LIFI SMART TOLL COLLECTION SYSTEM

Mentor Evaluation

Submitted by:

(102003130) Arpit Sagar

(102003171) Manpreet Singh

(102003177) Sanchita Bora

(102003183) Anshika

(102003188) Medhansh Verma

BE Third Year- COE

CPG No. 52

Under the Mentorship of:

Dr. Sharad Saxena

Associate Professor CSED

Wireless sensor networks, IOT, Ad-hoc networks

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

Computer Science and Engineering Department

Thapar Institute of Engineering and Technology, Patiala
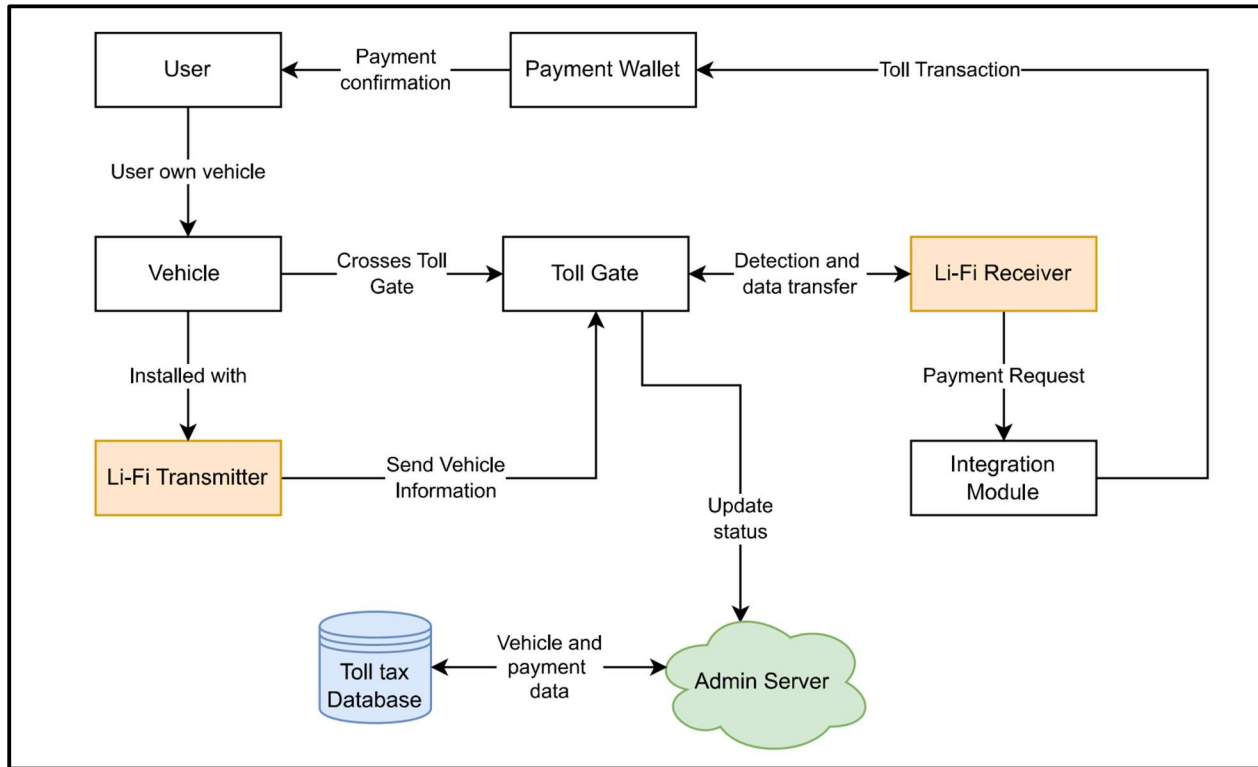
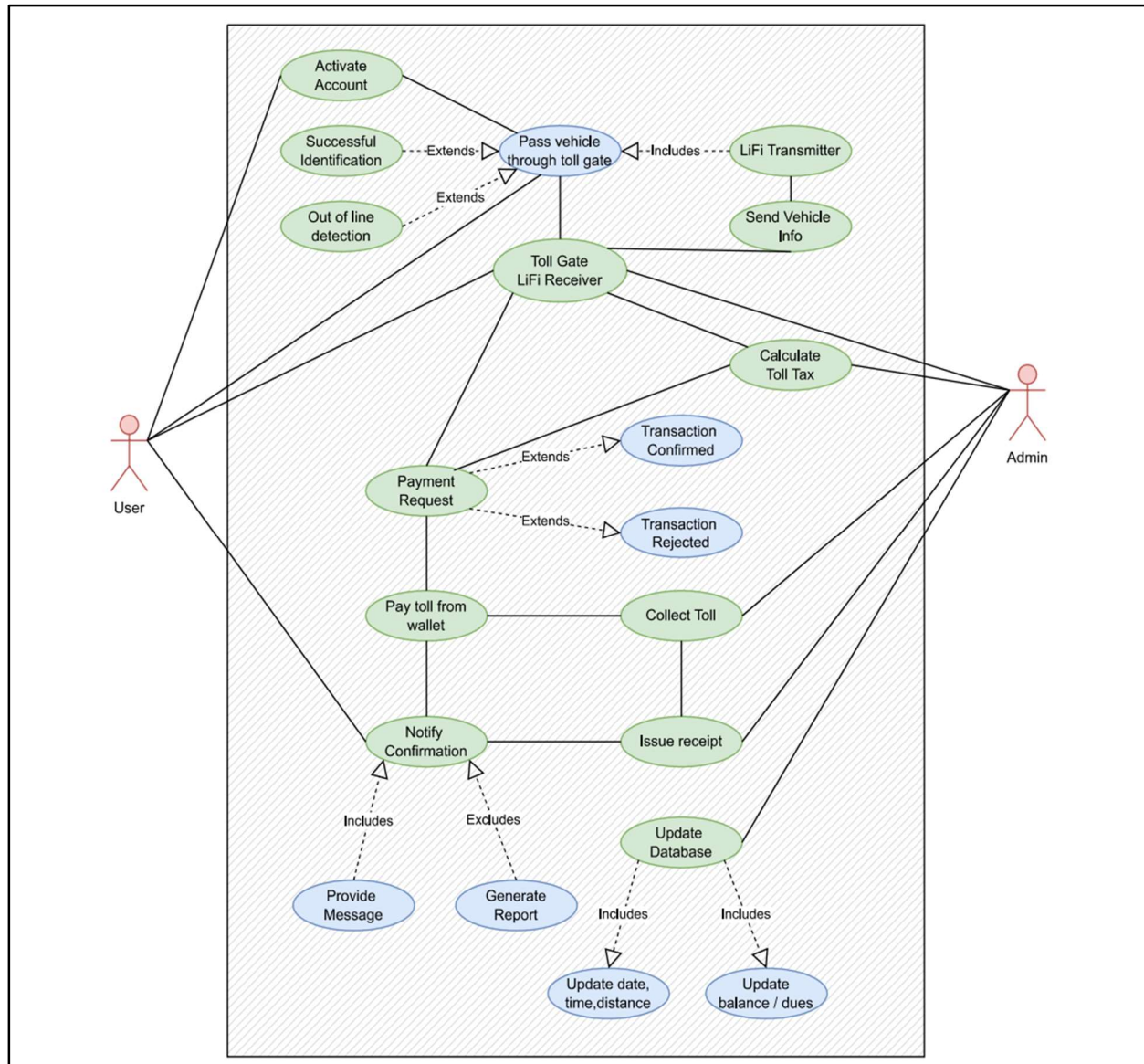**March/2023 – December/2023**

TABLE OF CONTENTS

Initial Visualization and Product Perspective

- Designed to automate and optimize the toll collection process at toll booth gateways, this system aims to provide a streamlined and smooth functioning through LIFI technology.

- The initial visualization of the system includes the work flow as the user vehicle approaches the toll gate , the LIFI(Light Fidelity) transmitter i.e the headlights of the vehicle encoded with the vehicle information such as the unique vehicle number as the ID is transmitted with in-line light detection.

- Strategically placed Lifi Receiver on the gate ensures reliable communication and detects vehicle information to identify the connected wallet and send payment request for toll collection. With comprehensive and user friendly interfaces to calculate toll amount and monitor the operations the system ensures automated transaction and safe user experience.

- The product perspective focuses to integrate hardware components, software systems and infrastructure to envision a comprehensive solution of advanced toll collection system. This includes installation of LiFi receivers , Lifi transmitter equipped vehicles and integrating modules at toll booth.

- Robust software systems and administrative tools for monitoring and managing the integration and scalability to deliver an accurate, efficient and user satisfied modern toll booth collection system.

Block Diagram

Use Case Diagram

Use Case Templates

Use Case ID	1
Use Case Title	Get LiFi System installed on vehicle
Actors	User
Description	This use case describes the steps involved in installing the LiFi transmitter system in the vehicle
Preconditions	User has purchased the LiFi system and installed it
Task Sequence	1. User will purchase the LiFi transmitter system and install it with the help of professional assistance. 2. User must ensure that the installation height of the transmitter is in accordance to the toll gate receiver height. 3. User should activate the module after installation.
Postconditions	LiFi system is installed and ready to use.
Alternative Flows	None.

Use Case ID	2
Use Case Title	Automatic Payment System
Actors	User, Admin
Description	With this facility the user can carry out automatic toll payment at the toll gate.
Preconditions	The user should have an account and the LiFi system installed
Task Sequence	1. The user's vehicle has to be at the appropriate distance from toll gate 2. On successful transmission of vehicle information, the received information is sent to cloud-based database. 3. The money is deducted from the user's account using the information present in the database.

Postconditions	1. The user will have a cashless payment which will be time efficient. 2. User can keep track of the money deducted. 3. The user can view the payment history.
Alternative Flows	1. When the receiver is unable to detect the information, the user have to do manual transaction. 2. In absence of account the user will have to create an account for the same.

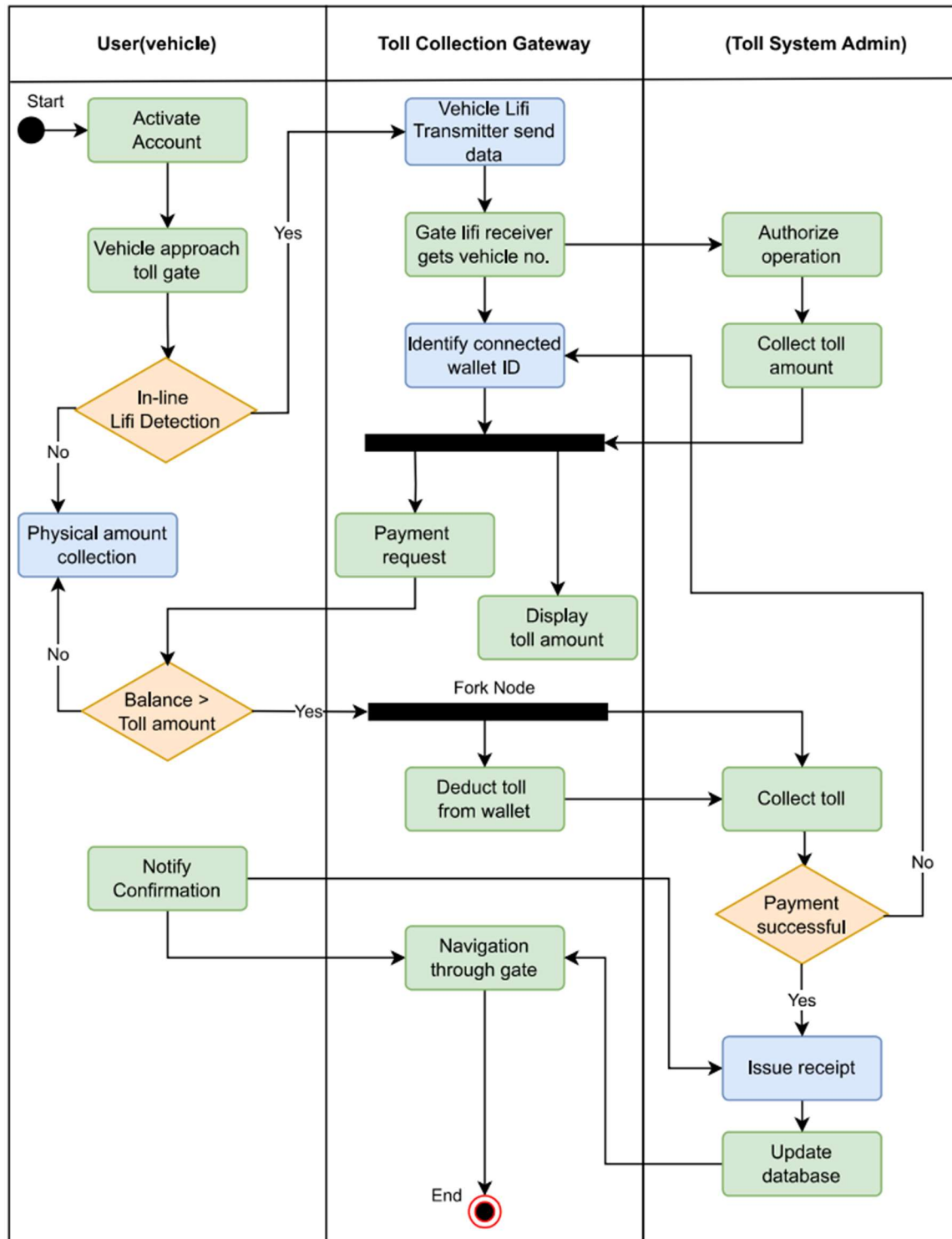| Use Case ID	3
Use Case Title	Checking and managing balance
Actors	User
Description	With this facility the user can manage his digital wallet.
Preconditions	The user should have an account.
Task Sequence	1. User has to have a minimum balance in his account for successful transactions. 2. If the balance is below the threshold the user can credit his wallet with the required amount.
Postconditions	The user can keep track of his wallet balance.
Alternative Flows	None.

Functional requirements:

1. The system shall be able to transmit and receive data through Li-Fi technology.
2. The system shall be able to capture and process vehicle number from Li-Fi signal.
3. The system shall be able to connect to Cloud Database to retrieve user information.
4. The system shall be able to check user information in Cloud Database to determine toll payment status.
5. The system shall be able to deduct toll amount from user's account balance automatically, if the user is registered with the system.
6. The system shall be able to create a new user account in Cloud Database, if the user is not registered with the system.
7. The system shall be able to update user account balance in Cloud Database after deducting toll amount.
8. The system shall be able to generate a receipt for the toll payment.
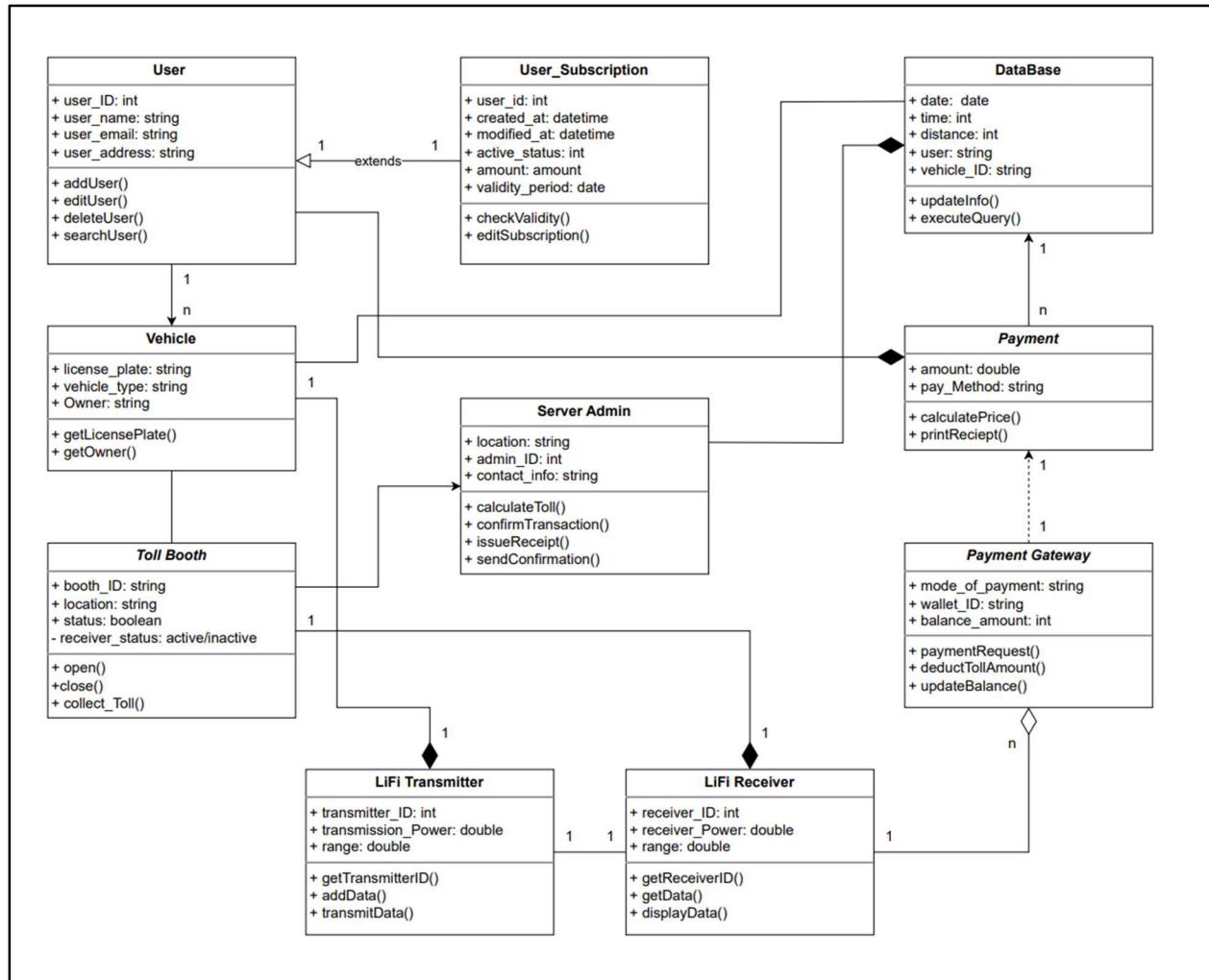
Non-functional requirements:

1. The system shall have a high data transfer rate through Li-Fi technology.
2. The system shall have a low latency to ensure fast processing of toll payments.
3. The system shall have high reliability to ensure that toll payments are processed accurately.
4. The system shall have high availability to ensure that it is always operational.
5. The system shall be scalable to handle a large number of vehicles and toll payments.
6. The system shall have high security to ensure that user information is protected and not accessible by unauthorized users.
7. The system shall be easy to use for both the Toll Gate operator and the user.
8. The system shall have a user-friendly interface to ensure that the user can easily create and manage their account.
9. The system shall be maintainable to ensure that it can be easily updated and repaired if necessary.
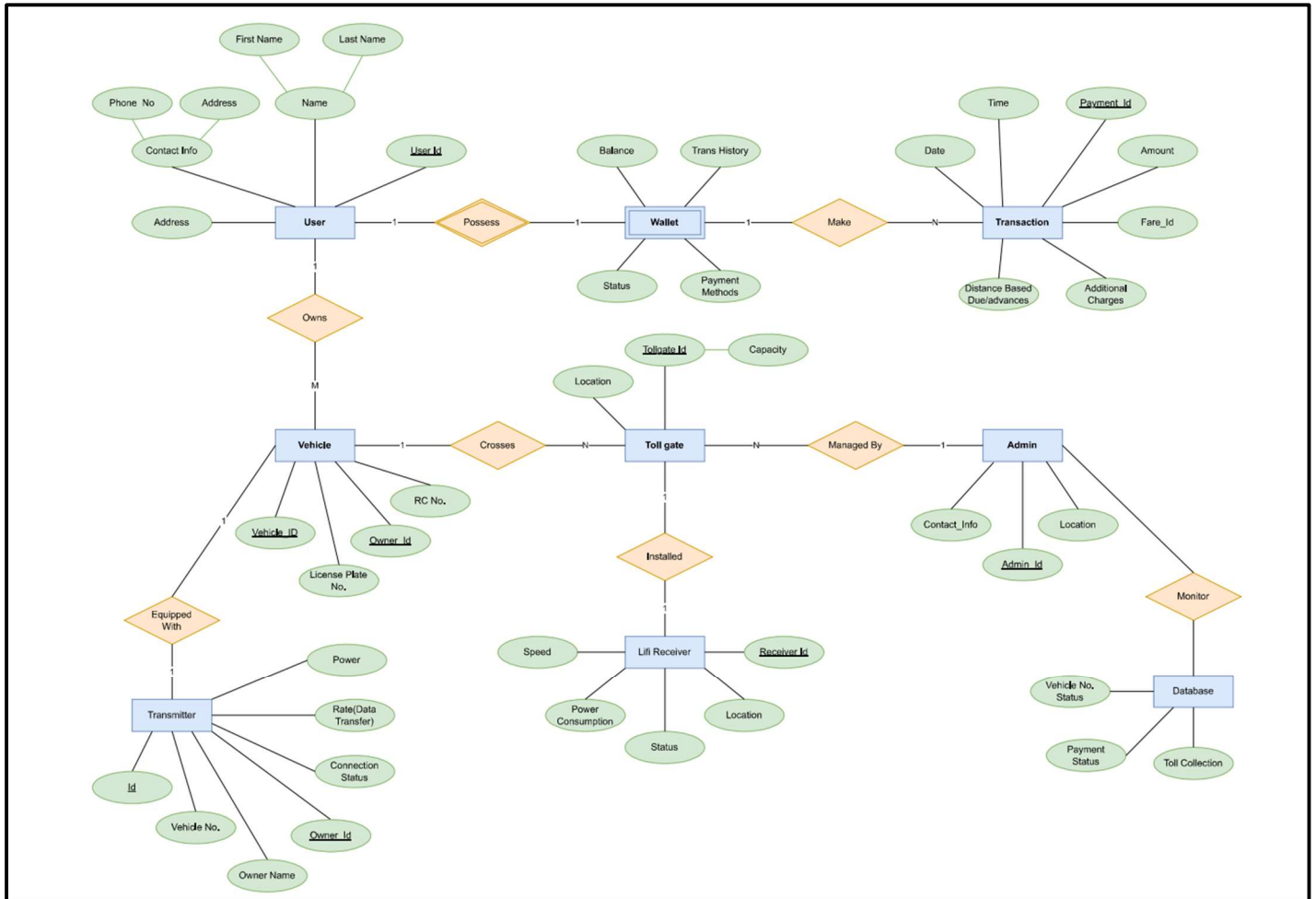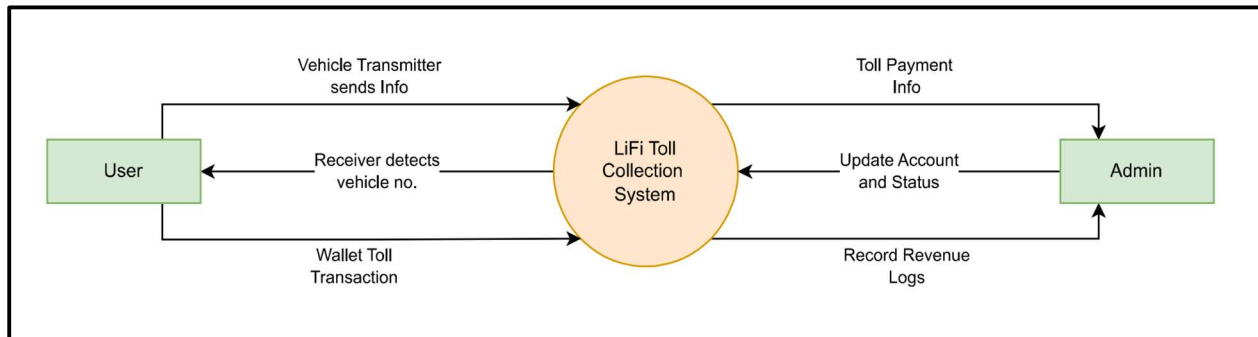
Activity Diagram

Class Diagram

User
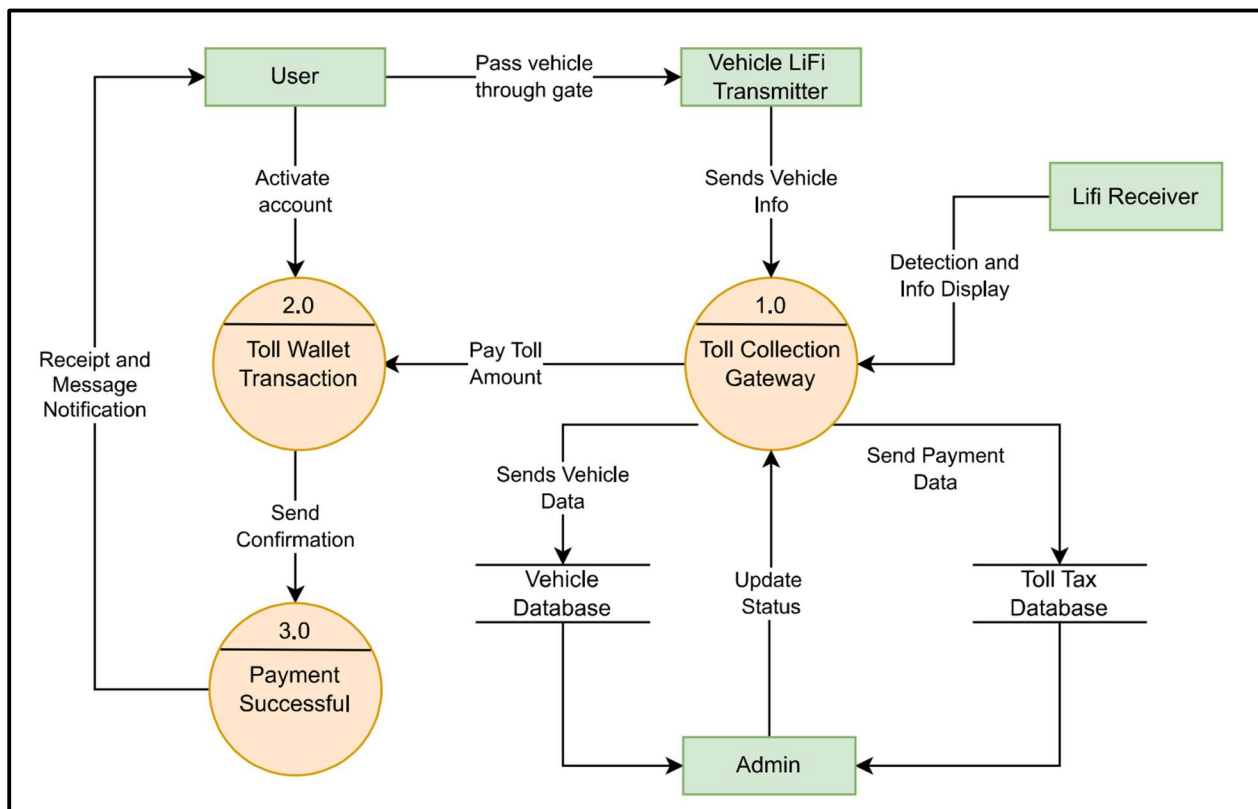+ user_ID: int
+ user_name: string
+ user_email: string
+ user_address: string

+ addUser()
+ editUser()
+ deleteUser()
+ searchUser()

User_Subscription
+ user_id: int
+ created_at: datetime
+ modified_at: datetime
+ active_status: int
+ amount: amount
+ validity_period: date

+ checkValidity()
+ editSubscription()

DataBase
+ date: date
+ time: int
+ distance: int
+ user: string
+ vehicle_ID: string

+ updateInfo()
+ executeQuery()

1 ◁ extends 1

Vehicle
+ license_plate: string
+ vehicle_type: string
+ Owner: string

+ getLicensePlate()
+ getOwner()

Server Admin
+ location: string
+ admin_ID: int
+ contact_info: string

+ calculateToll()
+ confirmTransaction()
+ issueReceipt()
+ sendConfirmation()

Payment
+ amount: double
+ pay_Method: string

+ calculatePrice()
+ printReciept()

Toll Booth
+ booth_ID: string
+ location: string
+ status: boolean
- receiver_status: active/inactive

+ open()
+close()
+ collect_Toll()

Payment Gateway
+ mode_of_payment: string
+ wallet_ID: string
+ balance_amount: int

+ paymentRequest()
+ deductTollAmount()
+ updateBalance()

LiFi Transmitter
+ transmitter_ID: int
+ transmission_Power: double
+ range: double

+ getTransmitterID()
+ addData()
+ transmitData()

LiFi Receiver
+ receiver_ID: int
+ receiver_Power: double
+ range: double

+ getReceiverID()
+ getData()
+ displayData()

ER Diagram

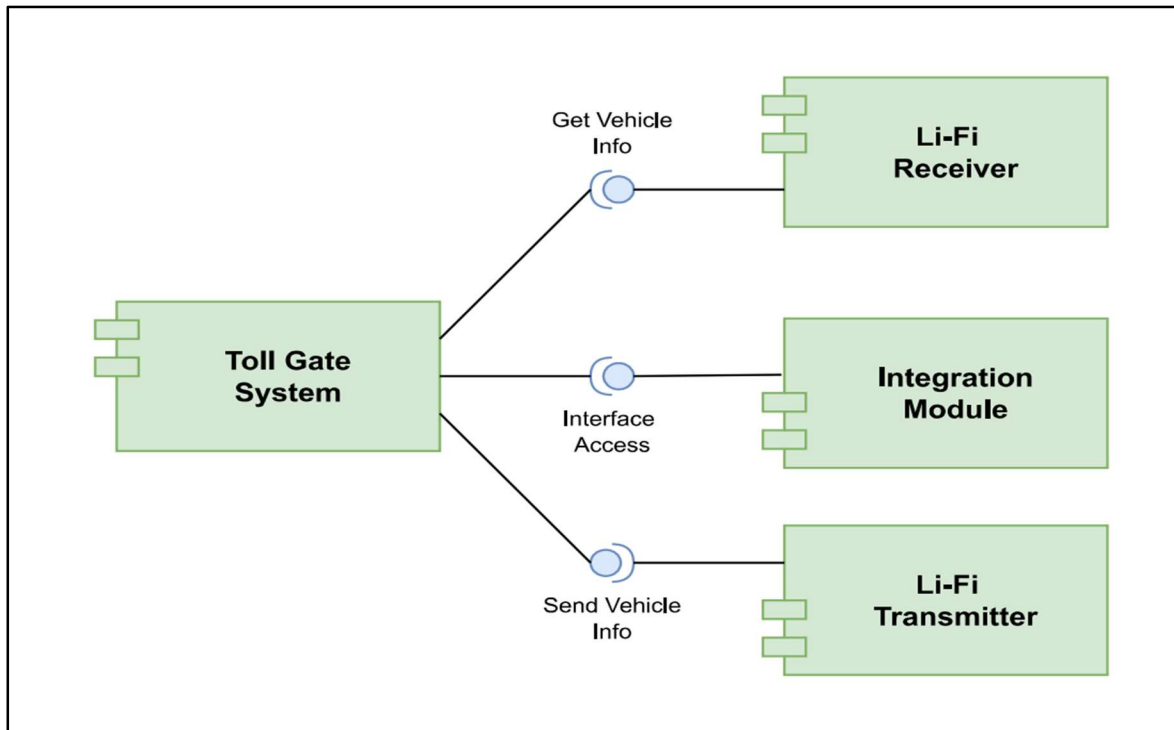# Data Flow Diagram (DFD) :
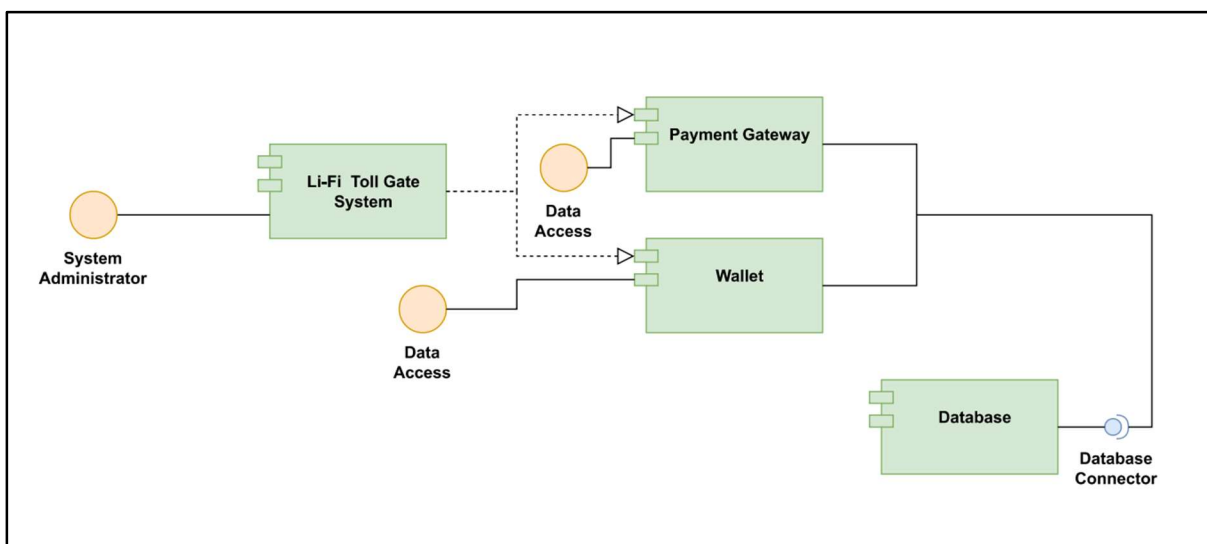
LEVEL 0

LEVEL 1

Component Diagrams

Component Hardware:

Component Software:

Cost analysis

Cost Categories:

1. Hardware Costs
2. Software Costs
3. Miscellaneous Costs

Cost Estimation: ₹10,000

<u>Hardware Cost Structure:</u>

Hardware	Cost
Components: • (Basic Structure) • Microcontroller(2 Arduino) • Sensors(:Ultrasonic, IR) • Connection equipments(breadboard, jumper wires, connecting wires)	₹3000
Module: • LiFi Transmitter • LiFi Receiver • Wifi Module (ESP8266) • LDR Module	₹1500
Setup Cost: • Installation • (Gantry, Track, Tunnel, Buggy Car)	₹1000
Testing: • LCD,I2C Modules • Power Supply • Calibration Components(Solder, Solder Plate, PCB)	₹800

Adding overhead miscellaneous costs: Approx. ₹1000

[Networking, LEDs, LDRs, Mounting and enclosures]

Total Potential Hardware Cost: ₹7000

Software Cost Structure:

Based on development approach,

Software App for Payment Gateway to facilitate Transaction with user login and in-house centralized database.

1. Third Party Libraries/APIs: Functionality and integration subscription costs around ₹1000.
2. Backend Database Storage: Cloud hosting services or including services can add charges of about 1000.
3. Maintenance: Bug fixes and feature enhancements for updates requiring technical support or online domain names and synchronization with hardware structure using wifi module can range from ₹500 - ₹1000.

Summarizing overall costs for software: ₹2000 - ₹3000.