

	VIAJEO
	Final Report

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Project	VIAJEO – International Demonstrations of Platform for Transport Planning and Travel Information			
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1. Summary

The Viajeo project is a FP7 project, funded by the EC as a Special International Cooperation Action (SICA) project. The project launched in September 2009 and completed in October 2012. The project has brought together stakeholders from Europe, China and Brazil. The Viajeo project developed and implemented an open platform concept for mobility services. The open platform is able to integrate data from various data sources, e.g. fixed sensor data from transport operators, floating vehicle data from private data owners, public transport data etc. Use the integrated data, the open platform is able to improve existing mobility services and facilitate new services. The open platform has been implemented in four demo cities: Athens (Greece), Sao Paulo (Brazil), Beijing and Shanghai (China). Due to different local conditions and availability of data sources, different mobility services were implemented and demonstrated in the four cities.

During the three year period, the project carried out extensive dissemination activities. The project organised a number of workshops in Europe, China and Brazil to engage transport stakeholders. The project also invited local stakeholders and end users to experience live demonstrations and collect their feedbacks on usage of the demonstrators. The project published papers and organised special sessions at a number of international conferences. The project also published articles in transport professional magazines.

Overall, the project has achieved success in both technical development and demonstration. Through the project activities, the consortium members of Viajeo have gained comprehensive experiences in carrying out mobility services and developing transport business in Brazil and China as well as developed extensive local contacts. Such experiences and local contacts would benefit their future business development.

2. Project context and main objectives

2.1. Main context

2.1.1. Technical Challenges

Congestion and air pollution are the challenges all big cities around the world face. It has been known that building new infrastructure cannot be the only solution to address the challenges due to limited space, environmental concerns and economic reasons. Therefore, in last two decades, transport solutions have been shifted from building new infrastructure to demand management policies, better management of existing network, and traveller information services. This trend has been driven and supported by new technologies, particularly the fast developed Information and Communication Technologies (ICT). Use of ICT in transport, also known as Intelligent Transport Systems (ITS) has brought revolutionary changes in transport industry and the way people travel.

There has been a revolutionary change in traffic data collection. To manage and maintain the transport network, considerable amount of traffic data is needed, in order to provide a comprehensive view on current situation of traffic network operation, to identify unexpected events, thus better management of the network, better planning of planned events and maintenance. It is not surprising that application of ITS initiated many new data sources which are significantly and fundamentally different from traditional traffic data.

One of a notable data source which emerged in the late nineties is Floating Vehicle Data. Floating vehicle data is a natural consequence of the rapid growth of GPS based navigation and vehicle tracking devices. The concept of floating vehicle data is to make an individual vehicle a remote sense by collecting its location and speed. Collected data from a number of vehicles can be then processed to generate speed information of current network, thus identifying congestion. Floating vehicle data has been proven as one of the fastest growing applications of ITS since 2000. It has been proven as a cost effective means of travel time collection and congestion monitoring.

GPS based vehicle tracking devices have also been widely used for management and operation of fleet, e.g. taxi fleet or bus fleet. Such device allows an operator to monitor location and speed of each individual vehicle of a fleet, resulting better real-time management and a better planning in the future. However, from traffic data collection aspect, such vehicle tracking devices also make any equipped taxis or buses as floating vehicle which can be used to collect traffic information.

It is no doubt that such new data sources would have positive impacts on overall traffic management and transport operation. However, the new data sources, as indicated above, are significantly different from traditional data sources. For example, one of typical traditional data sources is loop data which can provide speed and traffic flow at a fixed location while floating vehicle data can provide traffic speed along a road section but not at a fixed location. Quality of floating vehicle data can be various, that is also different from data collected by fixed traffic senses. Therefore, it is a huge challenge to integrate different data sources even though to integrate traditional traffic data with new data sources has a potential to improve overall understanding of traffic situation, thus achieving a better management and planning.

The Viajeo project proposed an open platform concept to facilitate the integration of different data sources, thus maximising the benefits of traffic data. Such integration can be used to improve existing traffic management and operation, fleet management, traveller information services. It also provides opportunities for new type of transport and mobility services.

2.1.2. The importance of international cooperation

As explained above, the Viajeo project aims at development of an open platform concept to facilitate the integration of different data sources. The implementation of the open platform has been done in four cities:

- Athens, Greece
- Sao Paulo, Brazil
- Beijing, China
- Shanghai, China

This project is funded as a SICA (Specific International Cooperation Actions) project. The project has engaged two of the most important emerging market countries: Brazil and China. Several reasons led to the engagement.

First, as emerging markets today are experiencing unprecedented economic growth, their transport and mobility needs are increasing, creating in consequence transport issues such as congestion, air pollution, green house emissions and energy waste. These countries face severe challenges in providing transport solutions to support economic growth and meeting citizen's demand in mobility. The demand in mobility is significantly increased with the growth of GDP due to massive urban migration, increased income and car ownership. Although the emerging markets have invested significantly into transport infrastructure it has been recognised widely that building new infrastructure is not a sustainable solution to meet the increasing demand.

Secondly, the environmental and energy issues are global challenges and cannot be solved by a single country or region acting alone. Therefore, in the last few decades, to address the global challenges, stakeholders from Europe and the emerging markets have been developing cooperation. European Commission (EC) had financed such cooperation through FP6 and FP7. Previous EC funded projects, such as SIMBA and SIMBA II, have created a solid ground for the Viajeo project. SIMBA (2006 – 2008) and SIMBA II (2008 – 2010) projects have established contacts with relevant local stakeholders. Working together with local stakeholders, the SIMBA and SIMBA II projects identified priorities and common interests in a number of countries including China and Brazil. The two projects also created working groups and carried out gap analysis of R&D needs. An example of cooperation in ITS is illustrated below. Traffic information services have been identified as one of the priorities to cooperate with Brazil and China. A R&D project with live demonstration was recommended by SIMBA and SIMBA II projects.

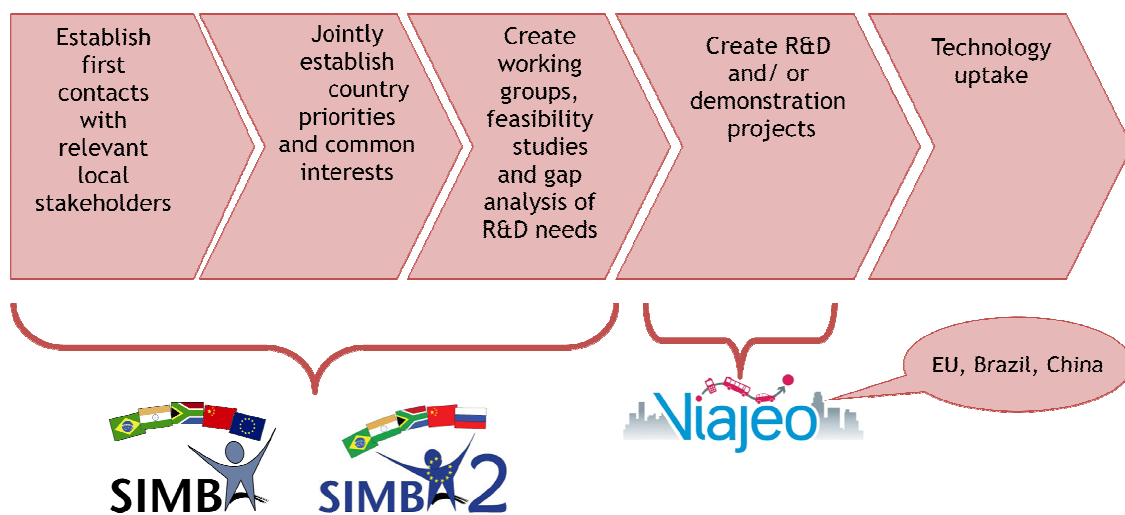


Figure 1 Roadmap of international cooperation and EC funded projects

2.2. Main objectives of the Viajeo Project

The scientific and technical objectives of the project are:

- Design of an open platform with interfaces to a wide range of mobility services
- Implementation of the open platform in Europe, and in the emerging Economies, i.e. China and Brazil.
- Validation of the open platform

- Assessment of social and transport impacts of the implementation and demonstration of the open platform

The VIAJEO project have involved end users, traffic managers, public authorities, transport operators, equipment manufacturers, vehicle manufacturers, service providers, application and service developers, content owners and providers, and research organisations.

The project started with review of existing systems and planned systems in the four demo cities. The project also assessed data availabilities for the project, taking into account data ownership and characteristics of data, e.g. coverage and quality. The project also reviewed standards used by current systems in the four demo cities and available European standards which can be applied to the project demonstrators. A user survey has been carried out in each of the four cities. Survey subjects included end users, transport operators and transport planners who have been foreseen as potential users of the Viajeo demonstrators. The survey results have been used for a gap analysis to identify gaps between user's need and existing systems, thus system functionalities were proposed in order to meet users' needs and fill the gaps.

Based on the defined functionalities and availability of data, an open platform was developed with a number of interfaces to access different types of data. The development of the open platform is based on existing platforms owned by the platform providers in the consortium, i.e. PTV and MIZAR. Both companies have commercial mobility platforms which were adapted following recommended standards, data formats and interfaces.

After the development of the open platform, each of the four demo cities started its work on implementation of the open platform, connection of the open platform to existing data sources at the local level. Before the implementation, each demo site has finalized services to be demonstrated and functions of each service. The implementation followed requirements of demonstrators and characteristics of the local data.

After implementation, each demo site city carried out laboratory tests to verify if each module performs as expected. After the laboratory tests, demonstration at each demo site city started. During the demonstration period, data were collected to evaluate technical performance of the demonstrators and to assess if users' needs have been made. The evaluation in the four demo site cities followed an evaluation plan. The evaluation plan defined evaluation methodology, and a number of indicators for the evaluation. Users' view and social impacts of the projects were collected and assessed through questionnaire surveys and focus group meetings.

3. Main S&T results and foregrounds

3.1 Investigation and User Needs Study

3.1.1 Methodology for investigation and user needs study

Three investigations were conducted to collect user needs. First, the current state of traffic information along with planned updates was described and any standards used were identified. Secondly, the needs and requirements of end users were identified. Third, the needs and requirements of transport planners were identified. These investigations led to a gap analysis of the systems and standards applicable in respectively China, Brazil and Europe and a formulation of requirements for future collection, processing, and dissemination of traffic information.

To complete the investigations in a conform manner, the WP2 leader prepared guidelines for each investigation and sent them to the test site leaders and the task leaders at each site. The intention was to have the test sites follow these guidelines to ensure compatibility of the information gathered.

The investigation deals with the collection of information on existing systems at each test site as well as new developments and already planned extensions to the existing systems. The information was to be collected through interviews with local partners and other organisations at each test site.

The objective of the end users' survey was to gather information about the views of end users. The task is to analyse their attitude towards existing information services and their need for further personalised delivery of information. End user surveys were carried out in the four demo site cities through questionnaire survey, focus groups and interviews. Survey subjects include local residents and visitors.

The object of the transport professionals' survey was to gather information about the needs of transport operators and planners who work with public transport and the road network. The task was to identify what data, methodologies, and tools transport planners' and operators' need to plan and manage local transport.

3.1.2 Investigation results in Athens site

End user survey

The provision of traffic information can be very helpful for both users and transport planners as various problems such as traffic congestion and delays can be avoided or diminished. However, it has been proved during the present investigation that this kind of services in the city of Athens still have a very wide field of improvement. The first and

most important conclusion that has been drawn is that although a large percentage of users, both residents and visitors do know where to find traffic information, they either do not use it or just do not follow it.

More specifically, the residents stated that they know where to find traffic information, but they do not use it as often as they would like to because they do not consider it to be accurate enough. A very interesting comment was that the source they consider the more trustworthy of all is the radio, as they believe that radio producers are the first to know about incidents that occur. Furthermore, the residents that use private motorcycles stated that they do not use traffic information often because their mode of choice is not seriously affected by traffic congestion. As regards the source that they choose for receiving the information, residents mainly use the internet.

On the other hand, foreign visitors mentioned language issues as a very serious barrier for using traffic information. Both foreign and domestic visitors, however, said that the primary reason for not using traffic information often is that they visit the city only for a few days and that they do not really trust the available information. They prefer to take a taxi or to ask hotel receptionists. People that were visiting Athens for touristic reasons showed a much higher interest in traffic information involving attractions and mentioned that information about moving between various touristic attractions would be really useful to them. Finally, as the residents also mentioned, visitors prefer the internet, but would also use a service that would send SMS to private mobile phones.

Regarding the type of information that users need, the answers were more or less anticipated. The car users need information about traffic congestion and incidents, the public transport users need information about timetables of the various modes and possible changes to programmed routes and as for the visitors, they also need mainly information about public transport. It should be noted that a number of the participants from all categories stated that they would be interested in information about environmental friendly routes.

Several problems, besides the above mentioned language barrier, were identified by the users. The most important of them was the quality of the provided information which was often found to be inadequate, wrong or late. Furthermore, the users also indicated as a problem, that not many sources exist that provide information through mobile phones which proves to be the most popular way of receiving information.

Concerning the possible solutions for the identified problems, the users were asked to mention any ideas they might have. Two answers were quite common. The first one was that due to the fact that there are few organizations providing traffic information, this has a serious effect on the quality of the provided services as the competition is very low.

Should more companies enter this sector, the competition would rise; having an immediate positive effect on the quality of traffic information. The second and more obvious solution was to update information more often so that it is actually useful. However, the phrase “updating more often” does not have the same meaning for all kinds of traffic information. For example, information about public transport timetables should be updated daily, information about traffic congestion should be updated every 5-10 minutes, while occurring incidents affecting either car usage or public transport routes should be announced immediately.

The final conclusion is that the majority of users do not change their behaviour due to received traffic information. The main reason is a lack of trust towards the received information. The hopeful conclusion however, was drawn by the final question; when the same people were asked if they would be willing to change their behaviour supposing the information would be accurate, correct and on time, a much higher percentage gave positive answers.

A similar conclusion was also drawn from the research that was done in existing surveys. Users had shown in these surveys also an intention to use traffic information and change their decisions based on them, given that they would be able to trust the information. Therefore, the overall conclusion is that should the quality of delivered information improve, the users would be willing to use it and therefore change behaviour.

End users’ needs in Athens are summarised below.

Table 1 End user needs in Athens

Category	Short definition
Public transport users and car drivers	More complete information
Public transport users and car drivers	More correct information
Public transport users and car drivers	More timely information
Public transport users and car drivers	Information on SMS to mobile phone
Public transport users and car drivers	Information through radio broadcast
Public transport users and car drivers	Information via Email to personal mobile with access to the web
Public transport users and car drivers	Information regarding specific geographical areas
Public transport users	Estimated travel times of public transport
Public transport users	Public transport timetables available online

	and at stops
Public transport users	Accurate public transportation arrival times
Public transport users	Information about occurred incidents affecting public transport (accidents, etc. for buses, closed stations for trains, etc.)
Public transport users	Information on displays in stations and bus stops
Car drivers	Estimated travel times for car drivers
Car drivers	Real time information regarding incidents such as accidents, strikes, closed roads due to public works, etc.
Car drivers	Park & Ride information
Car drivers	Information via VMS and DMS systems
Car drivers	Information through personal navigation system
Cross modal	Best travel route based on real time traffic information
Cross modal	Information on most environmental route
Cross modal	Information on most environmental friendly transport mode
Visitors	Information in other languages than the official language

Transport planner and operators' survey

The first step of the survey was the identification of the suitable interviewees, meaning persons that hold relevant positions in relevant organizations and most importantly, are familiar with the topic to be discussed. The final selection was based on the guidelines provided by the task leader and therefore the planners were representatives of both a higher and a lower level and of course from both the public transport and the road network sector. Regarding the content of the interviews, the list of questions provided by the task leader was the core of the questionnaires that were formulated. The first one was addressed to the Ministry of Transport, the second one to the Athens Urban Transport Organization and the final one to the representatives of the Public Works sector. Several questions were common for all three interviews, others were slightly changed so as to better serve the goal of the survey in each case and still others unique for each interview. All the above result in the following user needs having been uncovered in Athens: (the ones in bold are the ones which will be satisfied by the demonstration)

Table 2 Transport planners' needs in Athens

Category	Short definition
Road transport planner	Multi system cooperation between providers of traffic information
Road transport planner	Road traffic congestion information
Road transport planner	Real-time road traffic condition
Road transport planner	Information on traffic flows
Road transport planner	Tools to conduct speed measurements and occupation of lanes
Public transport planner	Information on freight transport in the city centre
Public transport planner	Multi system cooperation between providers of traffic information

Investigation conclusion in Athens

To cover the user needs identified, primarily implementing a cross modal journey planner and a website providing traffic information to end users is needed. These two demonstrations have great potential to meet most of the requirements voiced by the end users. It of course depends on the scope of the information provided and the design and usability of the tools. However, even though both tools provide real time traffic information, their use will probably be mostly pre-trip. Car drivers cannot enter the internet to check current traffic conditions while driving and still not all mobile phones have internet access. For real time information to be useful, an SMS service should be set up linked to the website and/or planner.

The demonstrations of dynamic assignments and traffic alerts will only involve a small group of professional drivers, for whom needs and requirements have not been identified. However, if the demonstration could be expanded and similar systems are available for all car drivers, many of the needs revealed for this particular group would be satisfied. It would fill the last gap so to say, concerning the difficulty for car drivers to receive real time traffic information while driving. With this system they could get it through on-board navigation units, which is a perfect media for car drivers as they can receive and read the information instantly and narrow the scope of information to what is relevant for their particular route.

Planners of public transport will not benefit from any of the systems implemented and none of their needs will thus be fulfilled.

Road transport planners benefit from the service through which they will get processed data based on real time and historic data to show traffic conditions. Contained in the model will also be indicators that can help the planners with strategic considerations and show performance and service quality, though this has not been voiced as a requirement from the planners. However, they will have their requirement for real time conditions and congestion information fulfilled.

3.1.2 Investigation results in Sao Paulo

São Paulo is the biggest and also the most congested city in Brazil. The city suffers from severe congestion and pollution from road transport. Investigation carried out by the Viajeo consortium found that although the São Paulo traffic control system covers 1427 traffic lights, only 10% of the traffic light has been fully operational due to poor maintenance of the system. Such results indicate that other data source, e.g. floating vehicle data, is needed.

With regarding of end user needs in São Paulo, two types of surveys have been carried out:

- constructed interviews for international visitors; and
- questionnaire survey for local residents

All international visitors surveyed indicated that they did not use any traveller information services. All visitors used taxis as the main transport mode in São Paulo due to lack of information and concerns on security. However, all visitors indicated that they would like to have a service which can give them a reliable estimate of travel time for a certain time of the day. Such information would allow them to better plan their trips in São Paulo. Moreover, international visitors also need real-time congestion warning, i.e. when they found out they were in a traffic queue, they would like to know how long the queue in front is and when they will arrive at their destinations.

96.4% of all residents surveyed use various types of traveller information services and only 3.6% never use any traveller information services. Among all services, website based direction services are the most widely used service. To access real-time information, 35.7% use radio, 53.6% use internet and only 10.7% use mobile phones. The residents surveyed believe that traveller information should cover the main roads in the urban area rather than city centre area only. Web-based direction is the most needed service. However, the majority (more than 80%) need estimated travel time, real-time congestion warning, dynamic route guidance to avoid congestion. End user survey results are summarised in the following table.

Table 3 End user survey results

Category	Short definition
Public transport users and car drivers	Information on SMS to mobile phone
Public transport users and car drivers	Information via internet
Public transport users and car drivers	Information regarding specific geographical areas
Public transport users	Estimated travel times of public transport
Public transport users	Public transport timetables available online and at stops
Public transport users	Accurate public transportation arrival times
Public transport users	Information about occurred incidents affecting public transport (accidents, etc. for buses, closed stations for trains, etc.)
Car drivers	Estimated travel times for car drivers
Car drivers	Real time information regarding incidents such as accidents, strikes, closed roads due to public works, etc.
Cross modal	Best travel route based on real time traffic information
Visitors	Information in other languages than the official language

3.1.3 Investigation results in Beijing

Survey for end users in Beijing covered:

- Motorists
- Public transport users – local residence
- Public transport users – visitors (domestic and international visitors)

For motorists, the preferred channels for receiving traffic information are the ones which have low cost, wide coverage and easy accessibility. In Beijing this is often mobile phone services. VMSs have good potential but because of their limited number in Beijing, they are not considered by many users as a good source. Also timeliness of the information is important but mostly drivers wish for intelligent real time route planning, so the information is taken into account without the users having to process it themselves.

Users of public transport in Beijing primarily want information concerning departure and arrival times so they can plan better. They want the information real time on demand.

They want services that are interactive so they can choose what information they want as they only want information relevant to them and their route.

Visitors do not need traffic information as badly as residents. They normal go by car with driver or taxi and thus do not need to know the way themselves. The visitors interviewed were all business travellers and therefore cost was of no concern for them; their companies covered all expenses. Visitors primarily need information on travel and arrival times and this is also their only reason for changing behaviour. If public transport, e.g. metro, is faster and more reliable than taking a taxi, most visitors will do this. Foreign visitors in excess have concerns regarding language, both when looking for traffic information and when taking taxies, and cost of receiving traffic information due to high roaming costs.

The Beijing demonstration includes a cross modal journey planner, which satisfies most requirements expressed by the end users. It has the same constraints as the one in Athens concerning the accessibility of information mid-trip. For users of public transport this issue has been solved by two further implementations; the display system of real time bus arrival times and terminals with internet connection located on the buses. These three applications combined fulfils the greatest need of public transport users in Beijing; information regarding bus arrival. After the implementation, users can find the information both from home, at the bus stop and while on the bus. The demonstration is of course confined, but a large scale implementation would with all likelihood be a great success.

Public transport planners will benefit from the real time bus arrival data being fed into their traffic models, so they can use it for real time bus operation. Needs and requirements of transport planners were not investigated in Beijing and it is thus not possible to say, whether this application was desired.

3.1.4 Investigation results in Shanghai

End user survey in Shanghai

Survey for end users in Shanghai covered:

- Motorists
- Public transport users – local residence
- Public transport users – visitors (domestic and international visitors)

For motorists, the main reason why the motorists cannot timely obtain information about accidents, temporary traffic restrictions, road construction etc. is that the information

provider cannot timely obtain such information and publish it to his users rather than users not having the necessary technical means or equipment.

For public transport users, the current public transportation information emphasises on the static information; allowing users to inquire about their journey before departure (pre-trip), but there is insufficient information dedicated to users during the trip. Furthermore, users require a journey planning service based on real-time traffic conditions and bus operation.

There is lack of necessary information leads visitors to choose a journey blindly, spend more time travelling, and decrease travel comfort level. Foreign visitors often use taxi as the only transport mode since there is not sufficient information on public transport.

Transport planners' survey in Shanghai

The survey interviewed a number of transport planners to understand their views on current data collection etc. The following needs of transport planners have been disclosed in Shanghai: (the ones in bold are the ones which will be satisfied by the demonstration).

Table 4 Transport planners' needs for Shanghai demonstrator

Category	Short definition
Road transport planner	Multi system cooperation between providers of traffic information
Road transport planner	Road traffic congestion information
Road transport planner	Traffic congestion causes
Road transport planner	Countermeasures analyses
Road transport planner	Real-time road traffic condition
Road transport planner	Vehicle fleet and type composition

Conclusion of investigation in Shanghai

The demonstration in Shanghai will include displays showing real time bus arrival information, information on Park & Ride via VMS and internet, a traffic model simulating air quality, and a traffic model for public transport calibrated with smart card data.

The first two demonstrations are directed towards end users and will fulfil many user needs. A wish high on the list from users of public transport was real time information on bus arrival. With the display systems they will have this at the bus stops so they know

how long they have to wait. The demonstration will not however, show arrival times for all buses but only for one line. Thus the suburban lines, where arrival times were most required, will not feature such information.

The second demonstration will benefit car owners only who are willing to take public transport also. It will satisfy the need for Park & Ride information, but will not provide information on anything else. The information will be available on some of the most popular devices such as VMS and internet.

The interviews with traffic planners in Shanghai were only conducted with planners of road traffic, wherefore it is hard to conclude whether a traffic model for public transport calibrated with smart card data is needed by planners of public transport. It will however, allow public transport planner to investigate public mobility by real data for the first time. Furthermore, it will facilitate changes to bus networks in the vicinity of the metro system, to accommodate for the rapid development the metro has experienced during the last few years. This will surely help planners of public transport in their efforts. The road planners might find the data useful as well as it could help them decide the location of parking for Park & Ride and adapt road networks in the vicinity of the Metro as well.

The traffic model simulating air quality is developed for planners of road transport, but from the interview conducted no need for such a model was identified. Whether this is a need that was not uncovered or it actually means that the transport planner sees no use of such a model, was not clarified. The end users in Shanghai did not express needs for information concerning air quality along their route either, which might be explained by a belief that air pollution will not affect drivers while in their cars.

3.2 The Open Platform

3.2.1 Definition of the open platform

The overall goal of the open platform is to support wide competition between providers of functional components and traffic information services.

To achieve this, the project aimed to standardise as many of the existing proprietary interfaces as possible as well as develop the necessary new standard interfaces while minimizing the required proprietary core functionalities.

The open platform thus facilitates both replacing existing components with similar components from other suppliers and implementation of new services by defining a “collection” of interfaces. These interfaces provide access to the core functionalities of

the platform as well as allowing data and processed information to be interchanged between different traffic and transport centres.

The Viajeo platform shall be ubiquitously applicable in different settings and under different ancillary conditions. Hence the platform shall provide a set of well defined interfaces for the exchange/management of specific data sets and core functionalities required as basis to operate the platform's functionalities. The system boundary is shown in Figure 2.

However, "open platform" is neither an official standard nor does a universal valid definition exist. Therefore the partners of the VIAJEO project agreed a definition which forms the basis of the overall validation plan as well as of the following validation and impact assessment:

A well defined set of core processes accessible via published open external interfaces which are accessible by external parties. The open platform consists of standardised, openly described interfaces for data exchange between processes in the realm of the open platform. This set of interfaces is to be used by any new functionality implemented within the open platform concept.

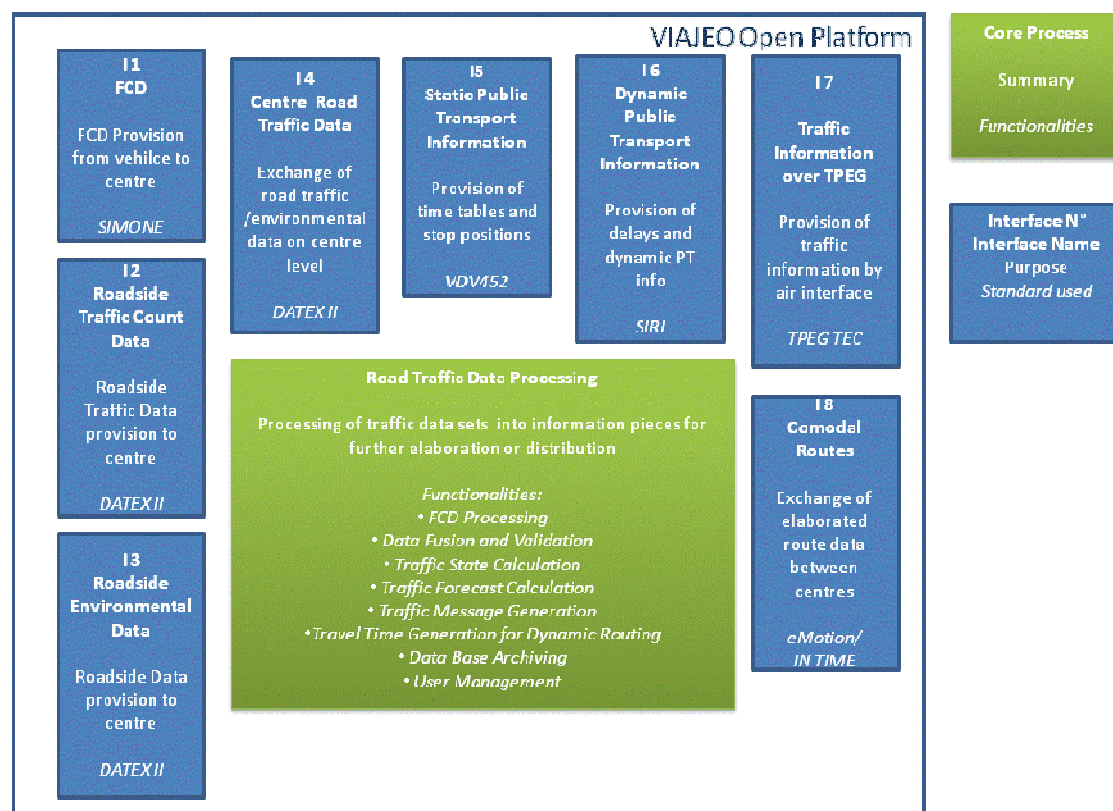


Figure 2 System Boundary

3.2.2 Interfaces the open platform

The following table gives an overview on interfaces defined in the Viajeo open platform. In total of 8 interfaces have been defined.

Table 5 Overview of the interfaces of the open platform

Interface Name	Designation	Chapter in Document	Data Typically Transmitted	Standard to be used
FCD	I1	Error! Reference source not found.	Vehicle ID Time Stamp Position Speed	SIMONE

Roadside Traffic Count Data	I2	Error! Reference source not found.	Detector ID Lane N° Direction Traffic Count (passenger cars) Traffic Count (lorries) Time Gap (between vehicles)	DATEX 2
Roadside Environmental Data	I3	Error! Reference source not found.	Detector ID Direction Measurement CO2 Measurement NOx	DATEX 2
Centre Road Traffic Data Interface	I4	Error! Reference source not found.	Traffic Events Traffic Load per Segment	DATEX 2
Static Public Transport Information	I5	Error! Reference source not found.	Timetables Stop Positions	VDV 452
Dynamic Public Transport Information	I6	Error! Reference source not found.	Update Time Tables (?) Vehicle ID Time Stamp Vehicle Position Vehicle Speed Delays (line,vehicle)	SIRI
Traffic Information over TPEG	I7	Error! Reference source not found.	Traffic Messages Traffic Load	TPEG RTM/TEC
Co modal Routes	I8	Error! Reference source not found.	Waypoints Travel Time on Links Traffic Mode	IN TIME / eMotion

The following figure shows an example of the chain for traffic information (traffic messages, traffic load) distribution. In contrary to the first figure, there are no routes compiled.

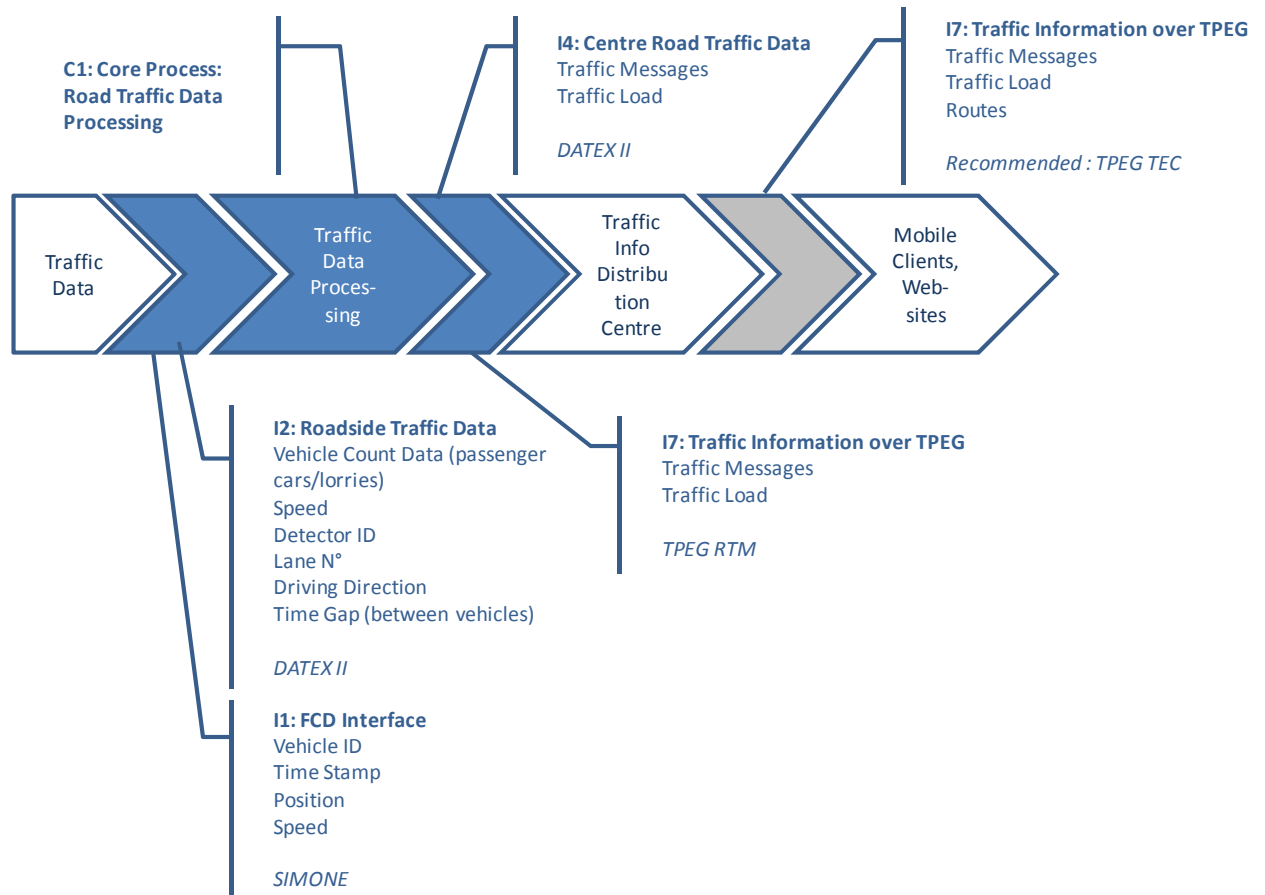


Figure 3 Interfaces and transmitted data for roadside data delivered to mobile clients and websites

3.2.3 Core functionalities of the open platform

This core processes offer the functionalities to receive specific data and information sets, to compute results on basis and to provide those results to subsequent processes. The core process of the VIAJEO platform covers several principle functions, these are:

- Floating car data processing
- Data fusion and validation
- Traffic state calculation
- Traffic forecast calculation
- Traffic message generation
- Travel time generation for dynamic routing
- Database archiving
- User Management

The following figures illustrate these VIAJEO core processes in their context:

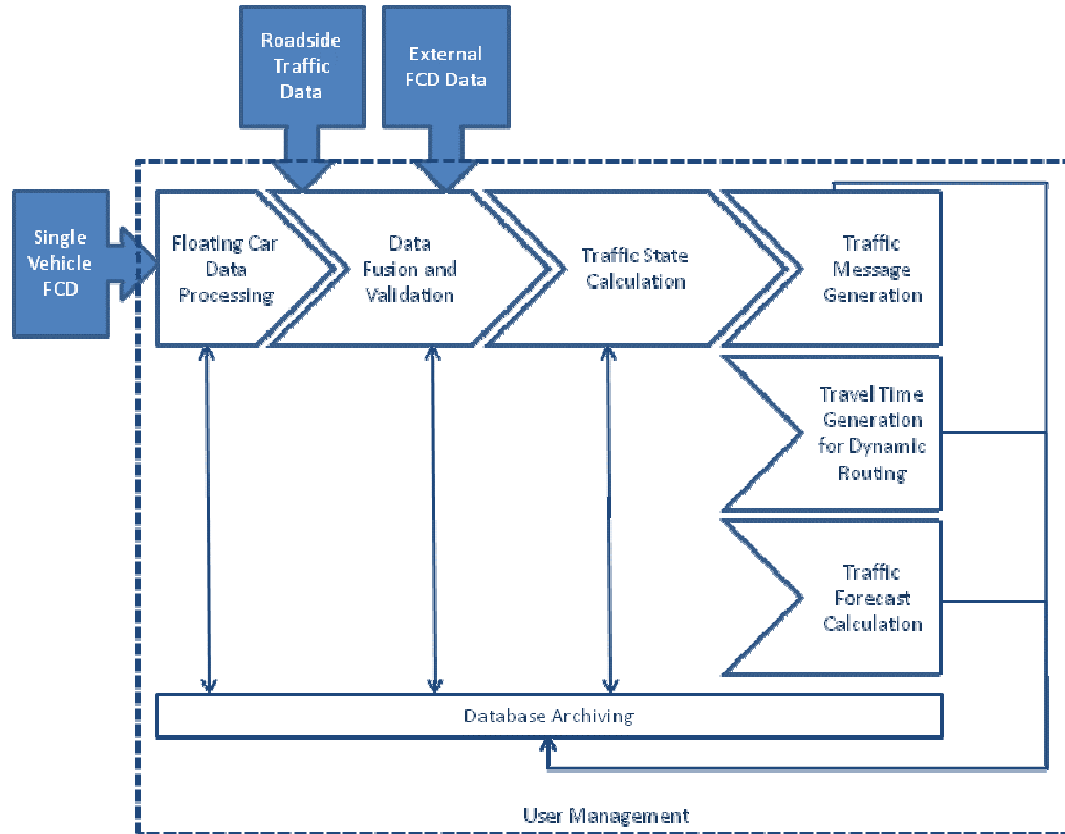


Figure 4: Core Processes of the VIAJEO open platform

The dark blue icons represent external data sources which feed data into the VIAJEO core processes. Interfaces on side of the core processes providing data to further external processes, such as e.g. a dynamic routing engine, would be applied to the database archiving process since all results are stored here until required.

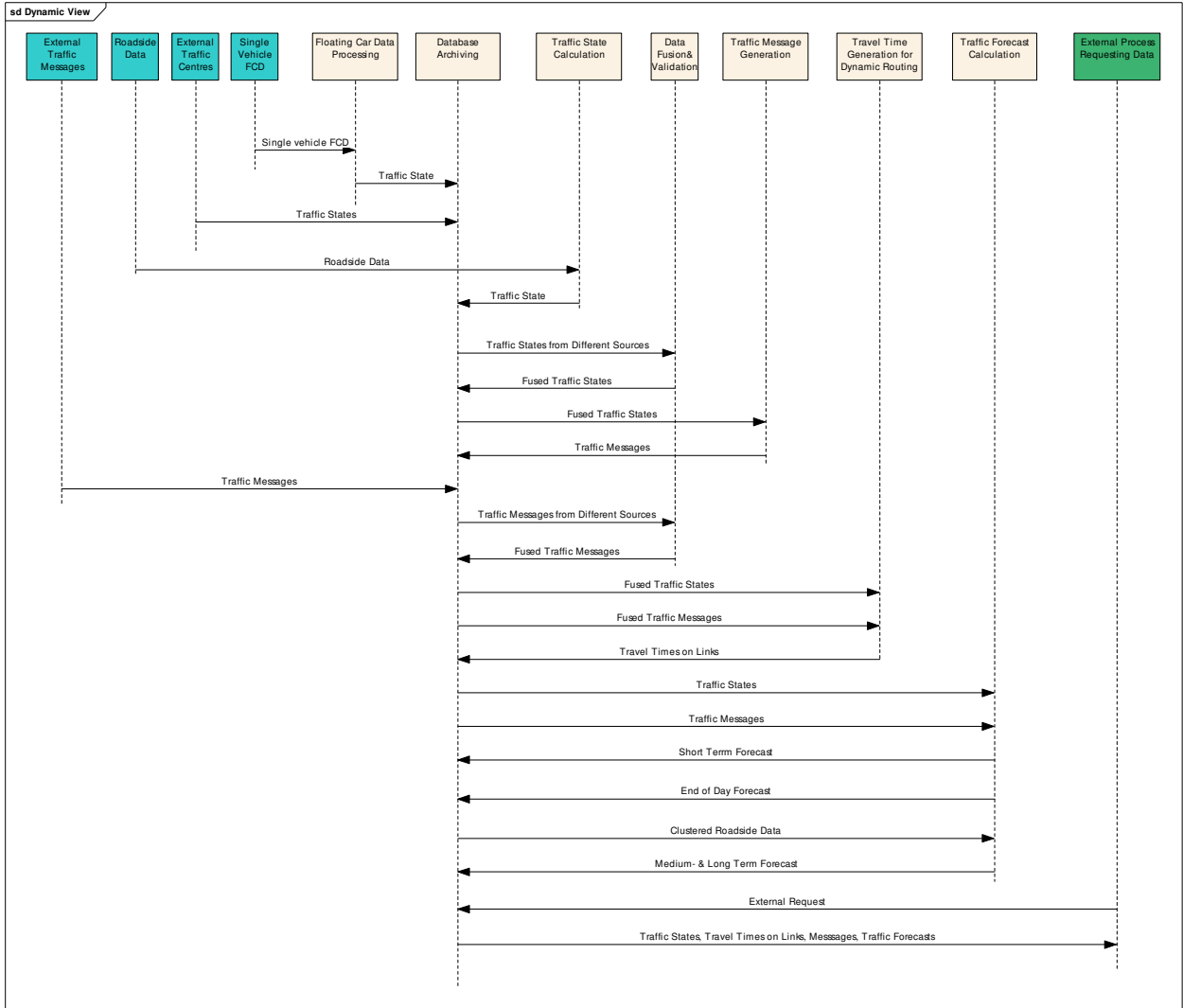


Figure 5: Sequence Diagram for the Core Processes of the VIAJEO open platform

3.3 Demo site

3.3.1 Athens

Architecture

In Athens, Viajeo has implemented a comprehensive database that integrates floating cars, data from fixed measurements and historical traffic data, which has led to the development of a dynamic traffic assignment model for mobility management. More precisely, companies which are responsible for passenger transport such as taxi companies are able to provide better quality services to their customers, providing to the driver the best dispatch route based on real time traffic conditions in order to reach customer's preferable location accurately. End-users obtain real time traffic information, via mobile device or a website, which is valuable for their daily trips in order to avoid unexpected traffic situation. Finally, the processed data and related traffic indicators provide traffic planners and authorities with aggregated information about traffic and support them to estimate the status of transportation system in the city. Architecture of Athens site is shown below.

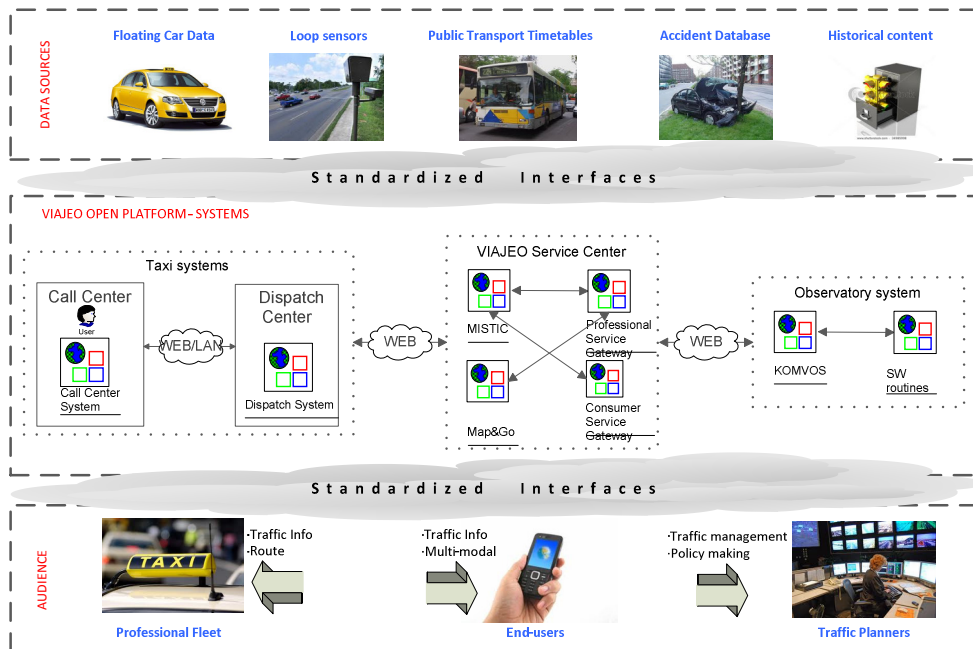


Figure 6 Architecture of Athens site

As per the definition of the Open Platform and system boundary specifications, standardised European protocols (standards) have been selected, capable of exporting traffic data such as DATEX II and TPEG. All system components of Viajeo Service center are located at INFOTRIP's premises as well as KOMVOS and the wider IT infrastructure that supports the Observatory operation are hosted in a dedicated and special designed area within the premises of CERTH/HIT.

Services

Three services have been implemented within the Viajeo open platform.

Service A: Taxi fleet management and traffic information: The aim of this service is to upgrade the management of the taxi fleet in the Athens site and alert the drivers on incidents that may affect the taxi service. At the end, the taxi drivers will be able to provide better quality services to their customers, while their daily operation will become more effective. The service contains two core functionalities:

- Dynamic assignment and navigation
- Traffic alerts

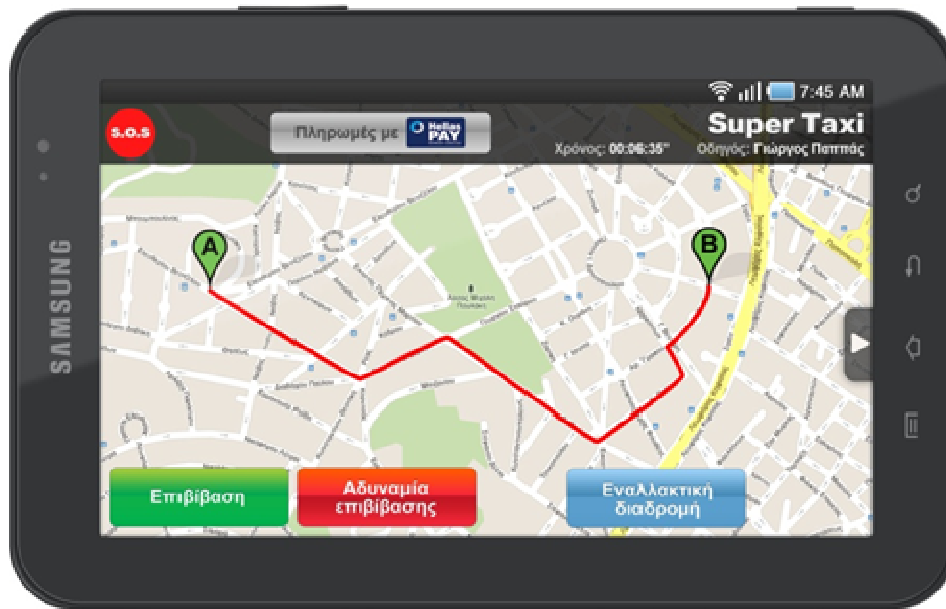


Figure 7 Proposed route displacement to taxi drivers based on real-time traffic conditions (based on Android OS)

Service B: End user multi-modal trip planning and traffic information: The scope of this service is to facilitate the mobility of residents and visitors in their transportation and mobility in urban areas. The users of the service have access to a web portal, through which they can find alternative routes from an origin to a destination using several transit modes, while they can also obtain traffic information that may be useful for their trips. The same information is also accessible through mobile devices. The service contains two core functionalities:

- Multi-modal real time trip planning
- Traffic information

This service has been implemented as a web-based application developed under the URL: <http://viajeo.myroute.gr>

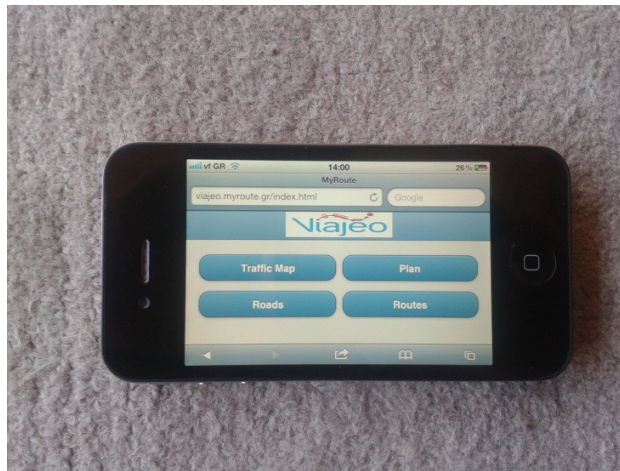


Figure 8 Mobile homepage – Main menu



Figure 9 Real-time Traffic Map

Service C: Observatory for public authorities and traffic planners: the objective of this service is to provide to all interested stakeholders aggregated information on the traffic conditions of the Attica region. The Viajeo Observatory addresses the needs of transport and traffic planners for data that would allow them to gain a sound picture of the traffic and transport conditions in Attica and, thereafter, to develop a structured decision and policy making. The service contains two core functionalities:

- Traffic content management
- Transport, traffic and accident related indicators

This service has been implemented as a web-based application developed under the URL:

www.viajeo.imet.gr.

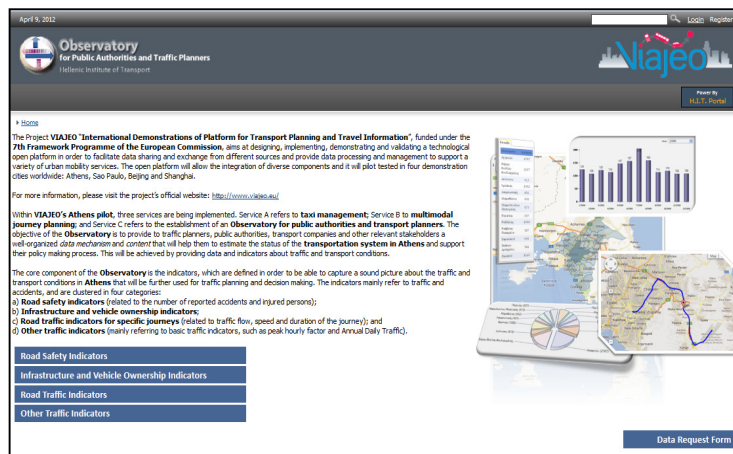


Figure 10 Observatory's home page

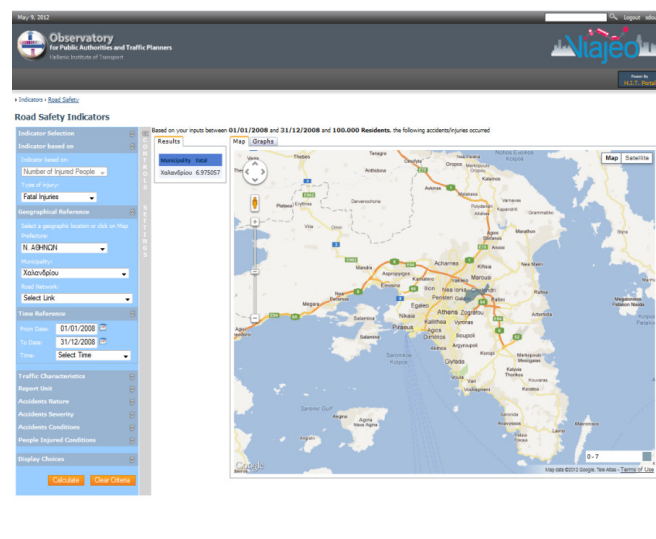


Figure 11 An example of an accident indicator provided by the Viajeo Observatory

Results

Users of the Athens demonstrator include taxi drivers (Service A), end users (Service B) and transport planner operators (Service C). Surveys have been carried out to collect feedbacks from different user groups on the services. Transport planner and operators were asked to evaluate all the three services.

Taxi drivers' opinion

Taxi drivers were asked to evaluate Service A. The sample of the participants in the assessment included 9 out of the 10 taxi drivers that have installed the on-board navigation unit on their vehicles. The taxi drivers participated in the survey through personal interviews. In overall terms the taxi drivers stated that they were very satisfied with the provided information and that they consider the service an important tool for the day-to-day operations. This was made clear from the very good rate they attributed to their level of satisfaction while using the VIAJEO services (all the taxi drivers were 100% satisfied with the information provided for the planning of routes and the traffic alert information provided by the service). They also found the user interfaces very easily accessible and comprehensive. Nonetheless, it was their general comment that the added value of the service is not easily perceived or/and accepted by the clients and, therefore, they didn't expect an improved clientele due to the availability of the service.

End user's opinion

End users were asked to evaluate the impacts of Service B to their day-to-day mobility. Some survey participants were reached through a Focus Group Meeting and others were asked to fill in the questionnaire individually. Their comments were overall positive in terms of the service's usefulness and to this point, over the 50% of the interviewees replied that the use of the multi modal journey planners will result to a complete or large increase of their satisfaction while travelling in the urban network as shown in Figure 13). Some important remarks were provided regarding additional information that the users would like to get, such as more personalized information (i.e. information provided via sms to the user's mobile phones), information for mobility impaired people, information on the arrival time of the multi modal journey, and more. Also, some remarks were made in regards to the improvement of the service's user interfaces.

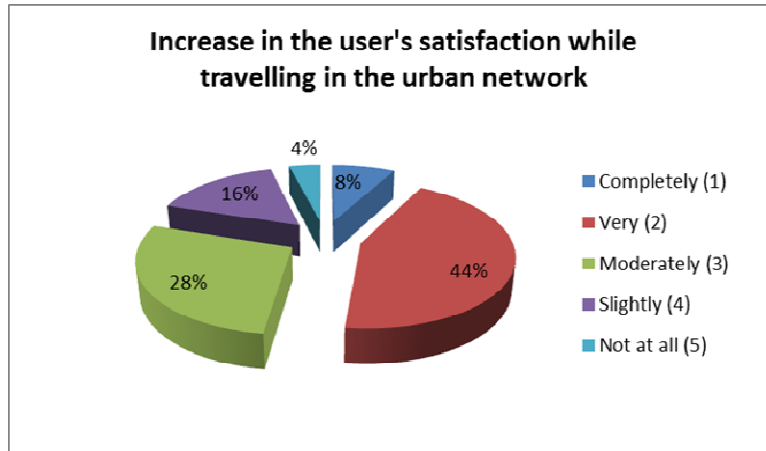


Figure 12: Increase in the overall satisfaction of the end user due to the availability of the multi modal journey planner

Opinion of transport and traffic planners and operators

Transport and traffic planners and operators participated in the evaluation of all the services and, furthermore, they were asked to evaluate the VIAJEO open platform, as this was implemented in the Athens pilot site. The procedure took place through personal interviews. When Service A was concerned, planners and operators expected an increased quality of provided services by the taxi companies due to the availability of the VIAJEO information, as well as a more optimized transport network due to the better assignment of the taxis. The attitude of planners and operators towards service B was overall very positive, nonetheless they stressed out the need to highlight the service's added value, mainly towards other similar applications that are already market products. In regards to Service C, the interviewees were very satisfied with the provided information in terms of adequacy, accuracy, comprehensibility and form of presentation. Some suggestions that were provided addressed their desire to have additional information in a future version of the service.

Finally, when coming to the VIAJEO open platform, planners and operators had a very positive attitude towards the adoption of existing European or international standards for the exchange of traffic and transport related data and they presented themselves very willing to adopt such standards in their area of activities.

3.3.2 Demo site Sao Paulo

Architecture

In São Paulo, the open platform collects floating vehicle data from probe vehicles to evaluate the concept and to highlight benefits and potential deployment issues. These data are integrated with existing data sources from the traffic control centre in the open platform in order to estimate real-time traffic condition. The real-time data are stored in a historical data base for purposes of statistical and prognostic analysis as well as for the computation of optimal routes for private cars. Precise traffic profiles are assigned to the road network of the demo area. Fleet operators can use the real-time information and historical database, which can be accessed through standardised interfaces, for better operation and management of their fleet (e.g. Taxi). The real-time information and historical database are used to support a web-based journey planner which is able to plan a trip for private cars and commercial vehicles. The dynamic traffic information is disseminated through a traveller information website. On-board equipment is coupled with high band width communication link through the GPRS channel. Moreover the on-board units equipped for floating data collection opens up the opportunity for safety and security application with special emphasis on the European Commission's emergency standards and policies. Differing from other demo sites which focus on one urban area only, Brazil demo site covers also surrounding motorways. The open platform will access motorway traffic data via MIST platform which was developed by IPT and is currently used to collect traffic data on motorway networks from different operators. The architecture of the demo site is shown below.

In the figure above input data are:

- Data sources for traffic data and travel time covering São Paulo's highway and main road network;
- Floating car data (FCD) collected by a small fleet of private vehicles.

Outcomes from the VIAJEO open platform are:

- Core functionalities for traffic management and route planning

- B2B interfaces for third parties service providers and traffic management centres.
- B2C interfaces for end-users (mobile application and web site).

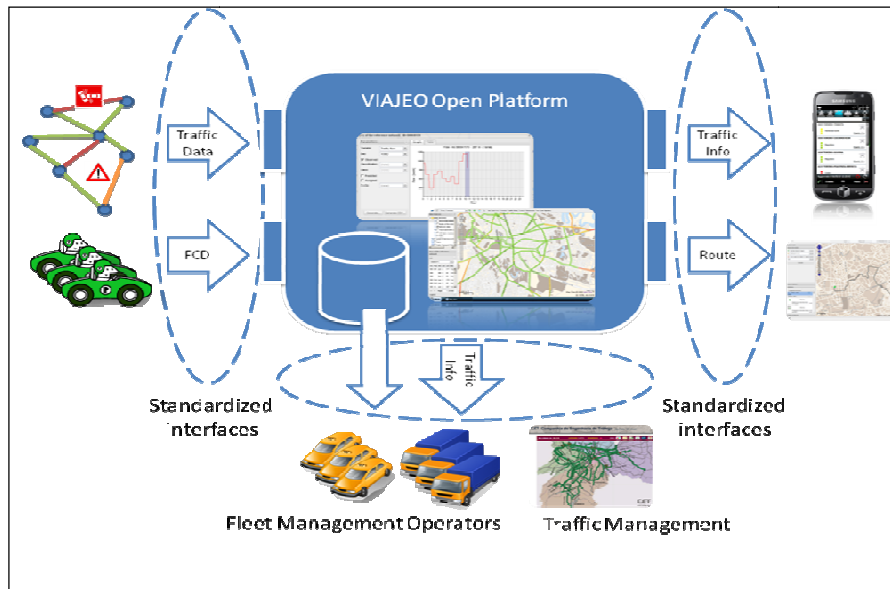


Figure 13: Sao Paulo demo site architecture

Services

Four services have been demonstrated in Sao Paulo:

Service A FCD collection and elaboration collects floating vehicle data from probe vehicles and fuses this with data from existing sources. The result is a real-time traffic condition which is stored in a historical database and it is used for statistical and prognostic analysis and for computation of the optimal routing.

Service B Open interface for transport platform is able to provide real traffic information and historical database for fleet operators and transport planners. The sharing of information is implemented through standardized interface which make the different operators able to manage their fleet according a real time traffic state.

Service C Web based real time journey planner uses static and dynamic information on the actual state of the network. The web-based travel planner can be used by private and commercial vehicles in order to optimise the journey and to reduce the travel time.

Service D Dynamic Traffic Information refers to real time data or to predictions based on the travel time profile assigned to each arc. The travel time and traffic events are detected by the existing sensors on the network or by the floating vehicle and are used to generate traffic information able to reflect the up-to-date traffic condition.

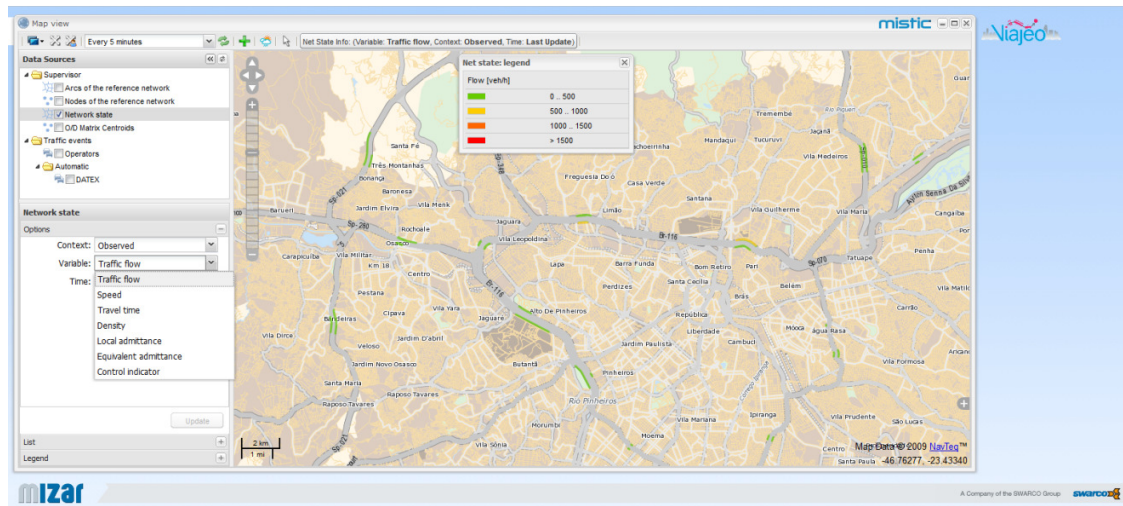


Figure 14: Dynamic traffic information - Sao Paulo network statue

Results

The level of acceptance of the services developed is studied through a set of questionnaires sent to end users and transport planner. In the respect to *car only journey planner* the level of satisfaction both of the End User and Transport Planner is considerably high. The answers to the three considered questions show that the information service contributes to improvement in the use of different transport mode and to reduction of travel time.

The *Services Provision of traffic Information to End Users and Indicators to Transport and Traffic Planner* received a medium-high evaluation in terms of level of acceptance and usability. In particular from the Transport Planner point of view the type, the format and the adequacy of data provided by the service has been evaluated satisfactory (at medium level) from more than one third of the interviewed. In respect to the improvement on the transport network plan more than 50% of the End Users and more than 70% of the Transport Planners, declare an improvement in the network plan related to the use of the service.

3.3.4 Demo site Beijing

Architecture

The Viajeo project in Beijing aims to encourage usage of public transport, reducing pollution and traffic congestions, so improving passenger information service is one of the main tasks. The project in Beijing connected real time traffic data collected by GPS/GPRS equipped public transport vehicles (over 200 buses from 6 bus lines), taxis (20,000 taxis in Beijing) and private cars. The open platform integrates data from the different sources to get a real-time “picture” of current traffic conditions and providing to the users a real-time multi-modal journey planner (pre-trip and on-trip), for private vehicles as well as for public transport travellers (using metro and bus transport services), a real-time “picture” of current traffic conditions, and the real time bus arrival information on displays at bus stops (20 in the area of interest). In addition it provides to operators an integrated view of the real time public transport operation and management integrated with display of real time traffic information. Architecture of the Beijing demo site is shown below.

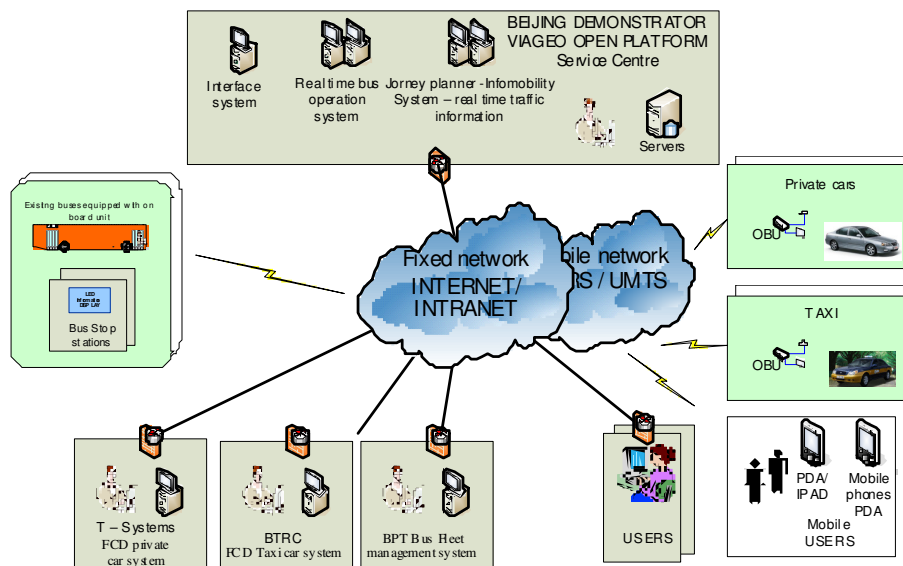


Figure 15 Architecture of Beijing demo site

Services

Three services have been implemented within the Viajeo open platform.

Cross modal journey planning and real time traffic information (Service A) provides a web based interface to users for PC and mobile device; the user can view the current traffic status (coloured links showing the current travel speeds on roads) and he can perform a route planning from A to B;

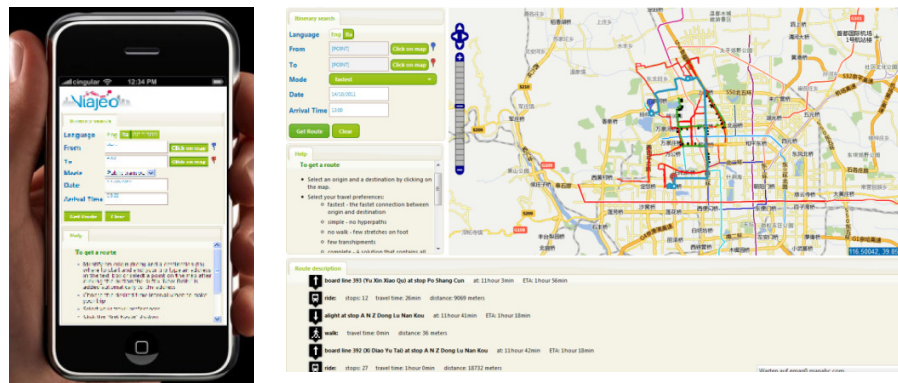


Figure 16 User Interface of Cross modal journey planner

Real time bus operation (Service B) provides information about the real time public transport operations, including vehicle management, for details about the status of the vehicles and check of planned service and real time service with alerts in case of deviation, improving the efficiency of the public transport service;

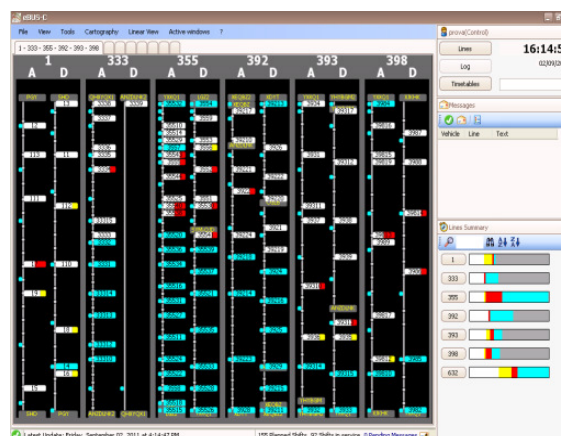


Figure 17 Public Transport Operator's interface

Passenger information display (Service C) provides information on displays at bus stops, such as arrival/departure time information or specific messages.



Figure 18 Passenger information display from Viajeo in Beijing

Results

The system has been running for six months. During the six months, there are total 65 failures. The Service is configured to be automatically loaded at the service start. Average re-start time is 34-35 seconds. The location measurement accuracy for buses in Beijing is 7.8 m with 98% confidence. The accuracy of vehicle speed measurement is 0.006 m/s with 98% confidence. During the day from 8:00 – 21:00, for one bus line, there were 2617 forecasts. Statistics of the forecast accuracies are shown below. Of all the forecasts, 33% are less than 60 second. 0.95% of forecasts have an error of more than 10 minutes.

Overall, a high satisfaction rate from users was obtained. A further conclusion that may be drawn from the analysis, regards the comparison between the provision of information from the multi modal journey planner before and during trip. Both operators/stakeholders and end users appreciate more the provision of information before trip, in relation to its potential impact on travel time decrease, modal shift to public transport, reduction of congestion and pollution and overall improvement. This is justifiable as, before trip, the traveller has the “freedom” and comfort of planning his route in such a way so as to

optimize his travel time, which is not always easy to do so when being already on route. In the same way, the reduction of congestion and pollution is more possible when the traveller has chosen a non-congested route in advance, than making such a choice as a detour to already congested conditions.

Furthermore, the use of internet before trip has been attributed with the better rating at any cases. This is quite reasonable, as for many people the web access to a variety of applications is done easier and more quickly through the personal PCs than the mobile phones.

As a concluding remark it could be said that the VIAJEO services in the Beijing site were positively accepted by both planners/operators and end users. The few elements that received a score higher than or near 2.50 should be further examined by the VIAJEO developers in terms of possible modifications/additions. To that content, the survey participants provided some valuable first remarks and suggestions for the optimization of the multi modal journey planner and the real time public transport operations. Finally, as a very important market issue for the VIAJEO Beijing site, the probability of establishing within the next 3 years the VIAJEO services in Beijing as an operational public service has been addressed. As a response to their scepticism on that matter, the survey participants identified the main challenges that the VIAJEO partners would face in such a case, therefore providing a first guidance for the services' market uptake.

3.3.4 Demo site Shanghai

Architecture

The VIAJEO Platform Shanghai connects the real time bus position system via SIRI interface to the expert web service system. Also available through the expert Web system are the (historical) traffic data and the pollutant data calculated for each road link through the HBEFA emission modelling. The architecture of Shanghai demo site is shown below.

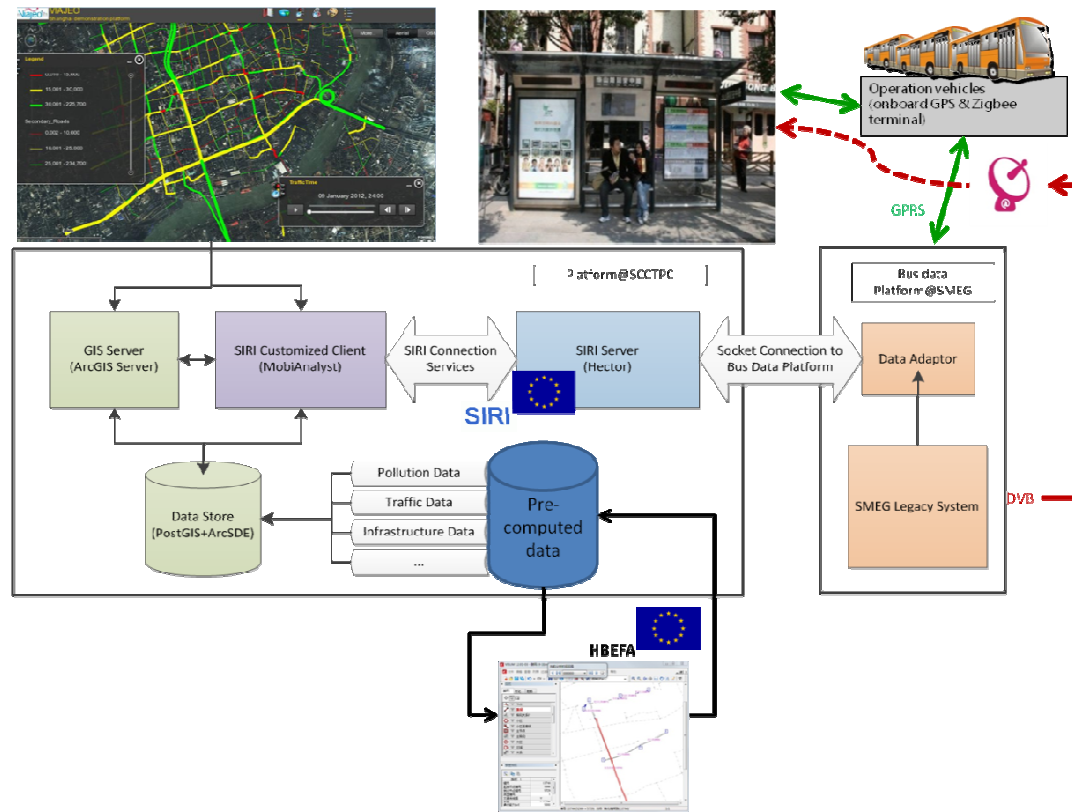


Figure 19 Architecture of Shanghai demo site

Services

The Shanghai test site has developed three services around the VIAJEO Platform:

- Service A: Real time bus information
- Service B: Real time traffic data access via SIRS and Web display module
- Service C: Historical traffic data and environmental modelling

Service A Real time bus information provides bus arrival time displayed at bus stops. Two bus lines were equipped for the demonstrator. A total of 40 buses were equipped with on-board devices and readers. A total of 34 bus stops were equipped with reader and displays. The on-board device consists of GPS unit and ZigBee short range communication in order to enhance accuracy of positioning.



Line 925 bus is 5 stops from here arrives in 14 minutes

Line 925 bus is 6 stops from here i.e. 3.1 km for the bus to go.

Figure 20 Real-time bus arrival display at bus stops in Shanghai

Information displayed at a bus stop can be either the line number, the distance in stops and the distance in metres or the line number, distance in stops and arrival time in minutes.

Service B real-time traffic data access via SIRI and web display module integrates inputs from Service A (real time bus position and forecast arrival time) and Service C (traffic emission model data) and display them at a website through a SIRI standard interface. The environmental emission model data and the historic traffic data are added as pre-computed data to the data store, from which GIS (Geographic Information System) functions draw the data on request and present it on the web site. Functionality of Service B is shown below.

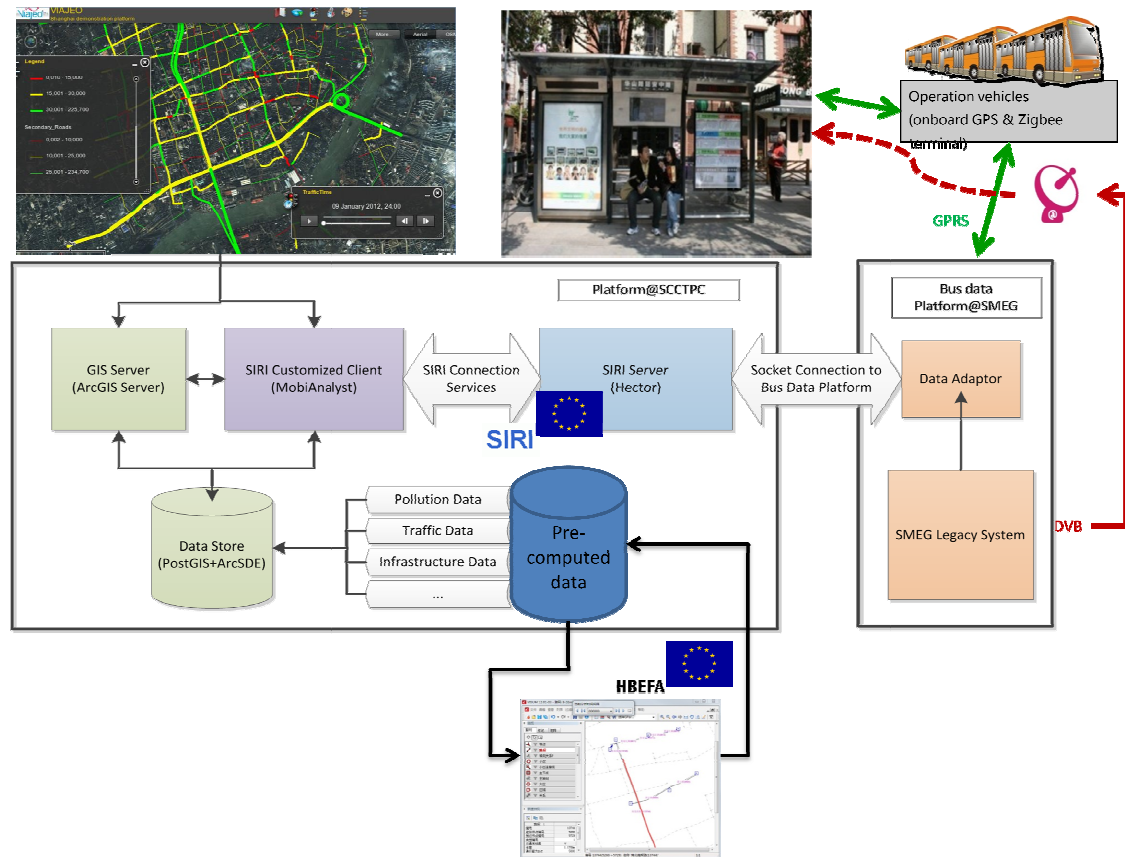


Figure 21 Functionality of Service B real time traffic data access via SIRI and web display in Shanghai

Service C Historical traffic data and environmental modelling aims at estimation of the pollution from road traffic. The model is able to estimate NO_x, PM, CO₂, HC and CO and results of the estimated pollution level are displayed on the web platform. The model is developed based on the European Handbook of Emission Factors (HBEFA). To apply HBEFA in Shanghai, the HBEFA emission factors needed to be calibrated to the different vehicle composition in Shanghai. Chinese engine emission characteristics were assigned to the best corresponding European equivalent. For the vehicle composition, statistics on Shanghai vehicle registrations were researched in order to identify the most likely composition of engines found in Shanghai traffic. Historic traffic data on the examined roads were used as input to the emission estimation for certain traffic situations. Road traffic situations and driving patterns were matched. Thus the calculation could be executed.

Results

During the 6 month demonstration period, the Shanghai demonstrator processed information in time. Bus positioning data was passed on between 0.5 and maximum 3 seconds through the systems. The web display of traffic information is updated every 10 seconds.

To evaluate accuracy of real-time bus arrival time forecast, data were collected at two bus stops at different locations. The results show that at the bus stops, the time gap between forecast and real arrival times is never exceeding 5 min, which proves the advantage of the combination of two positioning detection methods. In a former comparable check, in which only GPS unit was used, the time gap above 5 min reached 8% and the time gap within 2 min was only 77%. Below the table shows detailed statistics of forecast accuracy.

Table 6 Bus Arrival Time Forecast Accuracy

Time gap in prediction	Shuicheng Road St.	Hongqiao Development Area St.
< 1 min	90%	88%
1-2 min	7%	8%
2-5 min	3%	4%

Overall, passengers are satisfied with the service A and C. They believe that the information services can improve their experiences using buses. It is clearly indicated that users prefer arrival times rather than distances by stops or meters. In addition, users would like to have the service accessible through their mobile phones (e.g. through a smartphone app). Ideally an alert service is available.

Transport planners and transport operators have been surveyed for their opinions on the Shanghai demonstration. All survey subjects agreed that traffic & emission statistical information is needed for traffic related policy making and taking traffic operating plans. Considering the application of the European standards SIRI and HBEFA, 92% would apply SIRI in planning and design of public transport real time information systems. The HBEFA emission calculation approach is regarded as low cost and feasible. However, further improvement of basis data validation is required.