

## Assignment 2: Traffic Signal Simulation for Embedded Systems

### Group 20:

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**Github Repository:** [https://github.com/mandarc64/CS692\\_001\\_G20](https://github.com/mandarc64/CS692_001_G20)

**Objective:** The goal of this project is to simulate a traffic signal system using two sets of red, yellow, and green LEDs, which will be implemented on a BeagleBone board. The simulation aims to emulate a simple intersection with opposing traffic lights, incorporating user-configurable timing and standard transition cues.

### **Development Tools and Environment:**

- **SciTools Understand:** Used for checking compliance against coding standards.
- **QEMU Emulator:** For initial implementation and testing of the simulated traffic signal system.
- **BeagleBone Board:** The target hardware for deploying the final code.

### **Implementation Details:**

- **LED Simulation:** The system simulates two sets of traffic lights using red, yellow, and green LEDs. Each set represents the lights for one direction of the intersection.
- **User Input:** The program prompts the user to input the duration (in minutes or fractions of a minute) for the green light. This input is used to configure the timing of the traffic lights.
- **Light Transition:** The transition from green to red includes a 5-second yellow signal. After the red light is activated in one direction, there is a 2-second delay before the green light is activated in the opposing direction. During this delay, both the yellow and red lights are illuminated.
- **GPIO Pin Configuration:** The user is prompted to input the GPIO pins being used for the LED outputs. These pins are then used in the code to control the LEDs.
- **Modularity:** The code is modularized to allow for future expansion, such as the integration of different traffic signal devices or the addition of sensors for more intelligent signal control.

### **Testing and Validation:**

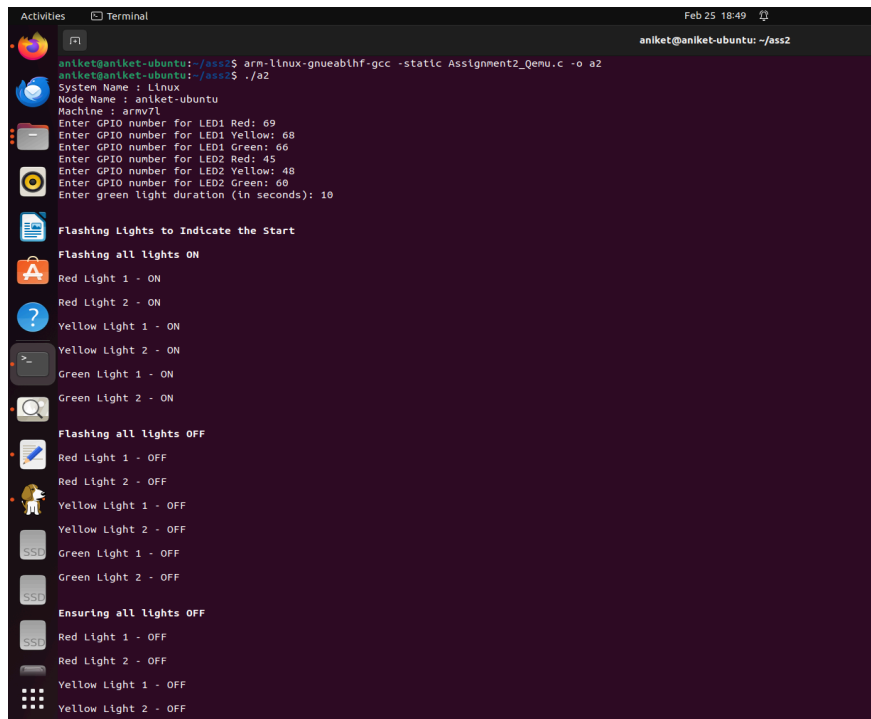
- **Emulation Testing:** The initial implementation is tested using the QEMU emulator. The actual GPIO output is stubbed out, and the light colors are printed to stdout for verification.
- **Hardware Deployment:** After successful testing in the emulator, the software is finalized and deployed on the BeagleBone board. The LEDs are connected to the specified GPIO pins to simulate the traffic lights.

### **Project Outcomes:**

- A functional traffic signal simulation that can be controlled via user input.
- Modular code that adheres to coding standards..
- Successful implementation and testing on both an emulator and BeagleBone board.

## Supporting Materials:

- **Screenshot of Emulator Output:** A screenshot showing the output of the code executed on the emulator, demonstrating the simulated traffic light transitions.



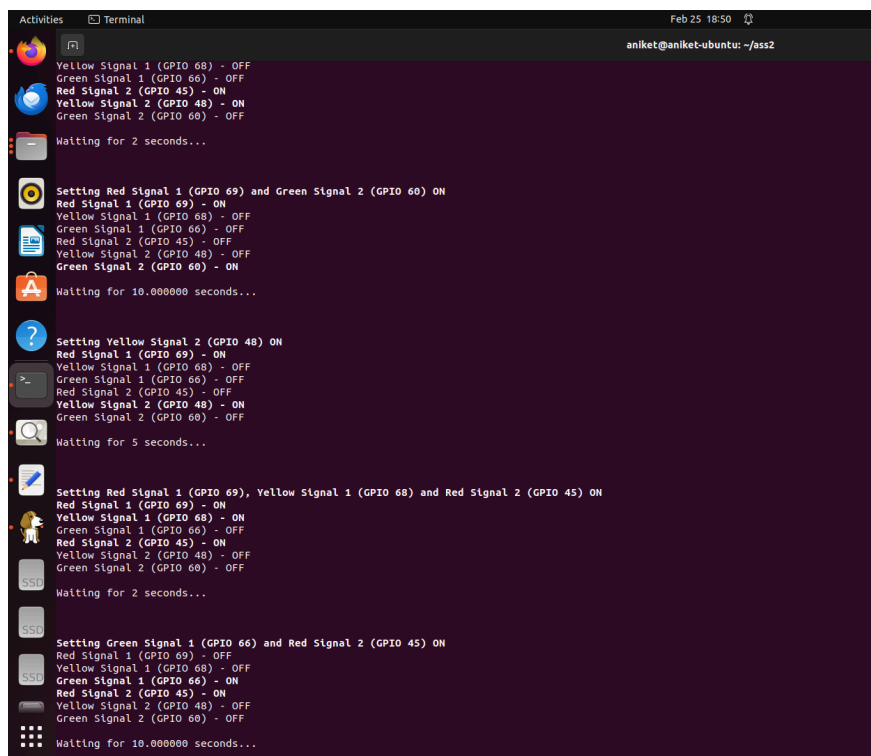
```
aniket@aniket-ubuntu: ~/ass2$ arm-linux-gnueabihf-gcc -static Assignment2_Qemu.c -o a2
aniket@aniket-ubuntu: ~/ass2$ ./a2
System Name : Linux
Node Name : aniket-ubuntu
Machine : armv7l
Enter GPIO number for LED1 Red: 69
Enter GPIO number for LED1 Yellow: 68
Enter GPIO number for LED1 Green: 66
Enter GPIO number for LED2 Red: 45
Enter GPIO number for LED2 Yellow: 48
Enter GPIO number for LED2 Green: 60
Enter green light duration (in seconds): 10

Flashing Lights to Indicate the Start

Flashing all lights ON
Red Light 1 - ON
Red Light 2 - ON
Yellow Light 1 - ON
Yellow Light 2 - ON
Green Light 1 - ON
Green Light 2 - ON

Flashing all lights OFF
Red Light 1 - OFF
Red Light 2 - OFF
Yellow Light 1 - OFF
Yellow Light 2 - OFF
Green Light 1 - OFF
Green Light 2 - OFF

Ensuring all lights OFF
Red Light 1 - OFF
Red Light 2 - OFF
Yellow Light 1 - OFF
Yellow Light 2 - OFF
```



```
Yellow Signal 1 (GPIO 68) - OFF
Green Signal 1 (GPIO 66) - OFF
Red Signal 2 (GPIO 45) - ON
Yellow Signal 2 (GPIO 48) - ON
Green Signal 2 (GPIO 60) - OFF

Waiting for 2 seconds...

Setting Red Signal 1 (GPIO 69) and Green Signal 2 (GPIO 60) ON
Red Signal 1 (GPIO 69) - ON
Yellow Signal 1 (GPIO 68) - OFF
Green Signal 1 (GPIO 66) - OFF
Red Signal 2 (GPIO 45) - OFF
Yellow Signal 2 (GPIO 48) - OFF
Green Signal 2 (GPIO 60) - ON

Waiting for 10.000000 seconds...

Setting Yellow Signal 2 (GPIO 48) ON
Red Signal 1 (GPIO 69) - ON
Yellow Signal 1 (GPIO 68) - OFF
Green Signal 1 (GPIO 66) - OFF
Red Signal 2 (GPIO 45) - OFF
Yellow Signal 2 (GPIO 48) - ON
Green Signal 2 (GPIO 60) - OFF

Waiting for 5 seconds...

Setting Red Signal 1 (GPIO 69), Yellow Signal 1 (GPIO 68) and Red Signal 2 (GPIO 45) ON
Red Signal 1 (GPIO 69) - ON
Yellow Signal 1 (GPIO 68) - ON
Green Signal 1 (GPIO 66) - OFF
Red Signal 2 (GPIO 45) - ON
Yellow Signal 2 (GPIO 48) - OFF
Green Signal 2 (GPIO 60) - OFF

Waiting for 2 seconds...

Setting Green Signal 1 (GPIO 66) and Red Signal 2 (GPIO 45) ON
Red Signal 1 (GPIO 69) - OFF
Yellow Signal 1 (GPIO 68) - OFF
Green Signal 1 (GPIO 66) - ON
Red Signal 2 (GPIO 45) - ON
Yellow Signal 2 (GPIO 48) - OFF
Green Signal 2 (GPIO 60) - OFF

Waiting for 10.000000 seconds...
```

```
Activities Terminal Feb 25 18:50
aniket@aniket-ubuntu: ~/ass2

Ensuring all lights OFF
Red Light 1 - OFF
Red Light 2 - OFF
Yellow Light 1 - OFF
Yellow Light 2 - OFF
Green Light 1 - OFF
Green Light 2 - OFF

Setting Green Signal 1 (GPIO 66) and Red Signal 2 (GPIO 45) ON
Red Signal 1 (GPIO 69) - OFF
Yellow Signal 1 (GPIO 68) - OFF
Green Signal 1 (GPIO 66) - ON
Red Signal 2 (GPIO 45) - ON
Yellow Signal 2 (GPIO 48) - OFF
Green Signal 2 (GPIO 60) - OFF
Waiting for 10.000000 seconds...

Setting Yellow Signal 1 (GPIO 68) ON
Red Signal 1 (GPIO 69) - OFF
Yellow Signal 1 (GPIO 68) - ON
Green Signal 1 (GPIO 66) - OFF
Red Signal 2 (GPIO 45) - ON
Yellow Signal 2 (GPIO 48) - OFF
Green Signal 2 (GPIO 60) - OFF
Waiting for 5 seconds...

Setting Red Signal 2 (GPIO 45), Yellow Signal 2 (GPIO 48) and Red Signal 1 (GPIO 69) ON
Red Signal 1 (GPIO 69) - ON
Yellow Signal 1 (GPIO 68) - OFF
Green Signal 1 (GPIO 66) - OFF
Red Signal 2 (GPIO 45) - ON
Yellow Signal 2 (GPIO 48) - ON
Green Signal 2 (GPIO 60) - OFF
Waiting for 2 seconds...

Setting Red Signal 1 (GPIO 69) and Green Signal 2 (GPIO 60) ON
Red Signal 1 (GPIO 69) - ON
Yellow Signal 1 (GPIO 68) - OFF
Green Signal 1 (GPIO 66) - OFF
```

**Video of Hardware Execution:** A video showing the execution of the simulation running on the BeagleBone board, with the LEDs representing the traffic lights.

Upon execution of the code, an indication of the program's operational status is provided through a series of five blinking cycles of all the LEDs. This feature serves as a visual confirmation to the user that the code is running and functioning as intended. These blinking cycles are integrated into the code to facilitate quick verification of program execution.

- <https://drive.google.com/file/d/1dPexqVN7Yn-xrppt4SLF2B5m2U5p0MWN/view?usp=sharing>

