Use Case Models for 407 ETR System

System Scope: 407 ETR Electronic Toll Collection System

System Boundary: The system includes all software and hardware components involved in processing toll transactions, including gantries, transponders, cameras, laser scanners, and the central processing system. It excludes the software running on the transponders, which is outsourced.

Actors:

Motorist: A person driving a vehicle on the 407 ETR.

Registered Motorist: A Motorist with an account and a transponder.

Unregistered Motorist: A Motorist without an account or a transponder.

System Administrator: A person responsible for managing the 407 ETR system, including account creation, vehicle registration, and toll calculation.

Government System: An external system providing access to vehicle registration information.

Transponder: A device attached to a vehicle that communicates with the gantry.

Gantry: A structure above the highway equipped with sensors, cameras, and communication devices.

Laser Scanner: A device used to classify vehicles based on their dimensions.

Camera: A device used to capture images of vehicle license plates.

Lights: Devices used to illuminate license plates for better image capture.

Goals:

Summary Level:

Manage Toll Transactions: The system manages the collection of tolls from motorists using the 407 ETR.

User Goal Level:

Register Vehicle: A Registered Motorist registers a vehicle with their account.

Pay Toll with Transponder: A Registered Motorist pays the toll using their transponder.

Pay Toll without Transponder: An Unregistered Motorist pays the toll using their license plate.

Manage Account: A Registered Motorist manages their account information.

Process Invoice: The system generates and sends invoices to Registered Motorists.

Enforce Payment: The system enforces payment of tolls and fines.

Sub-Functional Level:

Identify Vehicle: The system identifies a vehicle entering or exiting the highway.

Classify Vehicle: The system classifies a vehicle based on its type.

Read Transponder: The system reads the account number from a transponder.

Capture License Plate: The system captures an image of a vehicle's license plate.

Process Transaction: The system processes a toll transaction based on the vehicle's entry and exit points, time, and vehicle class.

Calculate Toll: The system calculates the toll amount based on distance and time of day.

Generate Invoice: The system generates an invoice for a Registered Motorist.

Send Invoice: The system sends an invoice to a Registered Motorist.

Enforce Plate Denial: The system enforces plate denial for non-payment of tolls and fines.

Use Cases

1. Register Vehicle

Scope: 407 ETR System

Level: User Goal

Intention: A Registered Motorist wants to register a vehicle with their account.

Multiplicity: Many Registered Motorists can register vehicles simultaneously.

Primary Actor: Registered Motorist

Secondary Actors: System Administrator

Main Success Scenario:

Registered Motorist provides vehicle details to System Administrator.

System Administrator verifies vehicle details and registers the vehicle with the Registered Motorist's account.

System Administrator informs Registered Motorist that the vehicle is registered.

Extensions:

1a. Vehicle details are invalid.

1a.1. System Administrator informs Registered Motorist of the error.

1a.2. Use case continues at step 1.

2. Pay Toll with Transponder

Scope: 407 ETR System

Level: User Goal

Intention: A Registered Motorist wants to pay the toll using their transponder.

Multiplicity: Many Registered Motorists can pay tolls simultaneously.

Primary Actor: Registered Motorist

Secondary Actors: Transponder, Gantry

Main Success Scenario:

Registered Motorist enters the highway with a transponder attached to their vehicle.

Gantry identifies the transponder and reads the account number.

Gantry records the entry time and date.

Gantry classifies the vehicle using laser scanners.

Registered Motorist exits the highway.

Gantry records the exit time and date.

Gantry matches the entry and exit data and calculates the toll.

Gantry debits the Registered Motorist's account.

Transponder signals a successful transaction.

Extensions:

2a. Transponder is not detected.

2a.1. Gantry captures an image of the license plate.

2a.2. Use case continues at step 4.

3a. Vehicle class does not match the registered class.

3a.1. System generates a fine for the Registered Motorist.

3a.2. Use case continues at step 8.

3. Pay Toll without Transponder

Scope: 407 ETR System

Level: User Goal

Intention: An Unregistered Motorist wants to pay the toll using their license plate.

Multiplicity: Many Unregistered Motorists can pay tolls simultaneously.

Primary Actor: Unregistered Motorist

Secondary Actors: Gantry, Camera, Lights, Government System

Main Success Scenario:

Unregistered Motorist enters the highway.

Gantry identifies the vehicle as unregistered.

Gantry activates cameras and lights to capture the license plate.

Gantry sends the license plate image to the Government System for identification.

Government System identifies the vehicle owner.

Gantry records the entry time and date.

Gantry classifies the vehicle using laser scanners.

Unregistered Motorist exits the highway.

Gantry records the exit time and date.

Gantry matches the entry and exit data and calculates the toll.

Gantry generates an invoice for the Unregistered Motorist.

Gantry sends the invoice to the Unregistered Motorist.

Extensions:

3a. License plate image is not clear enough for identification.

3a.1. A human operator reviews the image and identifies the vehicle owner.

3a.2. Use case continues at step 6.

4a. Vehicle owner is not found in the Government System.

4a.1. Gantry generates a fine for the Unregistered Motorist.

4a.2. Use case continues at step 11.

4. Manage Account

Scope: 407 ETR System

Level: User Goal

Intention: A Registered Motorist wants to manage their account information.

Multiplicity: Many Registered Motorists can manage their accounts simultaneously.

Primary Actor: Registered Motorist

Secondary Actors: System Administrator

Main Success Scenario:

Registered Motorist logs into their account.

Registered Motorist views their account information.

Registered Motorist updates their account information.

System Administrator verifies the updated information.

System Administrator updates the Registered Motorist's account.

System Administrator informs Registered Motorist that the account is updated.

Extensions:

4a. Registered Motorist forgets their password.

4a.1. System Administrator sends a password reset link to the Registered Motorist's email address.

4a.2. Use case continues at step 1.

5. Process Invoice

Scope: 407 ETR System

Level: User Goal

Intention: The system generates and sends invoices to Registered Motorists.

Multiplicity: The system can process invoices for many Registered Motorists simultaneously.

Primary Actor: System Administrator

Secondary Actors: None

Main Success Scenario:

System Administrator initiates invoice processing.

System retrieves transaction data for each Registered Motorist.

System calculates the toll amount for each transaction.

System generates an invoice for each Registered Motorist.

System sends the invoice to each Registered Motorist.

Extensions:

5a. System encounters an error during invoice processing.

5a.1. System logs the error and attempts to process the invoice again later.

6. Enforce Payment

Scope: 407 ETR System

Level: User Goal

Intention: The system enforces payment of tolls and fines.

Multiplicity: The system can enforce payment for many Registered Motorists simultaneously.

Primary Actor: System Administrator

Secondary Actors: Government System

Main Success Scenario:

System Administrator identifies Registered Motorists with unpaid tolls or fines.

System sends reminders to Registered Motorists with unpaid tolls or fines.

System enforces plate denial for Registered Motorists who refuse to pay.

System informs the Government System of plate denial.

Government System prevents Registered Motorists from renewing or obtaining new license plates.

Extensions:

6a. Registered Motorist pays the outstanding amount.

6a.1. System removes the plate denial.

6a.2. System informs the Government System of the removal of plate denial.

7. Identify Vehicle

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system identifies a vehicle entering or exiting the highway.

Multiplicity: The system can identify multiple vehicles simultaneously.

Primary Actor: None

Secondary Actors: Gantry, Transponder

Main Success Scenario:

Vehicle passes under the gantry.

Gantry detects the vehicle using sensors.

Gantry determines if the vehicle is equipped with a transponder.

Extensions:

7a. Transponder is detected.

7a.1. Use case continues at step 1 of "Read Transponder".

7b. Transponder is not detected.

7b.1. Use case continues at step 1 of "Capture License Plate".

8. Classify Vehicle

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system classifies a vehicle based on its type.

Multiplicity: The system can classify multiple vehicles simultaneously.

Primary Actor: None

Secondary Actors: Gantry, Laser Scanner

Main Success Scenario:

Vehicle passes under the gantry.

Gantry activates the laser scanner.

Laser scanner measures the vehicle's dimensions.

Gantry classifies the vehicle based on its dimensions.

Extensions:

8a. Vehicle class is not determined.

8a.1. System logs the error.

9. Read Transponder

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system reads the account number from a transponder.

Multiplicity: The system can read multiple transponders simultaneously.

Primary Actor: None

Secondary Actors: Gantry, Transponder

Main Success Scenario:

Gantry detects a transponder.

Gantry activates the read/write antennae.

Transponder transmits the account number to the gantry.

Gantry records the account number.

Extensions:

9a. Transponder fails to transmit the account number.

9a.1. System logs the error.

10. Capture License Plate

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system captures an image of a vehicle's license plate.

Multiplicity: The system can capture multiple license plates simultaneously.

Primary Actor: None

Secondary Actors: Gantry, Camera, Lights

Main Success Scenario:

Gantry activates the cameras and lights.

Cameras capture images of the license plate.

Gantry stores the license plate images.

Extensions:

10a. License plate image is not clear enough.

10a.1. System logs the error.

11. Process Transaction

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system processes a toll transaction based on the vehicle's entry and exit points, time, and vehicle class.

Multiplicity: The system can process multiple transactions simultaneously.

Primary Actor: None

Secondary Actors: None

Main Success Scenario:

System receives entry and exit data for a vehicle.

System retrieves the vehicle class.

System calculates the distance travelled.

System calculates the toll amount based on distance and time of day.

Extensions:

11a. System encounters an error during transaction processing.

11a.1. System logs the error.

12. Calculate Toll

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system calculates the toll amount based on distance and time of day.

Multiplicity: The system can calculate multiple tolls simultaneously.

Primary Actor: None

Secondary Actors: None

Main Success Scenario:

System receives the distance travelled and time of day.

System retrieves the toll rates for the given time of day.

System calculates the toll amount based on distance and toll rates.

Extensions:

12a. System encounters an error during toll calculation.

12a.1. System logs the error.

13. Generate Invoice

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system generates an invoice for a Registered Motorist.

Multiplicity: The system can generate multiple invoices simultaneously.

Primary Actor: None

Secondary Actors: None

Main Success Scenario:

System retrieves transaction data for a Registered Motorist.

System calculates the total toll amount.

System generates an invoice containing the transaction details and total toll amount.

Extensions:

13a. System encounters an error during invoice generation.

13a.1. System logs the error.

14. Send Invoice

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system sends an invoice to a Registered Motorist.

Multiplicity: The system can send multiple invoices simultaneously.

Primary Actor: None

Secondary Actors: None

Main Success Scenario:

System retrieves the Registered Motorist's contact information.

System sends the invoice to the Registered Motorist's email address or postal address.

Extensions:

14a. System encounters an error during invoice sending.

14a.1. System logs the error.

15. Enforce Plate Denial

Scope: 407 ETR System

Level: Sub-Functional

Intention: The system enforces plate denial for non-payment of tolls and fines.

Multiplicity: The system can enforce plate denial for multiple Registered Motorists simultaneously.

Primary Actor: None

Secondary Actors: Government System

Main Success Scenario:

System identifies a Registered Motorist with unpaid tolls or fines.

System sends a request to the Government System to enforce plate denial.

Government System prevents the Registered Motorist from renewing or obtaining new license plates.

Extensions:

15a. Government System fails to enforce plate denial.

15a.1. System logs the error.