



CPIT250 – IT3: Final Project Report

Traffic Lights Management System

| Student-Name | Student-ID |
|---------------------|------------|
| 1- Meshal Okairy | 2237836 |
| 2- Muayad Bajandooh | 2237970 |
| 3- Omar Bakhedar | 2237708 |

Supervisor: Prof. Dr. Awny Sayed

2023 – 2024

Table of Contents

| | |
|---|----|
| Introduction | 4 |
| Definition & Solution: | 5 |
| Interview: | 6 |
| Data Flow Diagram: | 8 |
| Context Diagram: | 8 |
| Level 0: | 8 |
| Level 1: | 9 |
| Level 2: | 10 |
| Diagram: | 11 |
| Use Case Diagram: | 15 |
| Written Use Case (General): | 15 |
| Use Case Diagram (General): | 16 |
| Written Use Case (Traffic Analysis): | 18 |
| Use Case Diagram (Traffic Analysis): | 19 |
| Written Use Case (Report Processing): | 20 |
| Use Case Diagram (Report Processing): | 21 |
| Activity Diagram: | 22 |
| Class Diagram: | 23 |
| Classes, Attributes and Methods: | 23 |
| Relationships: | 25 |
| Diagram: | 26 |
| Sequence Diagram: | 27 |
| Sequence of Interactions (Red light): | 27 |
| Red Light Scenario Diagram: | 28 |
| Sequence of Interactions (Emergency): | 29 |
| Emergency Scenario Diagram: | 30 |

| | |
|-------------------------------|----|
| State Diagram: | 31 |
| States for Controlling: | 31 |
| Event for Controlling: | 31 |
| Diagram for Controlling:..... | 32 |
| States for Maintain: | 33 |
| Events for Maintain:..... | 33 |
| Diagram for Maintain:..... | 34 |
| Forms & Reports: | 35 |
| UI for Drivers:..... | 35 |
| UI for Morror: | 37 |
| Conclusion:..... | 40 |

Introduction

In this project, our goal is to identify a real-world problem and devise solutions by applying the concepts and diagrams acquired throughout the CPIT250 course. The project serves as a comprehensive exploration of the various diagrams and models studied during the course, which we have effectively applied to address the chosen problem.

Definition & Solution:

Managing traffic lights can be a real headache. You've probably been stuck at a red light while no one's coming from the other side, right? Well, here's the fix, we can make traffic lights way smarter using intelligent cameras and AI.

The problem is that regular traffic lights follow a set schedule, whether there's lots of traffic or hardly any. The current solution is a traffic cop who works under the sun and switches manually between the traffic lights, but this is time and cost- consuming also inaccurate. With AI and cameras, we can change that. Cameras watch the roads and tell the AI what's happening in real time. The AI then decides when to make the lights turn green or red.

Imagine this, if the cameras see plenty of cars waiting at a red light, they can tell the AI to turn the light green sooner. But when there aren't many cars around, the AI can keep the light red for a shorter time.

This means less time stuck in traffic, fewer cars idling and polluting the air, and quicker trips. It's a clever solution to a common problem that can make our daily commute a lot smoother and greener.

Interview:

We recently conducted an interview with police officers and drivers to pinpoint any issues with our Traffic Lights Management System. Our goal is to work together to come up with solutions that will enhance traffic flow, safety, and overall efficiency. By involving both law enforcement and drivers, we can gain valuable insights from those who use the system regularly. This data-driven approach will inform future improvements, resulting in reduced congestion, increased safety, and more efficient roadways for everyone in the city.

| Questions: | Answers: |
|--|---|
| 1. What do you think are the main causes of traffic jams at traffic lights in your area? (Select all that apply) | a. Poor synchronization of traffic lights b. Inadequate traffic flow analysis c. Lack of real-time traffic monitoring d. Insufficient pedestrian and cyclist prioritization e. Other (please specify) |
| 2. Do you prefer access within the city limits or throughout the entire country? | I prefer each city to have access within itself, and for the capital city to have access to all other cities. |
| 3. Would you prefer to integrate the new system with the old one or keep them separate but working together? | I prefer it to be integrated but if this will make the system complex or if the system will have glitches, then make it separate since the project is very sensitive. |
| 4. What suggestions do you have for improving traffic light management during special events or emergencies, when traffic patterns may be disrupted? | It would be beneficial to install timers on all traffic lights and prioritize Sustainable Transportation. |
| 5. How satisfied are you with the accessibility and safety of pedestrian crossings at traffic lights in your area? | (Very Satisfied, Satisfied, Neutral, Dissatisfied, Very Dissatisfied) |

| | |
|--|---|
| 6. On a scale of 1 to 5, how satisfied are you with the current traffic light system in your area? | 1 is very dissatisfied and 5 is very satisfied |
| 7. What features or improvements would you like to see in the traffic light system to reduce traffic jams? | Utilize the statistics offered by this system to their fullest potential. |
| 8. How important do you think it is for your city or municipality to invest in advanced traffic management technologies to reduce traffic jams? | (Very Important, Important, Neutral, Unimportant, Very Unimportant) |
| 9. Please share your thoughts on the effectiveness of these initiatives in reducing traffic congestion. | If this initiative is applied correctly, congestion will be greatly reduced. |
| 10. Would you be willing to use a mobile app that provides real-time information about traffic light timing and suggests alternate routes to avoid congestion? | (Yes/No) |
| 11. Do you want to know traffic statistics? If so, who will have access? | Yes, I want traffic statistics to identify congested areas and causes. Access will be granted to statisticians for the purpose of generating reports. |
| 12. Have you ever experienced traffic congestion or jams caused by inefficient traffic light management in your area? | (Yes/No) |
| 13. How often do you encounter traffic jams at traffic lights in your daily commute? | (Rarely, Occasionally, Often, Always) |
| 14. Are there any specific intersections or areas in your city where you frequently encounter traffic jams caused by traffic lights? | There are many congested areas, particularly main roads during rush hour, which require attention. |
| 15. Do you believe that public transportation and alternative transportation options should be better integrated with traffic light management to reduce congestion? | (Yes/No) |

Data Flow Diagram:

Context Diagram:

1. **Process:** Traffic Light Supporting System

- **Source:** Cameras, Statisticians
- **Destinations:** Traffic Light System, Police

Level 0:

1. **Process:** Count Cars

- **Source:** Cameras
- **Destinations:** Compare Cars, Cars List

2. **Process:** Compare Cars

- **Source:** Cars List, Count Cars
- **Destinations:** Traffic Light Order, Control Traffic Light

3. **Process:** Control Traffic Light

- **Source:** Compare Cars, Traffic Light Order
- **Destinations:** Traffic Light System, Producing Statics

4. **Process:** Producing Statics

- **Source:** Statisticians, Cars List, Control Traffic Light
- **Destinations:** Generate Reports, Congested Areas

5. **Process:** Generate Reports

- **Source:** Producing Statics, Congested Areas
- **Destinations:** Police

Level 1:

1. **Process:** Open Traffic Light with Largest Number of Cars
 - **Source:** Compare Cars, Traffic Light Order
 - **Destinations:** Keep Other Traffic Lights Closed
2. **Process:** Keep Other Traffic Lights Closed
 - **Source:** Open Traffic Light with Largest Number of Cars
 - **Destinations:** Set Timer for Other Traffic Lights
3. **Process:** Set Timer for Other Traffic Lights
 - **Source:** Keep Other Traffic Lights Closed
 - **Destinations:** Traffic Light System, Access Cars List Files
4. **Process:** Access Cars List Files
 - **Source:** Cars List, Set Timer for Other Traffic Lights
 - **Destinations:** Gather Cars List Data
5. **Process:** Gather Cars List Data
 - **Source:** Access Cars List Files
 - **Destinations:** Apply Statistic Laws
6. **Process:** Apply Statistic Laws
 - **Source:** Gather Cars List Data, Statisticians
 - **Destinations:** Update Congested Areas
7. **Process:** Update Congested Areas Files
 - **Source:** Apply Statistic Laws
 - **Destinations:** Congested Areas, Access Congested Areas
8. **Process:** Access Congested Areas Files
 - **Source:** Congested Areas, Update Congested Areas
 - **Destinations:** Gather Congested Areas Data
9. **Process:** Gather Congested Areas Data
 - **Source:** Access Congested Areas Files
 - **Destinations:** Processes Gathered Data
10. **Process:** Processes Gathered Data
 - **Source:** Gather Congested Areas Data
 - **Destinations:** Police

Level 2:

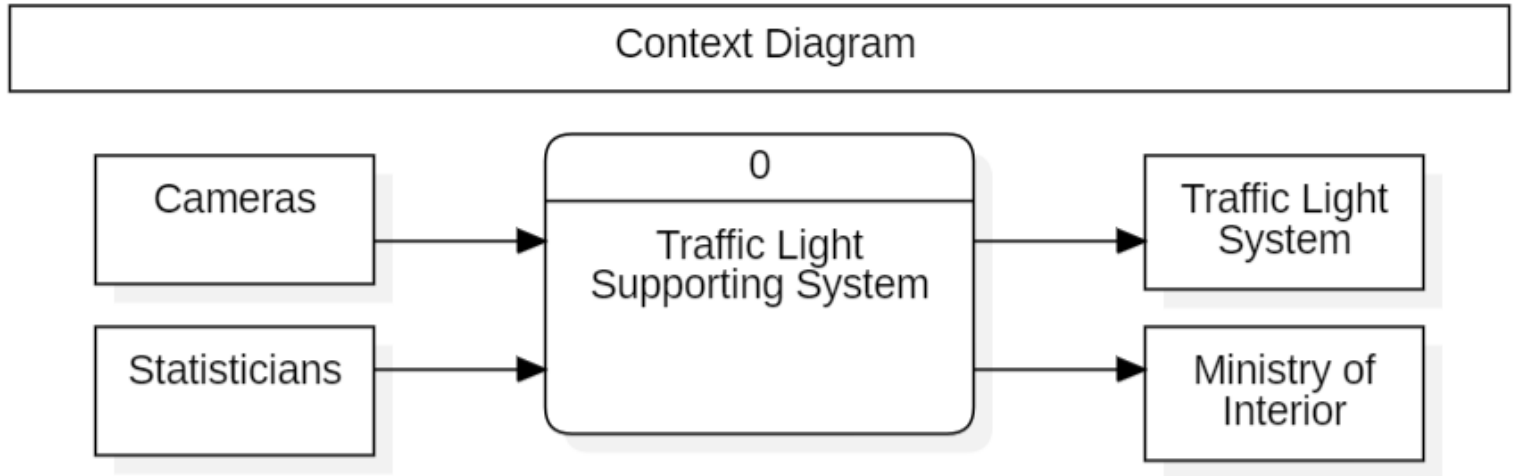
1. **Process:** Choose Data Format

- **Source:** Gather Congested Areas Data
- **Destinations:** Print Reports

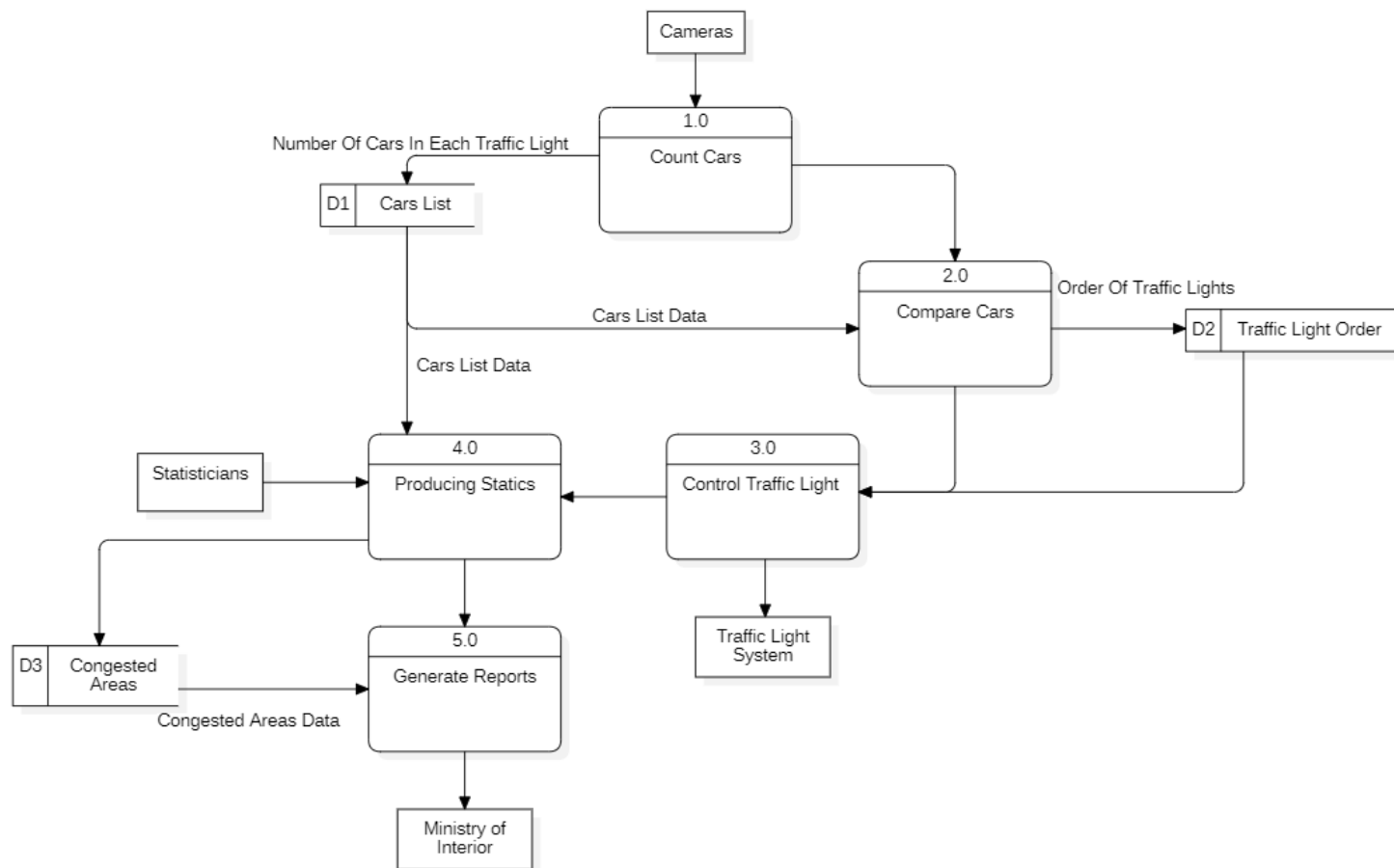
2. **Process:** Print Reports

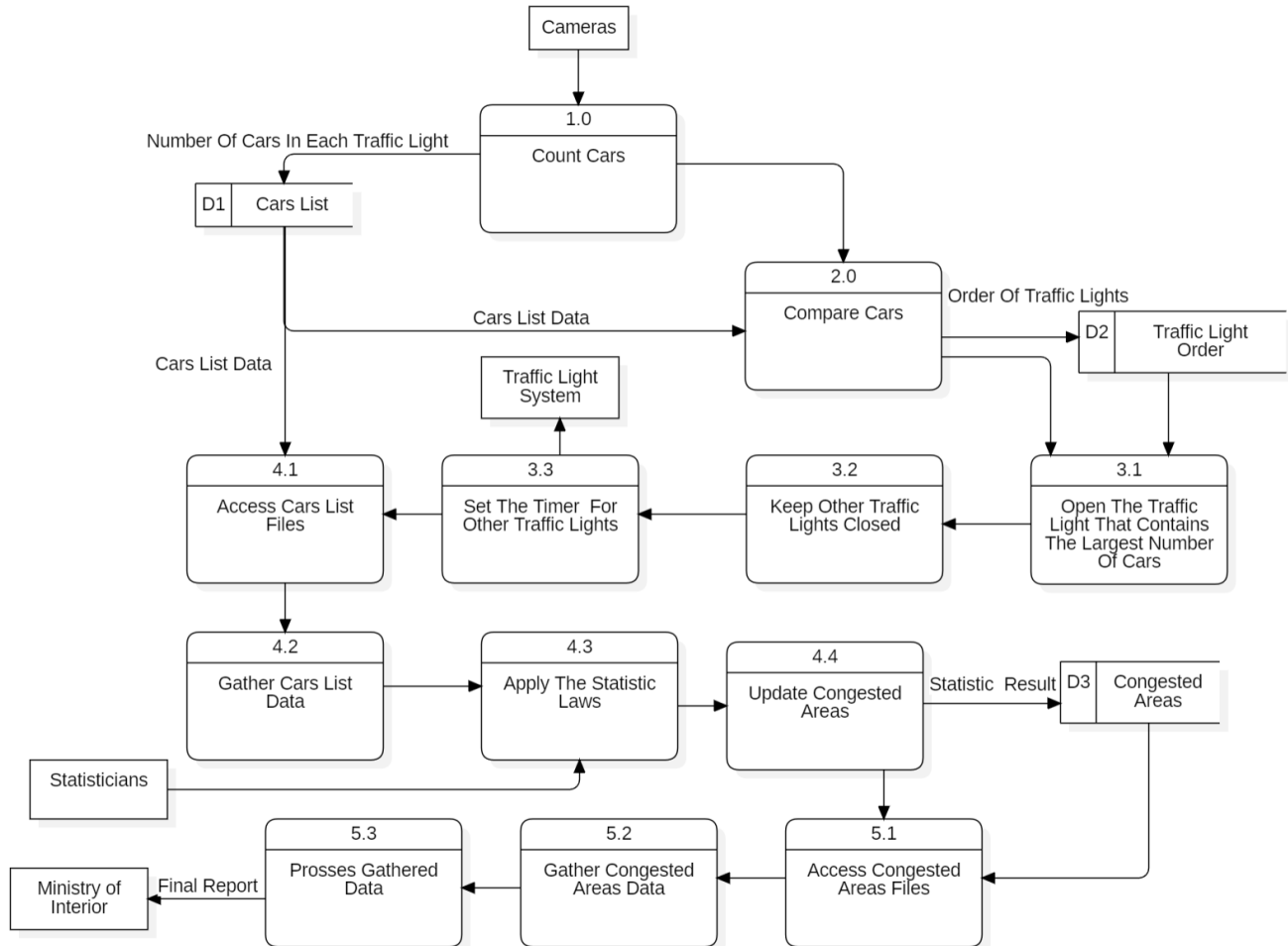
- **Source:** Choose Data Format
- **Destinations:** Police

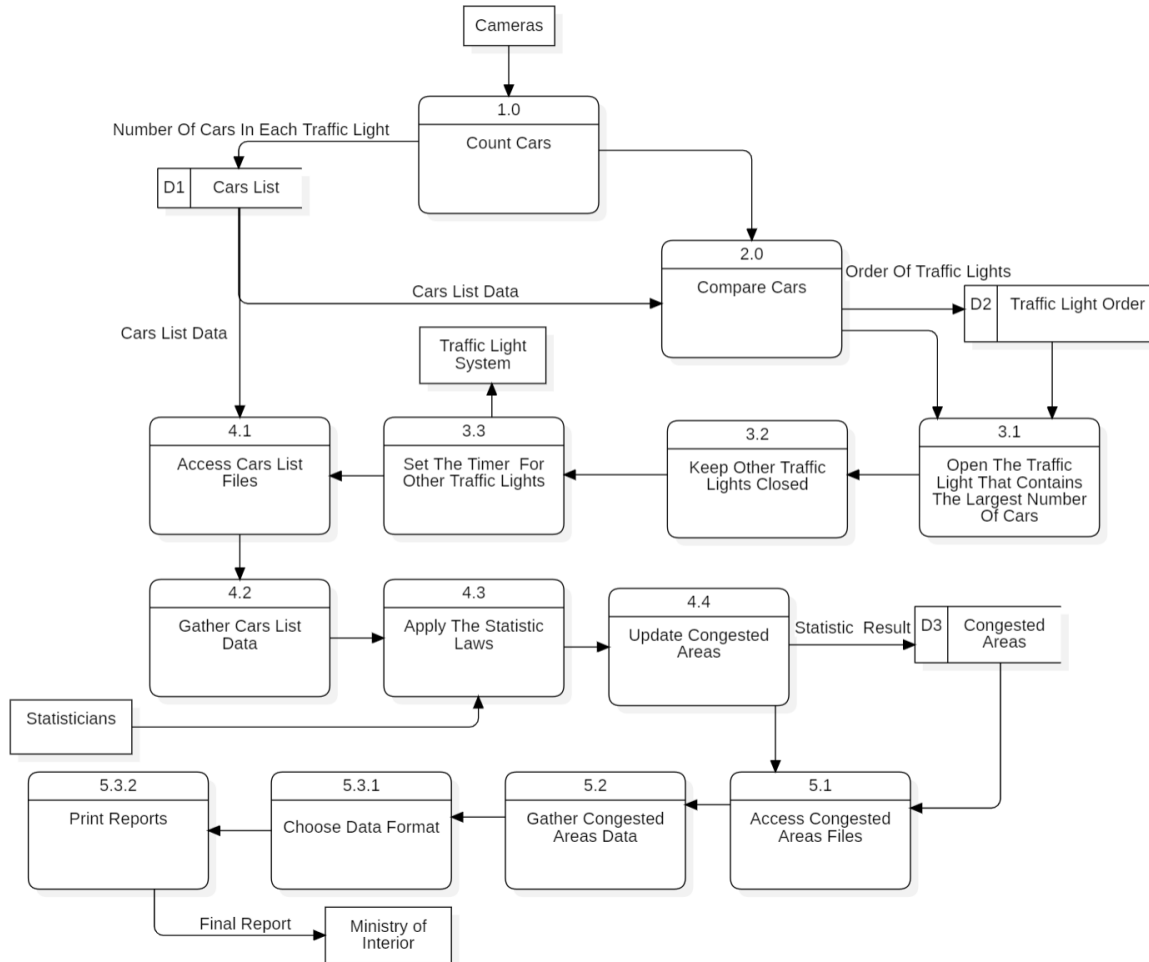
Diagram:



Level 0





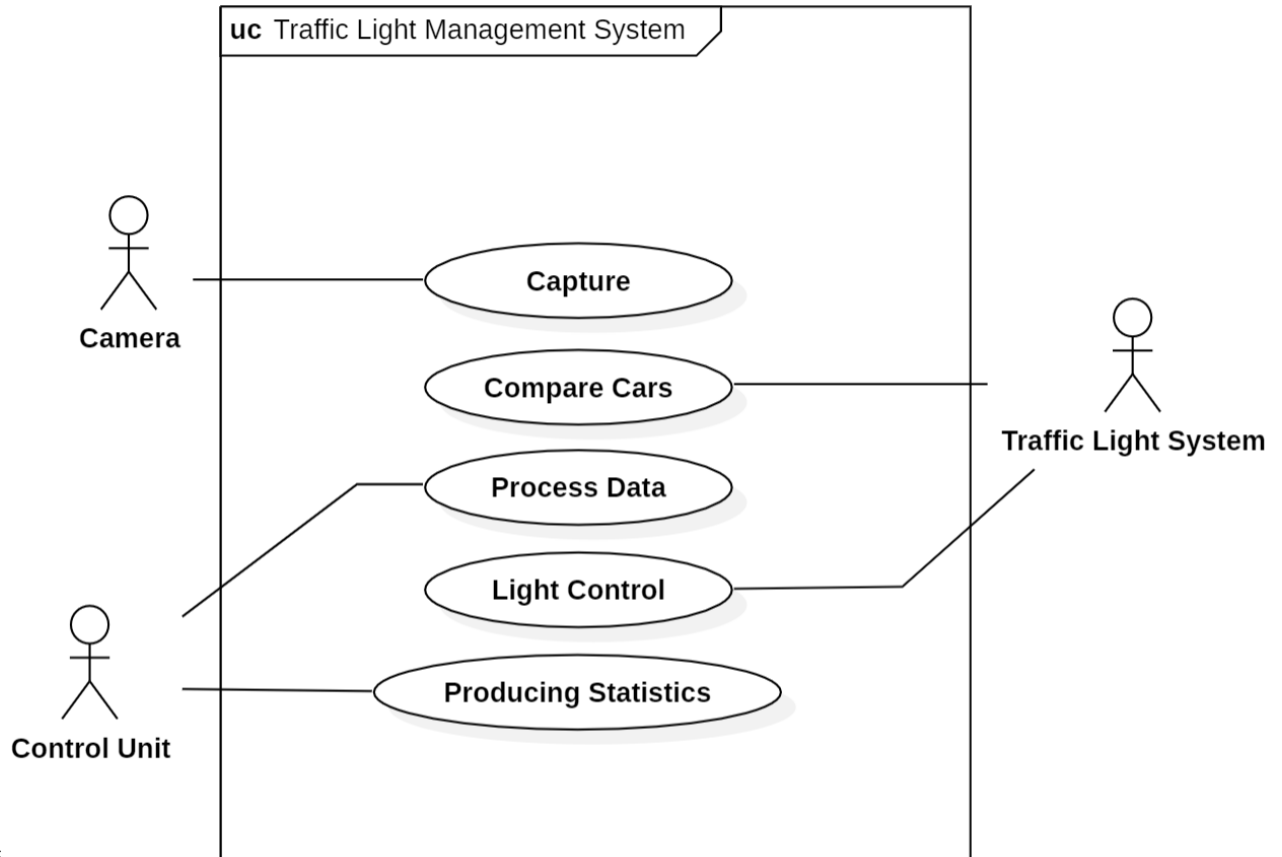


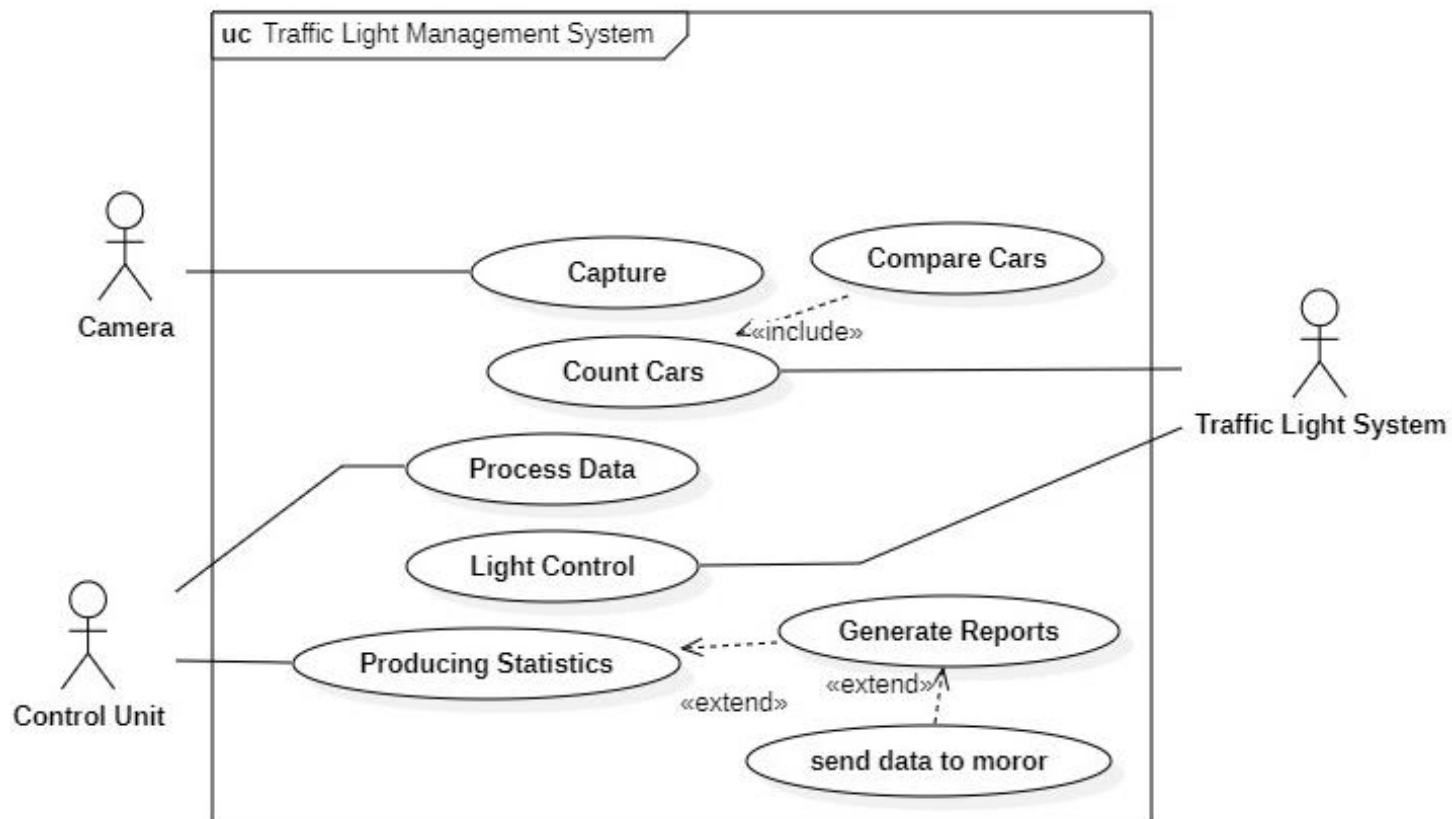
Use Case Diagram:

Written Use Case (General):

| |
|---|
| Use Case Title: Traffic Light Management System |
| Primary Actor: Control Unit |
| Level: kite(summary) |
| Stakeholder: Car Drivers At Traffic Light |
| Precondition: Cars Waiting at Traffic Light |
| Minimal Guarantee: The Timer on The Light Works on a Loop |
| Success Guarantee: Minimal Waiting Time at Traffic Lights |
| Trigger: At Least One Car Waiting at a Red Light |
| Main success scenario: <ul style="list-style-type: none">1. A Car reaches the intersection at a green light2. A Car reaches the intersection at a red light but no other lanes have cars so the light switches to green immediately3. All lanes have cars but the system switches the green light at the moment that the last car crosses the crosswalk |
| Extensions: <ul style="list-style-type: none">1. the camera is blurred and can't detect a car<ul style="list-style-type: none">1a. the car waits for the whole loop2. The power is down<ul style="list-style-type: none">2a. There is a backup battery that keeps the system going and requests maintenance2b. The system notifies a nearby patrolling officer that can guide the traffic until the system is back online |

Use Case Diagram (General):

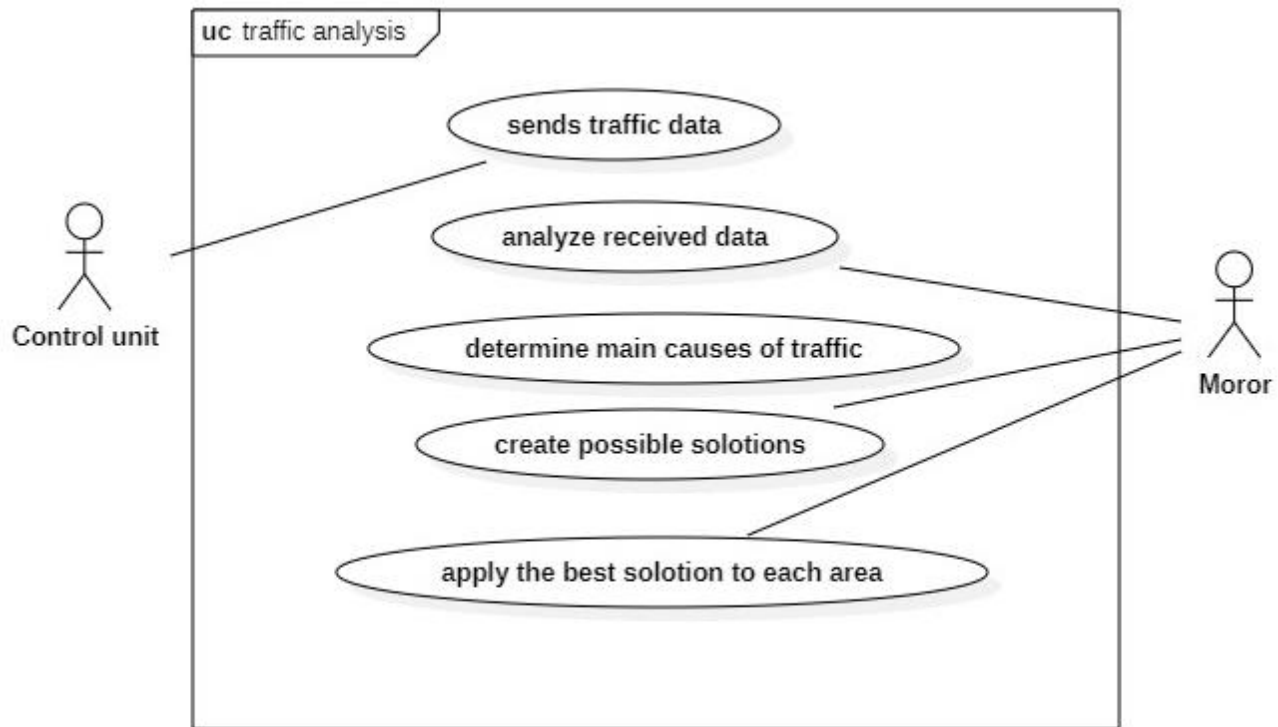




Written Use Case (Traffic Analysis):

| |
|--|
| Use Case Title: traffic analysis |
| Primary Actor: Moror |
| Level: Kite (summary) |
| Stakeholders: drivers |
| Precondition: sensors collecting data |
| Minimal Guarantee: Traffic patterns stay the same |
| Success Guarantee: Traffic delays reduce by a great margin |
| Trigger: sufficient traffic data has been collected |
| Main Success Scenario: <ol style="list-style-type: none">1. Moror can analyze traffic data correctly.2. Moror comes up with plausible solutions to minimize traffic.3. Moror sends best applicable solutions to Competent authorities.4. The best solution is applied.5. Traffic intensity is reduced. |
| Extensions: 1a- applied solution is ineffective. 1a1 restudy the cause of traffic. 1a2 come with another solution until the traffic intensity is at an acceptable level. |

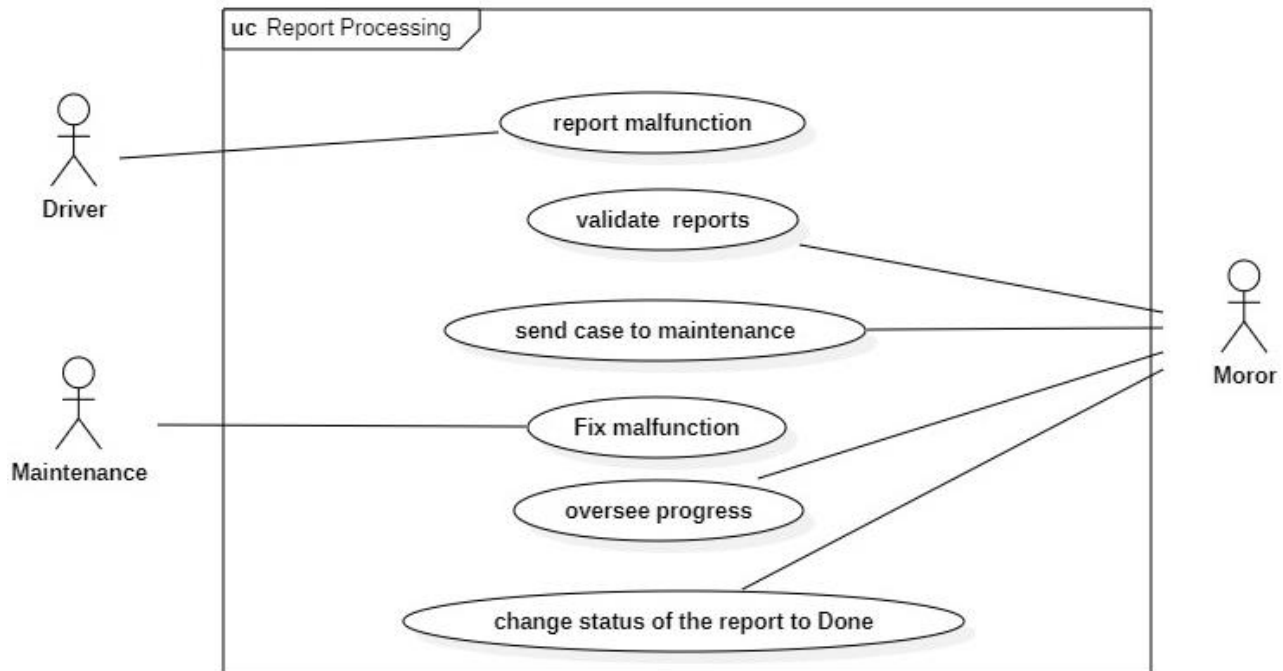
Use Case Diagram (Traffic Analysis):



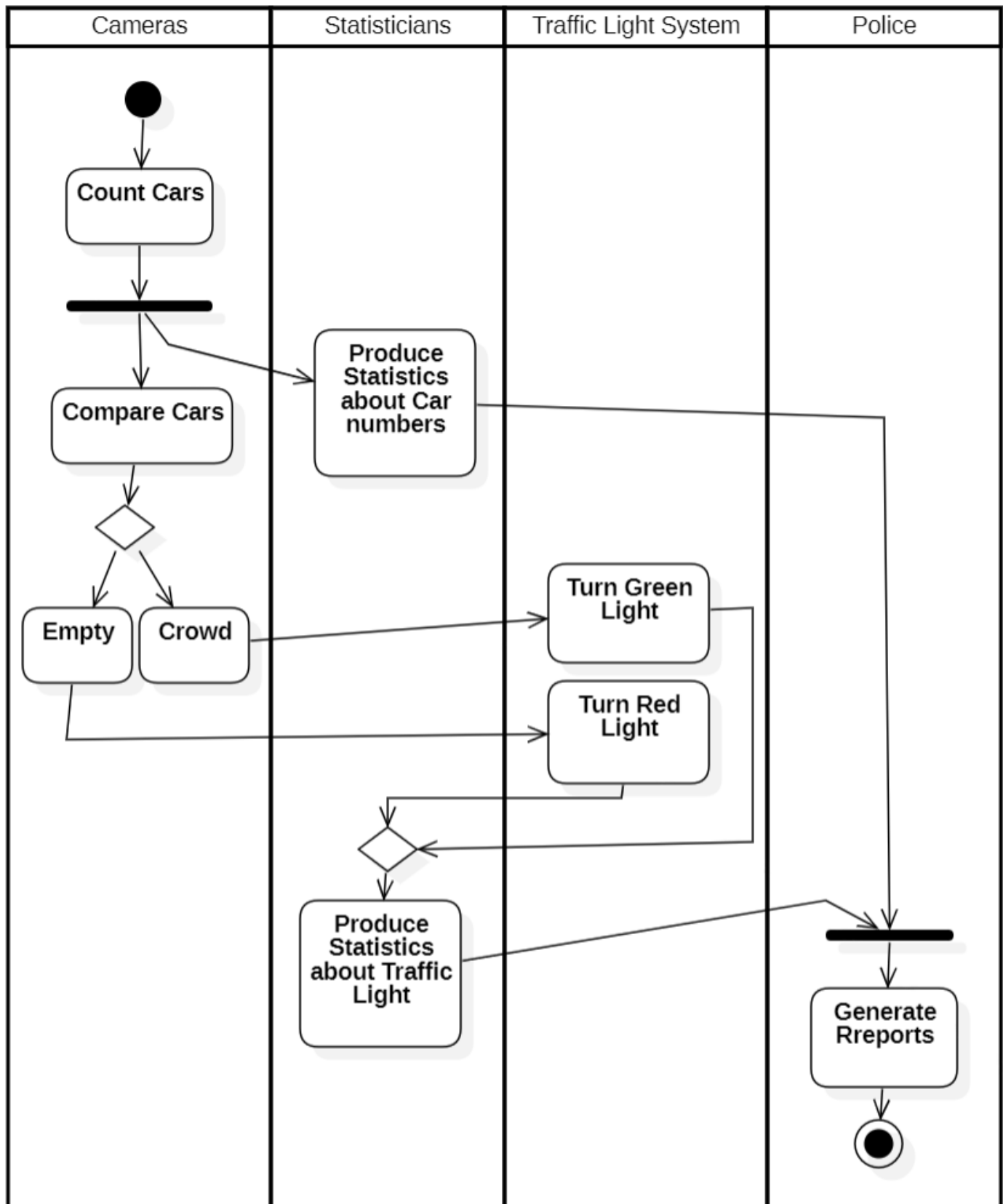
Written Use Case (Report Processing):

| |
|---|
| Use Case Title: Report Processing |
| Primary Actor: Moror |
| Level: Kite (summary) |
| Stakeholders: Drivers at a traffic light |
| Precondition: There is a traffic light malfunction |
| Minimal Guarantee: Traffic light malfunction won't be fixed |
| Success Guarantee: Traffic light malfunction is corrected |
| Trigger: Driver or citizen sees the malfunction |
| Main Success Scenario: <ol style="list-style-type: none">1. Driver sees the malfunction.2. Driver reports the malfunction through the app.3. Report gets sent by the app successfully.4. Moror officer validates the case.5. Case is accepted.6. Moror officer sends the case to maintenance team.7. Maintenance team fix the malfunction.8. Moror officer oversees the case until its done.9. Case is fixed.10. Moror officer changes the status of the case from processing to Done. |
| Extensions: <ol style="list-style-type: none">1a- app doesn't send the report to Moror.<ol style="list-style-type: none">1a1. App doesn't notify user of the report status.1a2. User re sends the report through the app.1b- the report is not a valid issue or malfunction.<ol style="list-style-type: none">1b1. Moror officer validates if the report is valid.1b2. Moror officer rejects the report. |

Use Case Diagram (Report Processing):



Activity Diagram:



Class Diagram:

Classes, Attributes and Methods:

1. Camera:

- Attributes:
 - isNight
 - picture
- Methods:
 - countCars()
 - sendCarsNum()
 - changeMode()
 - compare()

2. Car:

- Attributes:
 - plate
 - isEmergency
- Methods:
 - InitiateCounting()

3. Moror:

- Attributes:
 - EmployeeID
 - department
 - city
- Methods:
 - checkCrowdArea()
 - systemMaintenance()
 - calculateCrowd()
 - updateCrowdArea()
 - sendCrowdArea()
 - AnalyseReports()

4. TrafficLights:

- Attributes:
 - ID
 - isWorking
 - locationX
 - locationY
 - Status
- Methods:
 - turnON(ID)
 - turnOff(ID)
 - setStatus()

5. ControlUnit:

- Attributes:
 - isEmpty
 - redLightTimeCounter
- Methods:
 - prosesTraffic()
 - calculateLanePriority()
 - generateStatistics()
 - calculateRedLight()
 - generateLogs()
 - generateReports()
 - checkEmergency()

Relationships:

1. **Camera** has an association with **ControlUnit**

- Relationship: Aggregation (many-to-one)
- Explanation: ControlUnit uses the camera to know which lines contain cars.

2. **Car** has an association with **Camera**

- Relationship: Aggregation (many-to-one)
- Explanation: The camera detects cars and counts them.

3. **Moror** has an association with **TrafficLight**

- Relationship: Aggregation (one-to-many)
- Explanation: moror maintains and observes TrafficLight.

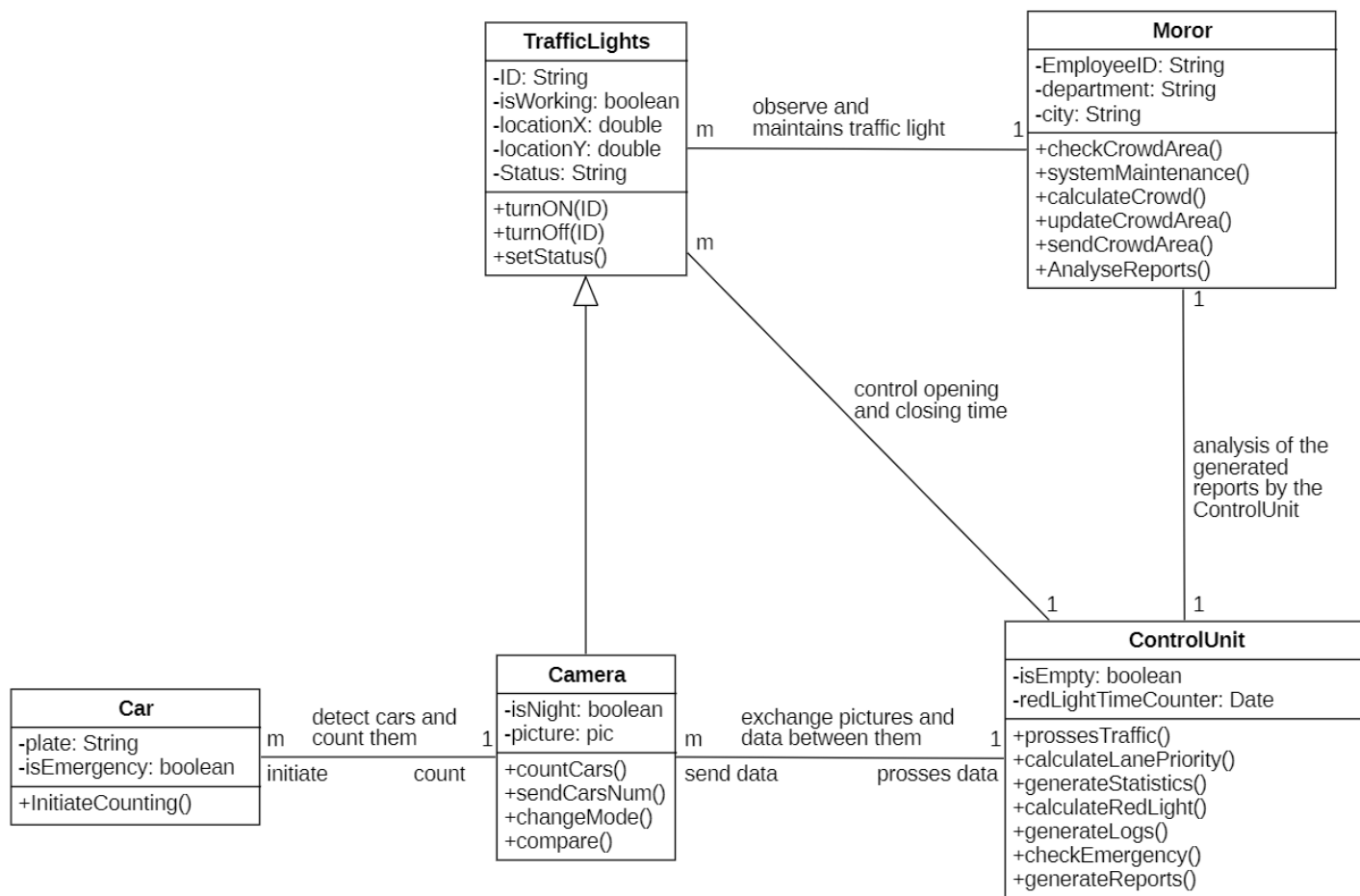
4. **TrafficLight** has an association with **ControlUnit**

- Relationship: Aggregation (many-to-one)
- Explanation: ControlUnit is responsible for controlling the traffic light and when to open and close.

5. **ControlUnit** has an association with **Moror**

- Relationship: Aggregation (one-to-one)
- Explanation: ControlUnit generates reports and sends them to moror for analysis.

Diagram:

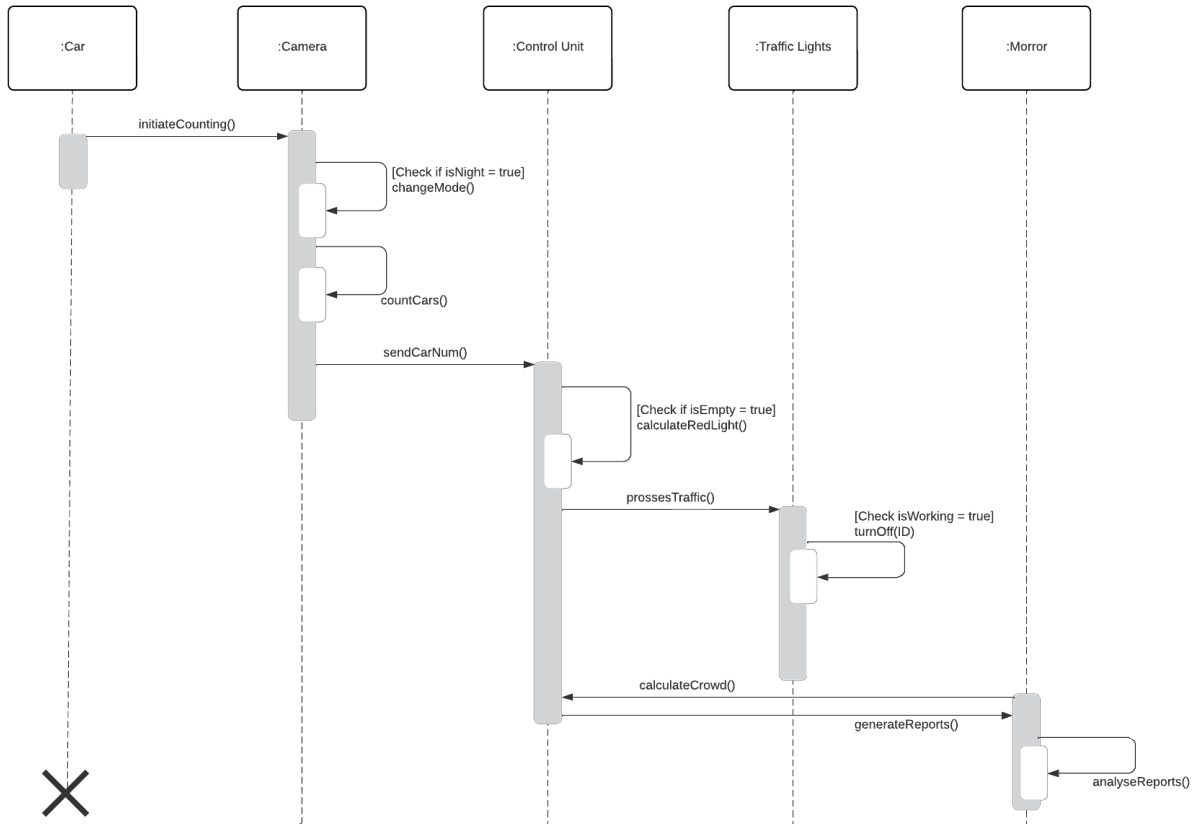


Sequence Diagram:

Sequence of Interactions (Red light):

- 1- "Car" stopping by the traffic light will begin the process by calling the **initiateCounting()** method to the "Camera".
- 2- "Camera" will check the lighting in the environment and if it is dark/night the camera will call the **changeMode()** method .
- 3- "Camera" will count the cars stopping by using the **countCars()** method.
- 4- "Camera" sends the total number of cars shown to the "Control Unit" with the help of **the sendCarNum()** method.
- 5- "Control Unit" checks if the number of cars=0 / empty it will start the **calculateRedLight()** method.
- 6- "Control Unit" will process the traffic by calling the method of **processTraffic()** to the traffic lights.
- 7- "Traffic Light" check if the traffic lights are working then the specific ID traffic light will turn off because no cars are available using the **turnOff(ID)** method.
- 8- "Morrer" will calculate the amount of crowd in different traffic lights using the **calculateCrowd()** method.
- 9- "Control Unit" will work on generating reports that will benefit the "Morrer" by the **generateReports()** method.
- 10- "Morrer" at last, will collect the reports and start analysing them using the **analyseReports()** method.

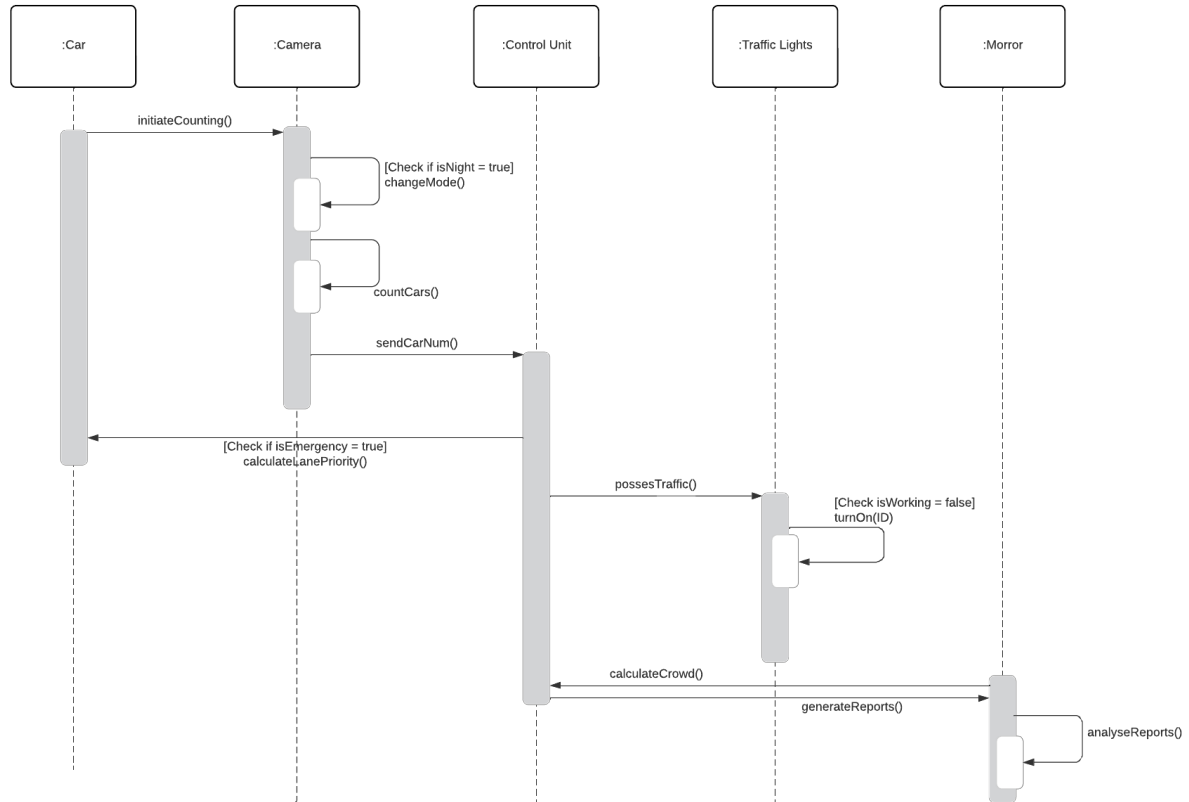
Red Light Scenario Diagram:



Sequence of Interactions (Emergency):

- 1- "Car" stopping by the traffic light will begin the process by calling the **initiateCounting()** method to the "Camera".
- 2- "Camera" will check the lighting in the environment and if it is dark/night the camera will call the **changeMode()** method.
- 3- "Camera" will count the cars stopping by using the **countCars()** method.
- 4- "Camera" sends the total number of cars shown to the "Control Unit" with the help of the **sendCarNum()** method.
- 5- "Control Unit" checks if there is an emergency such as an ambulance then it will start the **calculateLanePriority()** method.
- 6- "Control Unit" will process the traffic by calling the method of **processTraffic()** to the traffic lights.
- 7- "Traffic Light" check if the traffic lights are not working then the specific ID traffic light will turn on because emergency events make this specific traffic light top priority using the **turnOn(ID)** method.
- 8- "Morrer" will calculate the amount of crowd in different traffic lights using the **calculateCrowd()** method.
- 9- "Control Unit" will work on generating reports that will benefit the "Morrer" by the **generateReports()** method.
- 10- "Morrer" at last, will collect the reports and start analysing them using the **analyseReports()** method.

Emergency Scenario Diagram:



State Diagram:

States for Controlling:

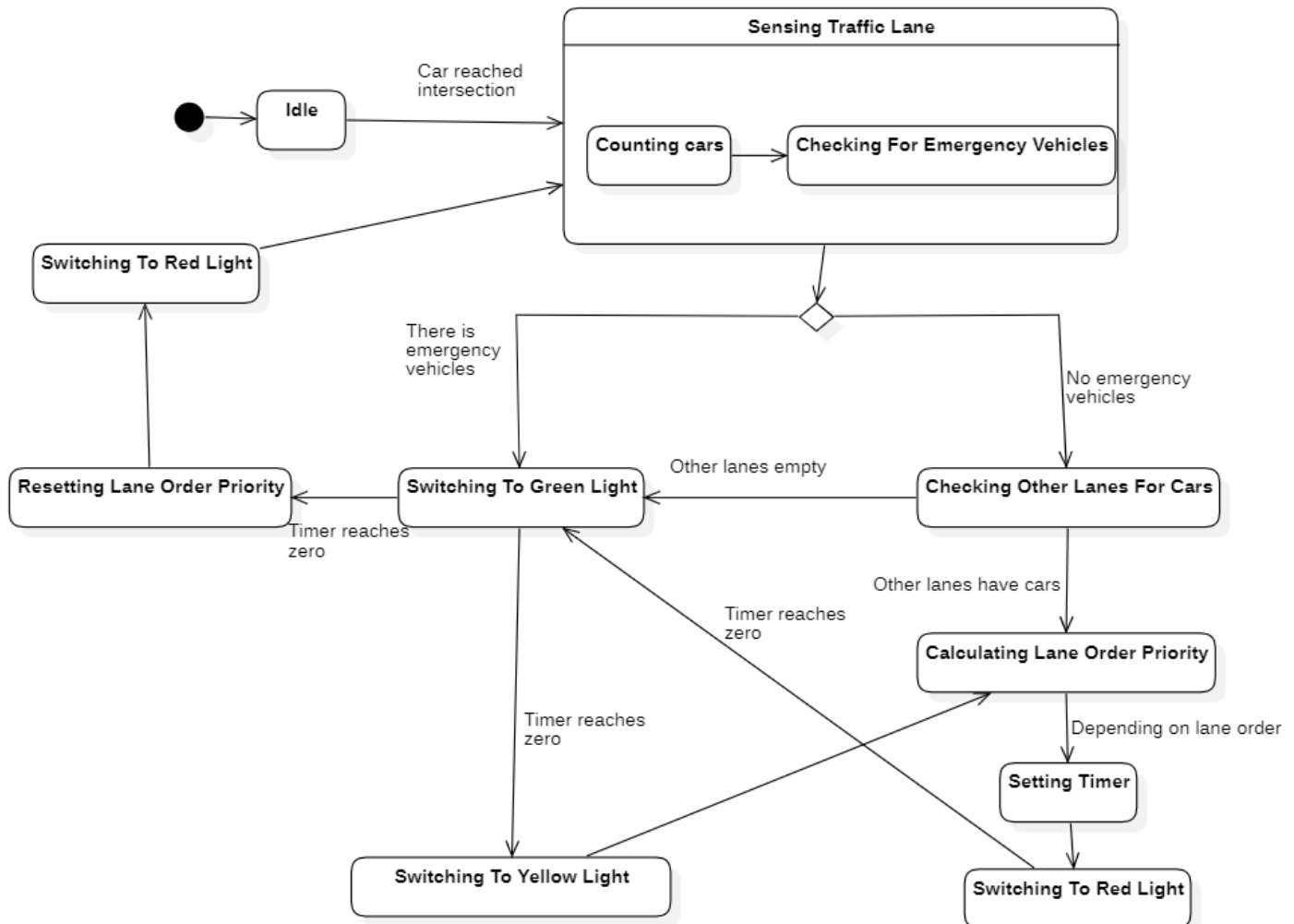
- Idle
- Sensing Traffic Lane
- Counting Cars
- Checking For Emergency Vehicles
- Checking Other Lanes for Cars
- Switching to Green Light
- Switching to Yellow Light
- Switching to Red Light
- Calculating Lane Order Priority
- Setting Timer
- Resetting Lane Order Priority

Event for Controlling:

- Car reached intersection
- No emergency vehicles
- Other lanes have cars
- Depending on lane order
- timer reaches zero
- There are emergency vehicles

Diagram for Controlling:

stm Controlling Lights State



States for Maintain:

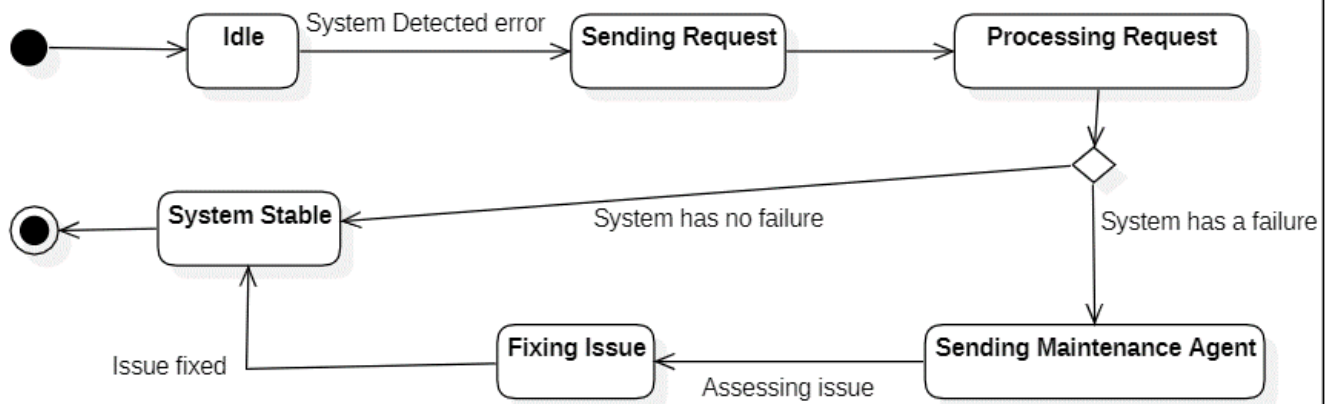
- Idle
- Sending Request
- Processing Request
- Sending Maintenance Agent
- Fixing issue
- System Stable

Events for Maintain:

- System detected error
- System has a failure
- System has no failure
- Assessing issue
- Issue fixed

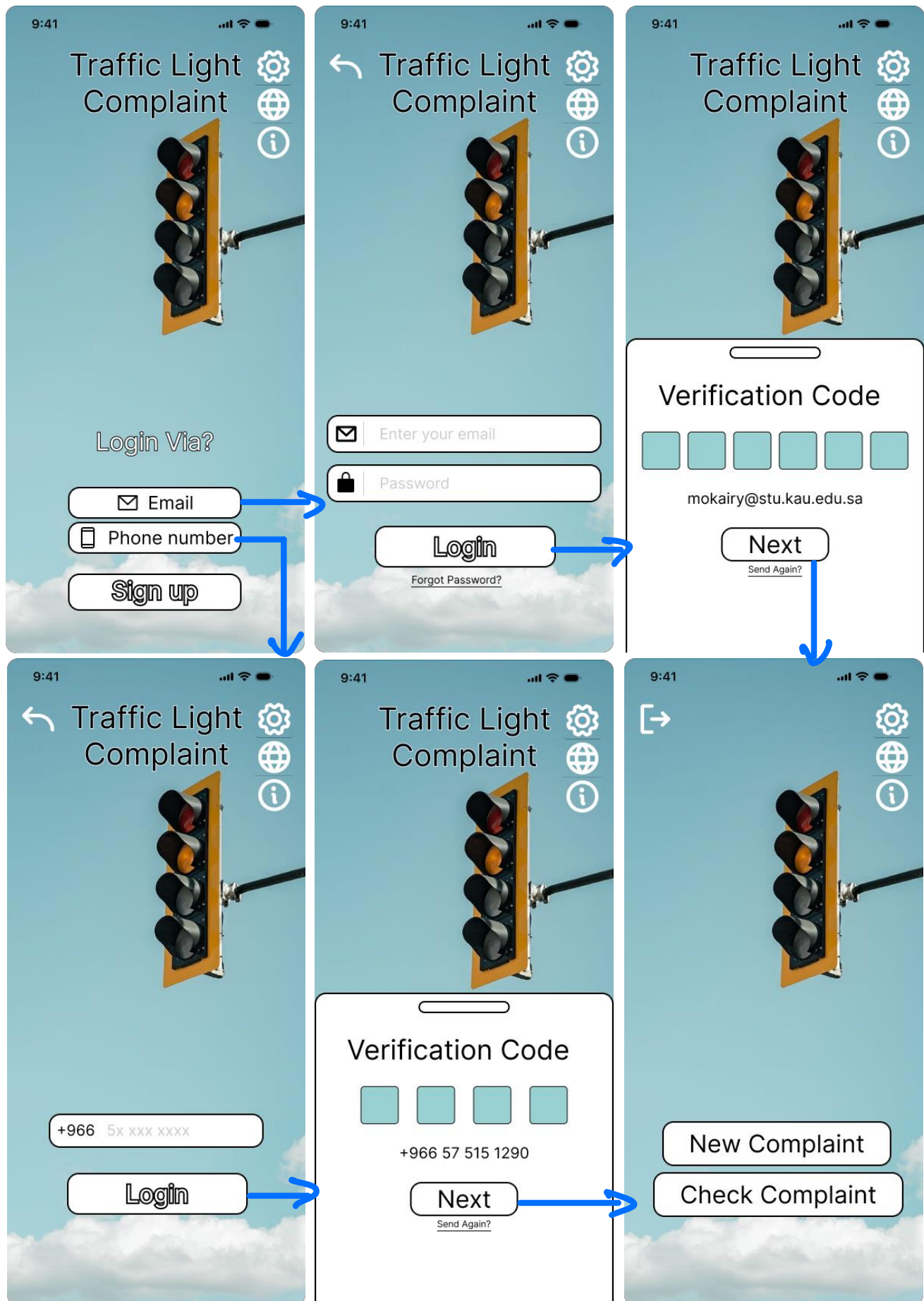
Diagram for Maintain:

stm Maintain Traffic Light State



Forms & Reports:

UI for Drivers:



9:41

←

⚙️
🌐
ℹ️

Location

📍

Upload Photo 🖼️ Take Photo 📷

Description

📄

Submit

9:41

🏠

⚙️
🌐
ℹ️

Your complaint has been sent

Complaint ID: 47647

Check Complaint

9:41

←

⚙️
🌐
ℹ️

Enter complaint ID

Search

9:41

🏠

⚙️
🌐
ℹ️

Complaint info

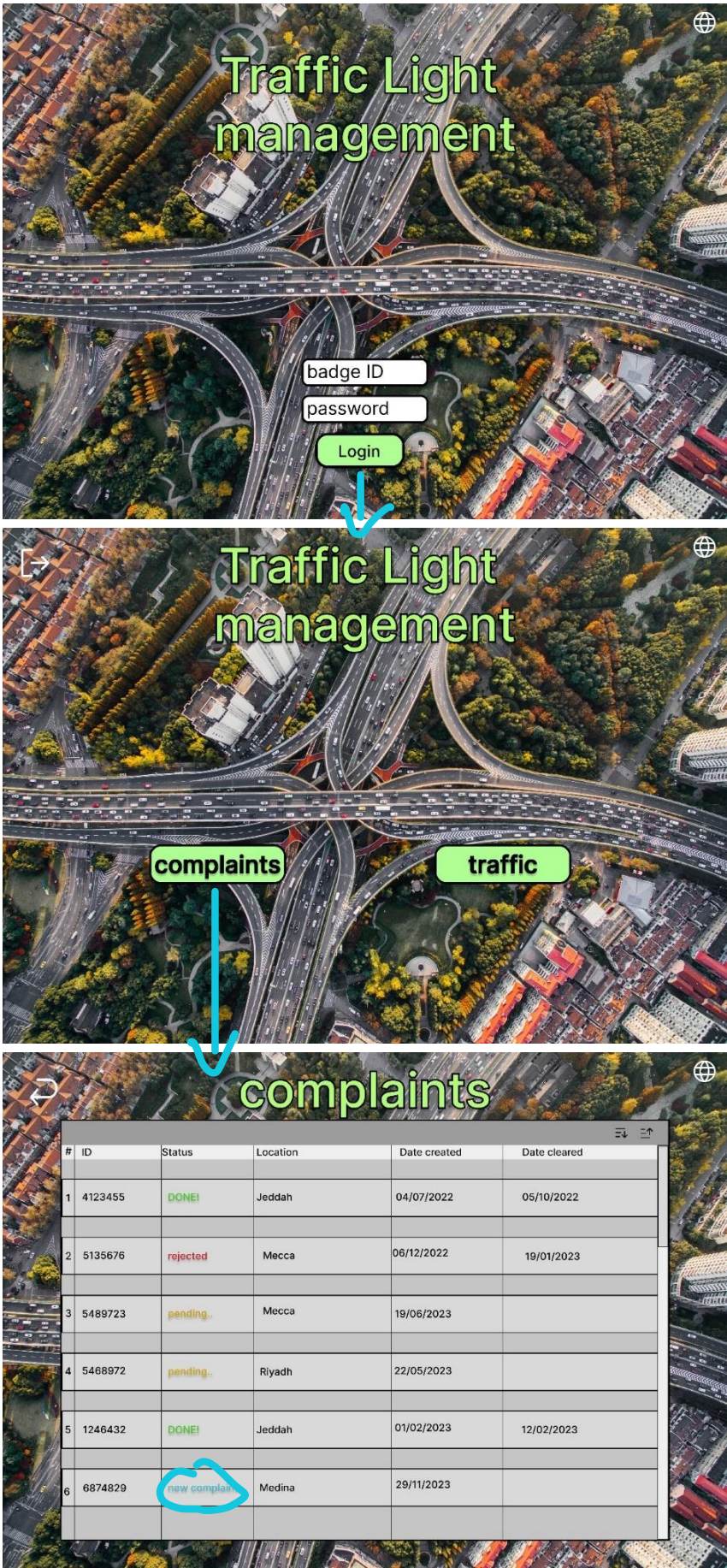
ID: 47647
Location: Al-Madinah Road
Status: **Under Process**
Time: 5:42 PM
Picture:

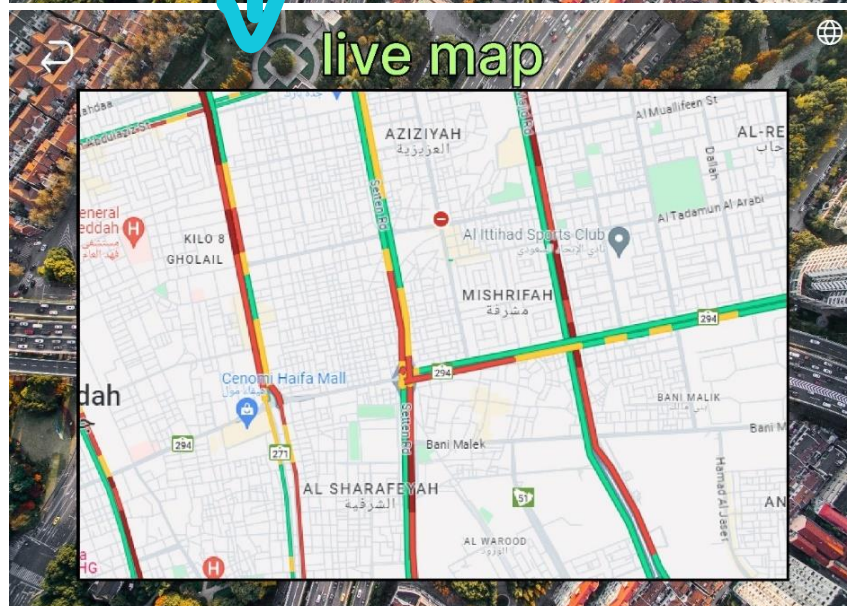
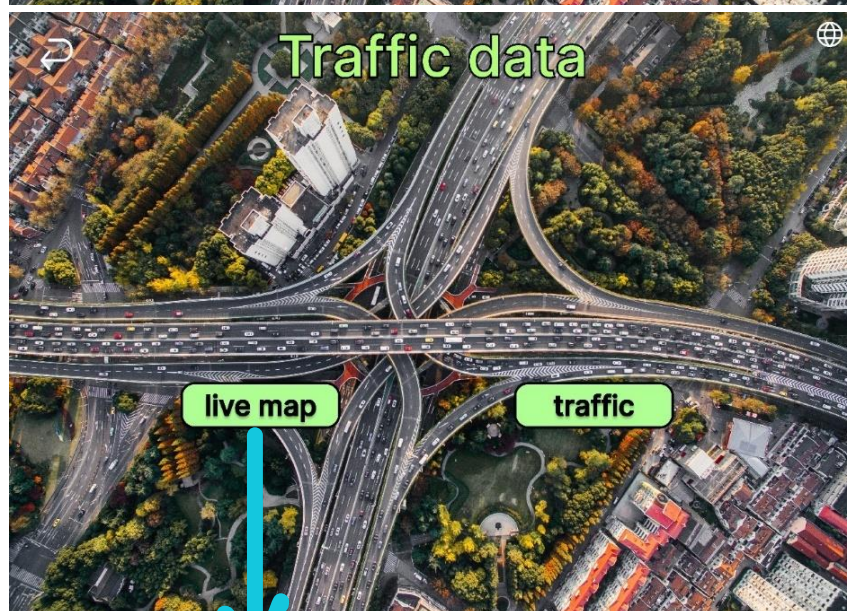
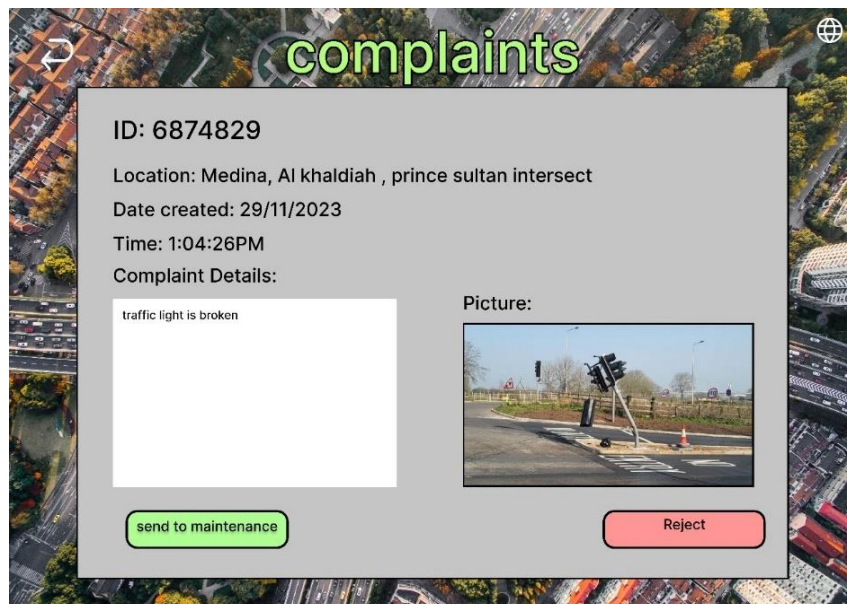
📷

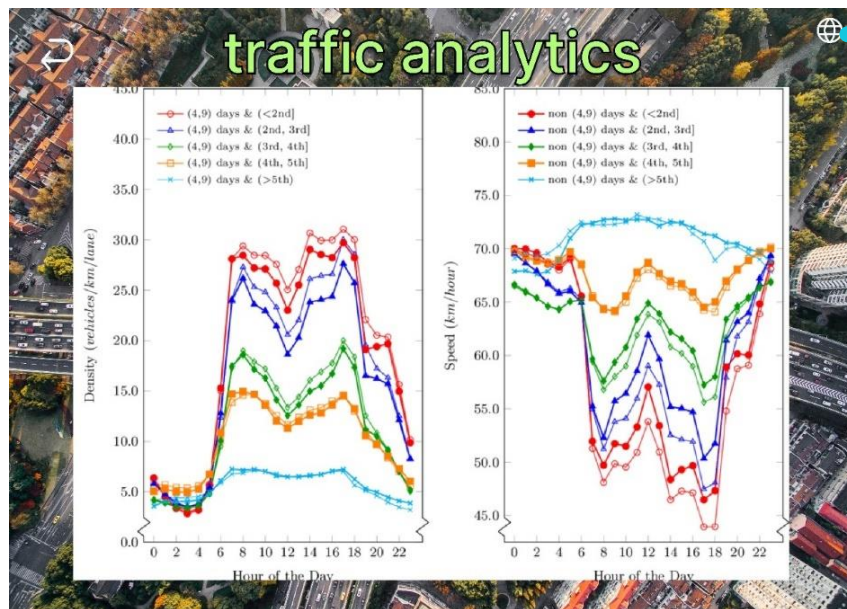
- 9:41
- ←
- ⚙️
🌐
ℹ️
- ✉️ Email Us
 - ☎️ Call Us
 - 💬 Live Chat
 - 🗨️ Most Asked

- 9:41
- ←
- ⚙️
🌐
ℹ️
- ✉️ راسلنا
 - ☎️ اتصل بنا
 - 💬 المحادثة المباشرة
 - 🗨️ الأسئلة الشائعة

UI for Morror:







Conclusion:

The Traffic Lights Management System is an innovative solution that significantly improves traffic flow. Unlike traditional systems that follow a fixed schedule, this system uses smart cameras and AI technology to adapt in real-time. This means you won't have to wait at red lights when there's no traffic, reducing the amount of time you spend on the road.

In the event of a complaint, there is an application dedicated to driver complaints, enabling them to promptly report any issues. The Morror also possesses real-time traffic monitoring capabilities and the capacity to handle and resolve complaints efficiently.

With this system in place, you'll experience less traffic congestion, which translates to fewer cars polluting the air and faster commutes. Our future plans involve expanding the system to more areas, collaborating with smart city initiatives, and continuing to innovate the technology. Imagine a future where your daily commute is smoother, faster, and environmentally friendly.