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Tesi di Laurea in
COMPUTER SCIENCE

An application for supporting citizens and tourists in their mobility

Relatore: Prof. Alessandra Raffaetà
Correlatore: Dott. Alex Zabeo

Tesi di Laurea di:
Lorenzo Donati, matricola 817622

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La creatività e l'innata facilità nell'utilizzo delle nuove tecnologie informatiche possono innescare meccanismi di trasformazione sociale a livello globale.

Creativity and easiness by using new information technologies can permit social revolution at global level.

[RLM06]

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Abstract

The general objective of the thesis is to encourage the use of public transport through the development of innovative services for smartphones. Few local transport companies offer a support for citizens and tourists to move around the town by using their means of transportation and besides when the service is provided is limited to the means of a single company.
The proposed system provides a user with various services related to public mobility: a user can specify the starting and ending points of her/his trip by visualizing a map of the city or selecting these points from a list of stations. The system returns a trip planning which illustrates the means of transportation, the time duration and other information connected to the different stops, e.g., an image of the stop. Moreover, the system offers specific services for tourists. According to the tourist's position, the numbers of days s/he intends to stay in the town and his/her preferences about things to do, the system provides different trajectories in order to visit the town.
The tourist can access various kinds of information about the points of interest encountered during chosen itinerary.
The system has been developed for iOS smartphones.

Keywords

Trip planning, mobility, tourism, IOS

Chapter 1

INTRODUCTION

1.1 Motivations

In the last decade, the problems caused by the rapid increase of urban car traffic have received more and more attention both from citizens and from local administration.

ITA:
Una conseguenza di un trasporto pubblico efficiente garantisce la possibilità a tutti i cittadini di spostarsi e di muoversi nel territorio nazionale come è indicato anche nell'articolo 16 della costituzione dove "Ogni cittadino può circolare e soggiornare liberamente in qualsiasi parte del territorio nazionale ... "
FRASE DI RIFARE !!!!!
One effective conseguence of efficient public transport solutions that can guarantee freedom of movement, which, as a practical realization of the same individual, is protected by the paper Costitution [1] .

The local public transport (or LPT) regards in first place the local administration, now close by the need to guarantee an appropriate level of services offered. The issue is the constant and progressive cutting of public resources. This problem affects both the companies that are in great difficulty and the user that benefit the services (the so-called commuters who complain every day delays and inefficiencies).
This involves even those who do not recourse to LPT, by the rapid

[1] **Articolo 16:** Ogni cittadino può circolare e soggiornare liberamente in qualsiasi parte del territorio nazionale, salvo le limitazioni che la legge stabilisce in via generale per motivi di sanità o di sicurezza. Nessuna restrizione può essere determinata da ragioni politiche.

increase of urban car traffic. Finally, if the LPT was more efficient all citizens benefit from this in terms of reducing emissions and in general of urban congestion.

In cities, congestion caused by the use of individual means of transport is becoming more and more unsustainable both from a practical point of view and from the environmental point.

DA TRADURRE !!!!!
Si parla di inquinamento atmosferico quando vi è un'alterazione dello stato di qualità dell'aria conseguente all'immissione nella stessa di sostanze di qualsiasi natura agenti inquinanti in misura e condizioni tali da alterarne la salubrità e da costituire pregiudizio diretto o indiretto per la salute dei cittadini e dell'ambiente o danno a beni pubblici e/o privati.

An actual example is the pollution problem in China where over 400.000 people die each year [Hys]. The China economic growth generates strong and rapid changes in consumption. This model involves, milion of people each year, use s/he private car as a means of urban transport and exponentially increase the pollution.

Figure 1.1: Pollution situation in China

As we can see from the figure 1.1 the air quality is major problem, mainly in big city such as Pechino or Shanghai. This is due not only at the energy production from coal, but the drastic increase of private car, estimated by 2030, about 130 milion vehicles.

Arpav data on 2012, show also in Veneto the pollution remains one of the most problem [VEN]. The Veneto region, by analyzing the Arpav network data (with regard to particulate also called Pm10) found that in the years 2010-2012 in all the cities[2], are over 35 the days number that exceeding the minimum threshold.

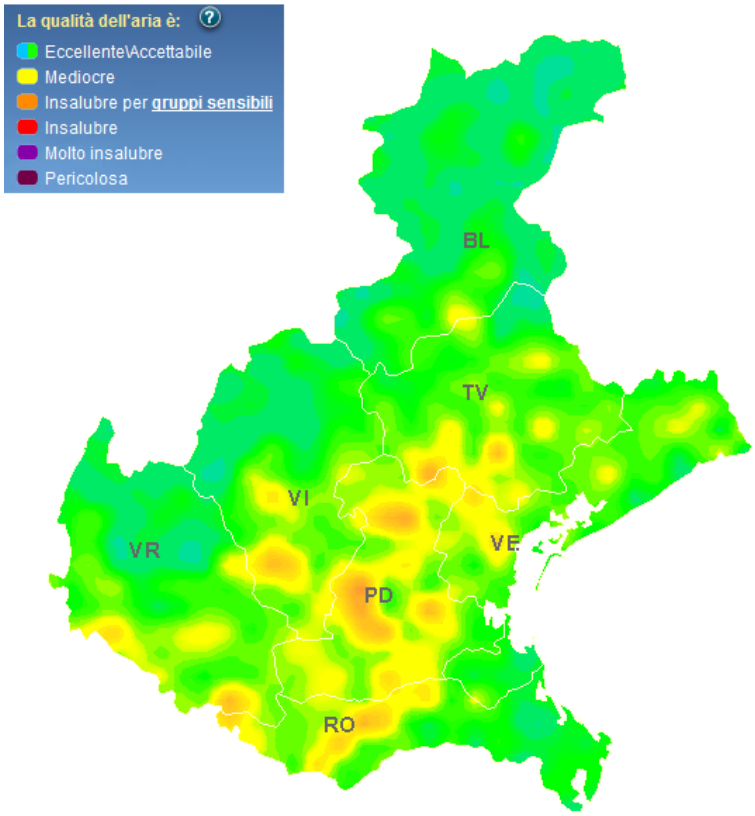


Figure 1.2: Pollution situation in Veneto on December 10, 2013

As we can see in figure 1.2, show that in the Padova and Rovigo city center and on west of Venezia are the area with the highest pollution. The situation is not alarming as in China but it is not to be undervalued.

Many societies have seen a growing environmental sensitivity and an increasing concern about the negative consequences of excessive car traffic on the health of the urban population and on the quality of life in cities. It is necessary to encourage the use of public transport and

[2]with the exception of Belluno and Feltre

try to develop as much as possible the public transport network for the user, who can be either a citizen or a tourist.

It is desirable that the use of public transport becomes more simple and friendly on the part of the user who should be able to make a trip plannig and buy the travel tickets without effort even when it is already in mobility or in times which the transport company offices are not expected to be open.
The simplicity of use is not the only factor that facilitates the use of the service, the main factor, in fact, is related to its quality and quantity of means available.

It is desirable and necessary, especially in the last years, where we are surrounded by systems information, that there is an interaction between user and public transport company.

FRASE DI RIFARE !!!!!
This unity of purpose should be directed both to provide new routes is that to improve the status of service already proposed, based on user feedback and through usage statistics of the same.

The main objective of our system is the management of all aspects of public transport associated with the interaction between the supplier and the user in order to simplify the use and improve the quality of the service. Our system is based on innovative technologies which will hopefully allow a more sustainable development of the urban life.

It is no longer possible to ask for citizens and tourists to have or download the timetable of stops or read the tables in electronic format because sometimes they are difficult to read. The user is often required to know lines, names of the stops or topology of the city and this leads to a lack of clarity and at the same time opportunity to take full advantage of the public transportation is missing.

There are several applications for the transport in the city, very few of them offer a complete service to the user. They provide the timetable in a paper or electronic format and in many cases they do not show you how to reach your final destination but only the nearest bus stop.

1.2 Technology opportunities

The improvement of local public transport (LPT) also passes through the extensive use of the solutions ITS (Intelligent Transport Systems) as outlined by [TTS]. The ITS, based on the interaction between information technology, telecommunications and multimedia, helps to solve the problem of the public and private mobility. These systems develops in a functional way solutions based on security, efficiency, effectiveness and cost-effectiveness in relation to the environment. Today, the ITS, can be considered indispensable instruments for mobility management in urban and metropolitan areas.

The European Commission classifies the ITS such as systems for:

- traffic management and mobility
- user information
- management of public transport
- fleet management and goods transport
- automatic payment
- vehicle control for safe transport
- emergency management and incident

According to the guidelines set by the European Commission, by cut the waiting time at bus stops, improve the regularity, accelerate the speed and increasing the comfort of the trip, making bus and subway transportation more accessible and attractive for commuters people in urban and suburban.

The installation of the systems made to date, both urban and suburban, allowed us to evaluate the benefits of the ITS. European Commission data [EUR] show that ITS applications implemented in different countries in the European Union have been obtained reductions in travel time in the order of 20% and improvements in terms of safety about 10-15%.

These positive results prove the benefits of the ITS systems. In a sustainable development, related to the enviroment, to improving the efficiency and the safety of citizens; confirm that today, ITS systems, are an indispensable instruments for the implementation of mobility policies.

The technological revolution of Italian public transport, according to TTS Italia[3], it should go through several steps.
The monitoring systems make possible to increase efficiency in use of the fleet, while the electronic ticket would give the chance to fight evasion rates. The implementation of video surveillance systems and alarm would help to increase the level of safety on board and at stations, while the mobile information would give to users more usability of the service.

1.3 Our proposal

In order to cope with the issues illustrated in 1.1 section, we developed an application called IPMobMan.

IPmobMan is an application services related to public mobility. It is composed of a set of modules linked to two types of infrastructure, a server-side for the management of global information used by the supplier (public transport company) where the resources, the schedules and the routes are managed. On the other hand a client-side used by mobile users to make trip plannig, expected the possibility to buy tickets with a previous according to the public transport company, make use of services during the trip and finally to receive touristic itineraries suggestions.

The application is not linked to a single supplier because it consists of general services. The services offered by the application can be divided into three category: pre-trip, post-trip and info-touristic service.

The pre-trip sevices concern information and the trip planning. In relation to information, the user can look at the list of stop names or otherwise the location of the same on a map and select the desired one. With regard to the trip planning, the user can, specify a point of departure and arrival (if the second one is not present by default is configured to the city center), the system provides a list of trip possibilities with the time of departure and arrival, as well as the means of transport to take.

[3]Italian National Association for Telematics, Transport and Safety

ITA:
Una volta che l'utente ha selezionato il percorso che preferisce, ad esempio in base alla distanza da percorrere a piedi o al numero di mezzi da prendere, l'utente viene aiutato ad intraprendere il percorso tramite delle accurate descrizioni.
ENG:
After the user selects the trip, for example based on foot distance or on the number of means to do, s/he is helped to take the trip through accurate descriptions.

The post-trip services are related to the possibility of leaving feedback concerning the trip or the means of transport. On the user side, s/he can launch ideas for new route or make any reports of poor service, complaints and/or suggestions. On the company side it allows to check the efficiency and effectiveness, as to cover the critical points and optimize the most frequently routes.

Well as the info-touristic services offer suggestions to the user for some itineraries related to points of interest (POI), in this version the itineraries are created by consulting [LC92].

1.4 Document structure

DA FARE ...

Chapter 2

STATE OF ART

I have identiefied and studied some similar services available both in Italy and abroad for the iOS or Android platform and I will present these tools in this chapter.
There are several applications dedicated to public transport for citizens and tourists to move around the city using the public means of transport but none of them offers a complete services for both parties. In some case, there are a simple transposition of the paper timetable into electronic format, instead, in other cases they do not show how to reach the final destination but only the nearest bus stop.
I have detected the common functionalities for different mobile applications, verified working standard and I was inspired for improvements in my application. It has been developed for the iOS operating system and in particular for the iPhone device.

The analyzed applications present in apple-store and some case in play-store, are listed below:

1. Bus Torino
2. Roma Bus
3. AMT BUS
4. Trento in bus
5. iATM - Milano
6. Guida di Venezia Vaporetto dell'Arte
7. iVenice
8. GoPublic
9. TreviMOve

2.1 Terms of comparison

In order to carry out a comprehensive evaluation of the applications and their features, the following aspects have been taken into consideration:

Official
: The official applications are few compared with available applications, but they are generally better from the point of view of reliability of the data.

Search stops nearby
: Possibility to search the nearby stop by using the gps-coordinates.

Calculation point-to-point route
: The trip planning service in general consists of planning your route from a point A to a point B (point-point). Many applications that use the public transport support the planning only between stops (stop-stop); the on foot path is not provided.

Select stops from map
: Possibility to select a bus stop directly on a map.

Favorite routes
: Possibility to save favorite routes.

Off-line navigation
: Possibility to save the route into the device (to consult without data connection)

Buy tickets
: Possibility to buy tickets about the selected trip.

News
: Possibility to check the news about the transport company associated with the application.

Feedback
: Possibility to post comments about the service just used or in general to improve the service provided by the transport company.

Turistic information
: Possibility to plan tourist tours.

2.2 Considered applications

- **Bus Torino**

  Bus Torino is a smartphone app for iPhone and Android that provides information about routes, lines and arrival times of buses from the city of Turin.
  The application interfaces the site "5T Gruppo Torinese Trasporti" that provides information in real time. The accuracy and as well as the avaibility of the information does not depend on the application but from what the site provides [1].

  This application allows several functionality such as stops seach, parameter setting, lines and favorites routes. From the setup view the application permit to choose the maximum distance from the user position to nearby stops. Also the user can set the measurement system between metric and imperial.
  However the search function (figure 2.1(a)) doesn't work because of the setup settings and the localization of the device at the time of use wasn't nearest Turin city center.

  Different matter we can see from the lines view, as show in figure 2.1(b), where we can found the lines list ordered by codes. The search of a particular line doesn't return any result. If the open a line from the list the application just show the stop names. The favorites allows to save the preferred and most used routes.

(a) Search view (b) Lines list (c) Map lines

Figure 2.1: Image example of Bus torino app

Finally, to conclude the analysis, I can affert that the application

[1] `http://www.5t.torino.it/5t/`

is more useful to the citizens that already know the city map and for language selection. A positive aspect is that data are obtained in real time from the official GTT web site.

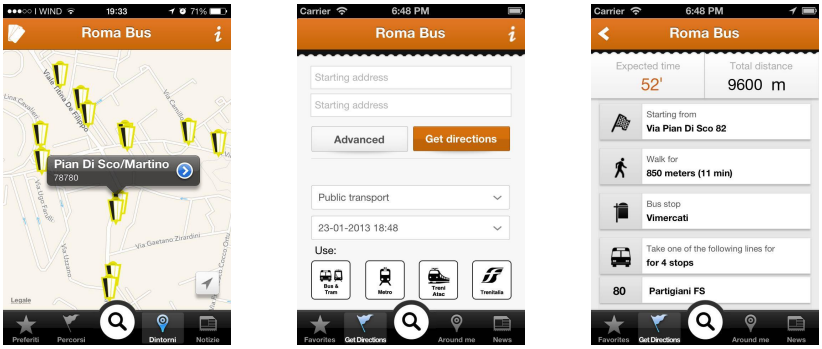
- **Roma Bus**

  Roma Bus is a smartphone app for iPhone, Android and Windows Phone that helps a user in the visualization of nearby stops (via GPS) from the city of Rome. The application is not official, it interfaces to Atac information systems (Italian: Azienda Tramvie ed Autobus del Comune di Roma).

  This application allows several functionality such as favorites, routes, search and news. A very useful feature is the news view that keeps you informed about the public transport, traffic and viability.

  Talking about the routes view the application permit to set up the start/end address, select private car or different public transport such as bus, tram, subway and train. Other possibility is to select starting date and time as show in figure 2.2(b).

  When the application calculate the routes appears the expected time and the total distance such as in figure 2.2(c). Show to the user a steps list, describing the action to do until the end of the route even if the walk actions are not clear.



(a) Map lines (b) Routes (c) Route detail

Figure 2.2: Image example of Roma Bus app

Searching a particular address, the program show the list of stops all around city. Selecting one, appear a real time list of bus that transit in that stop, providing the user with the route of the entire line both in textual and graphical view.

To conclude the analysis, I can affert that the application is useful both from citizien and tourist, the only limitation are that the services work from 6:30 AM to 24 PM .

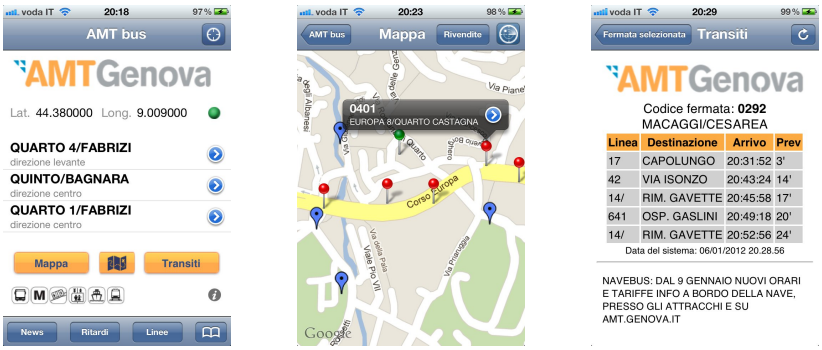
- **AMT BUS**

  AMT Bus is an official app for the public transport of Genova city. Identifies the three nearby bus stops where the user are located and shows the geographical coordinates. The data, such as news, tables of scheduled departures of the various lines, are retrieved from the official website.

  The starting page of the application show the coordinate position of the user. In the same page there are several functionality such as map, search route and buy tickets as shown in figure 2.3(a). The possibility to buy tickets in times which the transport company offices are not expected to be open. Take into account, the search route function refer to the google maps website.

  From the lines view the application allow to search a line, view the stop list in textual or in graphical view with marker into the map as shown in figure 2.3(b) and finally see the associated timetable as shown in figure 2.3(c).

  The favorites allows to save the preferred and most used routes, and news view that keeps you informed about the public transport.



(a) Home view (b) Maps detail (c) Stop detail

Figure 2.3: Image example of AMT bus app

Finally, to conclude the analysis, I can affert that the graphics application is to be reviewed because sometimes unclear. A posi-

tive aspect is that the possibility to buy tickets and the data are obtained in real time from the official web site.

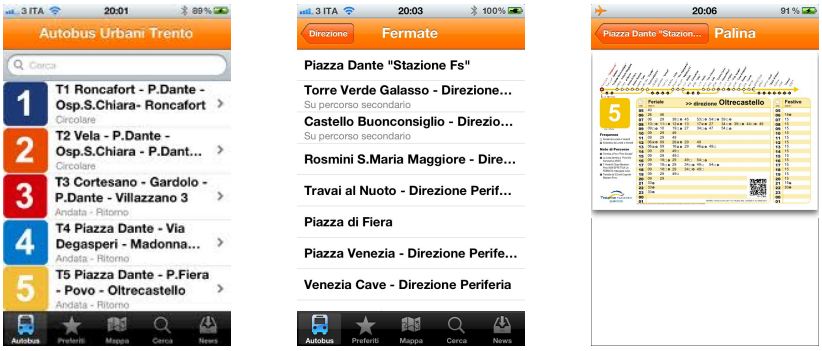
- **Trento in bus**

  Trento in Bus is an application that allows a user to view the schedules of buses in the city, is developed only for iOS system and are not official.

  The application give the possibility to see bus stops list as show in figure 2.4(b), save favorites, see news and finally visualize stops on the map. Talking about the autobus view the application permit to search bus line all around city as show in figure 2.4(a), afterwards for each of them, the user can visualize stops list.

  Map view visualize all stops into the map with a marker, the user can select one of them and see the associated timetable as show in figure 2.4(c). The favorites allows to save the preferred and most used routes and the news section alerts the user about change routes or schedules.

  To conclude the analysis, I can affert, that the application is just an improved version of a paper timetable moreover the application don't support the trip-planning.



(a) Lines list (b) Stops list (c) Stop timetable

Figure 2.4: Image example of Trento in bus app

Note that the same author has also developed the app "Verona in bus" which provides the same functionalities.

- **iATM - Milano**

  iATM (Azienda Trasporti Milanesi) Milan is the official application to move more easily with public transport in Milan and province. With iATM-Milano you can display the itinerary of the lines, the list of stops and see the detail, calculate routes, check the traffic info, see the points of interest on the map.

  This application allows several functionality such as favorites, routes, search lines or stops and news. The feature use for searching itineraries called GiroMilano, permit to set up the start/end address, date and time and the calculation routes option such as faster or with less stops. The application show the summary of the route with the action to do a global view of the route show into a map such as figure 2.5(a).

  From the lines view the application allow to search a line or select it from a list. After this the user can see the itineraries on the map. Similar features are the stops that permit to seach nearby stops from the user location and get information about the lines and the traffic info. Map give the list of metropolitan lines. By selecting one of each the user visualize the route map image. However the Info traffic view show the public transport news. The application allows other feature such as the search of ATM point, parking and company offices.

  A positive aspect is many features and services offered, the data obtained are in real time from the official site but a negative aspect is that the application in some situations are slow.

(a) Map line (b) Stop detail (c) Route search

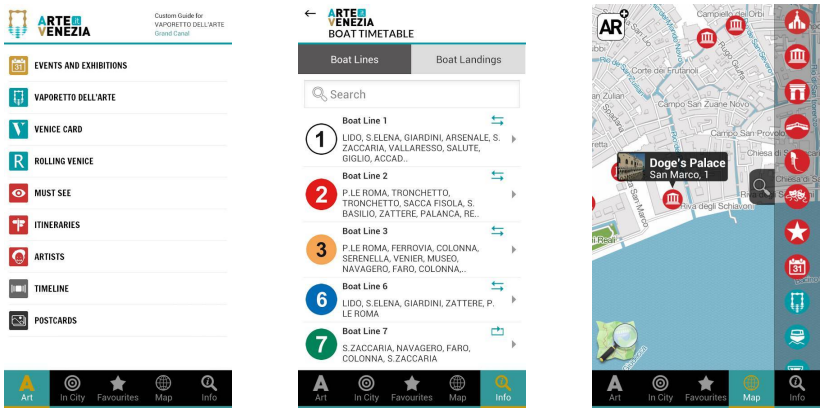
Figure 2.5: Image example of iATM-Milano app

- **Guida di Venezia Vaporetto dell'Arte**

  The Guide to Venice Vaporetto of Art is an application for iPhone and Android[2] for searching historical and artistic interesting points of Venice (museums, monuments, palaces ecc.). The user can check the official timetable of local public transport and organize a trip in the city. This application allows several functionality such as art, favorites, info and on trip.

  In art view the application provides several option as show in figure 2.6(a), the most important are events and exhibitions in Venice, to see, itineraries and at last artist. Artist option give a list of artist, the user selecting one of them can see her/his description and the most importart works present in Venice. To see option give a list of intesting points (churches, museums, theaters ecc.) and provides description, opening times, phone number, public transport to take and showing the points into the map as show in figure 2.6(c). A list of intesting points is clustered together into itineraries option.

  Similar matter as the on trip feature that permit the user to search restaurants, pubs, libraries, parks ecc. in Venice and provides the user the description, opening times and phone number.



(a) Application menu (b) Boat lines search (c) Map view

Figure 2.6: Image example of Guide to Venice Vaporetto of Art

As in previous applications the favorites features allows to save the preferred itineraries. At last Info feature provide water bus

[2]Android service was suspended on October 21, 2013

lines list and stops list as show in figure 2.6(b). The user can select one line and one stop and see the time of the next water bus.

A positive aspect is many features and services offered for the tourist, In fact, the application is more related to the tourist not to trip planning. Note that the POI data are all inside the application.

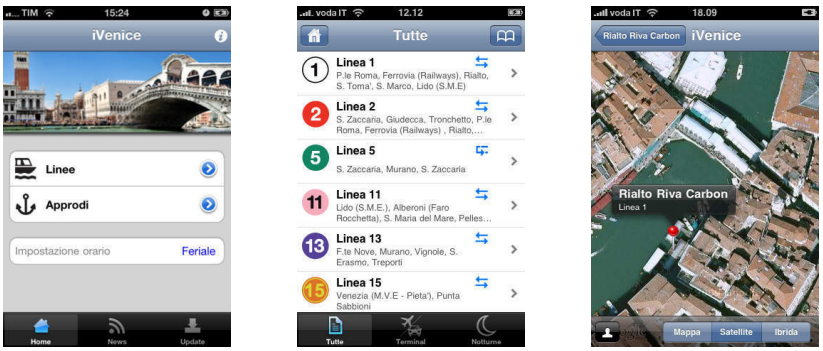
- **iVenice**

  iVenice is a smartphone app for iPhone that provides information about lines, departure times, stops of the Venice water bus.

  The database of timetable and stops are internal to the application. This application allows few functionality such as lines, stops, news and update as show in figure 2.7(a).

  The user can select from line view the desired, the application give the stops list, after for each stop the user can see the next departure time. Another possibility is to visualize on the map the stop position as show in figure 2.7(c). Stops view show the stops list in alphabetical order with search functionality as show in figure 2.7(b).

  To conclude the analysis, I can affert, that the application is a software version of a paper timetable, not support the trip-planning and the user must download extra packages to update stops times.



(a) Home view (b) Lines list (c) Map view

Figure 2.7: Image example of iVenice

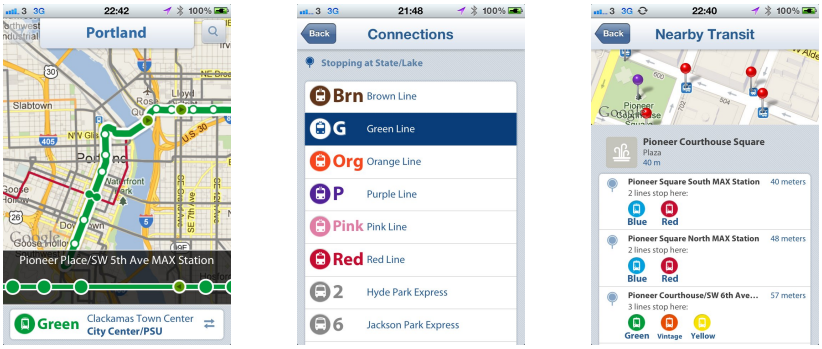
- **GoPublic**

  This application allows a user to get public transport map information, schedules and directions in various cities in the world (North America, Europe and Australia). In order to use this app you must download the CityPack to your device. The application is not official.

  The home view of the application provide the cities list in alphabetical order with the possibilty to download and install the database for each city. After package install the application allows few functionality such as setting for set the measurement system between metric or imperial, feedback to send via mail or via tweet and finally Map.

  Map view allows the user to search into the points of interest divided by category such as food, arts, shopping, coffee ecc. . By selecting the place the application provide a trip planning with the public transport means as show in figure 2.8.

  A positive aspect is that the application provide both touristic information and trip planning, the negative aspect is that the user hasn't the possibility to choose starting/ending point of the trip and moreover it is necessary for each city to download an extra package.



(a) Map view (b) Lines view (c) POI view

Figure 2.8: Image example of GoPublic

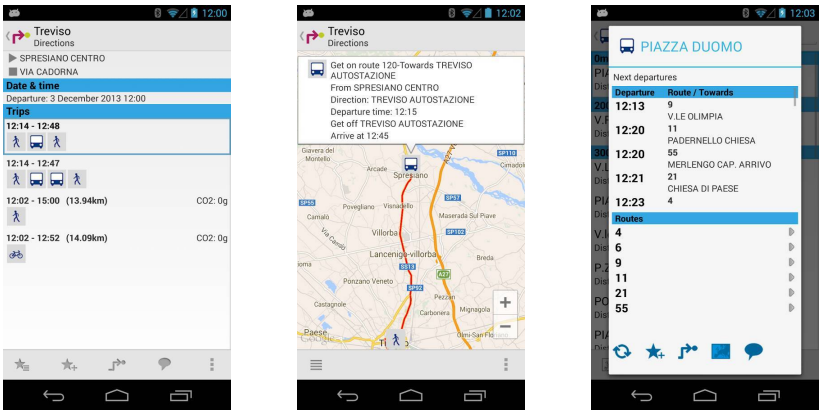
- **TreviMOve**

  TreviMOve is a smartphone app for Android that helps user to move in Treviso. The app provides trip planning and information by using the public transport of MoM (MObilità di Marca), finds

the nearest stop, for each stop you can see the schedule of upcoming bus rides coming up, save the favorites routes or stops, see the company news, buy the tickets on-line also find and learn about real-time availability of parking in the historic center of Treviso. Trip planning page of the application permit to set up the start/end address, select between private car, public transport, bike, walking path; other possibility is to select starting date and time.

As show in figure 2.9(a) the application show to the user the summary with the possible trips solution. In each solution are listed the action to do for reach destination. However the stop and line function where we can found the stops list and lines list ordered by distance. The user can getting information detail with the timetable of the next bus as show in figure 2.9(b) and 2.9(c). The news view keeps the user informed about the public transport, traffic and viability. The last functionality are the feedback that the user can send to the public transport company by compiling an online survey.

To conclude this analysis I can say that the application has almost all aspects taken into consideration in previous section. I haven't found relevant negative aspect.



(a) Route detail (b) Map stop detail (c) Stop detail

Figure 2.9: Image example of TreviMOve

As we can see from the table 2.1 the development of applications related to public mobility in Italy is very low-level, there are several products in the market (app-store or google.play) but none of these is of high quality with respect to the characteristics above listed.

DA RIVEDERE !!! vedere appunto in rosso su bozza
The main problem is that the transport company does not provide the data in standard or in a way that developers can read and/or interpret them in their applications, this implies the difficulty of being able to buy tickets through the application an authentication service is required.

From a technical point of view, there is little use of maps, many applications use an internal database or obtaine the data from the company's website to build the transportation network. In this way it is difficult to create a trip plannig point-to-point (certainly more complicated) and not only stop-by-stop.
Instead, the geolocation system is very popular, and it is available in all application. Few applications allow saving the trip off-line and almost none give the possibility to post feeedback or comments related to the transport service.
Finally the level of tourist information, which would bring considerable benefit both to the company and the town, is almost absent. Only in special cases such as "Guide Venice Vaporetto dell'Arte" is present with a lot of detail.

In conclusion, we can see that the best among the Italian applications analysed are iATM-Milano and TreviMOve.
They allow the user for exploring stops, timetables, lines of the transport, allowing the trip-planning point-to-point, seeing in the map the nearbly stops with the possibility of selection and saving of favorite itinerario.

DA RIFARE !!!
How we can say that is negative notes without purchasing the tickets, feedback, and news, no info for tourists about the point of interesting; probably the latter has never been taken into account.

App name	Official	Search stops nearby	Point-to-point route	Select stops from map	Favorites
Bus torino	✗	✓	✓	✗	✓
Roma Bus	✗	✓	✓	✗	✓
AMT BUS	✓	✓	✗	✓	✗
Trento bus	✗	✗	✗	✓	✓
iATM - Milano	✓	✓	✓	✓	✓
Venezia Vaporetto dell'Arte	✓	✗	✗	✗	✓
iVenice	✗	✓	✗	✗	✗
GoPublic	✗	✓	✓	✓	✓
TreviMOve	✓	✓	✓	✗	✓

App name	Off-line navigation	Buy tickets	News	Feedback	Turistic info
Bus torino	✗	✗	✗	✗	✗
Roma Bus	✗	✗	✓	✗	✗
AMT BUS	✗	✗	✗	✗	✗
Trento bus	✗	✗	✓	✗	✗
iATM - Milano	✗	✗	✓	✗	✗
Venezia Vaporetto dell'Arte	✓	✗	✓	✗	✓
iVenice	✗	✗	✓	✗	✗
GoPublic	✗	✗	✗	✗	✗
TreviMOve	✗	✓	✓	✓	✗

Table 2.1: Comparison features application

Chapter 3

PROJECT DESCRIPTION

In this chapter I will describe the software architecture and how the different interaction that takes place amog the various elements.

First, I will shortly present the programming languages used to implement the various components of the application. Then, I will illustrated how the various modules interact with each other to attain the main goal.

In the first place will be indicated in short the programming languages used to implement the various components of the global system. In the second place how the various modules interact with each other to provide a final result.

The resulting system consists of communicating modules settled in four different layers: database server, web server, Google services, Iphone application. Each of these layers (with the exception of Google services) contains several modules designed to perform the functionalities necessary for the entire application.

The implementation of the features presented in the functional requirements makes use of various programming languages like JAVA, SQL and PHP, JAVASCRIPT and finally OBJECTIVE-C, which is the core of this project.

Having approached the iOS programming environment with this thesis, before implementation, I'm documented on the guide lines [Inc] and the best ways for programming for mobile devices like iPhone.

In this regard were very useful the reading books before and during the development of the application such as [DM11],[Gol12] and [RL13].

In the following paragraphs the development enviroment, the system architecture and the software structure of each modules and at last

but not least the standard data used are presented in detail.

3.1 Development enviroment: Xcode

Xcode is an integrated development environment (IDE) containing a suite of software development tools developed by Apple for developing software for OS X and iOS. Xcode include GCC, able to compile java, C, C++ and Objective-C codes.

The Xcode suite also includes most of Apple's developer documentation, and built-in Interface Builder, an application used to construct graphical user interfaces, without the need to write a lot of code lines. The resulting interface is saved in a *.nib* file or, *.xib* file in the latest version as show the figure 3.1.

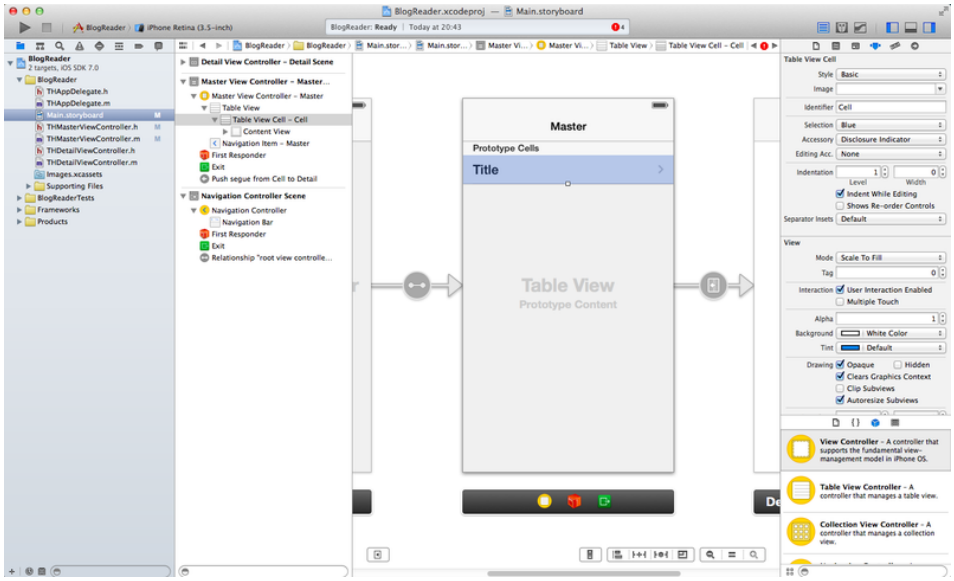


Figure 3.1: Xcode 5.0.2 inteface on Mac OS X 10.9

This development environment was chosen because it is the ideal tool for iOS applications. It is very easy to learn and fast both during the code development and during interface development. Furthermore, by providing a simulator, was using in the application test phase.

3.2 Architecture

As previously said, the system is composed of several logical layers which are divided into specific modules. Figure 3.2 illustrates the different components of the software architecture with the corresponding logical connections.

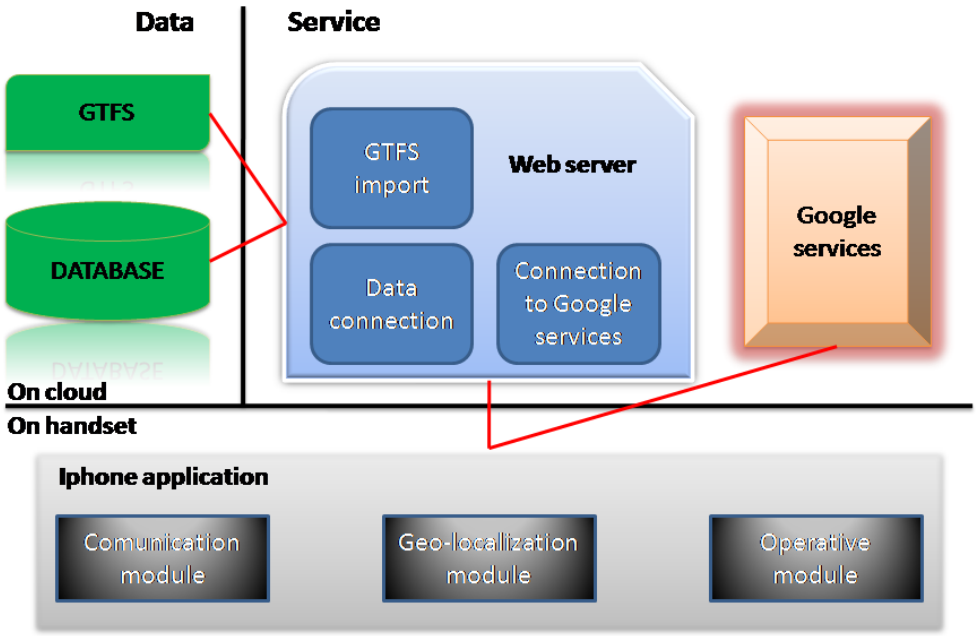


Figure 3.2: Software architecture

We can divide the software architecture into two macro-section, on cloud and on handset. First part contains the data and the services while the second part contains the on handset module that allow the application to interface and exchanging data with the on cloud services when the user request it.

Web server are important module because provide the connection between the application and the GTFS data or between the application and the Google services.

Specifically, Google APIs are used for all the features that require geocoding services (i.e. obtain geographical coordinates starting from the text), or which display the mapping of routes or stops for the portion relating to the trip planning while the demand for places for the part relating to the touristic paths.

Finally, within the application we have used in the tourism section,

other web services (i.e. Panoramio service and dbpedia service) to obtain information about points of interest.

3.2.1 Data

In this section we will analyze in detail the data layer which contains two components: GTFS and DATABASE.

GTFS
GTFS is just a data format that defines a common format for public transportation schedules and associated geographic information [GTF]. Data are sented according to this standard. GTFS "feeds" give an incredible amount of information about a transit system's routes, stops, schedules and trip.

The beauty of it, is that start at very low level through the arrival and departure time of every stops of every bus and thanks to the relational database structure with field and rules that connect tables with primary and foreign keys is possible to obtain any information about trip.

GTFS "feeds" allow public transit agencies to publish their transit data and developers to write applications that consume that data in an interoperable way. This specification defines the following files along with their associated content:

Filename	**Required**	**Defines**
agency.txt	Required	One or more transit agencies that provide the data in this feed.
stops.txt	Required	Individual locations where vehicles pick up or drop off passengers.
routes.txt	Required	Transit routes. A route is a group of trips that are displayed to riders as a single service.
trips.txt	Required	Trips for each route. A trip is a sequence of two or more stops that occurs at specific time.
stop_times.txt	Required	Times that a vehicle arrives at and departs from individual stops for each trip.

calendar.txt	Required	Dates for service IDs using a weekly schedule. Specify when service starts and ends, as well as days of the week where service is available.
calendar_dates.txt	Optional	Exceptions for the service IDs defined in the calendar.txt file. If calendar_dates.txt includes ALL dates of service, this file may be specified instead of calendar.txt.
fare_attributes.txt	Optional	Fare information for a transit organization's routes.
fare_rules.txt	Optional	Rules for applying fare information for a transit organization's routes.
shapes.txt	Optional	Rules for drawing lines on a map to represent a transit organization's routes.
frequencies.txt	Optional	Headway (time between trips) for routes with variable frequency of service.
transfers.txt	Optional	Rules for making connections at transfer points between routes.
feed_info.txt	Optional	Additional information about the feed itself, including publisher, version, and expiration information.

Table 3.1: GTFS files specification

DATABASE

Following the standard General Transit Feed Specification (GTFS) described in the previous paragraph the data related to a single service provider (public transport company), composed of several tables (see table 3.1) in text format CSV (Comma Separated Values), are grouped into a single archive compressed made available in a particular folder on a server of the service provider. The site[1] provides the transit agencies that upload GTFS Data in all the world and their recent uploads.

The web server, through the use of a program written in the Java language, downloads the GTFS archive directly from the provider's

[1] `http://www.gtfs-data-exchange.com`

server, the archive is unpacked in the original csv file which is processed one by one and imported into Mysql database server.

Since the data sources are the same that Google uses for its visualization inside a web-browser the consistency of information between the results obtained from query to the locally database and the geographic services provided by Google is guaranteed.

The structure of the database, only for required files, is presented in figure 3.3. Each table displays the equivalent CSV file format GTFS, are also made explicit the logical relationships between the different tables by using the relation module [AA05].

3.3 Google services

Google Maps is a web mapping service application and technology provided by Google. Many map-based services, including the Google Maps website, Google Directions, Google Place are powered by Google.

These web services use HTTP requests to specific URLs, passing URL parameters as arguments to the services. Generally, these services return data in the HTTP request as either JSON or XML for parsing and/or processing by the application, in our case the data are JSON format, is an open standard format that uses human-readable text to transmit data objects consisting of attribute-value pairs.

The Maps API Web Services used within the application are:

Maps API: to view into the map the nearby stops in a certain radius.

Directions API: with the aim to create the path for the trip planning with public transport company

Geocoding API: reverse geocoding with the goal of converting geographic coordinates into a city address.

Places API: with the goal to search the points of interest for the tourist trip. In this part two requests have been used : 1) *Text Search* returns information about a place based on a string 2) *Place Details* returns more information about the indicated place such as its complete address, phone number, user rating and reviews.

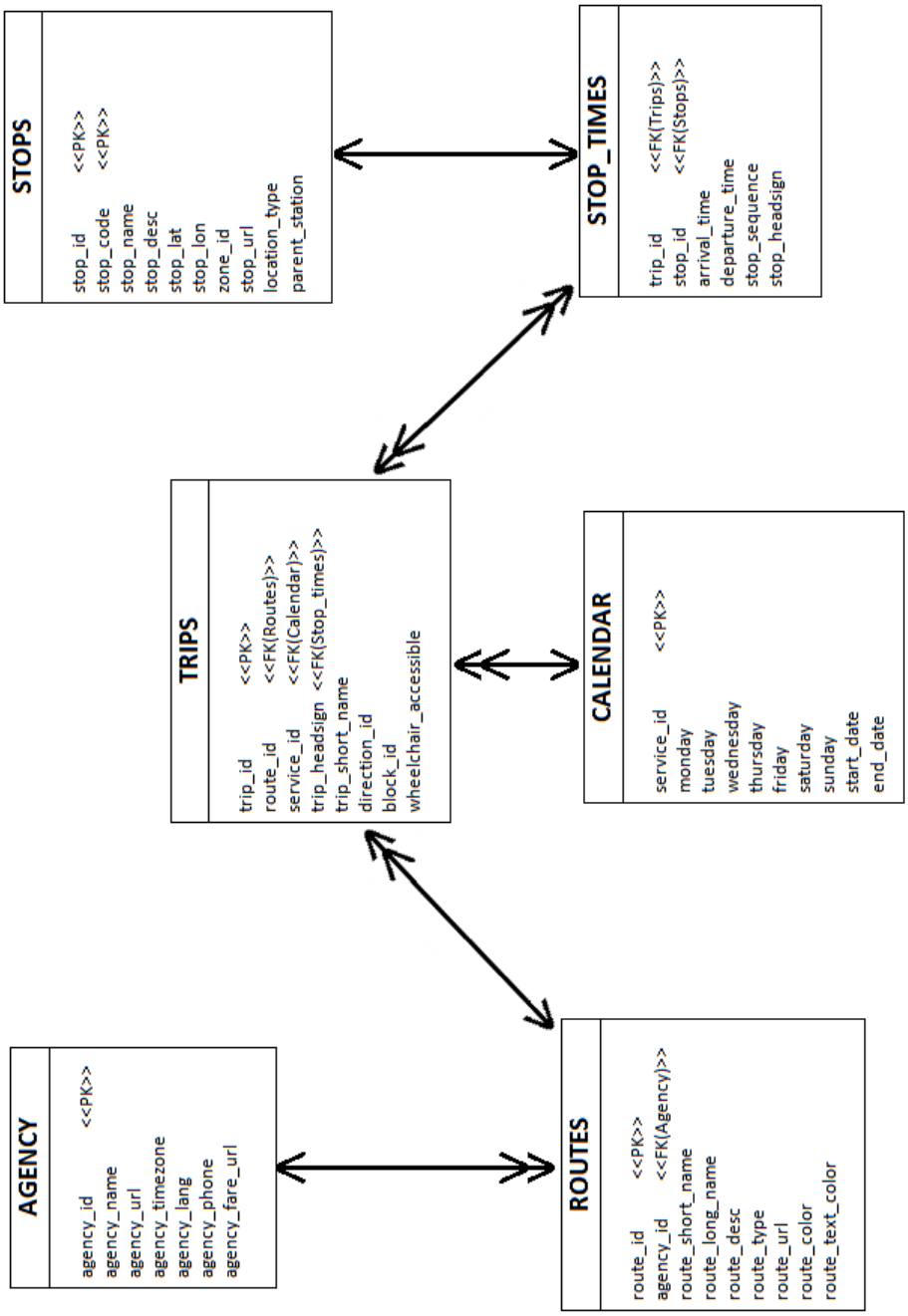


Figure 3.3: GTFS database architecture

3.4 Web server

The web server used into my local machine are MAMP[2], the abbreviation "MAMP" stands for: Macintosh, Apache, MySQL and PHP.
The created database provides such a data source for the services contained in the web server Apache. In this project five services have been realized:

- **Stops list**
- **Stops list into a map**
- **Map of the trip**
- **Stops list for feedback**
- **Stop time for feedback**

The services listed above were created by using PHP, SQL query and JAVASCRIPT language program.

The *Stops list*, *Stops list for feedback* and *Stop time for feedback* services provides as a final result a list of data in JSON format text, the same format as used in the response of Google's services; while in the other services, a web page with a Google map is returned. The stops with markers for *Stops list into a map* on the contrary the connecting lines for the required route are displayed for *Map of the trip*.

The following paragraphs describe the different services.

3.4.1 Stops list

This service receives from the iphone application an HTTP request using the POST method and responds with a JSON text format. The input parameters are:

- Starting point (latitude and longitude)
- Distance (meters or miles)
- Transport company (identify)
- Limit (maximum numer of result)
- Unit of measure (metric or imperial)
- Sorting (by name or by distance)

The paramters which are mandatory are: starting point, transport company, unit of measure and sorting type. The outcome of a call without parameters return null results. The remaining parameters are

[2] `http://www.mamp.info/en/index.html`

optional, but they provide aid in the accuracy and precision of the results.

The service has been implemented as a PHP page which performs a query to the local database and then encoding the result in JSON format before returning to the application.

Listing 3.1 shows the definition of the method in objective-C to call the service:

Listing 3.1: Get stop method

```
1 - (void) getStopsWithLat: (NSString*)lat  Lon:(NSString*)lon
    Dist:(int)dist  AgencyGlobalId:(NSString*)agid  Limit:(int)
    lim isMetric:(BOOL)ism  byName:(BOOL)byn;
```

3.4.2 Stops list into a map

This service receives from the iphone application an HTTP request using the POST method and responds with a Google map that contains a placeholder for each stops. The input parameters are:

- Starting point (latitude and longitude)
- Distance (meters or miles)
- Transport company (identify)
- Limit (maximum numer of result)
- Unit of measure (metric or imperial)

Mandatory and optional parameters are the same of the previous service. The service has been implemented as a PHP page which performs a query to the local database, the result is stored into a javascript variable.

Through the use of Google APIs the google maps markers are created. They correspond to the user's current location and the stops satisfying the condition of the search. Markers are finally placed in the map that is centered and zoomed in an appropriate manner, it is possible for a better view of other points to zoom out or zoom in the display area.

Listing 3.2 shows the definition of the method in objective-C to call the service:

Listing 3.2: Get stop list into map method

```
1 - (void) getStopsPostWithStringWithLat: (NSString*) lat  Lon:(
    NSString*) lon  Dist:(int) dist  AgencyGlobalId:(NSString*)
    agid Limit:(int)lim isMetric:(BOOL)ism byName:(BOOL)byn;
```

As a final step, in these service was used the framework JSBRIDGE[3] that consists in a lightweight API for iPhone to call Objective-C code from Javascript in a UIWebView. A Javascript code is provided, which is able to communicate to an extension of Cocoa's UIWebview.

3.4.3 Map of the trip

This service receives an HTTP request using GET method and returns a web page containing a map with a marker at the point of departure, intermediate and arrival, drawing with different colors the steps depending on the type of transport (walking, bus, metro etc.).

The input parameters are:

- List of the starting points of the step with different means
- List of the types of means
- List of the drawn lines
- End point (latitude and longitude)

All parameters are required since the goal of the service is to draw on the map the points and paths received previously from Google Directions service.
The service has been implemented as a PHP page which performs the decoding of the input parameters received and creates corresponding markers and pathways. Finally all objects are placed in the map that is centered and zoomed in an appropriate manner.

3.4.4 Stops list for feedback

This service receives an HTTP request using the POST method and responds with a JSON text format. The input parameter is only the transport company (identify). Results are the stops id and stops name list of the requested transport company.

3.4.5 Stop time for feedback

This service receives an HTTP request using the POST method and responds with a JSON text format. The input parameter is only the stop id. Results are the arrival time list of the input parameter.

[3] `http://code.google.com/p/jsbridge-to-cocoa/`

Both the services 3.4.4 and 3.4.5 has been implemented as a PHP page which performs a query to the local database and then encoding the result in JSON format before returning to the application.

3.5 Other services

In order to collect information to be presented to the user we use also the following data source: Panoramio and DBpedia.

3.5.1 Panoramio

Panoramio is a geolocation-oriented photo sharing website[4]. This website managed by the community with the goal to learn places across photographs. Photos uploaded by registered users, after having placed on Google Maps, are visible on the same and in Panoramio. By using Panoramio API[5] it is possible to view the images that are in Panoramio into the iphone application. These photos are useful information to enrich and illustrate the location where the user is located.

It is possible by using the Google Geocoding API with the reverse geocoding. The application convert the geographic coordinates of the user into a city string used into the Panoramio request.

Listing 3.3: Panoramio iframe request with Venice tag

```
1 <iframe
2  src="http://www.panoramio.com/wapi/template/photo_list.html?
       amp;width=300&amp;height=270&amp;tag=Venice&amp;list_size=5&
       amp;position=bottom&amp"
3  frameborder ="0" width="300" height="270" scrolling="no"
       marginwidth="0" marginheight="0">
4 </iframe>
```

The image 3.4 shows the result images after the request sent to Panoramio by using the code present in listing 3.3. Should be taken into consideration that some pictures may not reflect the place, for example due to the wrong tag, since this is the only parameter used to search photos.

[4]Available without any registration

[5]`http://www.panoramio.com/api/widget/api.html`

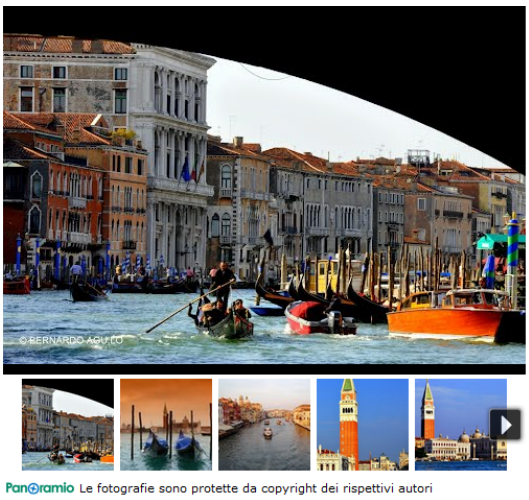


Figure 3.4: Panoramio API result

3.5.2 DBpedia

DBpedia[6] is a crowd-sourced community effort to extract structured information and interlinked it from Wikipedia and other various data sources and make this information available on the Web. As describe in [CB09b] the DBpedia project extracts a structured information; such as links to external Web pages, redirects between pages and links across different language editions, from Wikipedia and turns it into a rich knowledge base. DBpedia is based on linked data[7] (often capitalized as Linked Data) that describe a method of publishing structured data so that they can be interlinked and become more useful. This allows data from different sources to be connected.

Through publishing Linked Data, numerous individuals and groups have contributed to the building of a Web of Data which can reuse and integration of data from multiple and heterogeneous sources.
Just as traditional Web browsers allow users to navigate between HTML pages by following hypertext links, Linked Data browsers allow users to navigate between data sources by following links expressed as RDF[8] triples. Linked Data has the potential to enable a revolution in how data is accessed and utilised [CB09a].

The figure 3.5 represents Linking Open Data cloud diagram[9] and

[6] `http://dbpedia.org/About`
[7] `http://linkeddata.org/`
[8] W3C specifications
[9] Richard Cyganiak and Anja Jentzsch. `http://lod-cloud.net/`

gives an overview of some of these data sources:

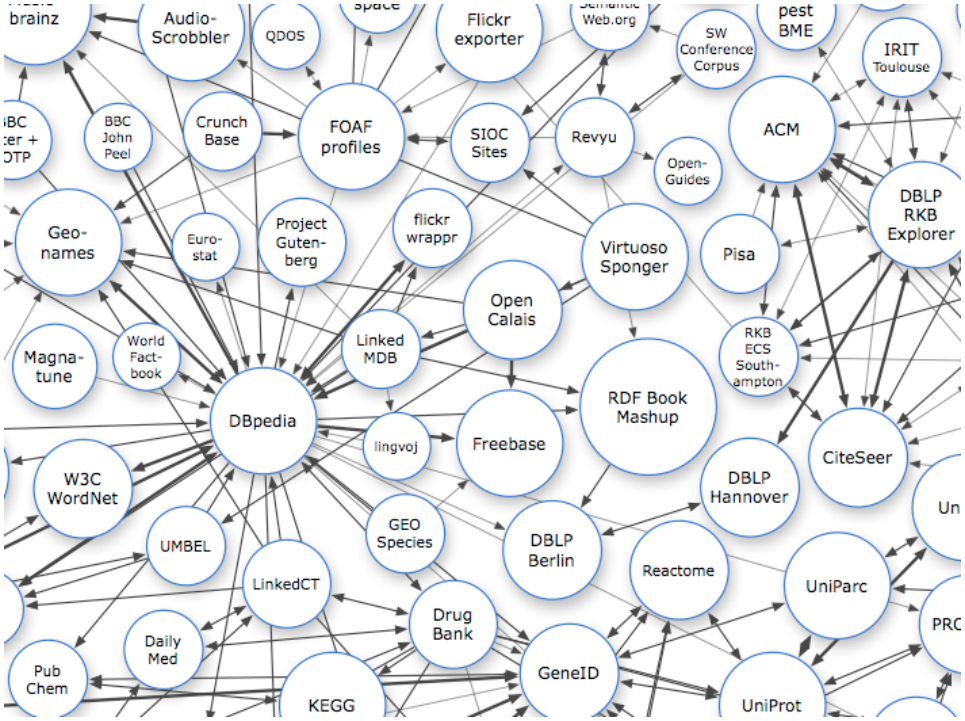


Figure 3.5: Part of the Linking Open Data (LOD) into DBpedia

In our application, the linked data are used to extract information from the web without the use of internal data structures or other static information. Specifically, we used the DBpedia database to find details on points of interest to visit for tourists. This allows on find the information for free (if available); it is worth noticing that given the enormous amount of information in these datasets, the drawback is that some information may not be interconnected and therefore missed.

In order to enable DBpedia users to discover further information, the DBpedia knowledge base is interlinked with various other data sources on the Web according to the Linked Data principles listed below:

1. Use URIs to denote things
2. Use HTTP URIs so that these things can be referred to and looked up by people
3. Provide useful information about the thing when its URI is dereferenced

4. Include links to other related things (using their URIs) when publishing data on the Web

The linked data principles provide a framework, however do not tell about implementation details. Several phrases are kept deliberately rather generic and this fact suggests that additional advises are needed to actually be able to use linked data in a practical setup.

3.6 Iphone application

The main part of the software development carried out for the project lies in the application for Iphone. Since it is an application addressed to tourists it has been developed to support multiple languages. As mentioned earlier, we can divide the application into two sections: trip planning and tourist trip.

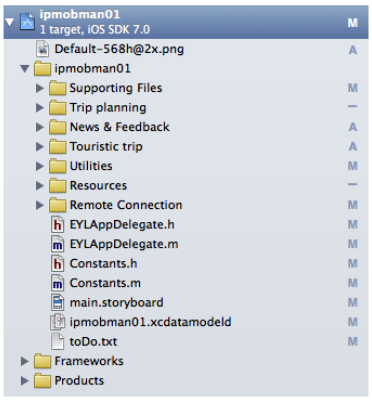


Figure 3.6: Hierarchical Ipmobman software structure

The software has a hierarchical structures as shown in figure 3.6. The main classes are collected in *Remote connection* where we can find utility and management of remote connection by using Core Location Framework[10] , *Touristic trip*, *Trip planning* and *News & Feedback*. Finally i have collected into *Resources* the icons used to application.

3.6.1 Core Location Framework

The Core Location framework allows you to determine the current location or direction associated with a device by using the available hardware. The developer can use the classes and protocols in this framework

[10]Allows you to determine the current location or direction associated with a device

to configure and schedule the delivery of location and heading events. Other possibility is to use it to define geographic regions and monitor when the user crosses the boundaries of those regions.

3.6.2 Storyboard

Storyboard provide another global graphical vision of the user interface of the iOS application, showing screens of content and the connections between those screens. It is composed of a sequence of scenes, each of which represents a view controller and its views; scenes are connected by *segue objects*, which represent a transition between two view controllers as shown in figure 3.7.

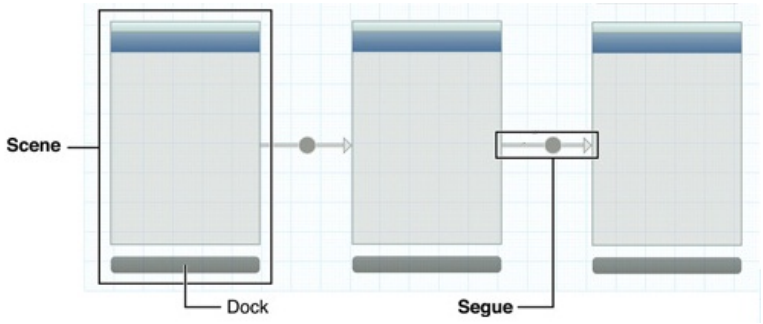


Figure 3.7: Storyboard

The figure 3.8 provides a graphical view of the feedback scene composed with a *View Controller* that contains two key objects such as *Text Field* and *Button*.

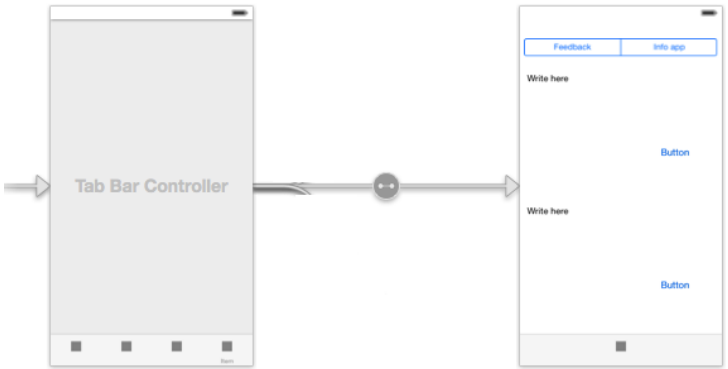


Figure 3.8: Storyboard of feedback

News scenes are composed as shown in figure 3.9 by a *Table view*

controller that display the news list and a *UIwebView* that visualize the news selected.

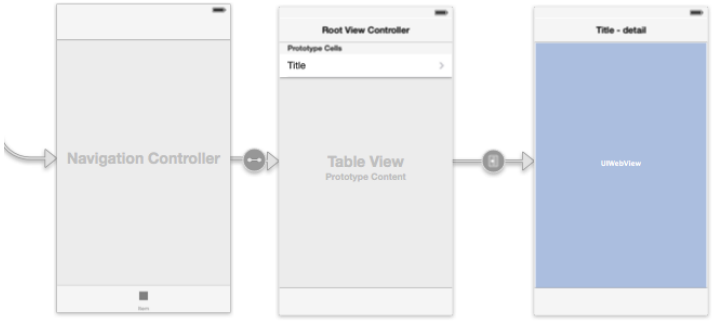


Figure 3.9: Storyboard of news

Trip planning section are more complex and its shown in figure 3.10. In **START** scene the user can select the starting and ending points, the time and date of trip. The **A** scene composed by *UIDatePicker* allow the selection of time and date. **B** scene permit to select one stop by

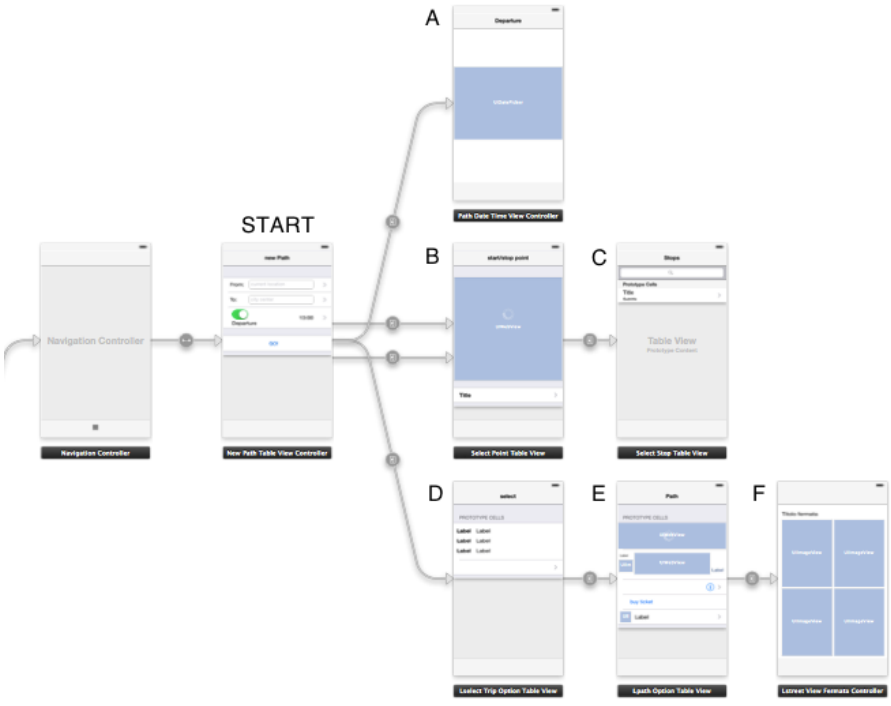


Figure 3.10: Storyboard of Trip planning

visualizing the map of the city into a *UIwebView*. On the contrary on

C scene the stops list are displayed to the user into a *Table view controller*. The possible route solution are displayed into **D** scene, instead **E** scene illustrates trip detail which shown the means of transport, the time duration and other information. Finally, the last **F** scene, permit to visualize from four different *UIwebView* the nearby image of one selected stop.

Figure 3.11 shown the storyboard tourist trip section. In **START** scene the user can select the category of the trip. **B** scene display into *UIwebView* some city images, by **C** scene the user can set the number of days. The possible itineraries are displayed with *Table view controller* into **D** scene after the POI lists are shown in **E** scene. **G** and **H** scene permit to get the trip between two points of interest. Finally, the last **F** scene, permit to visualize more information about the POI selected from the user.

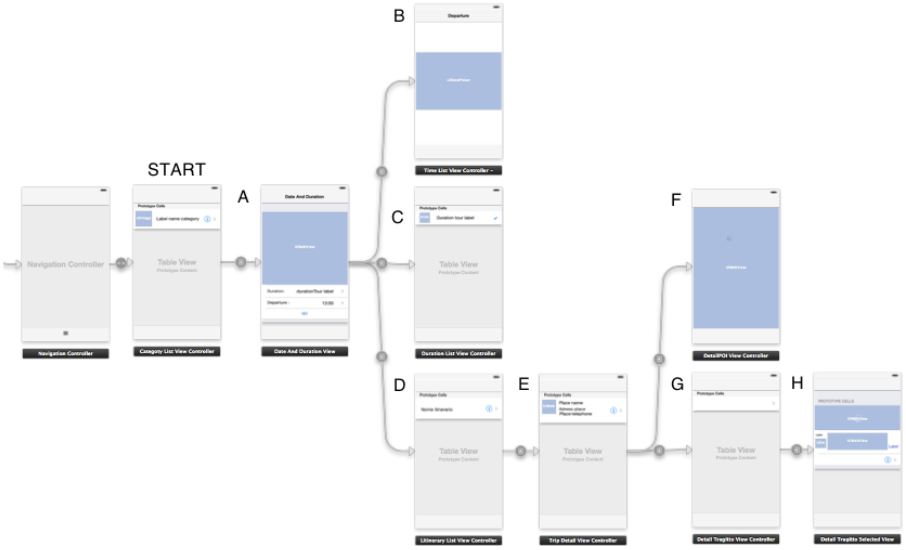


Figure 3.11: Storyboard of Trip planning

Chapter 4

SPECIFIC REQUIREMENTS

The idea of the project is to have an application dedicated to the search, selection, planning a route by using mainly public transport.

Specifically, the idea is that a user is able to request which are the nearby bus stops, to select a starting point and ending point and to get the route options that provide for trips on foot besides those with public transport.

Another interesting part of the software is dedicated to tourists who are suggested itineraries with points of interest. The tourist can choose a tour concerning different preferences: Art & Culture, Nature, Relax, Enjoy. Once selected one of these categories the application will show several tours and it will guide the tourist along the path. providing information about the points of interest and by proposing time to time the most appropriate means of transport.

For all users there is the possibility to leave feedback on the services of transport used and thus interacting with the service provider. On the side of the service provider the application can provide statistical data on the routes and on the satisfaction of the customers.

In order to analyze the above mentioned features, in this chapter I will describe the requirements, as cited in [Som07]: the requirements for a system are the description of the services provided by the system and its operational constraints. These requirements reflect the needs of customers for a system that helps solve some problem.

Software system requirements are classifield as **functional requirements** (FR) which describe the services and the features of the appli-

cation or **non functional requirements** (NFR) which describe the constrains on product and process development.

In the following paragraphs the functional/non-functional requirements, the requirements specification and the use cases are presented in detail.

4.1 Functional requirements

In this section there is a list of the functional requirements of the application that will be explained. The functional requirements define all the operations that the user can perform with the software in question, for each one will be provided with the following information:

Code	A short string identifying the requirement, in the form FRX.Y, where FR stands for functional requirement, X is a character that can be "P" indicating trip planning section or "T" indicating tourism section or "O" indicating that is related to application, Y is a sequential number
Definition	The definition of the requirement, summary in natural language
Motivation	Brief explanation of the reason for the requirement
Specify	Identifying string of the specific requirement described

Code	FRM.1
Definition	Select starting point
Motivation	The user want to select the starting point by inserting the address of the place
Specify	SFRM.1

Table 4.1: FRM.1

Code	FRM.2
Definition	Select ending point
Motivation	The user want to select the ending point by inserting the address of the place
Specify	SFRM.1

Table 4.2: FRM.2

Code	FRM.3
Definition	Create route depending on a certain time
Motivation	The user want create route at any preferred time and not only in the present moment
Specify	SFRM.2

Table 4.3: FRM.3

Code	FRM.4
Definition	See the position on the map
Motivation	The user want to see his/her current position on the map
Specify	SFRM.3

Table 4.4: FRM.4

Code	FRM.5
Definition	Select one stop from a list
Motivation	Possibility to select the stop from an alphabetically ordered stops list
Specify	SFRM.4

Table 4.5: FRM.5

Code	FRM.6
Definition	Select one stop from a map
Motivation	Possibility to select the nearby stop from a map
Specify	SFRM.3

Table 4.6: FRM.6

Code	FRM.7
Definition	Select one possible route from a list
Motivation	The user want to select the preferred route from an options list
Specify	SFRM.5

Table 4.7: FRM.7

Code	FRM.8
Definition	Visualize the trip
Motivation	The user want to visualize the trip detail
Specify	SFRM.6

Table 4.8: FRM.8

Code	FRM.9
Definition	Visualize the stop image
Motivation	The user want to visualize the nearbly stop images
Specify	SFRM.7

Table 4.9: FRM.9

Code	FRT.10
Definition	Select tour category
Motivation	The user can select the tour category among four options
Specify	SFRT.8

Table 4.10: FRT.10

Code	FRT.11
Definition	Select tour duration
Motivation	The user want to select the tour duration
Specify	SFRT.9

Table 4.11: FRT.11

Code	FRT.12
Definition	Visualize the itineraries
Motivation	The user can activate the tour and visualize the itineraries of the selected category
Specify	SFRT.10

Table 4.12: FRT.12

Code	FRT.13
Definition	Select point of interest
Motivation	The user can select one point of interest and visualize some detail information
Specify	SRFT.11

Table 4.13: FRT.13

Code	FRT.14
Definition	Ruote between points
Motivation	The user can select the route between points of interest
Specify	SFRT.5

Table 4.14: FR4T.14

Code	FRO.15
Definition	News
Motivation	The user want to keeps informed about the public transport, traffic and viability
Specify	SFRO.12

Table 4.15: FRO.15

Code	FRO.16
Definition	Send feedback
Motivation	The user want to send feedback in order to communicate a disservice or malfunction
Specify	SFRO.13

Table 4.16: FRO.16

4.2 Non functional requirements

Non functional requirements are not directly concerned with the specific functions delivered by the system. For example they may related to response timing constrains, store occupacy or connection web service. There exists a hierarchical structure of these requirements where on the top of the pyramid we can found **Product requirements**, **Organisational requirements** and **External requirements** [Som07].

Product requirements specify product behaviour for example the performance on how the system must execute, usability requirements, how much memory the system requires.

I will examine only the product requirements and for each the following information is provided:

Code	A short string identifying the requirement, in the form NFR.Y, where NFR stands for non functional requirement, Y is a sequential number
Definition	The definition of the requirement in natural language
Scope	Explanation of the purpose for which the requirement was elaborated
Type	Definition of the type of non functional requirement

Code	NFR.1
Definition	Create trip planning
Scope	The user must be able to create a trip planning in few minutes because the system are easy of learning and use
Type	Requirement of usability and performance

Table 4.17: NFR.1

Code	NFR.2
Definition	Create tourist trip
Scope	The user must be able to create a tourist trip in few minutes because the system are easy of learning and use
Type	Requirement of usability and performance

Table 4.18: NFR.2

Code	NFR.3
Definition	Connect to the web
Scope	The application must be connected to the web for creating trip and finding information about the points of interest
Type	Requirement of reliability

Table 4.19: NFR.3

Code	NFR.4
Definition	iOS system
Scope	The application must run only in iOS system
Type	Requirement of portability

Table 4.20: NFR.4

Code	NFR.5
Definition	GTFS database
Scope	The application are connected with a GTFS database to provide to the user the stops list
Type	Requirement of reliability

Table 4.21: NFR.5

4.3 Requirements specifications

This section deals with a precise and detailed description of the functionalities of the system. The specifications help to avoid duplication and inconsistencies, allow accurate estimates of the work and resources needed and provide guidance to testers for verification of each technical requirement.

Code	SFRM.1
Inputs	The user wants to enter an address
Outputs	The address is placed inside a textfield
Pre-conditions	The user are in the starting page of trip planning view
Post-conditions	The user enters the desired address by using the virtual keyboard

Table 4.22: SFRM.1

Code	SFRM.2
Inputs	The user wants to set the departure time
Outputs	The time is placed inside a label
Pre-conditions	The user are in the starting page of trip planning view
Post-conditions	The user selects the desired date and time

Table 4.23: SFRM.2

Code	SFRM.3
Inputs	The user wants to select the stop from a map
Outputs	The stop name is placed inside a label
Pre-conditions	The app is connected to the web
Post-conditions	The user visualizes on a map where s/he is and the nearby stops

Table 4.24: SFRM.3

Code	SFRM.4
Inputs	The user wants to select the stop from a list
Outputs	The stop address is placed inside a label
Pre-conditions	The app is connected to the web
Post-conditions	The user visualizes the stops list and s/he can select one stop

Table 4.25: SFRM.4

Code	SFRM.5
Inputs	The user wants to select one route from a list
Outputs	The route list are visualized
Pre-conditions	Start or end address have been selected
Post-conditions	The user visualizes the route list and s/he can select one stop

Table 4.26: SFRM.5

Code	SFRM.6
Inputs	The user wants to see trip detail
Outputs	Trip detail are visualized
Pre-conditions	The user have been selected one route option
Post-conditions	The user visualize the trip details which illustrates the means of transportation, the time duration and other information connected to the different stops

Table 4.27: SFRM.6

Code	SFRM.7
Inputs	The user wants to see stop images
Outputs	Stops image are visualized
Pre-conditions	One stop from the trip detail view have been selected
Post-conditions	The user visualize four stop nearby images

Table 4.28: SFRM.7

Code	SFRT.8
Inputs	The user can select the category of the tour
Outputs	The categories are displayed on a list
Pre-conditions	-
Post-conditions	The user selects only one category

Table 4.29: SFRT.8

Code	SFRT.9
Inputs	The user can select the duration of the tour
Outputs	The durations are displayed on a list
Pre-conditions	-
Post-conditions	The user selects only one possibility

Table 4.30: SFRT.9

Code	SFRT.10
Inputs	The user can activate the tour
Outputs	The itineraries are displayed with a list of points of interest
Pre-conditions	Category and duration tour have been selected
Post-conditions	The user activates the tour

Table 4.31: SFRT.10

Code	SFRT.11
Inputs	The user can see the detail of points of interest
Outputs	The detail are displayed (photos and information)
Pre-conditions	The app is connected to the web and the data source are available
Post-conditions	The user visualizes the details of the points of interest

Table 4.32: SFRT.11

Code	SFRO.12
Inputs	The user wants to see the news
Outputs	The news are displayed on a list
Pre-conditions	The news are published and the app is connected to the web
Post-conditions	The user visualizes the published news

Table 4.33: SFRO.12

Code	SFRO.13
Inputs	The user wants to send feedback
Outputs	The feedback are sent to the travel company
Pre-conditions	The app is connected to the web
Post-conditions	The company receives the feedback

Table 4.34: SFRO.13

4.4 Use cases

This section presents the main and most representative (more complex) use cases of the application according to the standard UML (Unified Modeling Language).

As specified in [Pre08] a use case is a briefly history which the user interacts with the application. Use cases diagram are used to represent the high-level use cases, by emphasizing the actors and interactions with the entity (in this case the application). Use cases and relative use cases diagram have been reported involving the request for a new trip planning and functionality of the Tourism trip.

4.4.1 Trip planning

This use case represents the creation of a trip planning by using only public transport (bus, tram, etc.) and the possibility to go on foot. It will lead the user from a point of departure to a point of arrival, both selected by himself/herself and also being able to choose a favorite time of departure/arrival.

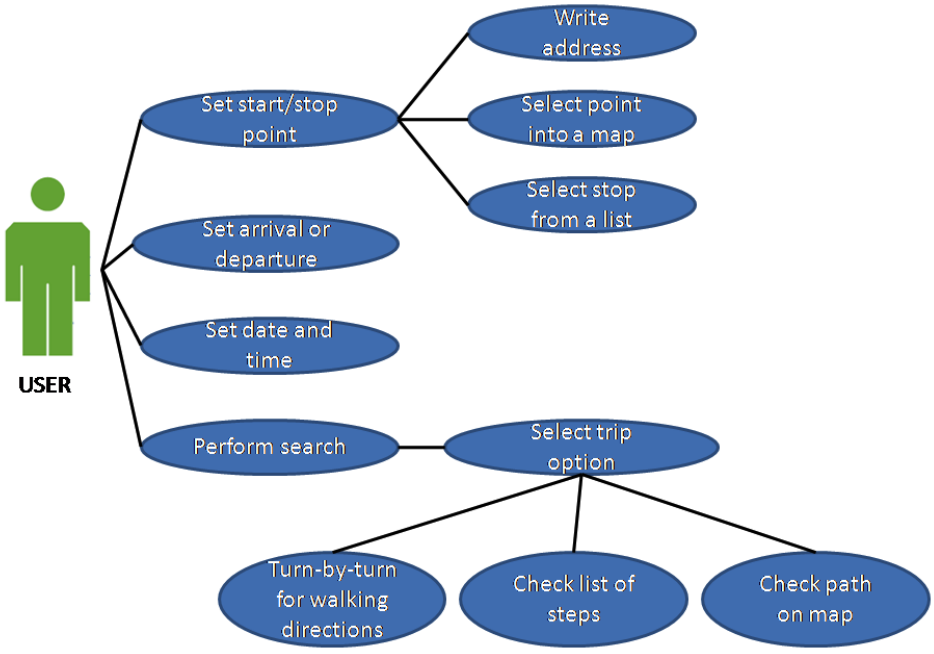


Figure 4.1: Trip planning use case diagram

The user can select the point of departure and arrival in many ways: by writing the address, by the visual selection of the various

stops present into a map or directly through the visualization of the stop list which contains all the stops in the town. After the setting of all the various mandatory fields, the system proposes some possible routes that the user can select.

After selecting the desired path option, this is displayed to the user in a graphical manner both on the map and as a list of steps, each having the main indications for each type of means (i.e. bus with time and number, on foot the route to be followed, etc..).

Figure 4.1 shown the use case diagram for the trip planning use case.

4.4.2 Tourism trip

This second use case concerning the functionality tourism offers users without tourist information to make a guided tour to the most interesting areas through the use of public transport.

The system allows the user to select the type of tour desired and the duration (half a day, one day or more days).

Once activated the tour the system guides the user step by step indicating the means to take or how to get to the place.

Figure 4.2 shown the use case diagram for the tourism trip use case.

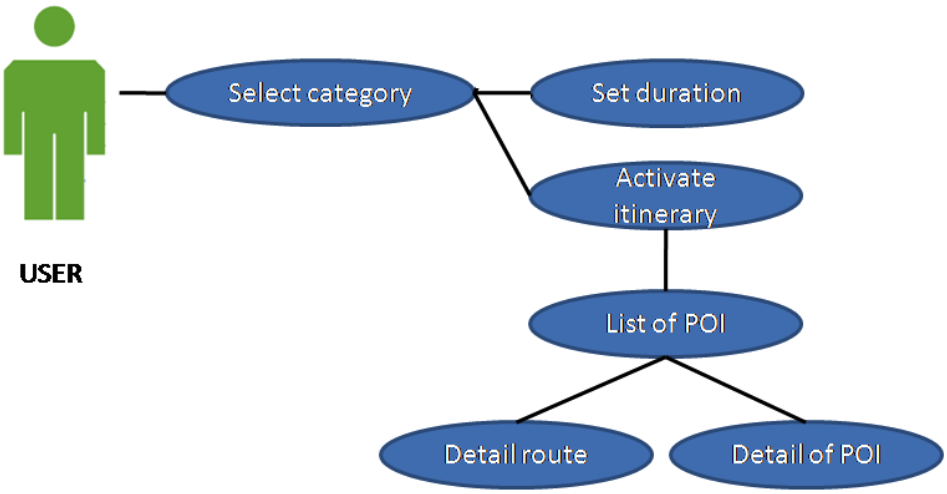


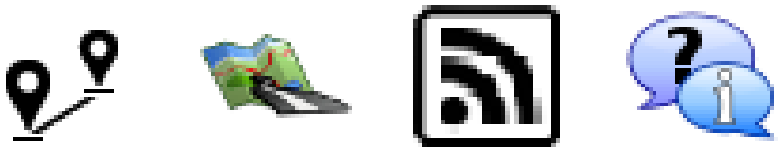
Figure 4.2: Tourism trip use case diagram

Chapter 5

USER INTERFACE

In this chapter I will emphasize the relation between application and final user, normally defined as user interface.

The user interface refers to the information (such as graphic, text and sound) the application presents to the user, and the control sequences (such as keystrokes with the virtualkeyboard, or selections with the touchscreen) the final user to interact with the application.
In the figure 5.1 are shown the features icon, trip planning is represented by two points and one line that indicate the path, a map wwith a route symbolize the tourist trip, News are represented by rss icon and finally the feedback icon are represented with a question and exclamation mark.



(a) Trip planning (b) Tourist trip (c) News (d) Feedback

Figure 5.1: Features icon

The user through the utilization of these symbols within the application is able to easily distinguish and without efffort the different features. Now I will present for each feature the steps that the user can make through the device to achieve his goal such as create a trip planing, follow a touristic itinerary in the town, read news and finally send feedback.

5.1 Trip planning

Figure 6.1 represents the starting view of trip planning features. The user can set or select some parameters:

- first the **starting point**; if the user does not specify any place the system sets up the current user location
- second the **ending point**; if the user does not specify any place the city center is set by the system
- third the **time** that the user wants to leave or arrive
- fourth the **switch depature/arrival** that sets the time as the starting/arrival time of the trip planning

Note that to retrieve the current user location, we make use of the CoreLocation framework described in Section 3.6.1.

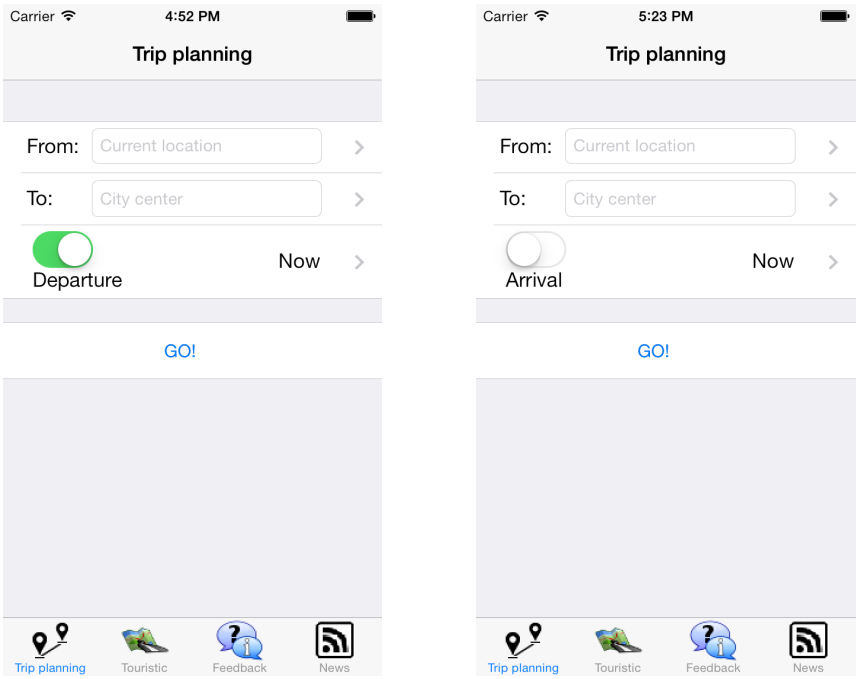


Figure 5.2: Home page trip planning - Switch Departure/Arrival

5.1.1 Time and date

As a first step I'm going to analyze the selection ot the time and the date. UIDatePicker class, that implements an object that uses multiple rotating wheels, is used to allow the user for the selection of

starting/arrival time as shown in Figure 5.3.

Figure 5.3: Selection of date and time

5.1.2 Starting/Ending point

The user has three possibilities to write the desidered address: write a text by using a virtual keyboard, select a stop from a map or finally to select a stop from a list.

The first possibility as shown in Figure 5.4 is to write the location or the address inside the text field by using the virtual keyboard, that is one of the most used functions on the iPhone, which opens automatically whenever we have to type a text.

The second possibility is given by clicking the arrow next to the text field. The user can select a stop from a map. The map and the stop marker are provided from **Map of the trip** (service described in Section 3.4.3) that helps the user with the graphic visualization of the nearly stops.

The application follows some steps. In the first step a request is sent to the mysql database by requiring neighboring stops (according to a certain radius) with the current location (latitude and longitude) of the user.

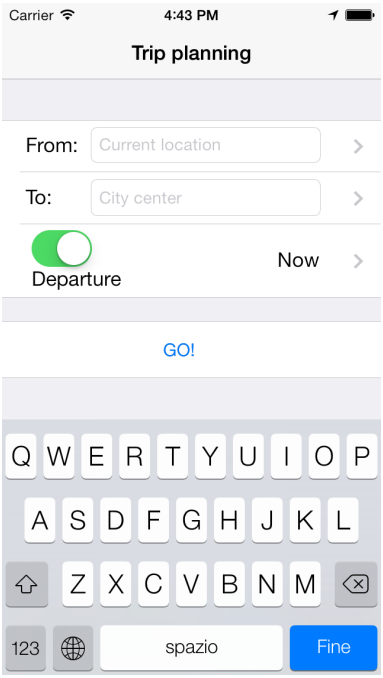


Figure 5.4: Write text with virtual keyboard

In the second step the stops values are stored into an array and by using the JavaScript language a connection to Google maps is made.

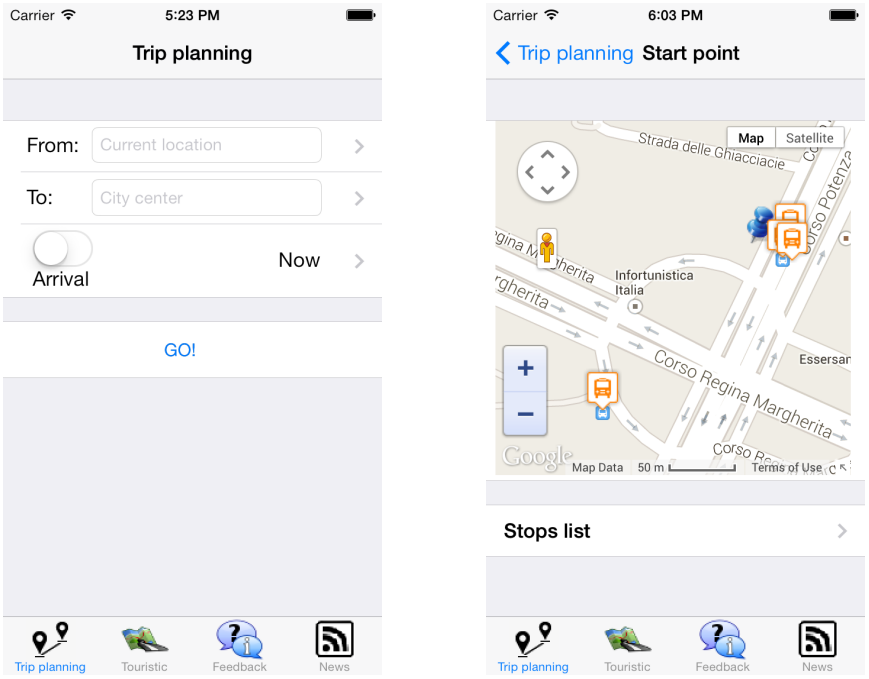
Finally the map is displayed into the device, where the user point with a pushpin (the point where the user is located) and the neighboring stops, with an adeguate icon (e.g. a bus icon in the example shown in Figure 5.5(b)).

Note that the map is the same as that found in a normal web browser and of course it is possible for a better view to zoom out or zoom in the displayed area.

To select a particular stop, just click the wanted marker, the user will see an InfoWindow where the contents (usually text or images) are displayed in a popup window above the map. In this situation the content shown in the InfoWindow is the selected stop name and a link "click here to select" as shown in Figure 5.6(a).

Jsbridge-to-cocoa framework [JSB] is used to communicate between JavaScript and Objective-C languages.

This framework consists of a lightweight api for iPhone to call Objective-C code from JavaScript in a UIWebView. A JavaScript code is provided, which is able to communicate to an extension of Cocoa's UIWebview. The JSBridge does not use any private api.



(a) Starting view (b) Map with stops

Figure 5.5: Select a stop from map

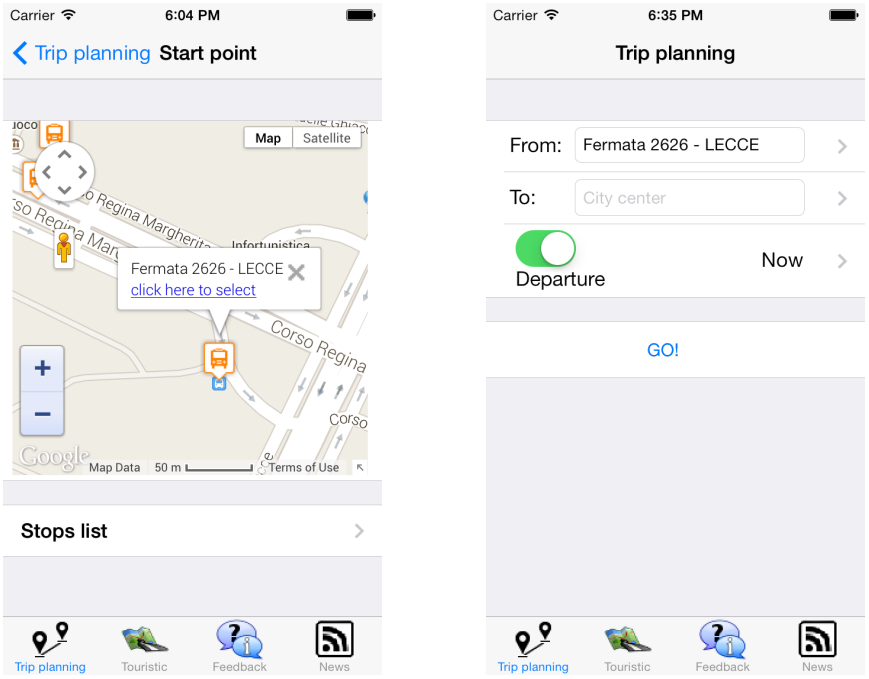
Using this framework, after the click on the link ("click here to select") inside the InfoWindow, the selected stop name is written directly inside the text field as shown in Figure 5.6(b).

The third possibility is to select the stop from a list by clicking the arrow next to the sign "Stops list" as illustrated in Figure 5.6(a). The effect is the visualization of the list of the stops as shown in Figure 5.7(a).

This feature is provided by using a **Stops list** PHP service. The application follows two steps. In the first step a request is sent to the mysql database by requiring stops ordered by name (according to a certain radius) to the current location (latitude and longitude) of the user.

After receiving the stops name list the application stores it into a class called NSDictionary that represents an ordered collection of objects. A key-value pair within a dictionary is called an entry. Each entry consists of one object that represents the key and a second object that is that key's value. Within a dictionary, the keys are unique.

In order to simplify the I have developed a search features that



(a) Markers with InfoWindows (b) After click on the link

Figure 5.6: Example of select stop by the map

allows the user to search the desidered stop as shown in Figure 5.7(b).

As in the previous option the selected stop name is written directly inside the text field as shown in Figure 5.6(b).

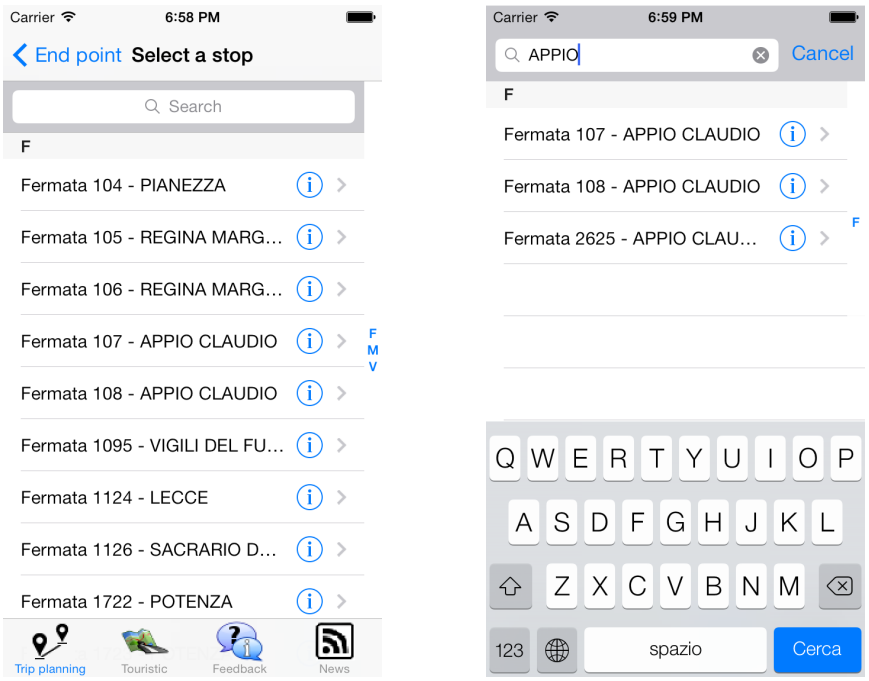
It is worth noting an info button (on the right of the stop name) is available in order to get more information about such a stop.

5.1.3 Trip options

In the previous section the starting view of trip planning has been described. After setting the parameters, **starting point**, **ending points**, **time** and **switch Depature/Arrival**, the application sends an HTTP request to Google Directions API, service that calculates directions between locations. A Directions API request takes the following form:

```
http://maps.googleapis.com/maps/api/directions/output?parameters
```

where output may be either of the following values:



(a) Stops list

(b) Search a stop into the list

Figure 5.7: Example of select stop by the list

• json (recommended) indicates output in JavaScript Object Notation (JSON), used in this project
• xml indicates output as XML

Google gives the possibility to search for directions for several types of transportation, including transit, driving, walking or cycling. Directions may specify as latitude/longitude coordinates or as text strings. The Directions API can return multi-part directions using a series of waypoints.

DA RIFARE IMMAGINE !!!!!

Possible alternative travels returned as answer to the request to the server are displayed in a summary view as shown in Figure 5.8. The application displays in the upper part the departure and arrival points and the time selected while in the lower the trip options. Therefore the user has the possibility to choose among the possible proposed solutions.

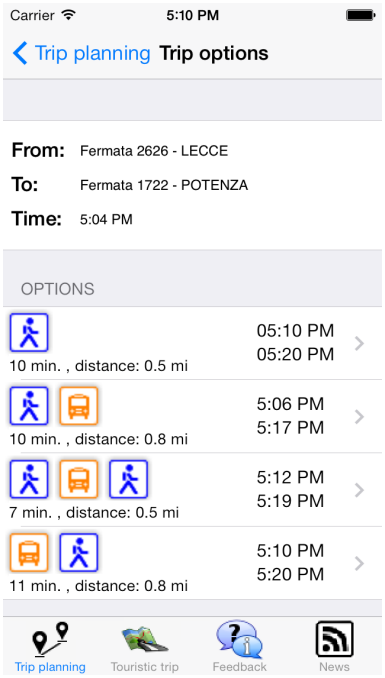


Figure 5.8: Trip options

There are some different types of public transportation means and the corisponding icons are shown in Figure 5.9. The goal is to give immediately an idea of the number and type of means for reaching the user's desired place.

Figure 5.9: Transportation icons, in order : Bus, Metro, Train, Tram, Taxiboat, Walk

It is important to remark that the application provides also the path the user has to do on foot. This is a relevant feature since several application as observed in the state of the art section, specifies only the stop by stop path.

Let us now describe one of the returned path, in particular we analyze the first path in Figure 5.8. It is immediately possible to undestand the composition of the route that consists of walking, bus and again walking.

In order to draw the map "own" PHP service has been used in order to be able to use different maps provider. When options are selected

the application sends an HTTP request to a PHP service: **Map of the trip** that helps the user with the graphic visualization of the route as shown in Figure 5.10.

The starting points list obtained previously is sent to the service through an HTTP request where the latitude and longitude, the means of transport and the polyline of each points are specified, as a result, into the map, markers and lines that connect the points are drawn.

In the following a portion of the HTTP request for drawing lines and markers on the map is reported:

```
/Services/overlayMap.html?0=45.0871,7.6504,W%7C45.0880,7.6520,B ...
```

The detailed screen of the trip contains on the top while a map, at the bottom the sub-route for each point to point connection is illustrated.

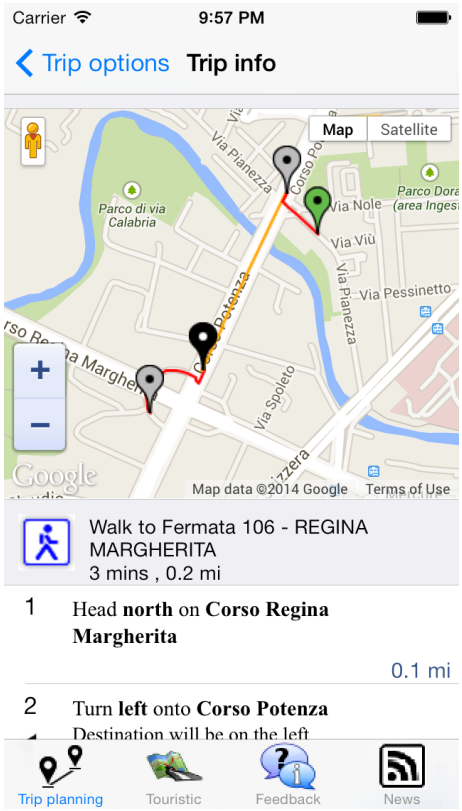


Figure 5.10: Trip info

We can distinguish two types of sub-route description: the first

is the walking paths while the second one concerns the use of public transport.

Walking path route is displayed on the screen so that the user is able to undestand in the shortest possible time the way to go. After an initial summary row, the direction indications to follow, are shown step by step, both in terms of graphics (through the use of directional arrows) both in textual with the description as shown in Figure 5.11.

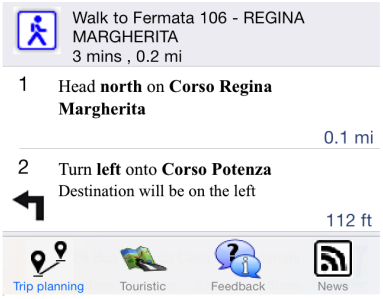


Figure 5.11: Sub route Walking path

On the other hand, the public transport route is composed of three parts. The first one provides the user with a summary of the route to be followed such as tipology of the means, starting/ending time, duration time and number of stops as shown in Figure 5.12. The second one indicates the name of starting and ending stop.

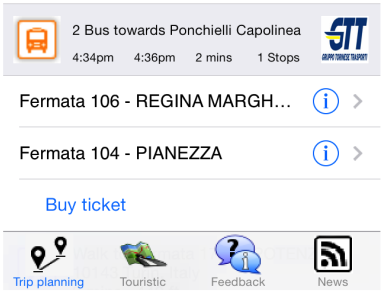


Figure 5.12: Sub route Public transport

Clicking on the stop name the application sends an HTTP request to Google street view. Four images help the user orientation with a 360° panorama about the neighborhood of the stop selected as shown in Figure 5.13.

The third part is tailored to buy on-line ticket for a specific path but it is not active in the current version of the application.

Figure 5.13: Street view of stop

5.2 Tourism itineraries

Initially, I have identify some different types of turism as mountain tourism, cultural tourism, spa tourism, nature tourism.

I have been grouped together the mountain and nature tourism in which these forms of tourism will held in contact with nature, countryside, farm or holidays in protected areas.

Insted the spa tourism it is one of the oldest forms of tourism, the beneficial effect of the water was already known in antiquity. Hydrothermal waters and spa centers are have a strong presence in Italian.

Finally the cultural tourism is that segment whose main motivation is the enrichment and knowledge of different cultures and experiences. It involves countries with a important artistic heritage.

After this research a have insert into the application four possible touristic category: Art & culture, Nature, Relax, Enjoy.

As described previously the user can select an itineraries concernig different preferences. After selected one of these categories the application show severl tours. The user can see in the map the itinerary path and see the list of points of interest. Finally the user can access various kinds information about the points of interest encountered duing the

path.

5.2.1 Starting view

In starting view of tourist trip feature the user can only select one possible category as shown in Figure 5.14.

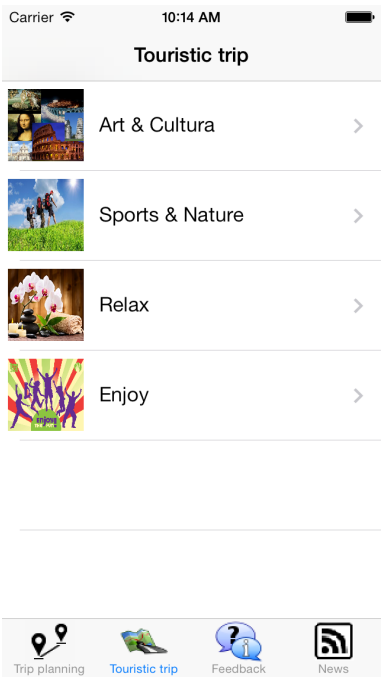
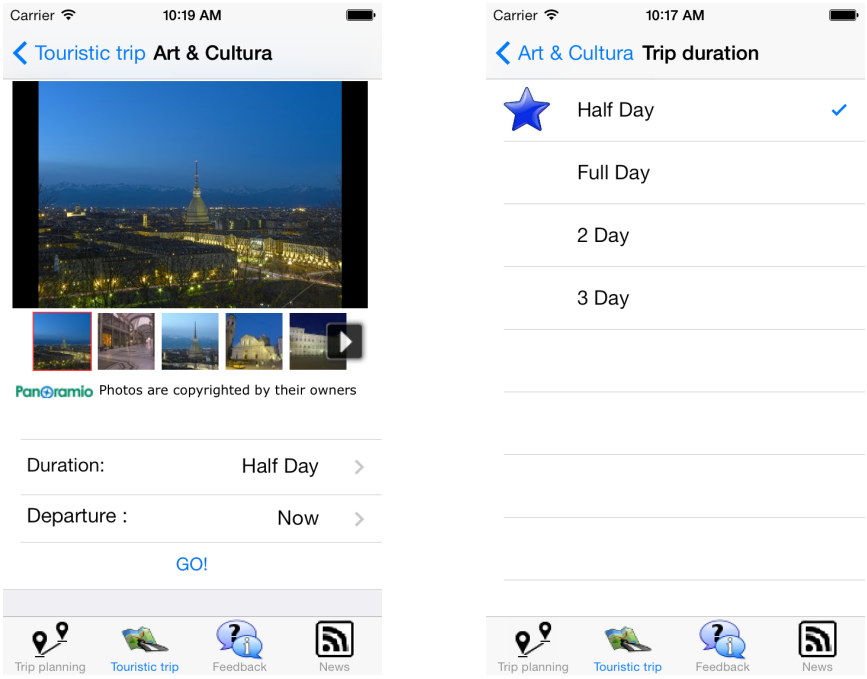


Figure 5.14: Tourist categories

Figure 5.15(a) shown the result image after the request to Panoramio. These photos are useful information to enrich and illustrate the location where the user is located. Another possibility for the user is to select the duration of the tours as shown in Figure 5.15(b). Further possibility is to select the time and date but in this software version these parameters are not keep into account.

According to the tourist's position, the category selected and the numbers of day's s/he inteds to stay at the town the system present different itineraries in order to visit the town. In figure 5.16(a) the user have two possibility, the first one is to select the itinerary and visualize the points of interest associated, the second one, by clicking the info button is to visualize the tour map and a briefly description of the tour as shown in Figure 5.16(b).

After one itinearary is selected, the points of interest list are dis-



(a) Panoramio image (b) Trip duration

Figure 5.15: Tourist duration

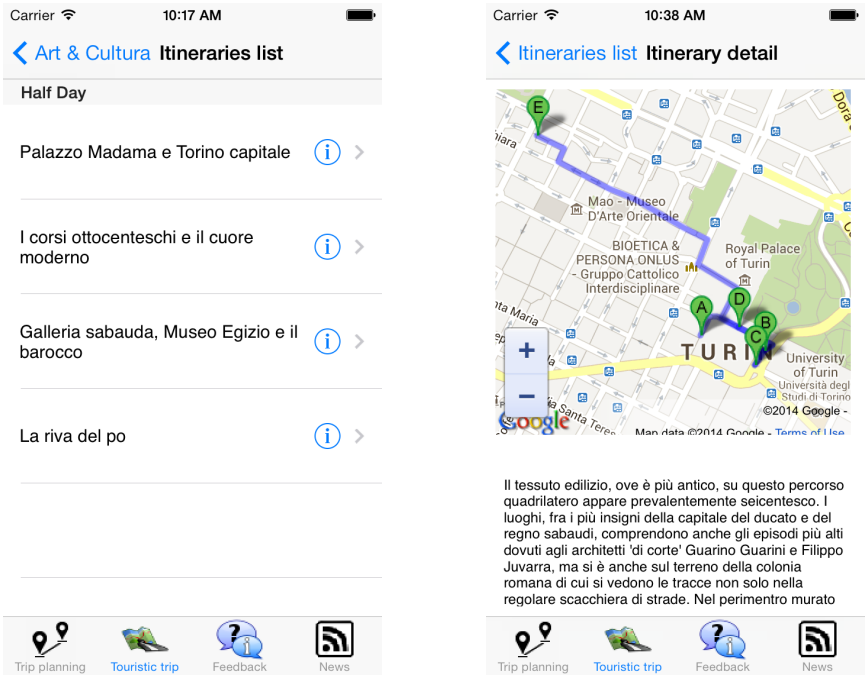
played into the application as shown in Figure 5.17. Each of these contains some information such as the name, the address, the phone number and an icon that represent the POI's tipology derived from the Google Place responce.

The user have two possibility, the first one is to access to various kinds of information about the point of interest selected by using the information button. The details as describe in the previously chapter are obtained from DBpedia as shown in Figure 5.18(a) and/or Wikipedia as shown in Figure 5.18(b). Note that the application provide in real time the information regarding the points of interest.

Finally by selecting one point the application visualize the trip planning option to reach the place as described previously in Section 5.1.3.

5.3 News

Checking the news about the transport company everytime and everywhere is very important. Allows mainly commuters to be updated on possible problems concerning lines interruption, heavy traffic, delays



(a) Itineraries list (b) Map trip

Figure 5.16: Tourist itineraries and map trip

and strikes.

If we want to increase the user satisfaction, we need an RSS feed. The RSS feed keeps users up to date on all of latest comunications from the travel agency. In our case we made a simulation with the apple RSS feed.

To do this the application sends an HTTP request to the following link that shows the Apple Hot News:

```
http://images.apple.com/main/rss/hotnews/hotnews.rss
```

The response is an html page. The application makes the parsing of the response inorder to obtain two basic elements such as the title and the link of the detailed page.

Figure 5.19(a) shows the list of news (only the titles), instead Figure 5.19(b) illustrates the html page of one selected news.

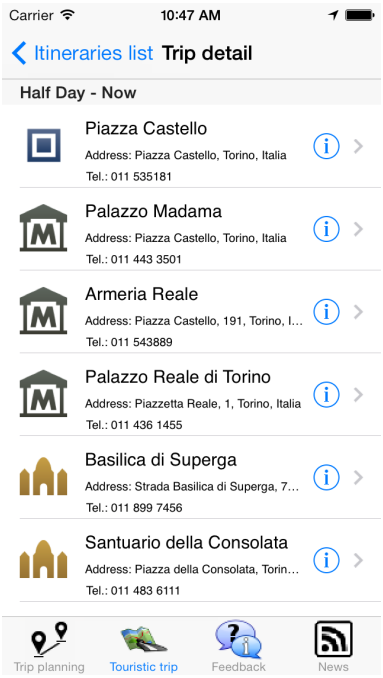


Figure 5.17: Points of interest list

5.4 Feedback

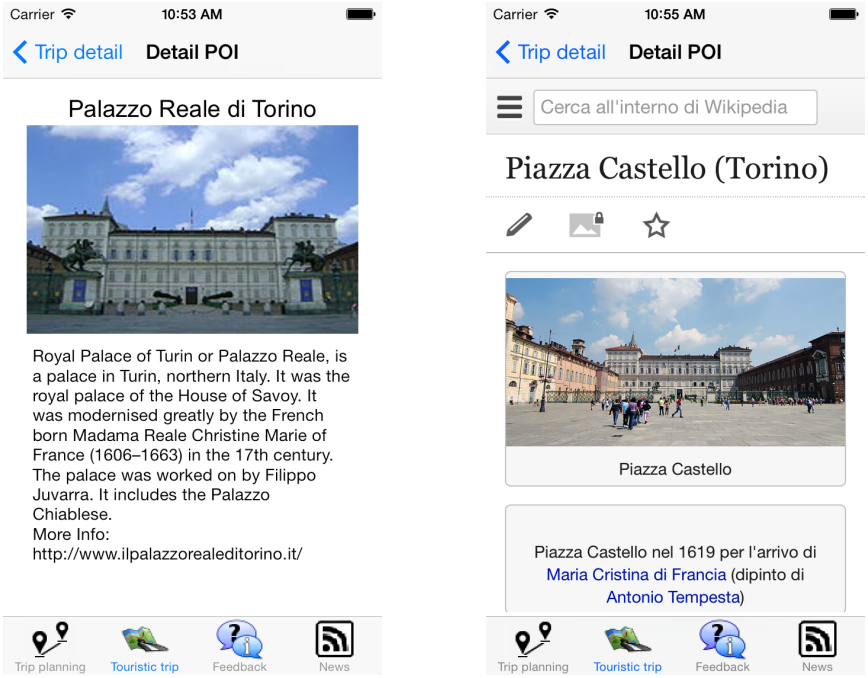
Feedback is helpful information or criticism that is given to someone to say what can be done to improve a performance a product.

Throught this functionality, a user can post comments about the used service or in general to improve the service provided by the trasport company. I have divided the view into two parts as shown in Figure 5.20.

In the upper section the user can write a general feedback, using the virtual keyboard, set the score by the stars and click the send button. On the contrary in the lower section the user can write a feedback associated with a particular stop. By cliking on the drop-down menu appears the stops list where the user can select one stop as shown in Figure 5.21. The next step is to select the time of the stop illustrated in Figure 5.22.

Finally the user can, write a comment, set the stars score and click the send button as in the previous case.

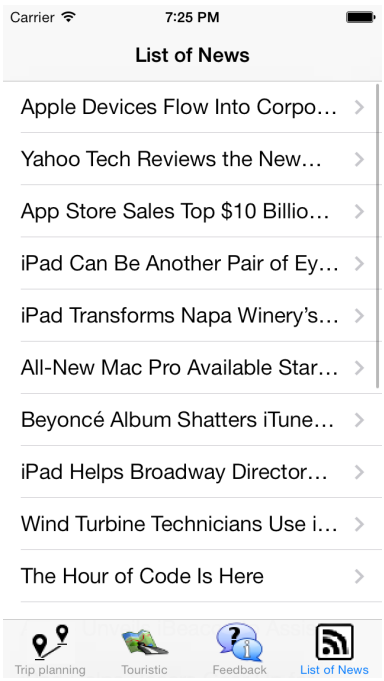
Note that the both lists (stops list and times list) are a result of a PHP service that provides in the first case the stops list and in the second one the stop timetable.



(a) DBpedia source data

(b) Wikipedia source data

Figure 5.18: Point details



(a) News list

(b) News detail

Figure 5.19: News view

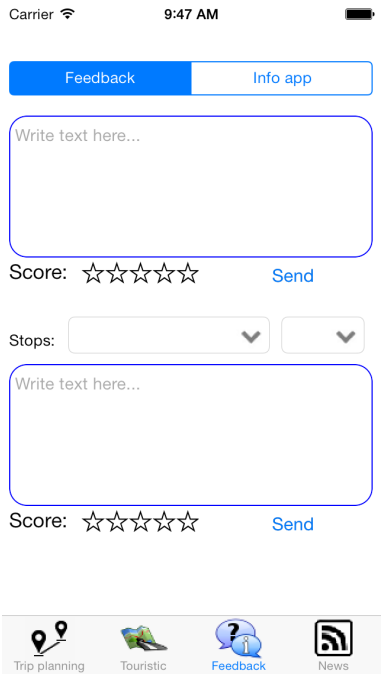


Figure 5.20: Feedback view

Figure 5.21: Stops list in feedback view

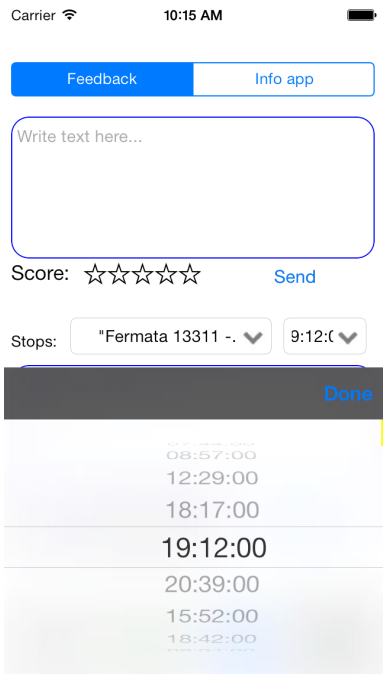


Figure 5.22: Times list in feedback view

Chapter 6

CASE STUDY

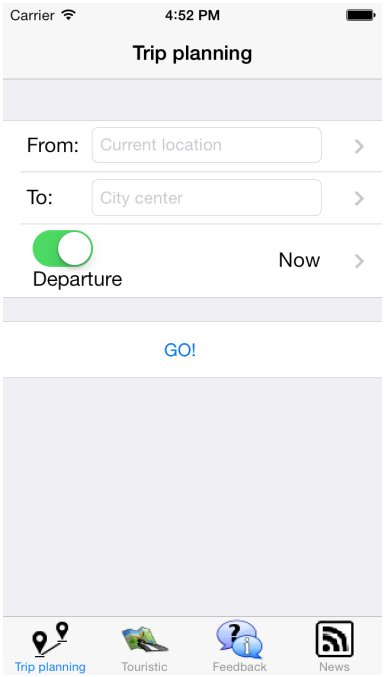


Figure 6.1: Home page trip planning - Switch Departure/Arrival

Chapter 7

CONCLUSION AND FUTURE WORKS

7.1 Conclusion

In this thesis I have tried to develop an application for mobile devide that allow the trip planning and tourism itineraries features with the general object to encourage the use of public trasport.

For understanding the current situation I have done a research work about existing software and techonology on the market (Google-Play and Apple Store).

The Apple environment was chosen by combining both the curiosity and looking at the smartphone performance, in particular I was particular to develop for iphone device.

As my first experience of design and implementation in Apple's iOS operating systems, the realization of this application was also a personal challenge but the obtained results was satisfactory.

The application, resulting from the user interface design work first and code implementation secondly, responds to the features that initially written, and can be the starting point for future works.

I have to make a clarification, the application needs more test for work, without error or malfunction. At now, tests are made only by using the simulator provide by iOS and have allowed to test the operation and usability.

Anyway, in addition to the technical and implementative adopted aspects for the realization of this project, one concept remain very important, such as to encourage the use of public trasport for reducing

emissions and urban congestion.

7.2 Future works

The application allows changes and extensions to improve both the yield and the stability also to add new features.

An example are **Actions buttons** that are added at the end of the trip detail as shown in Figure 7.1 but now was not implemented these features. Buy tickets feature represent the possibility the user to buy the needed ticket for the entire trip, Add to favorites permit the user to save and visualize later his/her most used trip (e.g work trip, school trip) and finally Save for offline to permit the users to create for example at home/hotel the trip and visualize it after by using the device offline.

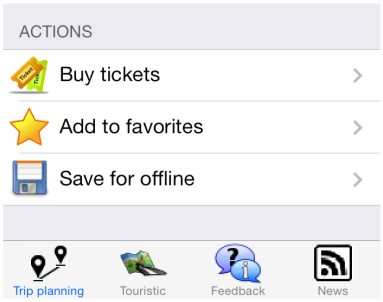


Figure 7.1: Actions buttons

I must devide the future works regarding the two section of the application: trip planning and tourist trip.

On the first side, immediately come to mind, is the real time notification service about the public trasport by using the GTFS real-time source data.

Another possible works is to add some section only for give at users the information about all lines, stops and schedules of the public transport company. Finally is the "Google dependency" in the trip planning, its possible to serch a different services (i.e. OpenStreetMap).

On the second side, in the tourism features, the possible change, are to develop a method for mining common pattern of movements of tourists in a given geographic area as incated by [BdMPR13].

The next step are to keep into account several constrains, such as opening hours of places, the time available for the visit or the average time spent in these place.

In addition to future works described previosly we can think many others features that make the application more complete. However, the technology, device and market evolves very quickly; even once the application are released and distributed, periodically upgrades are necessary to ensure that users always use the application.

GLOSSARIO

LPT	Public Local Transport
ITS	Intelligent Transport Systems
GTFS	General Transit Feed Specification
POI	Points of interest
CVS	Comma Separeted Values
JSON	JavaScript Object Notation
FR	Functional requirement
NFR	Non-functional requirement
UML	Unified Modeling Language (based on the object-oriented paradigm)
IDE	Integrated Development Enviroment
GCC	GNU Compiler Collection

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