Requirements Analysis and Specification Document

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Version 1.0

Contents

1 Introduction

1.1 Description Of Given Problem

THE purpose of this document is providing requirements and specifications about an application due to monitoring process done by city of Milan.
The application will be called 'SmartCityAdvisor' and its scope will be provide to citizen more information about pubblic service situation, like hospital queues or parking availability, and to manage in the best possible wayexceptional event like accidents, VIPs arrival or other, with a momentary traffic deviation. The objective of this project is improve the city life through a mobile application, that will allow to recive notifications about actual traffic situation or about momentary deviation, according to own GPS position, and also it will allow to check which is the empiest hospital in case of emergency or which is the best one for a precise emergency.
As required by city of Milan, as new functionality i will propose the parking availability, that is possible with data already measured.: the idea is that citizens will indicate the destination in the mobile app and system will propose all the possible solutions with free place. A possible updating for parking situation should be each 10 minutes during the week ann each five minutes in the weekend or during festivities.
The system also provides Application Programming Interface (API) to enable further developments.

1.2 Main Goals

MAIN goals of the project will be:

[G1] Limit traffic that enters in the city coherently with CO2 levels

[G2] Manage traffic situation in days with special events

[G3] Allows that citizens could arrive in less time in the best hospital

[G4] Allows an easier parking search

[G5] Improve the city life

[G6] Reduce Hospital queues

[G7] Offer an user-friendly app

[G8] Simplify the acces to the applications functionalities

1.3 Glossary

1.3.1 Definitions

- GUEST ⇒ This word will indicate all general people without a personal account

- USER ⇒ This word will indicate people that will use the application with a personal account
- HOSPITAL ⇒ This word will indicate hospital as istitution that will inform our system about queue situation
- PUBLIC TRANSPORT COMPANY ⇒ It will indicate the company of pubblic transport as entity that must inform our system about the precise position of public transport
- SYSTEM ⇒ In this document, this word will indicate our application
- CITY ADMINISTRATION (or simply administration) ⇒ It will indicate the entity that will manage all the application
- POLICE STATION ⇒ It will indicate the entity that could answer to help request

1.3.3Abbreviations

[An] : n-domain assumption.

[Gn] : n-goal.

[Rn] : n-functional requirement.

[Sn] : n-specification

2 General Description

2.1 Proposed System

In order to reach the scope, i will proposed a system with an interface develop both for web and smart device. Users will open the app and then they will choose what is their necessity : traffic situation, emergency or parking for example. Registration is not mandatory but it is strongly raccomended in order to be able to use all functionalities: for example, general notification could be recived only by registred users. With respect to the necessity to recive information, for example, about best way to do, will be necessary an internet connection. The system will interact with users directly via notification, via monitor (that are posed in the main streets) and, indirectly, with the management of traffic lights.

2.2 Assumptions

Coherently with specification document, is necessary to do some assumption in order to increase the clarity:

[A1] We assume that every user has a smartphone if he/se want use the app;

[A2] We assume that every user has a internet connection;

[A3] We assume that each citizen will follow the instructions provided by application;

[A4] We assume that special situation (as manifestation or VIP's visit) will be scheduled in advace;

[A5] We assume that in case of accidents, they will be notify as soon as possible;

[A6] We assume that when an accident happen, someone will call hospital or police and in that moment the first structure that will recive the help request will also insert it in the system, manually or by an automatic system

[A7] We assume that all hospital structure, all police stations, all car parks and the public transport company will answer in a positive way to this innovative solution

[A8] We assume that Administration has created an organization in order to keeping on work each sensor and actuator in the city

[A9] We assume that after the period indicated fot a scheduled event, system will deleted it automatically. On the DB will be manteined a documentation about all passed events

2.3 Idnetifyng Stakeholders

In this project stakeolders will be :

- Professors of the course Software Engineering 2 as product owner

- City of Milan, as entity that has open the call for application develop
- Citizen that might use the app and will take advantages from this application
- Any developers that will work on this application in the future

2.4 Future Upgrades

In the future, application might be upgraded with other functionalities like:

- Check public transports ⇒ if you need to use the public transport, you could use the app in order to see all buses or tram near you or to search the position of a fixed line and when you will find what you need, you could also buy the ticket.
- Medical Examination Reservation ⇒ when you need to a medical reservation, you could use the application in order to choosing an hospital and booking an appoinment, coherently with medical staff availability and hospital specialization

2.5 Document Overview

Chapter 2 of this document presents actors involved in the processes,.
Chapter 3 presents a general overview of the system. It aims to show the background of the requirements stated in the section below
Chapter 4 gives more detailed specific requirements for the offered functions.
Chapter 5 presents some possible example of usage in the real world
Chapter 6 and 7 present all types of digram used for describe processes

2.6 References

- Specification Document given us by teachers
- IEEE Std 830-1998 IEEE Recommended Practice for Software Requirements Specifications. (Revision of IEEE Std 830-1993)
- Other example of RASD given us by teachers

3. Actors Identifying

1. GUEST ⇒ He/she is a person that use the application with reduced functionalities.
2. USER ⇒ He/she is a person tha use the application with alll functionalities, he/she has a personal account with a personal page
3. CITY_ADMINISTRATION ⇒ It is the entity that manage the entire system. It can see usage reports, sent notify to user, insert special event in the DB, check the correct working.
4. HOSPITAL ⇒ It represent each entity that must inform the system about queue situation, its system is connected with the DB. Each time that a person require a waiting ticket for a paticular visit, system will update the DB. The same thinks will be done when a person will start his/her medical visit. It must be ready also for bring out to the system accidents happenend after has recived an help request and also accidents solved, if not alredy done by other entity
5. POLICE STATION ⇒ It represent each entity that could answer to an help request after an accidents. It's systrem is connected with the DB. Each time that it recives an help require for an accident, system will be update with the new fact. The same think will be done when the accidents is solved, if not already done by other entity.
6. PUBLIC TRANSPORT COMPANY ⇒ It is the entity that manage the pubblic transport in Milan, it must connect its GPS system of each vehicle with the DB of application, in this way there will be a real time updating. It will have also a personal interface in order to insert new pubblic lines in the DB , remove them or inform users about strikes or exceptional event (great delay or momentary pubblic line cancellations)
7. SYSTEM ⇒ It is the main importat part of the application, it coordinates all processes and if it goes down, the entire application goes down.

4. Requirements

4.1 Functional Requirements

4.1.1 Sign Up

[R1] Guest must no be already registered

[R2] Guest must provide some personal information : Name, Surname, Age, eMail, Username, Password

[R3] System will send an eMail to the indicate address in order to activate the account

[R4] System will ask to insert password times: the two password must be identical.

4.1.2 Log In as User

[R1] User must insert username and password

[R2] If he/she wants, he/she could use the email address as usernamen

[R3] If necessary, will be avaible a 'recovery password' process that will use the indicated email

4.1.3 Log In as Superuser

In this situation are included Administration, Police Stations, Hospitals, Public Transport Company and Parking Management. They will have some special account with special functionalities due to the fact that they must collaborate in order to guarantee a great service to customer (citizens and turists in this case).

4.1.3.1 Hospital Functionalities

[R1] Funcitonality could be done manually by an operator on automatically by an information system

[R2] When a person take a tiket for the queue, the queue for that specific medical visit will be update automatically

[R3] When a medical visit starts, the waiting ticked will be read electronically and this operation will update the queue for that specific visit

[R4] When Hospital recive a call for an accident on the street, it will be registred and automatically insert in the system

[R5] If the indicated position of the accident is already present in the system, there will not be any updating. This means that probably police station has already update the event.

[R6] When the medical staff return from the accident, it will be registred and automatically insert in the system

[R7] If the indicated position of the accident is not present in the system, there will not be any updating. This means that probably police station has already update the solve accident.

[R8] Hospital structure could change the specializations present in it, in case someone of them is closed

4.1.3.2 Public Transport Company Functionalities

[R1] It must constantly provide the position of each vehicle

[R2] It must send special notification reguarding company, as strike or own broken vehicle or line interrupted, but after Administration approvation

4.1.3.3 Parking Availability

[R1] Car Parks in the city must be complitely automated

[R2] Some actuator will releve the availability or not availability in a fixed car park.

[R3] The situation will be update in the system each time that actuators will detect somethings.

[R4] In case of reservation, system will be implementing for using QR code.

[R5] Each User that will reserve a place will recive a QR code that he/she must show when he/she will arrive to the car park

[R6] In each car park there will be a QR reader, near the entry

[R7] The QR will be valid coherently with the time indicate for the reservation (five, ten, fifteen...)

4.1.3.4 Administation Functionalities

[R1] Administration must manage the entire application, manually or autimatically

[R2] Administration must foresee at least 3 people in order to provide a quickly response if it is necessary

[R3] Administration could accept or refuse Public Transport Company notification

[R4] Administration could see usage report, as user access, user registred, accedets done in a period and so on.

[R5] It must provide manteinance, in order to guarantee the service

[R6] It is the only that can insert programmed event, as manifestations, road works, Vips visits, ecological days...

4.1.3.5 Police Station Functionalities

[R1] Funcitonality could be done manually by an operator on automatically by an information system

[R2] When Police Station recives a call for an accident on the street, it will be registred and automatically insert in the system

[R3] If the indicated position of the accident is already present in the system, there will not be any updating. This means that probably an hospital has already answer to the calling.

[R4] When the police staff return from the accident, it will be registred and automatically insert in the system

[R5] If the indicated position of the accident is not present in the system, there will not be any updating. This means that probably an hospital has already update the solve accident.

4.1.4 Profile Managing

[R1] User could change email address, but only one time.

[R2] User could change password one time at week

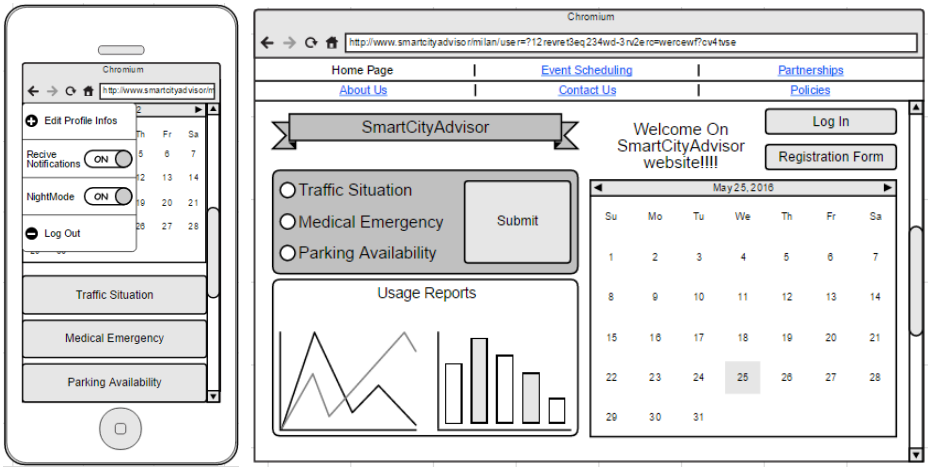
[R3] User could select which notification he/she wants recive (traffic, accidents, special notification, events....).

[R4] User could delete his/her account in each moment

4.2 Non Functional Requirments

4.2.1 User Interface

User interface of SmartCityAdvisor application is very user friendly. It is simple and intuitive, it has been tought in order to allows its use to all users
It has been produced to be used via web or mobile application and it has a main page. Here you can use all the functionalities of the project and, if you want, you can log in for changing your profile infos or changing preferences about notifications.
With a pc, on the top of the public page we could find six links that allow to navigate into the web site and below them we have the possibility to refine our search, we find a calendar and some statistics.
With a smartphone the interfece will have some little differences according to the operative system



The application will have principally three sections. In the first one, people could check autonomally the traffic situation, in the second one they could check the parking availabilities and in the third one, probably the most important, they could find assistance in case of emergency.
This last section will provide an iterface where people could see queues in the hospital or where hospital are or what are the specializations of each one.
But in case of emergency, with few simply click, they could receive assistance regardig which is the best hospital for that emergency, filtering by type of emergency, hospital position, traffic situation and location of citizens.
This functionalities will be automatic but it will have always the support of some human, in this way when arrives the request about a citizen in a critiacal situation, staff coulf deliver an ambulance.
Besides there will be other functionalities like 'contact us', 'about us', 'profile managing', 'policies'.. that are all functionalities in order to guarantee the best service and the higher possible transparency.

4.2.2 User Characteristics

SmartCityAdvisotis a service reserved to all people, citizens and turist. In order to registrate a new account is necessary to be more than 18 years old

4.2.2 Hardware Interface

The application could be run on a lot of different devices, as smartphones, PCs, tablet, desktop and so on. The application must be implemented in order to be visualized in different size of windows and some of this could be on touch-screan device. Devices should be enabled with internet connection and optionally also with GPS module.

4.2.3 Software Interface

Software for users will be implemented as a thin client. All principal operations will be done on server-side and will be used some popular APIs in order to reduce costs without reduce performance. For example, for the map service will be use Google Maps API.

4.2.3 Communication Interface

To communicate will be used Internet connection, in order to use all functionalities is neccessary to have a 3g or WI-fi module on the devices.

4.2.3 Constraints and other specifications

In order to allow a real time information, interested people must have or a smartphone with internet connettivity if they are on travel, or a PC (but always with an internet connection avaible) if they are at home.
All peolple that will obtain maximum performance by the application should have a basic knowledge about internet, usage of smartphone/pc GPS and usage of online maps.

Reguarding specification, i will explain some aspect on how i will reach goals of the project:

[S1] Only registered user could recive notification abount accidents or special events.

[S2] In order to use all the functionalities of the app, is recommended to activate GPS on smartphone.

[S3] Every events or accidents that will be notified, will be check in order to avoid wrong information for citizens

[S4] The highest priority will be done to the accuracy of information respect the velocity of notifications

[S5] Notification about serious accidents that involve people will have highest priority, in order tu simplify the rescue operation that could be slowed by traffic

4.2.4 Documentation

DURING this project i should perform different documentation:

1. Project plan (PP), it aims at defining a planning for your project
2. Requirement Analysis and Specification Document (RASD), to well-understand the given problem and to analyze in a detailed way which are our goals and how to reach them defining requirements and specificati3on
3. Design Document (DD), to define how we should implement our system.
4. Test Plan Document (ITPD), it aims at describing how you plan to accomplish the integration test

5. Scenarios Identifying

Now i will propose some situation that could happen in the real world, in order to bring out the real usage of SmartCityAdvisor:

5.1 Pope will arrive in the city

Next sunday Pope will be in Milan for a celebration in the cathedral. The way from airport Milano Forlanini to city center will be blocked from 8 a.m. to 10 a.m. in order to allow a safety travel. Administration will log in with its special account in the system and it will enter the event.
In the previus day, system will inform citizens and turists: each registred user will recive a notify that will inform about the event and in the notify will be indicated three different possibilities to pass from south-east to north-east of Milan (and from north-east to south-east) in order to reduce the hardships for citizens. Also in the large information monitor in the main street will be indicated the event and during that day, system will manage traffic situation trough particular actators that allow to control traffic lights.

5.2 It's happened an accident

Is Monday morning and all people are going to work. In the traffic is very easy that could happen and accident and it happens. When people involved on it or people that have seen it call the police, an automatically information will bi insert in the system. The system will send a notification to all people registered to SmartCityAdvisor whit position and hours of the accidents. If the accidents involve more vehicle, system might decide if divert traffic with the control of traffic lights and if use the large monitos in the city.
With all these information, citizens and turist could find the best way in order to reach their destinations.

5.3 Medical Emergency

Marco is working on the roof when he falls down. His girfriend Francesca must found an hospital that could trat probables fractures and, if possible, without long queue. She will open the application and will select 'emergency', then she could see hospitals w.r.t. their position. About each hospital she might see the principal specialization and if queues are long. When she will decide which should be the best structure, she will select it and a notification abount the new patient will be send to the selected structure.

5.4 Sunday Outing

Tommaso needs to go to the city center with all the family. For this reason he has decided to use his car but he knows that the parking availability is a big problem in Milan. Tommaso will open the app and will select 'parking availability' in the main page; after that he will insert his destination, system will propose him all available parking at maximum 15 minutes walk for the prefixed zone with the number of remaing car park.
In the first implementation of the service he could not do other things but probably, in the future, he could reserve the park for some minutes (five, then, fifteen....) and he will pay a price directly proportional with the time select.

5.5 One mounth without rain

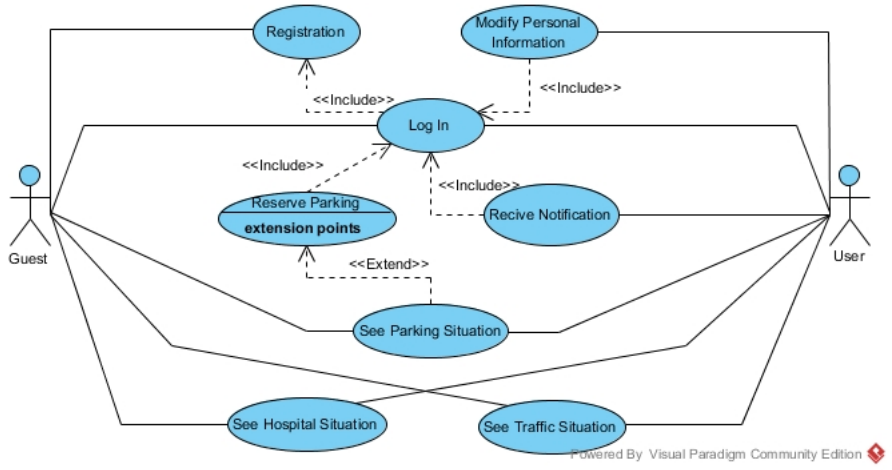
In city like Milan, one of the biggest problem are period without rain and this is just happened. In the last 30 days the city has exceeded the limit of fine particles imposed by the European Community for 22. This is a not trivial problem becouse is dangerous to healt, in particular for old people and children. The air is unbreathable so the city has decided to limit the cars entries in the city center. Exceptional rule has been indicated in the large monitore beside main streets and also by notification to all registered people to SmartCityAdvisor.
Furthermore, all cars of persons not resident in the city center that will be find into it during the block, will be fined.

6. Models

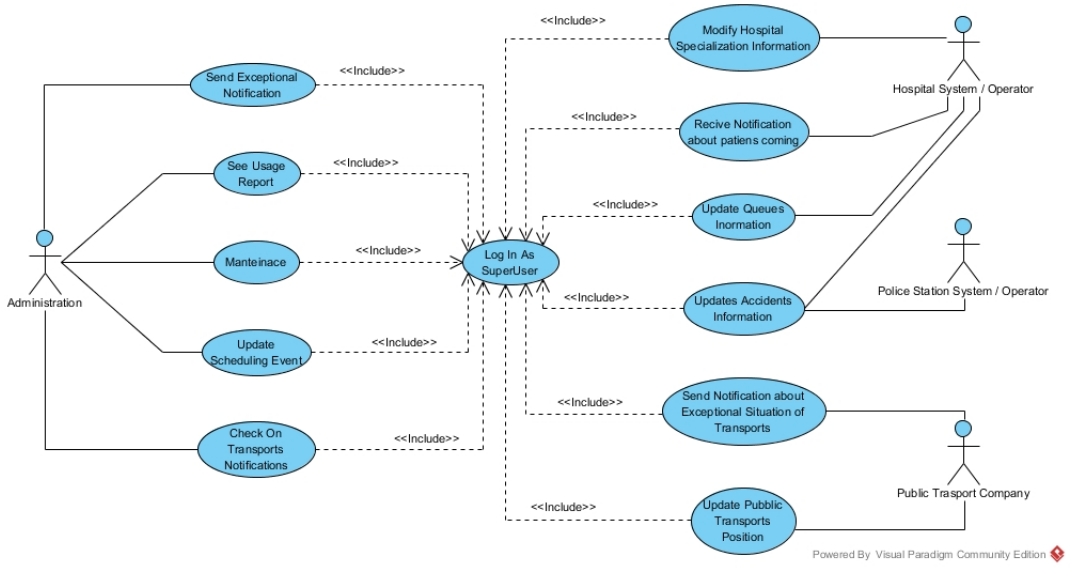
In the following sections i will reports models taht represent how the application might be implemented with all operation sequences and all functionalities that each actor could have, some of these one only after registration and log in.

6.1 Use Case Diagrams

6.1.1 Guests and Users

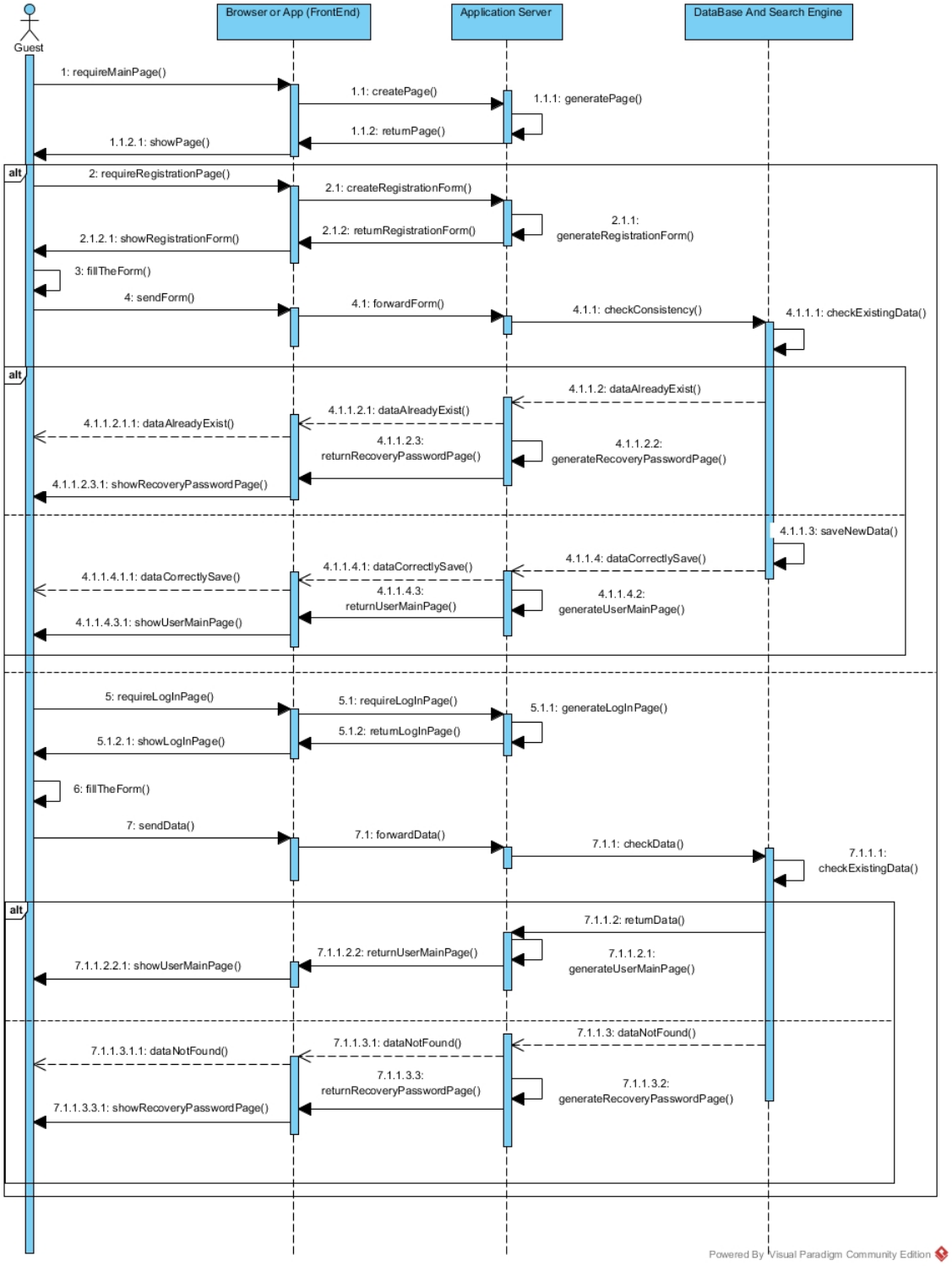


6.1.2 Superusers



6.2 Sequence Diagrams

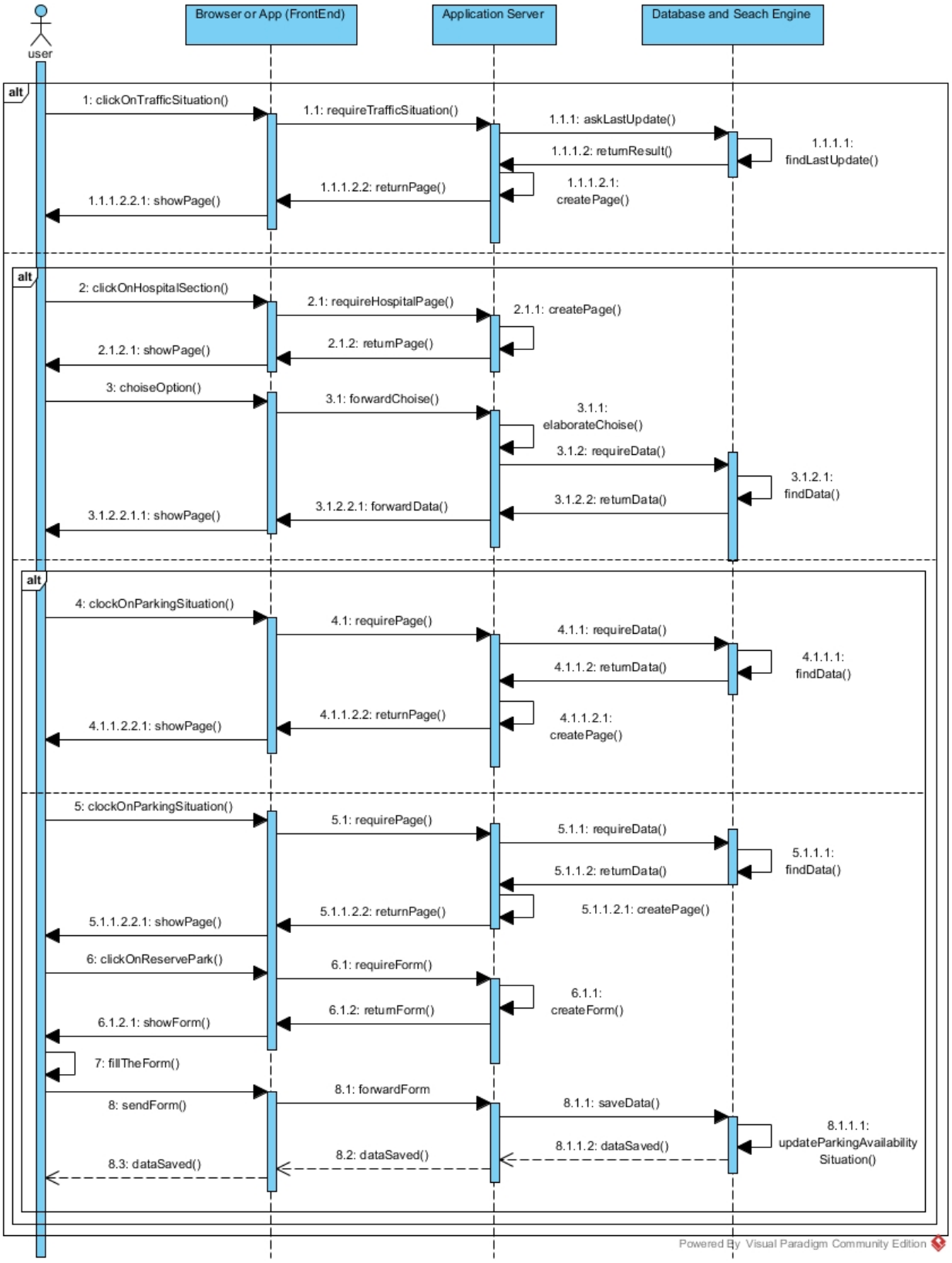
6.2.1 Registration And Log in

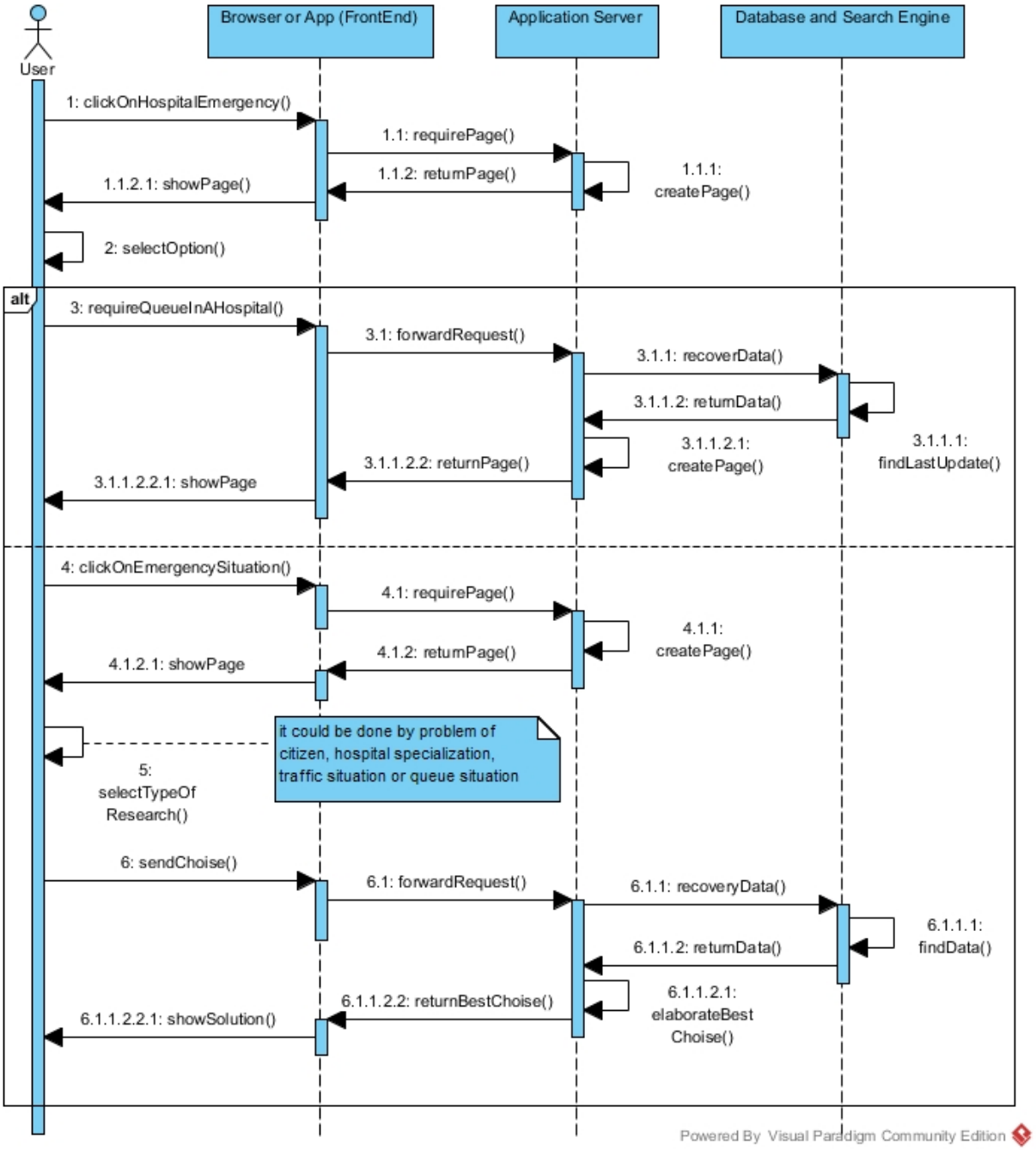


Name	Registration Process
Actors	Guest
Entry Condition	The guest is not already registered
Flow of Events	• Guest go on the web site main page or in the mobile app main page • Guest must select the registration page • He/she receive a page with a form, he/she will insert: Name, Surname, email address, Age confirmation, Username, Password (x2 times) • He/she will receive a confirmation email with a validation link If all the process is gone well, he/she will be redirected to his/her personal page
Exit Condition	The system has registered the new user
Exceptions	• email or Username address already exist • not all the gaps in the form are been filled In both situation system will show an error message
Reached Goals	[G7] [G8]

Name	Login process
Actors	Guest
Entry Condition	The guest is already registered
Flow of Events	• Guest go on the web site main page or in the mobile app main page • Guest must select the log in page • He/she receives from the system a page where insert username and password • If system will find corresponding data in the DB, guest will be redirect on his/her personal page and he/she will be considered as user • If system will not find any corresponding data in the DB, guest will have other two possibilities to insert correctly data • After the other two chance, system will propose him/her the recovery username/password solution After each error, system will show an error message
Exit Condition	The system has saved date of login and has shown personal page to user
Exceptions	• Correspondence between username and password are not correct • Wrong password has been inserted three times In both situation system will show an error message
Reached Goals	[G7] [G8]

6.2.2 Appication Usage

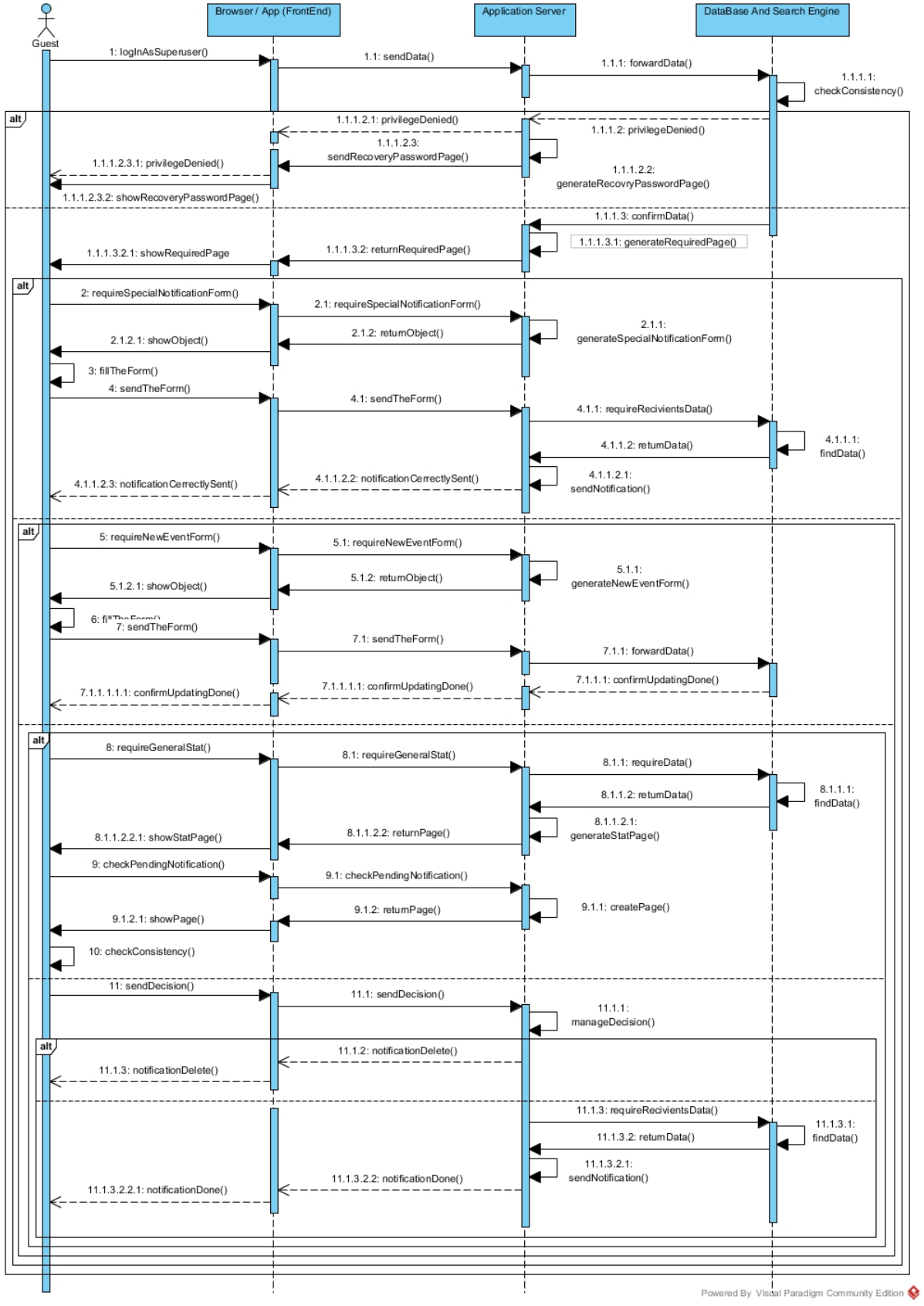



User
Browser or App (FrontEnd)
Application Server
Database and Search Engine
1: clickOnHospitalEmergency()
1.1: requirePage()
1.1.2: returnPage()
1.1.1: createPage()
1.1.2.1: showPage()
2: selectOption()
alt
3: requireQueueInAHospital()
3.1: forwardRequest()
3.1.1: recoverData()
3.1.1.2: returnData()
3.1.1.2.1: createPage()
3.1.1.1: findLastUpdate()
3.1.1.2.2: returnPage()
3.1.1.2.2.1: showPage
4: clickOnEmergencySituation()
4.1: requirePage()
4.1.1: createPage()
4.1.2: returnPage()
4.1.2.1: showPage
it could be done by problem of citizen, hospital specialization, traffic situation or queue situation
5: selectTypeOf Research()
6: sendChoise()
6.1: forwardRequest()
6.1.1: recoveryData()
6.1.1.2: returnData()
6.1.1.1: findData()
6.1.1.2.1: elaborateBest Choise()
6.1.1.2.2: returnBestChoise()
6.1.1.2.2.1: showSolution()
Powered By Visual Paradigm Community Edition

Name	Hospital Emergency process
Actors	Guest or User
Entry Condition	The person needs to find an hospital
Flow of Events	• Person click on Hospital Emergency link and system will provide the page • Person could choose between different possibilities of filtering (type of emergency, hospital specializations, waiting time, traffic situation) • System will elaborate information • He/she will receive a detailed notification regarding the option indicated
Exit Condition	The system has saved date of login and he/she has received all information required
Exceptions	• In order to perform a traffic situation filtering will be required to turn on the GPS signal. If it is not available, will be asked to insert actual position • If emergency will be consider too severe, an ambulance will be delivery on the indicated position
Reached Goals	[G3] [G5] [G7]

Name	Reservation Car Park process
Actors	User
Entry Condition	The person has already done the login
Flow of Events	• User require the availability parking situation • System will elaborate the request and will create the page. • User will indicate the zone where he/she must go and he/she already have a general view of availabilities • System will return a form coherently with the zone indicated • User will compile the form and system will update parking availability • User will receive a notification with the QR code that he/she will use to obtain the access to the parking.
Exit Condition	The system has saved new parking situation an user has received the QR code
Exceptions	• If during the reservation the indicated park will not available yet, will be shown an error message and system will redirect user to the parking situation view.
Reached Goals	[G4] [G5] [G7] [G8]

6.2.3 Log In As Superuser and Functionalities

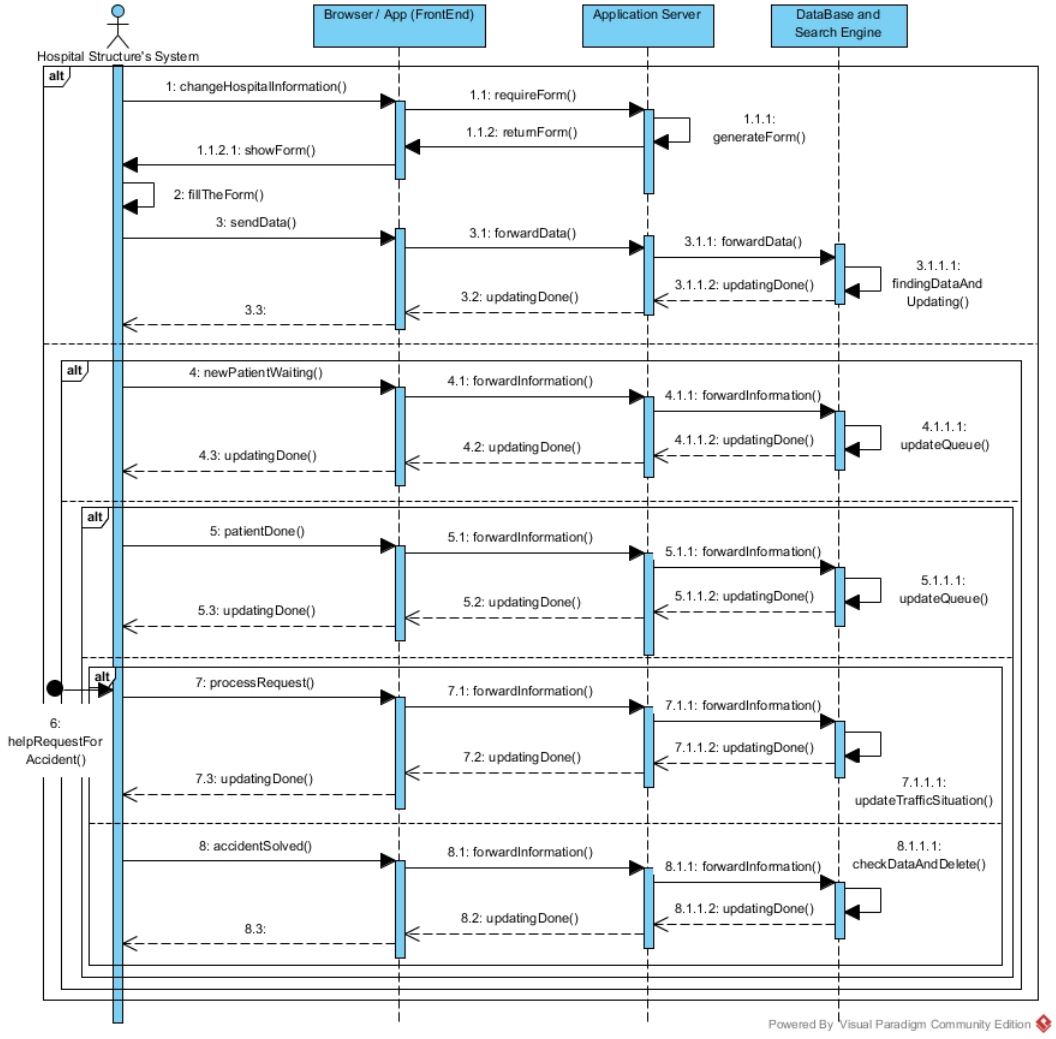


Name	Login as Superuser process
Actors	Administration , Hospitals, Police Station, Public Transport Company
Entry Condition	The entity must have precise username and password provided by administration
Flow of Events	• Entity go in a special page and select the log in as superuser • He/she receives from the system a page where insert username and password • If system will not find any corresponding data in the DB, entity will recive a an error message about privilege denied • If system will find corresponding data in the DB, entity will be redirect on its page and it will have functionalities enable by its privilege
Exit Condition	The system has saved date of login as superuser and has shown page to entity
Exceptions	• Correspondence between username and password are not correct • Privilege denied In both situation system will redirect the user to the recovery password form in the guest web site
Reached Goals	[G5] [G7]

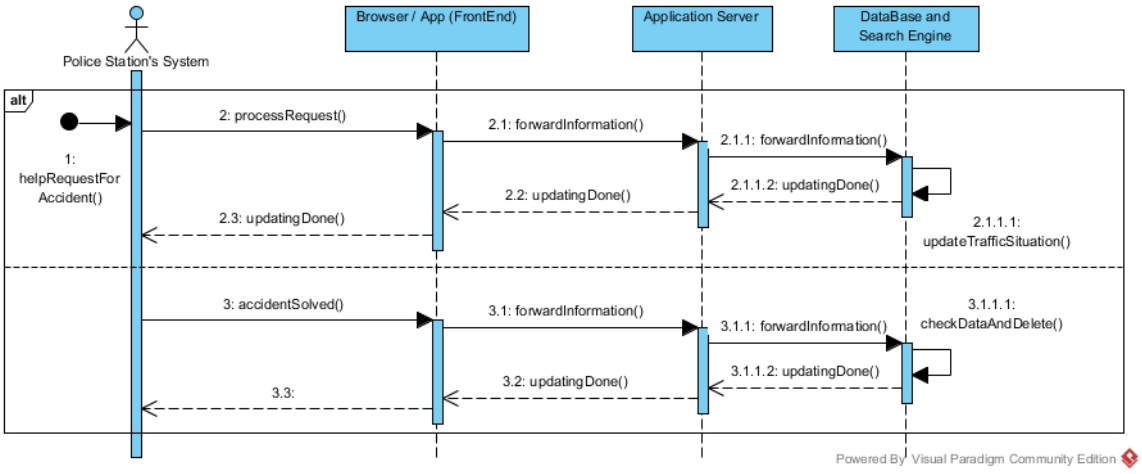
Name	Update Scheduling Events process
Actors	City Administration
Entry Condition	The entity must have done login as superuser 'administration'
Flow of Events	• Entity is in its special page with all the functionalities enables by its privileges • Entity could require the list of programmed event • Entity could require the form in order to update a new event and system will show it the required page • Entity must indicate: Name of event, type of participants, type of event, estimate number of attendance, period (from…to…), precise position or precise route of the event, additional info • System will assign ad ID to each event and it will be communicate to city administration with an email • Entity will be redirect to its main page
Exit Condition	The system has saved date of login as superuser and has added the new event
Exceptions	• Correspondence between username and password are not correct and privilege denied • Administration has not insert all the information In both situation system will show an error message
Reached Goals	[G2] [G5]

Name	Traffic Manage process
Actors	City Administration
Entry Condition	The entity must have done login as superuser ‘administration’
Flow of Events	• Entity is in its special page with all the functionalities enables by its privileges • Entity could require the CO2 levels of last days • Entity could decide to block immediately the traffic with the manual traffic light control • It require to the system the traffic light control • Automatically will be sent a notification about the new hardships • City Administration, in the shape of some employees, could be support automatic system with a manual intervention in the face of an unexpected event
Exit Condition	The system has saved date of login as superuser and city administration has partially solve the problem
Exceptions	• Correspondence between username and password are not correct and privilege denied • Administration has not insert all the information In both situation system will show an error message
Reached Goals	[G2] [G5]

6.2.4 Hospital Structure Functionalities

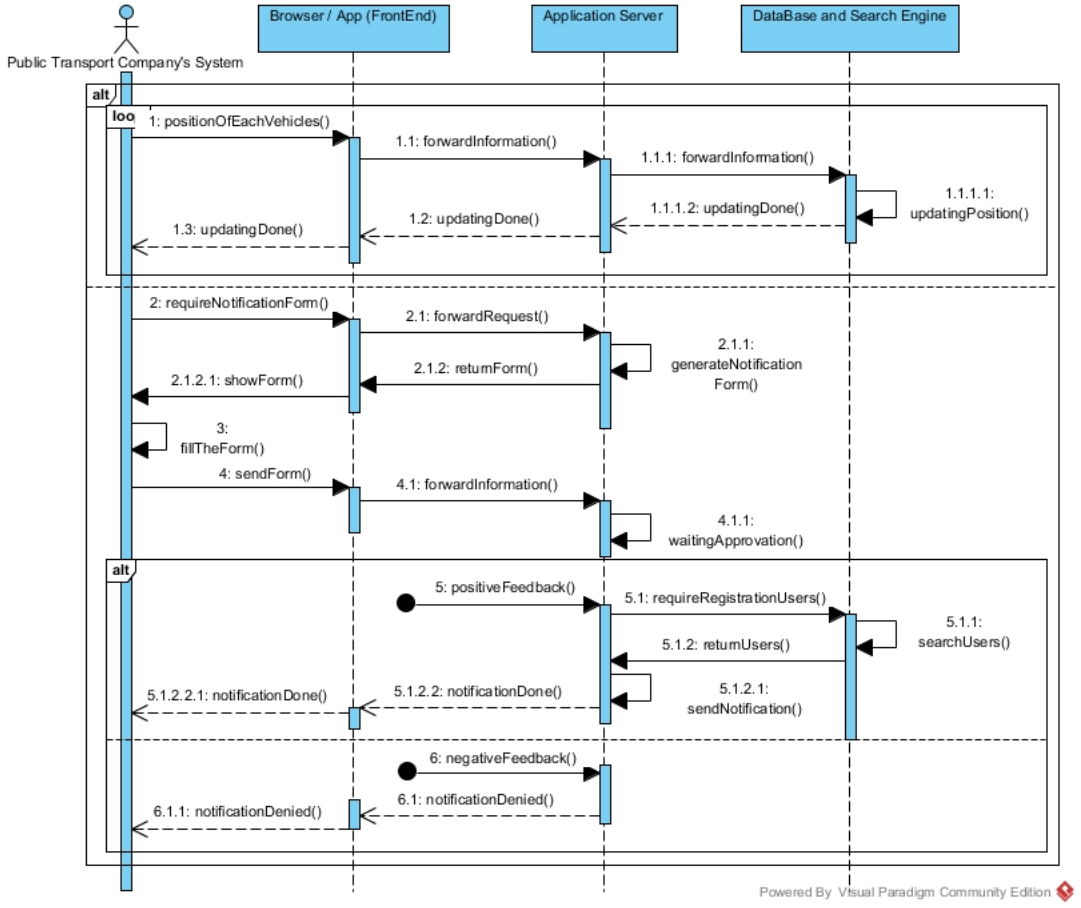


6.2.5 Police Station Functionalities



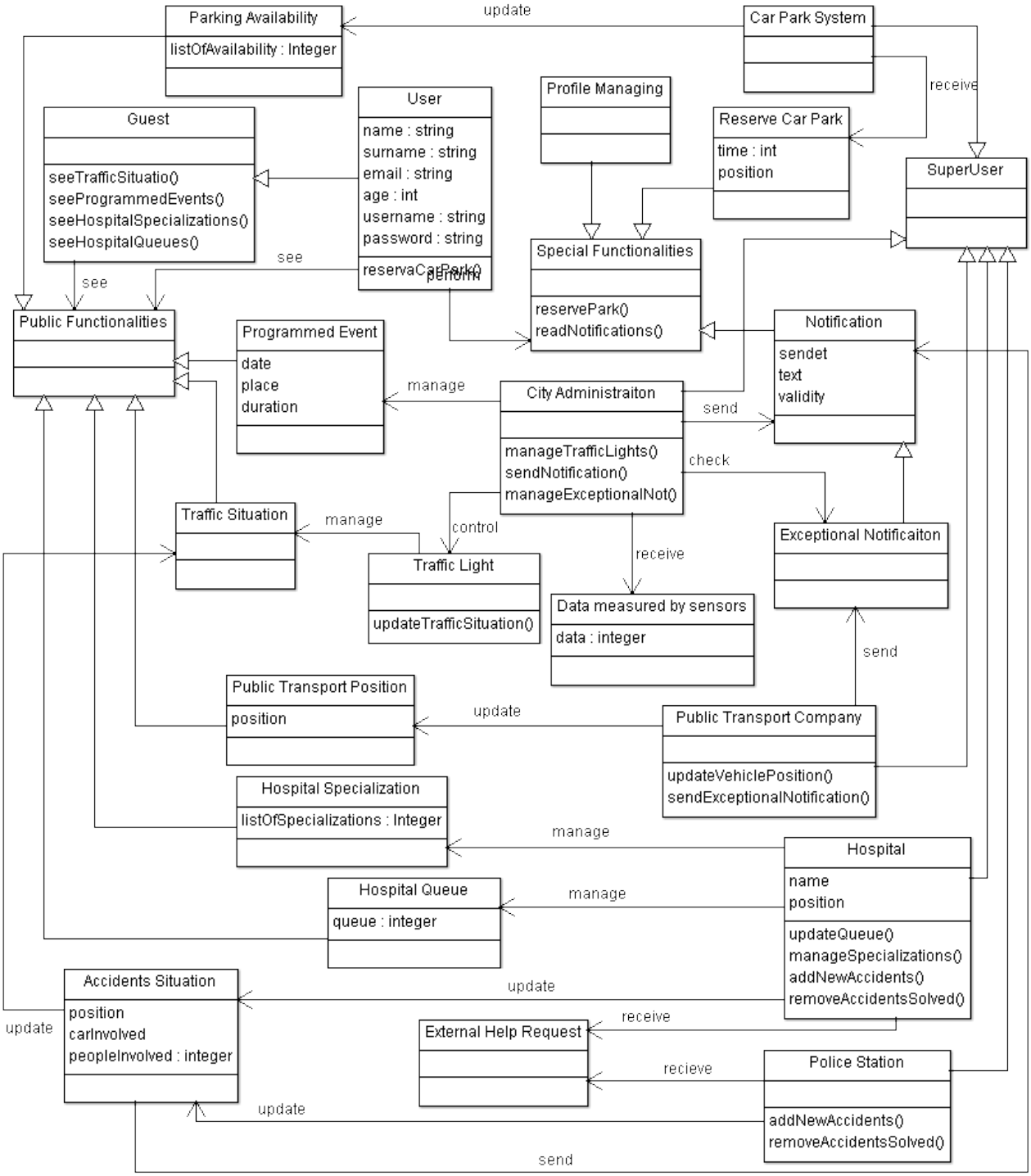
Name	Help requests process
Actors	Hospitals, Police Stations
Entry Condition	Entities must have log in as superuser and must have receive an help request after an accidents in the streets (no home emergency)
Flow of Events	• First entity that receives the call will go in the 'new emergency' page • While entity is registering the call, it will be insert directly in the system and will be necessary: position, car involved, eventually people injured (date will be insert automatically) • If system will found similar data base on proximity hourly, date and position, it doesn't update new information • If system will not found any similar data base on proximity hourly, date and position, it update new information and it will assign an ID to the new help request
Exit Condition	The system has saved date of login as superuser and has added the new help request, if necessary. Required medical staff and/or police is going on the place
Exceptions	In case of uncertainty in data, system will insert it on DB. This in order to avoid 'failure to rescue' situation
Reached Goals	[G5] [G6] [G7]

6.2.6 Public Transport Company Functionalities



Name	Special Notification process
Actors	Public Transport Company
Entry Condition	The entity must have done login as superuser ' Public Transport Company '
Flow of Events	• Entity is in its special page with all the functionalities enables by its privileges • Entity could try to send to all registered users a special notification • Entity could require the form and system will show it the required page • Entity must indicate: Notification Object, interested public line, interested user, period (from… to…), precise route of line interested, description • System will assign ad ID to each notification and it will be communicate to city administration with an email • Notification will be send only after city administration approval, in order to reduce any type on spam notification
Exit Condition	The system has saved date of login as superuser and has forward new notification to City Administration
Exceptions	• Public Transport Company will reveive an email with the City Administration feedback • If City Administration doesn't consider the Public Transport Notification, after 12 hour it will be automatically approved and sent to users
Reached Goals	[G5] [G7]

6.3 Class Diagrams



7.Alloy Modelling

In order to confirm concistency about models that are been presented, is been used Alloy model that allows to create the dependences between actors and actions in a simulater real-world. In next sections is been reported the Alloy code and some images that rapresent it when is executed, in order to bring out the concistency of our model.

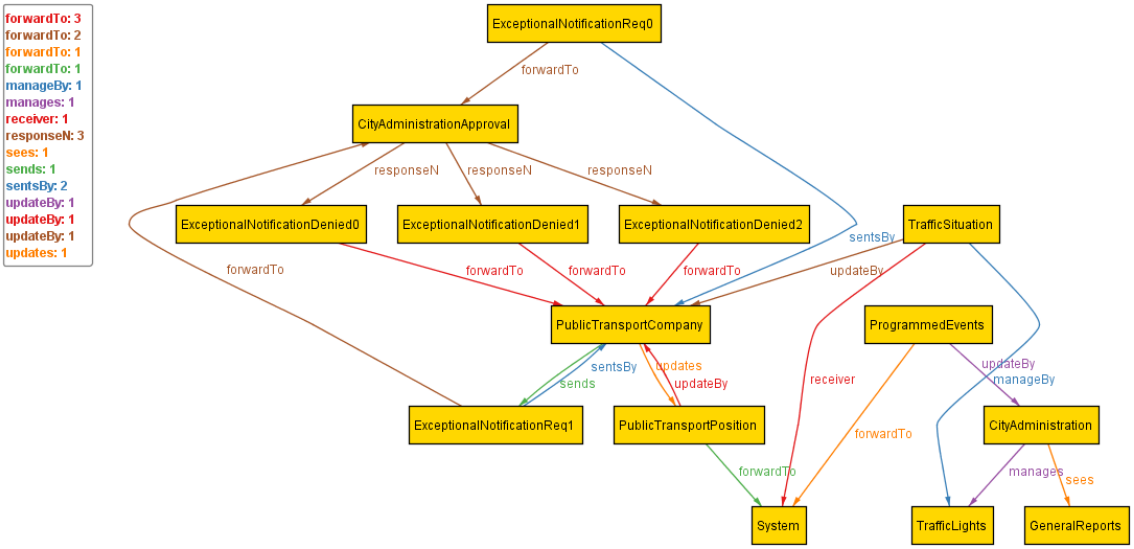
7.1 Alloy Code

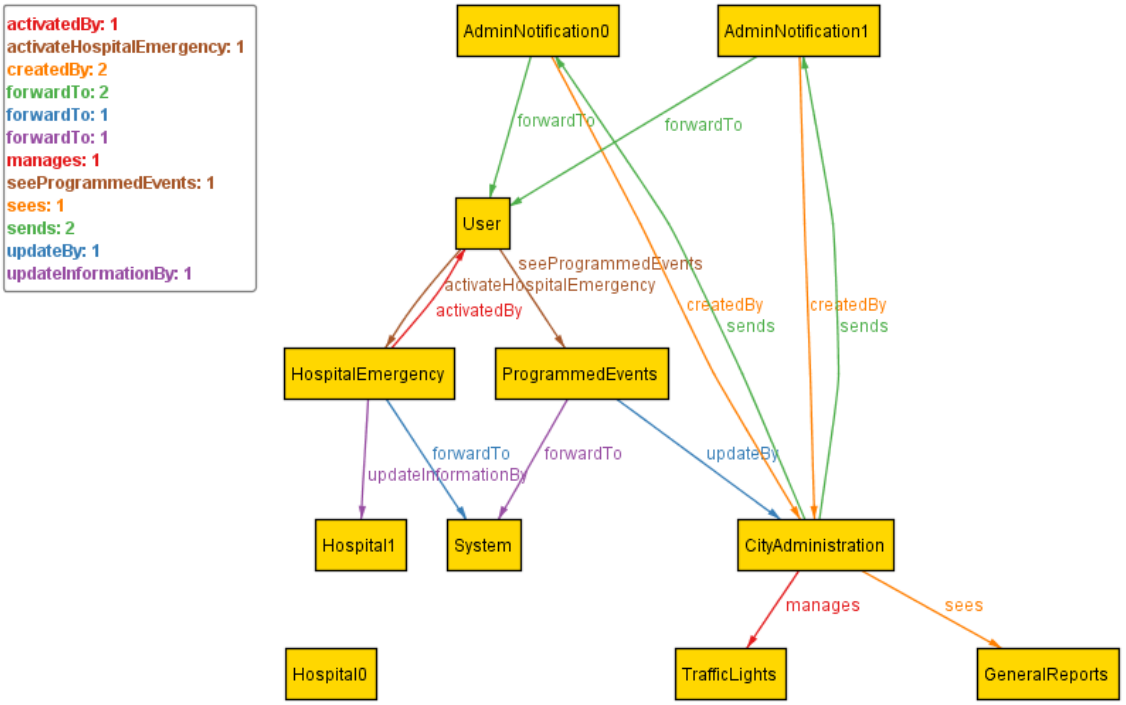
```
module SmartCityService

//-------SIGNATURES-------//

abstract sig Person{}

abstract sig Superuser{}

abstract sig System{}
{#System = 1}

sig Guest extends Person{
                seeTrafficSituation: set TrafficSituation,
                seeParkingSituation: set ParkingSituation,
                seeProgrammedEvents: set ProgrammedEvents,
                activateHospitalEmergency: set HospitalEmergency,
}

sig TrafficSituation {
                sender: lone Guest,
                receiver: one System,
                updateBy: one PublicTransportCompany,
                manageBy: one TrafficLights
}
{#TrafficSituation=1}

sig ParkingSituation {
                forwardTo: one System,
                updatesBy: one ParkingSystem
}

sig ProgrammedEvents {
                forwardTo: one System,
                updateBy: one CityAdministration
}
{#ProgrammedEvents = 1}

sig HospitalEmergency {
                activatedBy: one Guest,
                forwardTo: one System,
                updateInformationBy: one Hospital,
}

sig User extends Guest{
                reserve: set ParkingReservation
}

sig ParkingReservation{
                createsBy: one User,
```

```
                forwardTo: one ParkingSystem
}

sig CityAdministration extends Superuser{
                manages: set TrafficLights,
                sees: set GeneralReports,
                sends: set AdminNotification,
}
{#CityAdministration = 1}

sig TrafficLights{}
{#TrafficLights = 1}

sig GeneralReports{}
{#GeneralReports = 1}

sig CityAdministrationApproval{
                responseY: set ExceptionalNotification,
                responseN: set ExceptionalNotificationDenied
}

sig ExceptionalNotification{
                sendBy: one PublicTransportCompany,
                forwardTo: one User
}

sig ExceptionalNotificationDenied{
                forwardTo: one PublicTransportCompany
}

sig AdminNotification{

                createdBy: one CityAdministration,
                forwardTo: one User
}

sig Hospital extends Superuser{
                createsNew: set HelpRequest,
                manages: set HospitalSpecializations,
                updates: set Queues
}
{#Hospital > 1}

sig HelpRequest{
                createsBy: one Hospital,
                insertsBy: one Police,
                forwardTo: one System
}

sig HospitalSpecializations{
                updatesBy: one Hospital,
                forwardTo: one System
}

sig Queues{
                updatesBy: one Hospital,
                forwardTo: one System
}

sig Police extends Superuser{
                createsNew: set HelpRequest
}
{#Police ≠ 1}

sig PublicTransportCompany extends Superuser{
                updates: set PublicTransportPosition,
                sends: set ExceptionalNotificationReq
}
{#PublicTransportCompany = 1}

sig PublicTransportPosition{
                updateBy: one PublicTransportCompany,
                forwardTo: one System
```

```
}
{#PublicTransportPosition=1}

sig ExceptionalNotificationReq{
                sentsBy: one PublicTransportCompany,
                forwardTo: one CityAdministrationApproval
}

sig ParkingSystem extends Superuser{
                updates: set ParkingSituation,
}
{#ParkingSystem > 0}


//-------FACTS-------//

//Each person could activates his/her personal hospital emergency
fact guestRestriction{
                all g: Guest | #g.activateHospitalEmergency = 1
                all h: HospitalEmergency | #h.activatedBy = 1
                no disj g1, g2: Guest | g1.activateHospitalEmergency = g2.activateHospitalEmergency
                no disj h1, h2: HospitalEmergency | h1.activatedBy = h2.activatedBy
}

//Each user could be reserve only on car park
fact userRestriction{
                all u: User | #u.reserve ≤ 1
                no disj u1,u2: User| u1.reserve =u2.reserve
                no disj p1,p2: ParkingReservation | p1.createsBy = p2.createsBy
}

//Administration notification must arrive to all users
fact cityAdministrationNotifForAllUsers{
                all u: User, a: AdminNotification | a.forwardTo = u
}

//Each car park must have its parkink availability situation
fact parkingSystemAndSituation{
                all p: ParkingSystem, ps: ParkingSituation | #p = #ps
                no disj ps1, ps2:ParkingSituation | ps1.updatesBy = ps2.updatesBy
                no disj ps1, ps2:ParkingSystem | ps1.updates = ps2.updates
}

//Each hospital must have its queues situation and its specializations
fact HospitalQueuesAndSpecializations{
                all h: Hospital, q:Queues | #h = #q and h= q.updatesBy
                all h: Hospital, hs:HospitalSpecializations | #h ≥ #hs and h = hs.updatesBy
                no disj q1,q2: Queues | q1.updatesBy =q2.updatesBy
                no disj hs1, hs2:HospitalSpecializations | hs1.updatesBy = hs2.updatesBy
}

//Each exceptional notification request must have its own response
fact exceptionalNotificationPermissions{
                all c: CityAdministrationApproval, e: ExceptionalNotificationReq | #c = #e
                all c:CityAdministrationApproval | #c.responseY + #c.responseN = 1
                no disj c1, c2 : CityAdministrationApproval | c1.responseY = c2.responseY
                                or c1.responseN = c2.responseN
}

//-------PREDICATES-------//

pred generateWorld{}

run generateWorld for 3
```

7.2 Generated World





8.Used Tools and Work Timing

FOR create this documet we have used:

LYX to create a well-formatted document

moqups.com to create the UI sketches;

VisualParadigm10 Community Edition to create Sequence Diagrams and State Charts;

AlloyAnalyzer4.2 to prove the consistency of

REGUARDING the drafting of this document, i have spent about 28 hours. Problably, during a team group, this thin will be the same for each component becouse the time that normally is used for coordinate the work is very relevant.