Requirements Analysis and Specifications Document

POLITECNICO MILANO 1863

Version 0.1

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1 INTRODUCTION

1.1 Purpose

This document represents the Requirement Analysis and Specification Document (RASD). Goals of this document are to completely describe the system in terms of functional and non-functional requirements, analyze the real needs of the customer in order to model the system, show the constraints and the limit of the software and indicate the typical use cases that will occur after the release. This document is addressed to the developers who have to implement the requirements and could be used as a contractual basis.

1.1.2

The goals of the projects are:

- G1 The system must allow users to send a report of violations
- G2 The system must allow all users to mine the information that has been received by highlighting the streets (or the areas) with the highest frequency of violations
- G3 The system must allow authorities to mine the information that has been received to see the ranking of vehicles that commit more violations
- G4 The system must cross the information provided by the municipality about the accidents with its own data to identify potentially unsafe areas and suggest possible interventions.

1.2 Scope

The SafeStreet service is offered to common users that want to help the community. The S2B will give to the user the possibility to report traffic violation, in particular, parking violation (eg. parking in a spot reserved for disabled people, parking in an helicopter pitch, parking on the sidewalk). The system will allow the users to select the type of violation leading to differt amount of ticket value. The system will help the authorities to identify more infractions and therefore to issue more tickets which should increase the attention and respect of the citizens regarding the traffic rules. Furthermore thanks to the increased number of ticket the municipality will have more money to invest in the community. This extra money could be used to do some interventions following the suggestions provided by SafeStreets.

1.3 Definitions, Acronyms, Abbreviations

- **FOSS**: free and open source software
- **S2B**: software to be
- **Mine**: to process data for obtaining new data
- **Violation**: an infringement of the rules
- **Unsafe area**: area where often happen violation and accident
- **OSM**: Open Street Map

1.4 Revision history

- Version 1.0

1.5 Reference Documents

- Specification document: “SafeStreets Mandatory Project Assignment”
- ISO/IEC/IEEE 29148:2018
- UML diagrams
- Alloy documentation

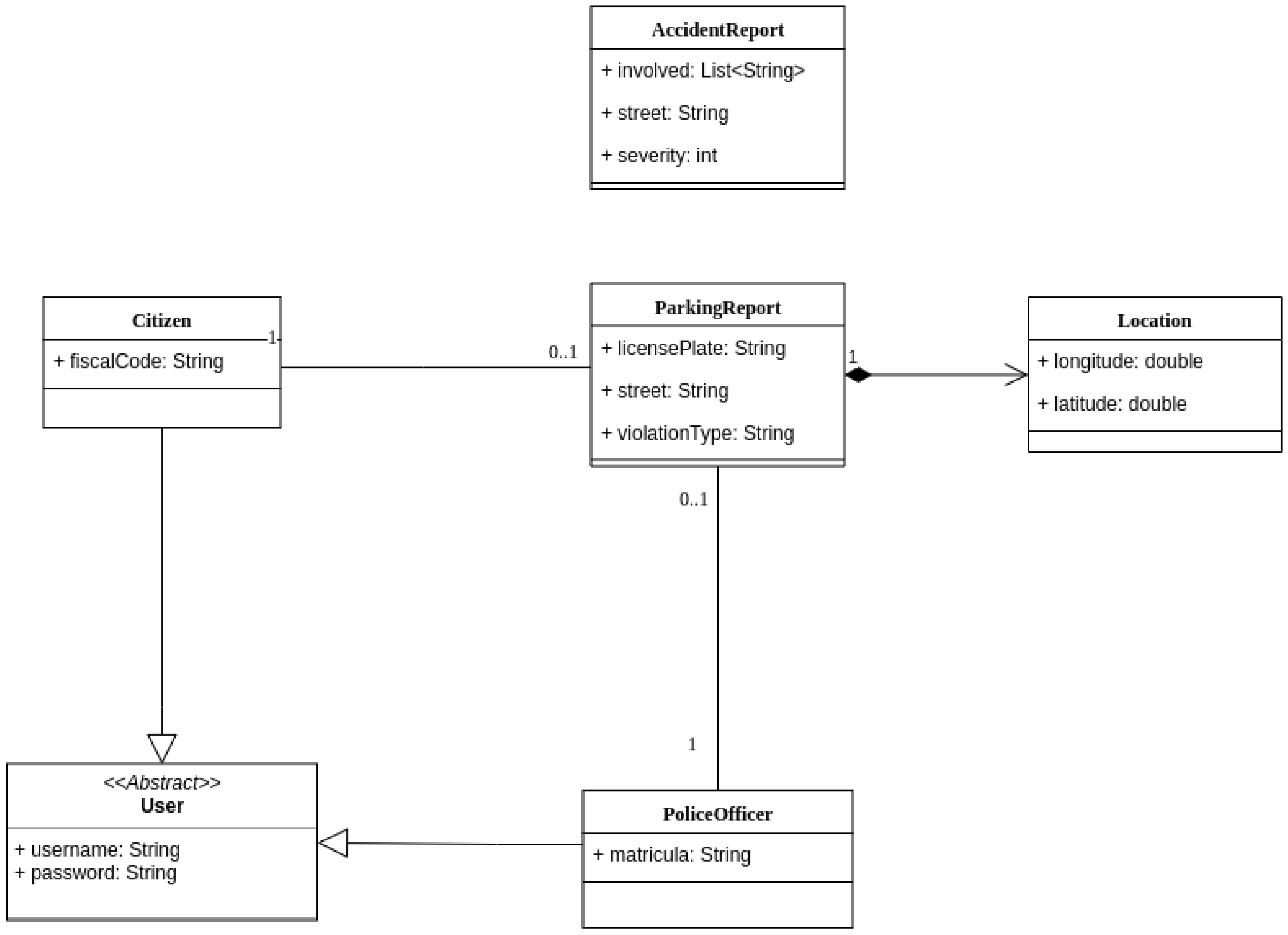
1.6 Document Structure

- **Chapter 1** Presents an introduction to the problem and describes the purpose of the application. The scope of the application is defined by stating the goals and description of the problem.
- **Chapter 2** Presents the overall description of the project. The product perspective includes details on the shared phenomena and the domain models. The class diagram describes the domain model used, and the state diagram analyzes the process of arranging a meeting and reaching it in time. Here the majority of functions of the system are more precisely specified, with respect to the already mentioned goals of the system. In the user characteristics section the types of actors that can use the application are described.
- **Chapter 3** Contains the external interface requirements (user interfaces, hardware interfaces, software interfaces and communication interfaces). The functional requirements are defined with use case and sequence diagram. The non-functional requirements are defined through performance requirements, design constraints and software system attributes.
- **Chapter 4** Introduces an alloy model and the discussion of its purpose. Also, a world generated by it is shown.
- **Chapter 5** Shows the effort spent by each group member.
- **Chapter 6** Includes the reference documents.

2 OVERALL DESCRIPTION

2.1 Product perspective: here we include further details on the shared phenomena and a domain model

The following high level class diagram provides a model of the application domain: it contains only few essential attributes of the various classes and does not include every class that will be necessary to define the Model (useful data) of the system.



Now we are going to analyze some critical aspects of the application, modeling their behaviors and showing the evolution over time of their states through appropriate state diagrams, which are reported below.

2.2 Product functions: here we include the most important requirements

Here it's Provided a summary of the major functions that the software will perform.

Report parking violation

This is the main function of the system: The software will allow users to notify authorities when traffic violations occur, and in particular parking violations. The application allows users to send pictures of violations, including their date, time, and position to authorities. Examples of violations are vehicles parked in the middle of bike lanes or in places reserved for people with disabilities, double parking, and so on.

Mine information

The S2B must gather all the reports of the parking violation and elaborate them with an algorithm to highlighting the streets (or the areas) with the highest frequency of violations, or the vehicles that commit the most violations.

The system will allow only police officers to access some kind of data (e.g. information about a specific vehicle), while more generic data will be available for every user.

Suggest interventions

The S2B must gather information about accidents that the municipality will provide and cross them with his parking violation reports to generate new data about potentially unsafe area. Those potentially unsafe area will be sent to the municipality which will take action.

2.3. User characteristics: here we include anything that is relevant to clarify their needs

1. Standard User

Common citizen who signs up to use the SafeStreet service. There are no constraints or age limitations, anyone can join. The user is a person who use the app to report a parking violation.

2. Traffic Warden

A police officer. The sign up process is made in collaboration with the authorities to guarantee their identity. He has to verify the violation.

3. Municipality

Certified municipality's clerks who can access the suggestion for possible interventions.

2.4 Assumptions, dependencies and constraints: here we include domain assumptions

- D1: All traffic wardens have a smartphone.
- D2: Each fiscal code number is unique.
- D3: The municipality will provide only well formatted report of accidents.
- D4: The map provider will provide only well formatted data.

3 SPECIFIC REQUIREMENTS

3.1 External Interface Requirements

3.1.1 User Interfaces

3.1.2 Hardware Interfaces

- The software, in order to work, will need an internet connection so the device must have access to the internet.
- A standard user will need a device with GPS to capture the exact location and a camera to take the photo in order to report a traffic violation.

3.1.3 Software Interfaces

- Safestreets will be available as a web application: so any modern up-to-date browser will be compatible (e.g. Firefox, Brave) and as a native app for Android and iOS (Android 4.4 and iOS 9.3 will be the oldest versions supported)
- Safestreets will use a map service to work with geographic data (maps and addresses).

3.1.4 Communication Interfaces

3.2 Functional Requirements: Definition of use case diagrams, use cases and associated sequence/activity diagrams, and mapping on requirements

3.2.1 Scenarios:

- Scenario 1

  Marco is tired of people parking on the sidewalk near his shop, so instead of shouting or starting a discussion with the violator, he decides to report the violation to SafeStreet using the application on his smartphone. He takes a photo of the violation and sends it, a lot better than calling emergency number to only report a parking violation.

- Scenario 2

  The budget of the municipality of Milan is negative, therefore, Omar, mayor of Milan, needs to find a way to raise more money. After a meeting with the head of the municipal police, who wants to improve his operate, he learns about SafeStreets and decides to adopt it in his city. Thanks to the application the traffic wardens will be more efficient and the number of traffic tickets should increase accordingly.

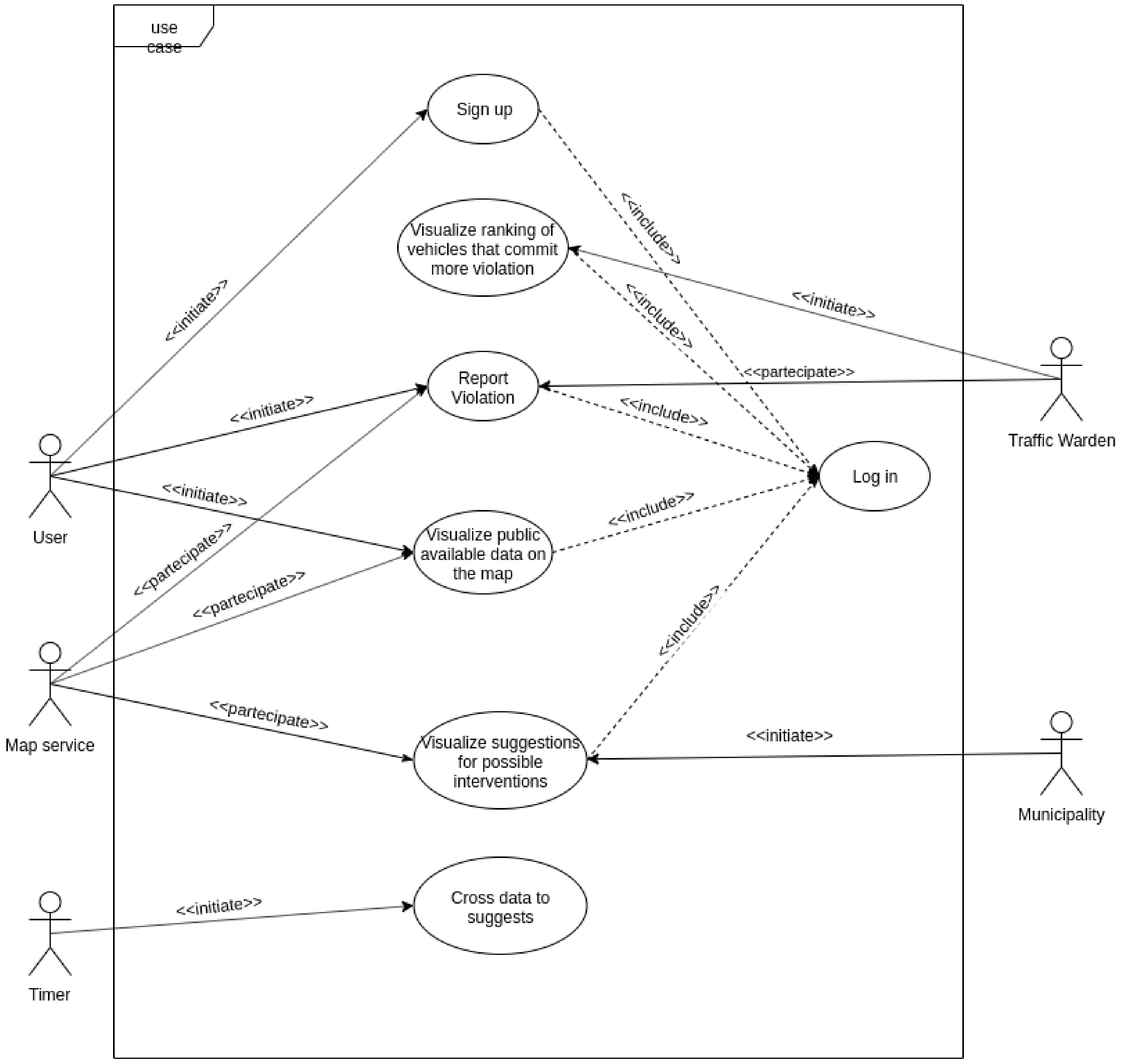
- Scenario 3

  Giuseppe the assessor wants to know where public interventions are most needed. Thanks to SafeStreet he can check out the suggestions provided by the advanced algorithm developed by SafeStreet.

- Scenario 4

  Award-winning traffic warden Nicola was commissioned by his superiors to use the SafeStreets application to get the notifications about traffic violations occurring near his position. Thanks to the application he can forget about imprecise indications and can now precisely reach the position to control the situation.

Use Case Diagram



3.2.2 Use cases:

Name	**SignUp**
Actor	User
Entry condition	The user has opened the application on his device.
Events flow	1. The user chooses the “Sign up” option. 2. The user fills the mandatory fields. 3.The user fills the optional fields with not mandatory data. 4. The user chooses the confirmation option. 5.The system save the data.

Name	SignUp
Exit condition	The user is registered and the system has his data stored
Exception	1. The user was already registered. In this case the system warns the user and suggests him/her to do the login. 2. The username is already taken. In this case the system warns the user and suggests him to change the username. 3. The username doesn't fill all the mandatory fields. In this case the system warns the user and notifies him which fields were left unfilled. 4. No internet connection. The system suggests to check network configuration or to reconnect.

Name	Log in
Actor	User
Entry condition	The user has opened the application on his device.
Events flow	1. The user clicks "Log In". 2. The user enters username and password. 3. The user decides if he wants to be remembered by the system clicking on the relative checkbox. 4. The user clicks "Confirm". 5. If the user chose to be remembered, next time the use case ends without asking username and password.
Exit condition	User is logged in and in the home page of the application with the possibility to use function based on his account privileges.
Exception	1. The user enters invalid data. 2. The user leaves blank at least one field. In both cases the system warns the user suggesting him to insert correct data. 3. No internet connection. The system suggests to check network configuration or to reconnect.

Name	Report Violation
Actor	User, Traffic Warden
Entry condition	The user and the traffic warden has already done the Log in activity.

Name	Report Violation
Events flow	1. The user chooses the “Report” option. 2. The user selects the violation type. 3. The user takes a picture of the violation. 4. The system shows the license plate. 5. The user checks if the license plate of the vehicle recognized from the picture is correct otherwise edits it. 6. The system shows the location provided by the GPS on a map. 7. The user checks if the location provided by the app is correct otherwise fixs it. 8. The user uploads the data clicking on "Upload" 9. The system sends a notification to the traffic warden. 10. The traffic warden selects the report from the list of reports. 11. The traffic warden clicks on "Take on". 12. The traffic warden checks if the violation exists, if it does clicks on "Verify" otherwise clicks on "Fail"
Exit condition	The traffic warden has checked if the violation exist
Exception	1. No internet connection. The system suggests to check network configuration or to reconnect.

Name	Visualize public available data on the map
Actor	User
Entry condition	The user is logged in and in the homepage
Events flow	1. The user cliks on "Show Map". 2. The system loads the map of the city. 3. The user can search for a specific location and select from a menu which kind of data he wants to see.
Exit condition	The requested information is showed on the map
Exception	1. No internet connection. The system suggests to check network configuration or to reconnect.

Name	Visualize ranking of vehicles that commit more violations
Actor	Traffic Warden
Entry condition	The traffic warden is logged in and in the homepage

Name	Visualize ranking of vehicles that commit more violations
Events flow	1. The traffic warden cliks on "Show Ranking". 2. The system loads the leaderboard with the license plate. 3. The police warden can add filter (e.g. filter by violation type).
Exit condition	The requested information is showed
Exception	1. No internet connection. The system suggests to check network configuration or to reconnect.

Name	Visualize suggestions for possible interventions
Actor	Municipality
Entry condition	Muncipality's employee is logged in
Events flow	1. The employee cliks on "Suggestions 4 interventions". 2. The system loads the map of the city and the suggestions for the visualized area. 3. The employee can search for a specific location, view the list of suggestions. 4. If the employee clicks on a particular suggestion he can check its details.
Exit condition	The requested suggestion is displayed.
Exception	1. No internet connection. The system suggests to check network configuration or to reconnect.

Name	Cross data to suggests possbile interventions
Actor	
Entry condition	Automated activity triggered by a timer
Events flow	1. The system contacts Municipality's database asking to send data if new data is available since the prevoius time. 2. The municipality's DB replies sending the data. 3. The System crosses his data with the received and starts an algorithm that identifies unsafe areas and generates possible interventions. 4. The suggestions list is updated.
Exit condition	Suggestions are updated.
Exception	1. No internet connection. The system suggests to check network configuration or to reconnect. 2. Municipality's server is not reachable.

3.2.3 Requirements

In this section we show that the requirements ensure the satisfaction of the goals in the context of the domain assumptions: the list of requirements and domain assumptions under each goal have this purpose.

[G1] The system must allow users to send a report of violations

- **R1** The system has to allow sign up of new users.
- **R2** The system has to allow users to login.
- **R3** The system must allow users to send pictures of violations, including their date, time, and position to authorities.
- **R4** The system, when it receives a picture, must run an algorithm to read the license plate.
- **R5** The system must allow the user to fix the license plate if the algorithm read it wrong.
- **R6** The system must allow the user to fix the location if the GPS acquired the wrong location.
- **R7** The system must store the information of the report sent by the users.
- **R8** The system must send a notification to the traffic warden.
- **R9** The system has to allow one traffic warden to "take on" the report.
- **R10** The system has to allow the traffic warden to validate or to invalidate the report.
- **D1** All traffic wardens have a smartphone.
- **D2** Each fiscal code number is unique.
- **D4** The map provider will provide only well formatted data.

[G2] The system must allow all users to see highlighting the streets (or the areas) with the highest frequency of violations

- **R1** The system has to allow sign up of new users.
- **R2** The system has to allow users to login.
- **R11** The system must mine the reports to higlight the streets (or the areas) with the highest frequency of violations.
- **R12** The system has to allow search for a specific location and select from a menu which kind of data he wants to see.
- **D4** The map provider will provide only well formatted data.

[G3] The system must allow authorities to see the ranking of vehicles that commit more violations

- **R2** The system has to allow user to login.
- **R13** The system must distinguish privilege of account (normal, traffic warden, municipality clerk).
- **R14** The system must mine the reports to create a ranking of the vehicles that commit more violation.
- **D1** All traffic wardens have a smartphone.

[G4] The system must cross the information provided by the municipality about the accidents with its own data to identify potentially unsafe areas and suggest possible interventions

- **R2** The system has to allow user to login.
- **R13** The system must distinguish privilege of account (normal, traffic warden, municipality clerk).
- **R15** The system must gather data about accidents from the municipality.
- **R16** The system must cross the information provided by the municipality about the accidents with its own data to identify potentially unsafe areas.
- **R17** The system must show possible interventions to improve unsafe area.

Tracebility Matrix

In the following table we are going to map, for each requirement, all the use cases which are related to it.

Requirement	Use Case
R1	SignUp
R2	Log in
R3	Report Violation
R4	Report Violation
R5	Report Violation
R6	Report Violation
R7	Report Violation
R8	Report Violation
R9	Report Violation
R10	Report Violation
R11	Visualize public available data on the map
R12	Visualize public available data on the map
R13	Visualize ranking of vehicles that commit more violations Visualize suggestions for possible interventions
R14	Visualize ranking of vehicles that commit more violations
R15	Cross data to suggests possbile interventions
R16	Cross data to suggests possbile interventions
R17	Visualize suggestions for possible interventions

3.3 Performance Requirements

The backend system must be able to serve requests of many clients simultaneously and be scalable in order to handle without problems the high volume of requests that will come with the increasing number of subscriptions. Especially if the S2B will be adopted in multiple towns.
The client applications must be very lightweight and simple in order to run smoothly on every supported device.

3.4 Design Constraints

3.4.1 Standards compliance

Individual countries have their own privacy laws so the system must be compliant with privacy laws in the states where it will be distributed. System must ask the customer to accept a statement that describes the term of service during the registration.
The system must respect the local traffic laws and ordinances of the towns where it will be distributed.

The web app must follow W3C standards.
Native apps must respect Android / iOS quality guidelines and standards.

3.4.2 Hardware limitations

Any compatible device that support iOS or Android versions (defined in the Software Interfaces section) will be able to run the application smoothly and also have GPS, camera and internet connection as specified in the Hardware Interfaces section.
Users internet connection speed with SafeStreets servers should be at least 100kbps to have a pleasant experience.
Safestreets servers must have access at least to a symmetric gigabit internet connection.

3.4.3 Any other constraints

There aren't other constraints.

3.5 Software System Attributes

3.5.1 Reliability

Redundancy and process resilience is expected to be used by the components of the system backend in order to guarantee a low failure rate.

3.5.2 Availability

In order to guarantee high reliability, the system is expected to offer an ideal 24/7 service. At least a 99.5% ("two nines five") availability must be guaranteed (1.83 days/year downtime).

3.5.3 Security

- All connections must use strong encryption using TLS/SSL in the most secure ways. Everything must be compliant to the latest standards specified in various RFCs and NIST papers.
- Users password must be stored using proper technique adding salt, pepper and then use a strong hash function like bcrypt.
- The data stored contains sensitive information so the security aspect is of primary importance, all disks used for storage must be encrypted.
- All data stored by the app on the user device must be encrpyted so other apps can't read it.

3.5.4 Maintainability

Maintenance is expected not to interfere with normal use of the Safrstreets service. Extraordinary maintenance that require to stop the service should be done when the service is rarely used (early morning) and completed in less than 2 hours.

3.5.5 Portability

The web application will be supported by any modern browser (Firefox, Brave, etc...)
Native apps for Android and iOS will be available. (As defined in the Software Interfaces section)

4 FORMAL ANALYSIS USING ALLOY

Here is an analysis of some critical aspects of the system using Alloy. Some of the features of the system are specified and explained in more details, in particular the focus is on the following constraints:

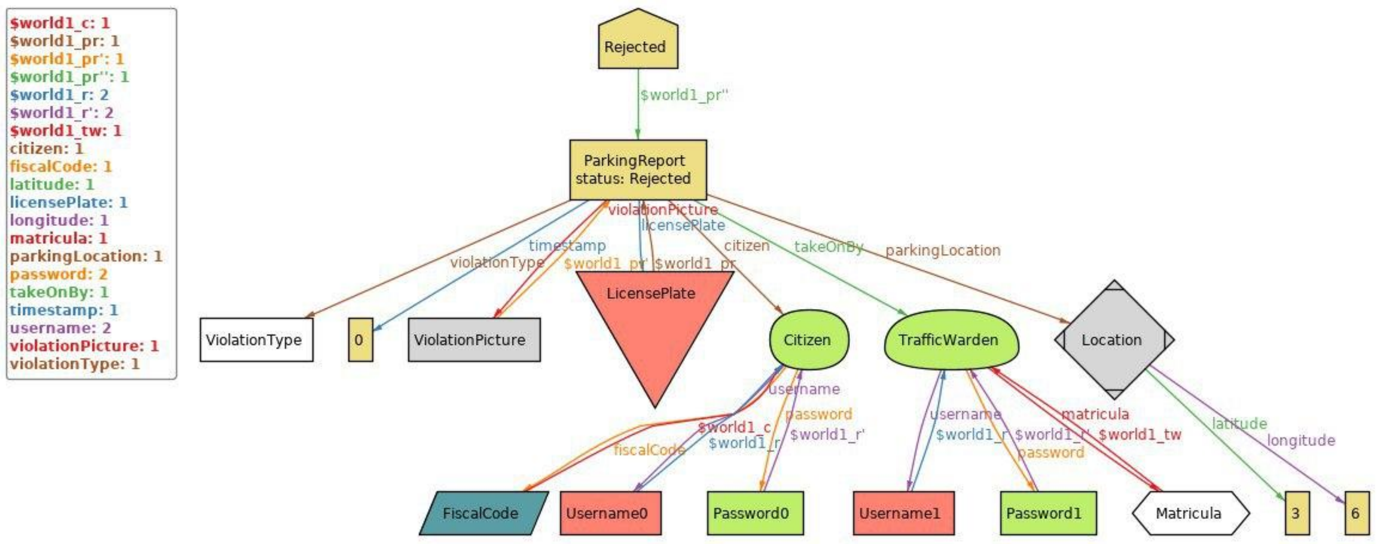
```
--signatures

sig FiscalCode{}
sig Matricula{}
sig Username{}
sig Password{}
abstract sig User{
    username: one Username,
    password: one Password
}
sig Citizen extends User{
    fiscalCode: one FiscalCode
}

sig TrafficWarden extends User{
    matricula: one Matricula
}

sig Location{
    latitude: one Int,
    longitude: one Int
}

--{latitude >= -90 and latitude <= 90 and longitude >= -180 and longitude <=
180}
--NB: scaled values for simplicity
{latitude >= -3 and latitude <= 3 and longitude >= -6 and longitude <= 6 }

abstract sig ParkingReportStatus {}
sig Approved , Pending , Rejected extends ParkingReportStatus {}

sig LicensePlate{}

sig ViolationType{}

sig ViolationPicture{}

sig ParkingReport{
    licensePlate: one LicensePlate,
    violationType: one ViolationType,
    violationPicture: one ViolationPicture,
    timestamp: one Int,
    parkingLocation: one Location,
    citizen: one Citizen,
    takeOnBy: lone TrafficWarden,
    status: one ParkingReportStatus
}
{ timestamp >= 0 }

sig Message{}

sig Suggestion{
    suggestionLocation: one Location,
    message: one Message
}

--facts

--All FiscalCodes have to be associated to a Citizen
fact FiscalCodeCitizenConnection{
    all fc: FiscalCode | some c: Citizen | fc in c.fiscalCode
}

--All Matricola have to be associated to a TrafficWarden
fact MatricolaTrafficWardenConnection{
    all m: Matricula | some tw: TrafficWarden | m in tw.matricula
}

--All Usernames have to be associated to a User
fact UsernameUserConnection{
    all u: Username | some r: User | u in r.username
}


--All Passwords have to be associated to a User
fact PasswordUserConnection{
    all p: Password | some r: User | p in r.password
}


--Every User has a unique username
fact NoSameUsername {
    no disj u1,u2: User | u1.username = u2.username
}

--There are no ParkingReport on the same vehicle within 1 hour in the same
location
fact NoParkingReportWithin1HourInTheSameLocation {
    no disj pr1,pr2 : ParkingReport | pr1.licensePlate = pr2.licensePlate and
pr1.parkingLocation = pr2.parkingLocation and
    (pr1.timestamp < pr2.timestamp and (pr1.timestamp + 3600) >
pr2.timestamp)
}

--Every User has a unique FiscalCode
```

```
fact NoSameFiscalCode {
    no disj c1,c2 : Citizen | c1.fiscalCode = c2.fiscalCode
}


--Every TrafficWarden has a unique Matricula
fact NoSameMatricula {
    no disj t1,t2 : TrafficWarden | t1.matricula = t2.matricula
}

--All LicensePlate have to be associated to a ParkingReport
fact LicensePlateParkingReportConnection{
    all lp: LicensePlate | some pr: ParkingReport | lp in pr.licensePlate
}

--All ViolationPicture have to be associated to a ParkingReport
fact ViolationPictureParkingReportConnection{
    all vp: ViolationPicture | some pr: ParkingReport | vp in
pr.violationPicture
}

--All Message have to be associated to a Suggestion
fact MessageSuggestionConnection{
    all m: Message | some s: Suggestion | m in s.message
}

--All Location have to be associated to a Suggestion or a ParkingReport
fact LocationSuggestionParkingReportConnection{
    all l: Location | (some s: Suggestion | l in s.suggestionLocation) or
(some pr: ParkingReport | l in pr.parkingLocation)
}


--All ParkingReportStatus have to be associated to a ParkingReport
fact ParkingReportStatusParkingReportConnection{
    all prs: ParkingReportStatus | some pr: ParkingReport | prs in pr.status
}

--Status in ParkingReport have to be Pending if there is no takeOnBy
fact ParkingReportStatusPendingIfNoTakeOn{
    all pr: ParkingReport | pr.takeOnBy = none implies pr.status = Pending
}


--Every ParkingReport has a unique Picture
fact NoSamePicture {
    no disj p1,p2: ParkingReport | p1.violationPicture = p2.violationPicture
}

--Assertions
```

```
--It should not be possible to have different ParkingReports on the same
vehicle in the same location in the range of a hour
assert noParkingReportOnSameVehicleWithinAnHourInTheSameLocation {
    no disj p1,p2: ParkingReport | p1.licensePlate = p2.licensePlate
    and ( p1.timestamp - p2.timestamp <= 3600 )
    and p1.parkingLocation = p2.parkingLocation
}

--check noParkingReportOnSameVehicleWithinAnHourInTheSameLocation for 3



-- Predicates
pred world1     {
    #ParkingReport      =       1
    #TrafficWarden = 1
    #Citizen = 1
    #Suggestion = 0
}

pred world2     {
    #ParkingReport      =       1
    #TrafficWarden = 0
    #Citizen = 1
    #Suggestion = 0
}

pred world3     {
    #ParkingReport      = 0
    #TrafficWarden = 0
    #Citizen = 0
    #Suggestion = 1
}

run world1 for 3
run world2 for 3
run world3 for 3
```

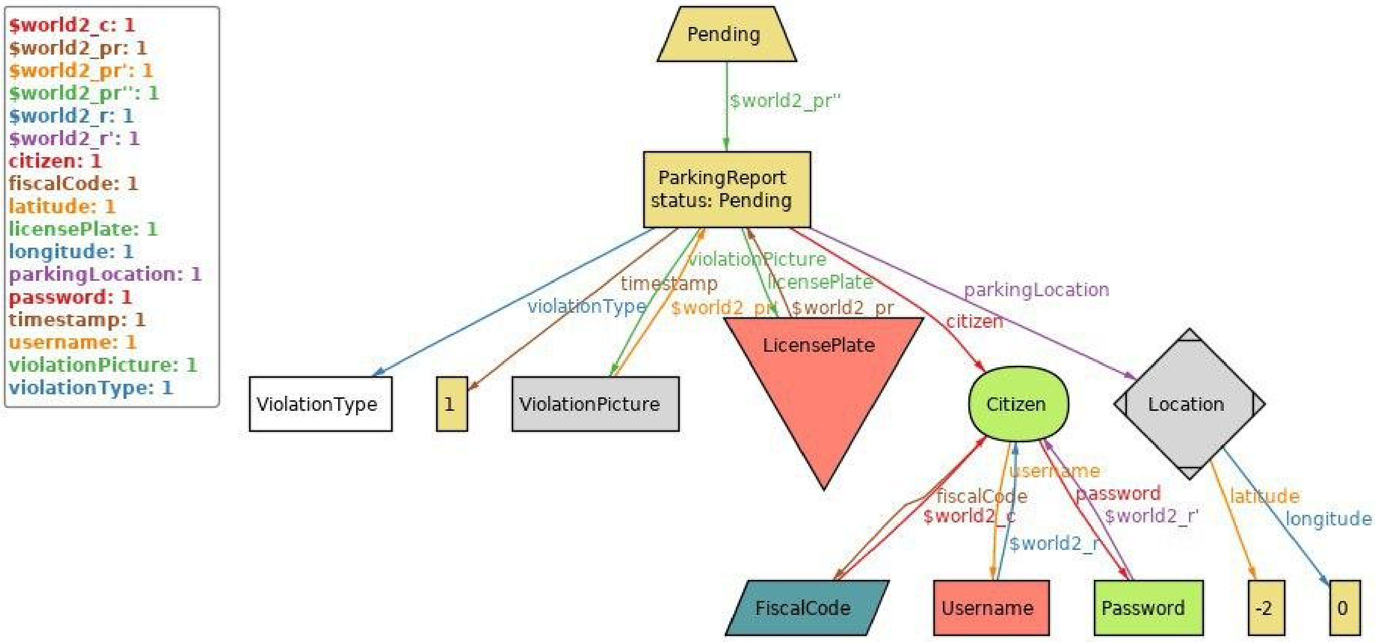
Worlds generated

- World 1

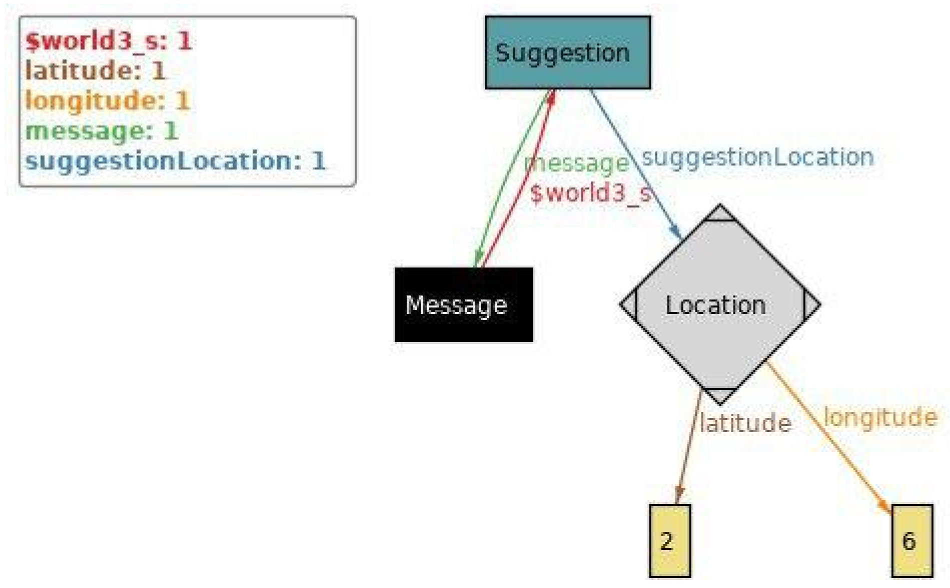


- World 2

In this world without traffic wardens, parking report status can only be pending. None can take on the requests.



- World 3



5 EFFORT SPENT

The statistics about commits and code contribution are available on GitHub however commits are actually common as most of the work has been done using the visual studio code live share plugin.

- 10530016 Federico Cazzola (@f-cazzola)
  federico.cazzola@mail.polimi.it

  27 hours

- 10530612 Francesco Dotti (@xX-1337-Xx)
  francesco3.dotti@mail.polimi.it

  28 hours

6 REFERENCES