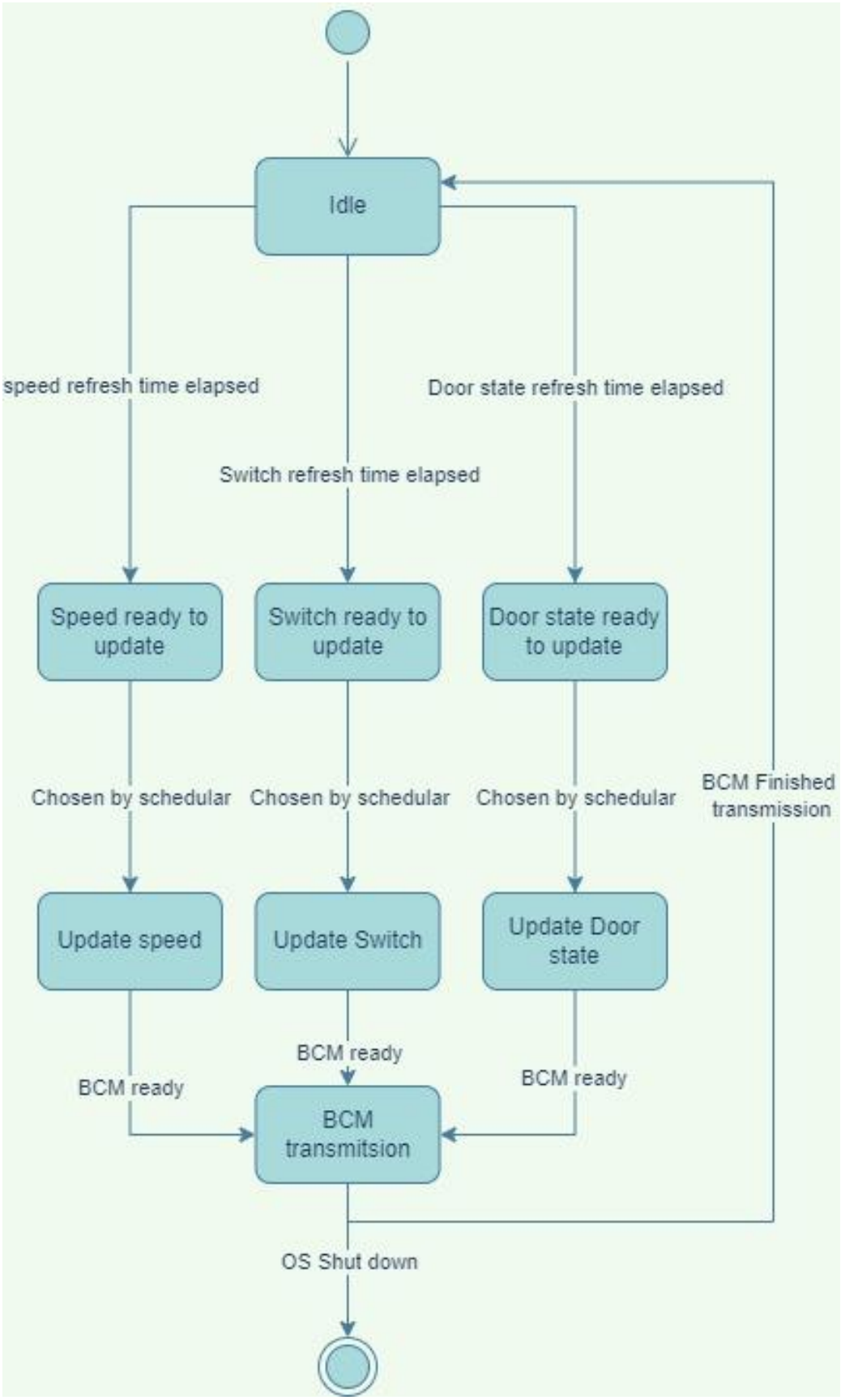
4. OS_State_Machine:



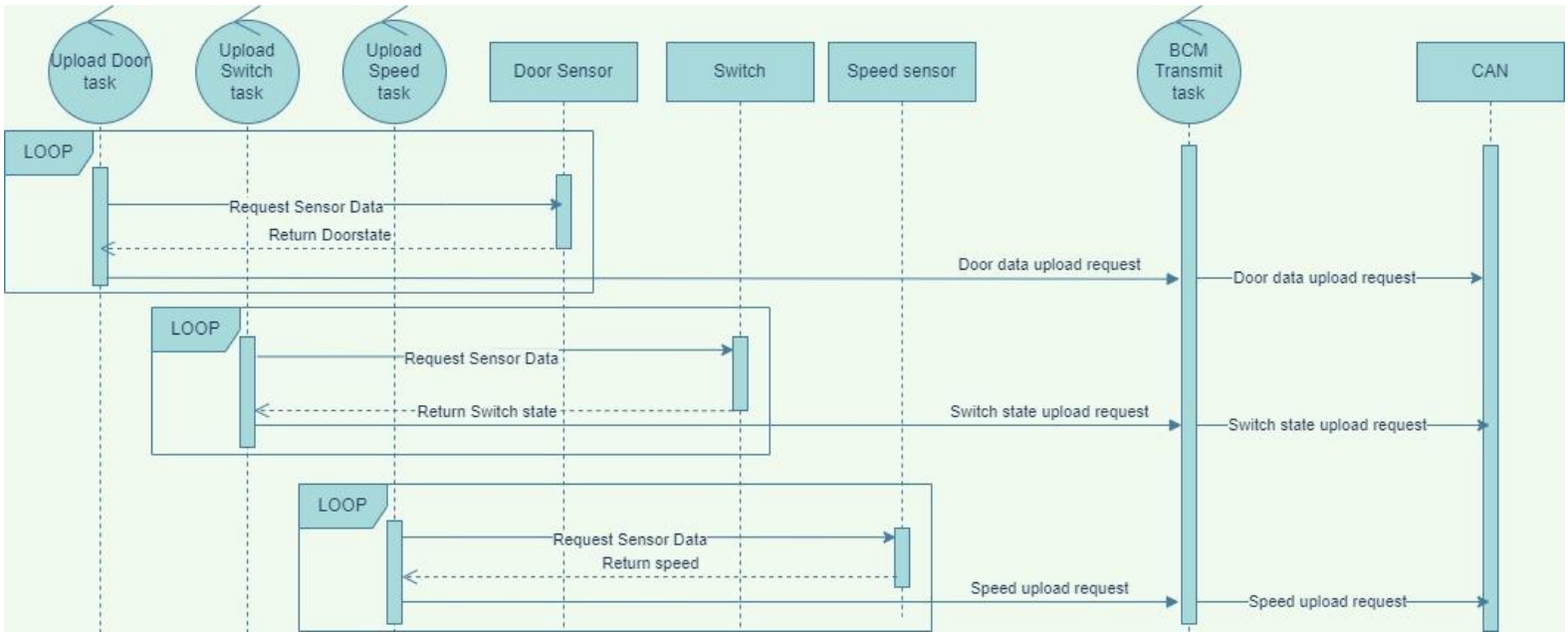
5.BCM_State_Machine:



ECU1_State_Machine:



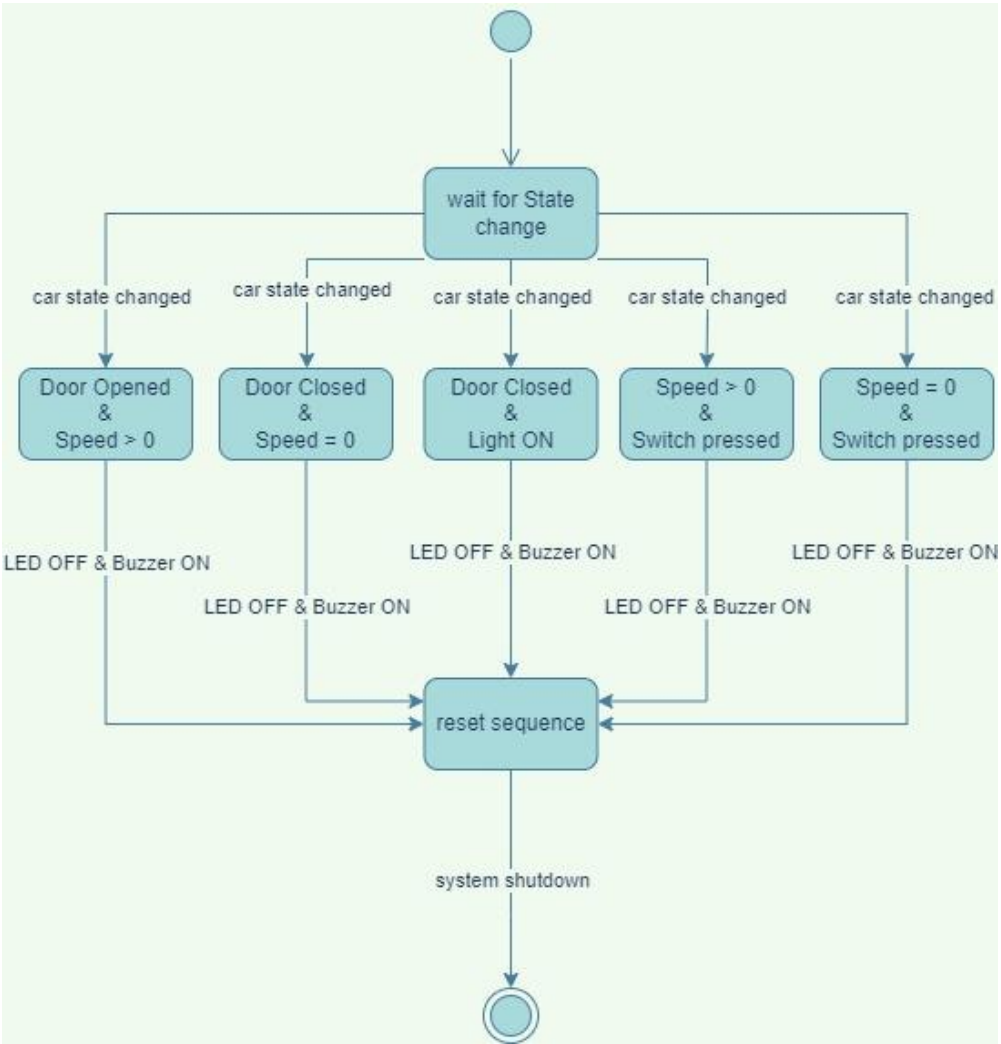
ECU1_Sequance_Diagram:



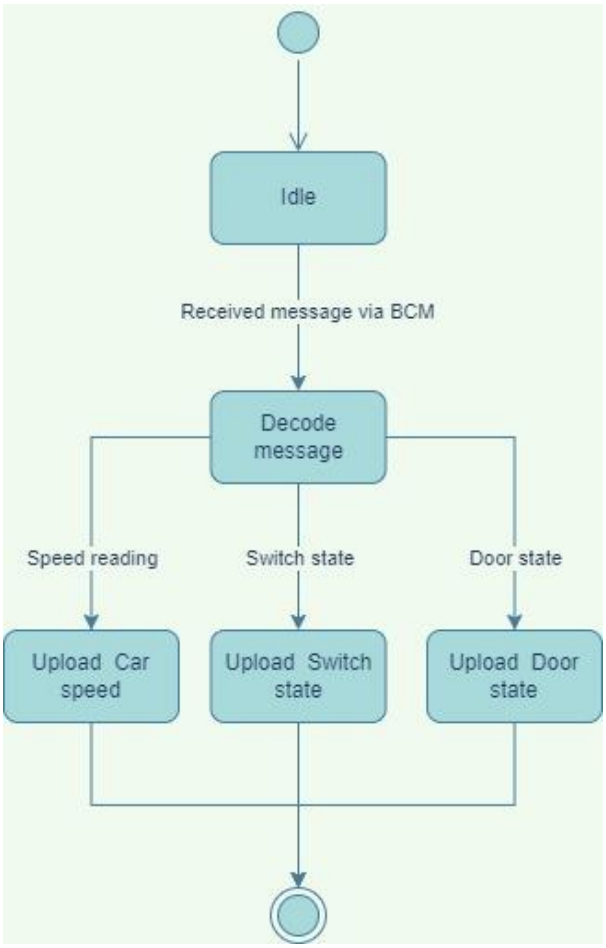
ECU2:

Modules_state_Machines:

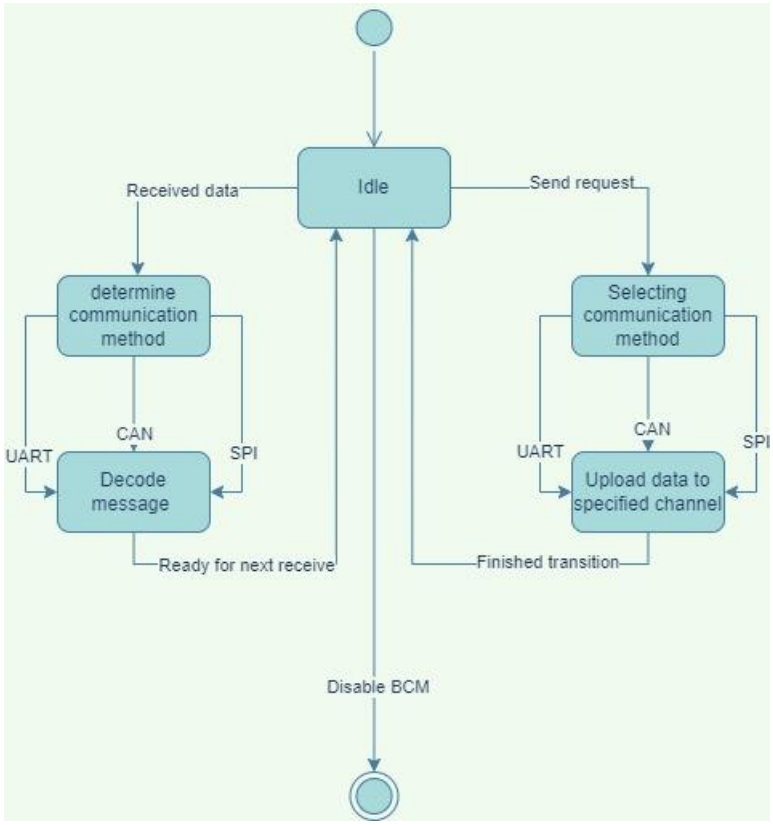
1.Car_Status_Control_State_Machine:



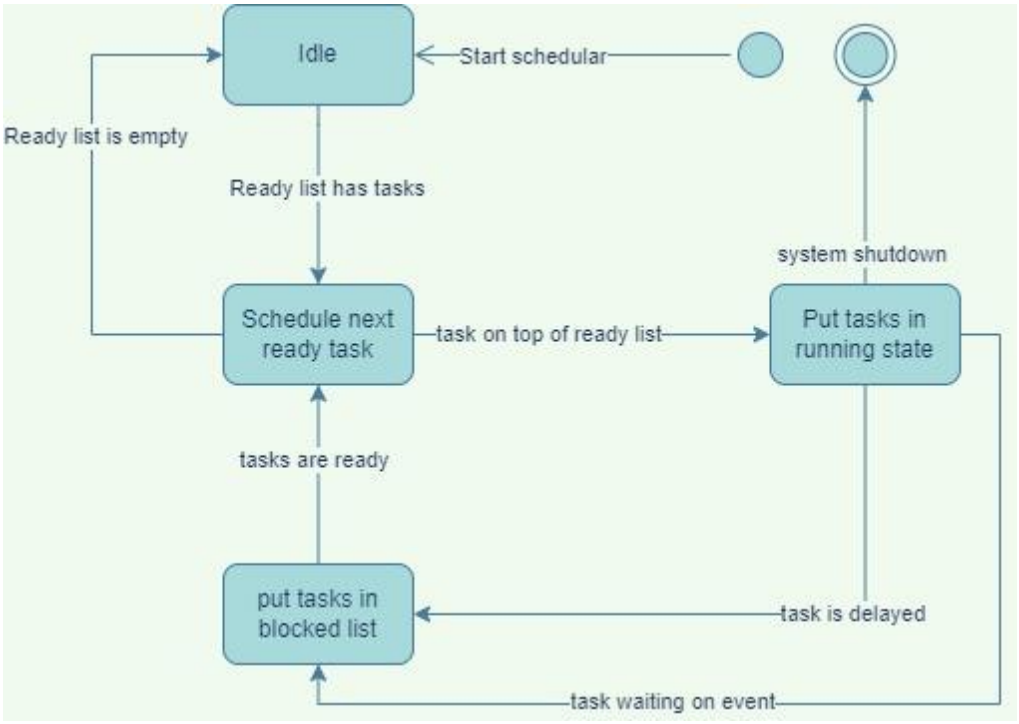
2.Car_Status_Update_State_Machine:



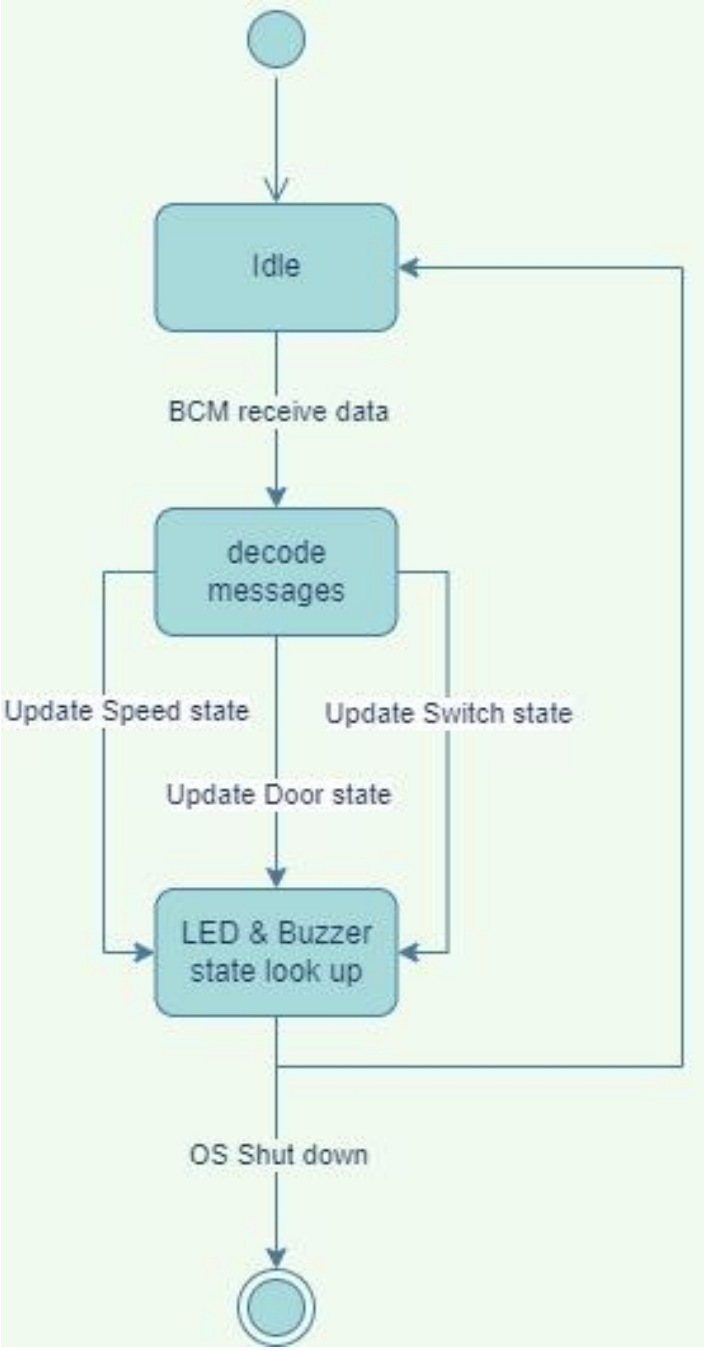
3.BCM_State_Machine:



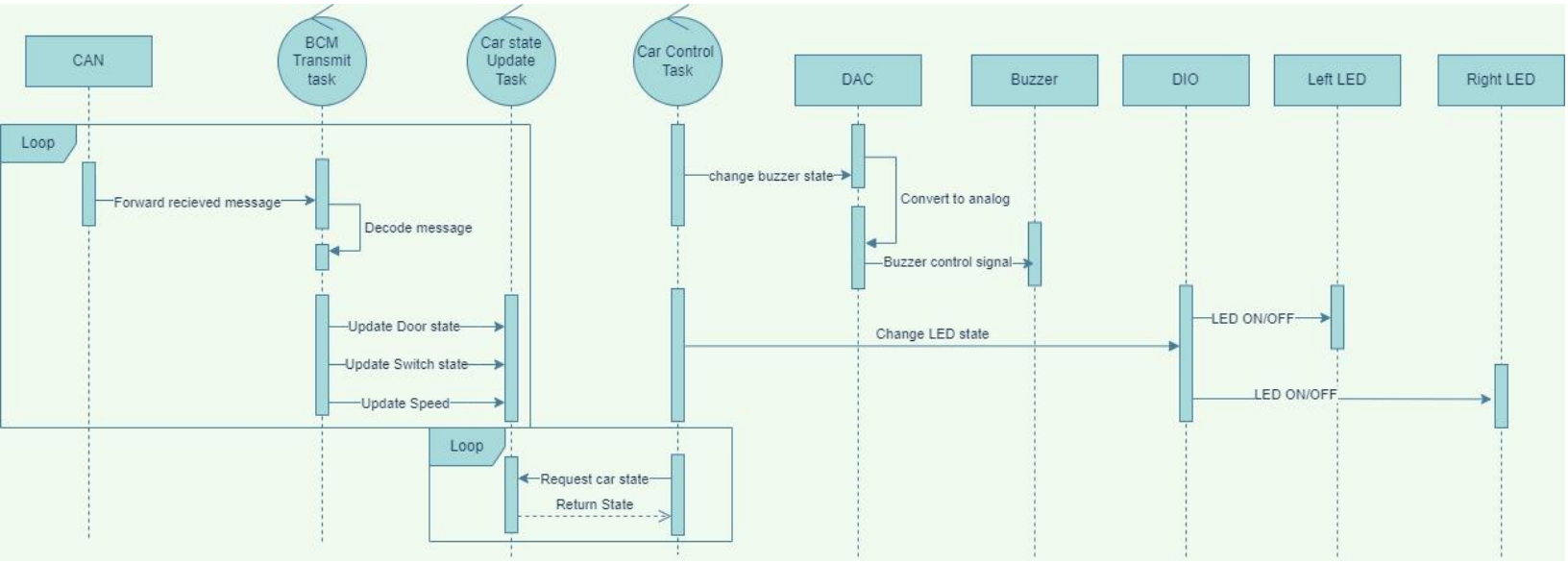
4.OS _State_Machine:



ECU2_State_Machine:



ECU2_Sequence_Diagram:



Bus_Load_Calculations:

Regarding CAN bus load calculation, assuming standard identifier, CAN frame consist of below field.

- 1 bit start bit
- 11 bit identifier
- 1 bit RTR
- 6 bit control field
- 0 to 64 bit data field
- 15 bit CRC
- Bit stuffing is possible in the above, for every sequence of 5 consecutive bits of same level. Somewhere around 18 bits in the worst case.
- 3 bit delimiter, ack etc.
- 7 bit end of frame
- 3 bit intermission field after frame

So 1 CAN frame contains approximately 125 bit.
Given we are using 500 kBit/s bit rate:
bit time = 1 / bit rate = 1 / (500 * 1000) s = 2 * 10^{-6} s = 2 µs
This means 1 bit will take 2 µs to transfer on bus when using 500 kBit/s.
So the approximate time to transfer 1 frame is (2 µs/bit * 125 bit) = 250 µs.
Door state every 10 ms = 100 frames every 1000 ms
Light switch state every 20 ms = 50 frames every 1000 ms
Speed every 5 ms = 200 frame every 1000 ms
This is in total 350 frames every 1000 ms
Total time on bus is 350 * 250 µs
Total time is 1000 ms = 1000 * 1000 µs

Bus load is ((350* 250) / (1000 * 1000)) * 100 % = 8.75 %

CPU load of ECU1:(assuming execution times)

Task1: Update Door state {period:10ms,Execution time:8us,Deadline:10ms}
Task2: Update Speed { period:5ms,Execution time:20us,Deadline:5ms }
Task3: Update Switch state { period:20ms,Execution time:8us,Deadline:20ms}
Task4: BCM { period:1ms,Execution time:12us,Deadline:1ms}

Hyper period=20ms

CPU load: ((8us*2)+(20us*4)+(8us)+(12us*20))/20ms = 1.72%

CPU load of ECU2:(assuming execution times and periodicity)

Task1: Car state update {period:2ms,Execution time:8us,Deadline:2ms}
Task2: Car state control { period:10ms,Execution time:20us,Deadline:10ms }
Task3: BCM { period:500us,Execution time:20us,Deadline: 500us }

Hyper period=10ms

CPU load: ((8us*5)+(20us*2)+(20us*20))/10ms = 4.8%