**Communication Challenge 2: FreeRTOS**



A screenshot of a computer

Description automatically generated

*Circuit used: red wires are to simulate power to the component that is connected to its designated pin. The black wires are to simulate being connected to the GND pin. Each LED represents a sprinkler and they are connected to my ESP32 as show in the above circuit.*

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## Introduction:

## Procedure:

I begin by setting up what I believe to be my circuit for this entire challenge. See above circuit diagram. I have set up the pins in the

### Setup:

|  |  |
| --- | --- |
| **COMPONENT** | **PIN** |
| LED\_1\_PIN (Sprinkler 1) | D14 |
| LED\_2\_PIN (Sprinkler 2) | D26 |
| LED\_3\_PIN (Sprinkler 3) | D21 |
| LED\_4\_PIN (Sprinkler 4) | D22 |

*Table 1: Hardware Pins*

### Design choices thread:

Based off of the requirements that were given to me, I came up with the following key conclusions:

* Each sprinkler own designated LED and a function to control turning the LEDs on and off.
* Store the operations of scenes. They are hardcoded and stored in my application
* Make a function to execute a scene, by reading these operations of the hardcoded stored scenes and perform said operations.
* I need to test this function. First without threads.
* Make on thread, that does nothing but read the UART repeatedly. If it receives a number (in this case representing a scene), then end echo this number back to my laptop. This thread should never end.
* In that same thread when a valid number of a Scene is received from the user, start another thread that performs the operations of that Scene by calling the function executeScene that was defined before.
* Make sure that that the thread ends itself in a controlled way when the Scene is done.
* Test my program with multiple Scenes running at the same time. For example: first type ‘1’ and a while later type ‘2’; Scene 1 and 2 should then run together, which you can check by looking at the LED’s.

### Thread implementation:

Now that I knew my requirements I began to work. I first defined my LED pins to simulate the sprinklers. I then made the predefined scenes. These are hardcoded arrays with messages to simulate its behaviour. I chose to do it like this because this is one of the methods I am most familiar with. I have made a simple function to control the state of the LED by providing it with the LED pin and the state I want the LED to be in. I defined another function to execute the scenes by providing it with the array and the size of the array. It would then perform the operations of the given array. Finally in my loop I call that function 3 times, to test all 3 scenes. The only issue I see with this implementation is that I need to implement delays in the main function for it to have my desired behaviour.

Now I will work on the thread part of this implementation.

I tested it in a way so that a user can input values. So I tested a case, where an invalid scene is provided, an invalid character is provided and the correct one. The special problems I had was that the LEDs do turn on per scene but they do not continue with the array. For example, if 1 was provided, the execute scene task would call the execute scene function and the execute scene function would receive array 1 and its size. However, it will not wait the 5 seconds or turn the LED off and then to the next operation etc. I am assuming this task is due to it being working along side of the other tasks. Because initially the array and the execute scene function worked flawlessly.

### Design choices mutex:

Based off of the previous thread requirements and the ones that were now given to me, I have come with the following conclusions:

* Make the program in a way so that the scenes do not interfere with eachother if both scenes are using the same sprinkler. I need to implement this by adding one mutex per sprinkler. (acquire the mutex before start and release mutex at the end of operation.)
* Make sure a scene doesn’t execute twice. If I use 2 scenes then they will run in parallel because, each scene has it’s own thread. But if I use a singular scene then the second operation of the scene must wait for the first to finish before running a second time.

Each scene must have 1 mutex. Before a thread executes the first step of a scene, it must acquire that scenes mutex and after the last step it will release it.

### Mutex implementation:

(EXPLAIN HOW I SOLVED SYNC FOR STEP 1 AND 3).

(ANY SPECIAL PROBLEMS ENCOUNTERED).

(WHAT WAS ADDED EXTRA).

### Design choices queue:

Based off of the previous thread and mutex requirements and the ones that were now given to me, I have come up with the following conclusions:

* When a new thread is created to execute a Scene, the steps of that Scene should be sent to that thread through a Queue (so the thread will not access the Scene-array directly anymore, but get the steps from the Queue).
* Test if my program is now completely thread safe? In other words, works correct all the time.

### Queue implementation:

(EXPLAIN HOW I IMPLEMENTED QUEUE IN STEP 1)

(ANSWER QUESTION 2)

(ANY SPECIAL PROBLEMS ENCOUNTERED)

(IF THERE ARE THING I COULD NOT IMPLEMENT, OR DID NOT WORK WELL)

## Results:

## Conclusions: