Cooperative Cities extend and validate mobility services

Deliverable D2.1

Report of cooperative cities services and set use cases

Version 2.0

Public

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1 Scope of the document

Main scope of this document is definition of use cases, where the feedback information from end-users can be collected. These use cases will be sorted to five basic service domain.

This has been done by defining the set of Use Cases for Co-Cities. They describe the high-level B2B and B2C interactions between the TISP, the RDSS and the End User defined as actors. This will include the back loop feedback and are formulated as a set of use case diagrams.

There are four major parts within this document:

- Report of currently operated traffic management and travelling information systems in each pilot city, where is provided summary for existing infrastructure and systems for all pilot cities Vienna, Bilbao, Reading, Prague and Regione Toscana.
- Use Cases for Co-Cities described using UML, which are partially based on the services defined by the In-Time project and are focused on the new feedback concept, mechanisms and detailed information
- Use cases and feedback services, where is described how the definition of Use Cases as a starting point for the identification and technical definition of service chain extension allows to identify all needed features to build a system which “closes the loop” from TISPs to the local actors with the feedback information element.
- Feedback Dataset derived from Use case definition, where is defined basic dataset for feed back loop processing.

2 Introduction

2.1 Project summary

The currently existing bottleneck for the dynamic adaptation of traffic management measures according to policy goals is the distribution of information to end users in urban areas and the adaptation of the information provided to the needs of the single user group. Further, current services are not able to deliver any feedback from the end-user to the Traffic Information Service Provider. These aspects are addressed by Co-Cities by providing one standard interface between city traffic information and the Traffic Information Service Providers, the In-Time common interface, secondly, the availability of the full “feedback loop” enables an end to end testing and validation process for the single traffic information service in the cities and elaborates the future expansion steps for cities and service providers.

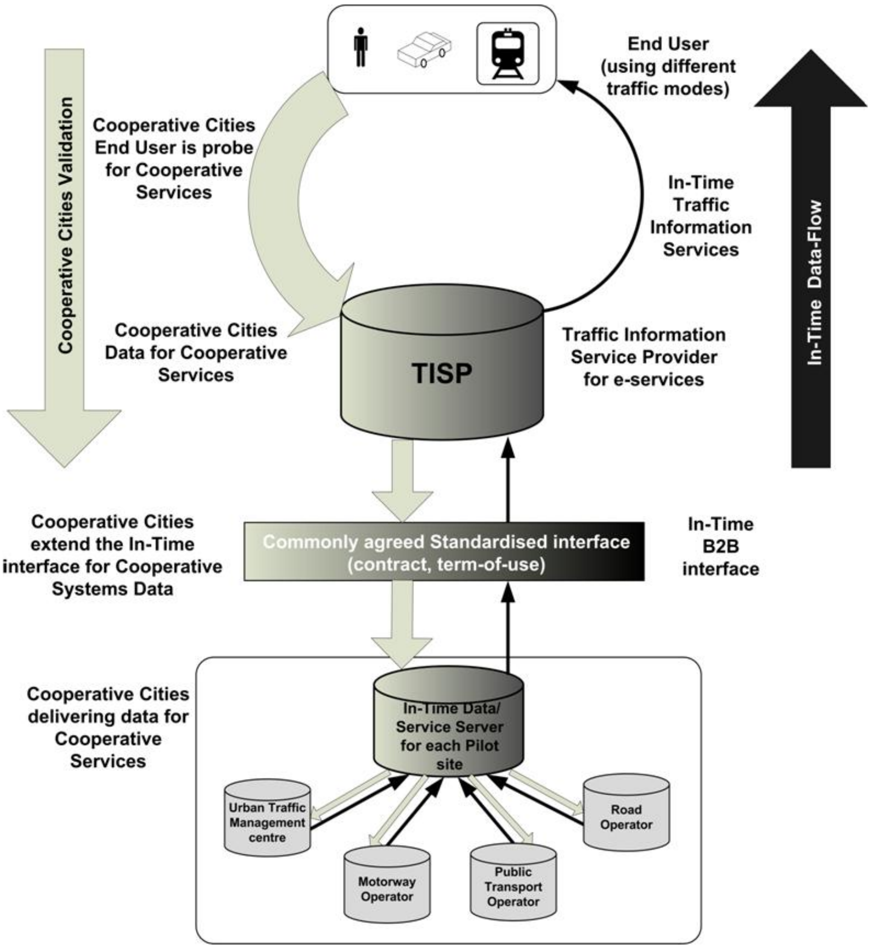


Figure 1: Technical concept from end users to traffic management centres.

The objectives of the Co-Cities project are:

- To extend the In-Time CAI with a 'feedback-loop' to extend mobility services with cooperative elements.
- To develop a fast and reliable validation process for cooperative traffic information services with the use of a "reference platform" with a feedback loop to the cities on data quality and the respective user acceptance of the traffic and travel information services.
- To extend the numbers of cities which install the In-Time common interface and as such be able to offer via their traffic management centre regular feed of data and information.
- To add new service providers as users of these data and allow them to access via the commonly agreed interface these local traffic information services
- To extend the number of traffic and travel information services and provide them in a more integrated and coherent way to the end user and
- To make these services more attractive and appealing to users, which is the basis for the future strength and viability of the business case for transport related personal information services.

The transport information services of Co-Cities are developed in a partnership between cities, public authorities, transport operators and regions on one side. They act as local service/content providers delivering high quality traffic information to Traffic Information Service Providers (TISP) on the other side. TISPs bring in their relations to the end users, customers and the capacity to extend the service concepts and user acceptance. As a useful tool to describe the complex interactions between all the partners involved in the service delivery chain the following value chain model for the activities involved in the service generation is used in this project.

In-Time Dynamic Multimodal Journey Planning		
Mandatory Core Service	**Core Service**	**Add-on Service**
• static road traffic information • dynamic road traffic information (higher road network) • static parking info • static public transport information • walking information	• dynamic road traffic information (secondary road network) • dynamic PT info • dynamic PT journey routing • dynamic parking info • enhanced walking planning • dynamic cycling planning	• dynamic freight traffic information • dynamic POI info • dynamic traffic event information • dynamic weather information • static and dynamic flight information

Table 1: Shows the entire set of services as defined in In-Time.

In-Time services are based on the known needs of mobile users and travellers and proven service concepts. The real challenge for cooperative cities and service providers is the accuracy and quality of the services delivered together with an attractive delivery to the end user in an integrated and consumer friendly way. Because the traffic management centres of Co-Cities combine data and information from several sensors before generating the messages to the Traffic Information Service Providers these services get more accurate and precise in terms of location and traffic impacts. They are delivered faster to the traveller and are integrated in an attractive end user consumer device with the option to directly feedback traffic related events to the cities' traffic management centres.

With this establishment of an automated "feedback loop" from the users to the traffic management, cooperative cities can react to changing traffic conditions and adapt their traffic management and control plans faster than before, communicate changes dynamically to travellers and people on the move and enhance mobility in urban areas.

2.2 WP 2 introduction and goals

The Cooperative Cities work package 2 addresses the definition of the Co-Cities services, related user groups and the validation strategy as a starting point for the project research and development activities. In the following the main tasks of WP2 are outlined:

- Service definition and use cases (SWP 2.1): Define the short list of services for the participating cities and the respective use cases with the necessary elements from an organisational and technical point of view, with the specific focus on cooperative elements of the services.

- User group definition and selection (SWP 2.2): Propose the user groups for the single service defined and the procedure how to involve them early in the development process. Define the necessary groups and their involvement in the process. Additionally to In-Time where B2B services were explored in Co-Cities the end user groups need to be involved, and this is the main effort in this SWP.
- Validation strategy (SWP 2.3): Define the testing and validation steps for the single service in the cities according to the following elements (based on use case list and user groups from previous SWP´s) - existing elements and access to common data interfaces - system extensions and their testing and validation, with requirements and pass criteria in the single validation steps - key aspects of the reference system and the test cases for services and the validation in the single cities.

2.3 SWP 2.1 introduction and goals

Main goal of SWP 2.1 is to define the short list of services for the participating cities and the respective use cases with the necessary elements from an organizational and technical point of view, with the specific focus on cooperative elements of the services. Tasks:

- revise the long list of services based on In-Time and ETSI standards for cooperative systems
- refine service list for the different levels of deployment in the participating cities, short list of core and additional services, list of service packages for e.g. travellers, professional users in the traffic management centres
- define use cases in the cities with reference to existing elements and system extensions and with the methodology based on following value chain for traffic information services, which will be adapted and extended.

This results in a list of use cases as input for system extensions in the single city. The output will also make it possible to the follower cities to assess their current status of available traffic information.

3 In–Time project services

In-Time aims at providing efficient information services in European cities in order to ease the modal shift and positively influence the mobility behavior of individual travellers with the final objective of reducing energy consumption in urban areas. In-Time system has been defined as a service-oriented middleware infrastructure providing service interoperability features in the domains of mobility and traffic which allow Traffic Information Service Providers (TISPs) to operate their value added end-user services by easily accessing data and services from local providers.

The core element for the achievement of the interoperability features is the interoperable, multi-service, **Commonly Agreed Interface (CAI),** a standardized access layer to local RTTI enabling a uniformed access of real-time multimodal traffic data and services typically available in different formats from local providers.

The CAI facilitates the **cooperation** between local **content/service providers** – e.g. Local Authorities, Transport Service Operators, etc. – and TISPs in the provision of value-added RTTI services to travelers. Using the CAI, in fact, TISPs can have knowledge of one single interface to access external data and services thus reducing the complexity needed to add data from more cities. Local contents/services, on the other hand, have generally to be "adapted" to the In-Time format. This may require a technical effort but the result is the availability of such data/services in a format suitable for use by any In-Time TISP thus enlarging the potential audience and number of platforms/channels through which local services/data can be provided.

In-Time was developing and evaluating in six European sites – Brno, Bucharest, Florence, Munich, Oslo and Vienna – the architectural solutions investigated and specified in the FP6 eMOTION project. The design principle of the In-Time Commonly Agreed Interface was, in fact, first defined in eMOTION which introduced the concept of "Single Information Space" with the idea of a unified and standardized specification of data and services in the domain of traffic and mobility suitable to make locally available offerings "understandable" by Traffic Information Service Providers.

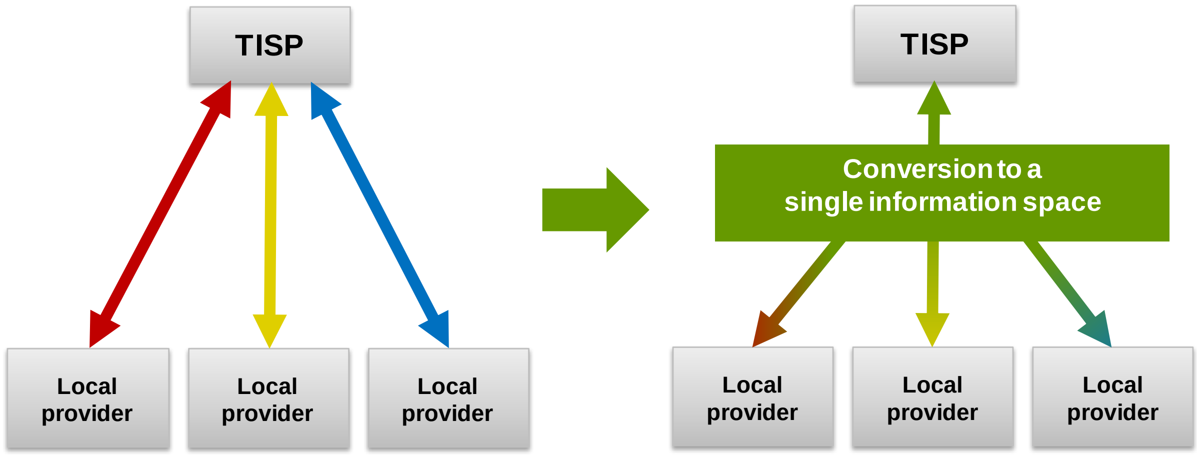


Figure 2: Use of different interfaces to access via a "Single information space" interface.

Based on the In-Time project results the concept behind the use of the CAI revealed to be successful and applicable to any follower city and TISP. This is especially the case of Co-Cities where the CAI will be extended with the specific cooperative elements.

Conceptually, the In-Time CAI has been defined to operate in a number of travel and traffic domains including Static road traffic, Dynamic road traffic & weather, POIs + Static and dynamic parking, Static and dynamic public transport, Dynamic Multimodal Journey Planning. From the identification of these domains the reference service definition and classification has been carried out as a starting point for the definition of the In-Time system architecture and for the identification of the needed CAI features.

Afterwards, in this process of design and production of the CAI specification, all requirements and service definitions identified during the analysis phase have been reviewed against the eMOTION specification. eMOTION mainly focused on the technical and research side and defined a complete and complex specification following a strict Model Driven Architecture approach based on international standards. As a similar complex technical research activity was not foreseen -nor possible in practice- in In-Time, most of the In-Time architecture and system specification have been reviewed and accepted by the In-Time consortium to be inherited from the original eMOTION specifications.

The eMOTION Deliverable D6 "eMOTION System – Technical Specification" is the publicly available background document for the In-Time and Co-Cities specifications. The document is available from the eMOTION project web site: www.emotion-project.eu

The In-Time technical specification, derived from eMOTION, includes:

- a reference conceptual model which describes the data and service provision made available by In-Time through the standard B2B interface. This is largely based on EU ITS and web service standards
- an encoding of the conceptual model in a Geography Markup Language (GML) Application Schema, derived from the Conceptual Data Model and providing the exchange format for In-Time data with other services and applications. GML encodings of In-Time accessible data are embodied into XML schema definitions (XSDs) associated to each Application Schema of the In-Time Data Model.
- a set of WSDL files, generated from the Conceptual Service Model, providing a formal description of the In-Time services usable by external applications according to the standard SOA publish-find-bind paradigm

These elements together with the documentation constitute the building blocks for designing In-Time systems in cities. At the same time they are the basic elements which will be extended in Co-Cities with the cooperative features identified in the analysis and design phase.

3.1 The In-Time service chain

Starting point of the In-Time RTTI service chain is the local data sources and information services available in the site covering different transport domains and services like: individual traffic, public transport, parking, intermodal transport planning.

Such data sources and services can often be combined as *integrated services* available via entities which can be defined as **Regional Data/Service Servers** (**RDSS**). RDSS provides a centralized access point to data and services at local/regional level.

Traffic Information Service Providers – like navigation service providers, journey planning service providers, etc. – can access regional data offered by local content providers (centralized –RDSS- or de-centralized) to build and provide end user B2C Services. Here the main issue of different access conditions (i.e. differences in data formats, interfaces, protocols, etc.) is addressed with the use of the In-Time CAI which implements a set of standardized **B2B services** that facilitates the communication between local providers and TISPs.

A summarized view of the In-Time reference application context, showing the above described service chain with its elements and actors is shown in the following picture:

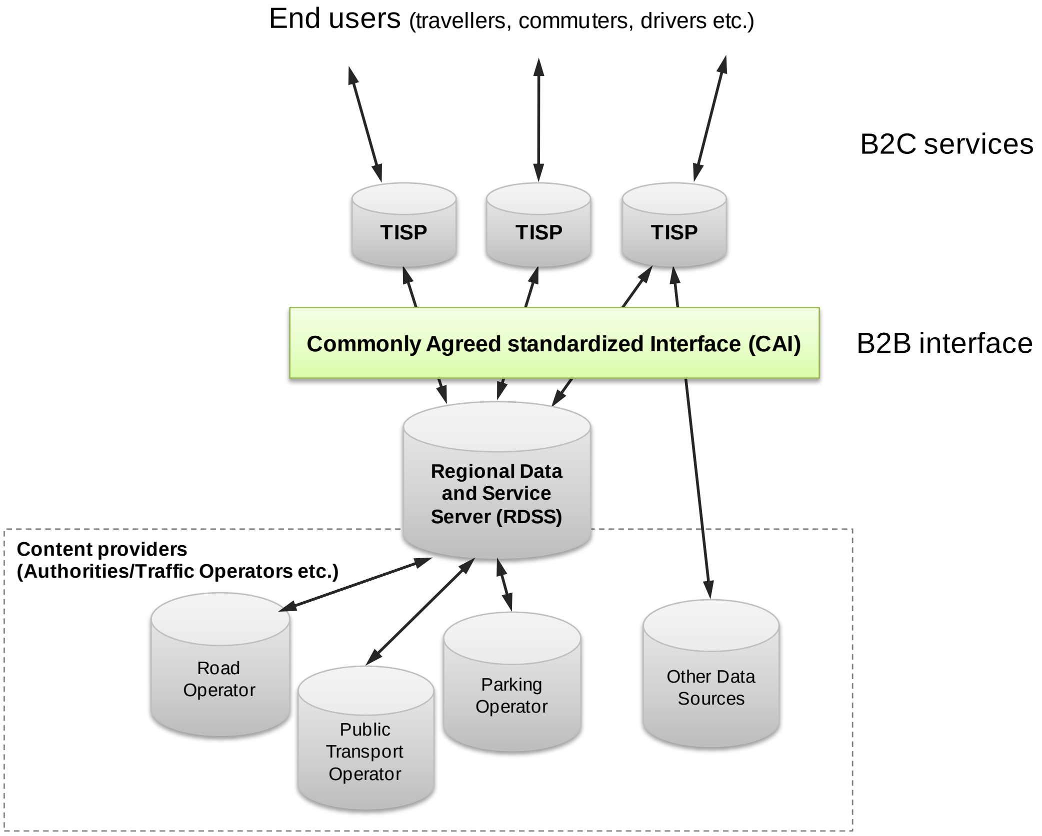


Figure 3: Reference application context for In-Time.

3.2 In-Time services

This definition of services in In-Time consider as a starting point the work of eMOTION project where the service analysis started from the definition of European ITS services carried out by TEMPO which distinguishes between "Minimum ITS Services" and "Common ITS Services". Minimum ITS Services are considered as "being essential and should become available in all Member States" whereas "Common ITS Services "should be compatible wherever available".

Based on this background analysis and on the set of requirements identified for the selected user categories, the target In-Time End-User RTTI services have been defined and arranged into three main groups of different relevance:

1. **Mandatory Core Services**: services which have been identified as necessary to provide a minimum level of information for the users' mobility needs. The implementation of these services was 'mandatory' for In-Time cities.

2. **Core Services**: services which were defined as 'non-mandatory' for the implementation in In-Time but of high relevance for the users' mobility needs
3. **Add-on Services**: services relevant for the users' mobility needs, which In-Time cities could optionally implement.

On top of the Mandatory, core and Add-on services, the 'Comparative Multimodal Journey Planning' Service has been defined as the most suitable B2C service for evaluating the modal shift and the mobility behaviors in a perspective of energy consumption reduction.

3.3 B2B and B2C Services

When talking about "Services" the basic difference, already introduced, between B2B and B2C Services has to be remarked. In-Time defines 17 services and basically they are intended as 'end user services' or B2C services. Nevertheless it has to be considered that:

- To provide each end user service a TISP requires to use or combine data and services available via the B2B interface from local providers. This suggests that a correspondence between a B2C and a B2B service in the same specific service domain exist.
- Although a TISP can implement each single In-Time B2C services, a real end user service will be more likely a 'complex' application which uses or combines one or more basic content/services available via the B2B interface.

The 17 In-Time services can then be intended as:

a) B2B services if they are available from cities via the In-Time interface. They are "consumed" by TISPs to build B2C end-user services. B2B Services comprises the entire set of 17 In-Time services and are basically of two types:
    a. OGC WFS Data Services (for the provision of data like traffic data, parking data, Public Transport data etc.)
    b. SOAP Services (the Multimodal Journey Planning Service)

b) B2C Services if they are built by TISPs using data available from cities via B2B services (which means: via the In-Time Interface). They are 'end user services' proper and each TISP can implement them using the preferred technology, end user interface etc..

3.4 In-Time services

In the following sub-sections the 17 In-Time services are briefly described.

3.4.1 Static road information

The purpose of the service is to provide static road information without any real-time interaction. This includes for example static road network information.

3.4.2 Dynamic road traffic information

The purpose of the service is to provide dynamic road traffic information about current or future traffic conditions. The service can be provided as pre-trip information service to plan a route or to select a destination or travel mode depending on the current or future traffic conditions.

3.4.3 Static parking information

Static parking information contains information around parking situation in a city. The following different parking information can be part of an In-Time service: parking facilities in general, parking garages, total number of parking lots, park and ride capabilities, different parking tickets, parking restrictions (e.g. place, closing times, vehicle types), differences in duration of parking (short-term, mid-term, long-term), cultural parking (e.g. parking garages next to theatres, cinemas,...), parking guide systems, parking type (covered/open air/mixed). The static information about individual parking lots includes: lot location, lot entrance locations, hours of operation, rates, lot capacity (number of spaces), lot type (Open Lot, Covered Garage, Permit Parking, Contract Parking, Free Parking - include P+R lot, Paid Parking, other), lot constraints (heights, type of vehicles, etc.), and handicap accessibility features.

3.4.4 Static public transport information

Static public transport information provides information about: time table, stops positions, stop related time tables, fares, rules, about all PT modes (Bus, Tram, Metro etc.); different ticket types.

3.4.5 Static walking information

Static walking information provides essential information for pedestrians for planning a trip.

3.4.6 Dynamic Road Traffic Routing Information (Core)

Dynamic Road Traffic Routing Information provides dynamic information about current conditions for specific connections from origin to destination for route planning or turn-by-turn navigation.

3.4.7 Dynamic public transport information

Dynamic public transport handles content like qualitative conditions of transport service, waiting times, regularity of service, news and transport services changed/cancelled.

For an In-Time service the forecast of next passage is relevant, that means dynamic interpolation of the theoretical timetable and the real position of the transport is necessary. Also the regularity of service is of prime importance, that means quantitative and qualitative evaluation of the gap between the real transport service and the scheduled one must be covered.

3.4.8 Dynamic public transport journey routing

The main goal of journey planning for a connection between a given origin and destination using public transport is to get information about the time of departure, connection and arrival (besides time of journey) based on static timetables as well as the modes (tram, bus, train, etc.) to be used. Additional notifications of delays or cancellations would be desirable, to enable travelers to change their journey plan.

The functions addressing dynamic public transport journey planning and routing require timetables of the various public transport services (trains, buses, ferries, planes, etc.) as well as information about the current conditions of service (delays, cancellations, etc.).

Dynamic public transport journey routing is very closely connected to dynamic public transport information as described in the section above.

3.4.9 Dynamic parking information

This service is offered additionally to static parking information, along with the current and possibly forecast availability of selected, automated city parking. The information returned by the In-time-Service includes parking facility name, location, parking type (covered/open air/mixed), total number of parking lots, parking restrictions (closing times, vehicle types), and actual or forecast number of free lots.

3.4.10 Dynamic walking planning

Dynamic walking planning provides information such as routes, type of route (circular, linear), level of walk (easy, leisurely, moderate, strenuous, technical), distance, estimated walking time, weather information (e.g. recommendation of heat protection), clothing recommendation (e.g. water proof jacket) and condition of landscape. Furthermore, updated walking information, e.g. actual changes in walking ways (construction, temporary closures, etc.) may be given to the user. Using this information, the end-user is re-routed accordingly.

Normally paths should be waymarked with country codes at regular intervals and at junctions with a distinctive path logo, usually on a metal or wooden post. In reality, there will be occasions when the waymarkers are missing or hard to follow, so the In-Time-Service guides the end-user to the planned destination via mobile guide.

Forced breaks due to injuries, or just tiredness, may mean that an end-user needs a shortcut home. A proposed back-up route, prepared before hand and delivered by the service will make it easier when out in the countryside to think quickly and act appropriately.

Opportunities for e.g. camping and overnight stop-overs could be provided by the In-Time service.

3.4.11 Dynamic cycling planning

Dynamic cycling planning provides information such as routes, type of route (circular, linear), type of terrain (bridle ways, fields, muddy tracks, public right of way, public byways, roads), distance, estimated cycling time, accessibility (begins/ends near bus route, begins/ends near parking, begins/ends near train station...), weather information (e.g. recommendation of heat protection), clothing recommendation (e.g. water proof jacket) and condition of landscape for a specific connection from origin to destination.

3.4.12 Dynamic freight information

Dynamic freight information provides dynamic information for specialized traffic such as waiting times at border crossings, ferry time tables or weather information for freight traffic.

In addition to traditional navigation services, this service aimed at freight industries may include the ability to specify multiple drops and optimize the route between drop points.

For unfamiliar drivers, particularly when involved in multiple-drops and home delivery operations, access to detailed information on exact delivery locations is important, as is information on parking facilities, goods-in entrances, etc. In terms of weather advice, high winds have the potential to topple high sided vehicles, so apart from receipt of weather information, drivers should be able to find out whether wind protection is available on bridges being travelled across.

Heavy goods vehicle (HGV) drivers are subject to further restrictions than other drivers, so this information should be provided.

3.4.13 Dynamic POI information

Points of interest can be of different type, depending on the user’s needs. Therefore different POI types are provided (e.g. by Tele Atlas) such as: Museum, Post Office, Court House, Railway Station, Park and Recreation Area, College, etc.

For each of these POI’s detailed attributes can be provided: national and local importance Name and alternative name, Address information: ID, parsed street name, house number range, Postal Code, municipality, built-up area , Contact information: Telephone, E-mail, URL, POI relationships

3.4.14 Dynamic traffic event information

Services in the area of event traffic can be of all types described whereas subscription services will not be of practical relevance because of the characteristics of events. Information and monitoring services interact to provide updated on-trip information.

Dynamic traffic event information provides information about temporary parking facilities, public transport lines for temporary rerouting around the affected area.

An event in the meaning of this service represents an important occurrence (e.g. cultural, sporting) attended by an excessive number of visitors causing a noticeable (and negative) effect on traffic conditions. Services in this category include trip planning, especially for non-residents, information about public transport or multi-modal connection, or traffic routing including appropriate parking facilities around the event location, route guidance including monitoring of traffic and parking conditions, as well as dynamic information for public transport or multi-modal trips to ensure connections.

3.4.15 Dynamic weather information

Dynamic weather information provides information for a specific road, route or administrative area with filters for specific message type and specific validity periods

Dynamic information about weather in most cases covers common weather data like temperature, precipitation or wind direction/wind speed for regional areas, road traffic related weather messages and warnings like fog, ice and heavy rain. This kind of information shall improve road safety and can affect the route chosen, departure time, stopovers, etc.

3.4.16 Static and dynamic flight information

Static and dynamic flight information provides information such as: time tables, destinations, stop related time tables, fares, rules, different ticket types, flight companies, connected PT modes (bus, tram, metro etc.), accommodations, prognosis of real-time departures/arrivals.

3.4.17 Comparative dynamic multi modal journey planning

Dynamic multi-modal journey planning provides dynamic information to allow the end-user a comparison between the different transport modes to generate an ideal (fastest / shortest / cheapest) travel route;

The end user is interested in a global view of his/her individual trip. Therefore a comparison with normal travel time is the main aspect of the requested information. The choice of the fastest / shortest / cheapest route can vary based on the travel purpose. Timetables or route information of a navigation system reflect a standard situation that is not satisfied if e.g. the travel time is clearly exceeded. If information is provided for several modes, the response should be dynamic information in order to allow the user to optimize their trip. The basic decision to choose a specific mode depends on deviations from normal travel situations. From the end user's point of view, a delay on the train may be more acceptable than being locked in congestion on the urban road network. Following this pattern of thought, the information offered must cover the entire travel chain and may recommend changes of the mode during the trip.

With such a global view of possible routes the end user is able to find a decision that fits to his/her individual travel requirements. In summary, the end user is interested in the following points:

1. Travel information showing the fastest/shortest/cheapest route from point A to point B with the option to choose several means of transport
2. The response to a specific route request can either be a comparison between several transport means (train vs. car) or a proposal to chose an inter-modal trip using several means of transport to get from A to B (e.g. take the train, then the ferry, then the bus etc.)
3. Provisional travel time, time for interchange, waiting time.

3.5 Classification of services in In-Time and Co-Cities

While the Co-Cities services definition strongly relies on In-Time, the classification given in the previous section has been re-discussed in Co-Cities considering the specific cooperative requirements and features which have to be provided by the new services. A key parameter which is used to classify In-Time and Co-Cities services is the domain in which each service operates.

The classification of Co-Cities services in terms of Service Domains reflects some optimization criteria identified in the light of the experience gained in In-Time. These optimizations are of two types and are listed in the following table:

In-Time services definition	Optimization
Some services are differentiated in terms of Static and Dynamic information (examples: Public Transport, Parking)	One single definition for services featuring static and dynamic elements
Different service definition for single-mode journey planners	One single definition of 'multi-modal Journey Planner' service

Table 2: Classification of services in In-Time and Co-Cities - differences

In the light of these criteria some main service domains can be identified including:

1. Static and dynamic **road traffic**, including weather
2. **POIs**
3. Static and dynamic **public transport** (including flight)
4. Multimodal Dynamic **Journey Planning**.
5. **Parking**

The complete and exact definition of Co-Cities Services Domains has to be cross-checked with the Co-Cities Use Case definition (section 5).

4 Report of currently operated traffic management and travelling information systems in each pilot city

4.1 Introduction

This chapter includes survey of existing traffic and public transport management systems in each pilot cities, although pilot cities differ with respect to the implemented Traffic Management and Information System (TMIS), chapters are organized in a way, that shows the key features of the respective TMIS systems.

Every major chapter contains several subchapters that describe the TMIS´s architecture and its properties, available services and data content. There is short notice about using CAI (Commonly agreed interface) in concrete pilot city at the end of each major chapter.

4.2 Prague

4.2.1 Overall description of pilot site

Prague is the capital of the Czech Republic. It is the country’s largest city and principal office of many international organizations. 1,21 million inhabitants live on an area of 496 km2.

Prague has (by European standards) slightly above-average urban public transport systems included Prague Integrated Transport. It consists of:

- Three lines of metro (labelled A, B and C)
- Tram (numbers 1-26)
- Bus lines: urban daily (numbers 100-297), suburban (numbers 301-398), non-urban (401-495), urban night (501-516), suburban night (601-609) and school buses (551-571)
- Funicular to Petrin
- Traffic on rail lines
- Six ferries

Prague has one of the highest rates of public transport usage in the world with 1.2 billion passenger journeys per annum. Per capita usage of the Prague metro is the highest in the world.

Prague's tram network is one of the biggest in the world by other measures: it runs more trams (900), has more routes (33) and carries more passengers (356 million), the third highest tram patronage in the world after St Petersburg and Budapest. All services have a common ticketing system, and are run by the Prague Public Transit (Dopravní podnik hl. m. Prahy, a.s.) and some other companies. Recently, Prague integrated transport coordinator (ROPID) has franchised operation of ferries on the Vltava river, which are also a part of the public transport system with common fares. Taxi services operate from regulated taxi stands, and from independent drivers who make pick-ups on the street.

The total transport output of municipal and suburban lines included in the PIT system operated by DP including a special line of transport for persons with limited orientation abilities and movement reached 162,937 thousand car kilometres (car/km). The transport volume expressed in seat kilometres (s/km) is 20,828.222 million s/km. The transport output in car/km increased year-on-year by 0.33%, the seat/km volume increased by 0.79%. This diference is affected by servicing a higher number of articulated vehicles at the expense of the standard ones.

4.2.1.1 Prague Subway

The Prague Metro is a subway, undeground public transportation network in Prague. It is the fastest means of transportation around the city and serves about one and a half million passengers a day, which makes it the seventh busiest metro system in Europe and the most-used in the world on a per capita basis.

The Prague Metro comprises three lines, each of which is represented by its own colour on the maps and signs: Line A (green), Line B (yellow) and Line C (red). There are 57 stations in total (three of which are transfer stations) connected by nearly 60 kilometres of mostly underground railways. Over 500 million passengers use the Prague Metro every year.

The metro is run by the Prague Public Transit Company Co. Inc. (in Czech officially Dopravní podnik hlavního města Prahy a.s.) which manages all means of public transport around the city (the metro, tramway, buses, the funicular to Petrin Hill and the chairlift inside Prague Zoo). Since 1993, this system has been connected to commuter trains and buses and also to "park-and-ride" parking lots. Together they form a public transportation network reaching further from the city called Prague Integrated Transport (Pražská integrovaná doprava—PID). Whilst the large system is zonally priced, the metro is fully inside the central zone.

4.2.1.2 Railway

The city forms the hub of the Czech railway system, with services to all parts of the Czech Republic and abroad. The railway system links Prague with major European cities, including Munich (Germany); Berlin (Germany); Warsaw (Poland); Budapest (Hungary) and Vienna (Austria) (all of which can be reached without transfers).

4.2.1.3 Prague Tram

The Prague tram system is the largest tram system in the Czech Republic, consisting of 140 kilometres of track, over 900 tram cars, and 33 lines with a total route length of 540 km. It is operated by Dopravní podnik hlavního města Prahy a.s., a company owned by the City of Prague.

4.2.1.4 Buses in Prague

The bus service in Prague is provided by several transport operators, chiefly by Dopravní podnik hlavního města Prahy, a.s. (Transport Company of the Capital of Prague, plc.). The base system of metropolitan and suburban transport is Prazska integrovana doprava (Prague Integrated Transport) organized by Prague municipal organization ROPID but several urban and suburban lines don't belong to it. PID system includes also metro and tram lines, Vltava ferries, a funicular and partly railway transport. DP operates within the Prague Integrated Transport a road network 823 km long, 118 daily municipal lines, 16 suburban lines, 15 school lines, 16 night municipal lines, 1 night suburban line and 1 line for persons with limited mobility. The overall length of all 166 lines was 1,809.00 km.

4.2.2 Introduction of the TMIS

Prague Integrated Transport (PID) is a transport system including Metro, trams, railways, city and suburban bus lines, funicular and ferry. This system is gradually integrated by common transport and tariff conditions and by a unified transport solution including coordination of schedules.

The PID system consists of the 3 metro lines that serves as an artery of Prague´s PT transport system. In addition there are about 133 km of tram lines and several bus lines. The connection to the outer regions of Prague is covered by regional buses and commuter train lines. Prague´s citizens as well as tourists can make use of the PT static route planner that provides route description from any origin to any destination within the covered region. The static PT route planner is located at: www.dpp.cz.

Dynamic information about departures is currently not available to end-users, although the dynamic data are collected from the majority of the PT vehicles.

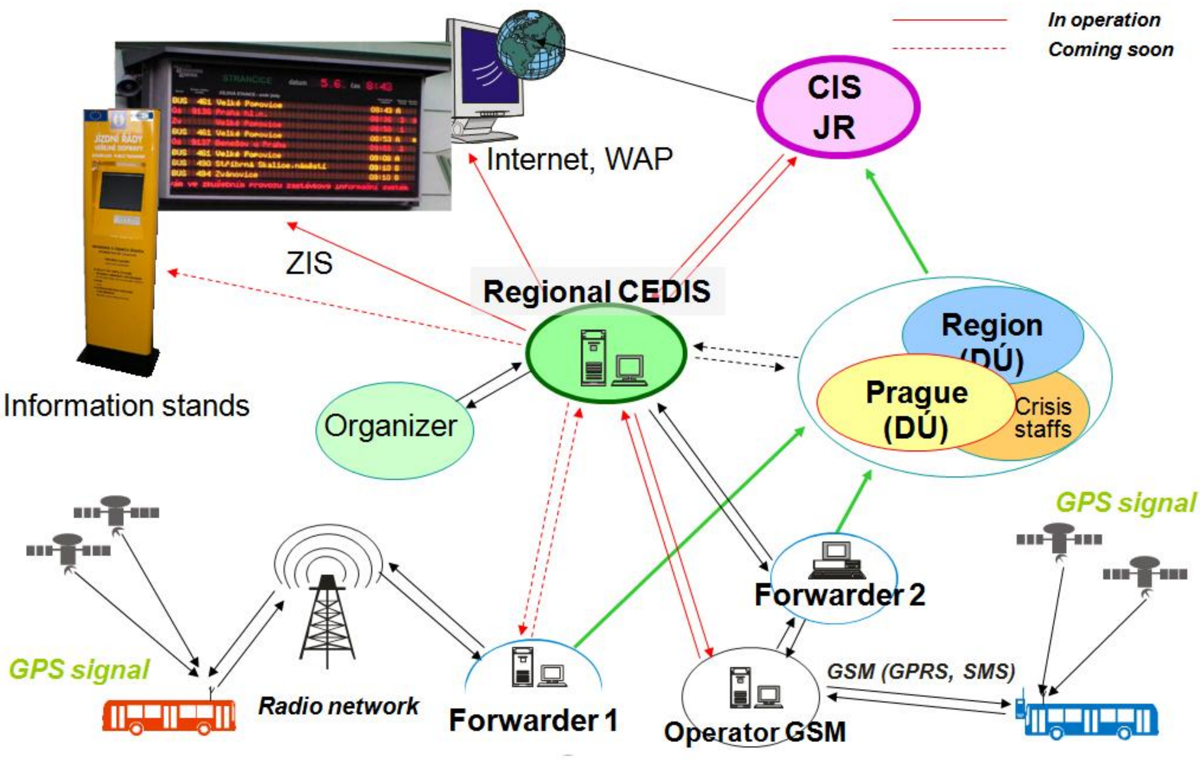


Figure 4: Layout of transport system of PID.

The vehicles (buses of PID except buses of DP) are equipped with RCA (Radio adapter) or modem, which contains both the GPS module and a SIM card for data transfer. RCA (or modem) is connected with the board computer in a vehicle. The board computer sends information about GPS location, reason to send the message, vehicle number, line number, traffic channel number, tour and additional data based on pre-defined parameters. The messages are sent on the basis of the following: bus stop notification, line/channel change, starting (the lowest speed exceeding, 10 km/h predefined), moved distance exceeding (it varies from 200 m to 2 km), the highest defined speed exceeding (c. 80 km/h), time passed since the last report (2 min.), entering the station, exiting the station. These messages are sufficient to show the trajectory of the vehicle and provide the connection with time table.

The dispatcher enters every day the dispatch schedule, so that the system knows which vehicle is deployed on what line and channel/circle. The data from vehicle are sent to the defined IP address via GPRS by a public mobile net. On the server, the messages from vehicles are connected with timetables (the timetables in National Information System on Timetables CIS JR are crucial).

Employees of ROPID (checking the timetables compliance, finding the records and evidence to solve the complaints), employees of transport-union of Central Bohemia Regional Authority and MHMP have an access to the internet application MPVnet, where the processed data are displayed (the MPVnet is provided by CHAPS). This application is available also to the councils and municipalities that can find out the performance within the frame of their register. As a matter of course, carriers have an access to this application too.

Only dispatchers and selected employees of ROPID have an access to the local application MPVDesktop. MPVDesktop provides an access to the code list of vehicles, circles´ catalogue, operative changes in dispatch (Real Dispatch) and dispatch overview.

4.2.3 Features and functionalities available to users of the Prague´s PT system

All official information related to the Prague´s public transport is covered by the web portal www.dpp.cz. As stated in the introductive part, static journey planner generates any public transport connection by taking into the consideration all PT modes of the public transport and moreover provides also separated PT schedules for selected PT line or stop point. More than a million passengers uses the Prague´s public transport system a day. The official information about the average visit of the portal is not available but according to the logged number of visits in the searching part of the portal the quantity is estimated to exceeds 50 000 visits a day.

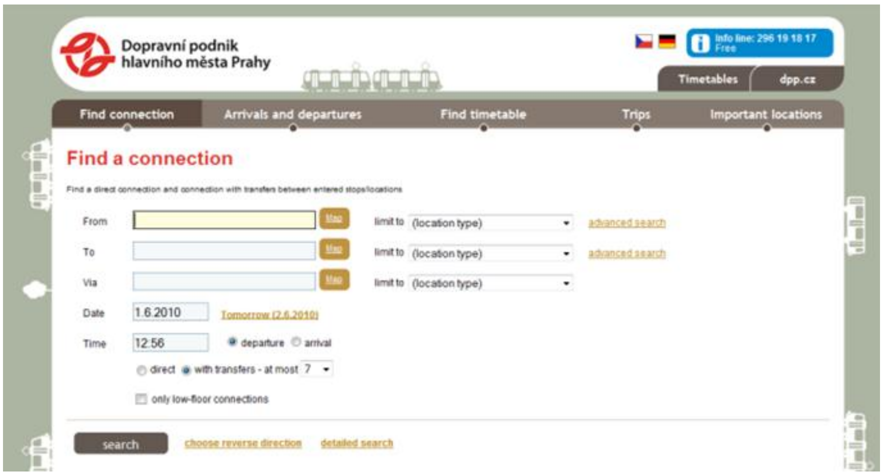


Figure 5: Prague´s PT system.

Some remarks related to current system:

- The system is built as open (based on CIS JR) - a prerequisite involving other regular forwarder (some forwarders already use system outside PID system).
- Information about capacity of communications.
- Feedback control of real number of connections that were made.
- Putting into service of automatic reports to ensure follow-up to/from vehicles.

4.2.3.1 Available services

Available services are summarized in the tables below distinguishing from individual and public transport area. The first table describes the individual transport services. The second table describes the services related to the public transport.

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Traffic conditions	Traffic Levels Information - Current		x
	Congestion Information – Current		x
Parking Facilities	Parking Spaces Information - Current	x	
Roadnetwork Information	Road Closures Information	x	
	Roadwork Information	x	
Driving Conditions	Weather Conditions Monitorting		x
	Weather Conditions Prediction		x
	Weather Conditions Alerts		x

Table 3: Prague´s individual transport services.

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Network Information	Bus (lines, stops, and other info)	x	
	Tram Service (lines, stops, and other info)	x	

	Train Service (lines, stops, and other info)	x	
Time Tables Information	Bus Service	x	
	Tram Service	x	
	Train Service	x	
Time Tables Deviations	Bus - current	x	
	Tram Service - current	x	
	Train Service - current	x	
Tariff Information/Schemas	Bus Service	x	
	Tram Service	x	
	Train Service	x	
Park & Ride Information	Locations	x	
	Opening Hours	x	

Table 4: Prague´s public transport services.

4.2.4 Individual traffic

The information from the road network is provided by Road operator “Technicka Sprava Komunikaci” (TSK). Drivers are supplied with information on the current occupancy of the P+R parking facilities and with the traffic levels and the information about road closures and road works. This information can be obtained from the portal http://www.tsk-praha.cz/web/doprava/ provided in the static map. Moreover images from the selected junctions are also available as well as weather condition collected from several measuring points.

4.2.5 Using CAI in Prague

CAI has been implemented for Prague’s public transport within CoCities project, there is used multimodal journey planning (service 17).

4.3 Vienna

4.3.1 Overall description of pilot site

Vienna is the capital of the Republic of Austria. It is the country's largest city and principal office of many international organisations. 1.67 million inhabitants live on an area of 414 km².

Currently Vienna's road network consists of 6 479 roads with a total length of 2 793 kilometres and 47 kilometres of motorway. Each citizen covers a distance of approximately 18 kilometres per day, which makes a total of 27.2 million kilometres daily for all inhabitants. Vienna has a well-developed public transport network of buses, trains, trams and underground lines. Vienna public transport operator offers five underground lines, 31 tram and 80 bus lines. The vehicle fleet currently consists of 600 tramcars and 500 buses.

Vienna is also the centre of the Vienna region. The Vienna Region consists of the three federal states Vienna, Lower Austria and Burgenland and is located in the eastern part of Austria respectively in Central Europe. With an area of 23 558 km² the Vienna Region is living space for about 3.53 million people, which is more than 40% of all inhabitants of Austria.

Vienna, Lower Austria and Burgenland are connected with each other in many fields, also in traffic affairs. For example, more than 200 000 commuters come to Vienna from the surroundings every day. Therefore traffic management and information only makes sense with a regional perspective. This is why ITS Vienna Region was founded by the three federal states of the Vienna Region as a cooperative project in the year 2006.

4.3.2 Introduction of the TMIS

Project ITS Vienna Region started in Sept. 2006 to build a Traffic Management and Information System for Vienna, Lower Austria and Burgenland. Related surveys are dated to 2001, real life operation begun during the European Soccer Championship in June 2008.

4.3.2.1 Architecture and concept

Overall architecture of the deployed system is presented in the figure below.

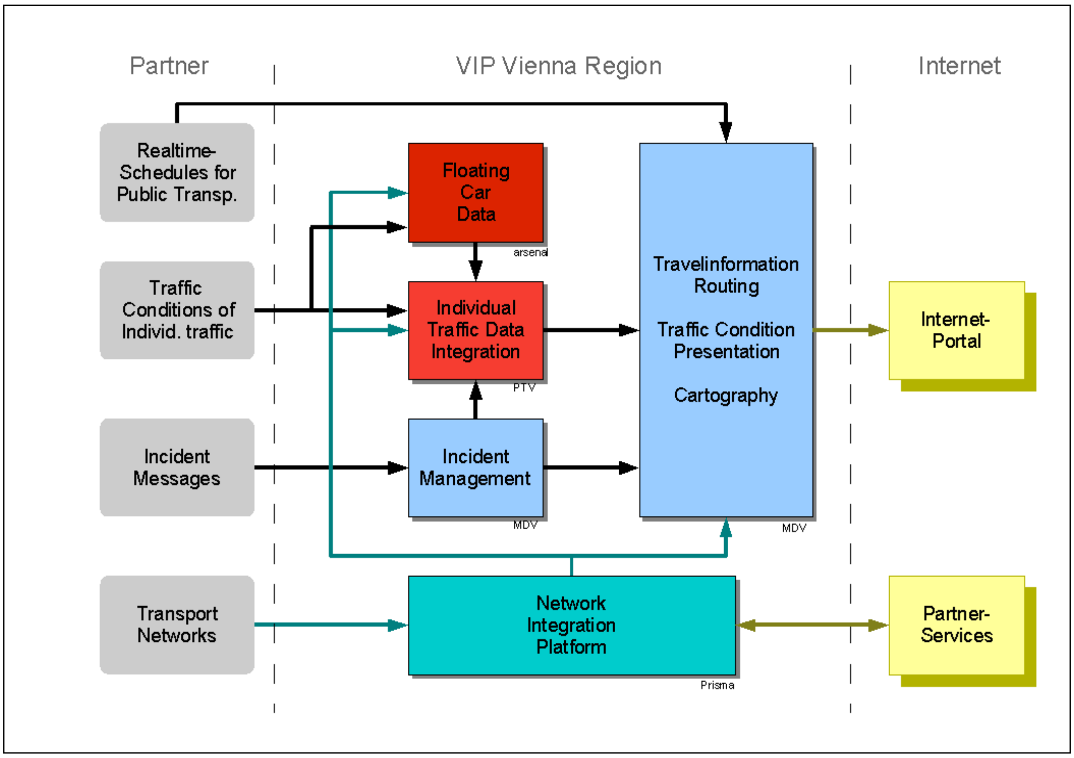


Figure 6: Overall architecture of the Vienna´s TMIS.

4.3.3 TMIS description

ITS Vienna Region provides real time traffic information for all modes of transport: Public transport, car traffic, bicycling and walking as well as parking and Park & Ride, Bike & Ride.

The traffic information is provided to the general public over the internet and via mobile devices. Via cooperation with the Austrian broadcasting operator the messages are provided to navigation systems by means of TMC.

Current traffic information is used to optimise the coordination of traffic lights in Vienna and in St. Pölten. Optimising Public transport is a major goal in this project. Cooperative traffic management with the motorway operator ASFINAG has been installed so that routing advice for the city can be displayed on the variable message signs on the motorway.

4.3.3.1 Data collection

There are about 350 traffic sensors in the city of Vienna and about 80 traffic sensors in Lower Austria and Burgenland. Data is received from about 250 sensors on the motorways. In addition floating car data from about 2500 taxis in Vienna is used.

Car traffic messages come from the Austrian Broadcasting Operators, the police, the city of Vienna, ASFINAG, Lower Austria and Burgenland. From the public transport operator in Vienna Wiener Linien messages and department time prognoses are obtained via a VDV 454 interface. The ÖBB also provides messages.

The network graph contains all modes of transport including bicycle infrastructure and routes and footpaths (parks, forest, cemeteries, etc.). The network graph is constantly updated by our partners.

Most of the interfaces are programmed by ITS Vienna Region. This results in the flexible use of all available data.

4.3.3.2 Implemented software tools

Within the Vienna region the following key software instruments have been utilized in the TMIS:

- Fleet: FCD-Server from Arsenal research
- PTV Traffic platform: Online traffic model from PTV
- EVA/DIVA: Traffic information system for the internet by Mentz-DV; with extensions

- GIP: intermodal reference network by PRISMA Solutions using ESRI ArcMap as one possible Client
- Various open source software: Mapserver, etc.
- Various interfaces and support software by ITS Vienna Region

4.3.3.3 Interaction with other systems

There are an extensive number of systems which are in interaction with the TMIS. Detailed interface specifications were designed and agreed upon the VIP Vienna Region research project. Many interfaces are custom designed to guarantee performance and timeliness.

Standardised interfaces used are listed below:

- VDV 454
- DatexII
- GML / OGC-Standards; WMS
- IDF – INTEREST Data Format (compatible with VIP Bayern)
- XTIS (for PT realtime messages)
- TIC-XML (XML format of GEWI TIC for car traffic messages)

The internet connectivity as available as follows:

- 100 Mbit/sec fiber optics
- 10Mbit/sec copper as cold backup

4.3.3.4 Additional information

All information on the internet traffic information site is available in XML.

All routing requests can be sent via HTTP to the router. The result is always a response in XML. This XML-response contains everything for the display of the rout alternatives (lists, links, images, coordinates of the route, etc.). The HTTP requests and the XML responses are well documented. On the internet site, the XML is transformed to HTTP and AJAX-Requests via XSL.

Many other systems use the Request – Response system that integrates the routing into:

- Mobile application

- Collective taxi systems
- Etc.

4.3.4 System functionalities

4.3.4.1 Available services

Available services are summarized in the tables below distinguishing from individual and public transport area. The first table describes the individual transport services. The second table describes the services related to the public transport.

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Traffic conditions	Travel Times Information - Current	x	x
	Travel Times Information - Predicted	x	x
	Traffic Levels Information[1] - Current		x
	Traffic Levels Information - Predicted		x
	Congestion Information - Current		x
	Congestion Information - Predicted		x
	Alternative Routing		x
Parking Facilities	Parking Spaces Information - Current	x	x
	Parking Spaces Information - Predicted	x	
	Routing to Parking Facilities	x	x
	Parking Tariffs	link	
	Opening Hours	link	
	P&R Facilities	x	
Road network Information	Speed Limits Information	x	
	Road Closures Information		x
	Roadwork Information		x
Driving Conditions	Weather Conditions Monitoring		x
	Weather Conditions Prediction		x
Tunnels & Bridges Conditions	Tunnels closures		x
	Tunnels Incidents		x
	Bridges closures		x
	Bridges Incidents		x
Incident Management	Incident Information		x
	Incident Impacts Information		x
	Alternative Routing		x

Table 5: Vienna´s individual transport services.

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Network Information	Bus (lines, stops, and other info)	x	x
	Tram Service (lines, stops, and other info)	x	x
	Train Service (lines, stops, and other info)	x	x
Time Tables Information	Bus Service	x	x
	Tram Service	x	x
	Train Service	x	
Time Tables Deviations	Bus - current		x
	Bus - predicted		x

[1] Traffic level is a term that describes qualitative classification of traffic density. Classification of traffic is often done in the form of a six letter A-F level of service (LOS) scale, or for wide public usage it can be expressed directly in the digital road map in terms of colors that are matched to each level of traffic. Green road usually stands for uncongested road, red for congested road ("traffic jam"), etc.

	Tram Service - current		x
	Tram Service - predicted		x
Park & Ride Information	Locations	x	
	Opening Hours	link	
	Tariffs	link	
	Routing to P&R	x	x
	Occupancy/Vacancies - current		x
Other	Cycle router with dynamic information	x	x
	Detailed routing for pedestrians	x	
	Bike & Ride, ...	x	x

Table 6: Vienna´s public transport services.

4.3.4.2 Geographical coverage of service

ITS Vienna Region has created a new common network (GIP – Graph Integration Platform) which also serves as a reference system for the Vienna city administration, for the traffic administration of Lower Austria as well as for the public transport map of Vienna Region (VOR).

The new common network is GIS based with distributed storage and with well-defined procedures for combining the data systems at the borders. The different attributes can be given to segments of links so that dynamic segmentation and events are possible.

While the municipalities of the federal states carry on with their decentralised data management and update, ITS Vienna Region takes care of quality management and efficient communication routines among the almost independent sub-networks. The network is used by and synchronised with the schedule of the public transport association of the VOR.

4.3.5 Using CAI in Vienna

Vienna is one of pilot cities for In-time project, there is operated CAI for these In-Time services:

- Multimodal journey planning (service 17)

4.4 Reading

4.4.1 History and the date of the TMIS establishment

Reading's Traffic Management and Information System is built on the UK's Urban Traffic Management and Control (UTMC) standard which has been adopted by more than 100 cities and authorities in the UK.

The UTMC standard has been in development since the early 1990's, initially as a Department for Transport (DfT) research project. The major step forward came between 1997 and 2003 with a £5M funded programme where Reading was one of four demonstrator projects.

Reading remains a UTMC development authority and Simon Beasley (RBC Network Manger) also chairs the UTMC Development Group (UDG) which was set up for the maintenance and continued development of the UTMC specifications and standards.

The Reading demonstrator project, which focused on providing travel information through UTMC, was well received throughout the UK. The web-site www.reading-travelinfo.co.uk remains one of the most comprehensive in providing travel information relevant to all modes. Reading is at the forefront of development in transferring the live website data into formats that can be received by mobile telephone, with the objective of reaching a wider audience.

Continued expansion of the information services now provides and will provide:

- Live bus stop service arrivals
- Live traffic congestion and live rail information
- SMS and email alerts for train services from Reading Station
- Car park capacity at all central multi-story facilities
- Search Bus Stops by Postcode
- Future SMS service to include Car Park spaces available
- Modal Choice
- Journey time for specific routes
- Map based travel service
- Road works and incidents

- Traffic Cams' still images and video clips
- Mobile payment for services

Reading also receives live Motorway journey time data from the NTCC (National Traffic Control Centre). This in turn provides a seamless link in travel information from the motorway to the centre of Reading. The inclusion of roadside Variable Message Signs around Reading has been welcomed by drivers. When an incident occurs, messages displayed on the roadside signs have resulted in better-managed situations with fewer driver complaints.

4.4.2 Future of UTMC in Reading

The future of the UTMC is integral to Reading Borough Council's overall Strategy as well as our Transport Strategy by working towards improving transport, the environment and supporting the economic development of Reading.

The very nature of ITS means that UTMC development cannot remain static, it must keep progressing with technology and keep pushing the boundaries of what is expected.

Ensuring that the UTMC thrives will ensure that any ITS projects that are developed have a stable, interoperable 'future-proof' backbone to support their development and success.

The rollout out of WiMAX along the A33 corridor and the Town centre that was developed as part of the SEEDA trial has proved invaluable in enabling cost savings across the network. With IP based technology it so much easier to deploy infrastructure at a reduced cost. This has enabled rapid deployment cameras for Bus Lane Enforcement and has also reduced the ongoing cost of the private wire circuits for communications to the Traffic Signal junctions and the system continues to be expanded.

The vision is to unite public road transport information to enable unified management of Reading's transport resources and. to enable the public to have relevant and correct information when they require it. We are also in development of a new multi media display software that will push out information to 40" display screens across Reading.

The current SCOOT method of network control is no longer the single best option to control congestion. Good, accurate information on all travel options and how they compare is key to encouraging modal shift. Many drivers are simply unaware of the alternatives or do not know where to find the relevant information, so publicity is also key.

Following on from the success of the south Reading demonstrator area, the principles of UTMC have continued to be developed across Reading. Much of this expansion has been in infrastructure hardware in the form of traffic sensors buried within the road surface. The purpose of these additional sensors is to collect accurate information on traffic conditions. Once profiles have been developed, unusual variations in traffic conditions can be easily identified and acted upon. Currently this work is confined to areas where there are traffic signal controlled junctions as funding has been limited.

4.4.3 Architecture and concept of TMIS

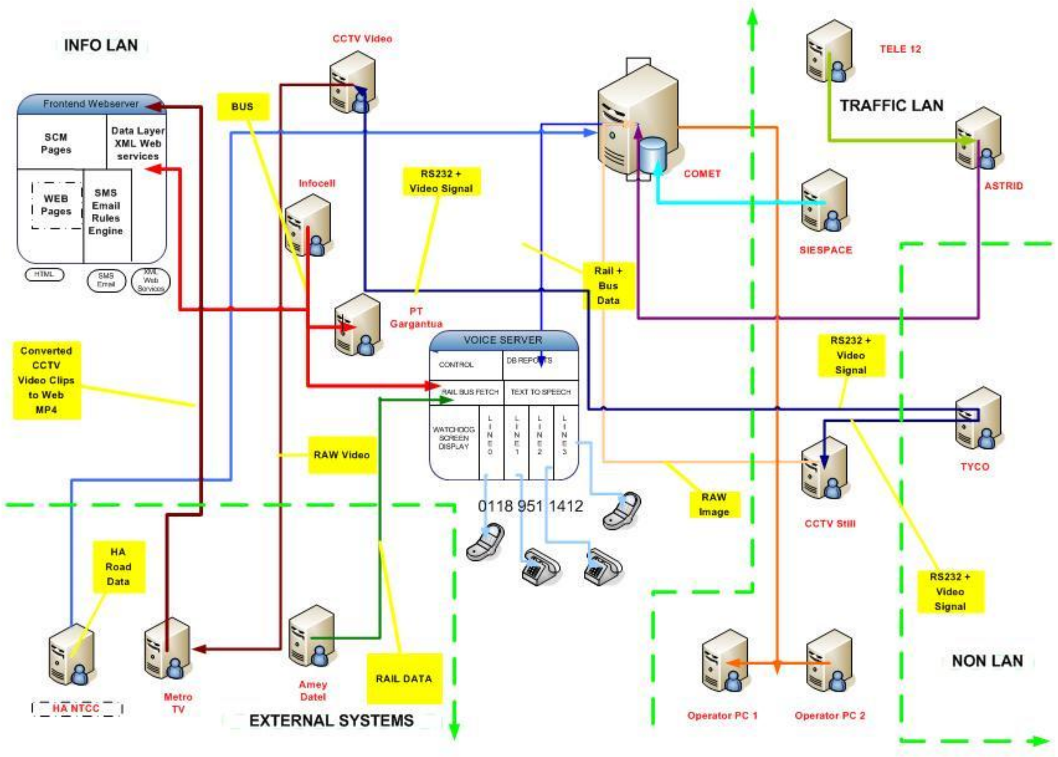


Figure 7: Layout of system in Reading.

The image above shows the layout of the system from around 2007. (Please note the system has changed however the principal is still the same.)

4.4.4 Detailed description of systems' functions integrated into the TMIS

Please provide detailed description of the subsystems incorporated into the TMIS as presented in the question 2. E.g. Tunnels' management, P&R, VMS, Traffic lights, Bike&Ride, PT management, etc.

Network Management Systems

- Siemens COMET UTMC System – Common database which links the UTMC systems together with graphical front end for network management and a strategy development / selection module allowing pre-defined strategies to be set up and implemented. An automated strategy could be e.g. - if car park ‘a’ is full and there is congestion on link ‘b’ then change signal timings to ‘x’, show ‘y’ on variable message signs and provide ‘z’ information to the web / mobile devices.
- Traffic Signal Urban Traffic Control (UTC) (linked to UTMC) – Reading has a mix of fixed time signals, signals under local control and SCOOT optimised traffic signals. SCOOT is a real time system which optimises the green times at each junction and the cycle time and offsets between junctions to minimise delay / maximise capacity. It uses occupancy information from single traffic loops generally located approximately 100m in advance of the intersections to centrally optimise timings across the network. The loop occupancy data can also be used to identify congestion and has also been used in Reading to give an approximation of journey time on some corridors.
- ASTRID – Database which collects historical SCOOT UTC data and can be used in analysing traffic flow trends.
- SIESPACE (linked to UTMC) – Siemens car park monitoring system and VMS management system. All main car parks in Reading have in and out traffic counters enabling real time car park occupancy information and short term occupancy information to be generated. This system is fully integrated into the UTMC system.
- Traffic CCTV cameras (TYCO) – cameras providing CCTV coverage of the main traffic routes in and around Reading. Linked back to a bank of LED monitors in the control centre.
- Automatic Number Plate Recognition (ANPR) - cameras providing journey time information for the A4 corridor
- Real Time Passenger Information System (RTPI) – Reading is currently connecting integrating this to UTMC to provide floating vehicle (car) data (FVD) from the buses for use in Comet for journey time monitoring.

Travel Information Systems

- Roadside Variable Message Signs (VMS) – linked to Comet through Siespace system. Text signs, located mainly on the inbound approaches, which are used to give drivers information on car parking, congestion, incidents, events etc. and have a number of 'at rest' messages including messages to promote the use of bus park and ride.

- Real Time Passenger Information system (RTPI) (formerly Infocel, now Connexionz) – operates separately from UTMC but shares key information with the UTMC system. GPS based Automatic Vehicle Location (AVL) system for the whole bus fleet (approximately 200 buses) providing next bus information at over bus shelters, via the internet and mobile devices.

- CCTV still images and video clips – system for transferring images from the traffic CCTV cameras to still images and MP4 video clips which can be viewed by the public over the internet, via mobile devices etc.

- External Information systems – Reading obtain automatic live feeds from other data sources including Network Rail, Highways Agency data for the motorways and trunk roads, and roadworks.

- Web-site www.reading-travelinfo.co.uk. Provides static and real time information including bus, rail, carparks, CCTV, incidents, congestion and roadworks.

- MetroTV - mobile phone based version of reading-travelinfo.co.uk. Currently unsupported as Reading migrates to a new generation of mobile phone based systems.

- Real time public transport mobile phone application – recently updated app for public transport information. Reading are looking to further develop this to include multi-modal information but will also look to In time applications.

- Voice Service – enables people to phone a number and be given real time information on public transport and car parking.

4.4.5 Detailed technical specification of systems integrated into the TMIS

4.4.5.1 VMS Signs

Reading has 12 VMS (Variable Message Signs) located around Reading and most of the VMS are inbound to Reading. Each VMS can display x characters over x lines and can provide a range of free text messages including advising drivers of parking availability, congestion, and forthcoming events, etc.

Communication for the VMS is through a Vodafone paknet system and it operates a standard X.25 packet-switched network at 8kbit/s radio link and provides seamless interconnection to any other public packet network. There is a base station at the traffic control centre that is linked to the comms server. The signs are managed through the Comet server and messages on the VMS can be triggered on an automatic basis or through manual intervention.

An example of automatic legend changing is the car park information where counts from the car parks are used to provide specific guidance to drivers based on occupancy of car parks and the approach into Reading that they are on. I.e. Oracle car park is full, use Queens Road for drivers coming from the east whereas from the west you might get Oracle car park is full, use Gerard Street.

4.4.5.1.1 COMET

Comet is a UTMC compliant common database provided by Siemens which is at the core of the UTMC system and enables data to be collected from and shared between Reading's network management and travel information systems. Comet also includes a graphical front end for the easy management of information and the systems connected to it. In Reading these systems include the SCOOT Urban Traffic Control (UTC) system, ANPR cameras, car parks, VMS signs, weather, incidents, roadworks etc.

At the heart of the COMET system is a large database of network management information and the database has been designed to be compliant with the data object definitions of the UK UTMC standard. As such, it should be readily compatible with any other systems that are designed to this standard.

The interface is currently the classic CORBA UTMC interface but an XML interface using the SiRI subscription and messaging protocols is now a standard and implementation is believed to be underway. In the meantime a primitive translation of classic UTMC into XML has been provided to support Traak.COMET in Reading also contains a basic representation of public transport real-time data through a basic linking of COMET to the Real Time Passenger Information System. This is entirely stop-based (can we expand on this?).

The database contains both the latest values for many items as well as over 8 years of Reading's historic record and profiles of key data items. These profiles are used in presenting comparative visual indications and are the input to applications such as Predictions. Much of the data is available for external use. The UTMC projects have ensured that a common interface exists to the database. Providing these interface definitions are used, external applications can guarantee that queries will be satisfied by the COMET database.

4.4.5.1.2 Communications and Communications Server

Reading have a dedicated server for communications with UTC (analogue copper lines to traffic signals), UG405 (digital comms for traffic signals), VMS (Vodaphone Packnet radio system) Comet and systems.

Reading have a rolling programme of implementing Siemens Gemini UG405 units in signal controllers which involves switching out the old TC12 copper wire analogue comms and replacing with IP based digital communications. This provides significant operational cost saving benefits as it enables a move away from expensive dedicated leased lines to either WiMAX wireless communications or broadband services which are cheaper to operate.

We have a Westermo digital Router set in the Control Room and all comms is relayed to this single westermo then sent to the comms server to be relayed between systems. This is also the case for the VMS system the Vodafone Paknet is linked to this server. Information is sent form the Comet Server to the comms server then out to the VMS.

4.4.5.2 RTPI Centurion Bus-Stop Unit System Overview

Centurion is a Real Time Information System for Public Transport environment providing the following information:

- Real time traveller information at stops, in-vehicles, the Internet, WAP phones or Personal Digital Assistants (PDAs)
- Real time management information at central management locations
- Driver information at in-vehicle board computer equipment.

Centurion serves the following benefits to all stakeholders in the field of public transport:

- Real time traveller information enables passengers to access accurate information and make adequate and comfort decisions before and during a journey
- Real time traveller management information enables transport management to monitor the positioning of the vehicles, optimise the deployment of their fleet and improve schedule adherence
- Driver information enables transport operators to improve punctuality

Typical standard functions of Centurion are:

- Vehicle positioning by GPS
- Automated priority requests related to schedule adherence
- Non-stop traveller information using a variety of display options.

This document describes the Centurion Bus-Stop functionality, which allows RTPI information to be presented to the public using state-of-the-art variable messaging outdoor display devices that are integrated into a sophisticated vandal-proof ruggedized housing. The document focuses on the Software / functionality aspects of the Bus Stop as opposed to detail of the hardware solution.

The Bus-Stop range comprises a multi-functional intelligent microprocessor that manages the delivery of relevant information from the Centurion application using a range of multimedia technologies including LED, LCD and Plasma/TFT displays.

The Centurion Bus-Stop system provides the following general features (depending on the configuration/data-availability):

- Shows expected/scheduled arrival/departure times for vehicles approaching the bus-stop
- Displays information for both RTPI and non-RTPI equipped vehicles (for the latter scheduled information is displayed)
- Allows display of either pre-defined or ad hoc text messages to provide additional information to the public. Messages may be displayed using a variety of effects (flashing, scrolling, etc.) – the exact functionality will be dependent upon the specific bus-stop display equipment

- In-built diagnostic capabilities to allow for detection of communication failures
- Provide optional clear down of RTPI data from the Bus-Stop display using direct short-range radio communication between the vehicle and bus stop unit[2]
- Provide Digital Voice Announcement (DVA) information at the bus stop[3]

4.4.5.3 RTPI On Vehicle Server: Introduction

Centurion is Connexionz UK's flagship system that delivers Real Time Information System for Public Transport environment providing the following information:

- Real time traveller information at stops, in-vehicles, the Internet, WAP phones or Personal Digital Assistants
- Real time management information at central management locations
- Driver information on in-vehicle driver terminal.

Centurion serves the following benefits to all stakeholders in the field of public transport:

1. Real time traveller information enables passengers to access accurate information and make adequate and comfort decisions before and during a journey
2. Real time traveller management information enables transport management to monitor the positioning of the vehicles, optimise the deployment of their fleet and improve schedule adherence
3. Driver information enables transport operators to improve punctuality

This document outlines the functionality provided by the software components of the Centurion OVS. An overall description of the system is provided in □1, which also references additional documents describing other elements of the Centurion system in more detail.

Typical standard functions provided by the OVS are:

- Vehicle positioning by GPS
- Storage of Bus timetables

[2] Requires the optional inclusion of additional short-range radio communication equipment into both the vehicle and bus stop unit.
[3] This functionality requires hardware/audio support from the bus-stop display unit, and a software protocol interface to enable Centurion to initiate audio announcements.

- Transmission of lateness messages to host server
- Interface with driver device to allow capture of driver log on information
- Transfer of text messages between Driver and central Dispatcher
- Display of information to on-vehicle Display devices (this can include data generated remotely that is transferred to the vehicle in real-time – for example, to display public transport information generated from a UTMC system)
- Initiation of Traffic Priority Requests (either direct to Traffic Junction equipment, or to Central Server to support a server-server link with the UTC system)

The specific functionality available on a vehicle varies dependent upon the particular equipment installed (for example, generation of OBU/OVS, the Driver's Terminal / Ticket Machine, in-bus display equipment).

Centurion has been designed as an open hardware and software platform to enable communications to external devices and systems using a range of serial and network ports. These include third party devices such as ticketing machine appliances.

Centurion OVSs are configured with sufficient memory that under normal circumstances will allow storage of all relevant bus and route information for specific depots.

Centurion uses either public digital networks or analogue Private Mobile Radio (PMR) to allow vehicles to provide the Host Controller with updated real time information regarding their actual position along a route.

4.4.6 Services available within the TMIS

<u>Public transport:</u>

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Network Information	Bus (lines, stops, and other info)	x	x
	Train Service (lines, stops, and other info)		x
Time Tables Information	Bus Service	link	
	Train Service	link	
Time Tables Deviations	Bus - current		x
	Bus - predicted		x
	Train Service - current		x
	Train Service - predicted		x
Tariff Information/Schemas	Bus Service	Capability to	Capability to
Park & Ride Information	Locations	X	
	Opening Hours	Link	
	Tarrifs	Link	
	Routing to P&R	x	x

Table 7: Reading´s public transport services.

<u>Individual transport:</u>

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Traffic conditions	Travel Times Information - Current	x	x
	Travel Times Information - Predicted	x	Very limited
	Traffic Levels Information - Current		x
	Traffic Levels Information - Predicted		Under devt
	Congestion Information – Current		x
	Congestion Information - Predicted		x
	Alternative Routing		x
Parking Facilities	Parking Spaces Information - Current	x	x
	Parking Spaces Information - Predicted	x	x
	Routing to Parking Facilities	x	x
	Parking Tarrifs	Link	
	Opening Hours	Link	
	P&R Facilities	x	
Roadnetwork Information	Road Closures Information		x
	Roadwork Information		x
	Tarrif Schemas (where applicable)	N/A	N/A
	Specific event routing	x	x
Driving Conditions	Weather Conditions Monitorting		Under devt
	Weather Conditions Prediction		Under devt
	Weather Conditions Alerts		Under devt
Incident Management	Incident Information		X
	Alternative Routing		X

Table 8: Reading´s individual transport services.

4.4.7 Using CAI in Reading

CAI has been implemented for Reading's public transport within CoCities project, there is used static parking and multimodal journey planning (service 17).

4.5 Tuscany region

Co-Cities pilot managed by Tuscany Regional Administration has approach, dimension and territorial coverage which is slightly different from the other "urban" sites. Indeed the local partner is not a local statutory or transport&traffic service managing operator acting on urban level but a NUTS 2 level stakeholder who acts:

1. Directly as contracting body for the implementation of common platform integrating the infosystems which are already running or planned (under contracting or under implementation). Among the others, Regional Administration contracted the implementation of:
   1.1. A multimodal journey planner (JP) both for private mode and public transport integrating the information provided by public transport operators over the whole regional territory;
   1.2. A common platform named Mobility Information Centre (MIC) integrating the dynamic data on public transport and mobility (traffic events) over the whole territory.
2. As promoter, funding authority and coordinator of different initiatives acting on urban level and managed by Municipalities. These initiatives act also for content provider systems feeding the integrated platform above pointed out.

Following this approach, the pilot in Tuscany will be seen as a Regional Data Service System which is physically distributed over the region. This system will offer a bundle of info services scaled up on different geographical dimensions and based on the enlargement and the duplication of former Florence In-Time pilot. The system will involve different cities (Florence, Lucca, Livorno, Grosseto) with different urban services available in each urban context. JP services integrating private and public transport mode is extended over the whole regional territory. MIC is planned to cover the whole regional territory even if not all the regional Transport and Mobility Companies are now able to provide effective dynamic data (see section 5 for details): static data are available for the whole region but dynamic PT data are available on Florence metropolitan area and Livorno area.

4.5.1 History and the date of the establishment of running traffic and transport infosystems

CoCities pilot in Tuscany Region is an extension of former In-Time pilot for metropolitan Florence area. In-Time pilot was developed in 2009 under In-Time initiative. No integrated common platform for the distribution of multimodal traffic and transport information was running before In-Time and no TMIS was operated. In order to build Florence In-Time pilot, a new integrated bundle of infoservices was created using, in some cases, infoservices already available and, in other cases, "rough data" provided by ITS systems on which new ad-hoc infoservices were generated. In-Time pilot collected data content from different sources and operators:

- PT data from ATAF, Public Transport Company of the metropolitan area of Florence and partner of In-Time project;
- Parking data from Firenze Parcheggi;
- Parking Management Agency;
- POI from ATAF db and from services offered by TeleAtlas – Tom Tom (LBS platform);
- Traffic event data generated by the managing system operated by Florence Municipality and accessed by ATAF db.

According to In-Time general timeplan, the set up of WFS Servers and SOAP Web Service for the implementation of adapting interfaces was developed between the end of 2010 and the beginning of 2011, tested in March - April and technically validated in May 2010. Pre-deployment phase and final performances tests took place in September 2010. End users testing of mobile application started in October 2010 with internal tests and through the involvement of expert users. In-Time Florence pilot was launched in November 2010 as "demo service" and finally available on large scale in End April 2011 on Androyd platform.

Initiatives promoted by Tuscany Regional Administration started in 2006 issuing the Development Program (RDP) over years 2006-2010. RDP included specific actions on "Territorial accessibility, integrated mobility" and, more in details, Planning Actions 1.7.7 e 1.7.8 focusing on "Information and telematics services for infomobility". The Regional Framework context was completed by the Regional Document for Infomobility 2008-2010 (RDI) and related Implementation plans and detailed specifications.

The objectives of these initiatives consisting of implementing an information infrastructure/platform to improve the overall territorial accessibility in Tuscany Region based on:

- the distribution of geographic Mobility/Transport information systems;

- the realization and/or the upgrading of ITS systems to support public transport, private mobility and transport co-modality in order to improve the integration of regional transport services.

These objectives were accomplished:

- by tendering the implementation of a geographical DataBase and related multimodal Travel Planner integrating private and public transport mode over the whole regional territory. This database integrates static timetable of public transport (bus, train, ferry) with the possibility to update it with dynamic data, if available (see following points);

- by tendering the implementation of the Multimodal Integrated Centre for the integration of road conditions related information (traffic and parking conditions) with public transport ones (Autostrade – National Highway Operator, Trenitalia – National Train Operator, roads managed by Provinces);

- by co-financing the implementation of AVM Automatic Vehicle Monitoring systems to be tendered and managed by all the 20 Transport Companies operating the service in the regional territory (total fleet of 2800 buses) for a total of around 8.5 Ml Euro of investment costs. These systems will enable the transport companies to provide the regulatory institutions (Provinces, Regional Administration) with on-line (dynamic data: i.e. location, service condition – delayed, on time, in advance, estimated arrival time and location over a pre-defined time period) and off-line (back processing) of data required for the management of service contracts. Dynamic data will be also used to fee multimodal travel planner with real-time information and to set up an integrated Call Centre for distributing multimodal PT infoservices. AVM systems is under operation in Florence metropolitan area by ATAF (installation almost completed) and Livorno urban and rural area by ATL whereas the other systems are still in tendering/contracting phase;

- by co-financing 14 projects presented by Municipalities and other local stakeholders/Authority in order to foster infomobility services at local level (for a total of around 9 Ml Euro). CoCities pilot that will set in Tuscany Region deal with the info provided by the most advanced of these projects: Lucca, Livorno and Grosseto.

4.5.2 *Architecture and concept of running traffic and transport infosystems*

In this section the functional and physical architecture of the infosystems involved in Tuscany Region CoCities pilot are described: the description is divided into In-Time Florence site (already running) and Tuscany Region infosystems (which will be integrated in the pilot).

The functional architecture of In-Time Florence pilot is described in next figure. The data providers, the ITS systems involved and the information flow generated by the pilot is showed in the same Figure.

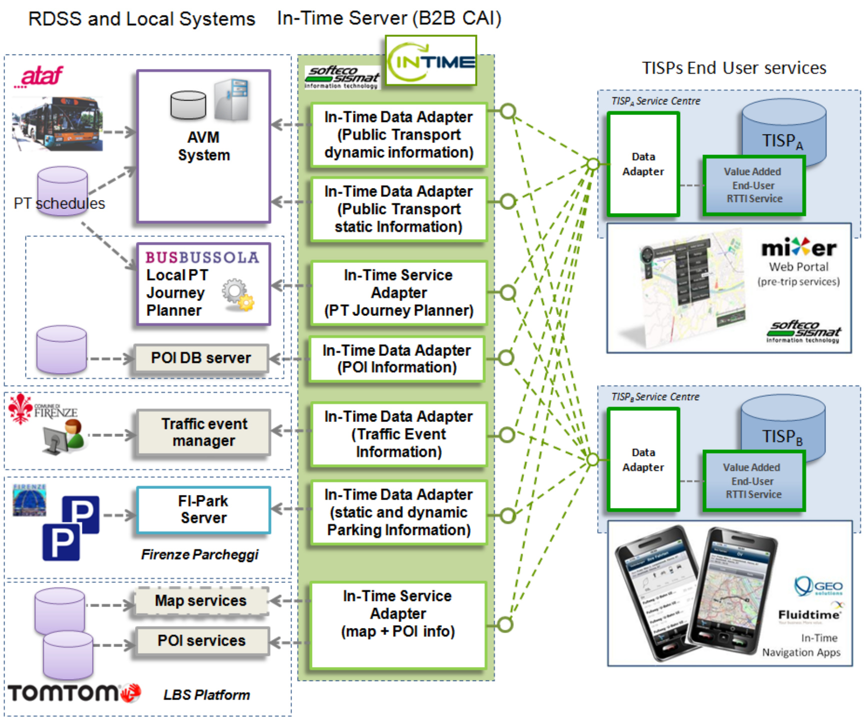


Figure 8: Functional architecture of In-Time pilot in Florence.

The physical architecture of Florence In-Time pilot consists of a geographically distributed set of data and service sources:

- resources located in two ATAF buildings (the main depot at Peretola and ATAF headquarter in the city centre);
- at Firenze Parcheggi main parking house (city centre);
- at the Municipality of Florence, where traffic and mobility event depicted in the following figure provides an overview of In-Time technical set up in Florence.

In-Time server is installed and configured in ATAF farm in Viale Cure. The main depot in Peretola ATAF is connected through a 10 Mbit MPLS optical fibre. The LAN network is on xDSL 10 Mbit lane and accessible from the outside on Virtual Private Network.

Tuscany Region have deployed two infosystems: Journey Planner (JP) and Mobility Information Integration Center (MIIC).

The functional architecture of JP consists of:

- integration of the different Timetables and routes of scheduled public transport (tram, bus, train, ferry boat);
- integration of the local road graphs, addresses and road bylaws;
- regional multimodal travel planner;
- searching and browsing points of interest.

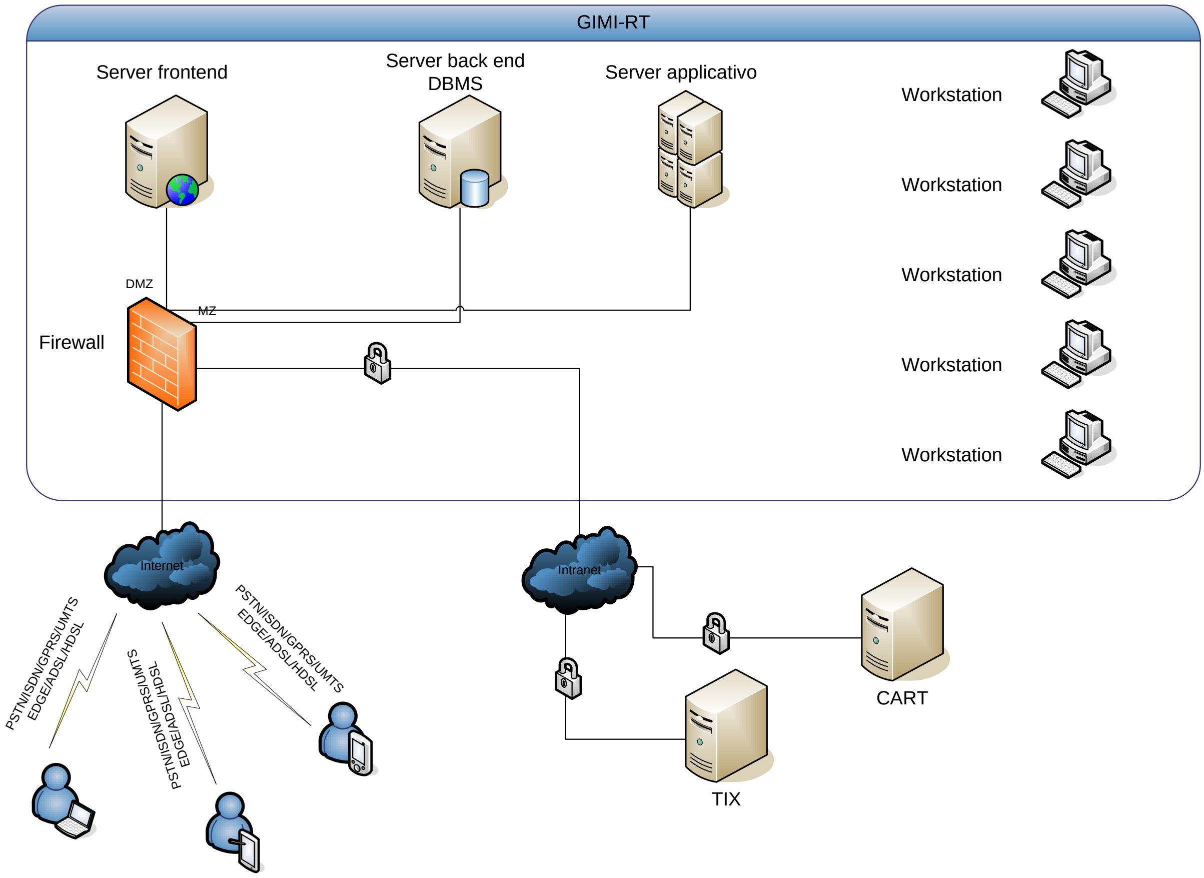


Figure 9: The physical architecture of JP.

The servers of JP are installed and configured in Tuscany IntereXchange (server farm of Tuscany Region).

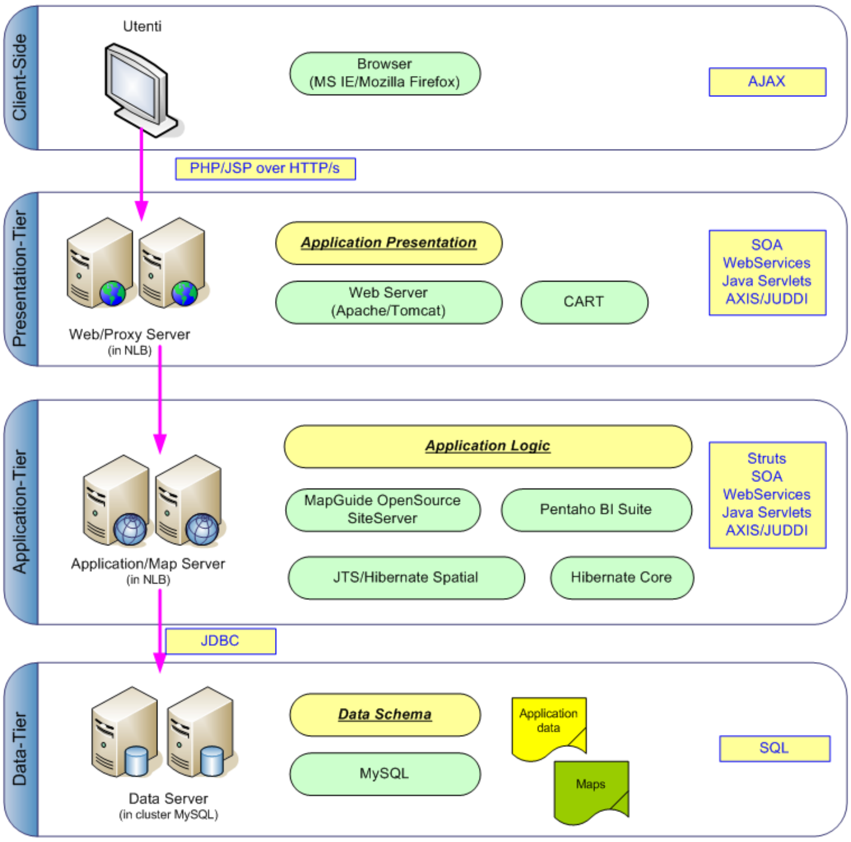


Figure 10: The functional architecture of MIIC.

The physical architecture of MIIC consists of:

- Real-time info traffic;
- Real-time info public transport;
- Real-time info car parking of municipality in Tuscany.

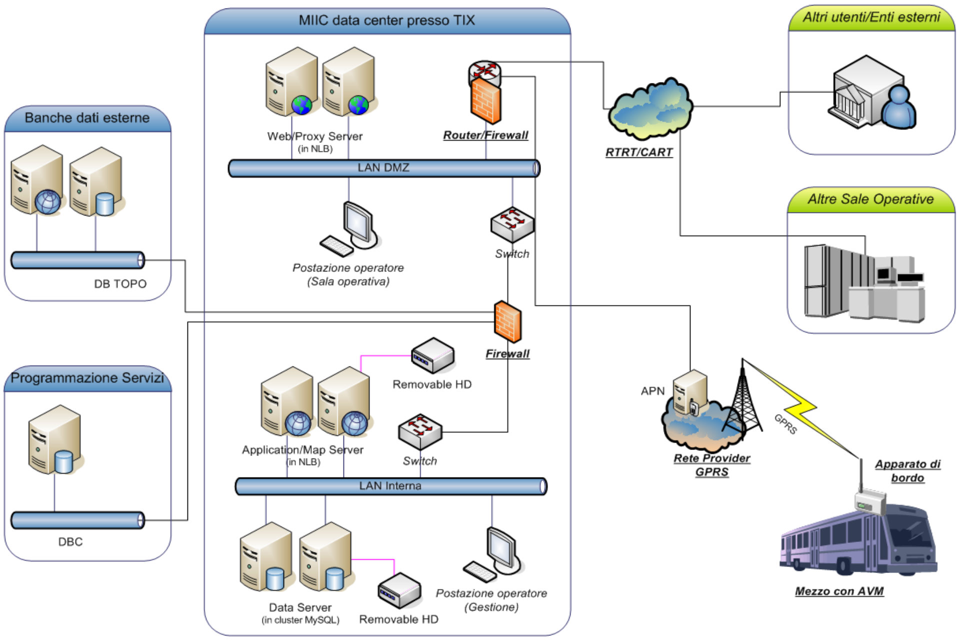


Figure 11: The physical architecture of MIIC.

The servers of MIIC are installed and configured in Tuscany IntereXchange (server farm of Tuscany Region).

4.5.3 Detailed description of system functions integrated into the pilot

In-Time services developed in Florence provide the following data:

- Dynamic Road traffic info (at the moment only notification of planned road works updated weekly;
- Static & Dynamic Parking Info;
- Static & Dynamic Public transport info;
- Dynamic POI info;
- Static multi modal journey planning.

All these data and related infoservices relate to Florence metropolitan area.

Data/services available on the whole Tuscany region are the following ones:

- Static timetable for all PT transport modes over the region:
- Static multimodal travel planner (private + public);

In Lucca urban area the following ITS systems are operating:

- Access control system to LTZ (only for entry) managed by the Municipality;

- Parking Management System providing static (location, tariff, open/close, etc.) and dynamic (real time availability of parking lots) managed by Metro srl;
- Environmental data monitoring system managed by the Province in collaboration with the Municipality;
- Traffic flow detection system (to be installed; purchasing process under progress).

In Livorno AVM system is under operation for the monitoring of the entire ATL fleet operating the public transport services in the urban area of Livorno and the rural area of its province. AVM system provides dynamic information on bus arrival time at bus stops and SMS, in the next future. Info data provided by AVM system will be also integrated at Regional JP and MIC level. The integration of data is not active yet.

In Grosseto static and dynamic data on parking area and facilities are provided by parking management system: these data have already been integrated at MIC level.

4.5.4 Detailed technical specification of systems

4.5.4.1 Metropolitan area of Florence

The technological solution adopted in Florence In-Time site to implement adapting interfaces consists in the following steps:

- Use and configuration of GeoServer v2 Open Source;
- Set up of a temporary DB jointly with GeoServer;
- Local data adaptation realized through the implementation of a mapping scheme between the existing data model and the one adopted in the CAI;
- Installation of a Data Fetcher for native data processing.

Services are offered as WFS/WMS through HTTP GET/POST. Data comply with the In-Time format (XSDs through Application Schema extension).

GeoServer (http://www.geoserver.org) is an open source software server written in Java. Is the reference implementation of the OGC Web Feature Service (WFS), Web Map Service (WMS) and Web Coverage Service (WCS).

Concerning the realization of services two scenarios can be considered:

- **Adaptation for data provision**: in this case a service which provides access to the data isn't already developed. A new service will be provided and implemented to support natively the In-Time Infrastructure;

- **Adaptation of available services**: In this case a layer will be added in top of the existing system, in order to wrap and adapt it to the In-Time Infrastructure.

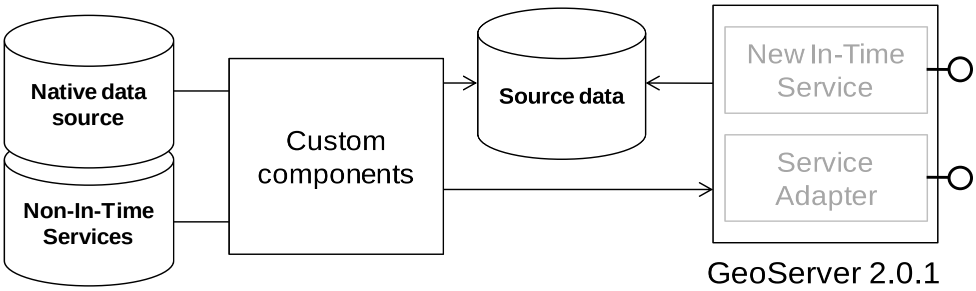


Figure 12: Application of GeoServer in Florence pilot site.

AVM system

The legacy ITS systems which provide data/services to In-Time Florence site are:

- AVM system operated by ATAF;
- Parking management system operated by Firenze Parcheggi;
- BusBussola JP by ATAF;
- Road work event DB by ATAF.

AVM system architecture is the following:

- N. 1 Control Centre for the monitoring of the service by the operators and the management and interactions with the system;
- N. 3 Depot systems providing short-range (Wi-Fi) communication link between the access points configured in LAN and the on-board vehicles;
- On-board vehicles (200 vehicles equipped with new system, 180 vehicles equipped with old system, new on-board system to be extended to all the fleet of 380 vehicles) consisting of:
    - PC (Control device);

- terminal for driver interactions;
- audio announcements to driver and passengers;
- next stops visualization on LED panels;
- alarm button;
- integration with electronic payment validators;
- integration with direction/line LED panels;

– GPRS/GSM long-range network for data/voice communication;

– Infosystem consists of:

- Infomobility sw managing the data exchange with AVM Control Centre (events, request, arrival time prediction of vehicles, etc.);
- N. 90 infopanels installed at bus stops;
- web portal;
- IVR;
- SMS info management platform.

In-Time server accesses data on timetable and prediction arrival time of PT service from AVM Control Centre sw. The data exchange between the Control Centre and the AVM system is carried out under two different procedures:

– Data publishing by AVM system through webservices to be accessed by infomoblity sw;

– Asynchronous data transmission from AVM system to infomobility sw trough dedicated webservices waiting for the requests.

AVM system publishes a webservice named “Data provider”. The infomobility sw module receives data and sends requests from/to Data Provider in order to collect data on events, lines, routing, arrival prediction times. The sw module which is in charge to send requests/receive data on IVR SMS is named “Data retriver” whereas the communication exchange for web publishing is carried out by the web portal itself.

Static and dynamic information are provided both for vehicles equipped with old and new on-board devices.

Parking management system

The system consits of 14 parking infrastructures (STAZIONE BINARIO 16, PORTA AL PRATO, P.ZZA ALBERTI, BANDINO GIANNOTTI, VIALE PIERACCINI, VIALE EUROPA, STAZIONE S. M. NOVELLA, PIAZZA S. AMBROGIO, PIAZZA BECCARIA, OLTRARNO, FORTEZZA DA BASSO, PARTERRE for a total amount of about 4.000 available slots) connected to a centralized monitored system installed in Firenze Parcheggi headquarters via optical fibre. Connecting network is a VPN WAN using IP addresses. Each parking areas is equipped with a workstation connected to peripheral devices for the definition of the number of available slots of each parking infrastructure

BusBussola JP

BusBussola provides PT + walking JP based on scheduled timetable. The service is available from ATAF web site. The search for origin/destination is allowed by address or by POI (to be selected through droplist). The user can select data and hours coverage (from/to) for its request and choice options (shortest travelling time, minimum number of walking trips, shortest walking distance, max number of bus changes).

Road works event DB

It is an access DB manually compiled by ATAF operator based on the weekly communication of road works carried out by the Municipality.

Flexible transport services

ATAF is managing DRT services in the metropolitan area of Florence (nightly hours, low demand and peripheral area). The service will be bookable through internet or by phone contacting ATAF Agency. Currently these services are not integrated in In-Time pilot but they could be seen as possible extension.

4.5.4.2 City of Lucca

Access control system

The access control system is based on a Operation Centre and n.9 detection gate consisting of cameras (for plate registration) and traffic detectors. The Operation Centre allows the monitoring and the configuration of the system, the management of white list, the data collection from the gate, the manual reconstruction of the images in case of incomplete detection, the elaboration of statistical report. The connection between the Operation Centre and the gate is on optical fiber.

Parking management system

The system consist of 6 parking infrastructures : Mazzini – Total occupancy: n. 362, Lorenzini - Total occupancy: 115, Cittadella / Manifattura - Total occupancy n. 252, Carducci - Total occupancy: n. 400, Railways Station - Total occupancy: 199, Luporini (restricted to camper) - Total occupancy: n.77 connected to a centralized monitored system installed in Metro srl headquarters. Each parking infrastructure provides the dynamic state of occupancy (free slots); users information is provided to on-street panels and on web portal (where static information are also provided). Static information provided on the website are the following ones: location of the parking area, typology, modalities and devices for payment, surface, total occupancy, opening hours, tariffs, minimum tariff, kind of subscription accepted, possibility to rent bike in the surroundings).

Environmental data monitoring system

The system is based on peripheral devices for real time data collection: these data are daily transmitted to a Operational Centre located in the Department of Regional Environment Agency of Lucca for validation, storing and management of data themselves. Daily the data collected are published on a web portal - http://www.arpat.toscana.it/aria/ar_bollettino.html.

Annualmente viene presentata una ulteriore relazione descrittiva dello stato della qualità dell'aria della provincia. The data collection devices are 2 and located in Piazza San Micheletto and Viale Carducci. In the following table the type of measures provided by each device is detailed.

Location	SO_2	NO_X	PM10	O_3	CO
Piazza San Micheletto	X	X	X		
Viale Carducci	X		X		X

Figure 13: Type of measurements provided by each environmental monitoring device in Lucca.

Traffic flow monitoring system (under purchasing process)

The system architecture is:

– N.5 on-street detection devices (to be enlarged in the future);
– N.1 control centre for the collection and monitoring of data;
– GPRS communication network.

Data collected by the detection devices are:

1. vehicles number;
2. data/hour of the transits;
3. lane;
4. direction;
5. detected speed;
6. typology and length of the vehicle.

4.5.4.3 City of Livorno

ATL, Public Transport Company operating the bus service in the urban and rural area of Livorno, operated AVM system for the monitoring and management of the fleet. AVM system is operated from 1998 and it has been revamped recently.

The architecture of the system is the following:

- N.1 Control Centre;
- GPRS/GSM long –range communication network;
- N.4 depots system for Wi-Fi short-range communication;
- On-board devices installed on the buses (n.80 buses of he fleet operating Livorno urban services and n.140 buses operating suburban and rural services) consisting of:
    - On-board Control Unit;
    - Driver Terminal;
    - Next stop LED infopanels (only for Livorno urban fleet);
    - Audio announcement and driver communication (only for Livorno urban fleet);
    - Integration with direction/line visualization panels;

- Infosystem based on:
    - N.12 on-street panels;
    - SMS distribution on request.

The integration of dynamic data (arrival prediction time) generated by AVM Control Centre will be integrated at MIC level.

4.5.4.4 City of Grosseto

The parking area of Grosseto urban area is managed by Grosseto Parcheggi, the mobility and parking area of the city. Parking infrastructure are the following ones: AMIATA - P.za Caduti di Nassirya – Total occupancy n.240 slots, PORTA CORSICA - Via Ximenes / Via Gramsci – Total occupancy n. 103 slots, GALLERIA OBERDAN - Via Buozzi – Total occupancy N.103 slots.

Real time availability of free spaces are calculated by each parking management system and centrally collected to provide users information on infopanels, company web portal and MIC level. On the company web portal the following static information on parking infrastructures are available: opening hours, tariff, payment modalities, and subscription.

4.5.5 Services available

Individual transport:

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Roadnetwork Information on Florence metropolitan area	Road work location	X	
	Road work type	X	
	Road work status	X	
	Road work duration	X	
Traffic conditions on Lucca urban area (detected at 5 measures point)	vehicles number		X
	data/hour of the transits		X
	lane		X
	Direction		X
	detected speed		X
Parking Facilities on Florence metropolitan area	Capacity	X	
	Disabled capacity	X	
	Toilets available	X	
	Disabled toilets available	X	
	Tariff	X	
	Parking Type	X	
	Real time occupancy		X
Parking Facilities on Lucca urban area	location of the parking area	X	
	typology, possibility to rent bike in the	X	
	modalities and devices for payment total	X	

	surface	X	
	tariff	X	
	kind of subscrption accepted	X	
	Capacity	X	
	Disabled capacity	X	
	Real time occupancy		X
Parking Facilities on Grosseto urban area	Capacity	X	
	Disabled capacity	X	
	Opening hours	X	
	Tariff	X	
	Payment modalitie	X	
	Kind of accepted subscription	X	
	Real time occupancy		X
Access control info on Lucca urban area	Opening hours	X	
	Access regulation	X	
	Traffic flow		X
Environmental monitoring on Lucca urban area	Emissions measurments		X

Table 9: Florence´s individual transport services.

Public transport:

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Network Information All transport mode operated in Tuscany Region	Bus (lines, stops, etc.)	X	
	Tram Service (lines, stops, etc.)	X	
	Train Service (lines, stops, etc.)	X	
	Airplane Service	X	
	Ferry Service (lines, stops, etc.)	X	
Time Tables Information All transport mode operated in Tuscany Region	Bus Service	X	
	Tram Service	X	
	Train Service	X	
	Airplane Service	X	
	Ferry Service	X	
JP Multimodal Travel Planner PT+private mode for the whole region		X	
Tuscany Region, predicted arrival time on: – **Florence metropolitan area;** – **Livorno Urban Area;** – **Livorno Province Area.**	Estimated arrival time at bus stop		X

Table 10: Florence´s public transport services.

4.5.6 Services/data available detailed description

Services described below are based on the availability that exists in the entire Tuscany Region, and generally refer to services at municipal or provincial level.

Service on Florence metropolitan area has data/interfaces compliant with In-Time standards.

Service MIIC on Tuscany Region has data/interfaces compliant with Datex 2.

Service JP on Tuscany Region will have data/interfaces compliant with In-Time standards.

Other systems use proprietary solutions.

Geographical service coverage:

- PT Network static info: Tuscany Region
- Journey Planner: Tuscany Region
- PT timetable: Tuscany Region
- Dynamic PT info: Florence and Livorno
- Static parking info: Florence, Lucca, Grosseto
- Dynamic parking info: Florence, Lucca, Grosseto
- Road work info: Florence
- Traffic data: Lucca
- Environmental data: Lucca

4.5.7 Using CAI in Florence

As is described in chapter 4.5.3 Florence is one of In-Time pilot cities and In-Time services developed in Florence provide the following data:

- Dynamic Road traffic info
- Static & Dynamic Parking Info;
- Static & Dynamic Public transport info;
- Dynamic POI info;
- Static multi modal journey planning.

All these data and related infoservices relate to Florence metropolitan area.

4.6 Bilbao

4.6.1 History and the date of the TMIS establishment

1991 By means of large cable installations the following services were implemented:

- Traffic light control system
- CCTV camera system

In 2005 Bilbao Council approves a Mobility Plan which is the first step to implement a new Mobility Control Centre in 2007. This Control Centre implies a technological and structural renewal in which new ITS equipment centralizes the following services:

- CCTV Camera system 2007
- Crossing in red light detection system 2009
- Vehicles' capacity system 2007
- Traffic lights regulation system 2007
- Information system to drivers 2009
- Access control to pedestrian areas 2009
- OTA system (regulated parking system) 2007
- Support system for exploitation of Bilbobus 2007

4.6.2 Architecture and concept of TMIS

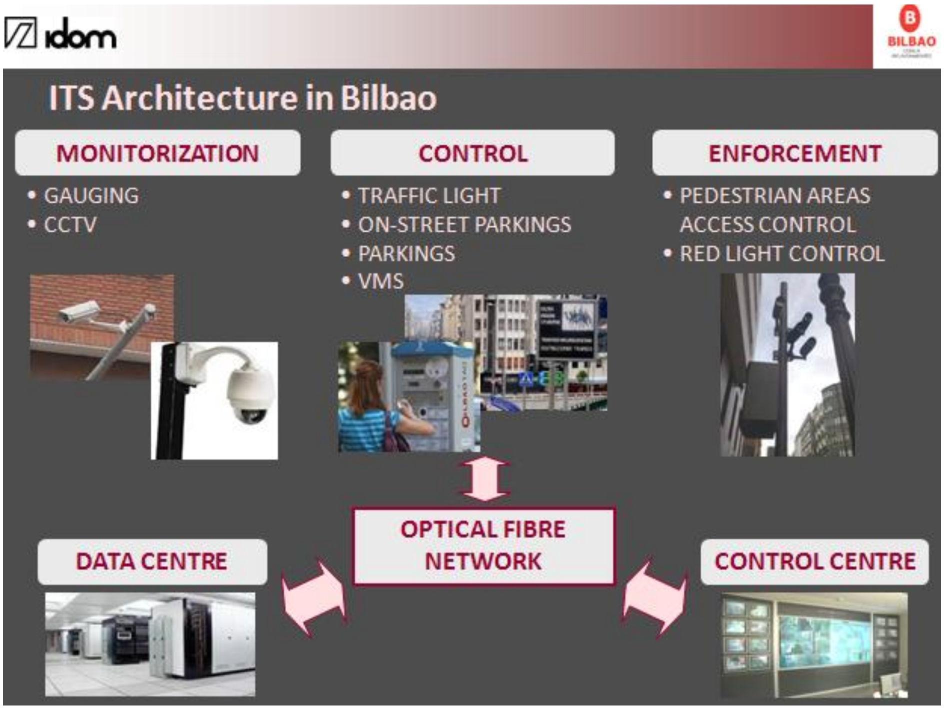


Figure 14: Architecture and concept of TMIS in Bilbao.

4.6.3 Detailed description of systems' functions integrated into the TMIS

4.6.3.1 CCTV camera system

Currently, Bilbao has a system of mobile CCTV cameras installed in some major intersections of the city. The CCTV camera system allows monitoring of traffic conditions in real time from the Traffic Control Centre, so it is an element of great value to operators.

The system consists of colour PTZ cameras connected to the Traffic Control Centre via the deployed Gigabit Ethernet communication network. The video images and remote control are integrated into the communications network through coding teams.

Having performed several deployments, the current system of CCTV cameras has a total of 53 CCTV cameras with colour Palm-Tilt-Zoom functionality. Cameras record the 100% of the images and vision screens of at least 24 video signals (monitor side, video wall and operator workstation). Thus, the cameras are focused mainly on offering a continuous overview of the traffic on some of the tracks, and the publication of images via the municipal website.

4.6.3.2 Crossing in red light detection system

Currently, the Bilbao Council has a crossing in red light detection system based in artificial vision in some of the major intersections of Bilbao. The system monitors 24 hours a day every day of the year the passage of vehicles through the intersection, creating penalties for those vehicles that don't respect red lights, creating a risk to the driver himself, other drivers and for pedestrians.

The system is defined as independent checkpoints integrated with the municipal system through the deployed Gigabit Ethernet communication network. The control points generate proposals for penalties (handled by the Municipal Police).

Since 31st December 2010 six control points are deployed (they were installed in 2009). The good results obtained, could make possible the deployment of new checkpoints for the future.

4.6.3.3 Vehicles' classification system

Vehicles'classification system provides information about traffic conditions in an objective way. This information allows on-line actions on the road in order to adequate the regulation to the traffic situation and to provide information on the features of the road, facing the tasks of planning and engineering conditions.

Bilbao has a graduated mixed system based on an intrusive system of electromagnetic bonds and in a non-intrusive artificial vision system introduced during 2009 and extended throughout 2010 at some points. This graduated system on the application integrates centralized traffic management SDCTU manufacturer called ETRA.

The graduated non-intrusive systems, presents better conditions in the maintenance of public roads, as its functionality is not affected by actions on the pavement.

4.6.3.4 Traffic light regulation system

The traffic light system allows the regulation of traffic by scheduling all phases of traffic light. The centralization of traffic light system enables real-time monitoring and performance of the Traffic Control Centre on the elements of regulation.

Although the traffic light system of Bilbao is mostly centralized (up to 87%), isolated regulatory management elements of the Traffic Control Centre are placed along the city. This isolation is due to the physical isolation of the locations, providing a total of 32 regulators without integration into the centralized system.

The centralization of a regulatory element is possible by connecting it to the communications network, to enable the logical connection between the central computer and a traffic light controller to centralize communications with the management application, in this case, the application SDCTU of ETRA.

Traffic management centralized application SDCTU of ETRA Group operates with equipment traffic light control system.

In 2010 Transport Department of Bilbao Council introduced priority of public transport in 45 crosses. The preference is based on daily time delay of the line. The implementation is based on the exploitation support system (SAE) which registers the location of the bus based on board equipment (GPS and odometer). In tests it was found a decrease of the crossing time of the vehicles due to the reduction of stops in red lights.

4.6.3.5 Information system to drivers (PMV)

The information system can provide real-time information to optimize the circulation in Bilbao, showing details of: traffic conditions on major tracks, availability of parking rotation and OTA (regulated parking system), and the conditions or incidents in the street. The driver, in possession of information and guided by the traffic control systems, can make decisions that allow a better performance and better use of road infrastructure.

The information system is based on variable message signs LED technology introduced in 2009. This system, operated centrally from the Control Centre, exploits the information maintained in the corporate platform with available information, traffic conditions, availability of parking rotation and OTA, and actions or incidents.

Whereas the driver information system allows the user to make decisions based on the information shown, the criteria for the location of information equipment (variable message panels = PMVs) is:

- The PMVs have been placed on existing road links to provide drivers information about the availability of parking slots.
- The PMVs have to be located at the entrance road to inform drivers of any exceptional circumstances that may affect traffic in Bilbao.
- The PMVs have to place at intersections of main entrance with the possibility to change the itinerary, to give drivers information about traffic conditions on

main roads and to allow adjustment of the route to the destination in case of density or incident.

- The PMVs have to locate in town exits and major intersections out to inform drivers of potential incidents on trunk roads.

4.6.3.6 Access control to pedestrian areas

Bilbao has some pedestrian areas in which vehicle traffic is only allowed:

- During loading and unloading time windows.
- Or for authorized vehicles.

Bilbao Council currently has in force a control point to some of the pedestrian zones (Ledesma Street, introduced in 2009). The implemented control system based on artificial vision technology, controls access out of allowed hours, arranging a penalty in case of an unauthorized vehicle access to the pedestrian area during the non enabled time window.

The system is integrated with the municipal system for the processing of penalties by the Municipal Police. The system, avoids the use of bollards and intercoms for communication between driver and control centre personnel, lowering deployment, maintenance and operation costs.

4.6.3.7 OTA (Regulated Parking System)

Bilbao Council's OTA system is operated in a concessionary mode. The control system is based on parking meters located in the sidewalk where the user makes a reservation of parking. The parking meters centralize the information on a server having connection with it through mobile operator network.

4.6.3.8 Support system for Bilbobus exploitation (SAE)

The support system for Bilbobus exploitation (SAE) is a system that, through continuous, instantly and automatically localization of buses network, enables its regulatory and operational control. This covers the following features:

- Permanent location for buses from the control point, which allows the knowledge of the situation of the bus and making decisions about the service.
- Permanent communication between operators and bus drivers, providing ongoing information about their situation (if arriving earlier or later) with respect to the theorical time.

- Automatic regulation of buses passing in the stops, improving the regularity and punctuality of buses.
- Traveller information, both at bus stops and on board (in the bus).

4.6.4 Detailed technical specification of systems integrated into the TMIS

Most of the systems are in the CPD (data processing center) and the information is in the DataBase (generally SQL server). Each system has its management application:

- Traffic lights and vehicle classification system: SDCTU of ETRA
- In red light crossing detection and access control: Infractor of TEVA
- Information system to drivers (PMV): InfoPanel of Leurocom
- Video recorder of NICE Vision and Videowall of BARCO
- OTA (regulated parking system): Concesionary‘s server

To connect all of these services there is a Gigabit Ethernet Network of Optical Fibre.

4.6.5 Services available within the TMIS

Individual transport:

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Traffic conditions	Traffic Levels Information - Current	X	X
Parking Facilities	Parking Spaces Information - Current	X	X
	Parking Tarrifs	X	X
	Opening Hours (parking)	X	X
Roadnetwork Information	Roadwork Information		X

Table 11: Bilbao´s individual transport services.

Public transport:

Service's Area	Service's Name	Information Type	
		Static	Dynamic
Network Information	Bus (lines, stops, and other info)	X	X
	Tram Service (lines, stops, and other info)	X	
	Train Service (lines, stops, and other info)	X	
	other – Tube (lines, stops)	X	
	other -		
	other -		
Time Tables Information	Bus Service	X	X
	Tram Service	X	
	Train Service	X	
Tariff Information/Schemas	Bus Service	X	

Table 12: Bilbao´s public transport services.

4.6.6 Services/data available detailed description

	Website	Variable Message Panels	Mobile phone application
1.Traffic levels information-Current	- Roadwork - Camera's location - Panels location - Traffic situation in concrete roads		
2. Parking spaces information-Current	-Availability indication - Location	-Availability indication -Orientation about how to arrive to the parking	-Availability indication
3. Parking tariffs	-Tariffs - Location		-Tariffs
4. Parking Opening hours	-Timetables - Location		
5. Roadwork information	-Location		
6. Bus network information	-Lines -Stops -Time of arrival	-Time of arrival -Accessibility features of the bus	-Timetables -Connections -Time of arrival
7. Tram service network information	-Stops		
8. Train service network information	-Lines -Stops		
9. Tube service network information	-Lines -Stops		
10. Bus service timetable	-Timetable	-Timetable	-Timetable
11. Tram service timetable	-Timetable		
12. Train service timetable	-Timetable		
13. Bus tariff information	-Tariff	-Tariff	-Tariff

More information can be found at: http://www.geobilbao.net/Default.aspx?mapa=cyt

4.6.7 Current challenges faced

The distribution of competences model in Spain is based in the decentralization, so one area's competences can be distributed among different administrations at different territorial levels (country, region, county and city). That's why mobility management competence distribution makes more difficult the establishment of a shared information and management system between different organisms.

The competence distribution of different modes of transports in Bilbao can be summarized in the following way:

- Bilbao Council: Bus -municipal level (Bilbobus)
- Bizkaia County: Bus -county level (Bizkaibus)
- Bizkaia Transport Consortium: Tube
- Basque government: Tram, Train (Euskotren)
- Spanish Government: Train (Renfe)

4.6.8 Future TMIS development

4.6.8.1 Planned developments affecting the operation of the CoCities project pilot

Bilbao is starting the development of a centralized management application of all the ITS systems in the Traffic Control Centre in order to operate jointly and make the work of the Traffic Control Centre easier. The goal is to implement an exploitation guide for the management tasks performed from the Traffic Control Centre.

Also, there is progress in the centralization of information about mobility systems on a common municipal platform.

These developments are intended to move forward on an open platform that enables integration of various systems and equipments, as well as the ordered exchange of information.

4.6.9 Using CAI in Bilbao

CAI has been implemented for Bilbao's public transport within CoCities project, there is used multimodal journey planning (service 17).

5 Use Cases for Co-Cities

This chapter describes the use case definitions for Co-Cities. These are partially based on the services defined by the In-Time project and are focused on the new feedback concept, mechanisms and detailed information.

The descriptions hold:

- Use case general description
- Concerned processes
- Concerned entities
- Interdependencies among Use Cases

End user services in this concept would be services which have the primary target to provide information TO the user. But of course most of the end user services will also deliver some feedback information within the context of the end user service. In the best cases the request for feedback is triggered automatically.

Examples how to trigger the request for feedback:

- The end of service is detected via the position
- A deviation from the proposed route is detected via the position
- The estimated time of arrival has been reached

Data collection services on the other hand have the primary and only aim to receive information FROM the user. That means the user will actively start the Data collection service to provide information to the TISP.

From the above concept, a representation of possible services and how they could be classified in Co-Cities is depicted in the following picture:

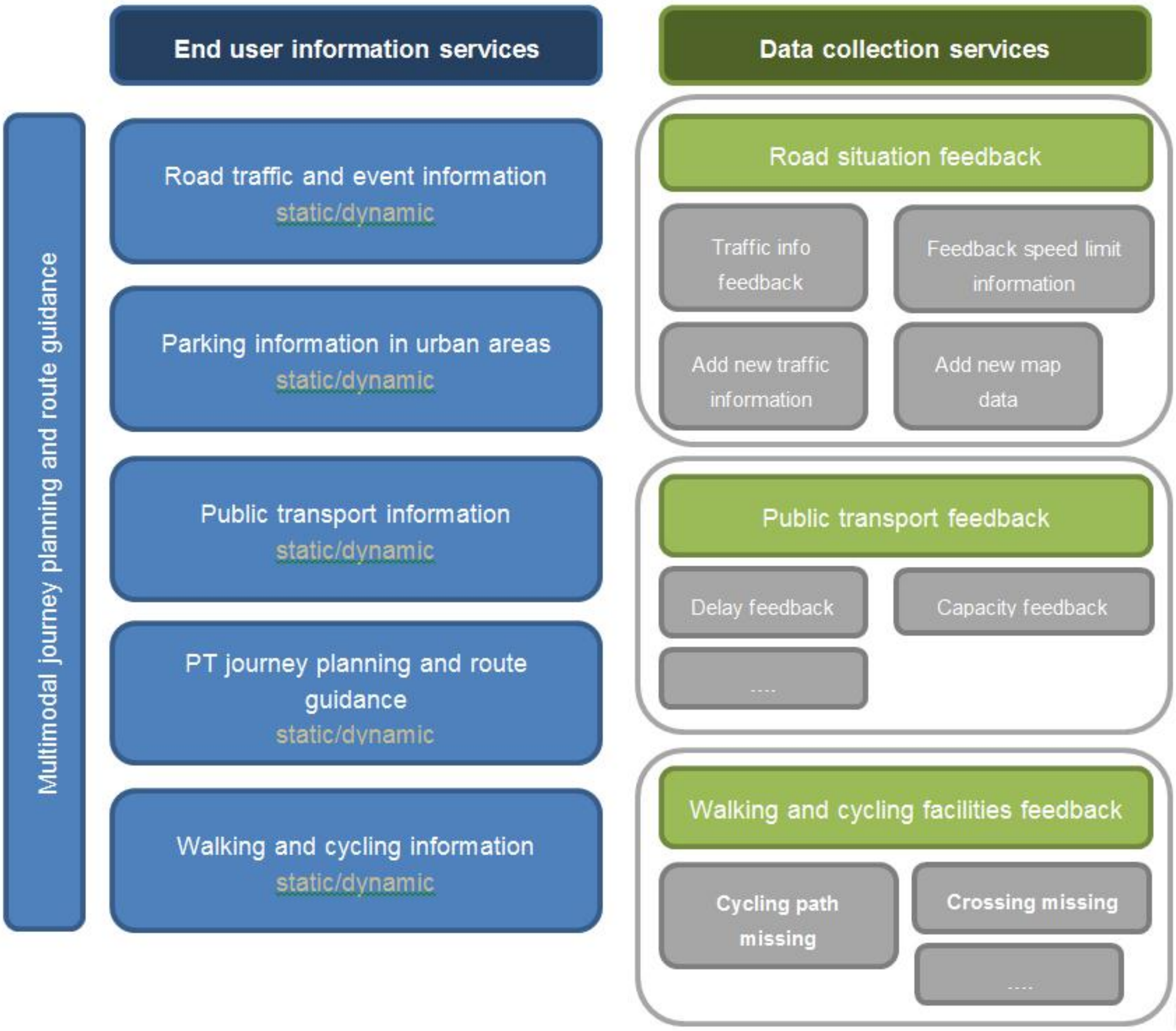
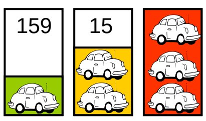
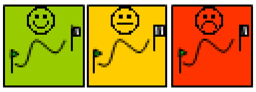


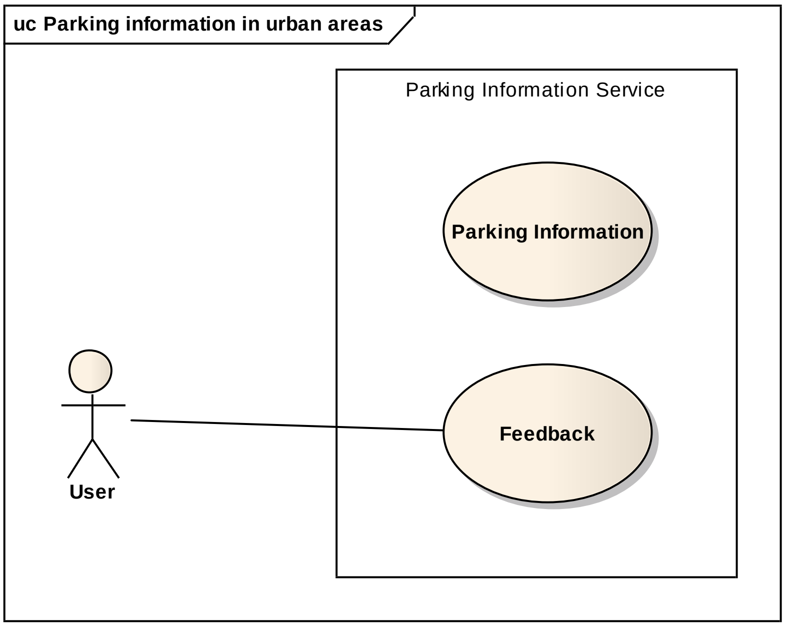
Figure 15: Survey of Co-Cities services classification

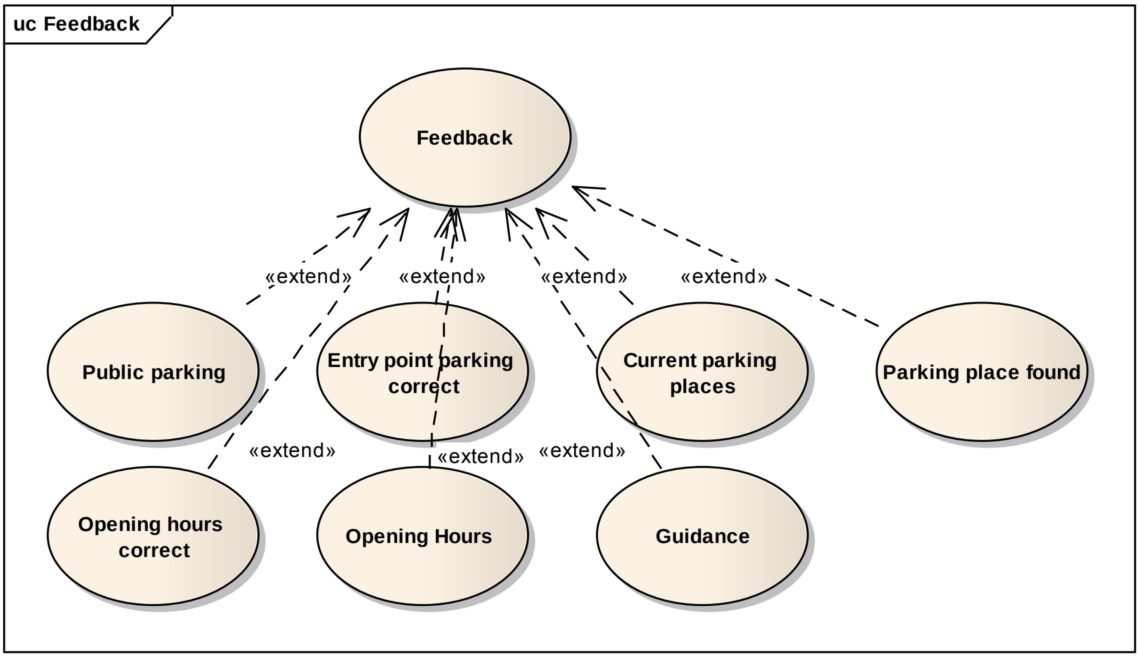
5.1 Parking information in urban areas

ID	1
Title	Parking information in urban areas
Service domain	Parking
Type of service	End user service
Service Content and Objectives	Parking information contains information around parking situation in a city. The following different parking information can be part of the service:

	• parking facilities in general • parking garages • total number of parking lots • park and ride capabilities • different parking tickets • parking restrictions (e.g. place, closing times, vehicle types), • differences in duration of parking (short-term, mid-term, long-term), cultural parking (e.g. parking garages next to theatres, cinemas,...) • parking guide systems • parking type (covered/open air/mixed),
Information included	The information about individual parking lots includes: lot location, lot entrance locations, hours of operation, rates, lot capacity (number of spaces), lot type (Open Lot, Covered Garage, Permit Parking, Contract Parking, Free Parking - include P+R lot, Paid Parking, other), lot constraints (heights, type of vehicles, etc.), and handicap accessibility features.
Feedback information	At the end of the UC the user should answer the question if the provided information was correct (was a parking space available) and helpful (other information, e.g. rates, entrance locations etc.)
Feedback mode / channel	Manual feedback via selecting Icons – representing the potential answers • Public parking? ☺, ☹ • Entry point parking correct? ☺ , ☹ • Current parking places?  • Parking place found? ☺, ☹

	• Opening hours correct? ☺ , ☹ , ? • Opening Hours  • Guidance? 
Actors	Application Navigation providers
Story line	• The user is requesting parking information around a specific location (the current one or another) or of a specific car park chosen • The request is processed and the information is provided • The user can select a specific car park and request an optimal route to this location (this triggers another user case) • The mobile device recognises that the user has arrived at the selected car park (via position, radius) • Finally, simple questions / icons are asked / shown to gain user feedback (see Feedback information). This concludes the use case.
Expected Result	Gain data to get more accurate parking information and to access information provided by car park operators.
Main Data Flow	The feedback is pushed from the end-user device to the “Feedback Database” of an application provider. The application provider send the feedback to the owner of the data as well as process relevant information directly in own services.
Related Services	S1: Static and intermodal dynamic in car navigation in city


uc Parking information in urban areas
Parking Information Service
Parking Information
Feedback
User


uc Feedback
Feedback
«extend»
«extend»
«extend»
«extend»
Public parking
Entry point parking correct
Current parking places
Parking place found
«extend»
«extend»
«extend»
Opening hours correct
Opening Hours
Guidance

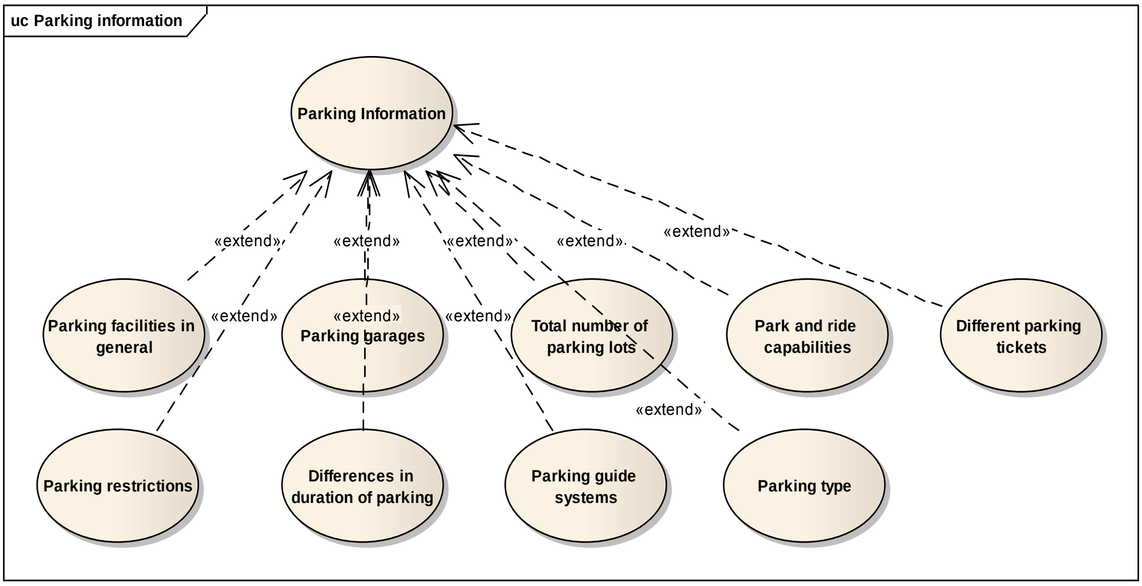
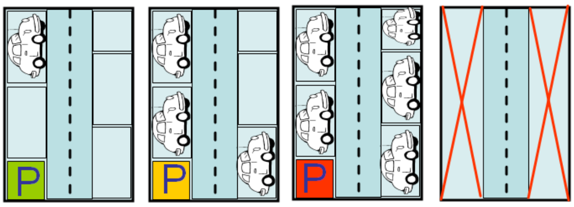


Figure 16: UML diagram for use case Parking information in urban areas.

5.2 Road side parking

ID	2
Title	Road Side Parking
Service domain	Parking
Service Content and Objectives	Parking information contains information around parking situation in a city. The following different parking information can be part of the service: • "probability" parking facilities along the road. (areas of locations of parking along the road – this information is provided as a semi transparent map on top of the map indication in 3 colours the "probability of parking along the road". • max duration of parking – the map can contain also icons on type of parking "eg max 2 hour " • cost parking / pay or parking card
Information included	The information about individual parking lots includes: areas of probability of parking along the road

	• "probability" parking facilities along the road. (areas of locations of parking along the road • max duration of parking • cost parking • pay or parking card
Feedback information	When requesting the service "Parking" – one should get near its destination not only the location of official available parkings, but also (after agreement) get a semi transparent coloured map of areas with probability of road side parking places. The user should select then (via icons) the area where there is still parking place / or where not The user also provides feedback on the "availability" The user also provides feedback on the mode of payment
Feedback mode / channel	• Manual feedback via selecting Icons – representing the potential answers • Current parking places?  • Payment 
Contributing Parties	TomTom should offer "parking availability maps" on top of the navigation map.

Actors	Navigation provider

Story line	• The user is requesting parking information around a specific location (the current one or another) or selects a parking lot.
	• Interested to find Road Side Parking ?
	• At that time also the semi transparent map of “Probability of parking along street” is displayed.
	• The user can select a green area, and ask to navigate
	• When driving in that green zone, the system asks whether there is indeed road side parking available
	• The user answers via icons
	• The system asks also to gives an indication on the “availability” of these places. User also answer icon based.
	  ○ At the end, the system sends
	  ○ the coordinates of the “Road side parking”
	  ○ the indication of the “current places”
	  ○ as well as the payment mode to the feedback database of the application provider

Expected Result	Gain data to get more accurate parking information of road side parking
Main Data Flow	The feedback is pushed from the end-user device to the “Feedback Database” of an application provider. The application provider send the feedback to the owner of the data as well process relevant information directly in own services.
Related UCs	Use Case 1: Parking information in Urban Areas

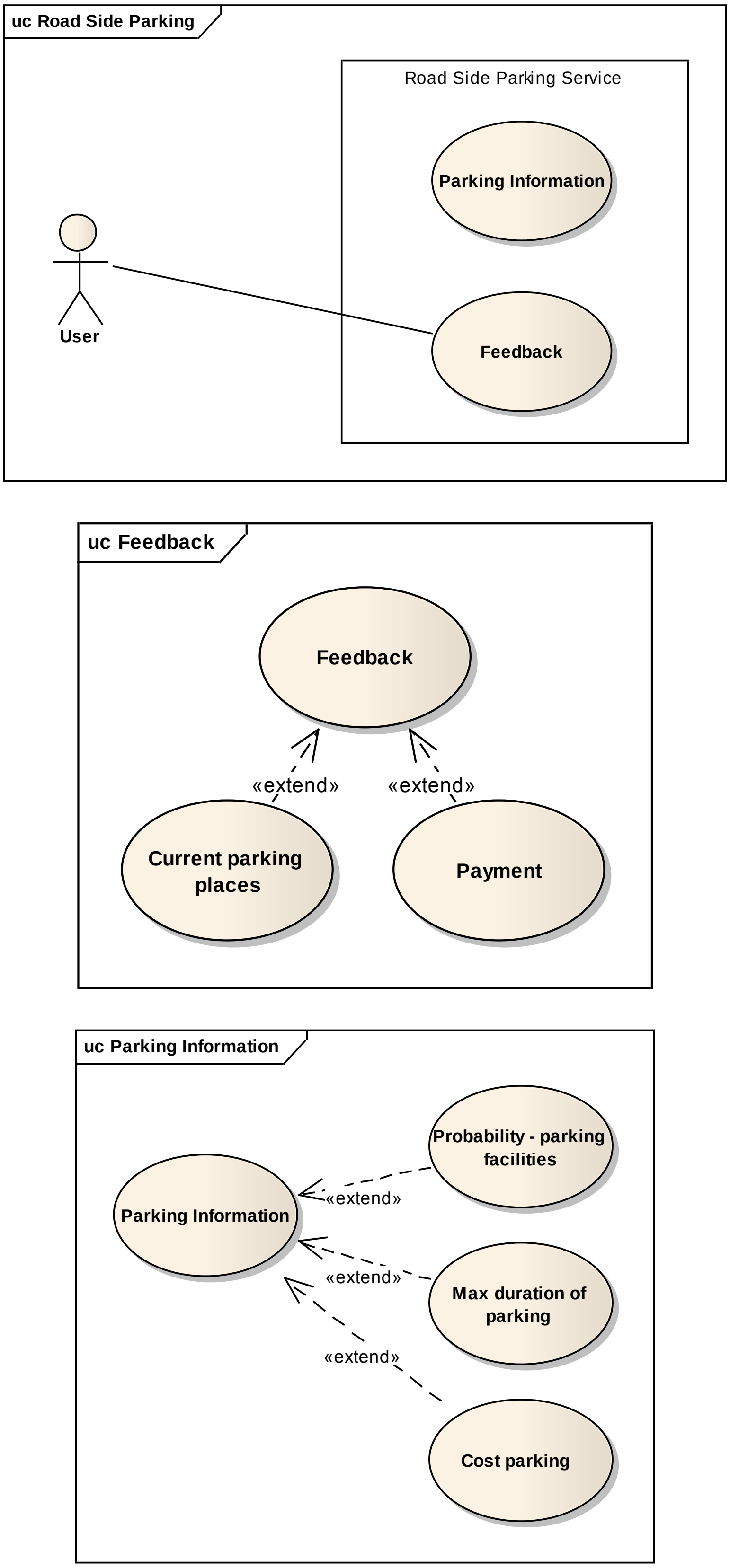


Figure 17: UML diagram for use case Road side parking.

5.3 Traffic info feedback

ID	3
Title	Traffic Info Feedback
Service domain	Road traffic
Service Content and Objectives	While driving, the user gets a map of the traffic situation. Different colours indicating the status of the traffic. (TomTom HD Traffic) • Green – Free flow • Orange – Delays • Red – Strong delays The user gets for its own route, a traffic flow profile. In a second phase: (Once the feedback loop info on the cause of the traffic problem and the event is processed.) The user will get initially also the icons on why and what of the traffic jam.
Information included	Delays caused by traffic situation
Feedback information	The **moment** the user is in a traffic jam (according to the map, or according to the decreased speed), following questions are asked: 1) Are you in a traffic jam? Yes - ☹ => go to 1B, No - ☺ 2) Is the Cause and Event of the traffic Jam Correct : ☺ , ☹ 3) What is the cause of the traffic Jam (all icons) - Accident - Police control - Weather conditions - Road Works - Peak Hour - Toll Ahead - Strike

	- No idea 4) What is obstructed (all indicated via icons) - Exit Closed - CarriagewayBlocked - CarriagewayPartiallyObstructed - LanesBlocked - LanesPartiallyObstructed - RoadBlocked - RoadPartiallyObstructed - Nothing
Feedback mode / channel	The user gives feedback via selection of icons. However the messages behind should be Datex II compliant (Most of the messages indicates are Datex II compliant)
Actors	Navigation application providers
Story line	• The moment the user gets an icon indicating there is a traffic jam , the first questions is sent … Are you in a traffic Jam? • If yes, the next questions are asked • User answers via the icons • After all questions are answered the system send the coordinates and answers to the application provider
Expected Result	Gain detailed data on the cause and event of a traffic jam. In order to provide to the end- user also by means of icons details on the traffic jam
Main Data Flow	The feedback is pushed from the end-user device to the "Feedback Database" of an application provider. The application provider processed this input as new input to all its end users.

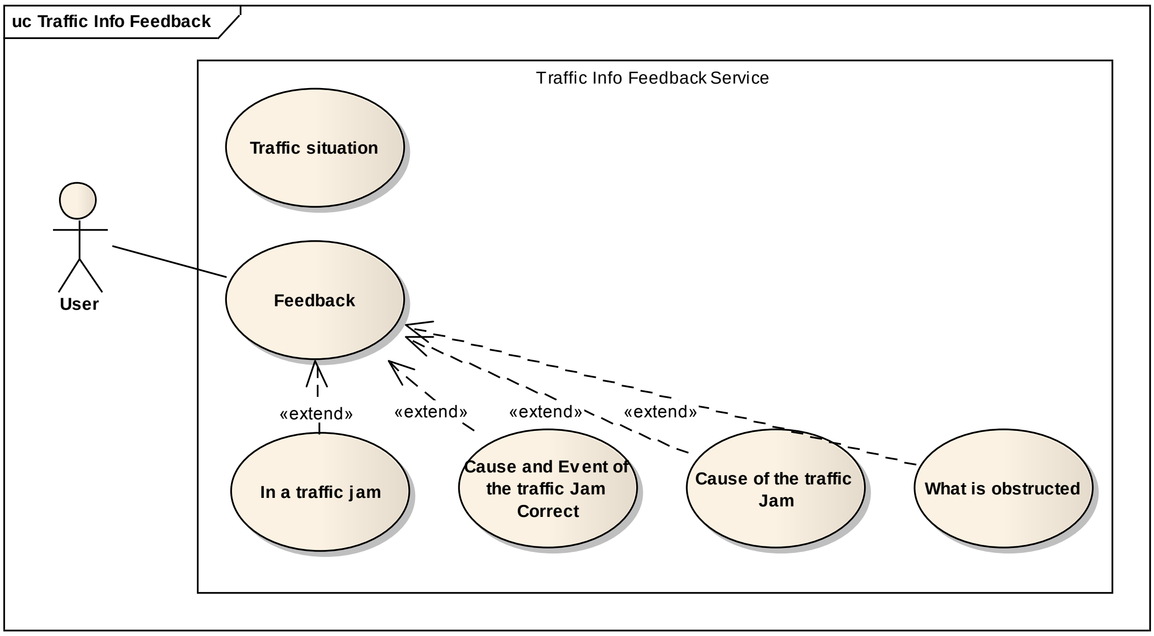


Figure 18: UML diagram for use case Traffic info feedback.

5.4 Feedback speed limit information

ID	4
Title	**Feedback speed limit Information**
Service domain	POI, Road traffic
Service Content and Objectives	User receives on map an icon of the max speed to drive
Information included	N/A
Feedback information	Correction on speed limit information
Feedback mode / channel	In case an icon of a speed limit is provided , the user can select an other speed limit icon in case the one provided is not correct  …
Contributing Parties	TomTom

Actors	Navigation application providers
Story line	• User uses navigation devices • User gets information on speed limits • In case speed limit is not correct , user is able to select via simple interface, current location and correct speed limit value. • The location (coordinate) and the type of sign are send to the feedback database of the application provider
Expected Result	Update information on location and correctness of speed limit information

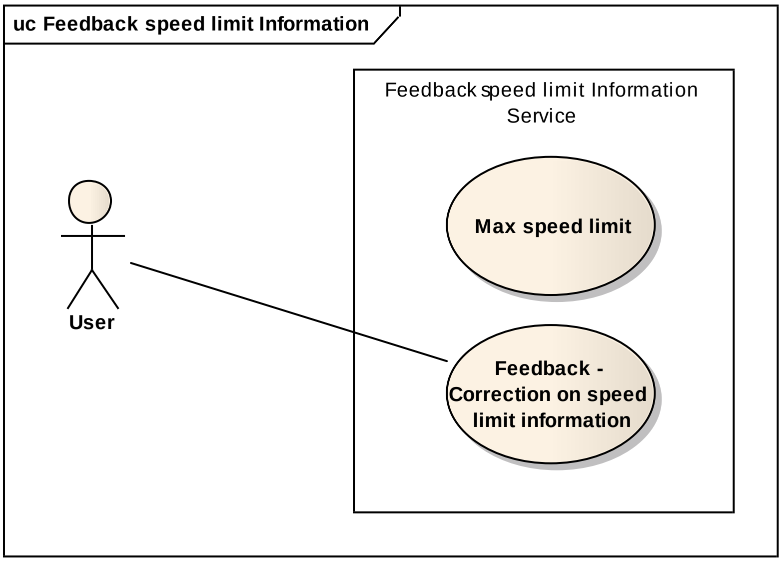
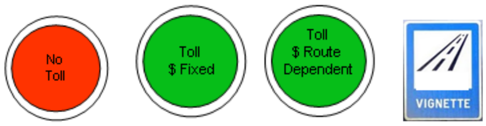


Figure 19: UML diagram for use case Speed limit information.

5.5 Feedback toll information

ID	5
Title	**Feedback Toll information**
Service domain	POI, Road traffic
Service Content and	User received before the last intersection of toll icon indicating

Objectives	that for following part of the road toll needs to be paid.
Information included	N/A
Feedback information	Information whether the location of toll roads is correct Information on the type of payment
Feedback mode / channel	The moment the information of toll is displayed the user get icons to indicate whether there is indeed a toll road ahead or not and if yes which type of payment. If “no toll” is **not** selected, information on the price is requested 
Contributing Parties	TomTom
Actors	Navigation application providers, end user
Story line	• User uses navigation system • User gets indications of toll ahead • User can act immediately when there is in reality no toll ahead, by selecting the icon – no toll • In case of toll, user can add via icons details on the type of payment. • After selecting the No toll / or the type of payment, the system sends the coordinate + icon information to the feedback database of the application provider
Expected Result	Updates on toll locations and type of payment

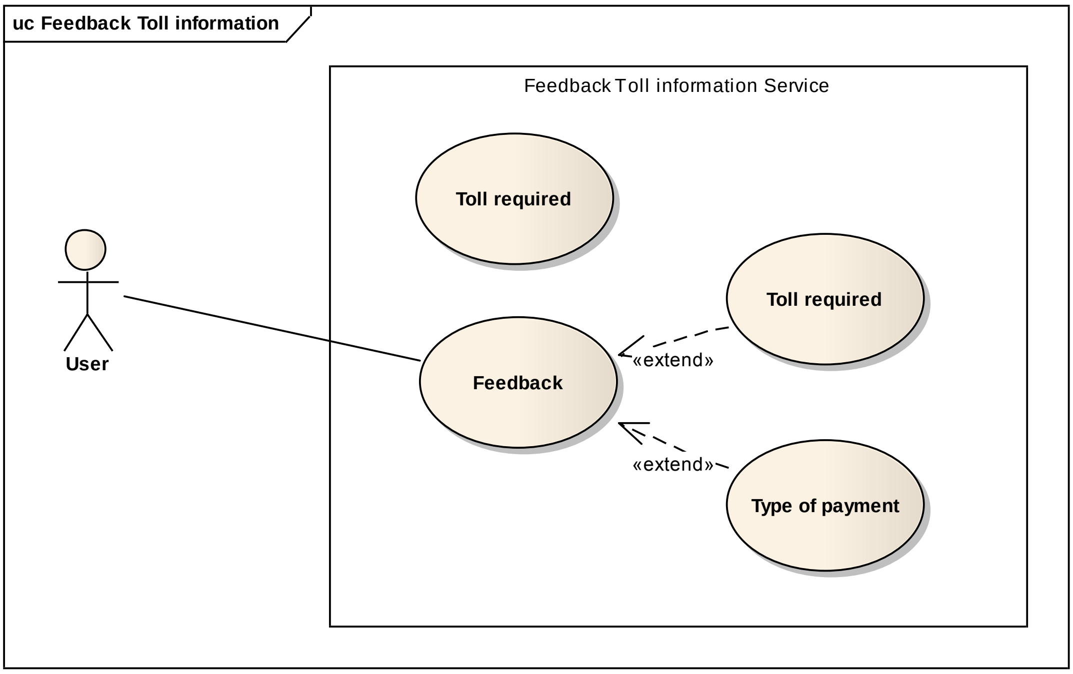
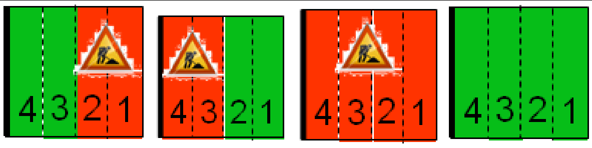


Figure 20: UML diagram for use case Feedback toll information.

5.6 Feedback road works

ID	6
Title	Feedback road works
Service domain	Road traffic
Service Content and Objectives	The user gets, during driving, on the map an icon whether there are road works ahead.
Information included	N/A
Feedback information	Feedback on the status of the roadworks. Which part of the road is affected.
Feedback mode / channel	The moment such an icon appears and the driver passes the roadwork, icons appear to give feedback on the status of the roadwork. (1 line, 2 lines, left lines, right lines, all lines ..) • Start

	•  + "Icon Mobile Road works" • End
Actors	Navigation application providers, end user
Story line	• User drives on road • User get indication that there are roadworks ahead • System asks: where does roadworks start – user can select icon (Start) • System asks: which roads parts are affected – user selects icons indicating the road parts selected • System asks: End road works • User indicates ends • All info: start – affected roads – end are send to the application provider
Expected Result	Feedback on start, end of road works and the road parts affected by the roadworks

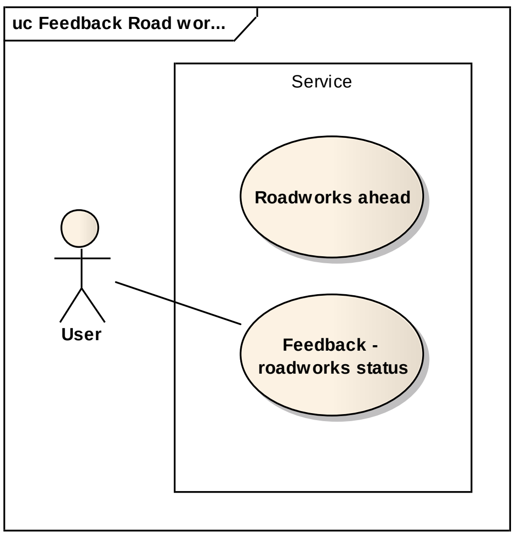


Figure 21: UML diagram for use case Feedback road works.

5.7 Add new traffic information

ID	7
Title	**Add new traffic information**
Service domain	Road traffic
Service Content and Objectives	The user gets its standard navigation information, with traffic info etc …
Information included	N/A
Feedback information	In all cases where the user wants to add something which is not there. There is a simple interface to add • Speed Limit Sign • Parking Sign • Toll • Road works • Traffic Jam …
Feedback mode / channel	Also here a simple icon based user interface should be offered to allow the user to offer submit this new information
Actors	Navigation application providers, end user
Story line	N/A

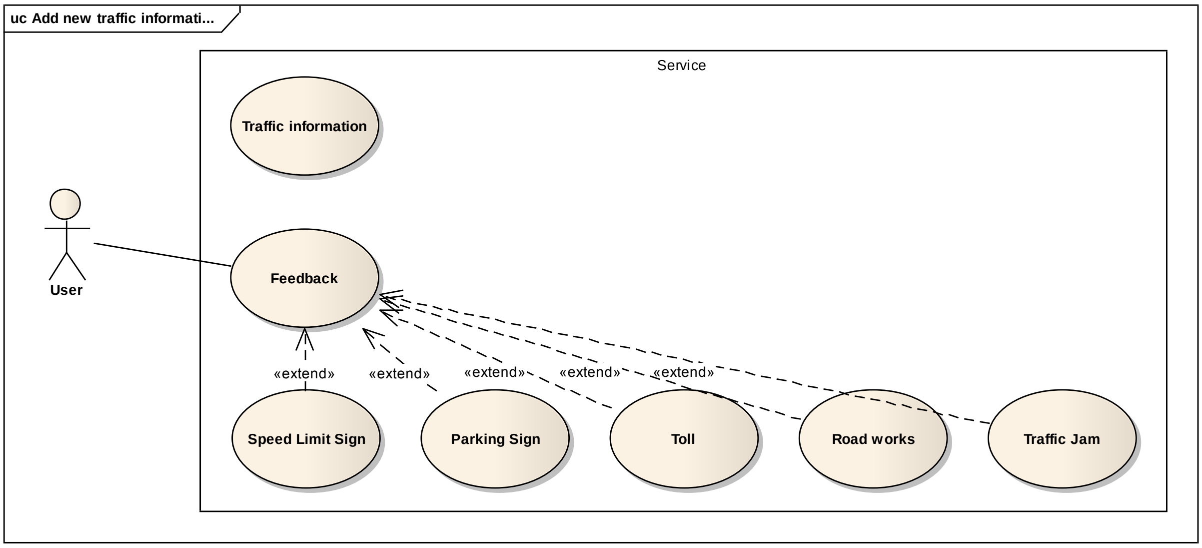


Figure 22: UML diagram for use case Add new traffic information.

5.8 Map related use case

ID	8
Title	**Map related use case**
Service domain	POI, Parking, Journey planning
Service Content and Objectives	The user gets its standard navigation information
Information included	N/A

Feedback information	User is able to add wherever possible map information, which is according to him relevant and not present, via icons. Eg. Select the "+" and indicate
	• add poi
	  ○ Parking
	  ○ …
	• add House Number information
	• add entry point
	• …

Feedback mode / channel	User interface: Icon based feedback
Actors	Navigation application providers, end user
Story line	N/A
Expected Result	New map content

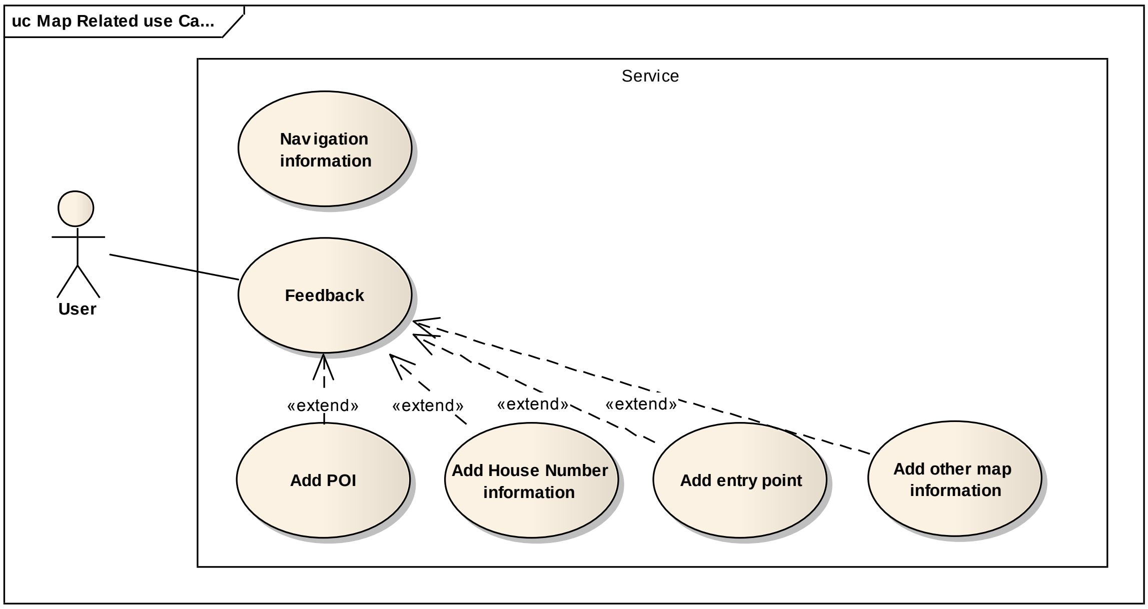


Figure 23: UML diagram for use case Map related use case.

5.9 Estimated time of arrival

ID	9
Title	Estimated time of arrival9
Service Content and Objectives	User select a destination and gets besides the route an Estimated Arrival Time
Information included	N/A
Feedback information	Feedback on the correctness of the Estimated Arrival Time

Feedback mode / channel	Automatic feedback. If arrival time = estimated arrival time, no feedback is send If arrival time ≠ estimated arrival time, the system sends a message to the application server with the time differences
Actors	Navigation application provider
Story line	N/A
Expected Result	Feedback on correctness of Estimated Arrival Time. In order to fine tune the correctness of this service

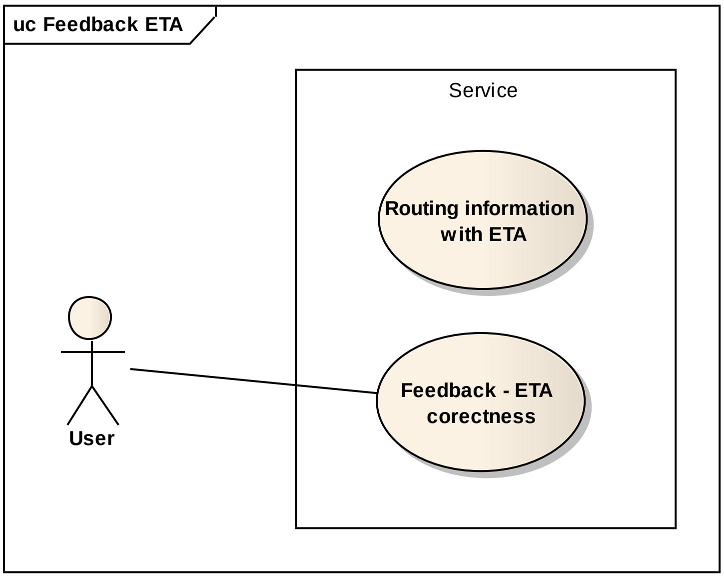


Figure 24: UML diagram for use case Estimated time of arrival.

5.10 Feedback visual destination information

ID	10
Title	**Feedback visual destination information**
Service domain	POI
Service Content and Objectives	User selects destination (as usual) and gets in return, next to Estimated Arrival Time, also a picture of its destination
Information included	N/A

Feedback information	User can give feedback at destination on the correctness of the picture of the destination . If picture is not correct, he can scroll to a list of pictures (which are adjacent of the original).
Feedback mode / channel	At destination automatically the user get the question whether the picture corresponds with its destination. If yes, no further action. If no, a set of adjacent pictures is offered to select the corresponding picture
Actors	Navigation provider, end user
Story line	N/A
Expected Result	Updates on destination information – Housenumber information
Main Data Flow	• User selects destination (streetname, HSN) • A request (coordinate, streetname, HSN) is send to the application server to send the picture of destination • The user gets picture of destination • At destination user indicates whether the picture is correct or not • If not, a new request is send to the server, and a set of adjacent pictures are send to the end-user device • The user selects the correct picture • The idd of the correct picture + the co-ordinate and the original destination address is send pack to application server

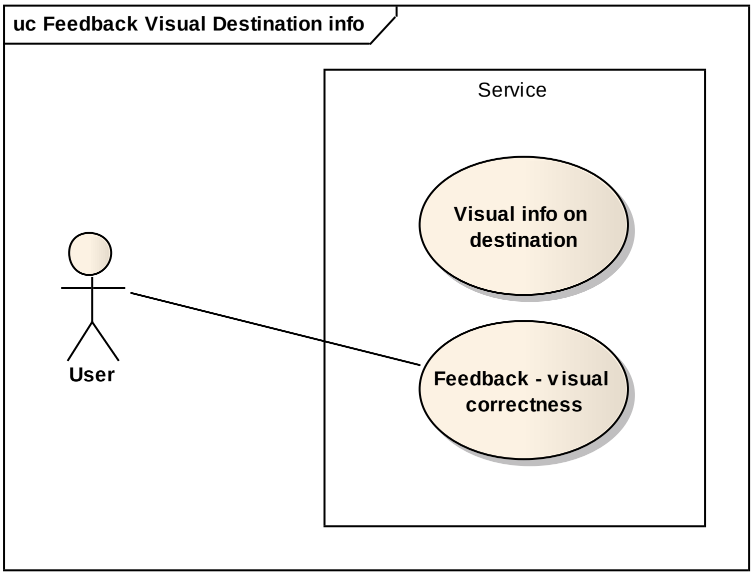


Figure 25: UML diagram for use case Feedback visual destination information.

5.11 Feedback Destination Information

ID	11
Title	**Feedback Destination Information**
Service domain	POI, Journey planning
Service Content and Objectives	User gets recommendation towards destination
Information included	N/A
Feedback information	At destination user can select whether the destination is correct or not. If destination is not correct, user gives feedback.
Feedback mode / channel	The user gives feedback via simple icon: Yes or no.
Actors	End user
Story line	User selects destination (streetname, housenumber) At destination , user get question whether the destination is correct If yes, user selects yes (icon based) , if no, user select No.

	(potential the user is able to indicate the streetname, house number where he arrived)
Expected Result	Feedback on correctness of addresses

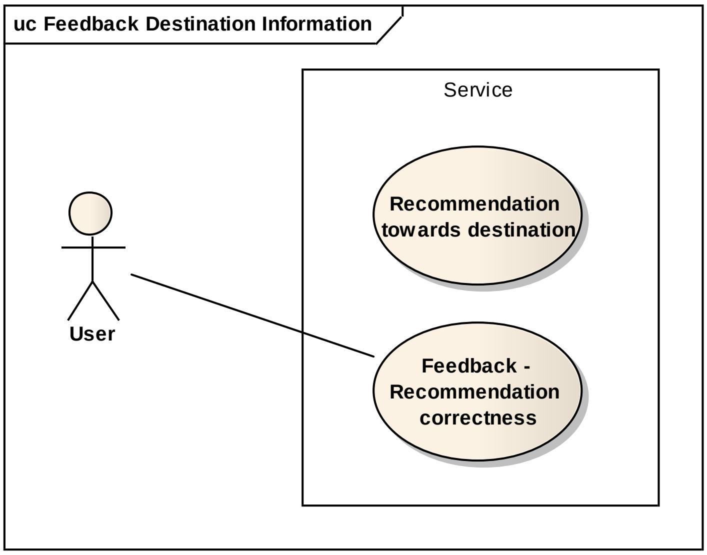


Figure 26: UML diagram for use case Feedback destination information.

5.12 Feedback map last mile to mobile device

ID	12
Title	**Feedback map last mile to mobile device**
Service domain	POI, Journey planning
Service Content and Objectives	User receives (after agreement from user) on mobile device a "last mile" map (aerial + extra pi layers), when stop location is different then destination. The last mile map contains a flag for the current location and a flag for the destination.
Information included	N/A
Feedback information	When return to car, user offers feedback on the correctness of the address.
Feedback mode /	Feedback can be provided via icons

channel	
Actors	End user
Story line	• Whenever current stop location is different the final destination, (or eg. < 5 km of destination), system asks whether you want to download the last mile map on your mobile? • User receives (on its mobile) an aerial image with location parking + location final destination • System asks whether you want to add specific poi layer / landmark layer on this last mile map • When back in car system asks user whether the last mile image was useful and whether the destination was correct
Expected Result	Feedback on the correctness of the “last mile” addresses

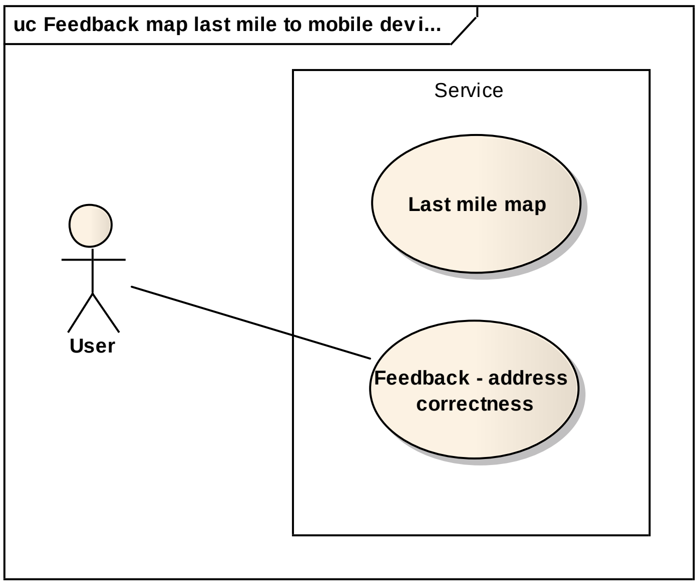


Figure 27: UML diagram for use case Feedback map last mile to mobile device.

5.13 Feedback on public transport location and schedules

ID	13
Title	Feedback on Public Transport location and schedules
Service domain	Public transport, Journey planning
Service Content and Objectives	When selecting "public transport", user gets a layer with the locations of the stop points. When selecting the stoppoint the user get information on the schedule of the busses passing that stoppoint.
Information included	
Feedback information	When selecting a "public transport " stoppoint, the user is asked whether the location is correct . Users answers "no" if not correct. System asks whether the time schedule is correct. User answer "no" if not correct.
Feedback mode / channel	On end-user device: icon based feedback to provide feedback on the correctness of the location, and the correctness of the time schedules.
Actors	End user
Story line	N/A
Expected Result	Feedback on the correct location of stoppoints and the correctness of time schedules

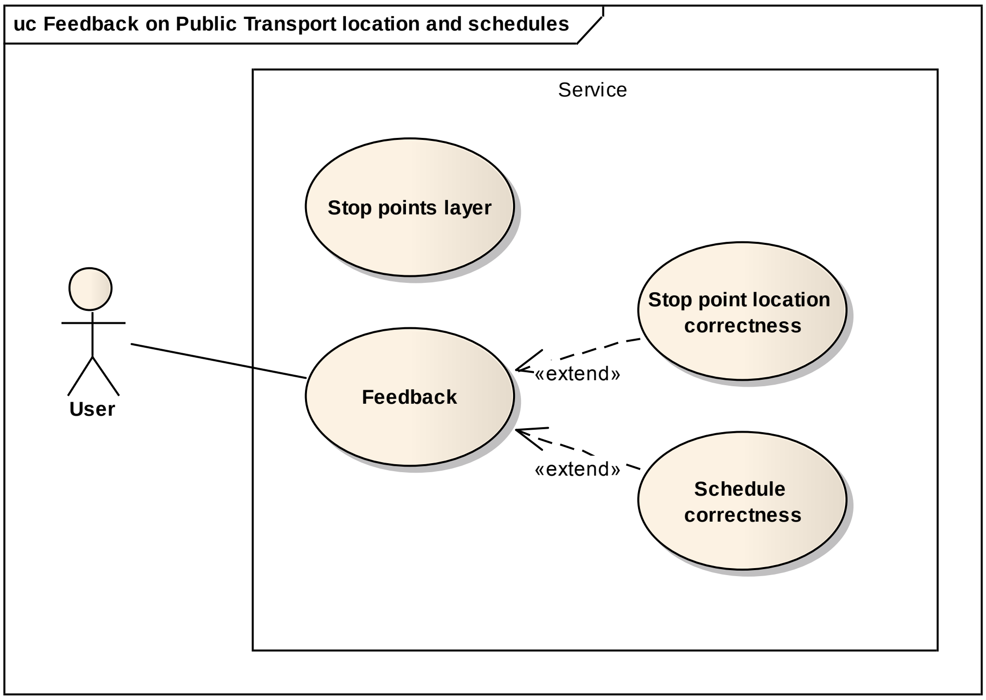


Figure 28: UML diagram for use case Feedback on public transport location and schedules.

5.14 Dynamic road traffic information, Dynamic traffic event information

ID	14
Title	Dynamic road traffic information Dynamic traffic event information
Service domain	Road traffic
Service Content and Objectives	Real time description about road network traffic conditions. This may include temporary road closures, information about traffic levels, traffic events (accidents, road works,…). There is assigned an exact location on the road network for all traffic events.
Information included	N/A
Feedback information	User feedback: 1.Content generation or user input - Road closures

	- Road works - Traffic levels - Accidents - Nothing 2. Evaluation of the service - received information is correct or not
Story line	- The user requests traffic information about a route of road network. - The request is processed and the information is provided - The user selects a route based on this service - Content generation: Through the mobile device the user sends information about traffic conditions of the selected route. - Evaluation of the service: Finally, the user evaluates if the service is good or not (if has received correct information).
Expected Result	Gain data to enable more accurate road network traffic information and to assess information provided by sensors.

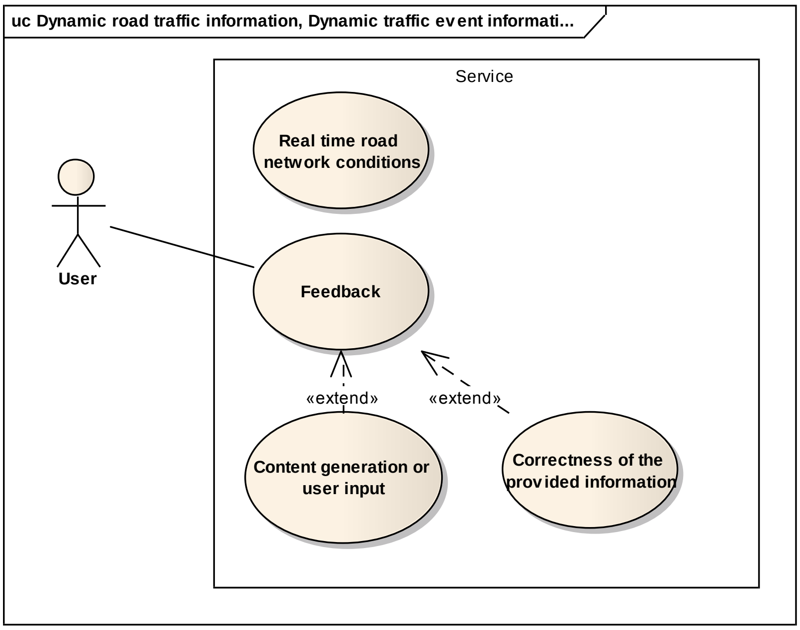


Figure 29: UML diagram for use case Dynamic road traffic information, Dynamic traffic event information.

5.15 Adaptive real-time multimodal journey planning

ID	15
Title	**Adaptive real-time multimodal journey planning**
Service domain	Public transport, Journey planning, POI, Traffic info
Service Content and Objectives	Based on the multimodal journey planning service the user provides a step-by-step feedback about his multimodal trip. This can be compared to the journey planning information provided for the same trip. The feedback information can be sent: - To the Traffic Information Service Provider - To the Traffic Control Center - To the Public Transport Operator The feedback has different objectives depending on the situation: - re-calculation of the Journey in real-time - feedback about the traffic - quality feedback about the mobile service - quality feedback about the PT service This is described with more details in the 'Feedback information' section
Information included	Journey Planning Information, Traffic Information
Feedback information	The traveler uses with the Multimodal Journey Planning Service via a mobile device, connected with a TISP application server. The service can be used as a classic trip planner. In addition, using a mix of integrated automatic and manual procedures the traveler can send feedback information whenever necessary to achieve the objectives described before (Service Content and Objectives) The information to be sent is especially relevant at: • **start point** • **stop point**

	• **interchange points** In general it can be associated to each *trip segment*, which are those parts of the trip delimited by a change of mode of transport or a change of service (e.g. change of bus line) At the beginning of each trip segment (and at the end of the whole Journey) the following data is relevant to produce feedback information: - **Confirmation of trip segment execution** For each trip segment the traveler is asked to indicate if he correctly started or concluded the segment as planned by the Journey Planning Service which means using the expected mode of transport or PT service for that specific segment (for example he's asked to confirm if he boards correctly at the expected bus stop and with the expected PT service: line number etc.) The user location and current time, necessary to complete the comparison between the planned trip segment data and the real situation, can be automatically retrieved. The user location can be retrieved using GPS or, if unavailable, using the approx. position based on available UMTS/HSDPA/WI-FI connections. If necessary a manual correction/input is asked to the user. - **Cause of misalignment between planned and real trip data** If a *difference* exist for a trip segment between the planned trip data and real trip situation (point a) the user is asked about the *cause* of such misalignment. Based on the cause the type and content of the feedback information is computed and the actors who should receive such information, identified. The feedback can then be appropriately sent to them via the Co-Cities interface. The feedback information can be associated to each actor or **receiver** as follows: Type of feedback information:

	• *Misalignment between the planned journey data and the real trip data due to different causes* Receiver: • ***Traffic Information Service Provider*** Purpose (based on the cause of the previous misalignment): • *re-calculate the journey* • *provide a feedback to the TISP about the quality of mobile service* Type of information: • *Misalignment between the planned journey and the real trip situation caused by traffic related situations* Receiver: • ***Traffic Control Center (TCC)*** Purpose: • *provide location based information about traffic conditions.* Type of information: • *Misalignment between the planned journey and the real trip situation caused by PT service delays, cancellations etc.* Receiver: • ***Public Transport operator*** Purpose: • *provide information about the quality of the PT service.*
Feedback mode / channel	The user gives feedback via a combination of data automatically retrieved (e.g. the position based on GPS data) and a manual selection via dedicated functions/commands on the mobile phone, provided by the specific application as described before. This data is sent to each actor via the Co-Cities interface. The process of computation of the feedback information can be done at TISP server side.
Actors	TISP, TCC, Data/Service Providers for Journey Planning service, PT Operator

Story line	A couple of tourists found an accommodation in a B&B in the Tuscany countryside and decides to reach Florence using public transport. They uses the adaptive Multimodal Journey Planning Services and indicates that they need to reach the city center using the 'Public Transport only' option starting from their current location at 9.AM. The system computes the journey: the first part of the planned trip has to be made by foot: 5 minutes walk to the nearest bus stop. Then they have to take the bus at 9:12 to arrive at the railway station where they will take the regional train at 9:45. The train will stop at Santa Maria Novella Station and from there they will start their sightseeing. They arrive at the PT stop and opens the mobile app to check for the real-time schedule. No delay is expected and they take the bus with no problem. After a while the system ask for confirmation about the current status of their trip. They indicates they regularly boarded as expected. A positive feedback is sent to the TISP and PT Operator about the quality of infomobility and PT services. Near the railway station, they see some shops and they decide to stop here even if this would certainly have prevented them to take the train as planned. After an hour, having walked a lot they found themselves in a completely different place. The JP app recognizes that the location and time is completely different than the planned one and ask to confirm and to indicate the cause of this. They indicates this was due to personal reasons. No feedback is sent to any actor but the system re-calculates the journey plan and indicates that now they can choose to take another bus to reach the center of Florence directly without taking the train. They choose this solution but due to the traffic conditions they reach their destination a bit later than expected. At destination

	the app detect such delay and ask for confirmation and for the cause. They indicates that this was due to the traffic and a feedback is sent to the TCC.
Expected Result	Gain detailed data on quality of Journey Planning information, traffic conditions, PT Service
Main Data Flow	The traveller send a basic feedback about his trip. This is integrated with automatically retrieved data (from the device) and sent to the TISP application server where a classification of such feedback information is computed to identify the correct receiver (see Feedback information section). Using the Co-Cities interface data is sent to each 'remote' actor (TCC or PT operator).
Related UCs	

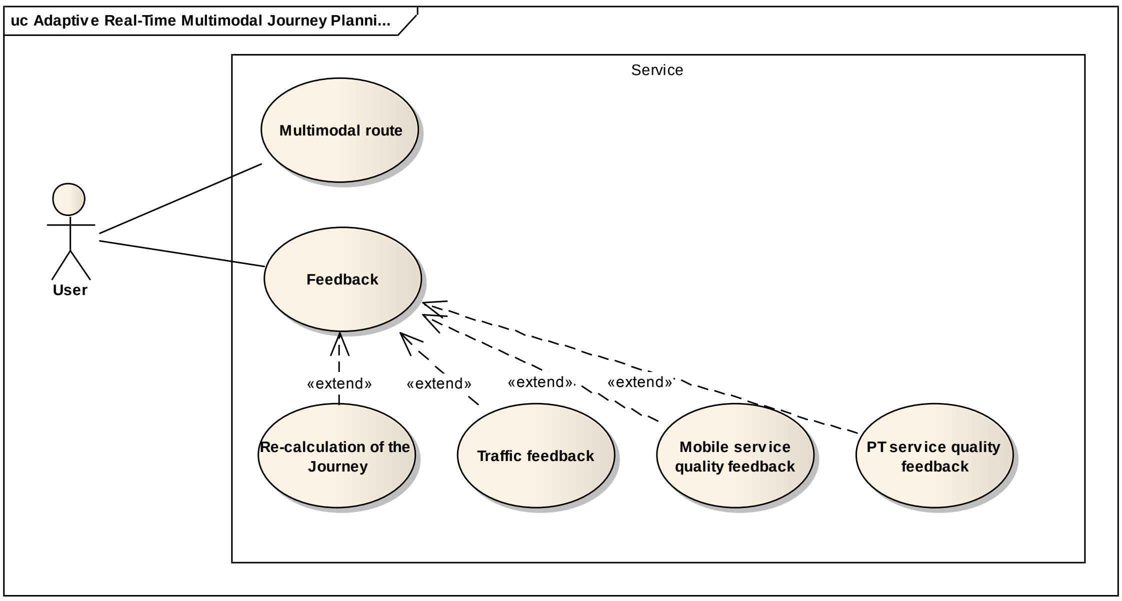


Figure 30: UML diagram for use case Adaptive real-time multimodal journey planning.

5.16 Occupancy of public transport vehicle

ID	16
Title	**Occupancy of public transport vehicle**
Service domain	Public transport
Service Content and Objectives	PT user will inform via the mobile phone about current occupancy of PT vehicle.
Information included	
Feedback information	The PT users, will send an evaluation of the public transport vehicle which they just used. The feedback information could be expressed by indicating a level with an intuitive value; for example a number of percentage (0%, 25% 50%, 75% 100%).
Feedback mode / channel	The user gives his feedback using a selection of icons on the mobile phone provided by the specific infomobility application. This feedback is sent to the PT control room via the Co-Cities interface.
Actors	End user, TISP, PT operator
Story line	A commuter goes to the bus or tram and during ride opens the Android application provided for free by the PT operator. Then send info about occupancy of PT vehicle.
Expected Result	Gain detailed data on quality of REAL TIME PT information provided by the operators via several information channels.
Main Data Flow	The feedback is pushed from the user mobile device to the "Feedback Database" of an application provider.

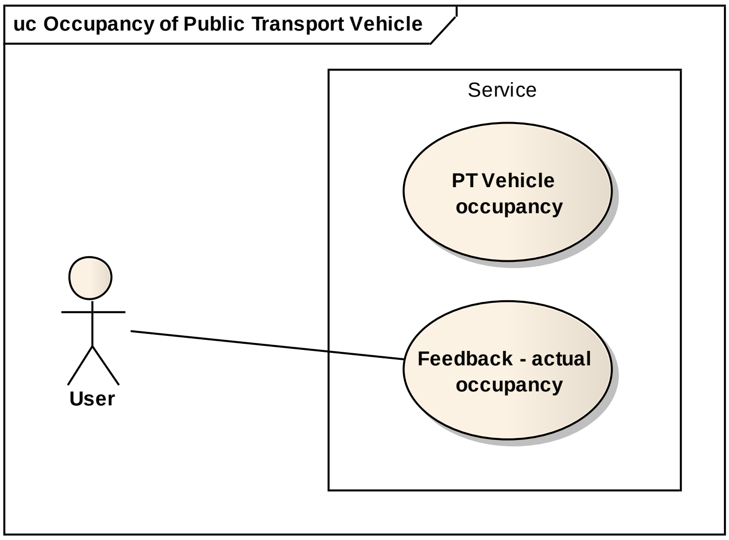


Figure 31: UML diagram for use case Occupancy of public transport vehicle

6 Use cases and feedback services

6.1 Feedback data in Co-Cities

As already introduced the architecture of the Co-Cities system is developed on the basis of

- the In-Time specification and its architectural principles
- new features for the management of feedback data and information. These can be defined as extension of the In-Time system.

The present chapter aims at depicting how the definition of Use Cases can be considered as a starting point for the identification and technical definition of this extension (to In-Time) as it allows to identify all needed features to build a system which “closes the loop” from TISPs to the local actors with the feedback information element.

Let’s consider the following diagram:

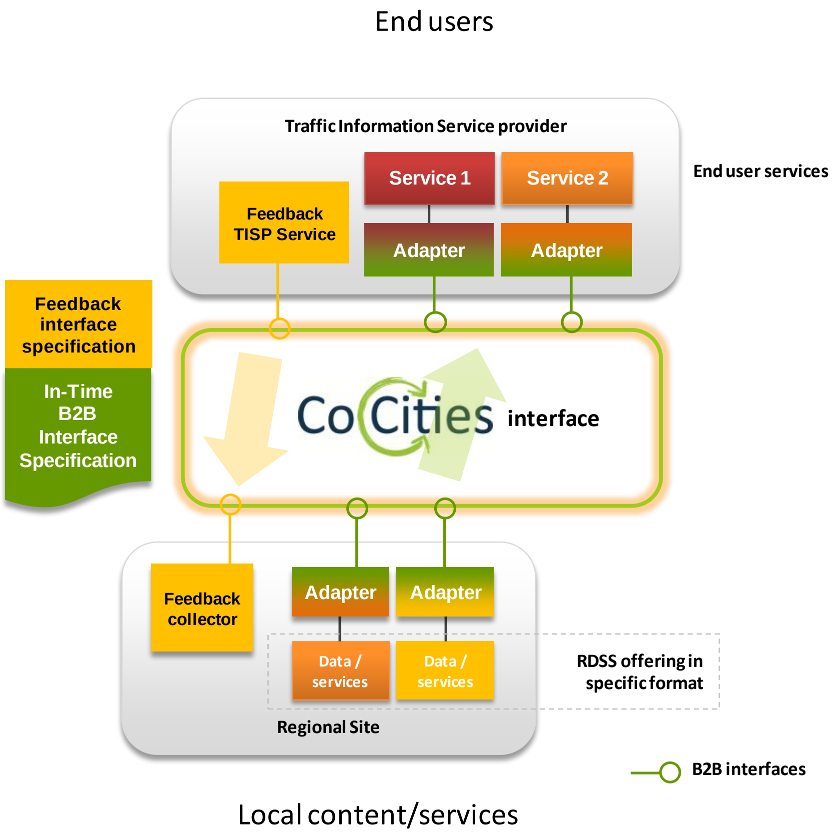


Figure 32: Basic Co-Cities architecture

In the diagram the basic In-Time components are depicted and the presence of the additional Co-Cities elements highlighted in yellow. In-Time adapters -necessary to translate services and contents from/to TISP/RDSS via the CAI- are built on the basis of the In-Time B2B Interface Specification. Along the same line, two additional types of components: "**feedback TISP services**" (TISP side) and "**feedback collectors**" (RDSS side) are introduced and defined on the basis of additional specifications which arises from the new specific Co-Cities requirements ("Feedback data interface specification").

Feedback TISP services are B2C services developed by TISPs as part of the end user applications. They are responsible for the production of the feedback information.

Feedback collectors are B2B services running RDSS side which are responsible for collecting the feedback information delivered by TISPs.

The feedback data is exchanged via the Co-Cities Commonly Agreed Interface, which is designed from the In-Time CAI as an extension of it with the necessary elements for Feedback information handling.

These topics will be extensively covered in Project WP3.

The identification of service domains for feedback information is a key aspect for the design of the Co-Cities CAI, in fact, following a MDA (Model Driven Architecture) approach, the essential part of the Co-Cities interface specification and design process is the definition of the data and service models supported by the target system and the identification of service domains is a key step to define these models.

6.2 Service Domains for feedback information

Feedback information is expressed and "sent back" to RDSSs via the Co-Cities Interface for a number of Domains of interest. These may be called "Service Domains for feedback information". These have to be distinguished from the "Service domains for the end users" because the latter ones refers to the actual provision of information to the end user which is done via the In-Time services.

In details:

1. End User Services are services giving traffic and mobility information to the end users. They are In-Time B2C Services provided by TISPs. These services operated in the domains defined in In-Time which can be defined as "Service domains for the end users"

2. End User Services can be extended with 'feedback functionalities' in Co-Cities in order to enable the feedback mechanisms.
3. The group of Co-Cities Use Cases describes in which domains the feedback information is formulated, calculated and provided. These domains can be defined as "Service Domains for feedback information" and they can be different from "Service domains for the end users" meaning that feedback functionalities may not be present for all Service domains for the end users.
4. Feedback data is sent from TISPs to RDSSs via the Co-Cities CAI exactly for those domains identified before ("Service Domains for feedback information")

The Domains covered by Co-Cities Use Cases (which is the information present in the "Service Domain" field of the Use Case definition table) forms the group of Service Domains for feedback information.

By cross-checking these domains with the Domain of interest in In-Time, in the light of the optimization criteria described in 3.5 the group of Service Domains for feedback information is defined as follow:

Service Domains for feedback information
Road traffic
Parking
Point of interest
Public Transport
Multimodal Journey Planning

Figure 33 – Service domains for feedback information

6.3 Feedback datasets

A more specific identification and classification of necessary additional "feedback" common information has been done in WP2 with the objective of:

- Classify and assign feedback datasets to the domain of interests
- Avoid inconsistency
- Have a real common definition of feedback datasets

For this purpose an excel file has been prepared to collect the following information for each domain of interest:

- Type Of Feedback (example: the correctness of the provided data as part of a quality feedback)
- Description of Data
- Recipient (TISP/RDSS/BOTH) – who is dealing with the feedback data.

The whole set of common feedback datasets, collected in the excel file, is identified from the use case descriptions. The synthesis made from the use cases resulted in a common identification and definition of feedback datasets which will be reflected in the formal specification design (which will be carried out in WP3) necessary to build the Co-Cities common interface.

In the appendix, a list of the identified feedback datasets is included as input for WP3 activities which will then develop the interface specification based on this input.

7 Appendix 1 – Feedback Dataset derived from Use case definition

7.1 Parking

PARKING INFORMATION SERVICE	
Quality of Data	
Type of Feedback	**Description of data**
- Correctness of data:	
- Parking Availability	(yes/no)
- Closing Times	(yes/no)
- Entrance locations	(yes/no)
- Parking Type	(yes/no)
- Fees	(yes/no)
- Parking places	(yes/no)
- Vehilce types	(yes/no)
- Max. parking duration	(yes/no)
- Payment method	(yes/no)
New Data Submitted by users	
Type of Feedback	**Description of data**
- New or updated Information	
- Parking status	(Park status enumeration)
- Parking place	(GPS coordinate)
- Parking type	(Park type enumeration)
- Parking opening times	(Opening times information)
- Parking fees / hour	(Parking tariffs information)
- Parking Entrances	(GPS coordinates)
- Admitted Vehicles	(Vehicle type enumeration)
- Parking places	(amount of total parking places)
- Maximum duration of parking	(number of hour / minutes max allowed)
- Payment type	(list of ways of payment)
Quality of Service (response time, reliability, ...)	
Type of Feedback	**Description of data**
- Evaluation of Service features:	
- Response Time (calculated)	(milliseconds automatically detected)

- Response time (user evaluation)	(Enumeration of possible responses)
- Overall Data Quality	(1-5 stars rating system)
- Reliability of service provision	(1-5 stars rating system)
- User interface quality	(1-5 stars rating system)
- Overall service quality	(1-5 stars rating system)

7.2 Traffic Information services

TRAFFIC INFORMATION SERVICES	
Quality of Data	
Type of Feedback	**Description of data**
correctness of data	
New Data Submitted by users	
Type of Feedback	**Description of data**
- New or updated Information	
- Event Type	(Accident, AbnormalTraffic, etc..)
- Event Position	(GPS coordinate)
- Queue Lenght	(Queue lenght in meters)
- Traffic Trend	(Traffic trend enumeration)
- Cause traffic problem	(list of causes)
- What is obstructed	(list of parts of road)
- Start roadworks	gps position
- End roadworks	gps position
- Affected part of roadwork	(list of parts of road)
Quality of Service (response time, reliability, …)	
Type of Feedback	**Description of data**
- Evaluation of Service features:	
- Response Time (calculated)	(milliseconds automatically detected)
- Response time (user evaluation)	(Enumeration of possible responses)
- Overall Data Quality	(1-5 stars rating system)
- Reliability of service provision	(1-5 stars rating system)
- User interface quality	(1-5 stars rating system)
- Overall service quality	(1-5 stars rating system)

7.3 Public Transport

PUBLIC TRANSPORT INFORMATION SERVICE	
Quality of Data	
Type of Feedback	**Description of data**
- Correctness of data:	
- Expected Time of Arrival	(1-5 stars rating system)
- PT lines available at stop point	(yes/no)
- Position of Stop Point	(yes/no)
- Location stoppoint correct	(yes/no)
schedule stoppoint correct	(yes/no)
New Data Submitted by users	
Type of Feedback	**Description of data**
- Location stoppoint	(gps position)
- Schedule input stoppoint	(fname line, times, ...)
Quality of Service (response time, reliability, …)	
Type of Feedback	**Description of data**
- Evaluation of Service features:	
- Response Time (calculated)	(milliseconds automatically detected)
- Response time (user evaluation)	(Enumeration of possible responses)
- Overall Data Quality	(1-5 stars rating system)
- Reliability of service provision	(1-5 stars rating system)
- User interface quality	(1-5 stars rating system)
- Overall service quality	(1-5 stars rating system)

7.4 Journey Planning

MULTI-MODAL JOURNEY PLANNING SERVICE	
Quality of Data	
Type of Feedback	**Description of data**
- Correctness of data:	
- Trip Segment Start Time	(yes/no)
- Trip Segment Start Position	(yes/no)
- Trip Segment Stop Time	(yes/no)
- Trip Segment Stop Position	(yes/no)
- ETA correct	(yes/no)
- Destination correct	(yes/no)
(destination last mile correct	(yes/no)
New Data Submitted by users	
Type of Feedback	**Description of data**
- Misallignment cause between planned and real:	
- Traffic Event Type	(Accident, AbnormalTraffic, etc..)
- Other Type of Event	(Strike, etc..)
- Correct destination	gps location
Quality of Service (response time, reliability, …)	
Type of Feedback	**Description of data**
- Evaluation of Service features:	
- Response Time (calculated)	(milliseconds automatically detected)
- Response time (user evaluation)	(Enumeration of possible responses)
- Overall Data Quality	(1-5 stars rating system)
- Reliability of service provision	(1-5 stars rating system)
- User interface quality	(1-5 stars rating system)
- Overall service quality	(1-5 stars rating system)

7.5 POI

POI		
Quality of Data		
Type of Feedback		**Description of data**
correctness of data		
	- Speed limit info correct	(yes / no)
	- Location toll correct	(yes / no)
	- Toll info available	(yes / no)
	- Payment method correct	(yes / no)
	- Fixed prices toll correct	(yes / no)
	- Location of parking sign correct	(yes / no)
	- Picture of destination correct	(yes / no)
	- Location start speed limit correct	(yes/ no)
New Data Submitted by users		
Type of Feedback		**Description of data**
New or updated info	- Speed limit	(value)
	- Location start speed limit	(gps position)
	- Location end speed limit	(gps position)
	- Start location toll	(gps position)
	- End location toll	(gps position)
	- Location toll house	(gps position)
	- Fixed toll cost	value on gps position
	- Toll payment method	(list of methods)
	- Location start parking sign	(gps position)
	- Location end parking sign	(gps position)
	- Poi type	(list of poi on gps location
	- Housennumber info	(value on gps position)
	- Add entry point	(gps position) + (for "list of poi type")
	- Ppicture of destination	(out of list of pictures around destination)
Quality of Service (response time, reliability, ...)		
Type of Feedback		**Description of data**
- Evaluation of Service features:		
	- Response Time (calculated)	(milliseconds automatically detected)

	- Response time (user evaluation)	(Enumeration of possible responses)
	- Overall Data Quality	(1-5 stars rating system)
	- Reliability of service provision	(1-5 stars rating system)
	- User interface quality	(1-5 stars rating system)
	- Overall service quality	(1-5 stars rating system)

8 Abbreviations

ANPR	Automatic Number Plate Recognition
AVL	Automatic Vehicle Location
B2B	Business to Business
B2C	Business to Customer
CAI	Commonly Agreed Interface
CCTV	Closed Circuit Television
ETSI	European Telecommunications Standards Institute
FCD	Floating Car Data
FVD	Floating Vehicle Data
GML	Geography Markup Language
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HGV	Heavy Goods Vehicle
HSDPA	High Speed Downlink Packet Access
ITS	Intelligent Transport Systems
LBS	Location Based Services
LOS	Level Of Service
MDA	Model-Driven Architecture
NUTS 2	Nomenclature of Units for Territorial Statistics (European Level 2)
OGC	Open Geospatial Consortium
PMV	Parcels and Miscellaneous Van
POI	Point of Interest
PT	Public Transport
RDSS	Regional Data and Service Server
RTPI	Real Time Passenger Information
RTTI	Real Time Traveller Information
SDCTU	Sistema Distribuido de Control De Trafico Urbano
SOA	Service Oriented Architecture
TCC	Traffic Control Center
TISP	Traveller Information Service Provider
TMIS	Traffic Management Interface Systems
TPEG	Standard for Traveller Information Services of the Transport Protocol Experts Group
UML	Unified Markup Language
UMTS	Universal Mobile Telecommunications Systems
VMS	Variable Message Sign
WFS	Web Feature Service
Wi-Fi	Wireless Fibrepower

WSDL	Web Service Description Language
XML	Extensible Markup Language
XSD	XML Schema Definition