*Multimodality for people and goods in urban areas*

**FP7.CP 284906**

# Instant Mobility Use Case Scenarios definition & analysis

## preliminary report

**Deliverable D3.1 (WP3.1)**

**September 2011**

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# Instant Mobility WP3.1

# D3.1 – Instant Mobility Use Case scenarios definition & analysis – preliminary report

| WP3 | D3.1 |
|---|---|
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| **Short Description** | This deliverable aims at characterising the five lead scenarios selected for analysis for their important potential of enhancement with Future Internet. This document provides a detailed description and functional analysis of the Instant Mobility services derived from the lead scenarios initially defined. It specifies service capability, service components, actors and their roles, data flows and database for each service in the five lead scenarios. Interactions and combinations of these services within the scenarios are also described. |
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## Document history

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# Deliverable Abstract

The “Instant Mobility” project is developing and exploring a concept for transforming the mobility of persons and goods in the future through application of advanced Internet technologies. This document presents a characterisation of five lead scenarios selected for analysis for their important potential of enhancement with Future Internet (FI).

It also provides a detailed description and functional analysis of the individual types of Instant Mobility services derived from the lead scenarios. It specifies service capability, service components, actors and their roles, data flows and databases of each service in the five lead scenarios. Interactions and combinations of these services within the scenarios are also described.

The five scenarios are named:

- Multimodal travel made easy
- The sustainable car
- Collective transport 2.0
- Trucks and the city, and
- Online traffic & infrastructure management.

*Multi-modal travel made easy* offers a traveller seamlessly a wide range of travel and transport options, according to the user’s preferences, for all the stages of a trip that may use various modes including public transport, car and non-motorised means, e.g. bicycles.

*The sustainable car* provides travellers who choose the use a car for at least part of their journey with the best route i.e. that with least delay, least CO2, shortest travel time or lowest cost etc. via a number of interactive online information services based on future internet technologies.

*Collective transport 2.0* expresses a vision where transport operators in the future will use Internet to sense passengers’ presence at stops and to register their destination, to offer innovative online services flexibly matching the vehicles, timetables and routes to the actual demand.

*Trucks and the city* shows how Internet based services can manage commercial vehicle deliveries and routeing, organise drivers’ shifts and synchronise vehicle movements and goods pickup and reception.

*Online traffic and infrastructure management* puts traffic management and control online, offering a greater flexibility and performance of the current functions of today’s traffic management, enables direct vehicle-to-traffic system interaction, and allows new possibilities for local, sector and wide area optimisation.

This document provides a detailed description of each scenario and each service in those scenarios, as well as the interactions and service combinations in each scenario. For each service, an end-to-end service chain, service capability, components of each service, actors and their roles and data flow are provided in this deliverable, which will form a base for functional and non-functional requirements of FI technologies in subsequent phases of the project.

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# 1 Introduction

## 1.1 Objectives of this document

The role of WP3 (Use Case Scenarios) is to develop a number of parallel, interwoven scenarios with both a user- and business-centred focus. Each scenario describes a number of Internet-supported services that are likely to be used by and to benefit a particular group of stakeholders. The Use Case Scenarios definition and analysis is described in three deliverables:

- D3.1 Instant Mobility Use Case Scenarios Definition & Analysis – Preliminary Report
- D3.3 Instant Mobility Use Case Scenarios Definition & Analysis – Final Report
- D3.5 Instant Mobility Use Case Scenarios Functional and non-Functional Requirements

In D3.1, five "lead scenarios" are described, that were selected to highlight the benefits of FI technologies in five distinct domains of transport and mobility, each reflecting the viewpoint of one principal type of stakeholder. Each scenario consists of a number of services. Based on descriptions of the services, use cases for each of the services will be defined in D3.3. D3.3 will also analyse the use cases in order to define functions of the services. The functions will be further analysed in order to identify functional and non-functional requirements in D3.5. This process of use case scenario definition and analysis is shown in Figure 1.

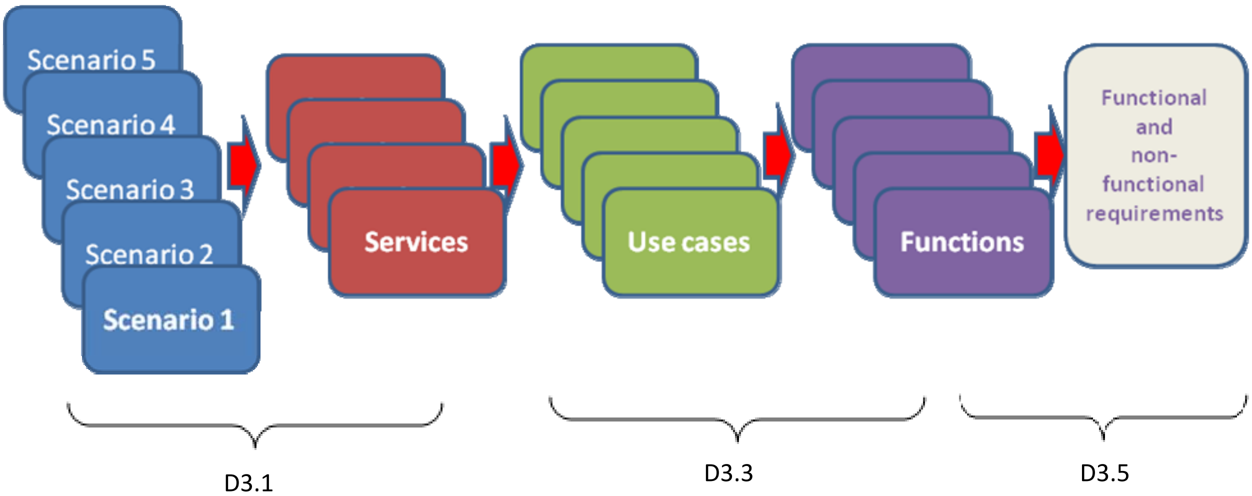


Figure 1 - the process of the use case scenario definition and analysis

This document (D3.1) aims to characterise the five lead scenarios selected for analysis for their important potential of enhancement with Future Internet technologies. The report provides a detailed description of each of the five scenarios, including the services and interactions and combinations of these services in each scenario. For each service, an end-to-end service chain, service capability, components of each service, actors and their roles and data flow will be provided. This information will be further analysed in D3.3 in order to form functional and non-functional requirements.

## 1.2 Overview of the lead scenarios and services

The five lead scenarios are:

- Multimodal travel made easy
- The sustainable car
- Collective transport 2.0
- Trucks and the city
- Online traffic and infrastructure management

Each of the five lead scenarios and their services is briefly presented in the following sections.

### 1.2.1 Lead Scenario 1 - Multimodal travel made easy

In this scenario, online services offer a traveller a wide range of travel and transport options, adapted according to the user's preferences, for all stages of a trip that may use various modes including public transport, car, and non-motorised means. Emphasis is on quality: shortest journey time and greatest convenience; least cost; greatest energy efficiency and reliability. The traveller's itinerary is continuously monitored in real-time and is adjusted whenever conditions or options would improve it. Various context defined services are "pushed" to the traveller just where and when needed.

The scenario consists of nine services. A detailed description of the scenario and the services is given in Chapter 2.

| Lead Scenario 1 - Multimodal travel made easy | | |
|---|---|---|
| Nr. | Service name | Short description |
| 1a | End-to-end itinerary planning | Traveller can choose preferred modes; online service provides optimised end-to-end itineraries, e.g. quickest, cheapest, least Green house Gas (GHG) modes. |
| 1b | Real-time itinerary monitoring | Online service monitors execution of itinerary on all modes, calculates actual versus planned service quality, identifies and notify service incidents and degradation as support services. |
| 1c | Continuously updated travel time information | Service provides continuous journey/arrival time estimate based on real reported journey times of all connected travellers. |
| 1d | Disrupted service assistant | Service detects disruption to any part of planned itinerary, identifies and offers best alternatives to traveller |
| 1e | Interchange & en route assistance | For multi-modal trips, provides specific information and guidance at mode-to-mode interchanges, and during each leg informs about stops/stations, connections etc. |
| 1f | On-the-spot POI & tourism information | During the journey, service delivers relevant point-of-interest (POI) or tourism information, at the right spot. |
| 1g | Special-needs travel support | Service for travellers with reduced mobility, guiding along fully accessible transport means and arranging for real-time support as needed, e.g. interchange. It will offer voice (for blind) or text (for deaf) information. |
| 1h | Ticketless mobile fare payment | Online service offers single account payment for multiple journey legs, so no need to purchase tickets; especially valuable for tourists and occasional users. Proof of payment provided via traveller's handset. |
| 1i | Bicycle sharing | Online service informs of bike and docking space availability, and |

| | | |
|---|---|---|
| | | allows multi payment on single account. It can accept reports of defective equipment etc. |

### 1.2.2 Lead Scenario 2 - The Sustainable Car

In this scenario travellers who choose to use a car for at least part of their journey are helped to find the "best" route, i.e. that with least delay, least CO2, shortest travel time, lowest cost etc., via a number of interactive online information services making use of newest internet features.

The scenario consists of seven services. A detailed description of the scenario and the services is given in Chapter 3.

| Lead Scenario 2 - The sustainable car | | |
|---|---|---|
| **Nr.** | **Service name** | **Short description** |
| 2a | Personalised route guidance | This service is enhanced with real-time recommendations for avoiding congestion, while interacting with a service that optimises each individual trip while optimising the overall traffic system. |
| 2b | "itinerary booking" service | This online service allows drivers to reserve "slots", departing at arranged time and following recommended route, and receiving limited traffic signal priority. Internet service pools all requests and allocates itineraries. |
| 2c | Real-time traffic & route information | Probe vehicle data from all fleets are gathered on internet, integrated with other sensor data to give real-time traffic conditions over full road network. Online traffic info services are available to drivers, and support other travel services. |
| 2d | Car sharing plus | Online service to locate, book and pay for a shared vehicle (small or large car; electric car; scooter; van…) for short-term use; may be offered as "mobility service" by vehicle manufacturer; may receive eco-incentive. The service can be delivered via mobile handset. |
| 2e | Ride sharing | Requests and offers of ride sharing from various social-networks are combined in online database, and mashed-up together to give greatest choice of time, location, type of person etc. |
| 2f | Congestion charging | Online service to monitor users' vehicles and apply variable charges according to location, time of day, vehicle type etc; can include negative charges, i.e. bonus for avoiding congested times and locations. It can be combined with service to suggest eco-friendly alternative easy to travel. |
| 2g | Parking assistance | Online services to provide parking space availability, booking, guidance and payment. Also social-network crowd-sourcing service to notify real-time availability of on-street parking spaces. |

### 1.2.3 Lead Scenario 3 - Collective Transport

This scenario expresses a vision where collective transport operators in the future will use Internet to know passengers' presence at stops and to register their destination, to offer innovative online services flexibly to match their vehicles, timetables and even routes to the actual demand. Internet will also allow fully cashless ticketing while providing better market information. Real-time video monitoring will offer greater passenger and crew security.

The scenario consists of seven services. A detailed description of the scenario and the services is given in Chapter 4.

| Lead Scenario 3 - The collective transport | | |
|---|---|---|
| **Nr.** | **Service name** | **Short description** |
| 3a | Floating passenger data collection | Sensors at stops and passengers' mobile devices provide location and destination information; when mashed up with route and service information this enables real-time operational optimisation. |
| 3b | Demand-responsive service coordination | Online service to receive passengers' requests and optimise operators' offer for demand-responsive transport (e.g. taxis, dial-a-ride, special transport services). |
| 3c | Flexible schedule adaptation | Based on real-time vehicle monitoring, operator uses online passenger demand information to adapt service route and timetable, and to inform passengers of service modification. |
| 3d | Adaptive collective transport priority | Internet service adapts traffic light timing to offer green light to bus & other collective vehicles, provides speed recommendation to vehicle driver. |
| 3e | Ticketless fare collection | Operator uses Internet to collect fares via users' mobile devices, and to connect to mobile ticket inspectors. E-ticket payments are mashed up with passengers' other mobility services and added to monthly account; internet used for inter-operator payment clearing. |
| 3f | Driver & passenger security monitoring | Real-time or stored video of vehicle interior is sent wirelessly to web service that automatically identifies problems (driver or passenger) and alerts security services. |
| 3g | Taxi sharing | Taxis can pick up and drop off additional passengers along the route through online service to match potential users with actual shared taxi availability (location and destination, number of places etc.) |

### 1.2.4 Lead scenario 4 – Trucks and The City

A transport scenario starts from goods pick-up at a terminal or in a city with the aim of delivery at another terminal or at the goods owner. This scenario shows how Internet-based services can manage commercial vehicle deliveries and routeing, organise drivers' shifts and synchronise vehicle movements and goods pickup and reception. In this scenario all elements, e.g. vehicle, driver, load carrier, goods, infrastructure and back-end systems, involved in commercial transport are connected to the future Internet.

The scenario consists of seven services. A detailed description of the scenario and the services is given in Chapter 5.

| Lead Scenario 4 – Trucks and The City | | |
|---|---|---|
| **Nr.** | **Service name** | **Short description** |
| 4a | Load sharing & balancing | Online exchange to mash up cargo requests with available transport, eliminating empty trips. May be combined with special "city logistics" vehicles. This kind of services addresses the need of transport management. |
| 4b | Loading/unloading zone booking | Online reservation service for on- or off-road loading/unloading spaces. Includes space availability info, fee payment if needed, physical access control and enforcement. This kind of services addresses the need of terminal management. |
| 4c | Goods supply chain | Total visibility of the Goods Supply Chain has the purpose to |

| | | |
|---|---|---|
| | visibility | enhance the performance of all distribution and pick up operations in the city zone. The service is an enabler for many of the other services in the scenario. |
| 4d | Automated access control & security check | The automated access control & security check is a service for streamlining the inbound traffic to hubs such as ports and terminals by eliminating the need of manual checking and authorization of access rights to restricted zones for goods, vehicle and driver. |
| 4e | Dynamic time/place drop point | The aim is to increase the flexibility in the delivery of goods by launching a service that dynamically points out the right time and place for delivering every single package. |
| 4f | Traffic zone control | The service will automatically control that the vehicles entering a specific zone is allowed to be there. If not allowed in the zone, appropriate measures will be taken; |
| 4g | Green corridors | *A green corridor is* a concept referring to a number of dynamic (based on need, availability and capacity) features which provide a virtual environment for green transport through/within the city to/from hubs and harbours. |
| 4h | Real time traffic optimized route navigation | The service will provide a route optimized to minimize e.g. average mission duration, average mileage, fuel consumption, pollution,.., via the on-board unit and the collection of information from various sources. |
| 4i | Eco-driving support | Online community and service to monitor truck drivers' fuel use and provide recommendations or reducing consumption based on peers' performance; managers can monitor consumption in real time and compare with other drivers, and provide incentives for improved performance. This kind of services addresses and encourages CO2 consciousness by driver. |

### 1.2.5 Lead Scenario 5 – Online Traffic & Infrastructure Management

In this scenario many of the functions of today's traffic management are performed with greater flexibility and performance thanks to future Internet enablers. Using Internet-based services allows a fully distributed but strongly connected architecture, and provides access to traffic system-sourced data for road user services. The high computing power allows wide area optimisation, making use of road user sourced data giving a more complete network monitoring than using a limited number of detector loops, cameras, etc.

The scenario consists of five services. Detailed descriptions of the scenario and the services are given in Chapter 6.

| Lead Scenario 5 – Online Traffic & Infrastructure Management | | |
|---|---|---|
| Nr. | Service name | Short description |
| 5a | Traffic control in the cloud | Traffic control operations are hosted in the Internet, in secure virtual traffic signal controllers and virtual traffic centre, leaving local |

| | | |
|---|---|---|
| | | systems the task of providing safety controls and communications. Virtual components and data are accessible anywhere to authorised personnel, while local units guarantee reliability. |
| 5b | Cooperative traffic signal control | Ad-hoc networks are created in the cloud between clusters of vehicles and the traffic management infrastructure, offering drivers a recommended speed to avoid stopping, and adapting the traffic signals to the real demand, in real time. |
| 5c | Area-wide optimisation strategies | Large amounts of data on vehicle movements and on traffic control measurements and predictions are mashed up in a comprehensive optimisation process, and self-learning strategies are applied to achieve least emissions, least delay etc. |
| 5d | Traffic-adaptive demand management | City-wide traffic demand is managed through adaptive physical control and pricing enabled by online services. Targeted flows are achieved through varying permitted vehicle flows and adaptive pricing |
| 5e | Demand-responsive parking management | Online service for controlling availability of parking spaces and their price, coupled with driver guidance to balance demand across available parking supply. |

# 2 Scenario 1 - Multimodal Travel Made Easy

## 2.1 Scenario summary

In this scenario online services offer a traveller a wide range of travel and transport options, according to the user's preferences, for all the stages of a trip that may use various modes including public transport, car, and non-motorised means. Emphasis is on quality: shortest journey time and greatest energy efficiency, comfort level and reliability.

The ideal scenario would be that, for a given journey, the traveller receives an integrated itinerary which is the optimal plan based on up-to-date information from all relevant modes such as time table, frequency, conform level and cost etc. Corresponding tickets would be booked and delivered as an integrated ticket together with the itinerary. During the journey, the traveller will be supported by online service to get off at the right stops, walk through a complex terminal or interchanges, find the next mode, etc. During the journey, the itinerary is continuously monitored in real-time and is adjusted whenever conditions or options change. The traveller will be given a new journey plan with corresponding ticket booking. Various context defined services are "pushed" to the traveller just when needed.

### 2.1.1 Purpose

- Selecting the optimum transport mode choices and interchanges for a trip by finding the best itinerary with the fastest route, the most economical use of available transport modes and the best interchanges through different modes;
- Automatically booking corresponding tickets according to the itinerary and making payment; all tickets will be integrated and saved in the traveller's diary and automatically pop up when the ticket is inspected.
- Providing a traveller travel support throughout a trip such as where to get off, how to find the next mode, including navigation in an interchange, and door-to-door navigation.
- Helping a traveller to avoid or minimise delays during a trip by continuously monitoring the execution of the itinerary, informing the traveller any disruptions and adjust the itinerary as needed. Availabilities of alternative transport modes will be checked, cost will be quoted and booking will be made as needed.

### 2.1.2 Problems to be solved

- Difficult especially during a journey to find information on journey choices, on making connections, on real-time services; little is available on portable devices, or is poorly integrated
- Car users often are unaware of collective transport alternatives
- Drivers think quality is higher by private transport, especially flexibility and reliability
- Separate ticketing; a multimodal trip is often involved with booking many tickets with different operators
- Users have bad experiences with finding the right stops to change, right directions in an interchange, etc.
- Users have bad experiences to find information on available transport modes and purchase tickets or make payment , particularly in an unfamiliar area
- Users have bad experiences with unforeseen problems, e.g. accidents, congestion, interrupted transport services.

### 2.1.3 Rationale: how Future Internet solution could address the above problems

Future internet would be able to provide the following solutions:

- Provide up-to-date information on transport modes, availability, tickets, operation situation etc which will allow planning of the optimised itinerary;
- Connect all transport modes, vehicles and travellers all the time to assistant a traveller through a multi-modal journey;
- Connect the traveller with various services to provide real-time information to the traveller through the entire journey, inform traveller with any disruption and deliver alternative solution
- With help of location information to guide traveller to find stops/stations, and provide location based information;
- Provide ticketless mobile payment to enable integrated ticket via mobile handset and allow traveller to buy tickets en-route using mobile handset when disruption occurs.

### 2.1.4 Short description of each service as a whole

The envisioned end user services may include:

- 1a **end-to-end itinerary planning.** An online service provides optimised end-to-end itineraries according to a user's preference e.g. quickest, cheapest, least CO2, preferred modes. The itinerary planning is able to assemble information on routes, schedules and operation situation of all available modes (motorised and non-motorised) and calculate the optimised itineraries for users. After the user selected an itinerary, the itinerary will be monitored through the entire journey (see service 1b) by real-time itinerary monitoring.
- 1b **Real-time itinerary monitoring**. A selected planned itinerary will be monitored through the entire journey in order to monitor execution of the itinerary and help the travellers to deal with any unexpected deviation from the journey plan during the trip. This service will calculate actual versus planned service quality, identified service incidents and degradation as support for real-time journey support services. Please note that the itineraries are monitored rather than the movement of the travellers. The real-time itinerary monitoring will be supported by continuously updated travel time information and disrupted service assistant.
- 1c **Continuously updated travel time information.** This service provides continuous travel time estimate based on real reported or short term forecasted journey times to inform the traveller arrival time. Travel times of all modes of the trip involved will be updated based on real time operation situation and overall network condition. The updated travel time information will be used to identify if any disrupted service occurs or may occur by the disrupted service assistant.
- 1d **Disrupted service assistant.** This service uses updated travel time information to identify any disruption to the planned itinerary. If a disruption is identified, this service will offer the best alternative to the traveller based on availability of the all modes and traveller's preference. This service is connected with the ticketless mobile fare payment. If the new itinerary requires ticket booking, it can be done through the ticketless mobile fare payment and deliver the ticket to the traveller's handset after booking.
- 1e **Interchange & en route assistance.** For multi-modal trips, this service provides specific information and guidance at mode-to-mode interchanges, and during each leg informs

about stops/stations, next connections etc. This service will include in-door navigation to guide travellers through the interchanges.

- If **On-the-spot POI & tourism information.** Point Of Interest (POI) provisioning is a crucial part of the journey both as assistance to the journey itself and from a societal and cultural point of view. Having the knowledge of surrounding environment helps people to have a more comprehensive view of the environment itself and understand the value of travelling in a sustainable way. This service provides travellers with the possibility to select relevant POI and notify the users when POI is in the surrounding area based on users' profiles and preferences.
- 1g **Special-needs travel support.** This service is provided for travellers with reduced mobility, guiding along fully accessible transport means and arranging for real-time support as needed (e.g. at interchanges). Special-needs are taken into account during the end-to-end itinerary planning. This service can offer voice (for blind) or text (for deaf) information.
- 1h **Ticketless mobile fare payment.** This Online service offers a single account payment for multiple journey legs, so no need to purchase tickets separately; especially valuable for tourists and occasional users. Proof of payment is provided via traveller's handset and automatically displayed when being inspected. The ticketless mobile fare payment is connected with the end-to-end itinerary planning and the disrupted service assistant.
- 1i **Bicycle sharing.** Online service informs of bike and docking space availability, and allows pre-booking and mobile payment on single account. The service enables shared bicycle as a part of multi-modal travel modes and to be included in pre-trip journey planning.

The following figure shows that the applications of the above services during a journey. Some of these services, i.e. real-time itinerary monitoring and continuously update travel time information, are working continuously through a journey while others are only in use for a part of the journey. These services are in use when the user requires or trigged automatically by location, incidents or other services. Moreover, some services are used only during a journey, i.e. real-time itinerary monitoring, continuously updated travel time information, disrupted service assistant, interchange & en-route assistant and on-the-spot POI & tourist information while some services are used before and during a journey, i.e. end-to-end itinerary planning, special needs travel support, ticketless mobile fare payment and bicycle sharing.

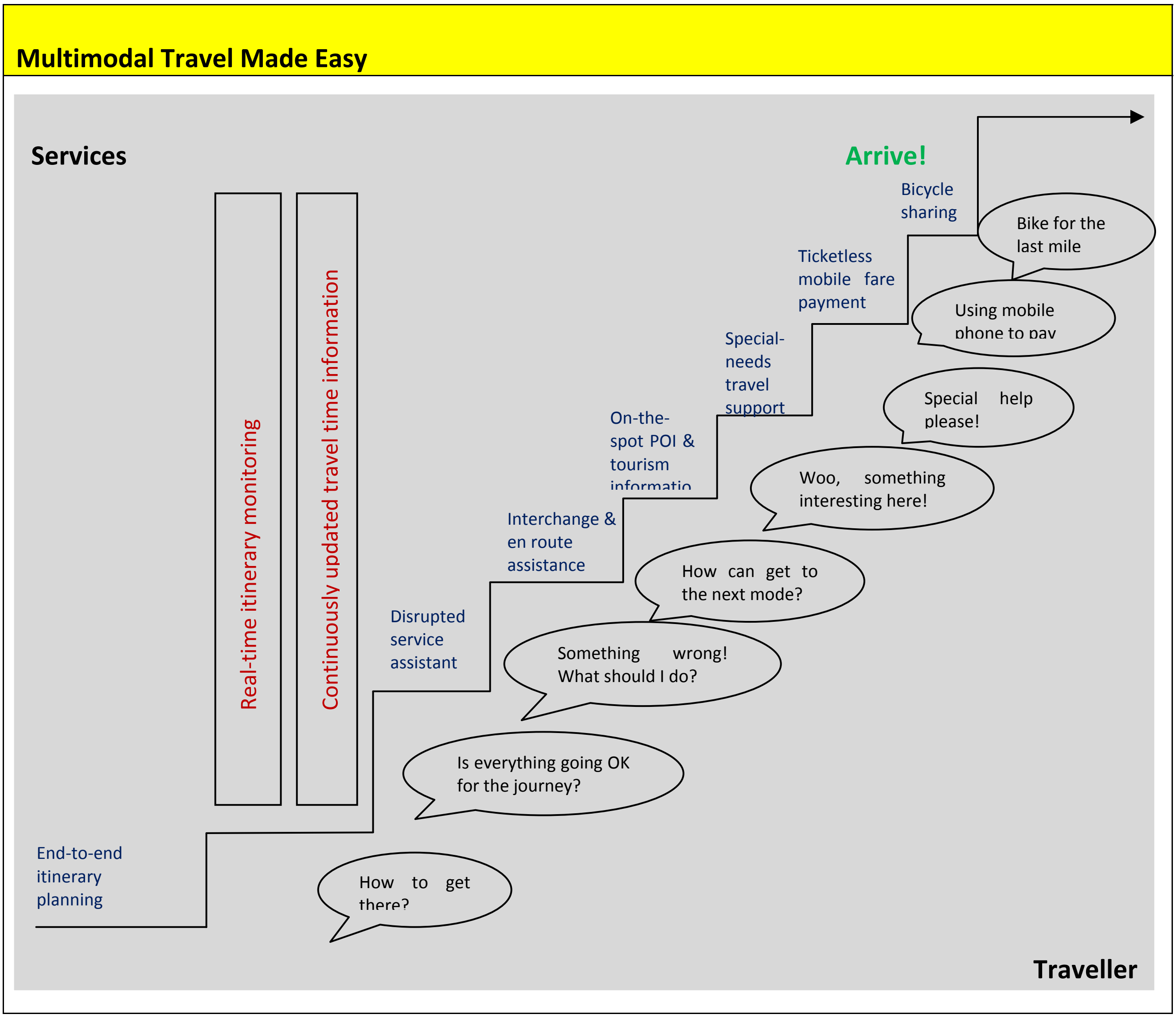


Figure 2 - Application of services during a multi-modal journey

### 2.1.5 How services interact and combine within the scenario

All the above services aim at assisting a traveller to plan and execute a multi-modal journey to meet the traveller's requirements and preference with the maximum comfort level and minimum worry before the journey and en-route. Each of these services can work as an independent service but within this scenario, they are often connected, requiring inputs from other services or/and providing outputs to others services.

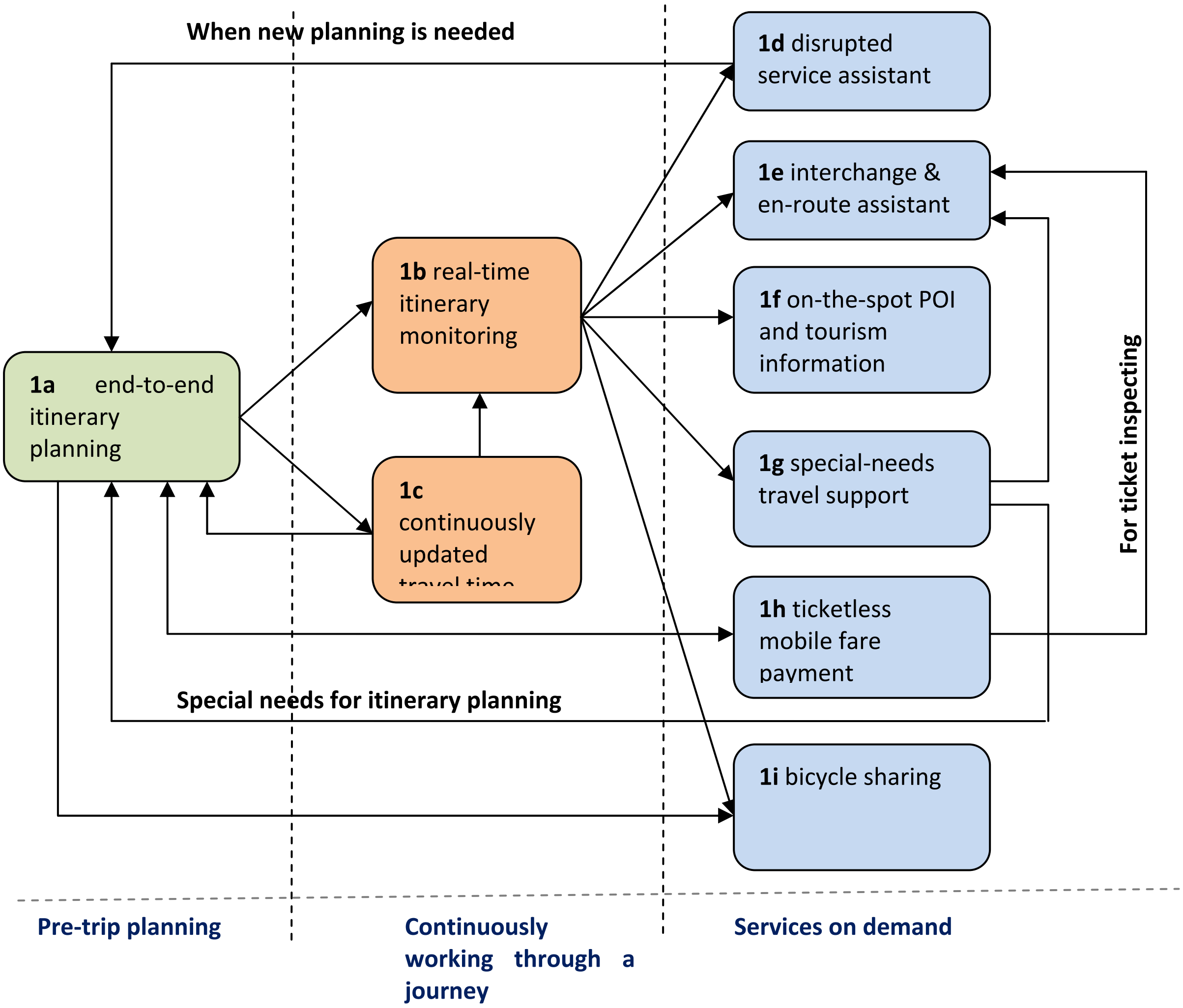


Figure 3 - Interaction of the services in Scenario 1

### 2.1.6 Summary of main actors and roles, and affected stakeholders

The following table gives an overview of the main actors and their roles in this scenario for *multimodal journey made easy*. In general, an actor will be involved in several services and their roles for different services are multiple. Main actors can be divided into the following categories:

- Transport provider and operator
- Infrastructure operator
- Map and location content provider
- Traveller service provider
- Mobile handset provider

Table 1 Main Actors and Roles of the Services in Scenario 1

| Main actors | | Services involved | Roles |
|---|---|---|---|
| Transport provider/ operator | Public transport operator in cities | **1a** end-to-end itinerary planning<br>**1c** continuously updated travel time<br>**1h** ticketless mobile fare payment | Providing static information on route, timetable, characters of vehicle, capacities, price;<br>Providing real-time information on delay and usage of the system |
| | Transport operator between cities, e.g. airline, railway, ferry operators | **1a** end-to-end itinerary planning<br>**1b** real-time itinerary monitoring<br>**1c** continuously updated travel time<br>**1h** ticketless mobile fare payment | Providing static information on route, timetable, characters of vehicle, capacities, price etc;<br>Providing real-time information on delay, cancelation, usage of the system and availability of ticket |
| | Bicycle renting provider | **1a** end-to-end itinerary planning<br>**1b** real-time itinerary monitoring<br>**1h** ticketless mobile fare payment<br>**1i** bicycle sharing | Providing static information on location of bicycle station, characters of vehicle, price;<br>Providing real-time information on number of available bicycle |
| Infrastructure operator | Road operator | **1a** end-to-end itinerary planning<br>**1c** continuously updated travel time | Providing static information on historical travel time, speed limit, one way route, planned events;<br>Providing real-time information on real-time travel time and incidents (congestion, road closure etc) |
| | Harbour, airport, railway station and other interchange operator | **1a** end-to-end itinerary planning<br>**1e** interchange & en-route assistant<br>**1g** special-needs travel support<br>**1h** ticketless mobile fare payment | Providing geographic information of interchange, ticket inspecting, information on services, e.g. restaurants, shops;<br>Providing real-time arrival information and usage of interchange |
| Map and location content provider | | **1a** end-to-end itinerary planning<br>**1e** interchange & en-route assistant<br>**1f** on-the-spot POI and tourism information | Providing geographic information, POI, tourism information |

| | | |
|---|---|---|
| Traveller service provider | **1a** end-to-end itinerary planning<br>**1b** real-time itinerary monitoring<br>**1c** continuously updated travel time<br>**1d** disrupted service assistant<br>**1e** interchange & en-route assistant<br>**1g** special-needs travel support<br>**1h** ticketless mobile fare payment | Collecting information from all modes and all actors for itinerary planning;<br>Collecting real-time information to monitor itinerary execution of the itinerary;<br>Providing service to end user itinerary planning, ticket booking, disrupted service assistant;<br>Providing special itinerary planning for people for travellers with special needs |
| Mobile handset provider | **1a** end-to-end itinerary planning<br>**1d** disrupted service assistant<br>**1e** interchange & en-route assistant<br>**1g** special-needs travel support<br>**1h** ticketless mobile fare payment | Providing handset which is able to receive itinerary and ticket;<br>Display on spot POI and tourism information<br>Display tickets for inspecting;<br>Providing navigation (outdoor and indoor) and reminder traveller where to get off;<br>Providing services to meet special needs (e.g. voice for blind people) |

### 2.1.7 Expected benefits

The following benefits are expected from this scenario:

- To deliver an integrated solution for user using various modes which can be used for itinerary monitoring and payment;
- To maximise use of sustainable transport modes, thus reducing car journeys;
- To minimise stress of trip planning for a user;
- To inform traveller in real-time about any disruptions and modification during a multimodal trip;
- To increase level of comfort and confidence for travellers;
- To improve energy efficiency by reducing delays;
- To enhance the navigation experience for the traveller by having continuous localisation during a trip;
- To improve traveller's satisfaction by providing seamless assistant through a entire trip;
- To give travellers information to help travellers to experience the journey having a more comprehensive view of the surrounding environment;
- To improve mobility for people who need special needs;
- To reduce time for travellers to spend on planning their trips and make payments;
- To improve operation and service quality of bicycle sharing

## 2.2 Service 1.a: End-to-end itinerary planning

End-to-end itinerary planning should be an online service providing optimised end-to-end itineraries according to a user's preference e.g. quickest, cheapest, least CO2, preferred modes etc. The itinerary planning is able to assemble information on routes, schedules and operation situation of all available modes (motorised and non-motorised) and calculate the optimised itineraries for users. After the user selected an itinerary, tickets associated with the itinerary will be booked and delivered to users through mobile ticketless fare payment (see Service 1g) and monitored through the entire journey (see Service 1b) by real-time itinerary monitoring.

### 2.2.1 End-to-end service chain

This service aims at assembling information from all modes of transports, including routes, interchanges, timetable, prices, availability of seats etc. All the information is updated regularly and the service is informed when disruption of any transport modes occurs.

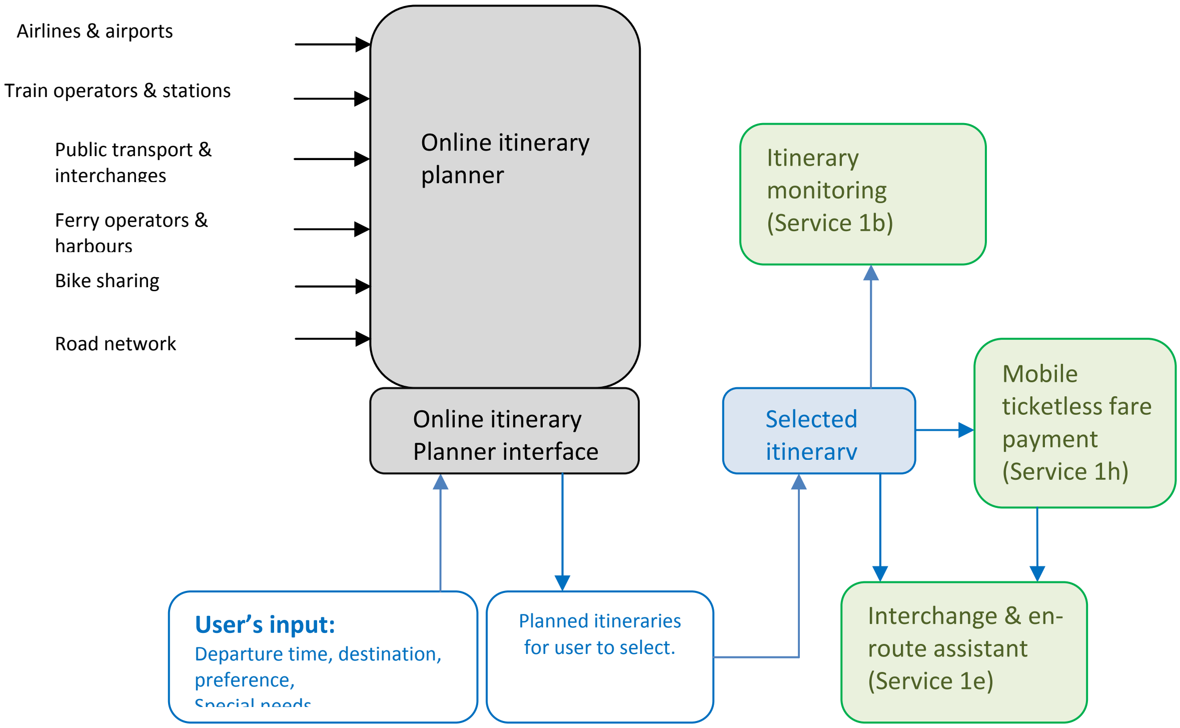


Figure 4 - End-to-end service chain

Figure 4 shows the end-to-end service chain of the itinerary planning. The service provider should provide:

- Online itinerary planner
- Interfaces to information services to various modes of transport
- User's database to store user's preference, special needs and previous trips
- User interface for user's input such as starting point, destination, preferred modes, special needs etc and select an itinerary

When a user plans a trip, he/she will log in the online itinerary planner and input his/her destination, starting point, preferences, etc. In an ideal system, the user will only need to provide his destination and current specific preferences. The other information will be either provided by the environment and sensors (his current location, for example) or by inference based on its personal private context data.

Based on its current dynamically updated knowledge of all travel means and traffic situation, the service will search all available modes and calculate travel times, then select a number of itineraries. The service will then select and propose one (or a small number) of itineraries from these planned itineraries best matching the users' preferences and special needs.

The service will then check if all the selected itineraries can be executed, i.e. if there are any potential disruptions e.g. weather, planned events. If an itinerary would be disturbed, it will be removed. The rest itineraries will be delivered to the user for selection. Alternatively the single best itinerary will be provided while allowing the user to examine alternate ones.

### 2.2.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Itinerary planning tools only cover limited modes of transport. For example, a public transport trip planner may not cover local train services. | The itinerary planning tool will cover all available modes. |
| Itinerary planning tools are based on timetable and do not take into account effective current travel time and position of means of transportation. | The itinerary planning tool will plan each trip based on actual location and dynamic rendez-vous (implicit or explicit) in multi-modal travels. |
| Itinerary planning tools do not include bicycle sharing. | The itinerary planning tool will include bicycle as a mode. Locations of bicycle stations will be included as mode interchanges. |
| For a long journey (e.g. from one country to another country), no integrated services cover different regions and all transport modes in the regions. A user has to use several trip planning tools for one journey. | The itinerary planning tool will cover all modes (including long haul flights) and all regions. User can use the tool for planning a short (local) and a long journey including inter-continental journeys. |
| Current services may not take into account personal preference, travel history and special needs. | More personalised service will be provided. The service will plan an itinerary based on personal profile, preference, special needs and itineraries in the past. |

### 2.2.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Static database of all modes of transport | Collecting and storing information on transport routes, timetables, location of stops/stations/interchanges, etc | Providing the base of itinerary planner | Interchange & en route assistance (1e) |
| Dynamic database of individual modes of transports | Updating in real time for each transport element (each bus, car, metro, tram, …) the current position, mean travel speed and capacity | Provide the capability to plan based on actual travel time and capacity | Continuously updated travel time information (1c) |
| Dynamic & forecast information | Collecting real-time and forecast information on weather, planned events, disruption of transport operation | The itinerary planner will check dynamic information to see if the planner itinerary is disrupted | Continuously updated travel time information (1c) |
| Interfaces with information from all modes of transport | Receiving static and dynamic general information from all modes of transport and other information sources | Temporarily amend the static database, based on general information. Take into account local authority regulations on a dynamic basis. | Continuously updated travel time information (1c) |
| Travel time forecast module | Forecasting travel time;<br>Forecasting impacts on travel time and services of weather and planned events | Dynamic & forecast information | Continuously updated travel time information (1c) |
| Itinerary planner | Use all available information to deliver one or several itineraries | All components of the services | Real-time itinerary monitoring (1b); |

| | | | |
|---|---|---|---|
| | | | Interchange & en route assistance (1e); Mobile ticketless fare payment (1h) |

### 2.2.4 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| 1 | End-user | Registers<br>Logs-in<br>Plans and books the trip<br>Cancels/modifies plans and bookings<br>Performs the trip | Service provider |
| 2 | Itinerary booking Service provider | Provides, manages and updates the running service, on the server side (e.g. scheduler, trip planner) | End-user(s), Map Provider, Traffic Information provider, information service providers for other modes of transport |
| 3 | Itinerary booking client provider | Provides the interface to the service (it could be a sw provider in case of a local application or the same service provider in case of a browser-based service) | Service provider, Nomadic device application Provider |
| 4 | Nomadic device application provider | Provides, manages and updates the nomadic device application | End-user, Map provider, Itinerary booking service provider, Itinerary booking client provider |
| 5 | Map provider | Provides updated maps for planning and navigation | Itinerary booking service provider<br>Nomadic device application provider<br>Location Based Content provider |
| 6 | Transport operators | Provide updated information on routes, schedules, fare, current operation statues of public transport, train, airlines, ferry etc. | Itinerary booking Service provider |
| 7 | Traffic Information provider | Provides updated traffic information to Itinerary booking; Service provider | Itinerary booking Service provider |
| 8 | Location Based Content Provider | Provides updated Location Based Contents | Map Provider, Itinerary booking Service provider |
| 9 | Public Authorities | Provide information about roadworks, events, etc… | Itinerary Booking Service Provider, Traffic Information provider, Map provider |

### 2.2.5 Data: data flows, databases

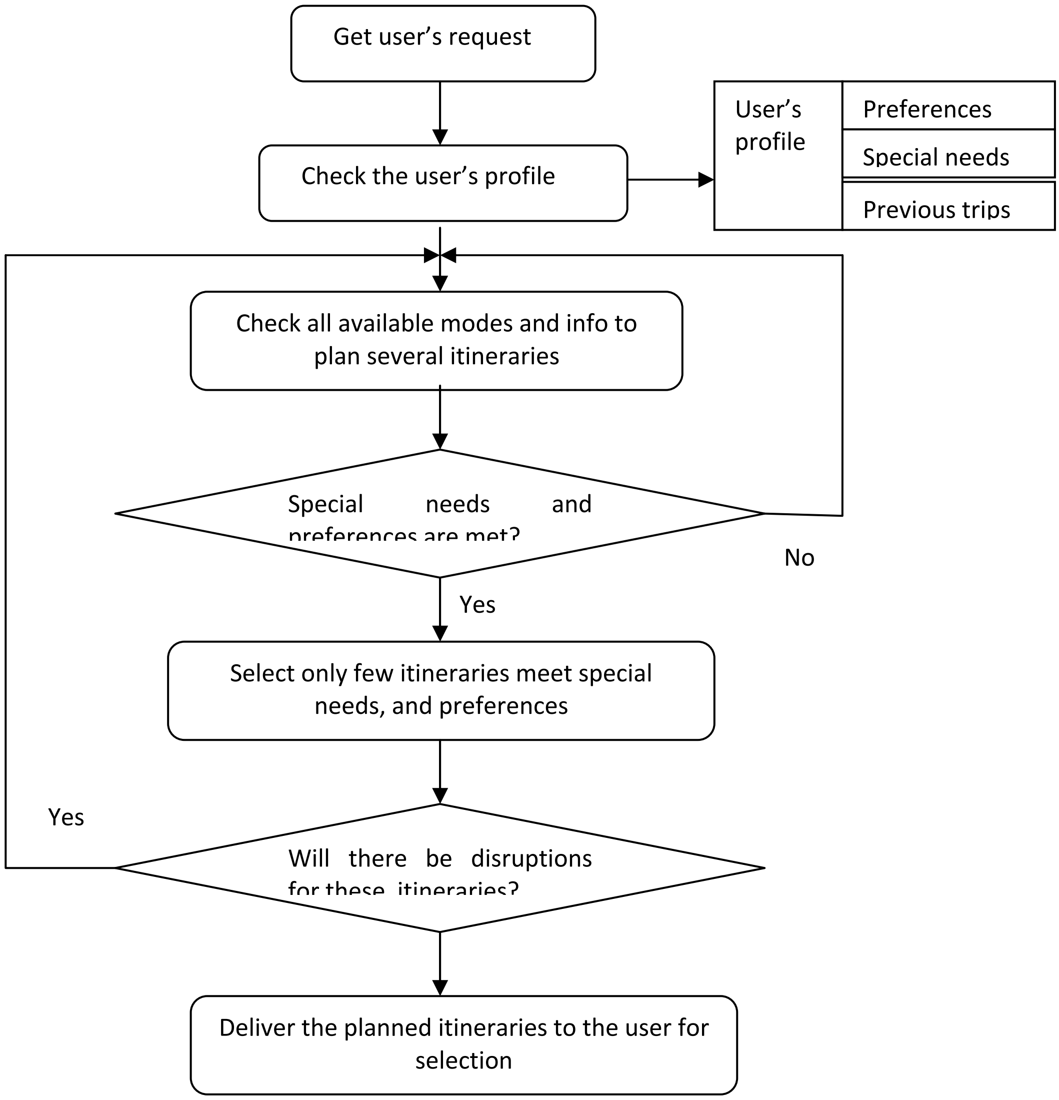


Figure 5 - Data flow of Service 1.a.

### 2.2.6 Expected benefits

- To deliver an integrated solution for user using various modes which can be used for itinerary monitoring and payment
- To maximise use of sustainable transport modes, thus reducing car journeys;
- To minimise stress of trip planning for a user;

### 2.2.7 References: other projects, actual services etc.

- i-Travel D1.1 State-of-the-art

- i-Travel D2.1 Use cases, traveller and supplier requirements

## 2.3 Service 1b: Real-time itinerary monitoring

This online service monitors execution of itinerary on all modes through the entire journey. This service also helps the travellers to deal with any unexpected deviation from the journey plan during the trip. It will calculate actual versus planned service quality, identified service incidents and degradation and is supported by continuously updated travel time information service and disrupted service assistant.

### 2.3.1 End-to-end service chain

This service aims at delivering real time information to the traveller during the trip. This service begins right after the selection of the itinerary by the traveller. Information displayed all along the itinerary is related to travel time, with updated value in terms of time and alternative itinerary in case of disruption or unexpected modifications according to the planned itinerary.

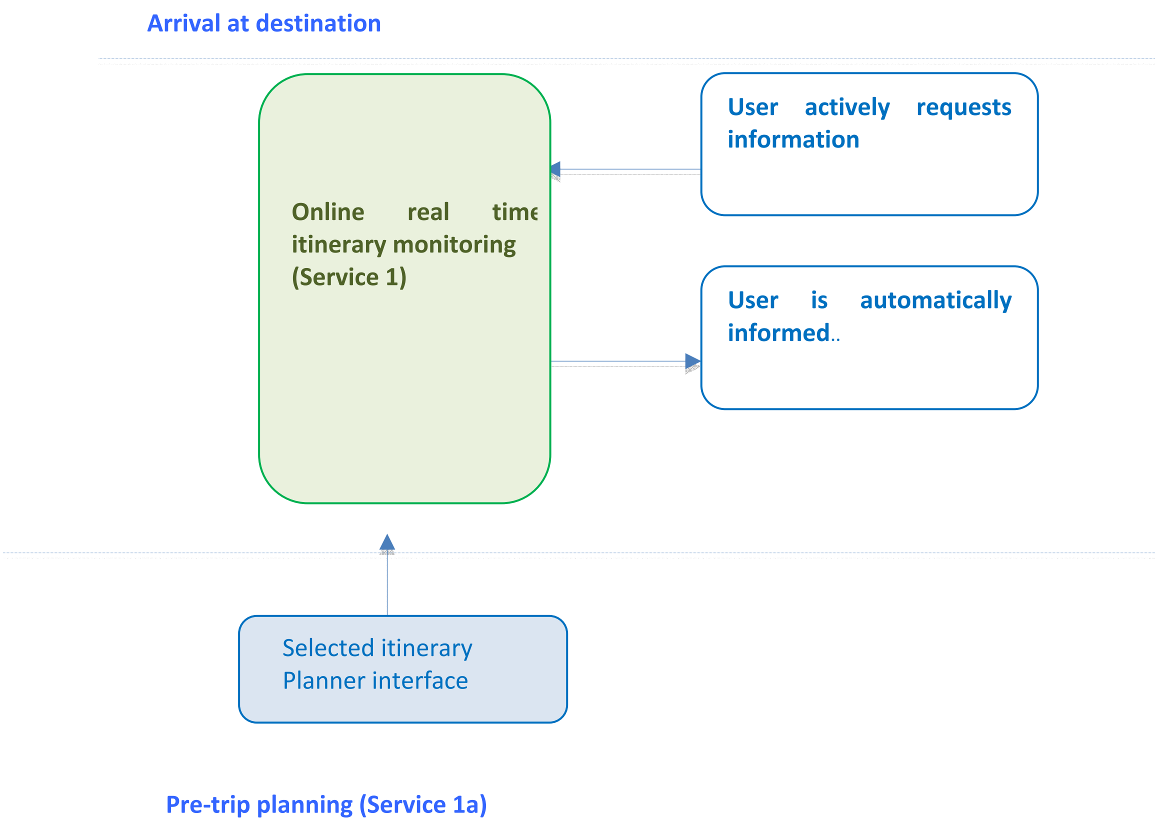


Figure 6 - the service chain of Service 1b

Below use cases are given as examples in order to explain the functionalities of the real-time itinerary monitoring.

| | |
|---|---|
| **Use Case ID** | UC_1b_1: End-to-end real time itinerary information |
| **Scenario title** | Multimodal travel made easy |
| **Services name** | Online Real time itinerary monitoring |
| **Short Description** | Traveller's perspective<br>After selecting his/her itinerary, the traveller is automatically informed in real time about any modifications in the timing of his/her journey |

| | |
|---|---|
| | that he/she defined during the pre-trip planning. This information is visually and/or auditory displayed, according to the importance and the priority of the message content and taking into account preferences defined by the traveller while setting up his/her trip.<br><br>The traveller has the possibility at any stage of the trip to refresh information on his/her travel timing by actively requesting this information. |
| **Goal** | • Support the traveller during all the length of the trip by updated information (safer, less stressful) |
| **Potential Constraints** | • Relevant updating of the information displayed to the traveller to be defined and optimized<br>• Gathering information from all potential data sources at real-time |
| **Components** | Information gathering unit to all the transport modes to receive up-to-date information;<br>Information processing unit (algorithm) to forecast potential impacts of the received up-to-date information;<br>Delivery mechanism (algorithm) to identity what kind of information should be delivered to the traveller;<br>A mobile application to deliver the relevant information to the travellers' mobile device |
| **Main flow** | On-Trip<br>• While the traveller starts the trip, the mobile application constantly uses the services of real time traveller monitoring, which control constantly the desired time of arrival<br>• In case there are changes, the traveller is informed in real time with an updated of the travel time, especially the arrival time, and possible proposition of alternative itinerary if necessary |

| | |
|---|---|
| **Use Case ID** | UC_1b_2: Informing traveller in real time about travel disruption due to traffic congestion |
| **Scenario title** | Multimodal travel made easy |
| **Services name** | Online Real time itinerary monitoring |
| **Short Description** | Traveller's perspective<br><br>The driver is automatically alerted (auditory message or beep) that his/her itinerary will have to be modified due to unexpected traffic congestion/accidents/road works on the road leading to the invalidity of the previously planned journey and travel time.<br><br>Some explanation of the type of traffic congestion/accidents/road works (location, severity of the event) and their consequences on the itinerary in terms of timing are given to the driver.<br><br>An alternate itinerary with all the useful information (type of road, exit to follow), in addition to the new arrival time is also proposed to the driver.<br><br>Service provider's perspective |

| | |
|---|---|
| | After receiving information on congestion or other events, the service provider will check if the affect routes are included in any planned itineraries. If yes, for each of affected itinerary, an alternative route should be planned and delivered to the traveller. |
| **Goal** | • To be able to limit the constraints and the stress linked to any journey disruption due to traffic congestion/accidents/road works by informing the driver as quickly as possible about the modification of his/her route and their consequences and by proposing an alternative itinerary. |
| **Potential Constraints** | • Uncertainty of the time consequences of identified disruption<br>• Uncertainty about the duration and the level of some disruptions (light or severe)<br>• Difficulty to give precise and reliable information to the driver in some cases |
| **Components** | Information gathering unit to all the transport modes to receive up-to-date information;<br>Information processing unit (algorithm) to forecast potential impacts of the received up-to-date information;<br>Delivery mechanism (algorithm) to identity what kind of information should be delivered to the traveller;<br>A mobile application to deliver the relevant information to the travellers' mobile device |
| **Main flow** | On-Trip<br>• During the trip, the disrupted service assistant detects a disruption in the previously planned itinerary and computed a new itinerary<br>• Data are sent to the real time traveller monitoring service |

| | |
|---|---|
| **Use Case ID** | UC_1b_3: Informing traveller in real time about travel disruption due to public transport disruption |
| **Scenario title** | Multimodal travel made easy |
| **Services name** | Online Real time itinerary monitoring |
| **Short Description** | <u>Traveller's perspective</u><br>The traveller is automatically alerted (auditory message or text) that his/her itinerary will have to be modified due to unexpected disruption in the travel chain at the public transport stage, leading to the invalidity of the previously planned journey.<br>Some explanation of the type of disruption and their consequences on the itinerary are given to the traveller. For example, the underground line is out of order for a specific amount of time and a bus connection will replace it.<br>The alternate itinerary with all the useful information (number and location of the platform or the bus stop, time) is then given to the traveller. The new arrival time is also calculated.<br><br><u>Service provider's perspective</u><br>After receiving information on disruption of public transport, the service provider will check if the disrupted services will have impacts on any planned itineraries. If yes, for each of affected itinerary, an alternative itinerary will be re-planned and delivered to the traveller. |
| **Goal** | • To be able to limit the constraints and the stress linked to any journey |

| | |
|---|---|
| | disruption by informing the traveller as quickly as possible about the modification related to the lines and the time schedule of public transport, in order for him not to miss the alternative itinerary. |
| **Potential Constraints** | • Uncertainty of the time consequences of identified disruption<br>• Uncertainty about the duration and the level of some disruptions (light or severe)<br>• Difficulty to give precise and reliable information to the traveller in some cases |
| **Components** | Information gathering unit to all the transport modes to receive up-to-date information;<br>Information processing unit (algorithm) to forecast potential impacts of the received up-to-date information;<br>Delivery mechanism (algorithm) to identity what kind of information should be delivered to the traveller;<br>A mobile application to deliver the relevant information to the travellers' mobile device |
| ***Main flow*** | On-Trip<br>• During the trip, the disrupted service assistant detects a disruption in the previously planned itinerary and computed a new itinerary<br>• Data are sent to the real time traveller monitoring service |

| | |
|---|---|
| **Use Case ID** | UC_1b_4: Informing traveller in real time about travel disruption due to flight cancellation |
| **Scenario title** | Multimodal travel made easy |
| **Services name** | Online Real time itinerary monitoring |
| **Short Description** | <u>Traveller's perspective</u><br>The traveller is automatically alerted (auditory message or beep) on the mobile terminal that his/her itinerary will have to be modified due to unexpected cancellation of his/her flight by the company, leading to the invalidity of the previously planned journey.<br>Detailed explanation about the new flight condition (the flight number, the name of the company, the location of the checking desk, the time and the terminal of departure…) is given to the traveller.<br>The new arrival time is also computed. |
| **Goal** | • To be able to limit the constraints and the stress linked to any journey disruption due to flight cancellation by informing the traveller as quickly as possible about the modification and the actions he/she has to make to be able to catch an alternative flight. |
| **Potential Constraints** | • Uncertainty of the time consequences of identified disruption<br>• Uncertainty about the duration and the level of some disruptions (light or severe)<br>• Difficulty to give precise and reliable information to the traveller in some cases |
| **Components** | Information gathering unit to all the transport modes to receive up-to-date information;<br>Information processing unit (algorithm) to forecast potential impacts of the received up-to-date information;<br>Delivery mechanism (algorithm) to identity what kind of information should be delivered to the traveller; |

| | |
|---|---|
| | A mobile application to deliver the relevant information to the travellers' mobile device |
| **Main flow** | On-Trip<br>• During the trip, the disrupted service assistant detects a disruption in the previously planned itinerary and computed a new itinerary<br>• Data are sent to the real time traveller monitoring service |

| | |
|---|---|
| **Use Case ID** | UC_1b_5: Informing traveller about modification of travel time linked to occupancy of bike station |
| **Scenario title** | Multimodal travel made easy |
| **Services name** | Online Real time itinerary monitoring |
| **Short Description** | Service provider's perspective<br>Bike sharing service provider collects data on bike and dock space availability for each bike station on real time<br>Whenever a bike station is full (no dock space available) or is empty (no bike available), this information is transmitted to the online real time itinerary monitoring service/itinerary planner in order to calculate on real time the updated itinerary<br><br>Traveller's perspective<br>At one stage of the trip, in a zone equipped with self-service bike stations, the previously planned itinerary included use of bicycle, as this mode was not eliminated in the preferences by the traveller while defining his/her itinerary during the pre-trip planning.<br>The online real time itinerary monitoring service calculates the actual time of the travel including time required to find relevant bike station based upon real time information (which station with available bike, or which station with empty dock) |
| **Goal** | • To update travel time taking into account localization of relevant available bike station |
| **Potential Constraints** | • Correct refreshment of the level of occupancy of bike station<br>• Computation of the new itinerary on real time |
| **Components** | A unit to connect to the bike sharing service;<br>A mobile application to deliver the relevant information to the travellers' mobile device |
| **Main flow** | On-Trip<br>• Bicycle sharing service sent real time data related to bike stations occupancy to real time itinerary service<br>• Display of map with available bike stations or updated itinerary if available |

### 2.3.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Tentative in informing travellers about disruptions exist, but not in a systematic and well-structured way, with not always computation of alternative itinerary | The real time itinerary monitoring will allow to be informed in real time about any disruption of the multimodal trip impacting the planned itinerary and |

| | |
|---|---|
| and update of the arrival time. | will propose automatic display of alternative solution. |
| There are some prototype services giving real time information to the traveller, but it required to be improved due to the complexity of the process. | Thanks to the continuously updated travel time, the real time itinerary monitoring will allow to be informed about any discrepancy between actual and planned timing. |
| Multimodal service does not include tailored information about real time schedule of public transport such as bus, tramway, … | The real time itinerary monitoring will calculate discrepancy between static time used for the computation of the planned itinerary and actual time for public transport |
| Some services propose geo-localization of self-service bike stations but with no possibility to propose an alternate station in case the closest one would not be available for the purpose of the traveller. | The real time itinerary monitoring will calculate actual time taking into account on real time the level of occupancy (bike or dock space) of the bike station and its potential impact on the planned timing. |

### 2.3.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Data related to the planned travel time | Providing data about planned travel time to be compared with actual time | Provide information for the computation of the discrepancy between planned and actual time | End-to-end itinerary planning |
| Data related to delay linked to disruption such as traffic congestion, flight cancellation,… | Providing data about the value of the delay to be able to recalculate the updated travel time | To be linked with any other information related to the computation of actual time | Continuously updated travel time |
| Data related to updated itinerary following disruption in the planned itinerary | Providing data about an updated itinerary taking into account disruption and dysfunction | To be linked with any other information related to the computation of actual time | Disrupted service assistant |
| Positioning service and map data | Providing data about localisation of the traveller on real time | To be linked with any other information related to the computation of actual time | End-to-end itinerary planning Continuously updated travel time;<br>Disrupted service assistant;<br>Bike sharing (real time data on availability of bike station) |
| Computation of actual versus planned travel time module | Providing the difference between actual and planned travel time | Resulting from the other components of the service | |

### 2.3.4 Actors, their roles and relationships

| Actor | Roles |
|---|---|
| Public transport operator in cities | Provide real-time information on delay, disruption and usage of the system |
| Transport operator between cities, e.g. airline, railway, ferry operators | Provide real-time information on delay, cancelation, usage of the system |
| Bicycle renting provider | Provide real-time information on number of available bicycle and dock space of bike station |
| Traveller service provider | Provide real-time information on traveller service |

### 2.3.5 Data: data flows, databases, required input from other services

In order to provide real time itinerary monitoring, this service will need, in addition to input from **1a end-to-end itinerary planning**, inputs from **1c continuously updated travel time** and **I d disrupted service assistant services** as prerequisite mainly, with input from **1i bicycle sharing** in some specific cases.

The first schema gives a global overview of the relationships between the various services and the real time itinerary monitoring one, while the three other schemas detailed the type of interactions. Interaction of the service **Real-time itinerary monitoring (1b)** with the service **Special needs travel support (1g)**

The itinerary will be monitored continuously during the journey, with a regular update of the travel time information.

The criteria related to the user's special needs has to be defined at the step of the pre-trip planning by the user, with detailed specification of the type of need (accessibility, visual or auditory disability,…). The online real time itinerary monitors information taking into account the pre-defined user's special needs. The user can request additional services on demand.

Interaction of the service Real-time itinerary monitoring (1b) with the services Continuously updated travel time (1c) and Disrupted service assistant (1d)

The travel time is continuously updated during the journey and information will be automatically display to the user, with a specific message in case of substantial discrepancy between actual and planned travel time, especially arrival time. Any modification of planned itinerary linked to detected disruption will be automatically transmitted to the user that will have to validate the new alternative or to select one in case of several possibilities. The choice of a new itinerary will have consequences on the planned travel time and expected arrival time. This information will be displayed to the user.

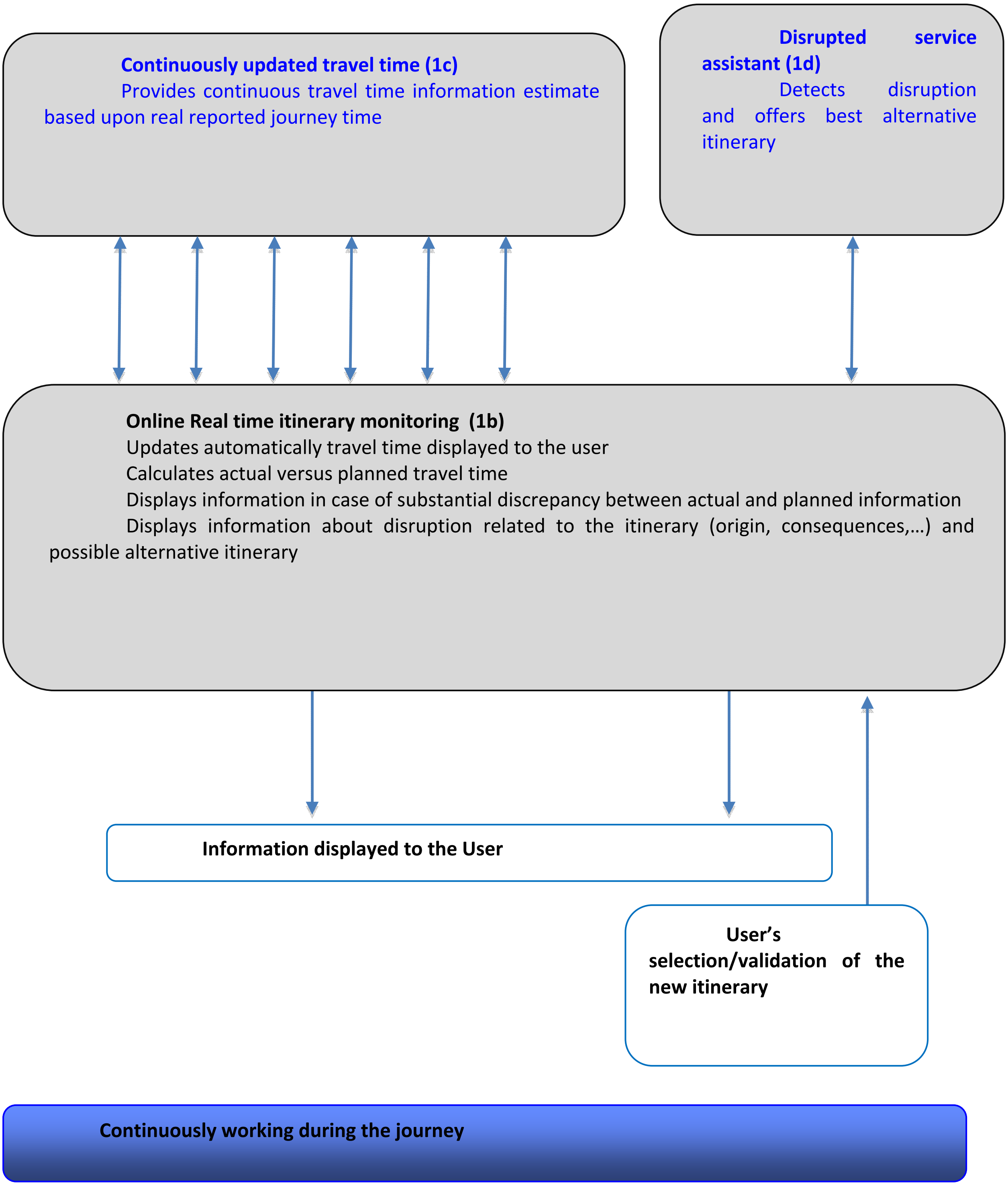


Figure 7 - Interaction of Service 1b with Services 1c and 1d

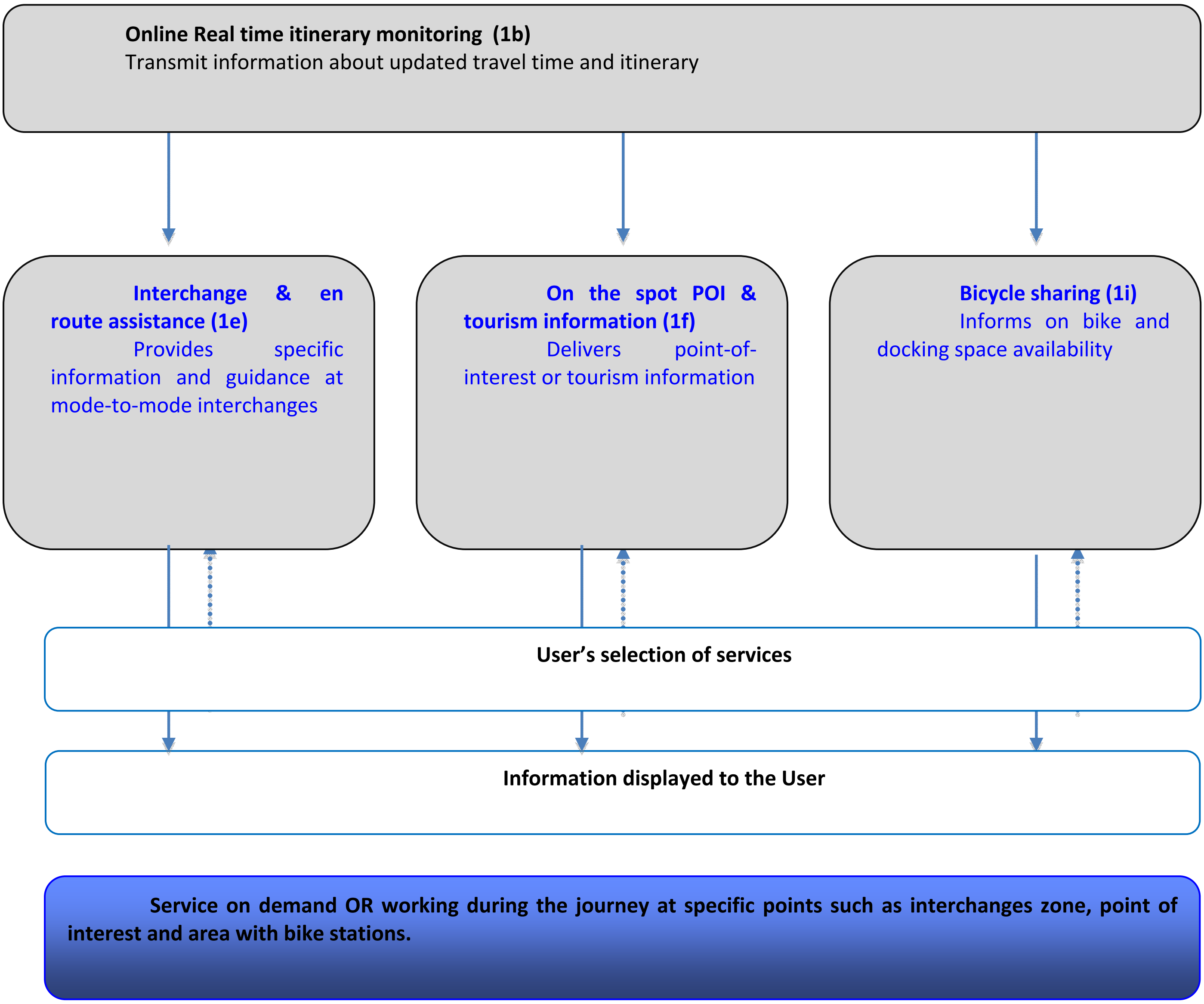


Figure 8 - Interaction of the service 1b with the services 1e, 1f and 1i.

### 2.3.6 Expected benefits.

- To inform the traveller in real time about any modification happening during the multimodal trip
- To propose alternative itinerary in real time in case of travel disruption
- To allow traveller to have the right action at the right moment in case of dysfunction, and this, for any mode of transport
- To increase efficiency and resilience of multimodal transport
- To increase level of comfort and confidence for the traveller

### 2.3.7 References: other projects, actual services etc.

- Infopolis, *User needs and system specifications of Public Transport and multimodal information systems, 1998-2000*
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## 2.4 Service 1.c: Continuously updated travel time information

This service provides continuous travel time estimations based on real reported or short term forecasted journey times to inform the traveller arrival time. Travel times of all modes of the trip involved will be updated based on real time operation situation and overall network condition. The updated travel time information will be used to identify if any disrupted service occurs or may occur by the disrupted service assistant.

### 2.4.1 End-to-end service chain

Info about travel times are directly integrated into the personal journey planner, the users will know in advance the time of arrival and if anything changes with the conditions of the road the users will be able to know the new travel times receiving constantly updates.

The next is a use case of this service:

| | |
|---|---|
| **Use Case ID** | UC_1c_1: Continuously updated travel time information |
| **Scenario title** | Multimodal travel made easy |
| **Services name** | Continuously updated travel time information – Journey planner |
| **Short Description** | road user perspective<br><br>Motorists will be able to know with high precision the time of arrival of a multimodal journey. |

| | |
|---|---|
| **Goal** | • Minimize fuel consumption and $CO_2$-emission by providing a service that can inform anytime, anywhere travellers<br>• Improve the mobility support for travellers |
| **Potential Constraints** | • Road users might not be willing to provide information of destination, positioning and transport mode used, because they could be afraid of privacy issues –("big brother effect") |
| **Components** | Journey planner, 1a end-to end itinerary planning service, 1 c continuously updated travel time, 1b real time itinerary monitoring Service 5.c and Service 5.d |
| **Main flow** | Pre-Trip<br>• The travellers want to plan their trip by using a journey travel application on your smart phone.<br>• They ask the best route to go from address X to the address "Y" including they desired arrival time.<br>• The journey travel application calculates the best route and computes the travel arrival time by using the information provided by the traffic adaptive demand management service (S5.4) for receiving the recommended strategy of traffic to be applied, for instance the list of roads which have not achieved the saturation state, as well as the aggregated data about traffic and forecasts from service (S5.3).<br>• The application shows the possible solution closed to the time requested.<br>• The users choose the solution which is more adapted to their preferences<br><br>On-Trip<br><br>• While the travellers start the trip, the mobile application constantly uses the services of real time traveller monitoring (S1.b), which control constantly the desired time of arrival of the user with the conditions of the roads.<br>• In the case there are changes regarding the traffic strategies or in the situation of the road, the service S1.c "continuously updated travel time" will send frequently updated travel times information to the service S1.b "real time traveller monitoring" which will send updated information to the Journey planner application.<br>• The users will enjoy the trip, and will follow the continuous set of recommendations done by the mobile application.<br>• The travellers will arrive to the destinations at the closer time chosen from the beginning. |

### 2.4.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| The route planners do not take in account the information provided by reliable forecasts of traffic systems which considers traffic demand strategies. | The route planners will calculate the routing following reliable forecasts of traffic systems which considers traffic demand strategies. |
| There are many applications of route planners and many navigation systems. | The service in the future will allow the creation of a Profile in order to allow the use of many devices, all with the same input information avoiding to ask the end user to repeat many times the input information about travels |

| | |
|---|---|
| The forecasts time of arrival of the current trip planner or navigation systems do not give an accurate time of arrival calculation. | The service in the future will be able to provide to the user more accurate forecasts of arrival time using multimodal transport. |
| | The service in the future will learn about the preferences of the driver and will be able to suggest the best solution with the best arrival time forecasts. |

### 2.4.3 Service components

| **Service component** | **Functionality** | **Interdependencies with other component of this service** | **Interdependencies with other services** |
|---|---|---|---|
| Traffic control centre | Providing data traffic information and customized traffic tips and strategies for applications and services. | Fleet operator, Roadside units, sensors in the road, Route navigation and planner | Traffic control in the cloud (5a) Area-wide optimisation strategies (5c); Traffic-adaptive demand management (5d) |
| Roadsite units, sensors in the road | Collecting information on traffic parameters like: number of vehicles in the road, number of turnings and sharing it in the network | Traffic control centre, Mash-up service | |
| Cooperative in-vehicle unit | Sending vehicle positioning, speed, routing (to inform the turning), characterises of the vehicles, priority | PT operation and monitoring system | Personalised route guidance (2a); Eco-driving support (4f) |
| PT operation and monitoring system | Sending vehicle positioning, speed, routing, PT time tables | Traffic control centre Mash-up service | Traffic-optimised fleet management (4e) |
| Route navigation and planner | Providing the GUI for getting data from the user and for sending routing results and updated information after and during the trip | Traffic control centre, mash-up service | End to end itinerary planning (1a)<br><br>Traffic control in the cloud (5a)<br><br>Area-wide optimisation strategies (5c)<br><br>Traffic-adaptive demand management (5d) |
| Mash-up service | Service which mash-up all the data coming from different | Traffic control centre, Route navigation and | Area-wide optimisation |

| | | | |
|---|---|---|---|
| | sources, and formatting it | planner<br>Fleet operator<br>Cooperative in-vehicle unit | strategies (5c);<br><br>End to end itinerary planning (1a) |
| Positioning service | Getting the data needed (traffic data, bus location, floating car data, etc) spatially located. This service must simplify the task of many differences between maps and many geo-localization systems.. | Mash-up service | Real time traveller monitoring<br>Continuously updated travel time information<br>Real time traffic & route information<br>Floating passenger data collection<br>Area wide optimisation strategies |

### 2.4.4 Actors, their roles and relationships

| **Actor** | **Roles** | **Relationships between actors** |
|---|---|---|
| Traffic operator | Calculating strategies of traffic management, making available traffic information and traffic advices to other applications and services. | Making available data for application developers and service providers |
| Public transport operator | Providing fleet vehicle destination, planned routes, and characteristics of vehicles;<br>Sharing floating car data. Time tables, etc | Communicating with traffic operator |
| Drivers | Providing destination, planned routes, and characteristics of vehicles before trip;<br>Providing vehicle speed and position during the trip | End –user applications |
| Application developers | Creating applications and services that take the data exposed by the TMC and use the Instant Mobility services for providing a GUI for different devices and by means of different technologies. | Service integrators |
| Service integrators | They will integrate different services in order to provide the most accurate service computation of travel times. Such service will be available for application developers. | Interacts with the data coming from different traffic operators, public transport and drivers |

### 2.4.5 Data: data flows, databases, required input from other services

In order to provide a continuously updated travel time information, this service will need input from other services as prerequisite. In the next Figure it is possible to see how this service interacts with the rest of services of scenario 1.

- The process begins when the user plans their trip, by using the service 1a.
- Then the service 1c calculates the travel times needed for execute the requested trip and will provide the results to the service 1b
- The service 1b will monitor the entire trip in order to supervise the execution of the itinerary plan during the trip.
- The service 1b will be supported by the service 1c continuously, because travel times can change during the trip and are extremely related with the condition of traffic of the network.
- Then the service1b will provide input for the rest of the services 1d,1e,1f, 1h and 1i

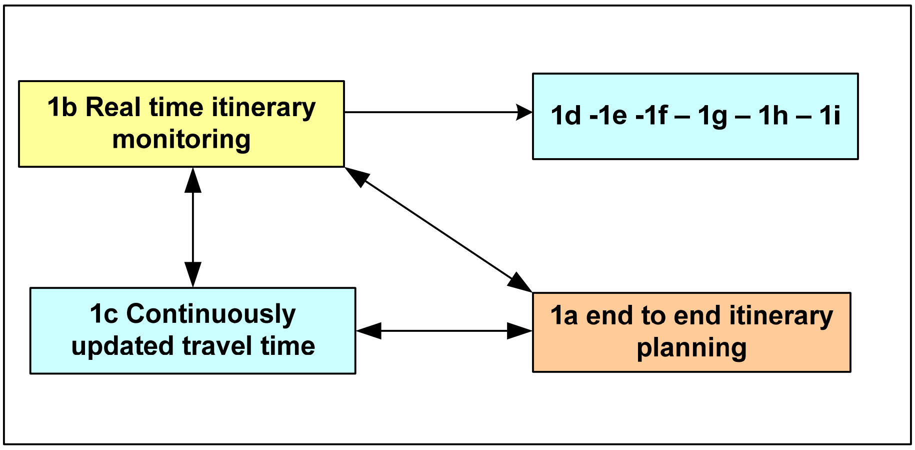



Figure 9 - Interaction of the Service 1c with the rest of services of the Scenario 1

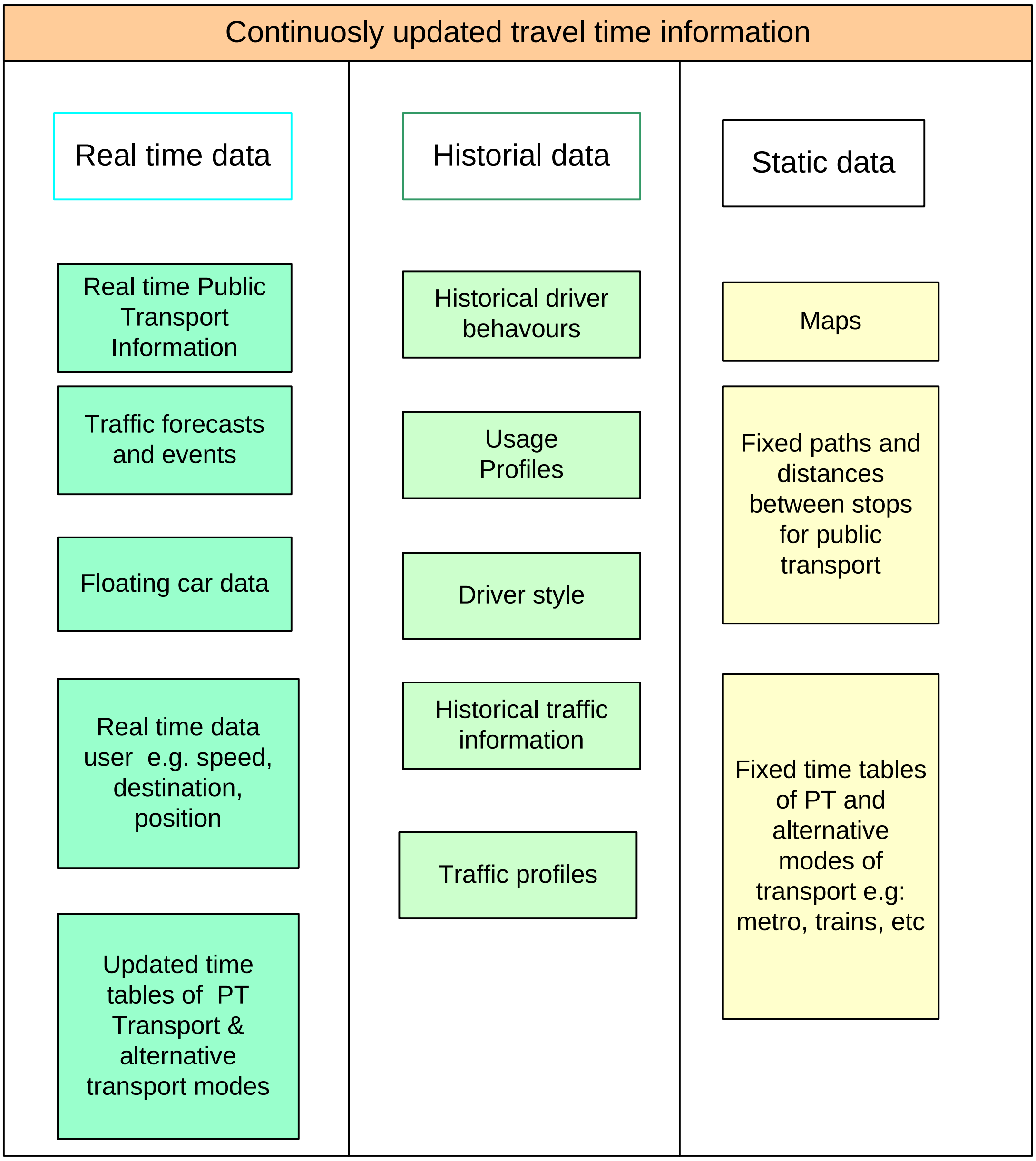



Figure 10 - Data and Service used by Service 1.c Continuously updated travel time information

In order to have continuously updated travel time information this service will need to use aggregated information from different sources such as: historical data, static data and real time data.

The set of information needed is the next:

- **Historical data:** this data concerns the historical traffic information, and inside IM it is possible to talk about historical data regarding users, such data can be: historical driver behaviours, usage profiles, driver style, etc.
- **Static data**: this data refers with the data that maintains itself static for a long period of time, such data can be: maps, fixed paths and distances between stops for public transport, time tables of PT and alternative modes of transport e.g: trains metro, etc.
- **Real time data:** This data will concern road network status, traffic data, bus location, floating car data, traffic forecast, etc

#### 2.4.6 Expected benefits

- Reduce traffic jams for example by increasing the use of public transport
- Improve safety in the road by reducing congestion
- Improve energy efficiency by avoiding roads with long travel times, for example: roads with traffic jams or with any disruptions

#### 2.4.7 References: other projects, actual services etc.

- InTime Project Deliverables

### 2.5 Service 1.d Disrupted Service Assistant

*This service is still under discussion as whether it should be a totally separated service. The document final version will either describe it or list it as an additional platform service.*

### 2.6 Service 1.e Interchange & en-route assistant

Service 1.e. will provide indoor and outdoor seamless navigation service will include indoor navigation to guide travellers through the interchanges and to ensure continuous connectivity, this is essential for multi-modal continual trips.

People spend 80-90% of their time indoors, 70% of cellular calls and 80% of data connections originate from indoors (Source: Strategy Analytics). This shows that people spend most of their time indoors during a trip. Many pedestrians are feeling frustrated when getting into indoor building and lose their navigation connectivity.

Outdoor navigation had a giant steps forward in the past years, on the other hand several attempts for indoor navigation systems have been around for some time with no concrete break through. A recent ABI Research study on alternative positioning technologies concluded that Cell-ID and Wi-Fi combined with A-GPS will provide 25 percent of all positioning solutions by 2014. ABI added: "The future will be about hybrid positioning systems, combining A-GPS, Cell-ID, Wi-Fi, cellular, motion sensors, and even TV broadcast and proximity technologies such as Bluetooth, NFC and RFID."

#### 2.6.1 Indoor and outdoor navigation service chain

This service aims at ensuring continuous connectivity between outdoor and indoor navigation. This will ensure a permanent localisation.

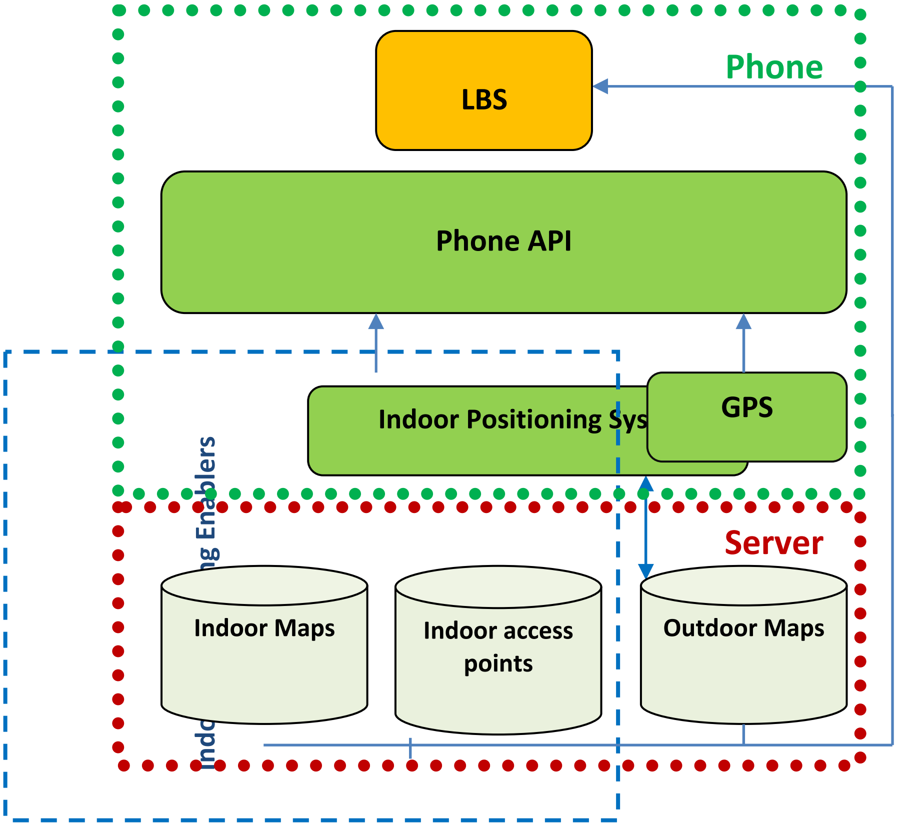



Figure 11 - Indoor-outdoor navigation service chain

Figure 11 shows the indoor-outdoor service chain of the seamless navigation. The service consists of the interaction of three different systems:

- Phone: who is hosting location based services, the phone API, GPS chip and indoor positioning system receiver.
- Server: To combine outdoor maps with indoor maps and indoor database positioning.
- Indoor positioning enablers including the indoor positioning system, indoor maps and indoor system positioning database.

When a traveller plans a trip, he/she will be navigating using GPS system, once he/she enters an indoor area then the service will ensure smooth transition to the indoor positioning system to continue seamless navigation. The service will be able to navigate horizontally on indoor maps and vertically to move to higher or lower levels. Location based services will be connected to the current location offering several related services.

### 2.6.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| No wide-spread indoor positioning systems and services are available | Indoor navigation and localisation will be possible using personal communication devices through using new emerging technologies connected to the internet or local applied solutions |
| Outdoor navigation is limited until the entrance of indoor places (e.g. shopping malls, exhibitions, airports, metro station, etc...) | A continuous navigation will be possible without interruption |

| | |
|---|---|
| Location based services are limited indoor | Location based services will be massively supported and enabled using mobile devices |

### 2.6.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Phone application programming interface | Set of rules and specifications that software programs can follow to communicate with each other | Providing the base of phone functionalities | |
| Indoor positioning system | Localise real-time mobile device position using local solution | The system will report the position to the phone API using the system access points | Real-time itinerary monitoring |
| Indoor access points | Inventory of all available fixed localisation points | Provide info directly to the indoor positioning system | |
| GPS | Outdoor localisation via GPS system | The system will report the position to the phone API | Real-time itinerary monitoring |
| Indoor maps | The indoor maps will provide a detailed routes for the indoor place, it will make sure to connect entrance/exit with the outdoor maps | Provide indoor routes to the LBS | On-the-spot POI & tourism information End-to-end itinerary planning |
| Outdoor maps | Outdoor maps with pedestrian routes until the entrance/exit of the indoor place | Provide outdoor routes to the LBS | On-the-spot POI & tourism information End-to-end itinerary planning |
| LBS | The location based services includes navigation, guidance, advertising and tracking services | Indoor/outdoor maps | Ticketless mobile fare payment |

### 2.6.4 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| *1* | Traveller | Operate Nomadic device, Performs the service | Service provider |
| *2* | Nomadic device application provider | Provides, manages and updates the nomadic device application | Traveller, Map provider |
| *3* | Map provider | Provides updated maps for indoor-outdoor navigation | Nomadic device application provider, Location Based Service provider |
| *4* | Location Based Service Provider | Provides updated Location Based Contents | Map Provider, Service provider |

#### 2.6.5 Data: data flows, service implementation

In order to provide continuous indoor-outdoor localisation, the service is activated through the traveller who is requesting his/her localisation via a location based service

- The location based service application is requesting the information from the nomadic device API.
- The Nomadic device API is constantly acquiring two types of locations: outdoor localisation determined via GPS system and outdoor maps, and indoor localisation via indoor positioning engine and indoor maps.

The figure below sketches the flow of data and service implementation:

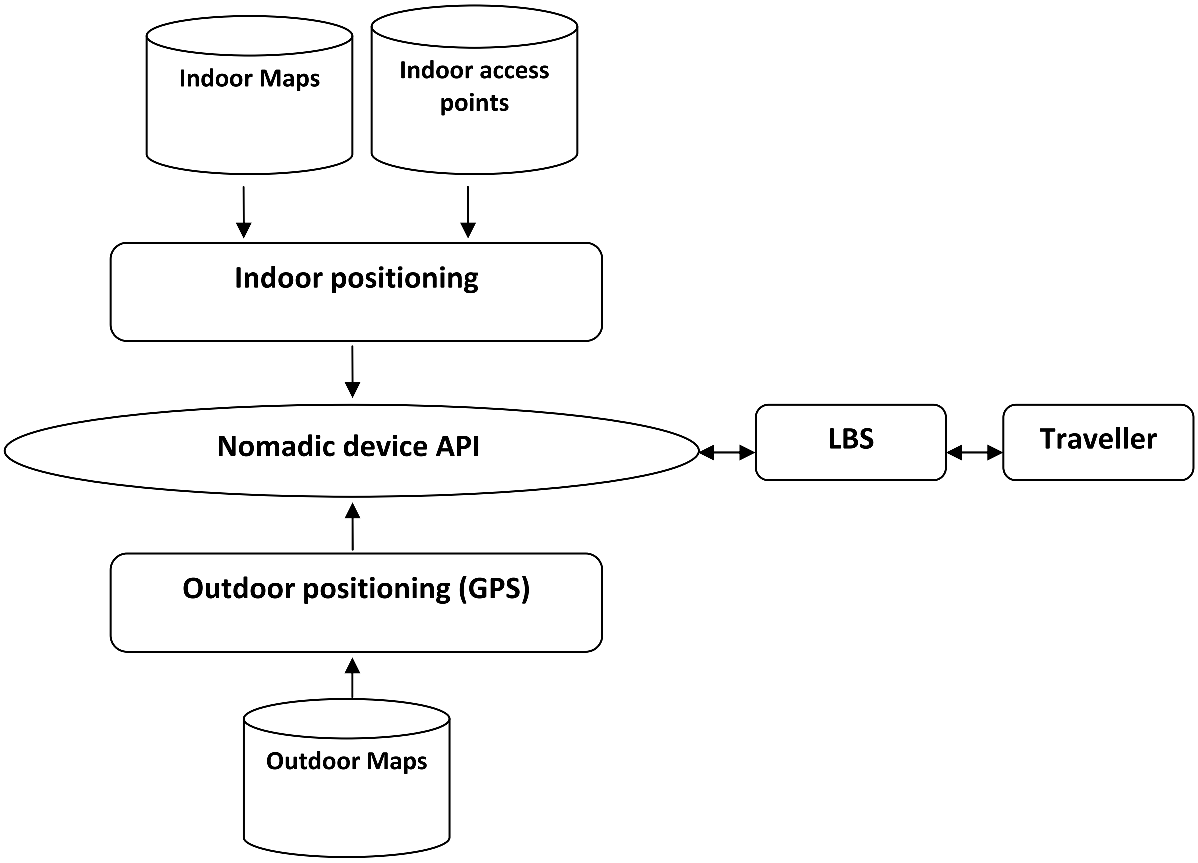



Figure 12 - Data flow of In-door and outdoor navigation for interchange & en-route assistant

### 2.6.6 Expected benefits

- Enhance the navigation experience for the traveller by having continuous localisation during the trip.
- Improver traveller's service and satisfaction by providing access to public transport hubs, malls, and event arenas.

### 2.6.7 References: other projects, actual services etc.

- HaptiMap project http://www.haptimap.com

## 2.7 Service 1.f: On-the-spot POI & tourism information

Point Of Interest provisioning is a crucial part of the journey both as assistance to the journey itself and from a societal and cultural point of view. Having the knowledge of surrounding environment helps people to have a more comprehensive view of the environment itself and understand the value of travelling in a sustainable way.

POI that could be delivered through Instant Mobility should be of four kinds:

- Journey related POI like stations, bus stop, car sharing parking and so on.
- Touristic and cultural POI like churches, museums, monuments etc.
- Facilities like post office, pharmacies and shops.
- Special events like concerts or exhibitions.

POI types from 1 to 3 may be considered as static, the fourth is dynamic i.e. it may change with time.

The key point in delivering POIs is the adaptation of the information provided based on several conditions like:

- Kind of journey (commuters, business, tourist etc …)
- Time (morning, afternoon, night)
- User profile and preferences

For instance is not worth mentioning a touristic site for a commuter or guide people to a shop when it is closed.

The objectives of the On-the-Spot POI & Tourism Information Service are:

- Provide the traveller with the possibility to select relevant POI.
- Notify the user when POIs are in the surrounding area.
- Select POIs to be notified based on user context.
- Offer an adaptable user experience both on the user terminal and POI displays.
- Collect user feedbacks to enrich POI databases.

### 2.7.1 End-to-end service chain

The users perspective of the service is described in the next picture.

Users may access the service from any terminal, both fixed and mobile, communicating with a server. At any time they may update their profile and preferences related to travel and in particular POIs.

During the travel planning phase, the travellers may refine their profiles selecting POI categories they are interested in; this can be done in relation with the choice of a planned itinerary but also before any travel. Also they can add specific POIs.

They may then select the preferred interaction modes; for instance the POI notification can be done using the geo-position, or through proximity wireless technologies. Moreover the notification can be done automatically or only upon users request.

During the travel the POI is notified to the user on a map, with basic indication. The POI interaction may vary; users may access multimedia content on their mobile phone; they may go the POI location where they may find a dedicated display. In the last case they may use the display and customize their experience through communication between the POI display and the mobile terminal. In case the POI is related to an event users may for instance book tickets for it.

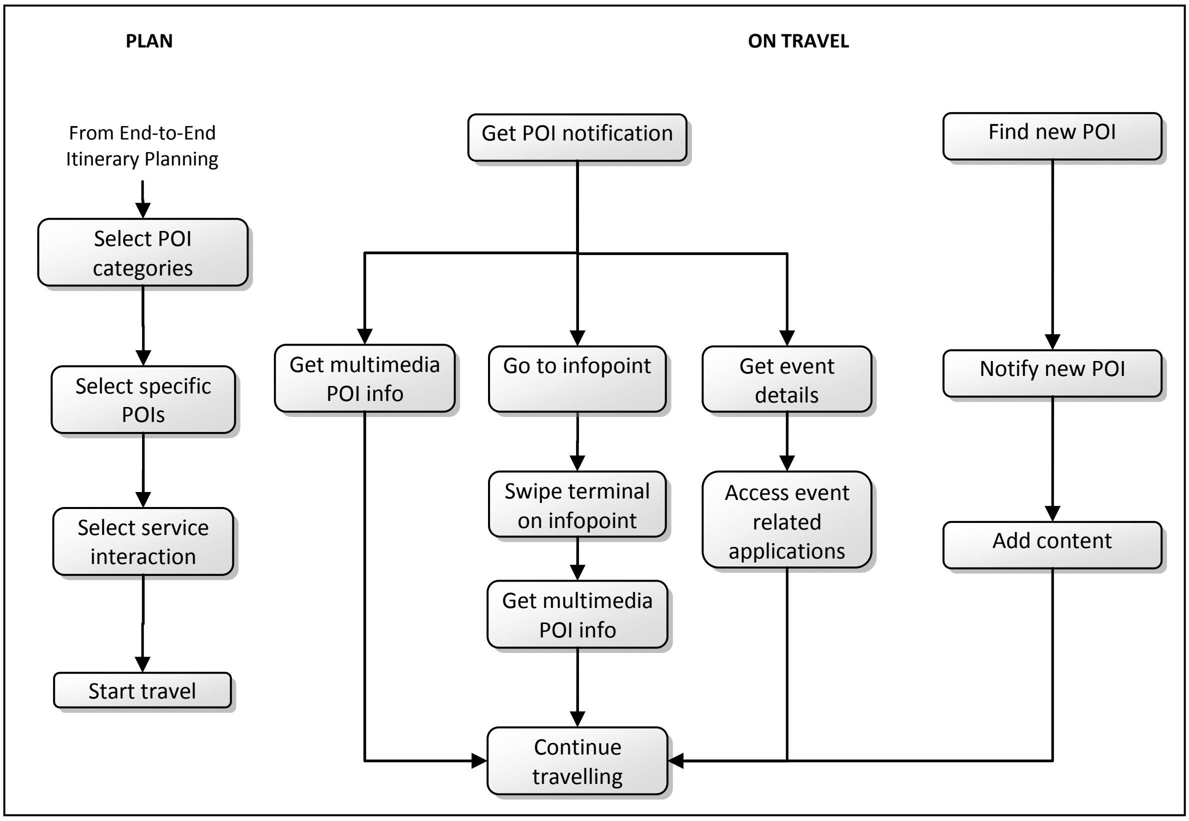



Figure 13 - User perspective of Service 1f

Users can also access POIs in addition to the selected ones; in particular POIs may be equipped with wireless devices (e.g. NFC) and the users can interact with them and be automatically redirected to the relevant information.

Users can also signal some sites that they consider relevant as a POI using their mobile terminals. All information collected by the users may be merged and used as a source for other users.

From the provisioning point of view (see next picture), the On-the-Spot POI & Tourism Information Service should be able to perform the following actions:

It is able to collect all the relevant information and link them to the POI physical infrastructure.

It collects all user preferences and choices about POI notification and selection.

It aggregates different source of POIs public, private or user generated.

During the users' travels, based on their position, it signals relevant POIs according to users' context, like time, type of trip, profile etc.

The service also provides methods to collect user feedbacks and to build a list of POIs that are user generated. Filters and sorting method will be available to build a consistent view of the POI generated list.

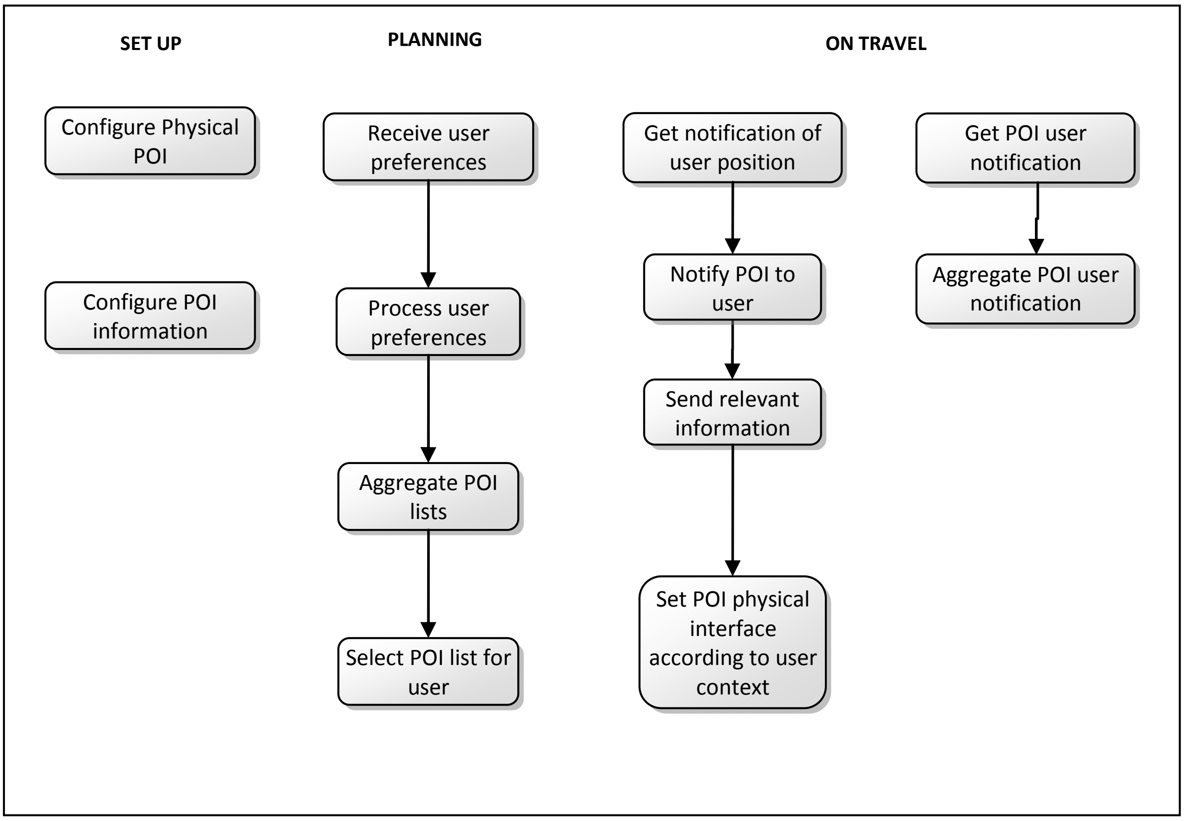



Figure 14 - Service Chain of Service provider's perspective for Service 1f

### 2.7.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| POI displayed on maps based on user search and geographical references (service pull). | POI information provisioning based on users profile and preferences. May also be automatically initiated by wireless proximity interfaces (service push). |
| Aggregation of different reviews and comments (e.g. Google) | POI collection and definition based on user inputs: Internet of People. Possibility to rate the POI on different channels and repositories. |
| Vertical solutions for On-the-spot information on mobile terminals based on 2D tags, SMS, manual insertion of reference. | Integration of different sources of information spread in the environment thanks to Internet of Things. Usage of contactless proximity communications. This may be applied also in vehicles through communication between the vehicle and infrastructure. |
| Text based information provided upon user request. | Vocal information option, enriched interfaces. Automatic selection of information when near the POI. |
| Some POIs are equipped with info kiosk and interactive displays. | Mobile terminals may interact with the POI kiosk display to customize the kiosk appearance based on user profile. Session switching between the terminal and the kiosk. |

### 2.7.3 Service components

| Name | Description and role | Comments | Dependencies |
|---|---|---|---|
| POI provider servers | Collect and provide the POI lists and related content. | They could be both public and private. | Linked with physical POIs. Provide information to POI manager server. |
| User POI aggregation server | Collect information and feedbacks provided by the users. | It could be a social-network like application | Provide information to POI manager server. Receives data from user mobile applications. |
| Physical POIs | 2D tags, wireless devices, interactive displays embedded or to POI | | They could be linked to POI repositories |
| User mobile application | Traveller access to service | It should be conceived to be portable on different terminals, both fixed and mobile. | Linked to physical POIs, user aggregation server, POI manager server. |
| POI manager server | It manages all user requests, collects information from different providers, manages active sessions to be delivered on different terminals. | It's the core of the service; also it is linked to external services like End-to-end Itinerary Planning | Besides links relevant to other components, it's linked to external services like End-to-end Itinerary Planning. |

### 2.7.4 Actors, their roles and relationships

| Actor | Role | Relationship between actors |
|---|---|---|
| Traveller | Configuring profile and preferences, selecting POI list, providing feedback and generate new POIs. | Subscribing to On-The-Spot POI & Tourism Information Service through POI manager. |
| POI provider | List of POIs and related content collection. Managing of physical POIs. | Providing list of POI to POI manager. |
| POI manager | Interfacing to traveller and POI providers, developing service and applications, interaction with external services, interaction with POI aggregation service. | Providing services to travellers and collecting information from other actors. |
| POI aggregator | Developing the POI aggregation server, defining sorting and filtering techniques. Managing the user POI generated archives. | Receiving information by travellers and providing information to POI manager. |
| POI owner | Providing POI information and content. | Subscription to or agreement with POI provider. |

### 2.7.5 Data: data flows, databases, required inputs from other services

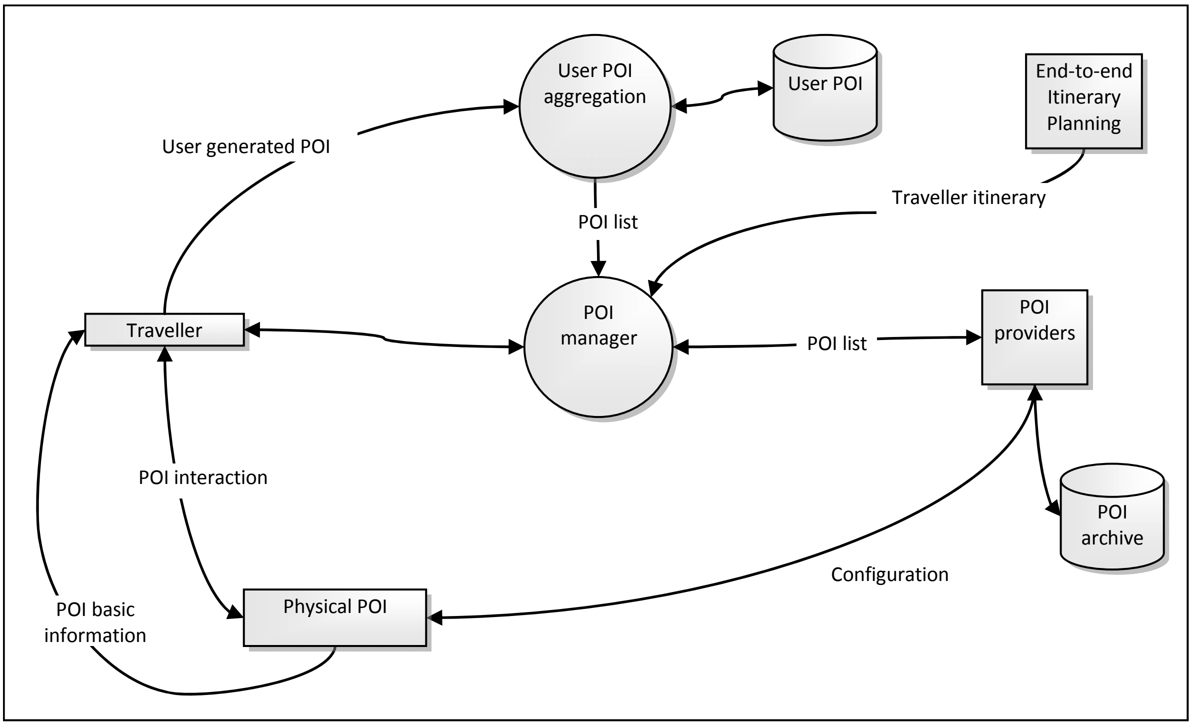



Figure 15 - Data flow of Service 1f

### 2.7.6 Expected benefits

Having on-the-spot information provides the following benefits:

- Users are not overwhelmed with flows of undesired information.
- User experience is enhanced through proximity communication and customized usage of kiosks interactive displays.
- The right information at the right time helps travellers to experience the journey having a more comprehensive view of the surrounding environment.
- Optimizing journey avoiding un-necessary displacements reducing environmental impact.

### 2.7.7 References: other projects, actual services etc.

Examples of today's services:

- *http://www.tripadvisor.it/*
- exploro.it (android application)

## 2.8 Service 1.g: Special-needs travel support

This service is provided for travellers with reduced mobility, guiding along fully accessible transport means and arranging for real-time support as needed (e.g. at interchanges). Special-needs are taken into account during the end-to-end itinerary planning. This service can offer voice (for blind) or text and/or image (for deaf) information. The service makes use of Instant Mobility system in the network. The service is available on the internet and on telephones (mobile phones) prior to and while travelling. The system and service provider can help ensure that the fundamental rights of people with reduced mobility are respected by providing easy access to comprehensive information, quality services and other special assistance for people with disabilities.

### 2.8.1 End-to-end service chain

The following diagram shows the end-to-end chain of the service.

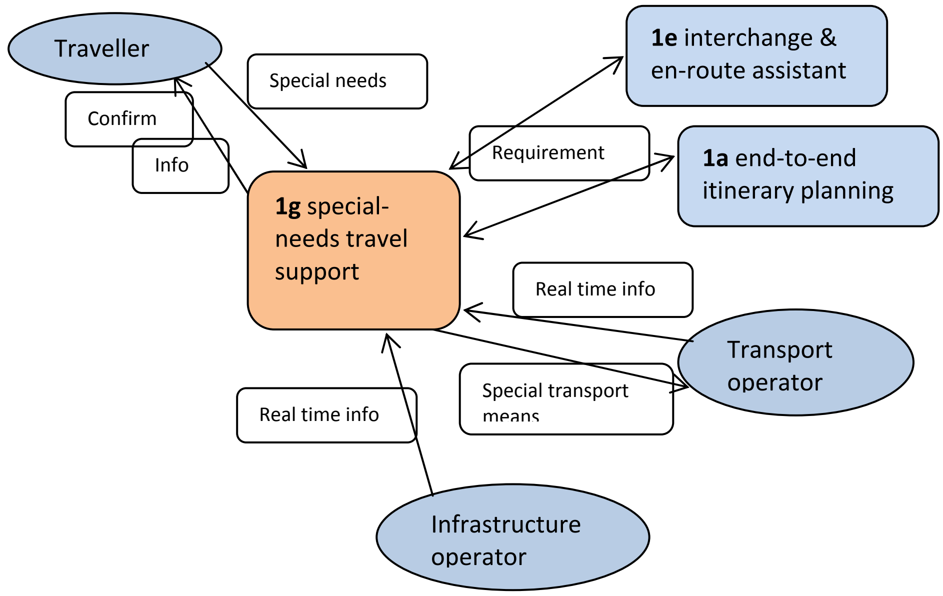



Figure 16 - Diagram of the end-to-end chain of special-needs travel support service.

Below use cases are given as examples in order to explain the functionalities of the special-needs travel support service.

| | |
|---|---|
| Use Case ID | UC_1g_1: End-to-end itinerary planning with special needs |
| Scenario title | Multimodal travel |
| Services name | Special-needs travel support |
| Short Description | <u>Service provider's perspective</u><br>• Special needs for itinerary planning service. Itinerary planning should be able to filter out those means not suitable for people with reduced mobility, according to their profile.<br>• Collects and integrates information from different sources and creates the detailed journey plan.<br>• Follows progress of the journey and seeks changes and disturbances concerning the rest of the journey.<br><br><u>Traveller's perspective</u><br>A traveller is able to create personal preferences (special needs/requirements) that are taken into account in each itinerary planning. A traveller uses itinerary planning service for barrier-free journeys according to a preselected personal requirements profile. The service is accessible in text or voice format for hearing or sight impaired people, or simply for elderly people not accustomed to mobile devices. |
| Goal | • To enable End-to-end itinerary planning service:<br>o To filter out those means not suitable for traveller. |

| | |
|---|---|
| | o To provide only accessible routes to the traveller. |
| Potential Constraints | Under discussion |
| Components | Under discussion |
| Main flow | Under discussion |

| | |
|---|---|
| Use Case ID | UC_1g_2: Using guidance with special needs |
| Scenario title | Multimodal travel |
| Services name | Special-needs travel support |
| Short Description | Service provider's perspective<br>Vocal, text or sign guide also for walking during modal change.<br>Vocal, text or sign guide to dedicated seats on train, buses etc.<br><br>Traveller's perspective<br>To board e.g. a train, at least some information about time, platform, train configuration and seat is required.<br>Visually impaired use speech, deaf use text or sign language. |
| Goal | To make travelling easy and safe.<br>Improve the accessibility of public transport information |
| Potential Constraints | Under discussion |
| Components | Under discussion |
| Main flow | Under discussion |

| | |
|---|---|
| Use Case ID | UC_1g_3: Using special assistance during the itinerary |
| Scenario title | Multimodal travel |
| Services name | Special-needs travel support |
| Short Description | Service provider's perspective<br>Special needs/requirements for interchange and en-route assistance service.<br>The service provider collects traveller's special needs.<br><br>Traveller's perspective<br>Traveller wants to have a specific seat and meal during travelling. Traveller books in advance special assistance to the defined interchange nodes and/or on-board. Traveller wants also to use in-door navigation to guide through the |

| | |
|---|---|
| | interchanges. |
| Goal | Special assistance for disabled people at interchange nodes or on-board can be booked in advance.<br>Supplementary travel facilities (dedicated seats, assistance from on-board personnel, specific meals, etc...) can be booked in advance.<br>To make travelling easy and comfortable. |
| Potential Constraints | Under discussion |
| Components | Under discussion |
| Main flow | Under discussion |

### 2.8.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Mobility apps are designed to help people travel more easily on public transport – showing the most suitable routes and asking for assistance in real time when necessary. | End-to-end assisted indoor/outdoor guidance |

### 2.8.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Traveller registration system | Register traveller's information and personal special needs | | End-to-end itinerary planning (1a);<br>Interchange & en route assistant (1d) |
| Traveller interface (via website or mobile device); | Traveller can use the interface to define and submit personal travel support request | | Interchange & en route assistant (1d)<br>End-to-end itinerary planning (1a); |
| Transport operator | Provides real time information if the vehicle approaching has facilities for special needs.<br>Provides specially equipped transport means when needed. | | |
| Infrastructure operator | Provides real time information about platform, train configuration, seats etc. | | |

### 2.8.4 Actors, their roles and relationships

| Actor | Roles | Relationships between actors |
|---|---|---|
| Infrastructure operator:<br>- Harbour<br>- Airport<br>- Railway station<br>- Bus station<br>- Other interchange operator. | - Providing geographic information of interchange, information on services, e.g. restaurants, shops.<br>- Providing real-time arrival information and usage of interchange. | In charge of the service<br>Responsible for communication with other actors in the service chain |
| Mobile handset provider | - Providing handset which is able to receive itinerary.<br>- Providing navigation (outdoor and indoor) and reminder traveller where to get off.<br>- Providing services to meet special needs (e.g. voice, text, image,video). | Communicating with traveller service provider |
| Traveller service provider | - Collecting information from all modes and all actors for itinerary planning.<br>- Collecting real-time information to monitor itinerary execution of the itinerary.<br>- Providing special itinerary planning for travellers with special needs. | Communicating with infrastructure operator |
| User/traveller | - Submitting request<br>- Receiving information<br>- Use the service. | Communicating with service provider |

### 2.8.5 Data: data flows, databases, required input from other services

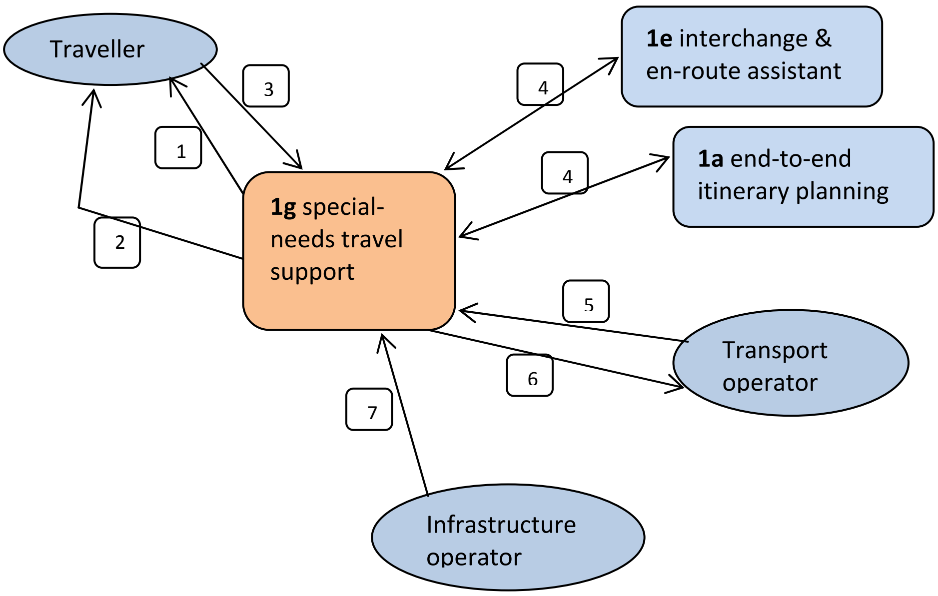



Figure 17 - Diagram of the dataflow of special-needs travel support service.

| Number shown in Figure 17 | Data | Input required from other services |
|---|---|---|
| 1 | Confirm | End-to-end itinerary planning (1a); Interchange & en route assistant (1d) |
| 2 | Info; Service query results yield not only information about possible travel connections (schedules) but also detailed information regarding paths and rides, and information about vehicles and stations. | End-to-end itinerary planning (1a); Interchange & en route assistant (1d) |
| 3 | Information about personal special needs. Different user profiles (disability/Mobility impairment types: no limitation, wheelchair user, restricted in walking and so on) can be chosen in order to get customized suggestions for barrier-free travel connections as well as information about the accessibility of facilities to be used during the journey. | |
| 4 | Requirements (profile) | |
| 5 | Information related to the approaching transport mean and its facilities | |
| 6 | Information related to the needed special equipped transportation means. | |
| 7 | Information related to stations, platform, train configuration, seats etc. | |

### 2.8.6 Expected benefits

- Better management of the fundamental rights of people with reduced mobility; integration in society.
- Has a positive impact on independent living of persons with reduced mobility through tailored and barrier free itineraries.
- Perform autonomously activities of daily life; potential to reduce costly special (door-to-door) transport services.
- Increase economic efficiency by adding value to existing public transport services and transport networks.
- Better image for public transport.

### 2.8.7 References: other projects, actual services etc.


- [1] AbleLink Technologies (2011). New technology to facilitate independent bus travel for those with special needs. URL: http://denveroptions.org/ablelink-technologies-wayfinder.
- [2] ISEMOA-project (2011). URL: http://www.isemoa.eu/.
- [3] The RATP Group (2010). BlueEyes: Geolocation for people with reduced mobility.

- URL: http://www.ratp.fr/en/ratp/r_6335/blueeyes-geolocation-for-people-with-reduced-mobility/

## 2.9 Service 1.h: Ticketless mobile fare payment

A multimodal travel will involve different transport means from different operators, each of them having its payment systems, ticketing solutions, price policies. The objective of the Ticketless Mobile Fare Payment is to relieve travellers of the burden of dealing with each single ticket and its corresponding payment; the service will do it for them and submit just a single "multimodal ticket" to their payment authorization. This service is therefore different from "Ticketless Fare Collection" in Scenario 3, which instead handles one payment to one single mobility operator. It's worth mentioning that multimodal travel may be encouraged applying discounts and offers on the total price.

In the following it is assumed that Future Internet will provide mobile payment services based on a virtual wallet embedded in traveller's mobile terminal. Such wallet will be used to pay both goods and services like, in this case, a single dematerialized "multimodal ticket". Traveller will confirm payment through a menu on his/her mobile terminals' display or using its embedded radio proximity interface; this latter method is particularly suitable when price depends on the travel's length ("pay as you go"). In such cases payment authorization will be implicitly repeated simply swiping the mobile terminal near a contactless radio interface; for instance, to take a shared car the traveller will swipe the mobile terminal a first time to check in, drive as long as needed and then swipe again to check-out and leave the car.

Virtual tickets will be stored in the travellers' mobile terminals; whenever needed, the virtual tickets will be accessed by wireless transponders, which may be integrated in barriers, vehicles, or in ticket inspectors' terminals.

### 2.9.1 End-to-end service chain

The following picture describes the user's perspective of the service. After planning a multimodal journey (with the End-to-end Itinerary Planner) the traveller will receive the total travel price and a preliminary list containing the price of each segment of the travel.

After accepting the final route and global price, the user will pay with the mobile wallet and receive the set of virtual tickets for the transport means involved in the multimodal travel; in this way, he/she will not have to make several payments to different transport operators, each of them adopting different procedures and menus. Furthermore, both the preliminary price list and the virtual tickets will be presented to the traveller using always a unique common format no matter which operator they come from; this will facilitate and speed up the user experience. Segments having "pay as you go" pricing will be properly highlighted because their cost can only be estimated and be assessed only at the end.

The travelling phase of the service will begin when travellers go to the first transport mean in their route. As said before, depending on the pricing policy chosen by the operator, there will be two possible types of virtual tickets: those with a fixed "a priori" known price, and those whose price will mostly be proportional to travel length and duration ("pay as you go").1 In case of a fixed price virtual ticket the traveller will punch it when accessing the transport mean; this action may correspond to swiping the mobile terminal to a subway barrier or to a small machine mounted on a bus.

[1] The most obvious examples are of course car or bike sharing but, since ticketing and payments will be so greatly facilitated (see Scenario 3) it is quite likely that "Pay as you go" pricing policies will become more and more popular also on buses and subways.

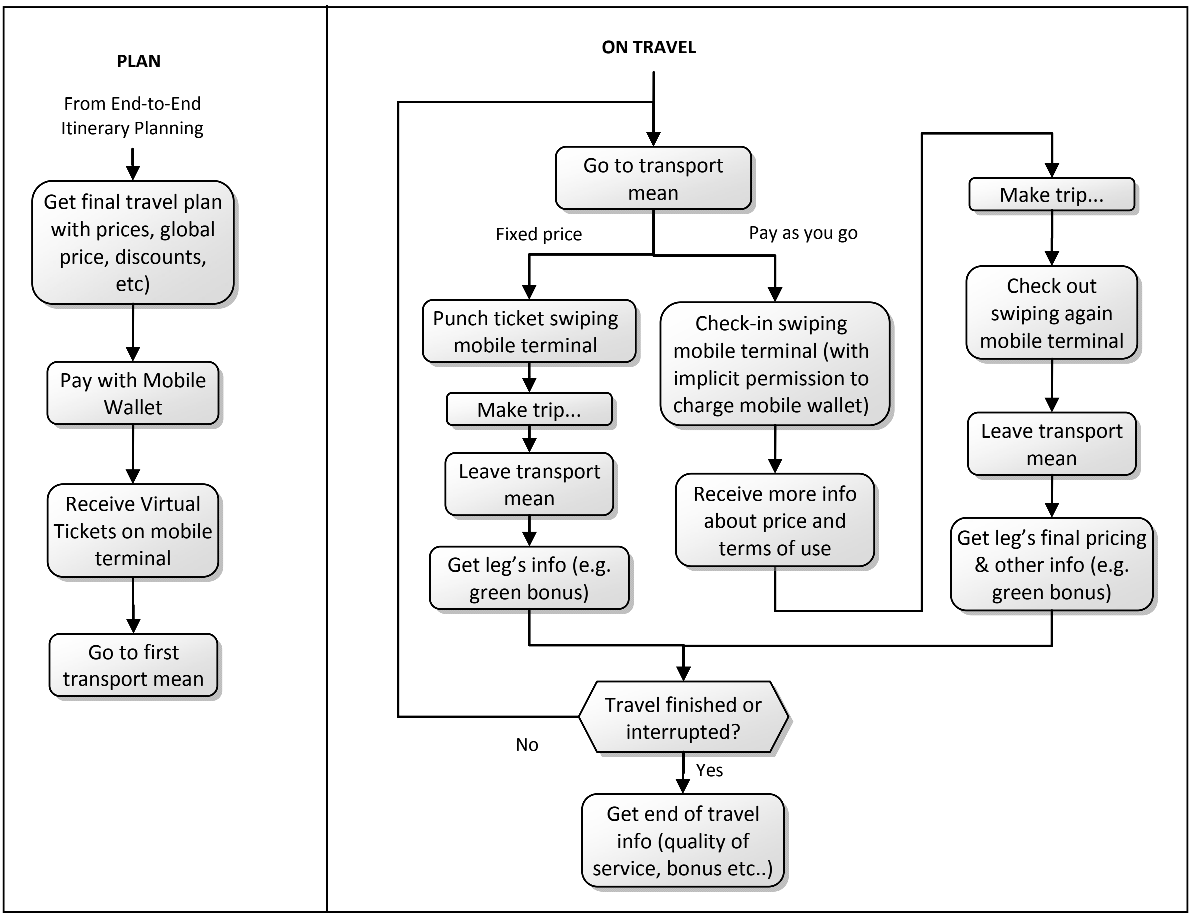



Figure 18 - Service Chain in Traveller's Perspective

In case of a "Pay as you go" virtual ticket, the traveller will swipe the mobile terminal both when beginning the trip (check-in) and when ending it (check-out); the trip price is calculated by the service and then sent to the traveller's terminal. It shall be noted that with the check-in event, together with the corresponding virtual ticket's purchase in the plan phase, the traveller will confirm the authorization to charge his/her mobile wallet. In all cases, when leaving the transport mean the user will be notified about the end of the virtual ticket validity and other related info, for instance green credits gained for having used public transport.

The next picture shows the provider's perspective of the service. In the planning phase, the service will receive the set of travel segments of a multimodal route and, for each of them it will collect pricing information from the involved transport operator specifying also the traveller's profile and any additional custom information. After sending all the collected pricing data to traveller, the service will wait for payment notification from the each transport operator and only then proceed to virtual ticket collection. The last step of the planning phase is formatting and forwarding virtual tickets to traveller.

While the traveller is along the route the service waits for information from the Transport Operator that is carrying him/her. The possible events will be ticket punching and traveller entering (check-in) or leaving (check-out) a vehicle; each time the service will gather from Transport Operator the pricing information and any other ancillary data and will transfer them to traveller after adapting to a unique presentation format. Events and data from Transport Operators will be logged in a local history archive.

When the traveller completes the last travel segment (or just decides to terminate it) the service will analyze the whole travel history and send him/her a report about the overall final cost and the details of each segment. If the traveller does not complete the scheduled route, the service will take care of cancelling all the remaining virtual tickets and bookings.

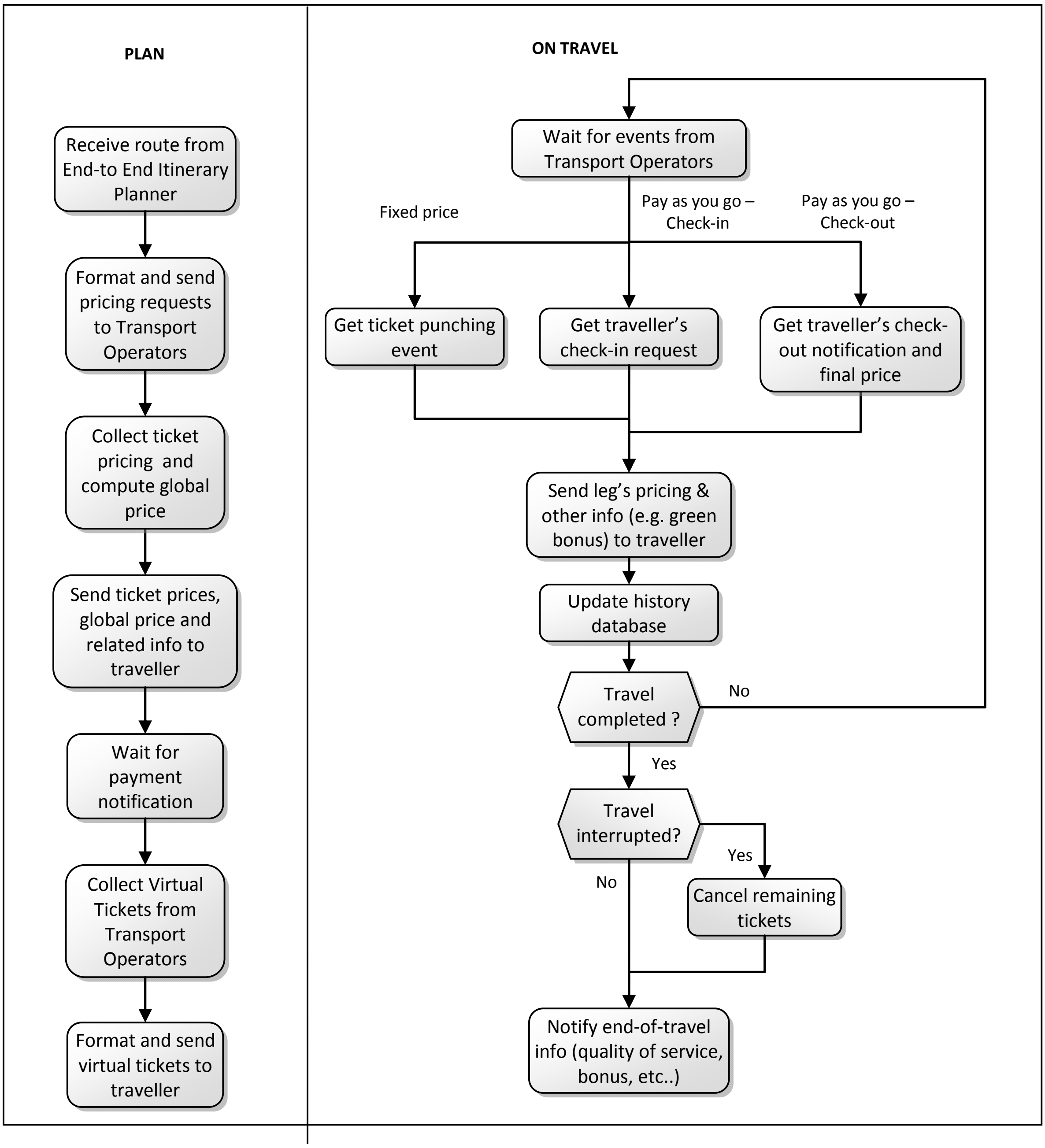



Figure 19 - Service Chain in Provider's Perspective

### 2.9.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Not existing | **Single payment for a multi-modal travel** involving different transport means from different operators. Unique visualization format for tickets from different operators. |
| **Proof of payment**. Mainly with paper tickets, minor use of SMS, bar code on traveller's mobile terminal or phone call. | Virtual tickets stored on Traveller's mobile terminal and accessible through wireless interface. |
| **Access control to transport means** Gates (underground), bar code check or just human visual inspection. | Mainly through proximity radio interface on traveller's mobile terminal, with minimum traveller's intervention. |
| **Booking** Phone call, website, travel agency. | Mainly through mobile terminal, one-stop booking for multiple means. |
| **Payment** Cash, credit card, website. | Through mobile wallet with traveller's authorization from mobile terminal. |
| **Ticket cancelling** Through desks, fax, e-mail, phone call. | Performed automatically when traveller cancels whole trip or a part of it. |

### 2.9.3 Service components

| Name | Description and role | Comments | Dependencies |
|---|---|---|---|
| User Mobile Application | Enables access to service, stores virtual tickets and traveller's info. | Runs on traveller's mobile terminal. In user's perspective it is seamlessly integrated in End-to-end Itinerary Planner | Must communicate with End-to-end Itinerary Planner. May be shared with other services. |
| Fare Processing Server | Retrieves route segments and translate them into local price and ticket requests. | Masters the overall service | Communicates with all components. |
| Transport Operator Interface Server | Requests prices and virtual tickets to each Transport Operator involved in a multimodal route. Receives payment notifications and Traveller's events | Traveller's events are payment notification, ticket punching, check-in and check-out (see Ticketless Fare Collection in Scenario 3) | Interacts with transport operators information systems. |
| Traveller Interface Server | Send price information and virtual tickets to Traveller adapting them to a unique presentation format. | Manages any other function related to user interface. | Accessed by user mobile application. |

### 2.9.4 Actors, their roles and relationships

| Actor | Role | Relationship between actors |
|---|---|---|
| Traveller | User of the service. | Uses IM End-to-End Itinerary Planner. |
| IM End-to-End Itinerary | Provides user choices and preferences related user journeys. | Used by travellers to plan trips. |

| | | |
|---|---|---|
| Planner | | |
| Mobile Payment Processor | External entity that manages the mobile payment processing. | Travellers have their own subscription to Mobile Payment Processors. |
| Transport Operators | Partners of the service. | Get payments notifications by Mobile Payment Processor and forward them. |

### 2.9.5 Data: data flows, databases, Required input from other services

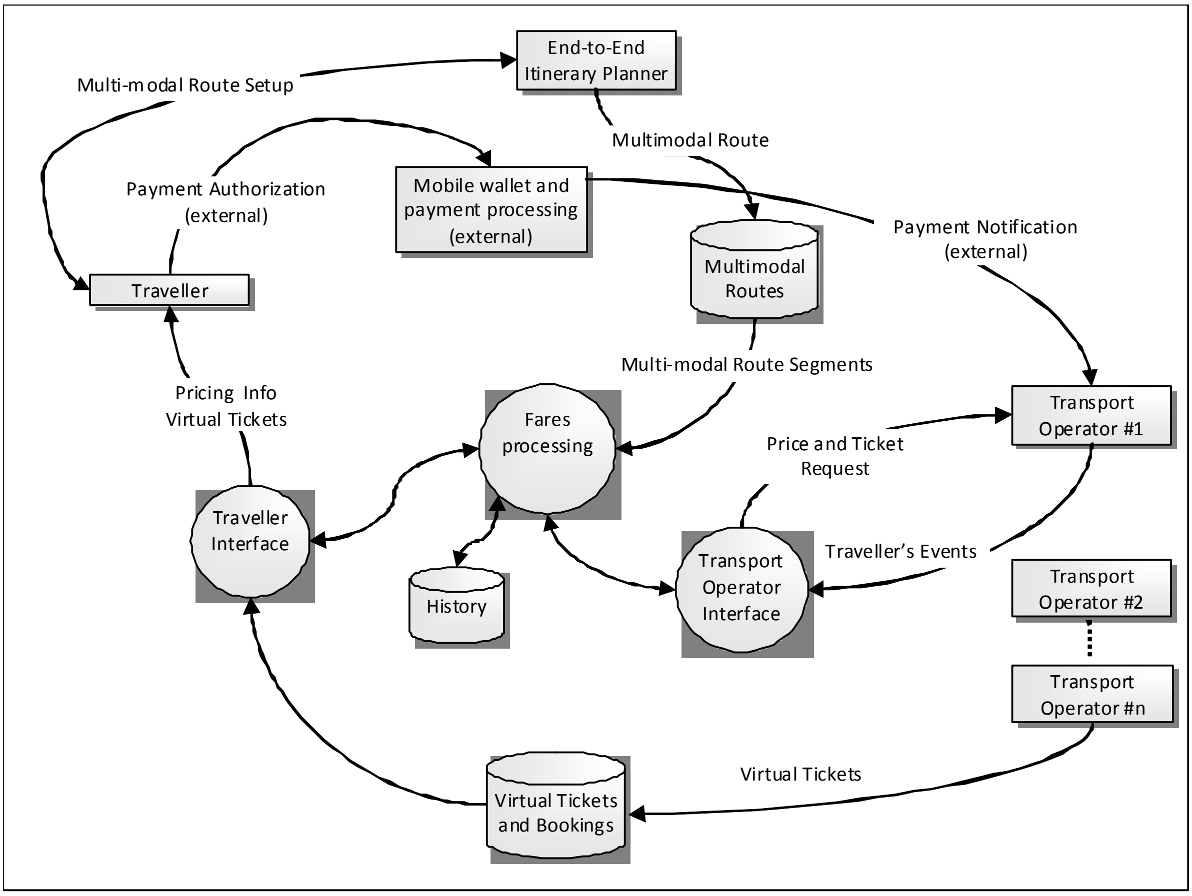



Figure 20 - Data flows of Service 1h

### 2.9.6 Expected benefits

Payment of multimodal travels will be much simpler and shorter; thus, the time spent in payment procedure and the probability of user's mistakes will be dramatically reduced. Single payment will be particularly appreciated by tourists and occasional users, who will feel more encouraged and effectively helped to use collective transport means.

### 2.9.7 References: other projects, actual services etc.

N/A.

## 2.10 Service 1.i: Bicycle Sharing

Bicycle sharing is an online service which is able to inform of bike and docking space availability, and allows bicycle sharing as a part of multi-modal journey. The service provides up-to-date information to the end-to-end itinerary planning service (Service 1a) and receives booking requests from 1a to reserve a bicycle or a docking space for a planned trip. The service can be paid via mobile payment, also as a part of the ticketless mobile fare payment (Service 1h).

This service also allows a user to report any malfunctions of bicycles and operators to monitor positions and conditions of bicycles, in order to better manage and maintain the bikes.

### 2.10.1 End-to-end service chain

This service aims at using future internet technologies to integrate bicycle sharing as a part of the multi-modal mobility service chain. This service connects individual bicycles with service providers, users and other modes of transport. Each individual bicycle may be equipped with monitoring devices to monitor location and conditions, e.g. type pressure (remote diagnosis). This service will also allow users to give feedback on usage of bikes, i.e. reporting any malfunctions of a bicycle via mobile devices. These will allow the service providers to maintain bicycles quickly.

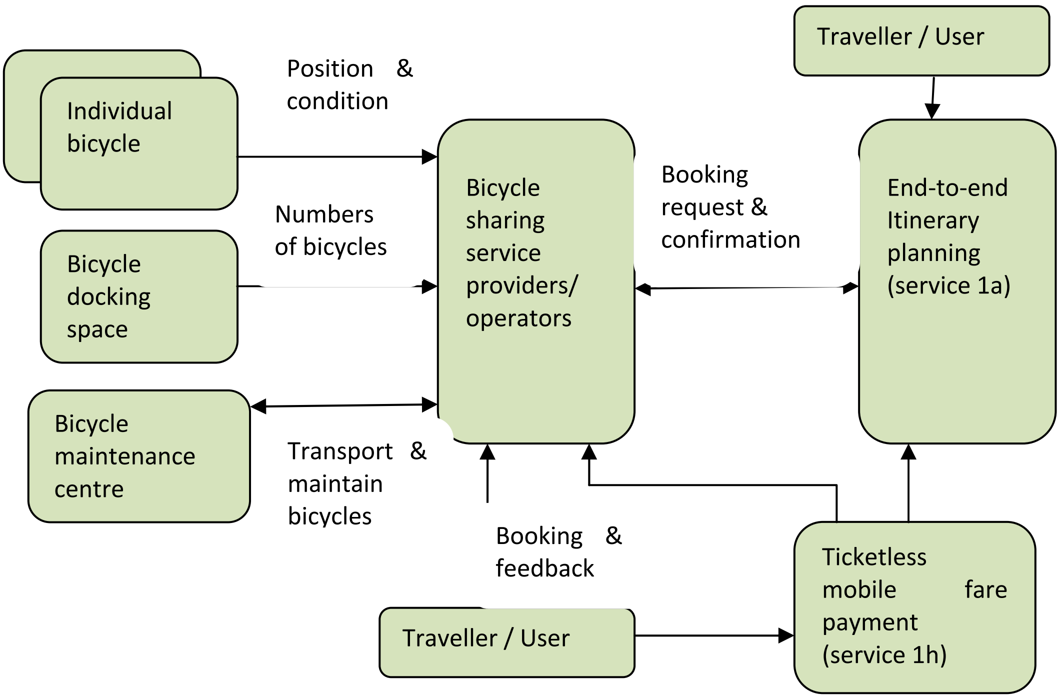



Figure 21 - End-to-end service chain of bicycle sharing

Below two use cases are given as examples in order to explain the functionalities of the bicycle sharing service.

| | |
|---|---|
| **Use Case ID** | UC_1i_1: Pre-book shared bicycle as a part of multi-modal itinerary planning |
| **Scenario title** | Multi-modal travel made easy |
| **Services name** | Bicycle sharing |
| **Short Description** | <u>User perspective</u><br>Pre-trip: user will book a trip via Service 1a end-to-end itinerary planning. The planned trip includes a shared bicycle for a part of the journey. The user receives |

| | |
|---|---|
| | location of the bicycle docks, how to get there and an instruction how to use the bicycle. Use of the bicycle has been pre-paid together with other modes of transport.<br><br>During the trip: the user will go to the bicycle dock following guidance on his/her mobile device and use the integrated e-ticket to unlock the pre-reserved bicycle. After using it, the user will return the bicycle following the guidance to the next bicycle dock and return the bicycle to a pre-reserved parking space.<br><br>Service provider perspective<br>Bicycle sharing operator will provide information on location of all bicycle docks, real-time information on number of available vehicles and available spaces for returning bicycles. Itinerary planning service providers will be able to access the data and use it for itinerary planning. If a planned itinerary requests a shared bicycle, the itinerary planning service will inform bicycle sharing operator when a bicycle is needed and where the bicycle will be returned. |
| **Goal** | • Integrate shared bicycle as a part of multi-modal travel<br>• Pre-booking a bicycle or a parking dock<br>• Ticketless payment |
| **Potential Constraints** | • Usage of bicycles from other users may be different to forecast<br>• Dynamic information from each bicycle and each docking station is needed |
| **Components** | Bicycle & dock booking and reserve system;<br>Ticketless payment system for bicycle sharing;<br>Interfaces between bicycle sharing system and Services 1a and 1h |
| **Main flow** | While a traveller books a journey, if for a part of the journey the best mode is shared bicycle, the itinerary booking system will then book a bicycle for the traveller. The payment of the usage of the bicycle is part of a single ticket for the entire journey. The booking information will be given to bicycle sharing operator. The bicycle sharing operator needs to ensure a bicycle is available when the traveller arrives at the location where the bicycle will be picked up. The traveller can use the single ticket for the journey to unlock the bicycle. The bicycle share operator needs also to ensure a dock space is available at the location where the traveller should return the bicycle. |

| | |
|---|---|
| **Use Case ID** | UC_1i_2: User reporting malfunction of a bicycle |
| **Scenario title** | Multi-modal travel made easy |
| **Services name** | Bicycle sharing |
| **Short Description** | User perspective<br>When a user uses a shared bicycle, he/she notices that the bicycle does not work well. The user can use his/her mobile device to report the malfunction including:<br>• Location;<br>• The bicycle ID;<br>• Malfunctions of the bicycle, i.e. flat tyres, problems with breaks etc.<br><br>The user may report the malfunction when he collects or return the bicycle. If when he/she collects the bicycle, the system will automatically gives the user another bicycle at the same location. However, if the user finds the malfunction during a trip and the bicycle cannot be use, the bicycle can be left at the location. The user will be given other options of transport.<br><br>Service provider perspective<br>After receiving report from a user, the service provider should react to the report:<br>- If the user sends the report at a dock station when he/she picks up a bicycle, the operator should allocate a bicycle at the same location;<br>- If the user sends the report at a dock station when he/she returns a |

| | |
|---|---|
| | bicycle, the operator will mark the bicycle as 'malfunction' and not let other users to use it. The operator will collect it and send it for repairing.<br>- If the user sends the report between dock station. The operator will inform disrupted service assistant (1d) and new transport mode will be arranged and delivered to the user. The operator will collect the bicycle at the location where the user left the bicycle. |
| **Goal** | • Receiving malfunction report from user directly |
| **Potential Constraints** | • Users may not be able to identify problems<br>• False alarms<br>• Users leaving and operators collecting broken bicycles from roadside may be challenging |
| **Components** | Bicycle & dock re-booking system;<br>Bicycle location unit;<br>User reporting function via mobile device; |
| **Main flow** | While a user reports malfunction of a bicycle via his/her mobile device, the information will be sent to the bicycle sharing operator. The operator will react the report based on situations. If the user is taking a bicycle from a dock station, the operator will check availability of bicycles in the same location and allocate another bicycle for the user. If the user reports the malfunction during his/her journey, the operator needs to pass the information to disrupted service assistant. A new transport mode will be arranged and information will be delivered to the user's mobile device. |

### 2.10.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Taking and returning a bicycle at a dock station, users may face no bicycle or no parking space available. | Pre-book bicycles and parking space for returning bicycles |
| Bicycle sharing is not included by multi-modal journey planning services. | Bicycle sharing will be included by multi-modal journey planning services. |
| Operator has no real-time information on available bicycles and dock spaces. | Operator will have real-time information on available bicycles and dock spaces at each dock station. |
| Bicycle sharing is paid specifically. | Bicycle sharing will be paid as part of integrated ticketless payment. |
| Operator cannot know locations and conditions of bicycles. | Operator will know location and condition of all bicycles. |
| Malfunctions are not reported by users and cannot be detected earlier than being checked by service providers. | Users can report malfunctions. |

### 2.10.3 Service components

| Service component | Functionality | Interdependencies with other component | Interdependencies with other |
|---|---|---|---|

| | | of this service | services |
|---|---|---|---|
| Booking and payment unit for a bicycle and docking space | The unit at each docking station is able to receive information from operator to reserve a bicycle or a docking space. | Static and dynamic database of bicycle sharing docking stations | End-to-end itinerary planning (Service 1a)<br><br>Ticketless mobile fee payment (Service 1h) |
| | At each docking station, if a bicycle or a docking space is pre-booked, it will be marked as 'reserved'. Other users cannot use it. | | |
| | At each docking station, the user can use a mobile device or a barcode to unlock a bicycle without separate payment. | | |
| Static database of bicycle sharing docking stations | Proving location of each docking station, number of docking spaces | Serves as configuration of the payment management. | End-to-end itinerary planning (Service 1a) |
| Dynamic database of bicycle sharing docking stations | Providing dynamic information on availability of bicycles and docking spaces | | End-to-end itinerary planning (Service 1a) |
| Malfunction reporting module | User can use the malfunction reporting module in his/her mobile device to report malfunction. | Bicycle /docking space booking/payment unit; Dynamic database of bicycle sharing docking stations | Disrupted service assistant (Service 1d) |

### 2.10.4 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| 1 | End-user | Registering<br>Giving preferences<br>Validating booking and payment requests<br>Collecting and returning bicycle<br>Reporting malfunction | |
| 2 | Bicycle sharing provider/ operator | Providing and main bicycles and dock stations<br>Providing static and dynamic information to itinerary planning provider | Interface with itinerary service provider |
| 3 | Itinerary service provider | Collecting information from bicycle sharing provider and book bicycles for a journey | Interface with bicycle sharing provider and end users |
| 4 | Disrupted service assistant | If malfunction of a bicycle occurs during a journey, the disrupted service assistant will be informed and an alternative mode of transport will be provided to the user | |

### 2.10.5 Data: data flows, databases

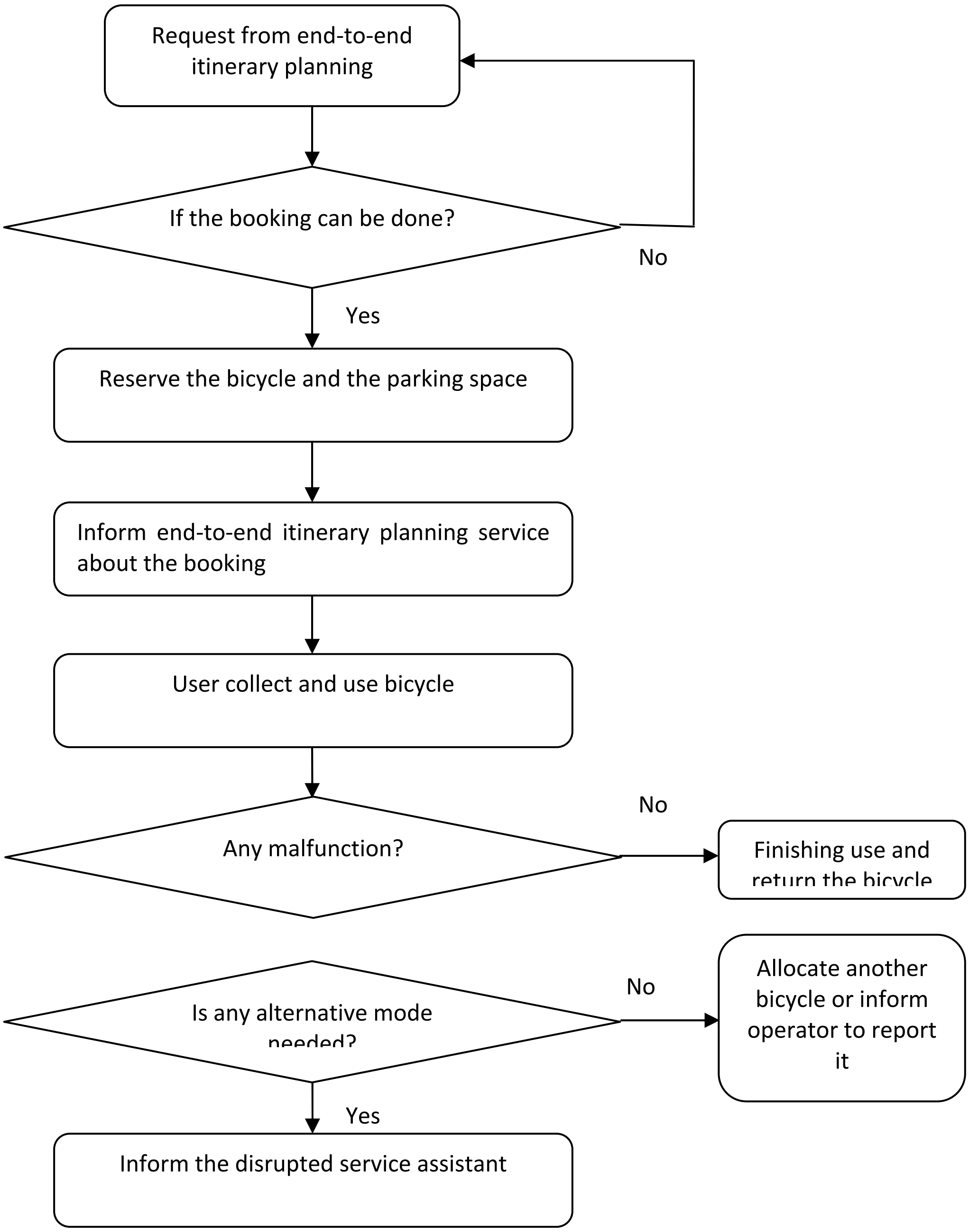



Figure 22 - Data flow of Service 1.i

### 2.10.6 References: other projects, actual services etc.

N/A.

# 3 Scenario 2 – The sustainable car

## 3.1 Scenario summary

Flexibility is one of the most relevant aspects of individual mobility based on private car. On the other hand, overcrowded scenarios, which already represent a threat in terms of congestion, pollution and emissions, without countermeasures will impact on the same flexibility, as citizens will feel more and more dependent on the availability of parking slots, the level of congestion, etc.

Recently navigation and parking assistance, info-mobility, novel concepts of collective transport (car and ride-sharing) as well as regulatory policies to contain congestion and pollution have shown promising results. However, their introduction and user acceptance have to face limiting factors, among which the difficulty of aligning information used and provided by these systems to the ever-changing needs and situations of the real world. Sudden changes of user preferences, traffic situations, car lifts, contingencies, emergencies, co-modal scheduling, Point Of Interest and road network updates, pollution risk growth, etc., together have such a great impact on mobility that cannot be handled as exceptions to the ordinary flow of events, but rather as a rule.

To find a solution, the key feature to be considered is again flexibility, and the Internet of the future can be of great help in this context. Indeed, a scenario of always connected vehicles, instantly exchanging a large amount of data on the internet, can foresee an enhancement of the aforementioned services, as it enables real-time information, planning and assistance.

Furthermore, novel services can be thought of, like the itinerary booking described hereafter, allowing an intelligent management of displacements with minimum effort by the user. The flowing chapters will give an overview of the services building the sustainable car scenario of Instant-mobility.

### 3.1.1 Purpose

The purpose is to offer travellers the “best” route by car, in terms of comfort, efficiency, safety and reduced impact, for instance with least delay, least CO2, shortest time, lowest cost etc.

This will be achieved enriching the trip planning services with a number of interactive information provided by online services, thanks to novel Internet features.

### 3.1.2 Problems to be solved

- While representing a key factor for independent living, the ever-increasing usage of the private car leads nowadays to frequent congestions, and thus to the opposite effect of limiting people mobility.
- Congestion has a high societal cost, represented by energy consumption, pollution, greenhouse gases emissions and time waste. This problem has to be addressed in order to achieve a sustainable mobility.
- Nowadays traffic can be inferred and the related warning can be issued (VMS, RDS-TMC) however, such information is often received too late by the drivers. Easy, ubiquitous, and seamless access to info-mobility services should be foreseen.
- Inefficiency of displacements of the single user is very much depending on the crowd of users, like park place finding or the rush hour effect.
- Overall, this results in a non-optimised usage of the road with respect to its actual capacity.

- Apart from the cost of petrol, there is no common cost/benefit mechanism taking this fact into account, and fostering instead an efficient behaviour of drivers and travellers in their displacements.
- Navigation and route guidance systems are very useful; however, they are currently optimised for finding a single route, not for scheduling a complete trip avoiding congestion.
- Integrate energy consumption information in the different algorithms used in the services (itinerary planning and way of driving especially eco-driving)

### 3.1.3 Rationale: how Future Internet solution could address the above problems

- Advanced internet-based services will allow to know, in privacy-friendly way, the displacements of users, and thus to schedule the usage of road network, optimising it.
- Data from vehicle fleets, jointly with the data from different service providers will allow delivering real-time traffic information. Here the Future internet will be a core factor for the actual adoption of this policy (which has been already addressed in the last decades) as it will allow an enhanced data transfer with respect to typical Floating Car Data systems.
- Navigation systems and routing services could be combined with scheduling policies and users' profile to perform an optimised and dynamically updatable journey planning.
- The users will thus be able to plan trips not only receiving the way, but finding and *booking* their entire journey in all its details and transferring it on their own devices
- Ubiquitous internet access could enable more pervasive info-mobility services, through a seamless access to online information sources
- Ubiquitous internet access could also enable a constant feedback from the users' devices to the service providers, for situation updating purposes
- Collective transport such as car sharing and ride sharing could be enhanced and become more attractive to users, thanks to advanced scheduling mechanisms combined with info-mobility and congestion charging mechanisms.

### 3.1.4 Short description of each service as a whole

- **2.a: Personalized route guidance**. Autonomous route guidance service is enhanced with real-time recommendations for avoiding congestion, while interacting with a service that optimises each individual trip while optimising the overall traffic system.
- **2.b: "Itinerary booking" service**. Drivers can reserve "slots", departing at arranged time and following recommended route, and receiving limited traffic signal priority. Internet service pools all requests and allocates itineraries.
- **2.c: Real-time traffic & route information.** Probe vehicle data from all fleets are pooled on Internet, mashed-up with other sensor data to give real-time traffic conditions over full road network. Online traffic info services are available to drivers, and support other travel services.
- 2.d: **Car sharing plus**. It is an online service to locate, book and pay for a shared vehicle (small or large car; electric car; scooter; van…) for short-term use; may be offered as "mobility service" by vehicle manufacturer; may receive eco-incentives; may be used via mobile handset or through the new devices of future internet.
- **2.e: Ride sharing.** Requests and offers of ride sharing from various social-networks are combined in online database, and mashed-up together to give greatest choice of time, location, type of person etc.
- **2.f: Congestion charging:** Online service to monitor users' vehicles and apply variable charges according to location, time of day, vehicle type etc.; can include negative

charges, i.e. bonus for avoiding congested times and locations. Can be combined with service to suggest eco-friendly alternative ways to travel.

- **2.g: Parking assistance:** Online services to provide parking space availability, booking, guidance and payment. Also consist in social-network crowd-sourcing service to notify real-time availability of on-street parking spaces.

### 3.1.5 How services interact and combine within the scenario

Although the design is still at a preliminary stage, some considerations can be made in terms of service roles and combinations within scenario 2. This exercise helps avoiding double components with the same role in the system. Rather, the output of tasks logically pertaining to one service (e.g. park finding for 2.c) should be re-usable by other services (e.g. by booking service 2.b), for example by the itinerary booking service. The result is reported in the following picture.

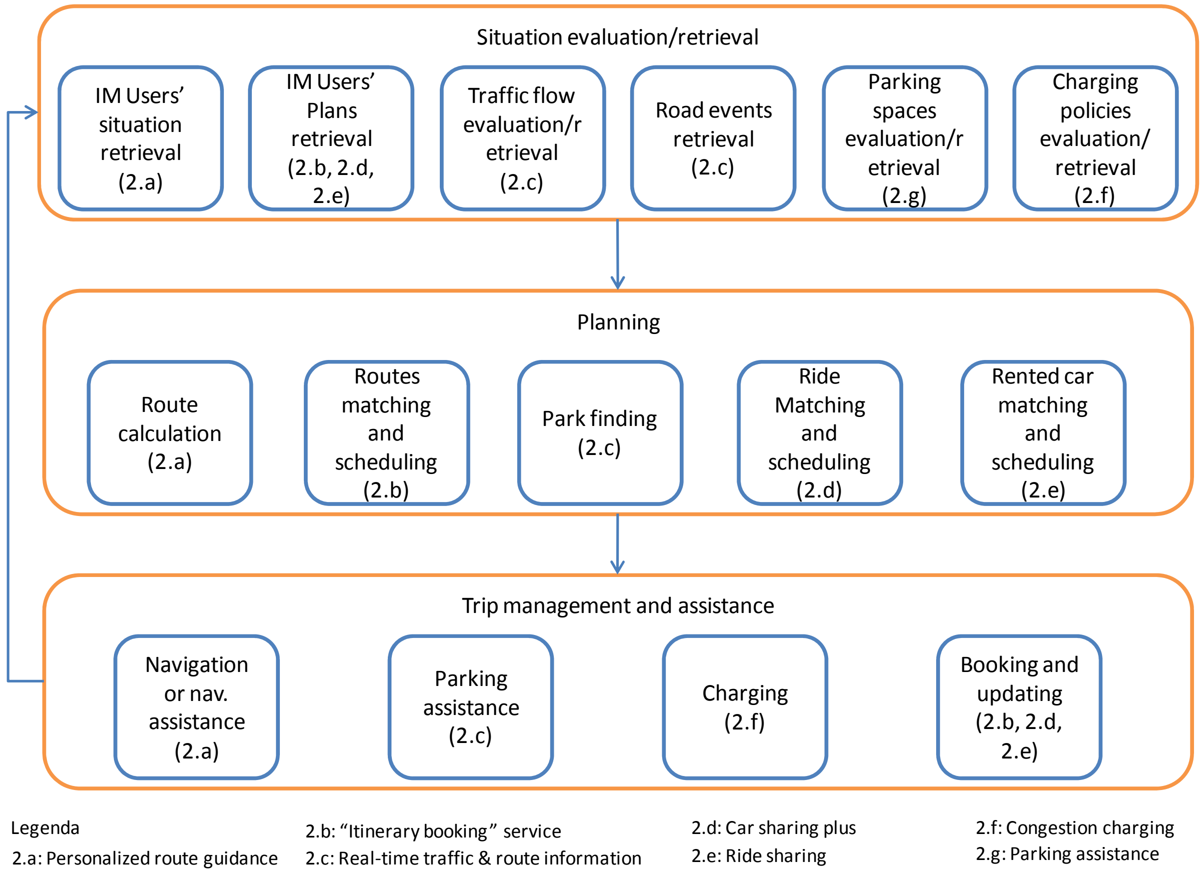



Figure 23 – preliminary outline of services and related tasks within the scenario

As can be seen, the scheme is divided into three groups of tasks:

- Situation evaluation/retrieval: preliminary tasks to obtain the needed input data from the multitude of factors coming into play.
- Planning: tasks to find the best solution for a given request
- Trip management and assistance: tasks dealing with the provision of the service, i.e. the resulting action towards the end-user.

Within each group, where possible a single task is assigned to one specific service. In two cases ("IM Users' plan retrieval" and "Booking and updating") three services are involved (itinerary booking, car sharing, ride sharing) because they represent three different ways of travelling the combination/complementarities are still to be defined.

In the end, it can be foreseen that the system is composed of modules (tasks) coming into play in combination at different stages, indicatively following the flow outlined in the picture.

IT should be highlighted, that the tasks this representation does not specify the actual service architecture and it does not make any assumption on the components performing given tasks. For instance, route calculation can potentially be a combination of on board and off-board software modules exchanging route requests, plans and updates. Further relationships between tasks and services will be clarified at a later stage.

### 3.1.6 Summary of main actors and roles, and affected stakeholders

Hereafter, the list of main actors directly or indirectly involved in the services and their high-level role is reported.

| Main actors | Roles |
|---|---|
| *End-user* | The user can be a driver (car owner, car user) or a passenger. The user feeds profile and needs to the system. The user interacts with the system for accessing and utilising the service. The stakeholders can private users, as well as associations and communities. |
| *Service provider* | It provides, manages and updates the running services and related data on the server side. The service stakeholder can be a private or public company directly operating the service or outsourcing its provision and maintenance. The stakeholder for implementation is likely a software provider or system integrator. |
| *Client (or client interface) provider* | It provides the interface to the service.<br>It could likely be the same company as the service provider or the nomadic application provider. |
| *Nomadic device application provider* | Provides, manages and updates the nomadic device application<br>It could be the nomadic device provider itself or another software house. |
| *Vehicle OEM* | It integrates the On board unit on the car. It provides vehicle data and features for in-car usage of the application. It can be a car maker or a first level supplier. |
| *Road and parking infrastructure manager* | Operating and maintaining road infrastructure and providing relevant information (e.g. traffic flow across a stretch of road, transits, parking availability, etc.). It can be a public/private infrastructure owner or manager. |
| *Map provider* | Provides updated maps for planning and navigation.<br>Can be a private digital map company or a public body providing digitalised map data. |
| *Traffic Information provider* | Provides updated traffic information. |
| *Content provider* | It provides digital content relevant to the services, e.g. Points of Interest |
| *Public Authorities* | Responsible for regulation, traffic flow, traffic data monitoring. Typically provide input data and policies. |
| *Other Instant Mobility Services* | May influence input data and avail of output data from the services of scenario 2. |

### 3.1.7 Expected benefits

Overall, the main expected benefits are

- A more efficient planning by the end user, thanks to the booking of itineraries (both individual or shared) and parking slots. In their plans, users are no more relying just on their common sense or on generic advice and information, rather they are assisted by a service optimising their trip.
- A reduced user workload to plan, book, navigate, manage payments, as the system will take care for these operations during the whole trip, thanks to a constant and transparent interaction between the user's terminal and the central system
- A more homogeneous distribution of traffic in time and space, reducing congestions, emission, pollution and consumption at the root.
- A general improvement of traffic and event management, especially in terms of flexibility and reaction to contingencies, thanks to a real time re-routing system based on both traffic conditions and on the gathering of users' trip plans.
- An easier deployment of all the new mobility support systems (trip navigation, car sharing, ride sharing, park finding, free flow charging, traffic management, etc.) which are currently in an experimental phase but need a technology improvement to become more flexible and reactive to the events happening in real conditions. This improvement can be given by the internet of the future.

## 3.2 Service 2.a: Personalized route guidance

**User case**

The user of this user case lives and works in Brussels. He has to go to Lyon in France for his job. This trip is urgent and not planed. So he decides to take his car and use the guide system integrated in his vehicle. He sets the destination and his preferences, and starts the journey.

Later, he's arriving near Paris, when his guidance system suddenly changes the itinerary. The system is aware of a huge traffic jam on the highway A1 thanks to its real time connection to the central service of personalized route guidance. So it decides to guide the users to highway A104. The two highways have the same size, so the system knows that this will not create another traffic jam.

A few km further, the user guidance system is informed by its real time connection to the central server that an accident occurred and that it's necessary to change the itineraries of the users circulating on this highway. But this time, there are no more highways available. Therefore, the central guidance service decides to dispatch the drivers on small roads. Thanks to its precise database it calculates how much drivers can take different roads in order to avoid traffic jam and maintain fluidity.

A few minutes later, our user found his original itinerary. His integrated guidance system has avoided an important waste of time.

### 3.2.1 End-to-end service chain

In this user case, most of the drivers use system guidance compliant with the instant mobility project service. That means it is always connected to a central server. In a perfect world, 100% of the vehicles are equipped with this system.

Service consumption

- The user sets the system guidance with the destination and eventually with his preferences.
- The user starts his trip following the instructions of his guidance system.
- Based on is preferences, the user is eventually invited to validate the choice(s) of new itinerary by the guidance system

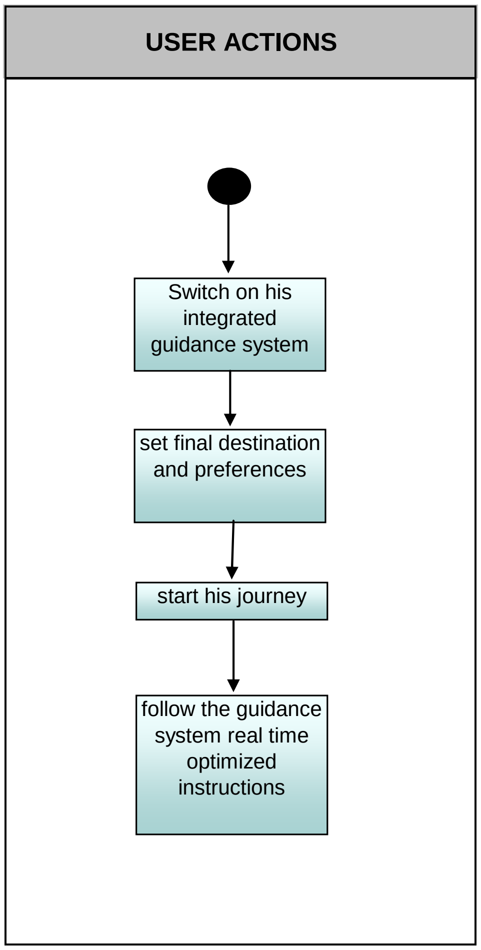



Figure 24 - Service delivery for users; Personalised route guidance

Service delivery:

- The embedded autonomous route guidance system is real time connected to an instant mobility service. It sends its calculated itinerary once, and regularly its position and other pertinent information (average speed, instantaneous speed, timestamp, etc …).
- So the instant mobility service is real time aware of the overall traffic and can calculate the occupation rate of the roads. Moreover it collects traffic information by the traditional ways like public authorities, highways providers, etc …, to be more precise.
- Because the maps database is very accurate, the instant mobility service is able to estimate the maximum occupation rate for each road.
- When a problem occurs, like an accident, traffic jam, roadworks, etc …, the instant mobility route guidance service can send a new itinerary to each vehicle route guidance system. Optimizing each individual itinerary permits to fluidize the overall traffic.

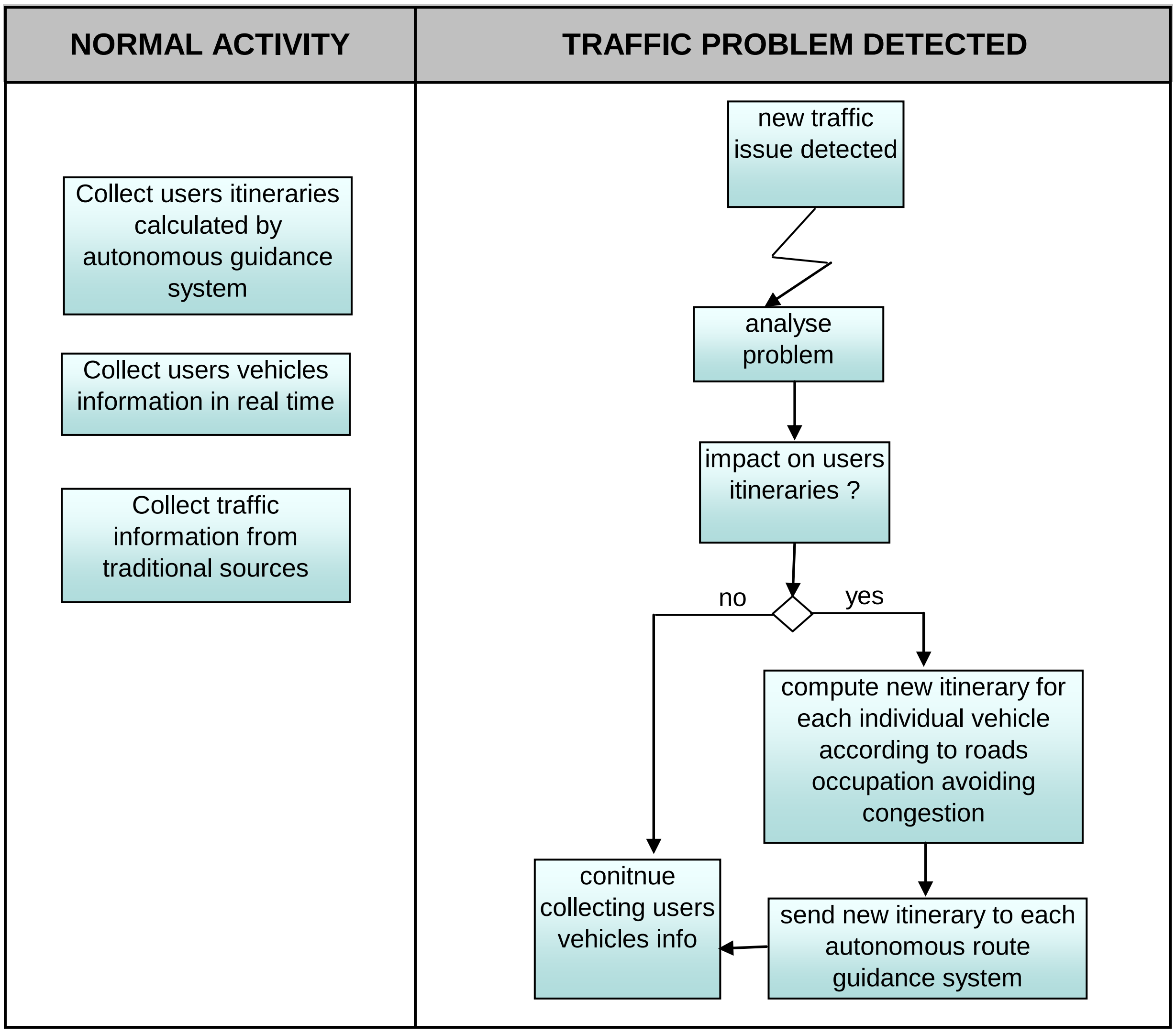



Figure 25 - Service delivery of personalised route guidance

*Service capability comparison description (today, future)*

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| [General] Autonomous route guidance systems already exist. | |
| [Autonomous route guidance systems] Can receive real time traffic information. | Instant Mobility Autonomous route guidance systems are able to send to Instant Mobility route guidance server, users and vehicles information. |
| [Autonomous route guidance systems] Can calculate new itinerary in case of traffic trouble. | Instant Mobility Autonomous route guidance systems will receive from Instant Mobility route guidance server traffic information and new itinerary to avoid route issue and congestion of overall traffic. Based on local policies requirements may be forwarded to drivers. |

### 3.2.2 Service components

| Nr | Name | Description and role | Comments | Involved actor |
|---|---|---|---|---|
| 1 | Vehicle autonomous route guidance system | It enables the user to plan his itinerary and guide him to destination according user preferences. | It is a vehicle provider device. | Automotive constructors. Hardware and software designers. |
| 2 | Instant Mobility route guidance server | It collects all the vehicles pertinent information.<br><br>It collects all the users itineraries.<br><br>It collects the maximum traffic information using all the available sources in real time.<br><br>It communicates to vehicle autonomous route guidance systems, traffic information and itinerary changes. | It is a server on the internet. All vehicle autonomous route guidance systems communicate with it. | Network designers, database designers. |
| 3 | Traditional info traffic sources | Send in real time traffic information. | | |

### 3.2.3 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| 1 | End-user | Follow the vehicle autonomous route guidance system instructions. | |
| 2 | Vehicle | Provide itinerary plan service. | End-user. |

| | | | |
|---|---|---|---|
| | autonomous route guidance system | Provide video and/or audio instructions to the driver.<br>Collect real time vehicle information.<br>Exchange data with Instant Mobility route guidance server. | Instant Mobility route guidance server. |
| 3 | Instant Mobility route guidance server | Collect overall vehicle information and traffic information from traditional sources.<br>Calculate new itineraries depending on traffic issues avoiding congestion and optimizing user trips. | Vehicle autonomous route guidance system.<br>Traditional info traffic sources. |
| 4 | Traditional info traffic sources | Send in real time traffic information. | Instant Mobility route guidance server. |

### 3.2.4 Data: data flows, databases

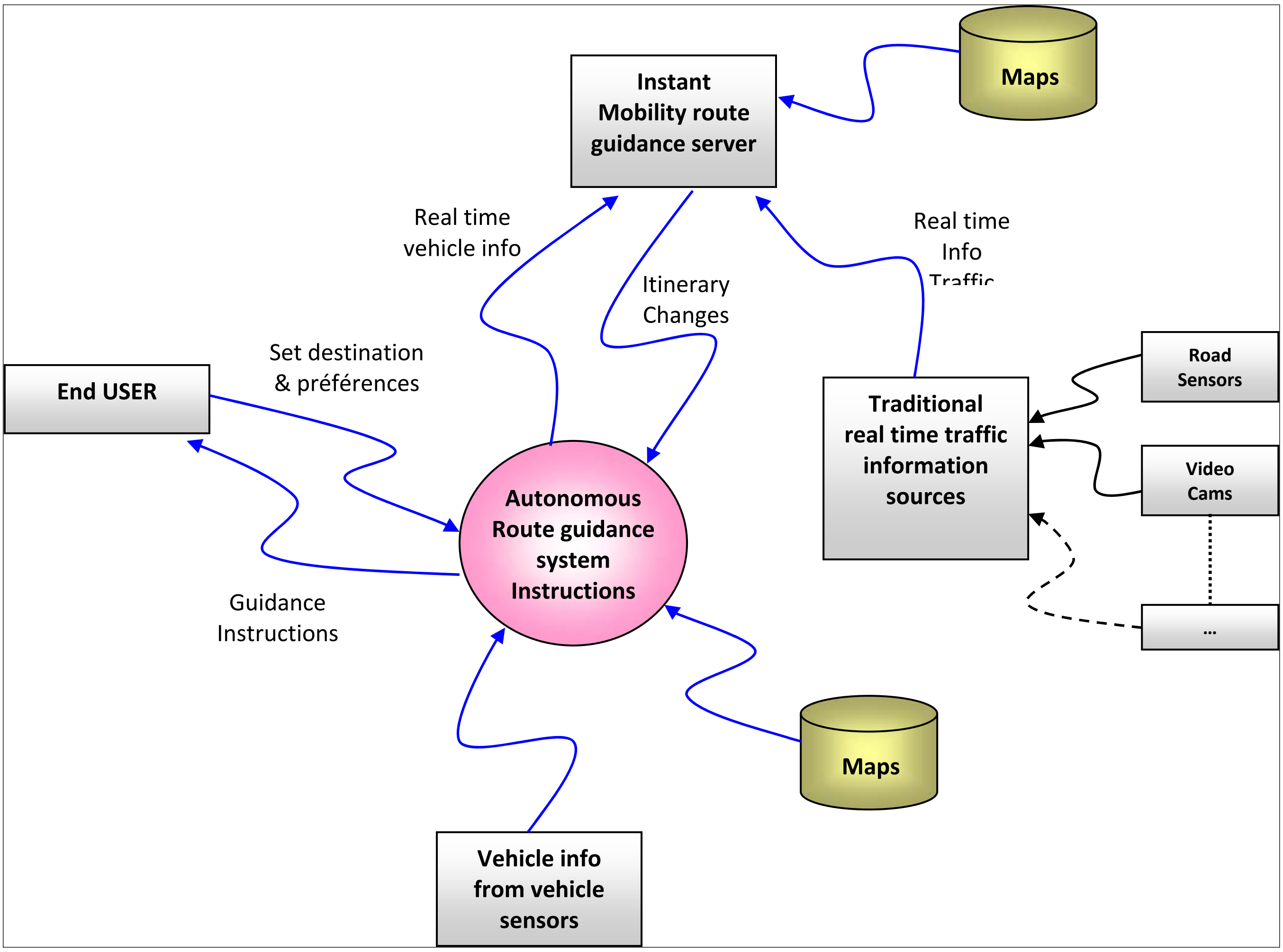



Figure 26 – Autonomous route guidance data flow

The autonomous route guidance system only needs from user its destination and preferences. Integrated maps database permits to calculate an optimize itinerary to reach the destination. Then it displays and/or tells the instructions.

On the other hand, the system can communicate with an instant mobility route guidance server. It sends information about the user itinerary and real time data about the vehicle. The server receives real time traffic information from other sources like road sensors, video cameras, etc. It can use his maps database to send deviation instructions to the overall vehicles in case of traffic trouble.

### 3.2.5 Expected benefits

The main improvement of this service compared to the existing systems is the fact that the integrated autonomous route guidance system can communicate in real time with a server which is able to give its instructions to avoid traffic issues. Meanwhile, this server collects information of the overall traffic. In case of appearance of a traffic trouble, the server can dispatch the traffic according to the size of the roads, optimizing the itineraries and avoiding congestion.

### 3.2.6 References: other projects, actual services etc.

Today's services:

- http://www.navteq.com/
- http://www.tomtom.com
- http://www.garmin.com
- http://eu.mio.com

## 3.3 Service 2.b: "itinerary booking" service

The user is considering driving to the city centre on Saturday afternoon to go shopping. He knows he will need his car, because he/she will have many packets and bags to bring home.

Some days before, he decides to plan his/her mission. Hence, he/she spends some time browsing over the Internet to find all the shops where he/she would like to go.

In order to do that, he logins into a portal he/she previously had subscribed to. Among all possible services offered, the User can find the possibility to locate all such destinations and to add them – as bookmarks – to a personal map.

Once all destinations have been identified and inserted into the map, the User can decide (either manually or – if possible – automatically, selecting upon suggestions made by a specific functionality offered by the Service Provider) where he/she would like to drive to in order to start his/her mission.

### 3.3.1 End-to-end service chain

Service consumption

If the User decides to book his/her itinerary, he/she is asked to fill in a form with some information useful to correctly plan the trip, such as:

Requested final destination

Estimated departure time / desired arrival time

Other preferences (max. walking distance from the parking area to the final destination)

Thus, the Service Provider processes the request and – through the same Web Portal – gives an immediate feedback to the User, such as:

the availability of parking areas in the nearby (with the possibility of booking a parking lot: see dedicated Use Case)

Information about traffic restrictions in the selected time slot

Information about any possible roadworks or events impacting traffic conditions and viability in the area

The possibility to synchronize his/her online calendar (both on a selected server and on his/her mobile) with the mission just configured

Finally, the Web page informs the User that the booking procedure was successfully completed and that he/she will be provided with a detailed travel plan before the departure time.

In advance with the time of departure, the User receives an message that informs him/her that his/her travel plan is available and that he/she can either check it accessing his/her personal page on the Web Portal or download it on his/her mobile, in order to use it also with the navigation application available.

Finally, the trip can take place: the user starts the navigation application on his/her mobile and follow the instructions provided until he/she reaches his/her destination.

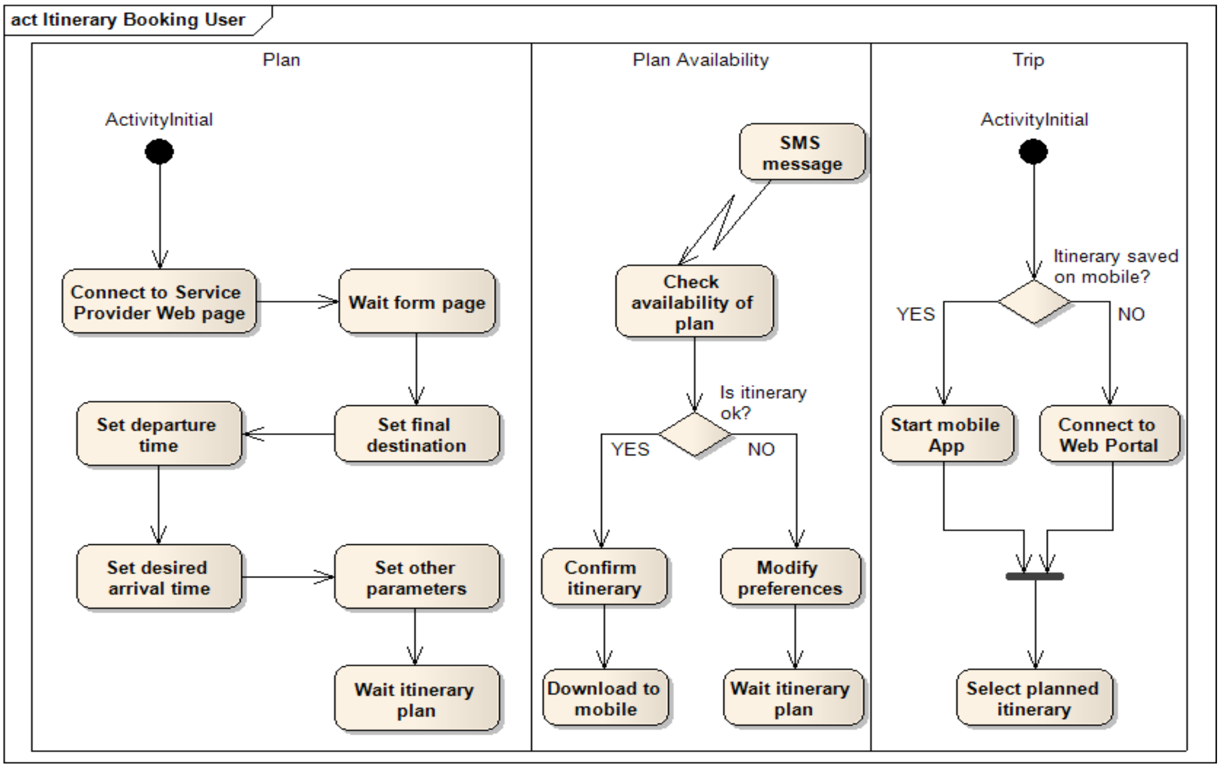



Figure 27 - Itinerary booking from the user’s perspective

Service delivery

Meanwhile, the Service Provider collects and processes all requests – related to the same city area for the same time slot – made by different Users and, using traffic management algorithms, calculates the best routes for each of them to reach their final destination (or – at least – the nearest parking area available, taking into account existing traffic restrictions). These routes are calculated in order to optimize not only travel distance/time (like traditional navigation systems) but also traffic balancing, thus preventing that all Users access the same city area through the same roads.

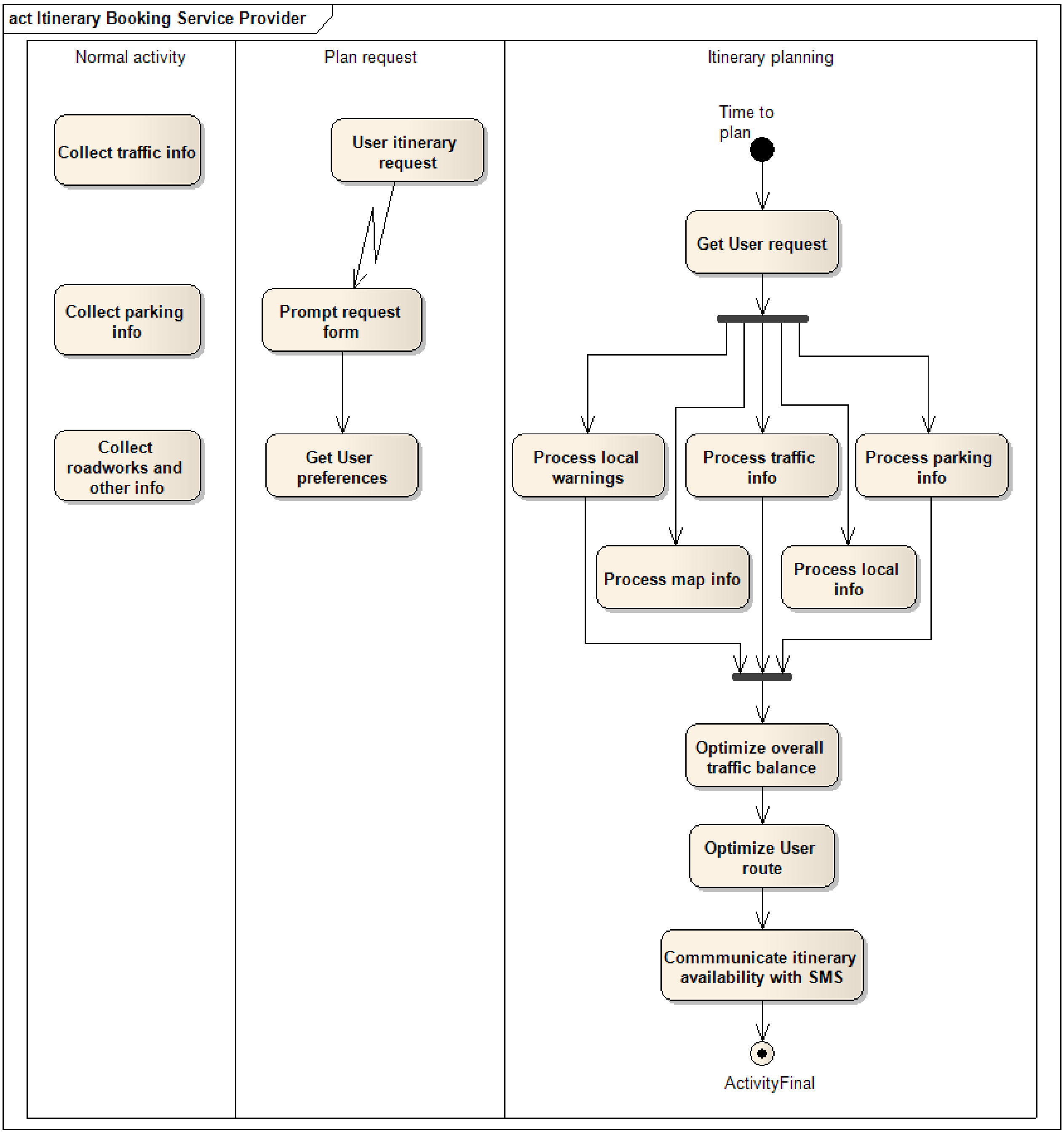



Figure 28 - Itinerary booking from the Service Provider's perspective

### 3.3.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| [General] Booking services exist for collective transport, tourism, specific business applications. | Instant Mobility itinerary booking service is meant for everyday mobility needs in private, individual transport. |
| [Booking client, Booking service centre] No specific itinerary booking service exists for private transport. | The itinerary booking client and service centre of Instant Mobility will allow the users to schedule private/individual journeys, optimising them with respect to the specific point in time, situation and needs. |
| [Booking service centre] Nowadays, examples can be found of optimised route-finders with respect to user preferences, profile and traffic conditions. | At the booking service centre the route-finder and planner based on the aggregation of data currently available, *plus* the user specific planning of multiple destination (e.g. set of POI) *and* the schedule of other users *and* the real-time knowledge of specific events affecting the schedule (e.g. booking cancellation) |
| [Nomadic device application] Currently the navigation systems are detached from booking services. | Navigation will avail of the booking service data, providing a route based on the Booking service centre planning. Furthermore, there will be feedback from the application to the Booking service for (anonymous) journey updates, needed for the booking service. |
| [On board unit] Vehicle data are not available for this kind of internet-based services. | Vehicle data will be available for dynamic itinerary allocation. |

### 3.3.3 Service components

| Nr | Name | Description and role | Comments | Involved actor |
|---|---|---|---|---|
| 1 | Itinerary booking Client | It enables the user to book and download the itinerary | It is on a device of future internet accessible to the end-user. | Software provider |
| 2 | Itinerary booking Service centre | It collects and processes all requests and plans all the routes based on several information sources | It is on the service centre | Map provider, routing service provider |
| 3 | Nomadic device application | It enables the user to be guided to destination<br><br>It provides (anonymous) data feedback to the Service centre for overall planning updates (based on mission/trip completion) | It is on a nomadic device, which can be connected to the vehicle system | Nomadic device provider, vehicle OEM |
| 4 | On board unit | It enables connectivity to car info-tainment system, e.g. for utilising car HMI<br><br>It enables car data provision, e.g. to the service centre | It is a sw macro-component which is installed on the on-board telematic system and represents the gateway between vehicle system and Instant Mobility | Vehicle OEM |

### 3.3.4 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| 1 | End-user | Registers<br>Logs-in<br>Plans and books the trip<br>Cancels/modifies plans and bookings<br>Performs the trip | Service provider |
| 2 | Itinerary booking<br>Service provider | Provides, manages and updates the running service, on the server side<br>(e.g. scheduler, trip planner) | End-user(s), Map Provider, Traffic Information provider |
| 3 | Itinerary booking<br>client<br>provider | Provides the interface to the service (it could be a sw provider in case of a local application or the same service provider in case of a browser-based service) | Service provider, Nomadic device application Provider |
| 4 | Nomadic device application<br>provider | Provides, manages and updates the nomadic device application | End-user, Map provider, Itinerary booking service provider, Itinerary booking client provider |
| 5 | Vehicle OEM | Provides On board unit<br><br>Provides vehicle data and features for in-car usage of the application | Nomadic device application<br>Provider |
| 6 | Map provider | Provides updated maps for planning and navigation | Itinerary booking service provider<br>Nomadic device application<br>provider<br>Location Based Content provider |
| 7 | Traffic Information provider | Provides updated traffic information to Itinerary booking<br>Service provider | Itinerary booking<br>Service provider |
| 8 | Location Based Content Provider | Provides updated Location Based Contents | Map Provider, Itinerary booking<br>Service provider |
| 9 | Public Authorities | Provide information about roadworks, events, etc… | Itinerary Booking Service Provider, Traffic Information provider, Map provider |

### 3.3.5 Data: data flows, databases

In Figure 29 the Data Flow Diagram of the Itinerary booking service is depicted, from the Itinerary Booking Service Provider perspective. In the diagram the rectangles represent the *actors* involved in the operations related to the booking of an itinerary, while the circles represent a *process* carried out by the Itinerary Booking Service Provider; the arrows correspond to the *flow of information* from one part of the system to another one and the component delimited by the two bold lines are the **database** or data store.

Looking at the scheme, the procedures logically start from the *End User*, who would like to request an itinerary to go from a starting point to a certain destination; moreover the user can specify some other preferences and parameters.

The *requested itinerary* data are fed into the process *Receive Booking Request*, which then updates the **User Profiles** database with the *user data* and the **Itinerary Requests** database with the specific *request details*.

In parallel and independently from the user requests, three more actors are involved in the overall system:

- the *Map Provider*, which continuously updates the **Maps** database with the *map updates*,
- the *Traffic Information Provider*, that monitors the road system in order to provide the *traffic updates* to the **Traffic Info** data store,
- the *Location Based Content Provider*, which keeps track of the *local info updates*, communicating them to the **Local Info** database.
-

When the *Itinerary Booking Service Provider* determines, based on its own algorithms and logics, that it is time to plan the itinerary of the *End User*, it requests all the needed information from the different database systems, i.e.:

- the *request*, from the **Itinerary Request** DB;
- the *user preferences*, from the **User Profiles** DB;
- the *updated map info* from the **Maps** data store;
- the *updated traffic info* from the **Traffic Info** DB;
- the *updated local info* from the **Local Info** DB;
- the *local warnings* from the **PA Info** database.

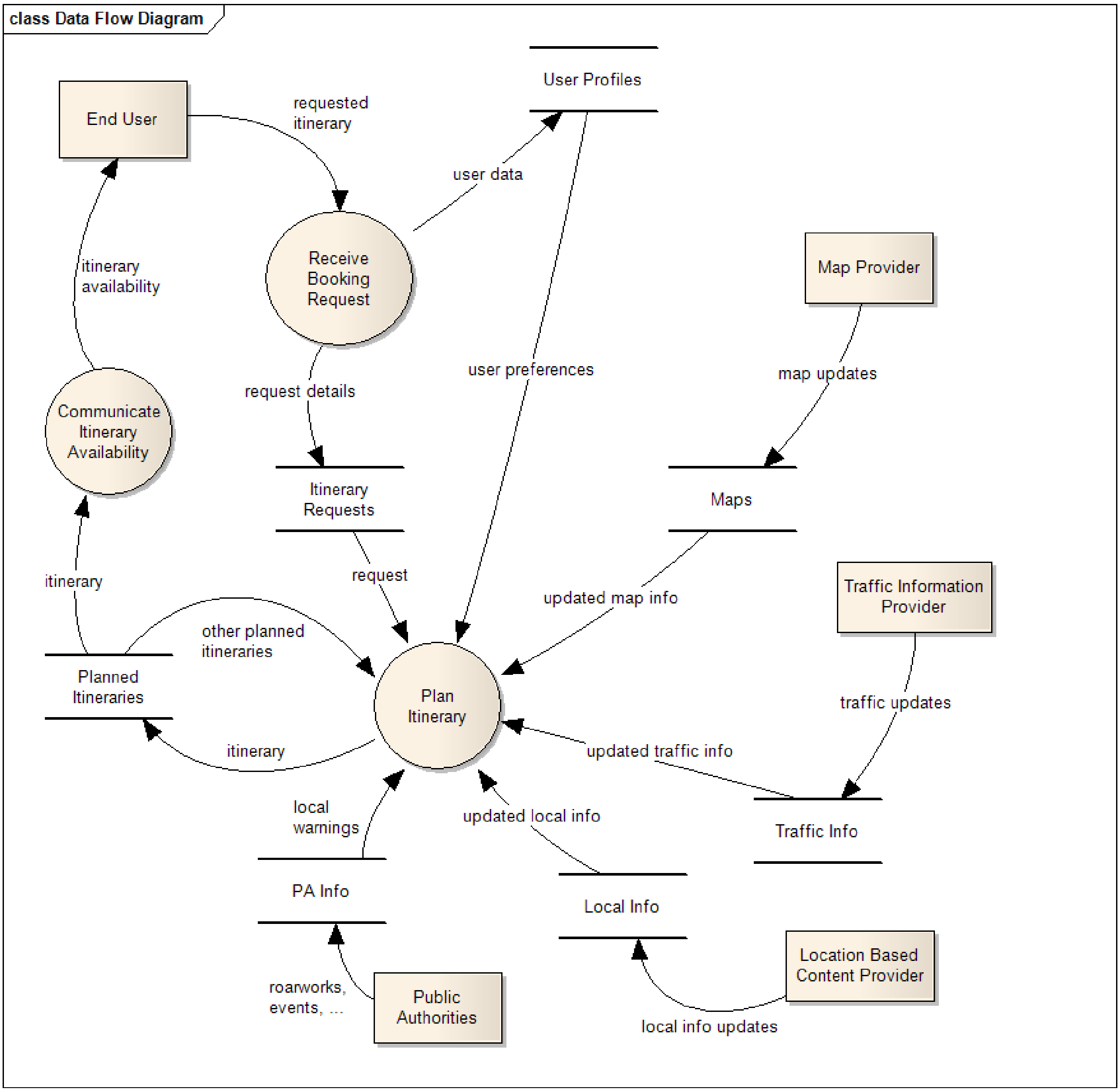



Figure 29 - Data Flow Diagram of the Itinerary booking service

All these data would allow the Itinerary Booking Service Provider to optimize the itinerary of the single user who asked for the route, in a traditional way. An important improvement given by the Plan Itinerary process is the optimization of the overall traffic situation obtained thanks to the usage of the other planned itineraries from the Planned Itineraries data store. In this way, the itinerary planned for a certain user takes into account not only the real-time information but also the information on the itineraries already planned by the other users. It is thus possible to establish in advance how much the booking service contribution will weigh on the overall traffic at a given time on given roads, by planning the itineraries of the End User according to the already planned routes and the allowed traffic on the specific road.

When the itinerary is planned it is then saved in the Planned Itineraries and then the process Communicate Itinerary Availability is performed in order to inform the End User of the availability of his/her planned itinerary; this could be visible on the Web Portal of the Service Provider or downloadable on the user mobile device.

#### 3.3.6 References: other projects, actual services etc.

- ACTMAP
- FEEDMAP
- CVIS

## 3.4 Service 2.c: Real-time traffic & route information

Real-time traffic is considered the most important feature of navigation services, it is a constantly growing source of information, as traffic congestion is increasing, waiting time and fuel consumption increase, globally traffic information users expected to grow from 57 million in 2010 to more than 370 million in 2015 (ABI Research).

NAVTEQ proprietary research shows that traffic-enabled users spent 18% less time driving on average than those without navigation. On an annual basis, this time savings would amount to 4 days less on the road!

By delivering detailed information about the speed that traffic is moving and incidents occurring along the route such as accidents or obstacles enables navigation devices and drivers to display it on the map and to make smart routing and re-routing decisions and delivery of most accurate arrival time estimates.

Commercial and consumer GPS probe data (vehicle and mobile) are dramatically growing in quantity and availability. These data are pooled on Internet, mashed-up with other sensor data to give real-time traffic conditions over full road network including secondary roads.

#### 3.4.1 Real-time traffic & route service chain

This service aims at delivering accurate and precise traffic information via mixing several sources of data inputs: probe data, sensor data, incident data (including congestion) and historical data.

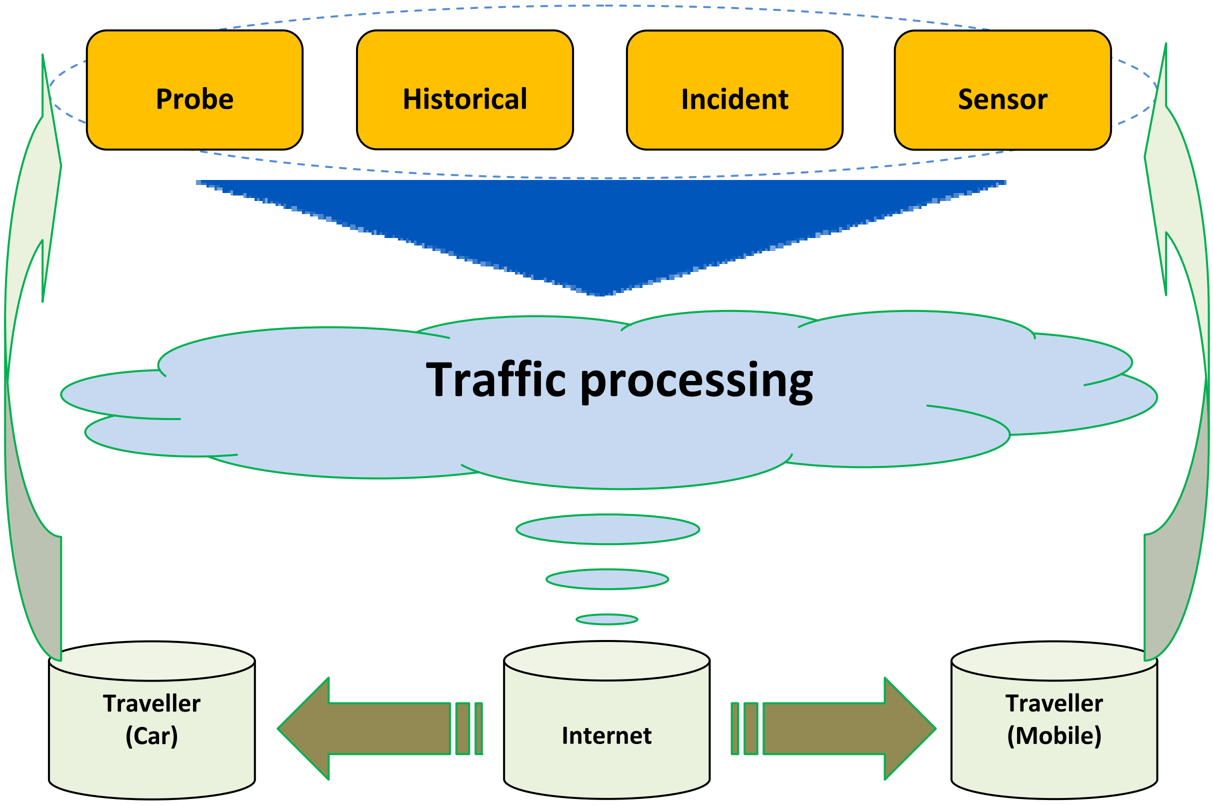



Figure 30 Real-time traffic service chain

This figure shows the real-time traffic service chain. The service consists of the integration of various traffic sources from a range of comprehensive data inputs:

- Probe data from commercial fleets, private drivers and mobile devices
- Historical collected traffic data
- Incidents happening en route such as accidents or road works, etc...
- Fixed and mobile sensors along the road

The collected traffic inputs are then entered into data models to be processed and further podcasted via internet, vehicles and mobile devices.

The traveller is feeding back the data sourcing by its probe data input and incident reports.

### 3.4.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Public authorities are requesting severe anonymous measures of the collected probe data which is adding extra restriction on it | Highlighting the importance of less restriction on probe data by public authorities and enhancing probe data collection methods will allow for even higher traffic coverage and more precise information |
| Travellers are mostly receiving late traffic info | Via connected traffic services travellers will be offered easy, ubiquitous, and seamless access to info-mobility services |

### 3.4.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Probe data | Collected GPS points | Direct input to data models and processing | |
| Historical data compilation | Historical build up of sensor and GPS data | Direct input to data models and processing | |
| Incident data | Accidents, road works, congestion info | Direct input to data models and processing | |
| Sensor data | Fixed and mobile sensor devices along the route | Direct input to data models and processing | |
| Traffic processing | Data models and processing technology | Running highly advanced calculation models to produce final traffic info | |

### 3.4.4 Actors, their roles and relationships

| *Nr* | *Name* | *Main actions* | *Relationships within the service* |
|---|---|---|---|
| *1* | *Traveller* | *Has dual role:*<br>*Receive and use the info*<br>*Real source of probe data by moving around and using his car, mobile, etc...* | *Service provider* |
| *2* | *Service provider* | *Receive and provide traffic info to travellers using their connected devices* | *Traveller* |

### 3.4.5 Data: data flows, service implementation

- On the one side the real-time traffic service is receiving continuous flow of data via several channels, on-board units, moving mobile devices, fixed and mobile road sensors and en route incidents reports
- On the other side the service is continuously updating other services (Instant mobility route guidance, itinerary booking service, congestion service, etc...) with up to date information about traffic conditions

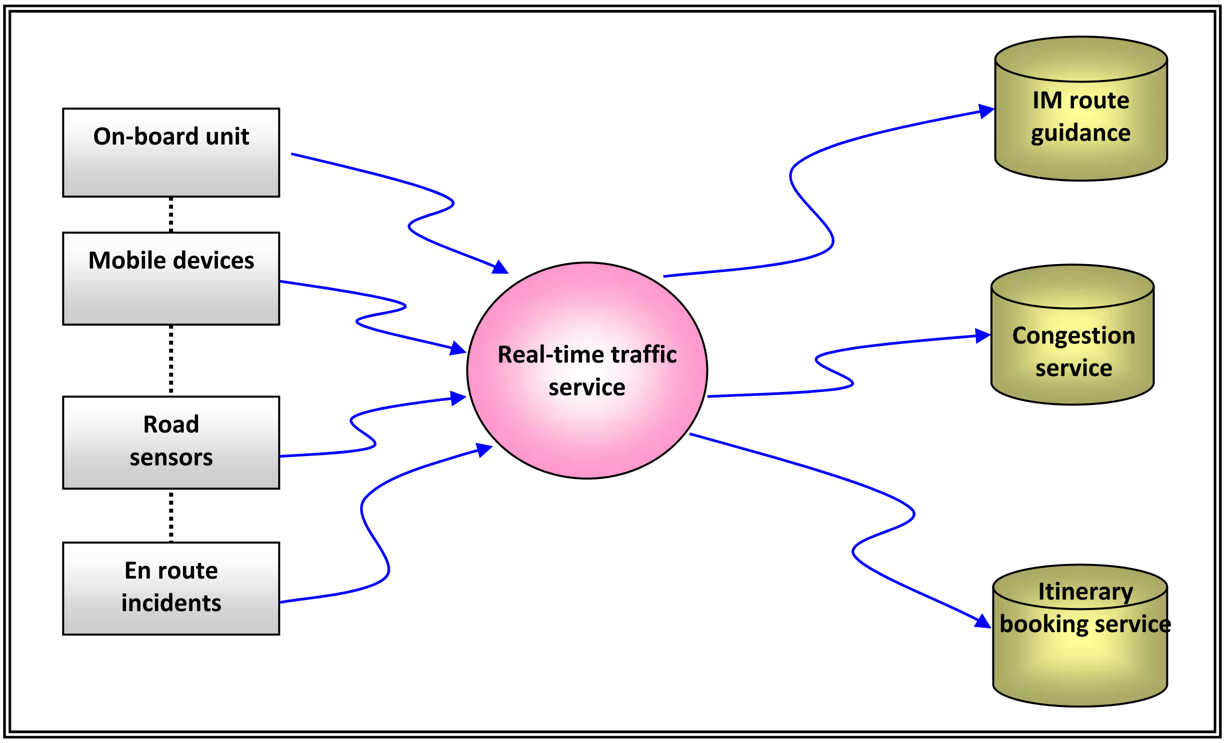



Figure 31 - sketches the flow of data and service implementation

### 3.4.6 Expected benefits

- Enhance route calculation for the traveller by having improved, more coverage service.
- Up-to-date information service will help to re-route the traveller more accurately and save more $CO_2$ emissions.

## 3.5 Service 2.d: Car sharing plus

Under Discussion

## 3.6 Service 2.e: Ride sharing

User case

The user A is planning his journey of the next day. He'll have to make an unusual business trip approximately 50km from home.

This user has a special account in order to share his journeys. When he created this account, he defined his profile and the profile of the users he wants to travel with.

Then he connects to a web site to plans his trip. The itinerary plan service will give him the best way in the best conditions to reach his destination. When he validates the result, he chooses to eventually share his journey with another user, because this web site is compatible with the instant mobility ridesharing service. So, he fills a web form of this site, dedicated to the ridesharing with the details he can accept to share his trip (driver/passenger, max deviation accepted, free of charge or not, number of seats, etc …). He gives also his ridesharing service account information.

Later, another user, let's call him B, is planning his journey, in another itinerary plan service. Of course, this service is also compatible with instant mobility ridesharing service, and he chooses to share his trip too. So he can fill the options dedicated to the ridesharing like user A has done.

After each user has validated his journey and ridesharing data, each itinerary plan site can communicate with the instant mobility ridesharing server. This server stores the data and can analyse the possibilities of matching itineraries.

The server founds that the itineraries of user A and user B are compatible with the constraints they defined during the itinerary plan.

Therefore, the service contacts the users via its preferred means. And they can both connects to ridesharing service web page to analyse the proposition and to accept it.

At the end, both users will be able to make an appreciation in the ridesharing service site, about the trip and the other user. This data will be stored in the instant mobility ridesharing database for other users.

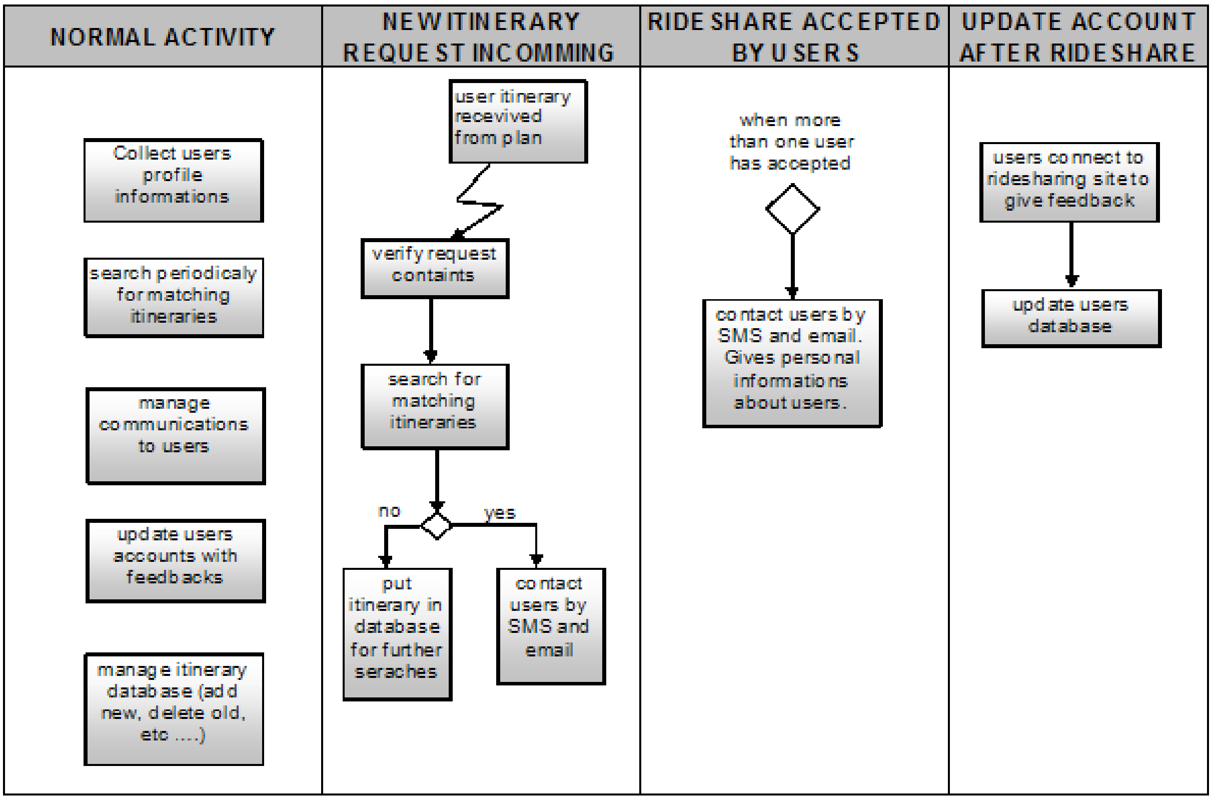



Figure 32 - New itinerary request flow

### 3.6.1 End-to-end service chain

Service consumption

The itinerary plan service has to be compatible with instant mobility ridesharing service.

All the users who want to use instant mobility ridesharing service have to create an account. Itinerary plan web sites can do it and can validate it with the ridesharing server.

It consists in filling a web form with some personal data and with some preferences:

- personal data (name, address, phone, email, …)
- profile (male/female, age, …)
- Personal focus (sports, movies, ...
- user profile criteria for ridesharing (this could be a profile or personal focus criteria, or one defined by user, for example, smoker or not, specific sport player, …)

Once the user has planned his journey, he can accept to share it, by validating an option on the form web page. If so, the itinerary plan service will communicate with instant mobility ridesharing service in order to verify the user account. If the user has no account, it can propose him to create one.

When the details of the trip are defined, the itinerary plan service will communicate them to instant mobility ridesharing service. Then instant mobility ridesharing server can analyse all the current trips in memory in order to find matching itineraries. If it finds one, it can contact the concerned users by SMS and by email for more details.

All the users will be able to check the details about the trip and about the other users. So he can accept or not to travel with. If they accept, the instant mobility ridesharing service will warn the other users by SMS and email, and give them the possibility to communicate directly.

During the ridesharing trip, some unexpected events could occur to a user. He could be late, wants to cancel his trip, have a car issue, etc. In that case, the user can connect to the instant mobility server via an internet connection with its mobile phone or another device to update the ridesharing page. Then the instant mobility ridesharing service is able to advertise the other users of the impact of the unexpected event by SMS and/or email.

After the trip, the itinerary plan service will give the possibility to the users to give a feedback about the travel and the other persons. This will be used to rank users and to add their feedback to their profile.

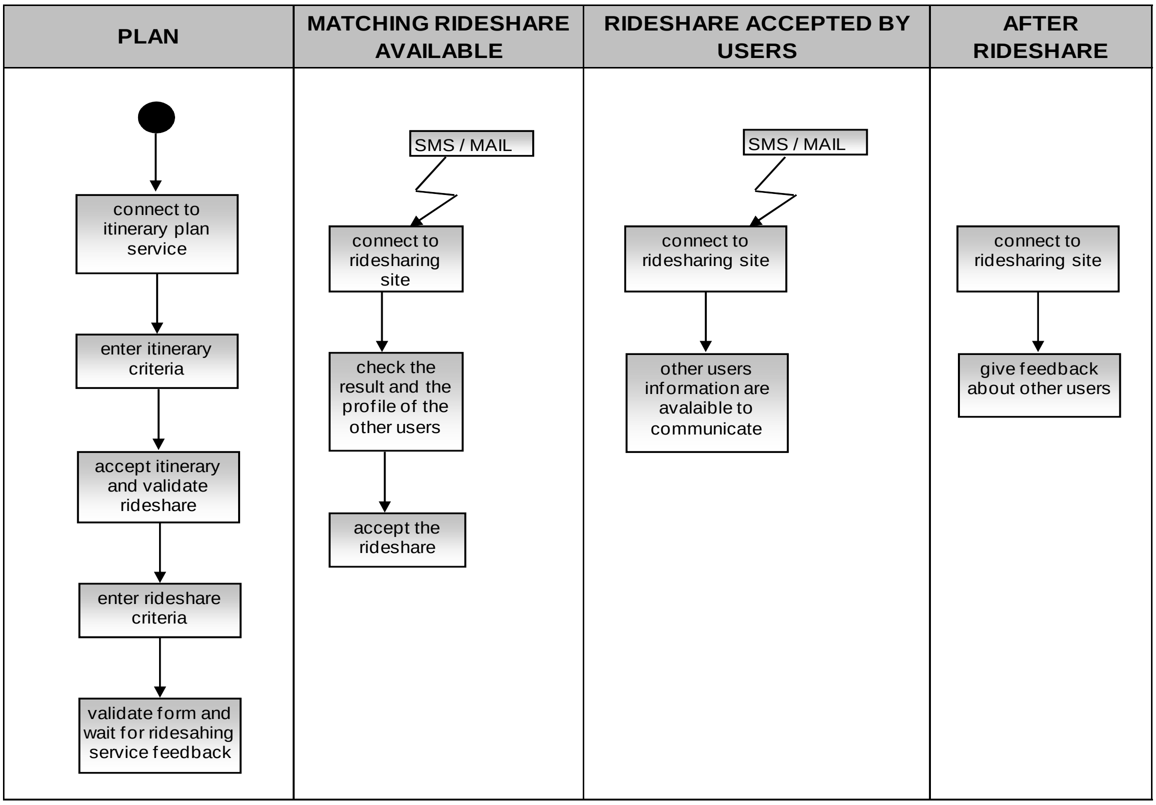



Figure 33 - Ride sharing from the User's perspective

Service delivery

The instant mobility ridesharing service

- gathers all the data about the users (profile, appreciations, ranking, etc …)
- gathers all the details about user trip in real time, these data is received from the different itinerary plan services.
- uses its resources to search for matching itineraries.
- warns the users and manages the exchanges between the users until they are agreed.
- is able to receive information from the users during the rideshare, and is able to warn the users if a modification is necessary, in real-time.
- gathers the trip feedback, updates the users profile with the ranking and the appreciations.

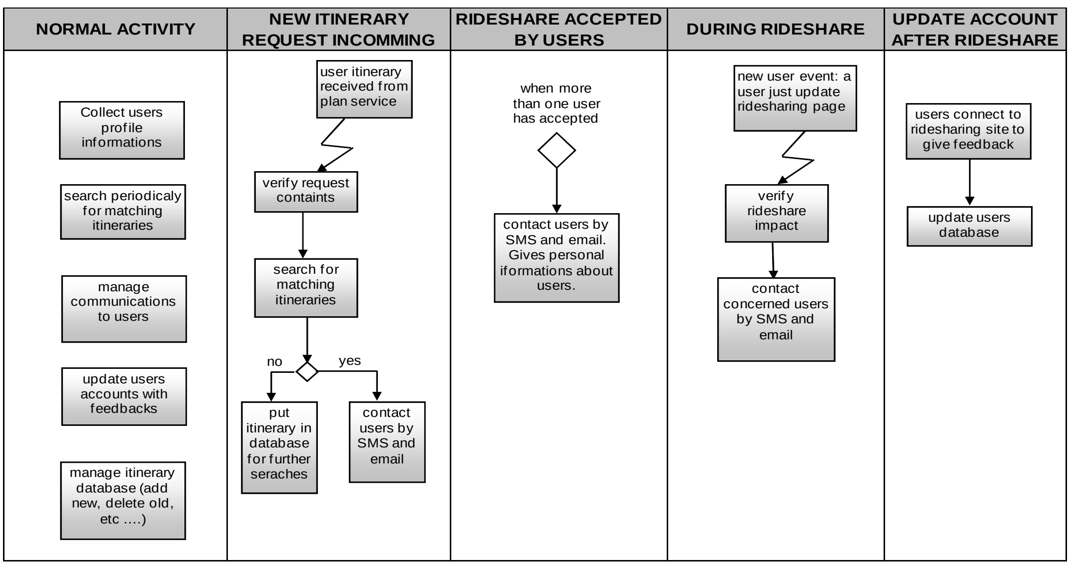


Figure 34 – Ride sharing from the Service Provider's perspective

### 3.6.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| [General] Ridesharing services already exist. Some web sites provides such services (www.rideshare.co.uk, www.erideshare.com, … | Instant Mobility ridesharing service is meant to be compatible with plan services and to propose automatically matching itineraries. |
| [ridesharing service] The user has to fill a form with departure and arrival point then he can check matching itineraries. | The instant mobility ridesharing service is requested by the instant mobility itinerary service. He only enters itinerary parameters one time. |
| [ridesharing service] The user has to check regularly for matching itineraries on the ridesharing site. | The instant mobility ridesharing service periodically searches for matching itineraries.<br>Furthermore, the service will contact the users when matching itineraries were found in real-time. |
| [ridesharing service] Once the itinerary accepted, the user has no more information in case of an event occur. | The instant mobility ridesharing service can always be updated by users, even if the trip has begun.<br>The service is able to contact users in real-time if necessary, by email or SMS. |

### 3.6.3 Service components

| Nr | Name | Description and role | Comments | Involved actor |
|---|---|---|---|---|
| 1 | Itinerary plan centre | It enables the user to plan his journey and send data to ridesharing server. | It is a web site.<br>It is independent of the ridesharing service. | Web designers. |
| 2 | ridesharing Service centre | It manages the users account.<br>It collects and processes all requests.<br>Periodically searches for users matching itineraries.<br>Manages the system contact (SMS, email, etc). | It is a server on the internet. All itinerary plan services can communicate with it. | Network designers, database designers. |
| 3 | Nomadic device application | It enables the user to be warned of the matching itineraries. | It is on a nomadic device, such a smart phone or a tablet pc. | Nomadic device provider |

### 3.6.4 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| 1 | End-user | Creates an account on the ridesharing service using a web interface.<br>Logs-in and plans the trip using a plan service and validates the ridesharing option.<br>Checks the real-time information given by the ridesharing service centre.<br>Performs the trip<br>Updates the ridesharing page in case of an unexpected event occurs.<br>Gives other users feedback to the ridesharing service using a web interface. | Itinerary Service.<br>Nomadic device. |

| | | | |
|---|---|---|---|
| 2 | Itinerary plan Service provider | Provides plan service.<br>Provides ridesharing option on the interface.<br>Provides a web form to be filled by the user with his preferences for this ridesharing trip.<br>Exchanges data with the ridesharing service server. | End-user UI.<br>Ridesharing service. |
| 3 | Ridesharing Service provider | Manages the user accounts.<br>Provides an UI to manage the user account creation.<br>Manages the requests from the itinerary plan services.<br>Searches for the user matching itineraries.<br>Contacts users by SMS or email when it finds matching itineraries.<br>Contacts users in real-time by SMS or email when an unexpected event occurs to a user.<br>Provides an UI to permit the users to give their feedback of the other users. | Itinerary Service.<br>End-user nomadic device. |

### 3.6.5 Data: data flows, databases

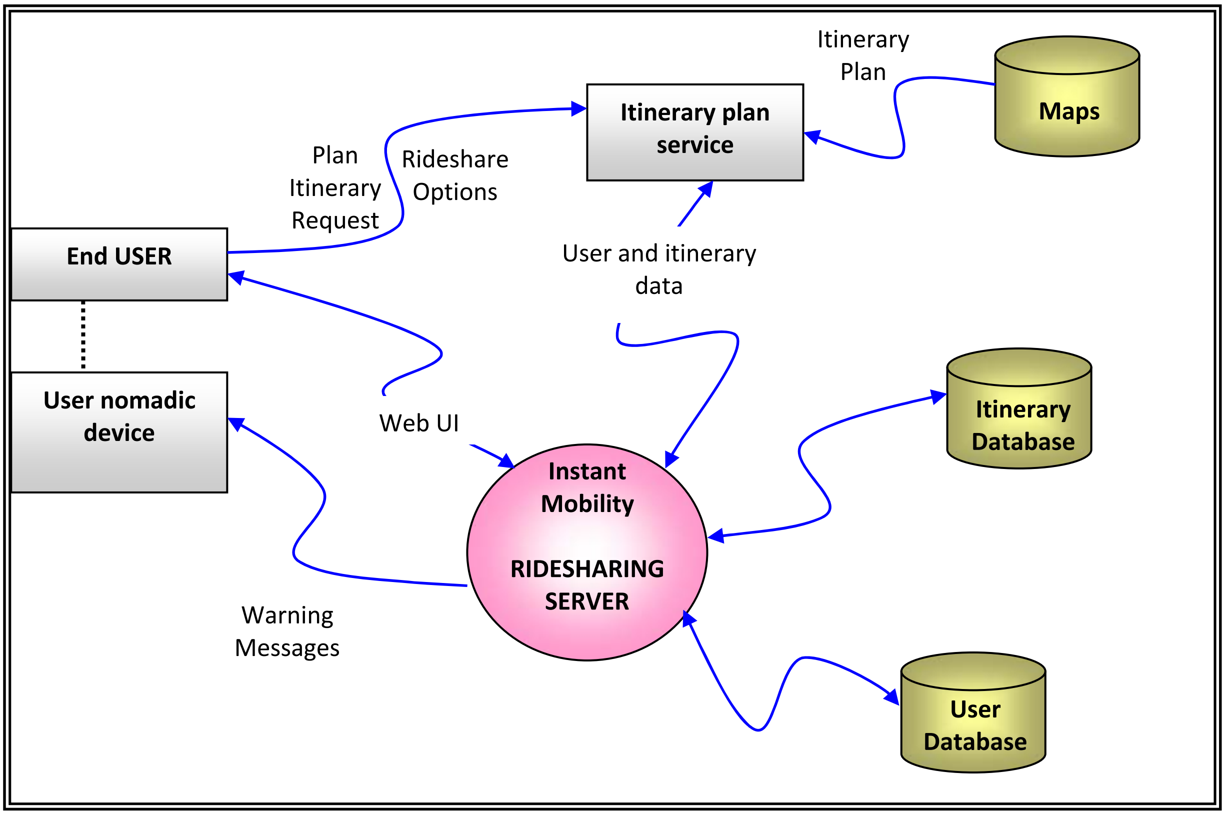



Figure 35 – Data flow diagram of the Ride sharing service

The maps database is not part of the instant mobility ridesharing service. It is used by the itinerary plan service.

The instant mobility ridesharing service needs 2 databases:

- The user database, which contains all the information about the users.
- The itinerary database, which contains all the users itineraries

Thanks to these databases, instant mobility ridesharing service can manage the requests from the itinerary plan service and from the user.

### 3.6.6 Expected benefits

The main improvement of this service compared to the existing systems is the fact that it is independent of the itinerary plan. The user can use his favourite itinerary plan service, if this one is compatible with instant mobility systems, he has nothing to do, eventually enter some preferences, and the system will manage all the search tasks and contacts the users in real-time.

Furthermore, the system is able to receive in real-time user notifications in case of unexpected events. Thus, it can contact in real-time the impacted users by these events.

With only one service which concentrates all the user itineraries, we can expect that the performances of the search results will be much better than today, with a lot of independent ridesharing services.

Another important point is the fact that it will be easy to improve and upgrade the system with minimum impact on the clients: users and itinerary plan services.

### 3.6.7 References: other projects, actual services etc.

Today's services:

- www.e**rideshare**.com
- http://www.rideshareonline.com/
- http://www.rideshare.co.uk/
- http://www.rideshareinfo.org/
- http://www.rideshare.org/NewHome.aspx

## 3.7 Service 2.f: Congestion Charging

Congestion Charging is today already present in many towns in Europe in several forms. The main concept is defining the borders of a traffic-critical area or a road corridor and allowing access only to paying vehicles; according to local implementations, there are exemptions for some kind of vehicles, like buses, taxis or vehicles belonging to people living in the restricted area. Congestion Charging service is carried out delimiting areas with signs, selling subscription stickers to be put under the wind shield and then checking violations manually or automatically with cameras at each entrance; there are towns (like Stockholm) with more advanced solutions making use of On-Board Units (OBU) for controlling access to restricted areas and Internet for handling payment.

Restricted areas are static, fare policies are fixed and applied indifferently to most drivers (exemptions for drivers with special needs already exist, but still on static basis), motorists coming from outside the town often find hard to understand signs and fares, a lot of effort must be spent in enforcement and assessment of the positive impact of the traffic restrictions. These drawbacks can limit public acceptance more than the charge cost itself.

In the Instant Mobility scenario, Congestion Charging is integrated with the other mobility services and is no more necessarily limited to a static area. Public authorities will be able to dynamically shape restricted areas according to rush hours, holidays, pollution level etc.; they will also be able to set up flexible access and pricing policies that really take into account the different drivers' needs and profiles.

Drivers will interact with the service in a very easy, fast and safe way using intuitive applications on their mobile terminals and will be charged for their effective road usage. They will have no more to bother about buying stickers or unintentionally violating restricted areas because information, payment, maps and navigation will be seamlessly integrated in the service.

In most cases the driver will have to pay for having the right to access a restricted road facility; since the payment procedure for a generic mobility service is detailed in Scenario 3, the related procedure and components are not here described in detail, even if they are mentioned wherever needed.

### 3.7.1 End-to-end service chain

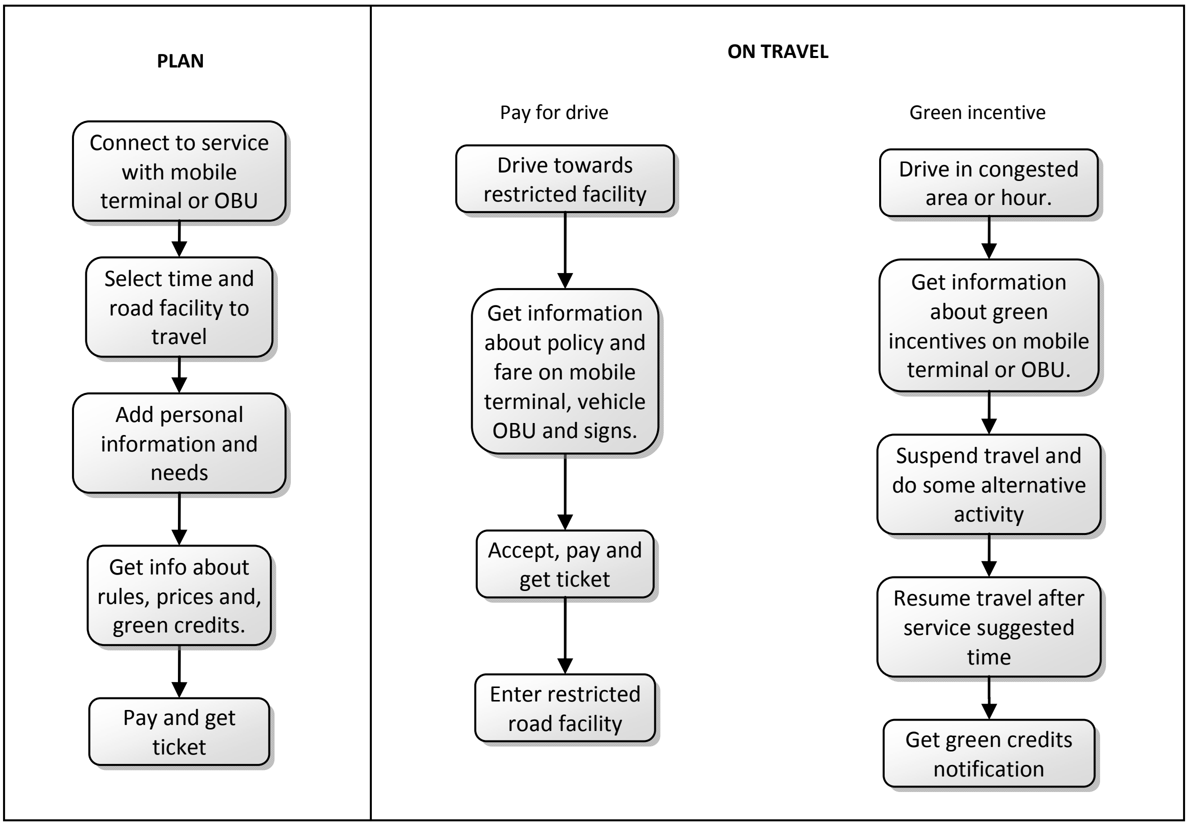



Figure 36 - Congestion charging from the User's perspective

The Congestion Charging service will be available on mobile terminals both before and during travel; it will also provide information to the End-to-End Itinerary Planner from Scenario 1. The picture above describes the service as seen from driver's perspective.

If the chosen route needs to use a critical road facility subject to Congestion Charging (e.g the town centre or a bridge), the driver will go through all the menus needed for getting information about the terms of use of the road facility and the price; the downloaded content will be customized to the driver's/vehicle's profile and to additional information coming from him/her (e.g. necessity to carry a person with special needs). After payment, a corresponding virtual ticket will be saved in the driver's terminal, which may be his/her mobile terminal or the vehicle On Board Unit (OBU).

However, many times this first scenario is not very suitable, for instance drivers visiting the town or changing destination; for such cases an alternative diagram is provided in the same picture. Drivers publishing their position in Instant Mobility services and approaching a restricted road facility, will be informed automatically about the presence of Congestion Charging service and will receive all the information needed for a complete awareness of the possible choices and actions that they can take (maps, prices, policies, parking, etc.).

Outside very critical areas, Congestion Charging may take the form of a green incentive to collaborate to global traffic shaping. Drivers willing to take part to this initiative will be invited to suspend their travel when traffic congestion becomes excessive along their route. This collaborative behaviour will be rewarded with green credits, which may lead to tax reductions or other forms of discount.

The service provider's perspective is provided in the next picture and is pretty similar to the previous one. It shall be noted that, according to traffic policies from authorities, one possible response to access request may also simply be a denial due to excessive congestion or vehicle type (not shown in picture).

Regarding the "Green incentive" sub-diagram, it must be noted that the presence of an OBU on vehicle is explicitly needed for verifying that the vehicle's has really suspended travelling.

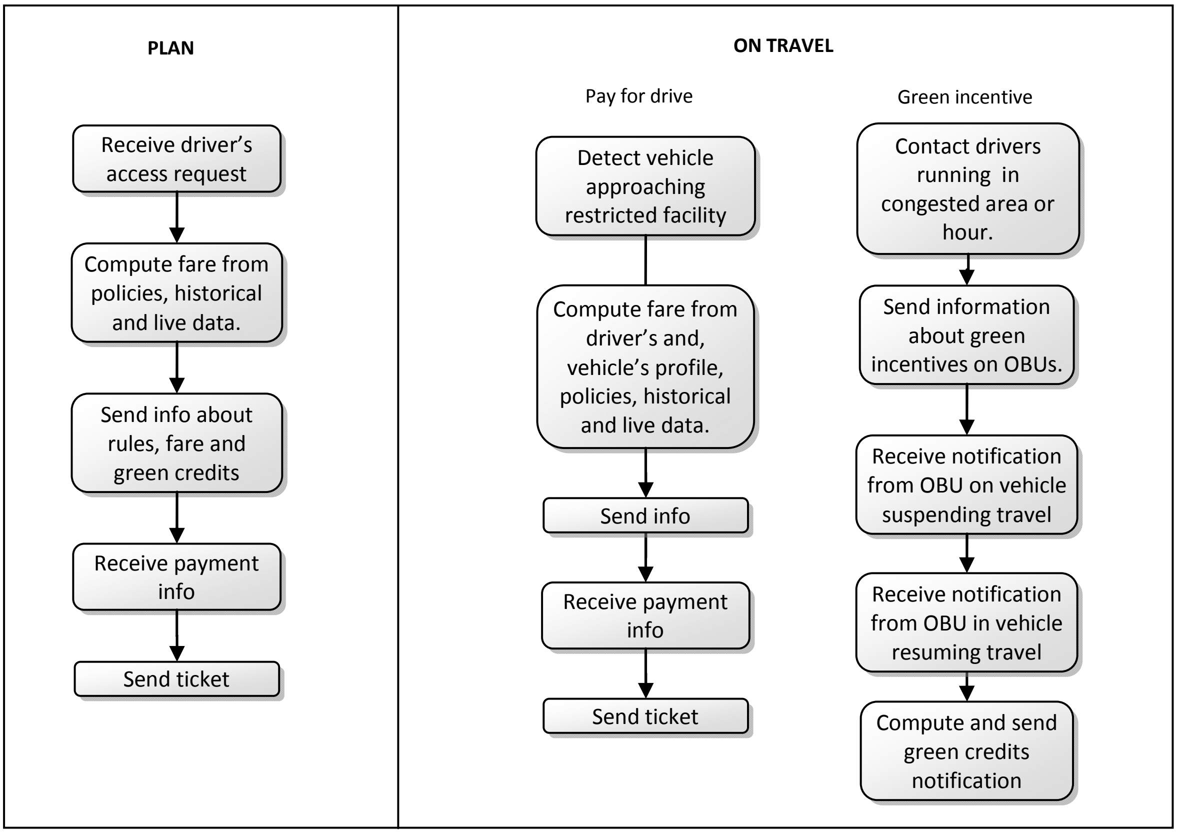



Figure 37 - Congestion charging from the Service Provider's perspective

### 3.7.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| **Charging area**. It is a well-defined and delimited zone, typically the town centre, historical areas, critical road segments. The zone is fixed and delimited by infrastructure like gates and signs. | Charging will be applied to very flexible areas or road segments, whose number, shape and extension can dynamically change, according to rush hours, pollution level, holidays and working days, special events etc. |
| **Information**. Fixed traffic signs or Variable Message Signs must be deployed all around the charging area. Despite of this, foreign drivers may still unintentionally violate the charging area. | By means of their mobile terminals, drivers will always receive clear information about the restricted area and their relative position. Foreign drivers will get information in their national language. |

| | |
|---|---|
| **Pricing**. Fixed price: daily, weekly, monthly, annual subscription or simply "per trip". Exemptions for people with special needs or local residents are available but still in a fixed way. | More fair and equitable pricing policies will be possible, e.g. "Pay as you drive". Fares will be dynamic and change according to holidays and working days, pollution level, special city-scale events, etc.<br>There will also be opportunity for "negative" fares, i.e. green credits will be granted to drivers adopting sustainable behaviours like not using car during rush hours. |
| **Payment**. Usually done with cash for buying stickers at self-service machines, kiosks and shops. Subscriptions available also on websites. In some cases it is possible to pay with a phone call or SMS. | The default method for paying will be using the personal mobile terminal. |
| **Enforcement**. Cameras with Automatic Number Plate Recognition, gates, magnetic loops, traffic policemen are used to detect vehicles violating the restricted area. | Since drivers will be encouraged but not forced to publish their position and destination, today's enforcement means will still be needed but in smaller quantities. Gates and traffic policemen terminals will have wireless connectivity helping them to detect unauthorized vehicles. |
| **Monitoring**. The enforcement infrastructure is also used for monitoring the real impact of congestion charging on urban traffic in terms of number of vehicles, average speed and pollution. | On-Board Units in vehicles will constantly upload their position and fuel consumption figures, thus enabling real-time fine-grained usage monitoring of access restricted areas and emission levels. |

### 3.7.3 Service components

| Name | Description and role | Comments | Dependencies |
|---|---|---|---|
| On Board Unit (OBU) | Sends position, instant fuel consumption, route, destination and vehicle related info. Receives virtual tickets. | Vehicle info may be pollution level, type of vehicle (bus, car, van, lorry, shared vehicle, etc ), sizes. | Communicates with Road Infrastructure and ticket inspector terminal. |
| User mobile application | Enables access to service, stores virtual tickets and driver's info. | It can run on driver's mobile terminal or OBU or be split between them. | Linked to driver profile. |
| Road Infrastructure | Can be Variable Message Signs for sending visual messages to drivers, gates for Number Plate Recognition (through radio technology or camera) and magnetic loops for detecting vehicle transit. | It will be dedicated to service enforcement for vehicles and drivers without connectivity and can also have radio interface to/from vehicles/drivers | Providing high level network interface to Congestion Server. May communicate to OBU through radio technologies. |
| Congestion Server | Compute virtual tickets according to policies, hour, day, driver's and vehicle profiles, info from other services, previous service history. Feeds archives. Interacts with drivers. | May link to similar servers in other towns for fast and easy service roaming. | It is linked to several other Instant Mobility services (see picture in 3.7.5) |

### 3.7.4 Actors, their roles and relationships

| Actor | Role | Relationship between actors |
|---|---|---|

| | | |
|---|---|---|
| Drivers | Feed profile and needs.<br>Collaborate to reduce congestion by planning access in advance or suspending travelling when traffic is excessive. Do not need to buy in advance or to subscribe to service. | |
| Road Infrastructure Manager | Operating and maintaining road infrastructure. Sends transit events . | Could be managed by Public Authorities. |
| Ticket Inspector | Use a mobile terminal to check vehicles in restricted areas. Sends violation reports. | Could be managed by Public Authorities. |
| Public Authorities | They set charging and access policies, receive and analyze traffic reports based on service history. | May manage both Ticket Inspector and Road Infrastructure Manager. |
| Other Instant Mobility Services | Influence access grant/denial and prices computed by Congestion Server. | |

### 3.7.5 Data: data flows, databases, required input from other services

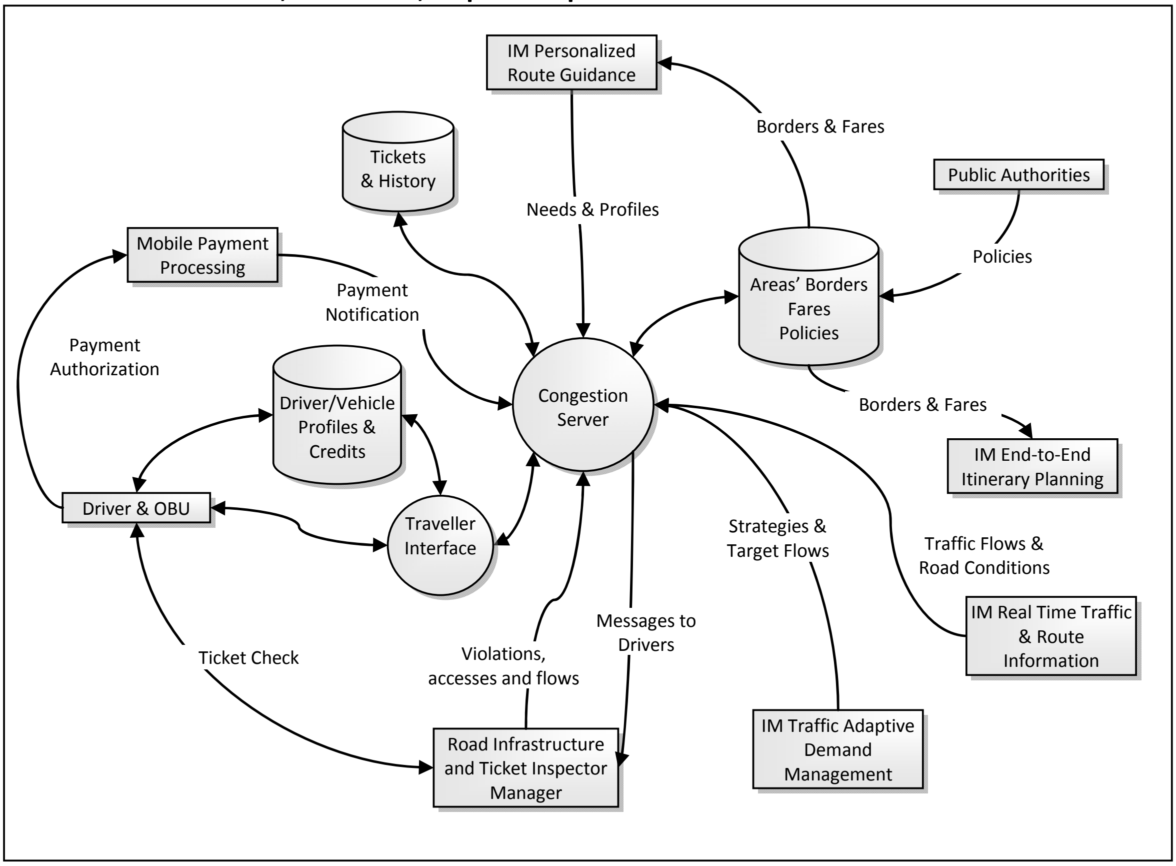



Figure 38 - Data flow diagram of the Congestion Charging service

Other Instant Mobility services will strongly interact with Congestion Charging. The Personalized Route Guidance will provide user specific data (special needs, exemptions, bonus) and then gather from Congestion Charging any information useful for building and evaluating new routes (e.g. restricted areas' borders, policies, fares). The Real-time Traffic & Route Information will provide real-time information about global traffic conditions inside and outside restricted areas.

Congestion Charging is also deeply integrated with Scenario 1 (Multi-Modal Travel Made Easy) and Scenario 5 (Online Traffic and Infrastructure Management). When processing a multi-modal journey, the End-to-End Itinerary Planning will access Congestion Charging servers and get data about:

- Current restricted areas and restricted roads segments.
- Current policies on vehicles and drivers.
- Current fares/discounts/bonus.

Congestion Charging processing will receive from the Traffic Adaptive Demand Management service:

- Area-wide optimization strategies.
- Traffic-target flows.

According to those data, Congestion Charging will dynamically determine access permissions and fares for each driver.

### 3.7.6 Expected benefits

Advanced Future Internet Congestion Charging will decrease and shape traffic both in the more congested areas and in the town as a whole. Traffic reduction will also imply less air and noise pollution.

Drivers' interaction with the service will be simpler and faster and prices will correspond to effective road usage (not only flat fares); more ease of use and more equity will help to maximize public acceptance.

Since the service is operated through mobile terminals, road infrastructure will decrease to the minimum required for providing enforcement, thus allowing significant operating cost reductions.

### 3.7.7 References: other projects, actual services etc.

Today's services:

http://en.wikipedia.org/wiki/Stockholm_congestion_tax
http://en.wikipedia.org/wiki/London_Congestion_charge

## 3.8 Service 2.g: Parking assistance

The User is going to the city centre around noon on a Sunday to go shopping. Since he/she expects that there will be many bags to bring home he/she takes the car. As we all know, it is usually impossible to find a parking space within the city centre in the middle of the day. Below follows an explanation of how Instant Mobility can help.

When starting his/her trip from home, the user enters the location where he/she wishes to start his/her shopping spree. As the user approaches the destination, he/she gets directions to a nearby parking space or parking lot with available spaces. Information on availability and price for the parking is readily available in the mobile, and other alternative parking opportunities are also presented to the user. Once in the parking lot directed to, the driver is directed to an available parking space. If the user wants to be sure to get a parking space in close vicinity to the area where he/she intends to shop, he/she can make a reservation of a parking space; either once presented with the parking opportunities in the mobile, or through a web-page even before starting the trip, while still at home or at the office.

When the user gets back to the car with all his/her bags and leaves the parking space, the total time parked is registered so that the correct parking fee can be charged. The fee is withdrawn directly from the users account or billed regularly, upon the choice of the user. The user, thereby, does not have to attend a parking ticket vending machine, risk paying for too long time or getting fined for arriving too late to the car. The kind of parking assistance referred to above will hereinafter be referred to as parking operator assisted parking.

An alternative way for the user to find a parking space, not within a controlled parking lot or parking garage but perhaps rather along the street, when having already entered the city centre is to use the mobile application to look for parking spaces which other users have recently marked as available. Bringing up the map in the application, the user can instantly see such spaces. Parking spaces marked as available by other user show up in the map. The time since the space was reported available is indicated. If claimed by another user of the system, the mark is removed immediately; otherwise it is removed after a certain amount of time. The rationale for removing the dot if unclaimed is that the likelihood that it is still available diminishes with time since a driver not using the system may have claimed the space. When the user gets back to his/her car and leaves the parking space he/she can in turn mark it as available for other users of the service. Below, this version of the parking assistance service is referred to as social-networking assisted parking.

### 3.8.1 End-to-end service chain

#### Service consumption

If the user intends to make use of the *parking operator assisted parking* service, he/she is asked to enter information useful for being able to direct him/her to a suitable parking space:

- Requested final destination

Other preferences (maximum walking distance from the parking area to the final destination, maximum price the user is willing to pay for the parking, estimated parking time, etc.) (some of the user's preferences may be stored in the user's profile so that it does not have to be entered at each occasion)

The parking request is processed by the service provider and a parking lot suggestion, together with alternative parking opportunities, is immediately presented to the user containing information to support the user's parking choice:

- Distance from parking space to requested final destination
- Maximum parking time allowed
- Price of parking
- The possibility to reserve a parking space
- Total number of available parking spaces at parking lot
- Other information (such as guarded parking and other services)

Once a parking space selection or reservation has been made, the user's mobile can be used for direction. If the selection or reservation has been made through a computer's web browser, the user gets an SMS to his/her mobile containing a link associated with the navigation application. If the selection or reservation is made through the mobile interface this information is already available to the navigation application and the trip can take place.

The *social-networking assisted parking* service is less complex but builds upon the courtesy of other users. If looking for an available parking space, the user simply starts an application on his/her mobile device which shows a map where parking spaces marked as available by other users show up. The time since it was marked as available is also indicated to show the likelihood that it is still available.

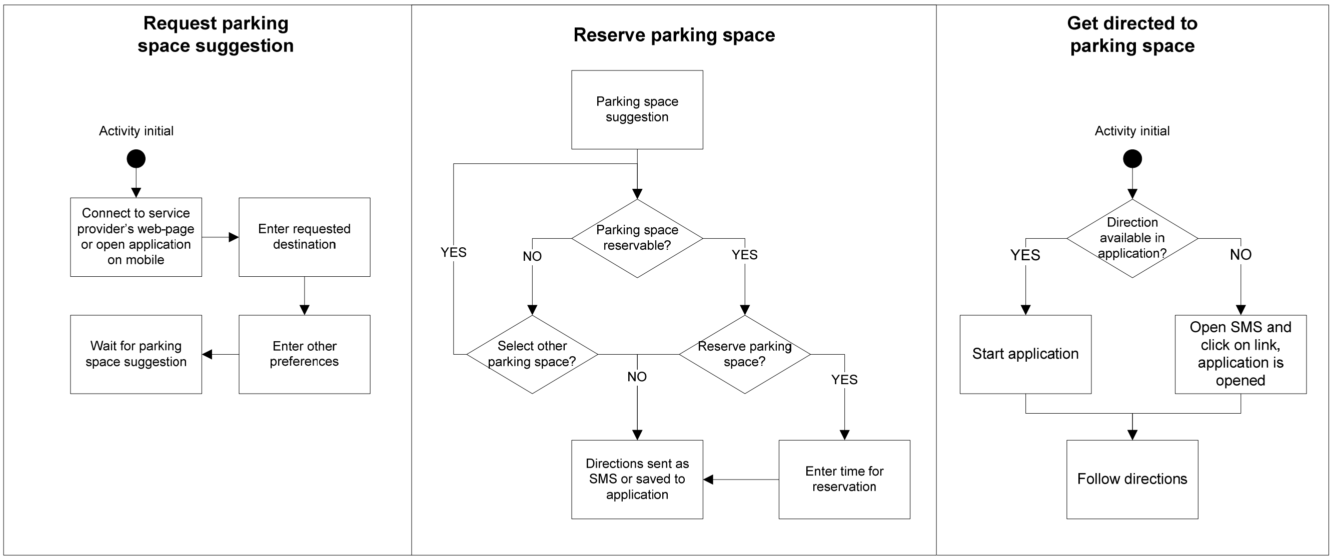



Figure 39 - Parking assistance from the user's perspective

Service delivery

The service provider of the *parking operator assisted parking* service has to feed the system with parking space information such as:

- Parking space location
- Maximum parking time allowed
- Price of parking
- The possibility to reserve a parking space
- Other information (such as guarded parking and other services)
- Parking space availability (parking spaces not used or reserved)

When a request for a parking space is received, the system shall use the information to suggest a suitable parking space based on the preferences of the user, and forward the information to the user who thereby can take a decision upon which parking space to use.

If the user desires to reserve a parking space, this shall be updated in the system so that the space is marked as unavailable for the time period the user intends to park there.

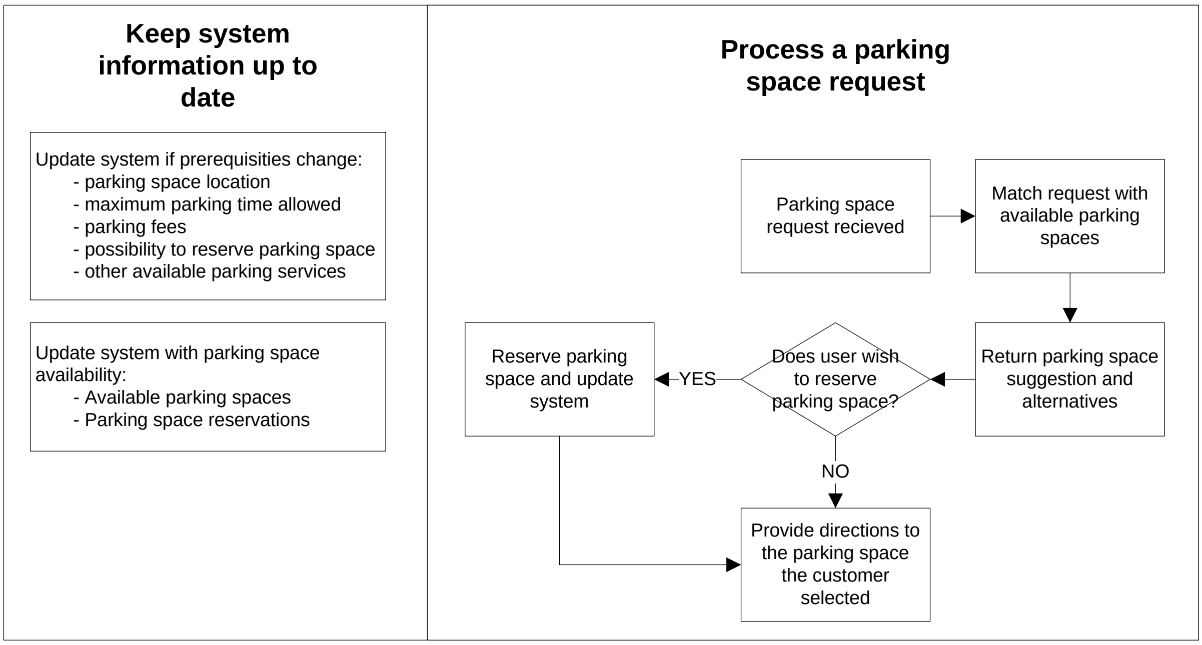



Figure 40 - Parking assistance from the Service Provider's perspective

The *social-networking assisted parking* service gets information on available parking spaces from users leaving their parking spaces. Such a user starts a mobile application to report the space he/she just left as available. The application uses the mobile device's current gps-location to position the parking space.

### 3.8.2 Service capability comparison description (today, future)

| ***Parking operator assisted parking service*** | |
|---|---|
| **Service today (if it exists)** | **Service in future (with Instant Mobility)** |
| [Parking reservation] On-line parking space reservation is today available, e.g. for parking spaces near airports. You enter the parking lot operator's website, select when you want to check-in and when you want to check-out, provide vehicle information for identification and sometimes pay a reservation fee. | In the future, parking reservations will be made easier and available for more parking spaces through Instant Mobility. Without knowing who operates the parking spaces in a certain area it shall be possible to reserve a parking space, directly from the car through a mobile phone or nomadic device, or from a computer e.g. at home or at the office. Simply enter a location and suggestions on parking spaces possible to reserve close to the location are presented.<br><br>Any parking space owner can provide information on available parking spaces through the same system. |
| [Parking space availability] Information on parking space availability is provided to drivers through signs outside the parking lot. | The driver can instantaneously get information on parking space availability for all parking lots which he/she is interested in through his/her mobile phone. |
| ***Social-networking assisted parking service*** | |
| **Service today (if it exists)** | **Service in future (with Instant Mobility)** |
| [Parking space availability] Information on parking spaces that has recently been left is available through Google Open Spot in Canada, the U.S. and the Netherlands. | Similar to the existing Google-service but with the possibility to interoperate with the P*arking operator assisted parking* service. |

### 3.8.3 Service components

| *Parking operator assisted parking service* | | | | |
|---|---|---|---|---|
| ***Nr*** | ***Name*** | ***Description and role*** | ***Comments*** | ***Involved actor*** |
| *1* | *Web-site interface* | *It enables the user to look for and reserve parking spaces e.g. from home or from the office* | *It is a web-site accessible through any computer with Internet* | *Software provider* |
| *2* | *Nomadic device application* | *It enables the user to request suggestions for suitable parking spaces and to make reservations* | *It is an application run on the user's mobile phone* | *Software provider, nomadic device provider, vehicle OEM* |
| *3* | *Parking assistance service system* | *Receives requests from service users and matches these against information provided by the parking space owners* | *It is a system matching requests with available parking spaces* | *Map provider, routing service provider, parking space providers* |
| *4* | *On board unit* | *It allows directions to be provided through the car's HMI*<br><br>*It enables real-time system updates on parking space utilization to the parking assistance service centre* | *It is a sw macro-component which is installed on the on-board telematic system and represents the gateway between vehicle system and Instant Mobility* | *Vehicle OEM* |
| ***Social-networking assisted parking service*** | | | | |
| *1* | *Nomadic device application* | *Allows users to report and look for available parking spaces* | *It is an application run on the user's mobile phone* | *Software provider, nomadic device provider, vehicle OEM* |
| *2* | *Parking assistance service system* | *Receives user information on available parking spaces* | *It is a system storing information on parking space availability* | *Software provider, nomadic device provider, vehicle OEM* |

### 3.8.4 Actors, their roles and relationships

| ***Parking operator assisted parking service*** | | | |
|---|---|---|---|
| *Nr* | *Name* | *Main actions* | *Relationships within the service* |
| *1* | *End-user* | *Registers*<br>*Logs-in*<br>*Requests parking space information*<br>*Reserves parking spaces*<br>*Parks the car* | *Service provider* |
| *2* | *Service provider* | *Provides, manages and updates the running service, on the server side* | *End-user(s), Parking space owner(s), Nomadic device application provider* |
| *3* | *Client interface provider* | *Provides the interface to the service (it could be a sw provider in case of a local application or the service provider if browser-based interface)* | *Service provider* |
| *4* | *Nomadic device application provider* | *Provides, manages and updates the nomadic device application* | *End-user, Map provider, Service provider* |

| | | | |
|---|---|---|---|
| *5* | *Parking space owner* | *Provides information about parking spaces. Provides information on parking space availability* | *Service provider* |
| *6* | *Vehicle OEM* | *Provides On board unit*<br><br>*Provides features for in-car usage of the application* | *Nomadic device application provider* |
| *7* | *Map provider* | *Provides updated maps for planning and navigation* | *Service provider, Nomadic device application provider* |
| ***Social-networking assisted parking service*** | | | |
| *1* | *End-user* | *Marks parking spaces as available*<br>*Requests information on available parking spaces* | *Service provider* |
| *2* | *Service provider* | *Provides and maintains the database containing information on available parking spaces* | *End-user(s), Nomadic device application provider* |
| *3* | *Nomadic device provider* | *Provides, manages and updates the nomadic device application* | *End-user(s), Map provider, Service provider* |

### 3.8.5 Data: data flows, databases

In Figure 41 the Data Flow Diagram of the Parking operator assisted parking service is depicted from the Service provider’s perspective. The rectangles represent the actors involved in the operations related to providing information on parking spaces and making parking space reservations. The circles do in turn represent a process carried out by the Service provider and the components delimited by two horizontal lines are databases or data stores. The arrows represent information flows from one part of the system to another.

The procedure logically starts from the End-user and there are mainly two closed information-loops. The first loop relates to the procedure where a user is requesting information about parking spaces in the vicinity of a defined location. The Service provider processes this request by collecting additional information from various databases and provides the End-user with parking space alternatives.

The other closed information-loop relates to the procedure of an End-user requesting to reserve a selected parking space. The Service provider consults the *Parking space data* database to check the availability of the requested parking space. If the parking space is available, a confirmation is sent to the user and the *Parking space data* database is updated to include the reservation.

The databases consulted when the Service provider creates parking space recommendations and reservations are maintained by various actors. The *maps database* is maintained and updated by a maps provider; the *parking space data database* is maintained by the Service provider and updated upon reservation requests and requests from the parking space owners. The database containing *user profiles* is updated by the users themselves using provided account information.

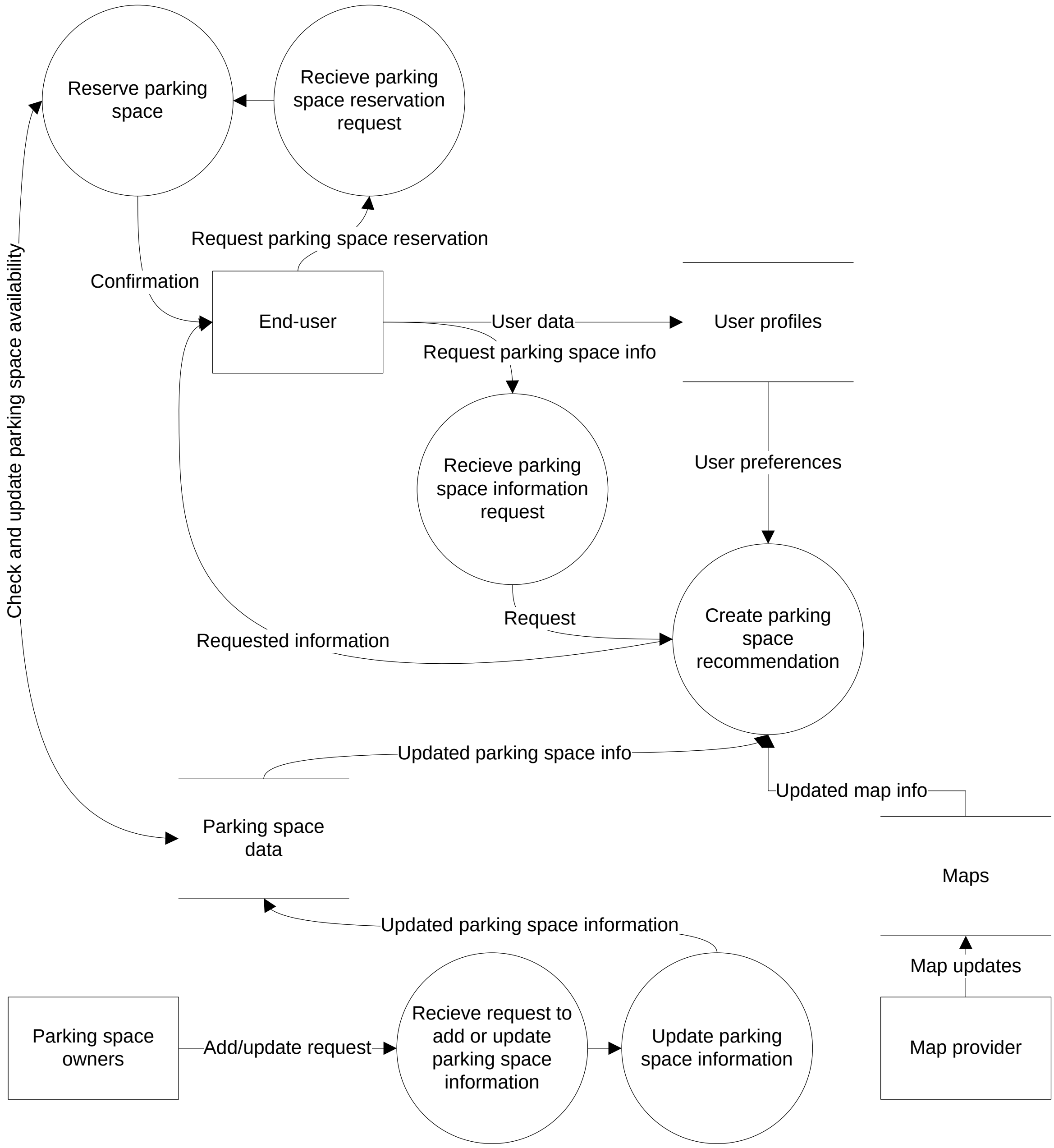



Figure 41 - Data flow diagram of the Parking operator assisted parking service

Figure 42 depicts the information flow of the Social-networking assisted parking service, from the perspective of the service provider. Rectangles once again represent actors, circles processes performed by the Service provider, two horizontal lines databases, and arrows the flow of information from one part of the system to another. The information flow begins with the End-users. An End-user reports that the parking space he/she just left is available. The service provider stores the coordinates and the time of the report in a database. When another user wants to know if there are any available parking spaces in the area where he/she currently is, the service provider consults the database to bring up information on such parking spaces which have been reported available in the area by other users during the last 15 minutes. The location of the parking spaces and the time of the reports are provided to the service's End-user.

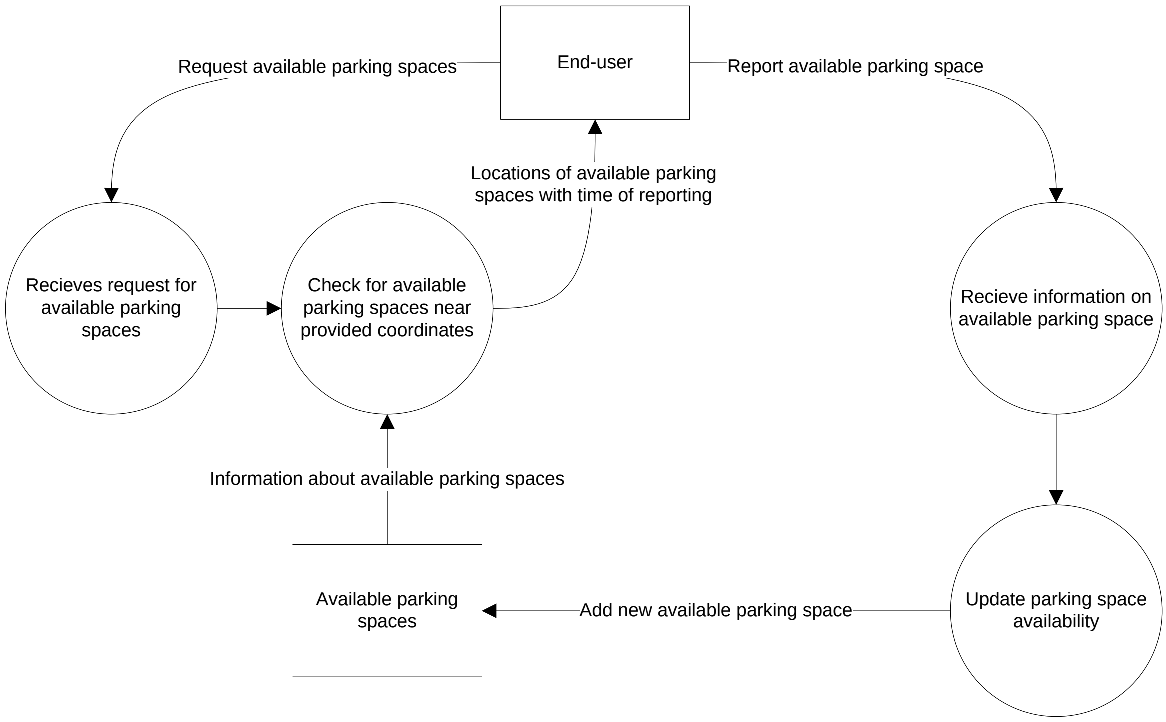



Figure 42 - Data flow diagram of the Social-networking assisted parking service

### 3.8.6 References: other projects, actual services etc.

Car park availability signalling

There are urban parking systems which intend to help the drivers localize available parking spaces within a parking lot or parking garage. Lights can for instance be used for signalling if a parking space is available (green light) or occupied (red light). As a result, available parking spaces become more visible and the drivers can spend less time circulating the parking area.

Airport parking space reservation

There are several companies offering online information and booking of parking spaces in close vicinity to airports. Examples of such (in the U.S.) are *AirportParkingReservation.com* and *The Parking Spot*. The user browses to the companies' respective websites and selects what airport he/she wants to park at and receives information on available parking opportunities. *The Parking Spot* operates the parking spaces they provide information about themselves and it is possible to directly reserve a parking space online. *AirportParkingReservation.com* in turn lists many more parking opportunities, with information on distance from airport and parking fees. Some of the parking lots which show up on the *AirportParkingReservation.com* website can be booked online.

FREILOT – Delivery Space Booking

The FREILOT project will pilot Delivery Space Booking functionality in Lyon, France and Bilbao, Spain. Two systems will be piloted, one in France and one in Spain. Both systems will feature a web-application for delivery space booking where the availability of the different delivery spaces used in the project is shown. A fleet operator can reserve time-slots at the various delivery spaces.

When a delivery space is booked it is in France indicated by a LED-sign put on a pole next to the delivery space. In Spain LED-lights in the street showing either green or red indicates available or occupied delivery spaces.

CVIS – Urban Parking Zones

In the CVIS project, one use case concerned Urban Parking Zones. The goal was to support the driver, fleet manager and road operator (including parking zone operator) in the booking, monitoring and management of the urban parking zones for freight driver activities.

The main information flow looked as follows:

- The Fleet Operator plans a journey.
- All parking zone reservation requests are sent to the Parking Operator. The requests include vehicle type, delivery time, delivery duration, and flexibility in the schedule.
- The Parking Operator allocates spaces and time slots to the Fleet Operator.
- When the vehicle approaches the allocated space/time, an ETA is sent to the Parking Operator who confirms the booking.
- The vehicle arrives and the Parking Operator allows the vehicle to park.
- The vehicle leaves the parking zone and reports to the Parking Operator that the bay is free.

Depending on the circumstances there may be exceptions to this main flow. Such circumstances can e.g. be:

- The Parking Operator can not accommodate the request. Alternative times are then provided so that the Fleet Operator can update the journey plan.
- The parking zone is not free at the requested ETA (e.g. due to the previous delivery running late). The Parking Operator offers an alternative parking zone or a “holding” zone whiting the premise. The vehicle system / driver accepts the new parking zone.
- The parking zone is occupied by a vehicle that has not been registered. An enforcement procedure is launched and the vehicle which couldn’t load/unload is rescheduled.
-

Google – Open Spot

Open Spot is a Google application for mobile phones running Android 2.0 or higher. It is currently available in the US, Canada, and the Netherlands. Google One Spot lets users report when they are leaving a parking spot. This results in a red dot showing up on a map to be seen by other users of the application. As time passes, the red dot turns yellow. Users who are searching for a parking space can bring up the application which, just like a regular GPS-application, shows where the user currently is but also where parking spots recently have been reported as available.

### 3.8.7 Expected benefits

The Parking space operator assisted parking service

The main benefit for the user of the service is the convenience to avoid circulating the city in search for an available parking space. Through the system, the user will get directed to such with minor effort. This helps the user save time which instead can be spent on shopping and to save gasoline as a result of reduced fuel consumption.

The main benefits for the city and its inhabitants are reduced congestions and pollution as a result of less traffic. Reduced traffic also improves the safety for both road traffic users and pedestrians, as well as makes the city traffic less stressful on drivers and other users.

The parking space and parking lot operators’ benefit from better use of their parking spaces; also such parking spaces located in hidden, still central, areas. Other benefits for the parking space operators are reduced governance costs and accurate compensation for the use of their parking spaces by users of the service; no parking warden is needed to control vehicles using the service and the system knows how long time the car has been parked and can charge the user accordingly. The parking space operators also get accurate information on parking space usage and demand which can support future planning.

<u>The social-networking operated parking service</u>

The main benefit for the user of the service is to be able to locate parking spaces which have recently been left by other users of the system. This way, circulation in congested areas can potentially be avoided. The system will guide the user to available parking spaces with minor effort. The user can save time and gasoline, just as for the Parking space operator assisted service described above.

The main benefits for the city and its inhabitants are reduced congestions and pollution as a result of less traffic. Reduced traffic also improves the safety for both road traffic users and pedestrians, as well as makes the city traffic less stressful on drivers and other users.

The service provider’s may be able to make a profit from providing the service. Users can for example be asked to subscribe for the service or pay on a per-use basis.

# 4 Scenario 3 – Collective Transport

## 4.1 Scenario overview

This scenario expresses a vision about the collective transport of the future. In that vision a number of services cooperate to deliver seamless, traveller focused and demand based service.

The cooperating services in this scenario are:

- Floating passenger data collection (where is and who are everybody? Where do they want to go?)
- Demand-responsive service coordination (coordination and delivery of the needed services at any moment)
- Flexible schedule adaptation (vehicle, staff and route adaptation to the needed service)
- Ticketless fare collection (paying for the service actually used in a dematerialized way)
- Adaptive collective transport priority (making sure that in the city's surface traffic, collective transport receives priority when and where it is needed)
- Driver & Passenger Security monitoring (increasing security for the person in transit; be it driver or passenger)
- Taxi sharing ( taxi sharing service as a part of the collective transport)
- The perspective taken is that of Collective Transport Services Provider(s) delivering the services.

### 4.1.1 Future Collective Transport

The traditional Public Transport Operators will continue to act as key players for collective transport. The concept of collective transport has widened and in it the transport operator may act as a flexible mobility services provider within its radius of action.

Service flexibility is improved by federating complementary offers (such as with taxi companies for taxi sharing, car sharing or car pooling), around the traditional PTOs offering a one stop shop for collective travel.

The collective travel offer of the future is also envisioned to be seamlessly extendable by European-wide cooperation to the geographical and functional areas of responsibility of other (regional) transport operators.

### Descriptive Use Case

This scenario expresses a vision where collective transport operators, either public (bus, metro…) or private (car sharing or taxi sharing managers) in the future will use Internet to sense passengers' presence at stops and to register their destination, to offer innovative online services flexibly to match their vehicles, timetables and even routes to the actual demand.

The transport operators will get the set of individual travelling plans corresponding to the set of transport service they will have to provide. Those services either matching fixed routes & time-tables, or flexible journeys such as On-demand Transport.

Additionally, they are able in real-time (1) to know the position of Instant Mobility passengers, (2) to monitor occupation and vacancy of their own stations & stops and vehicles and (3) to detect any service disruption, evaluate corresponding time delays and previsions to recover normal service.

This information will be shared and fused with other sources of information, independent from the transport operators, extracted for instance from Mobile Phone Operators data, Social Network semantic extraction…

Transport operators will be able to assess first whether they are able to provide the requested transport service and what will be the resulting Quality of Service that will be offered. This assessment has to include both Instant Mobility travel plans, as well as other mobility data, coming from other real-time or statistical sources. This is a continuous and real-time assessment, resulting in alarms raised when the transport operator cannot commit any more to fulfil passenger requested QoS.

Internet will also allow fully cashless ticketing with a huge number of public/private transport operators, allowing a precise and secure financial clearing, while providing better marketing information.

Mutual confidence, safety and security are also key points to promote new mobility usage such as car sharing, car pooling or collective taxis. Therefore (as done on e-bay for example) it must be possible for the passengers to score the quality of the service offered by the transporters (scoring should be also envisaged for the transporters to evaluate passengers behaviour).

In offending situations, adequate recording must be done for further arbitration or to be used as evidence. Emergency call capability must be offered in any situation.

As a dual usage, video-based surveillance can also be used to sense passenger presence or density, either at stops or in the vehicles.

This scenario will show the benefits of a coordinated multi-modal information exchange in a traveller oriented way, between multiple public transport operators and the benefits of a fully dematerialized dynamic payment system.

### 4.1.2 Purpose

- To manage the flows of travellers, vehicles and money (fare) in a way that gives QoS and balances the expectations, demands and restrictions from passengers, partners and society.
- Provide the capability to adjust the Transport Service offer to actual passenger density and travel plans, on a real-time or a short term prevision basis.
- Provide a robust, accurate and secure ticketing framework, allowing :
    - To charge dynamically passengers as long as they actually consume transport services
    - Clear financial transactions between Transport Service Providers and Transport Services Resellers
    - Allow flexible or incentive fare policy as an additional way to regulate passenger flows
- Provide the necessary means to rate transport operators (especially the private individual ones) and passenger to encourage virtuous behaviour and raise confidence of individual people in the system (as in the Internet shopping and auction system).
- Provide the necessary means to collect evidences in case of offending behaviour or criminal acts. Develop dual use for some of these means to improve transport network status awareness.

### 4.1.3 Problems to be solved

- Get an accurate measurement and prediction of passengers' flows, as well as a measurement of instantaneous transport offer.
- Privacy management.
- Potentially huge number of "individual" transport operators (e.g. car sharing).
- Security of financial transactions (authenticity) that are performed by the general public
- Set-up an incentive system to develop system confidence and social acceptance.
- Complex coordination (including choices, parameters etc) of different services to deliver demand responsive transport offer with QoS and optimized infrastructure use.

### 4.1.4 Rationale: how Future Internet solution could address the above problems

The Future Internet will provide enabling technologies to allow:

- Seamless connectivity anytime/anywhere of passenger with the Instant Mobility network and resources, every time using the adequate security level.
- Real-time transmission of measured data, real-time processing of this data, and real-time distribution of processed data
- Social networking technologies to emphasize the human dimension of the Instant Mobility system
- Scalability of the system, allowing a growing number of users, without the need to review architectural fundamentals, and taking benefits from cloud resources to manage increasing needs in computing capabilities.

### 4.1.5 Short description of each service as a whole

#### *4.1.5.1 3.a : Floating passenger data collection*

This will provide passenger density and position measurements over the transport network, and will be able to perform accurate predictions on passenger density, based on a wide range of input data. These measurements are then used by the Transport Operators and the Organizing Authorities to optimize and regulate instantaneous quality of service (InstantQoS).

This service has two aspects:

1. Gather all the available information, from various sources to make an accurate estimate of passengers' density, within the transport network. The data will originate from Transport Operators real-time or statistical data, from Instant Mobility individual travelling plans, from surveillance systems, from other data sources such as mobile phone operators' data, weather data, road traffic data, perturbations or special events (disruptions, strikes…), etc. Prediction models will be included or will be called as complementary services.
2. Distribute the relevant information to Transport Operators and Organizing Authorities.

#### *4.1.5.2 3.b : Demand-responsive service coordination*

When a picture of the instant, short and longer term service needs has been established, the Transport Operator activates the proper mechanisms to coordinate the services to match as near as possible, given predefined restrictions, the services needed at any given point in time.

This service has the following 3 aspects:

1. Create a dynamic picture of the services needed. This includes the coordination and comparison of short term and medium term needs, as well as the integration of real time information, schedule, vehicle, staff etc information.
2. Create and choose response scenarios. The possible response may contain various services to be deployed, and various criteria for choosing a response.

3. In useful time coordinate and deliver the necessary services.

#### *4.1.5.3 3.c : Flexible schedule adaptation*

Flexible schedule adaptation is a service that adapts public transport service route and timetable and informs passengers these service modifications to enhance fleet usage and service quality for passengers. Flexible schedule adaptation is based on real-time online passenger demand information, real-time traffic information and real-time vehicle monitoring and fleet capacity information. By exploiting this information, Public Transport (PT) operator can optimise for example bus schedule (frequency, number of vehicles per line, bus capacity etc.) also taking real traffic conditions into account.

Furthermore, in the depots, PT service managers receive all the info from bus sensors to determine service levels and maintenance needs and to adjust adaptively fleet operations. They have a detailed report and certification of service carried out daily (number of journeys, km driven, possible causes of delays at terminuses and intermediate stops).

In case of service disruption on the subway or on a bus line (for failures, traffic jams, road incidents, demonstrations, strikes, etc.), passengers are informed about waiting times, alternative routes, service restoration, etc.)

#### *4.1.5.4 3.d : Adaptive collective transport priority*

Internet service adapts traffic light timing to offer green light to bus & other collective vehicles, provides speed recommendation to vehicle driver.

#### *4.1.5.5 3.e : Taxi sharing*

Taxis can pick up and drop off additional passengers along the route through online service to match potential users with actual shared taxi availability (location and destination, number of places etc.) This will require information exchange among passengers, taxis, taxi operators, road operators and operators of other transport modes.

#### *4.1.5.6 3.f : Ticketless fare collection*

In the following it is assumed that mobile payment services will provide a mobile wallet or a payment application embedded in travellers' mobile terminals (e.g. smartphones). Such wallets or applications will be used to pay both goods and services, like also mobility services; travellers will confirm payments on their mobile terminal display/keyboard or just simply swiping it near a contactless radio interface.

The same type of mobile terminal will be also used by individual & private transport service providers (such as car-sharing drivers) to record transactions with their passengers and get paid on a regular basis.

Financial clearing will have to be implemented to share collected revenue between mobility services providers.

Public Transport Operators and Organizing Authority will be able to set-up incentive tariff rules so that travellers are encouraged to use their services.

These tariff rules must be available on internet as well as their associated services like find the best way between 2 points, propose several routes… with their availability (timings and prices) and depending on the traveller preferences and profile. These services will be presented under a common format based on Web Services. Answers to the requests are updated in real-time depending on other contingencies like those already mentioned above.

#### *4.1.5.7 3.g : Driver & passenger security monitoring*

Security and confidence are two cardinal requirements to guarantee adoption and development of Instant Mobility services:

- Security of people (passengers and drivers, as well as transport operator staff) regarding incivilities and aggression. Security forces must be able to be alerted in case of a security issue. Investigation teams must be able to collect necessary data to identify offenders and produce related evidences in courts.
- Confidence in drivers and passenger courtesy or behaviour

Detection of security issues will be automatic (detection of video, audio, behavioural templates) or manual (emergency call, personal security reports).

After a careful consolidation, rating of vehicles drivers and passengers, will allow to improve global quality of service, the most virtuous actors getting the best capabilities to match their need or to provide mobility services.

A special attention will be paid to privacy, according to the potential legal diversity.

#### 4.1.6 How services interact and combine within the scenario

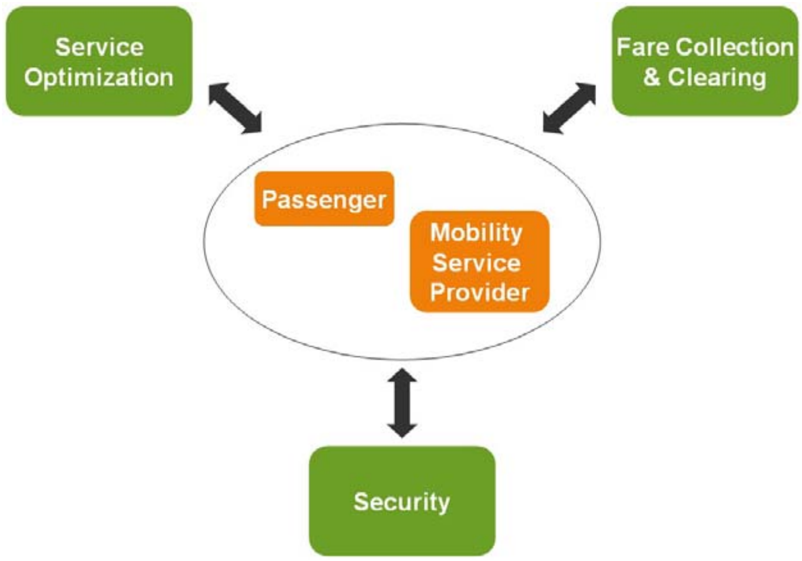



Figure 43 - Service Clusters

Services illustrated in scenario 3 may be grouped in three functional clusters:

- Service Optimization
  - 3.a Floating Passenger Data Collection
  - 3.b Demand Responsive Service Coordination
  - 3.c Flexible Schedule Adaptation
  - 3.d Adaptative Collective Transport Priority
  - 3.e Taxi Sharing
- Fare Collection & Clearing
  - 3.f Ticketless Fare Collection
- Security & Confidence Management
  - 3.g Driver and Passenger Security Monitoring

Note that interactions exist with services in other scenarios (e.g. Scenario 1). Light interactions are existing between the three clusters.

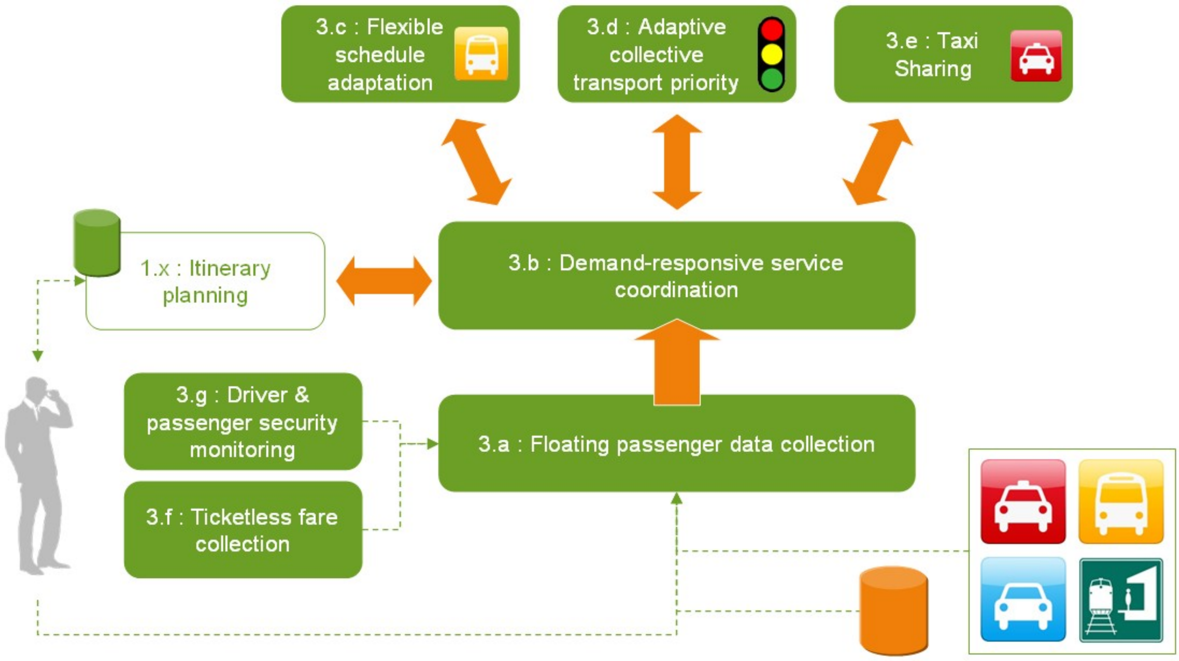



Figure 44 - Scenario 3 Services interaction

### 4.1.7 How services interact and combine within the scenario

Under discussion

### 4.1.8 Ecosystem, main actors and roles, and affected stakeholders

In order to describe the services and their interactions the Ecosystem for the Future Collective Transport had to be envisioned. Very shortly the imagined actors are:

- Passengers
- Organizing Authority
- Financial Services Actors ( Banks, Clearing house)
- Mobility Services Actors ( Mobility Service manager, Information manager)
- Transport Service Retailers
- Mobile phone technology actors
- Individual Transport Managers & Providers
- Collective Transport Managers & Providers
- Transport infrastructure Managers

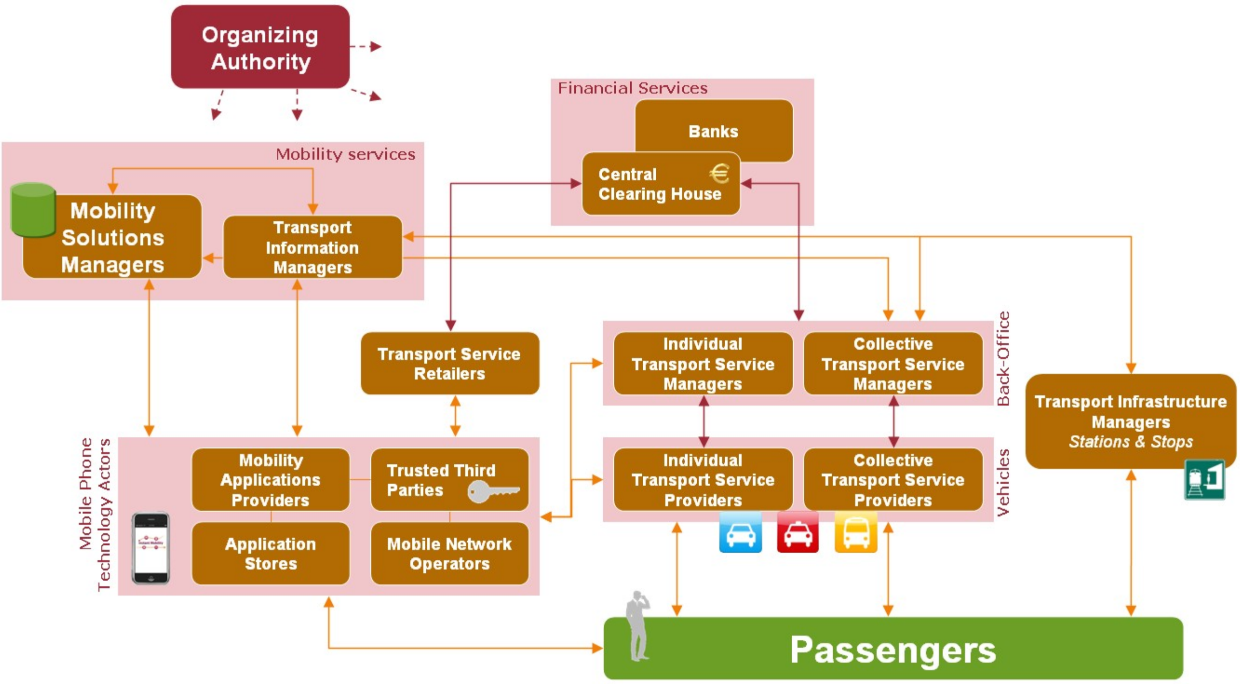



Figure 45 - Scenario 3 Reference Ecosystem

These roles are purely conceptual, and an actor may have one or more roles in any given ecosystem.

A unifying Transport Organizing Authority is envisioned as an important part of the ecosystem. The role of such a Organizing Authority is to be responsible, for a specified geographical area, for defining the cooperative rules between the different parties, and in general for facilitating cooperation between individual actors. The Transport Organizing Authority may be a Regional or Municipal Transport Authority, or a Cooperative Body made up of the individual actors.

#### *4.1.8.1 Value proposition to the traveller and to society*

The Transport of the Future will deliver a flexible, dynamic and need oriented mobility service to the individual with a high level of convenience and comfort for any travel between any two points of their mobility area at any time of day.

The transport offer needs to balance various considerations. It has to balance the needs, requirements and wishes of the individual traveller as expressed - directly or indirectly by that traveller with the capabilities of the transport operator(s) and partners, and the needs of society (of which the traveller is a part) for as an example lower emissions, reduced energy/ fuel spending and shortened travel times.

Quality of Service is a key issue and increasingly important for traveller retention.

With the active collaboration of the Mobility Solutions Providers, the Transport Service Managers & Providers, as well as other actors, the Organizing Authority optimizes the flows of travellers, vehicles and money (fares) within its action area in order to live up to the simply stated value proposition.

The transport offer will be constrained by the requirements made by society at the time in question; such as sustainability.

#### 4.1.8.2 What the Mobility Solution Manager must know to realise the value proposition

It must be known where everything is. This includes travellers, vehicles and the geographical structure of the city and the transport network,

It must be known where everything will be if no changes are made to the system: travellers, vehicles etc and know what this means for the future Quality of Service.

The traveller requirements must be known, their travel plans and inherent preferences and habits.

The Mobility Solution Manager must know the impact on QoS of every decision that is made, how the QoS is defined; as this can be defined in various ways.

This will require a deep integration of data and planning including traditional transport operators, as well as with emerging transport operators, managing new mobility means such as shared taxis or shared cars.

The Organizing Authority may delegate part of this job to a third party service provider, with the necessary skills and capabilities to operate Instant Mobility global services.

#### 4.1.8.3 What the Organizing Authority must be able to do to fulfil the Value Proposition:

The organizing authority must be able to receive/collect and manage/use all the aforementioned data from the transport operators.

The organizing authority must ensure that :

- the transport operators will be able to manage the flow of travellers and vehicles (with their staff).
- the transport operator will be able to achieve requested QoS for the traveller and optimal usage of the infrastructure, fixed and mobile for himself.

The organizing authority must ensure that collection of transactional data from transport usage is accurately done, allowing a correct and convenient payment for all services used.

| Main Actors | | Services Involved | Roles |
|---|---|---|---|
| **Passengers** | | 3.a Floating passenger data collection<br>3.e : Taxi Sharing<br>3.f : Ticketless fare collection | Benefit from transport and mobility services, updated on real time during his journey. Use their Personal Mobility Assistant (e.g. smartphone) to manage their personal profile, request mobility service and allow continuous geo-location during journeys. |
| **Organising Authority** | | All, prior to operations, to define relevant policy and regulations | Is responsible for the Mobility Services policy in a defined mobility area (town, region, country…). Initiates, coordinates and regulates those services |
| **Transport Services** | Individual Transport Service Providers | 3.a Floating passenger data collection<br>3.b : Demand-responsive service coordination<br>3.e : Taxi Sharing<br>3.f : Ticketless fare collection | Provide a transport services to passengers, who needs to share part of the journey.<br>Example : a private car driver, who shares his car. |
| | Individual Transport Service Managers | | Operators that federate individual transport resources.<br>▪ Provide the necessary back-office resources to manage affiliated resources<br>▪ Provide also these resources with a single business interface<br>▪ Monitor and consolidate QoS measurement, rating, etc.<br>Example : a car-sharing operator |
| | Collective Transport Service Providers | 3.a Floating passenger data collection<br>3.b : Demand-responsive sce coordination<br>3.c : Flexible schedule adaptation<br>3.d : Adapt. coll. transport priority<br>3.f : Ticketless fare collection | Provide an elementary collective transport service to passengers (Trip), for instance on a bus line, a metro or a train service. Is focused on the |
| | Collective Transport Service Managers | | Operators that federate collective transport resources.<br>▪ Provide the necessary back-office resources to manage a set of mono/multimodal collective transport services.<br>▪ Manage the business interface with the central clearing house.<br>▪ QoS monitoring and consolidatation<br>Example : metro, bus or train or multimodal operators |
| **Transport Infra-structure managers** | | 3.a Floating passenger data collection<br>3.b : Demand-responsive sce coordination<br>3.c : Flexible schedule adaptation<br>3.d : Adapt. coll. transport priority<br>3.f : Ticketless fare collection | In charge of the management of the transport infrastructures, especially the stations, the stops, the platforms, or any part of the public area, when assigned to transportation services delivery. Can provide information on passengers and vehicles flows. Can host also some backup or complementary equipment to Personal Mobility Assistants. |
| **Transport Services Retailers** | | 3.f : Ticketless fare collection | Sell to passenger transport services. They are the commercial interface between the passenger and the transport services providers. They can sell either pre-paid or post-paid products.<br>This role can be cumulated with others roles, such as Transport Service Manager, Mobile Phone Operator, Application Provider or Banks. |

| Main Actors | | Services Involved | Roles |
|---|---|---|---|
| **Mobility Services** | Mobility Solution Managers | 3.a Floating passenger data collection<br>3.b : Demand-responsive service coordination<br>3.c : Flexible schedule adaptation<br>3.d : Adapt. coll. transport priority<br>3.e : Taxi Sharing | Compute real time mobility solutions for individual passengers, and update those solutions along the whole journey. |
| | Transport information Managers | 3.a Floating passenger data collection<br>3.c : Flexible schedule adaptation | Distribute general interest and collective transport information to infrastructure and transport services managers, as well as to the Mobility Solutions Managers : Traffic status, disruptions… |
| **Mobile Phone Actors** | Mobile Network Operators (MNO) | 3.f : Ticketless fare collection | Provide the passengers and the transport service providers that needs it the necessary cellular communication and data exchange infrastructure. Must cover the considered mobility area.<br>May propose a secured area in mobile phone SIM to store requested secrets/keys needed to guarantee transactional security. |
| | Mobility Applications Providers | 3.a Floating passenger data collection<br>3.b : Demand-responsive service coordination<br>3.e : Taxi Sharing<br>3.f : Ticketless fare collection | Will develop and operate the Personal Mobility Assistant applications that will be used by the passengers and some (mainly individual) transport services providers |
| | Application Stores | | Will distribute the mobility applications on Personal Mobility Assistant |
| | Trusted Third Parties | 3.f : Ticketless fare collection | An intermediate service provider to deploy security features and interface between the world of services retailers and the world of PMA through MNO |
| **Financial Services** | Central Clearing House | 3.f : Ticketless fare collection | Collect all the sales and usage financial transaction, to redistribute transport services sales revenues amongst transport services providers |
| | Banks | 3.f : Ticketless fare collection | Manage bank accounts of transport service providers and bankable passengers. *(Non-bankable or anonymous can be managed on a pre-paid basis by Transport Services Retailers)* |

#### 4.1.9 Expected benefits

- Higher QoS for the individual traveller, better travel experience, shorter travel time
- Ridership improvement for transport operators
- Optimised and sustainable collective transport, taking into account the needs of the individual and the needs of society, contributing to a higher quality of living in cities (reduced congestion, reduced pollution, reduced energy/fuel spending, shorter travel times, less stressful experience travelling , contribute to a cleaner city environment and better land use.
- Contributing to the city/ region's competitiveness by increased attractiveness of region

### 4.1.10 Other

Under discussion

## 4.2 Service 3.a : Floating passenger data collection

### 4.2.1 End-to-end service chain

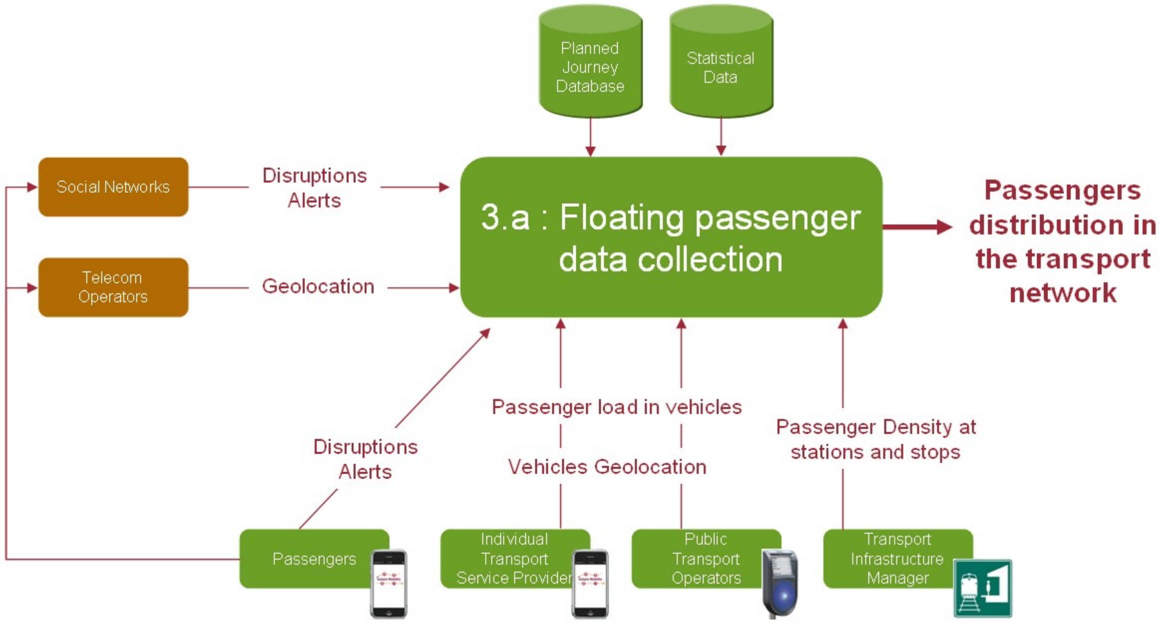



Figure 46 - End-to-end Service chain of floating passenger data collection

### 4.2.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| The real passenger density and distribution is estimated based on measurements done by passenger counting gates, or using the ticketing system. | Additional sources are integrated, improving instantaneous and short term predictions. |
| Predictions on the evolution of the service in the next hour is difficult, with no clear correlation between measured data and planned journeys. | Journey planning allow to predict more accurately the traffic evolution during the day.<br>Projections can be done on the passengers not using Instant Mobility services. |
| Passengers are not integrated as information sources to detect disruptions, raise alerts, etc. | Information originating from passengers can be collected and processed, either using cooperative, direct messages, or extracting relevant informations from social networks or mobile phone operators. |
| Sudden congestion and traffic disruption are hard to detect, quite impossible to predict | Sudden congestion can be detected earlier, or can even be predicted, leading to immediate information, alternative proposals and service recovery measures with an improved reaction time. |

#### 4.2.3 Service components

Under discussion

#### 4.2.4 Actors, their roles and relationships

| Actor | Roles | Relationships between actors |
|---|---|---|
| ▪ Collective Transport Service Providers<br>▪ Individual Transport Service Providers<br>▪ Transport Infrastructure Manager<br>▪ Transport Information Managers | Collecting information from passenger via registration, collecting itineraries and positions of passengers', collecting positions/utilization/ routes of public transport vehicles, collect historical and real-time traffic information, inform users | In charge of the service; Responsible for communication with other actors in the service chain |
| ▪ Public Transport Service Managers | Providing adapted schedules to drivers;<br>providing static and dynamic information of its fleet | Communicating with service provider and drivers |
| ▪ Transport Service Providers | Drivers receiving schedules from PT Service Managers and follow the schedules | Communicating with PT operator |
| ▪ Passenger | Upload real time geo-location information.<br>Upload personal reports on service disruptions or behaviour | Communicate directly or indirectly (e.g. through social networks or MNO) with transport information managers |

#### 4.2.5 Data: data flows, databases

Under discussion

#### 4.2.6 References: other projects, actual services etc.

N/A

### 4.3 Service 3.b: Demand-responsive service coordination

When a picture of the instant, short and longer term service needs has been established, the Transport Service Manager activates the proper mechanisms to coordinate the services to match as near as possible, given predefined restrictions, the services needed at any given point in time.

This service has the following 3 aspects:

- Create a dynamic picture of the services needed. This includes the coordination and comparison of short term and medium term needs, as well as the integration of real time information, schedule, vehicle, staff etc information.
- Create and choose response scenarios. The possible response may contain various services to be deployed, and various criteria for choosing a response.
- In useful time coordinate and deliver the necessary services.

#### 4.3.1 End-to-end service chain

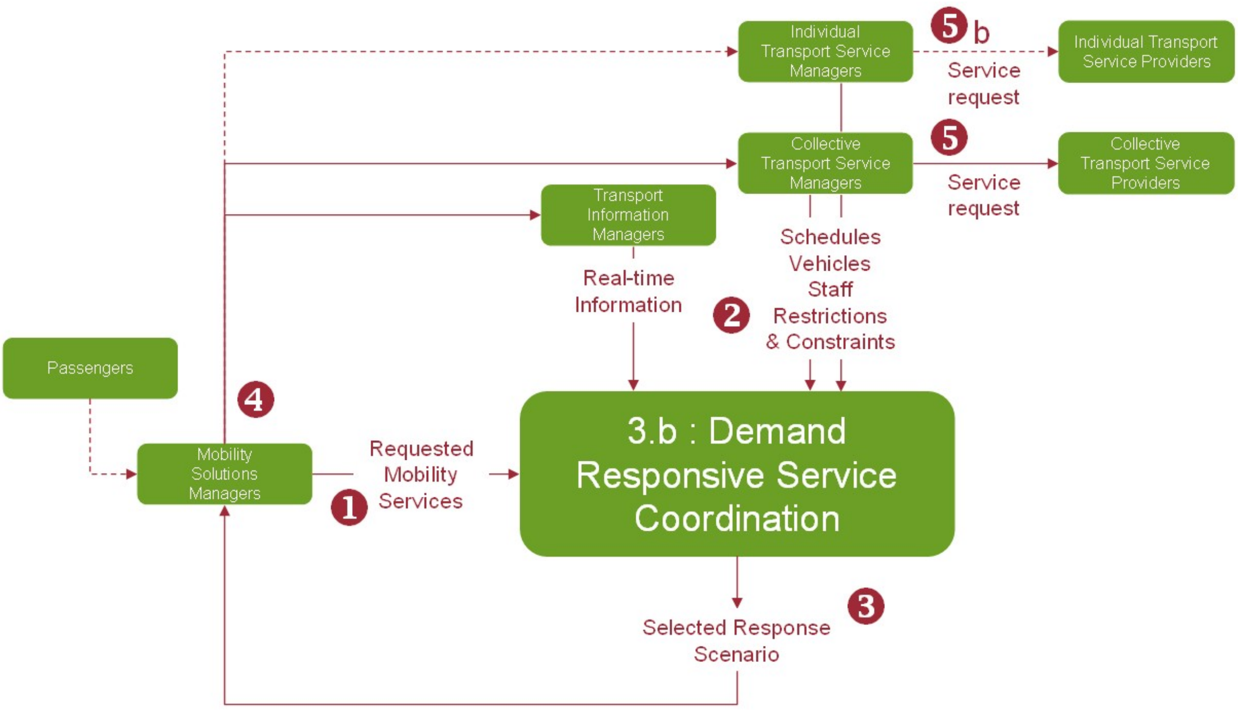



Figure 47 - End-to-end Service Chain of the Demand Responsive service

### 4.3.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| The collective transport service is modulated *a priori* based on a daily (peak hours, night…), weekly (week-ends…) or annual (holidays, special events…) basis. It is not possible to add additional resources on a short term basis to face an unpredicted attendance. | The service can be adapted to instantaneous service requirements (attendance, routes…), provided that :<br>Vehicle, staff, etc are available<br>Alternative routes are compatible with existing regulations (accessibility, infrastructures, security…)<br>This can be manage without prejudice to other users (e.g. those not affiliated to Instant Mobility) |
| When a collective transport is not able to provide passengers with the requested QoS, there is no possible alternative. | Individual Transport Services will provide the necessary additional transport capacity to overcome limitations in collective transport capacity. |

### 4.3.3 Service components

### 4.3.4 Actors, their roles and relationships

| Actor | Roles | Relationships between actors |
|---|---|---|
| **Mobility Solutions Managers** | From passenger's mobility requests, elaborates the list of (new or updated) requested mobility services.<br>Provide resulting adapted transport service requests to Transport Services Manager for implementation, and to Transport Information managers for information diffusion. | |
| **Transport Information Manager** | Give real time transport information, update the information with adapted transport service requests | |
| **Collective Transport Service Managers** | Provide information on the transport services they manage, their occupation, their restrictions, etc. | |
| **Collective Transport Service Providers** | Receive adapted services requests for operation. | |
| **Individual Transport Service Managers** | Provide information on the transport services they manage, their occupation, their restrictions, etc. | |
| **Individual Transport Service Providers** | Receive adapted services requests for operation. | |

### 4.3.5 Data: data flows, databases

Under discussion

### 4.3.6 References: other projects, actual services etc.

N/A

## 4.4 Service 3.c : Flexible schedule adaptation (VTT)

### 4.4.1 End-to-end service chain

The following diagram shows the end-to-end chain of the service.

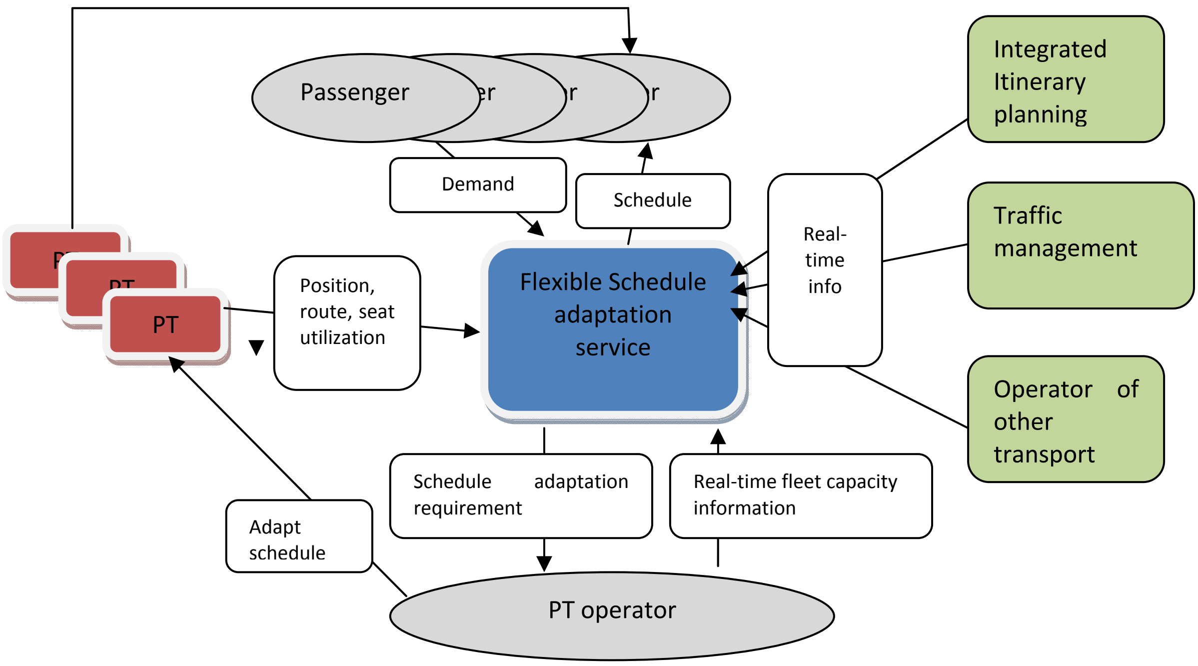



Figure 48 - Diagram of the end-to-end chain of Flexible Schedule adaptation service

Use cases are shown below as example to explain how the flexible schedule adaptation service works:

- Use case 3c_1: Informing passengers on (bus) service delay
- Use case 3c_2: Rerouting bus route due to traffic incident

| **Use Case ID** | UC_3c_1: Informing passengers on (bus) service delay |
|---|---|
| **Scenario title** | Collective transport |
| **Services name** | Flexible Schedule adaptation |
| **Short Description** | Service provider's perspective<br>The service provider collects information on buses' position, route and seat utilization. The service provider holds passenger information through itinerary planning service. When a passenger is scheduled for the bus, the passenger's location can be automatically reported via mobile location device. The service provider forecasts the bus arrival on passenger's bus stop utilizing real-time traffic and other appropriate information. If the bus will be late on the bus stop, passenger will be informed on new timetable.<br><br>Passengers' perspective<br>A passenger has to be registered in passenger registration system to be able to send his/her plans via itinerary planning service. Location of the passenger can be automatically reported to the operator. The passenger will be informed any service interruptions or delays. |
| **Goal** | - To make public transport more attractive to passengers<br>- To improve public transport service level<br>- To increase public transport use |
| **Potential Constraints** | The service requires itinerary planning. Passengers' information held by the service provider may lead concerns on privacy. |
| **Components** | Passenger itinerary planning system; passenger location unit via mobile device (optional); public transport vehicle on-board unit; public |

| | |
|---|---|
| | transport management system; schedule service centre (e.g. collecting information from all public transport means and passengers, traffic information, etc. and calculate the schedule) |
| **Main flow** | All users of this service should register with the service. The location and mode of user is updated real-time to the service. When a user comes into vicinity of public transport link starting point (i.e. bus stop) the service compares bus arrival forecast with timetable and informs he/she on possible delays or changes. |

| **Use Case ID** | UC_3c_2: Rerouting bus route due to traffic incident |
|---|---|
| **Scenario title** | Collective transport |
| **Services name** | Flexible Schedule adaptation |
| **Short Description** | Service provider's perspective<br>The service provider collects information on buses' position, route and seat utilization. The service provider holds passenger information through itinerary planning service. When a passenger is scheduled for the bus, the passenger's location can be automatically reported via mobile location device. The service provider gets real-time traffic information in which a traffic accident on service route is informed. The service plans a temporary route that avoids the accident spot. The passengers will be informed on new route.<br><br>Passengers' perspective<br>A passenger has to be registered in passenger registration system to be able to send his/her plans via itinerary planning service. Location of the passenger can be automatically reported to the operator. The passenger will be informed any service interruptions or delays. |
| **Goal** | - To make public transport more attractive to passengers<br>- To improve public transport service level<br>- To increase public transport use |
| **Potential Constraints** | The service requires itinerary planning. Passengers' information held by the service provider may lead concerns on privacy.<br>Passengers not using the service may find decrease on service quality and level. |
| **Components** | Passenger itinerary planning system; passenger location unit via mobile device (optional); public transport vehicle on-board unit; traffic management system; public transport management system; schedule service centre (e.g. collecting information from all public transport means and passengers, traffic information, etc. and calculate the schedule) |
| **Main flow** | All users of this service should register with the service. The location and mode of user is updated real-time to the service. Users will be informed any changes on his/her route. |

### 4.4.2 Service capability comparison description (today, future)

| **Service today (if it exists)** | **Service in future (with Instant Mobility)** |
|---|---|
| Public transport operators plan fixed service routes based on historical data. | Service routes can be adapted flexible in real-time to offer passengers good service and optimize fleet usage. |

| | |
|---|---|
| Public transport operators plan fixed timetables based on historical data. | Timetables can be adapted flexible in real-time to offer passengers good service and optimize fleet usage. |
| Passengers may wait for long time to have public transport arriving without knowing the reason and duration for delay. | Public transport operators will have real-time information on service disruption and duration. |
| Passengers may wait for long to have public transport arriving although he/she may see many busses/trams etc. with full of passengers on board unable to stop for him/her. | Passengers will have minimum delay to get on public transport. Public transport operators will have real-time passenger information to ensure good service level by forecasting transport needs. |
| | |

### 4.4.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Passenger registration system | Register passenger's information | flexible schedule service centre | End-to-end itinerary planning (1a) |
| Passenger information interface (via website or mobile device) | Passenger is informed any changes in public transportation schedule | flexible schedule service centre | Ticketless mobile fare payment (1g) |
| public transport vehicle on-board unit | Giving real-time information on location of the vehicle, current seat utilization | flexible schedule service centre;<br>PT operation system | |
| PT operation system | Giving adapted schedules to public transport vehicles | flexible schedule service centre; public transport vehicle on-board unit | |
| traffic management centre | Giving real-time information on traffic | flexible schedule service centre | |
| flexible schedule service centre | collecting information from all public transport vehicles and passengers, traffic information, etc and calculate the schedules for vehicles;<br>giving instructions to PT operator;<br>giving information to passengers on adapted schedules | Passenger registration system; passenger information interface (via website or mobile device); passenger location unit via mobile device (optional public transport vehicle on-board unit; PT operation system | End-to-end itinerary planning (1a);<br>Real-time traveller monitoring (2b);<br>Real-time traffic management |

### 4.4.4 Actors, their roles and relationships

| Actor | Roles | Relationships between actors |
|---|---|---|
| **Service provider** | Collecting information from passenger via registration, collecting itineraries and positions of passengers', collecting positions/utilization/ routes of public transport vehicles, collect historical and real-time traffic information, inform users | In charge of the service;<br>Responsible for communication with other actors in the service chain |
| **PT operator** | Providing adapted schedules to drivers; providing static and dynamic information of its fleet | Communicating with service provider and drivers |

| | | |
|---|---|---|
| **Drivers** | Receiving schedules from PT operator and follow the schedules | Communicating with PT operator |
| **User/passenger** | Registering with the service;<br>Receiving information;<br>Use the service | Communicating with service provider |

### 4.4.5 Data: data flows, databases

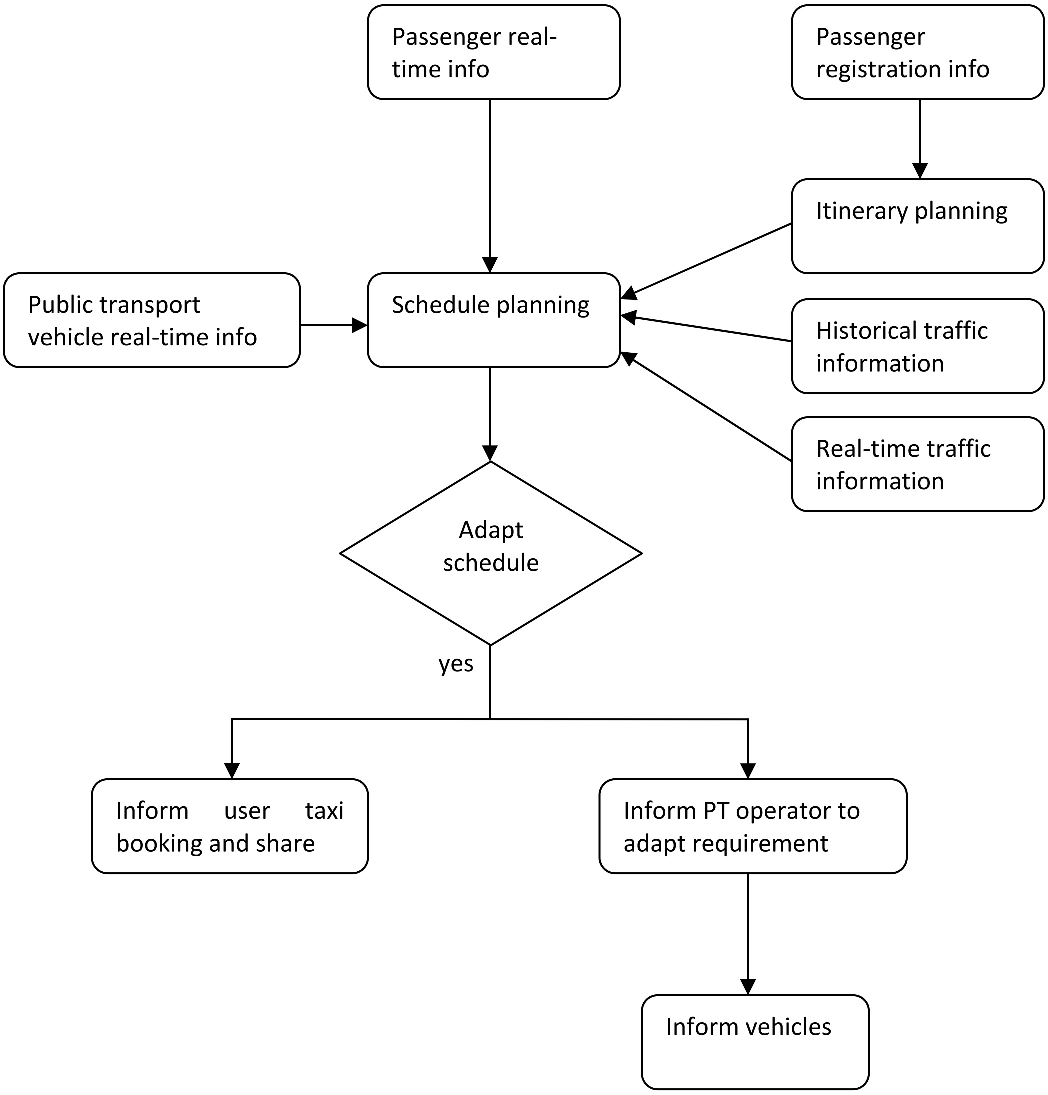



Figure 49 - Diagram of the data flow of schedule adaptation service

### 4.4.6 References: other projects, actual services etc.

N/A

## 4.5 Service 3.d : Adaptive collective transport priority

Under discussion

## 4.6 Service 3.e : Ticketless fare collection

Payment of services and goods using mobile terminals is today already available in some countries, carried out with many different platforms, architectures and techniques, but it is not the core subject of this chapter. The focus here is to describe how the Future Internet will leverage mobile payment and integrate it to build truly innovative ticketing functions for mobility services.

In the following it is assumed that mobile payment services will provide a mobile wallet embedded in travellers' mobile terminals. Such wallets will be used to pay both goods and services, like dematerialized "virtual tickets"; travellers will confirm payments on their mobile terminals' display/keyboards or just simply swiping them near a contactless radio interface.

Virtual tickets will be stored in the travellers' mobile terminals; whenever needed, the virtual tickets will be accessed by wireless transponders, which may be integrated in barriers, vehicles, or in ticket inspectors' terminals.

### 4.6.1 End-to-end service chain

Travellers willing to book and pay in advance for one or more virtual tickets will be able to do it directly from their mobile terminal; a virtual ticket will be sent back as proof of payment to be used for accessing transport means or for allowing check from ticket inspectors.

Proximity interface will allow detecting travellers' entering or leaving transport means thus enabling "pay as you go" pricing as an alternative to fixed pricing. Diagram in the next picture shows how the user will experience this way of paying for mobility; by simply swiping or putting the mobile terminal against a proximity radio interface mounted on transport mean the traveller will automatically communicate the content of his/her virtual ticket; such content will differ according to the type of transport mean (bus, train, shared car or bike, etc.). When leaving the transport mean, the proximity interface on mobile terminal and the one embedded on the vehicle will communicate again to close the trip ; the traveller will then get information about the cost of the trip, which will be proportional to its effective length. The picture shows also the user experience in case of use of a virtual ticket with fixed price.

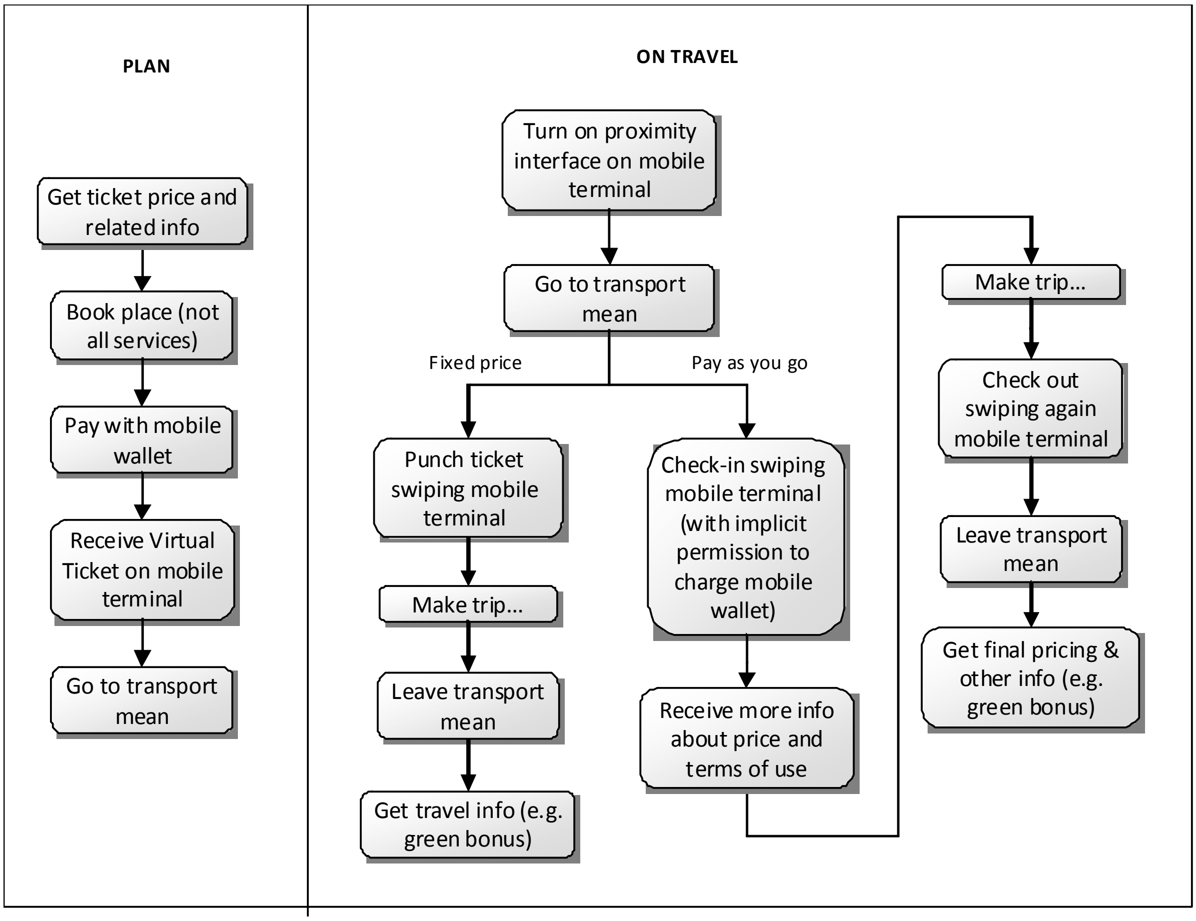



Figure 50 - End-to-end Service Chain of ticketless fare collection: User perspective

The service provider (see next picture) will constantly process all the events captured by sensors and proximity interfaces installed both on fixed infrastructure (barriers, gates, ticket machines) and vehicles (buses, trains, cars, bikes, etc.). Both for “pay as you go” and fixed tickets, price will be computed taking into account policies from public authorities, hour, day and the traveller’s profile.

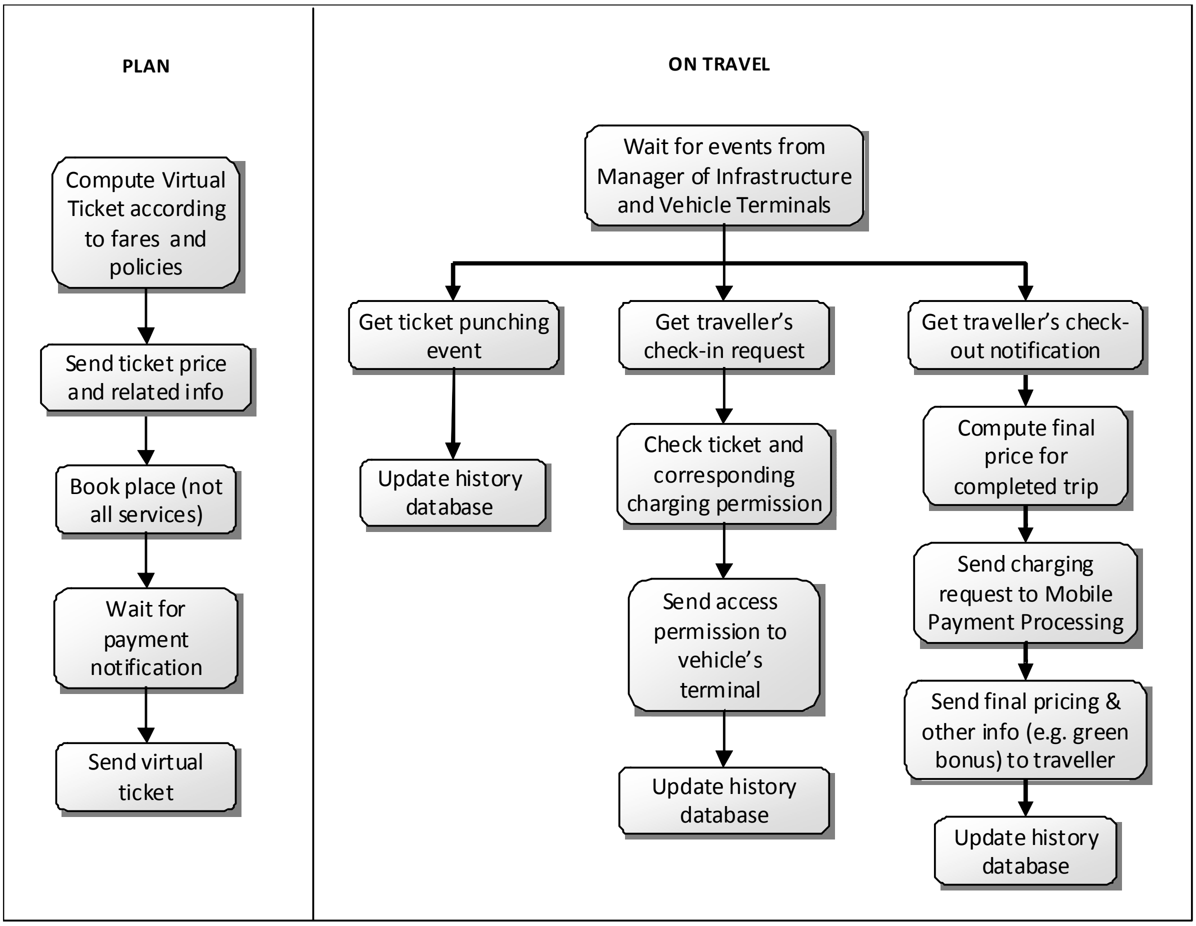



Figure 51 - End-to-End Service Chain of ticketless fare collection: Service Provider's perspective

### 4.6.2 Service capability comparison description (today, future)

| **Service today (if it exists)** | **Service in future (with Instant Mobility)** |
|---|---|
| **Proof of payment**. Mainly with paper tickets, minor use of smartcards, SMS, bar code on traveller's mobile terminal. | Mainly through wireless interface on traveller's mobile terminal, without or with minimal traveller's intervention. |
| **Access control to transport means** Gates (e.g. subway) that open by smartcard or ticket insertion, bar code reading; often only human visual check from ticket inspectors. Smart cards or hard keys for car or bike sharing. | Mainly through wireless interface on traveller's mobile terminal, without or with minimal traveller's intervention |
| **Booking** Phone call, website, travel agency, ticketing machines. | Mainly through application on traveller's mobile terminal. |
| **Payment** Cash, credit card, website. | Payment by means of mobile wallet will be integrated in the ticketing/booking application running on travellers' mobile terminals. |
| **Information** Travellers must examine signs or paper leaflets and signs and learn about pricing options and zones. Info also from mobile and web applications | Using their mobile terminals, travellers will receive only the pricing information regarding their desired destination. Information filtering and shaping according to traveller's profile |

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| **<u>Income reporting</u>** Since most of the tickets are in paper format and sold through a variety of channels (shops, machines, kiosks etc.) the real amount of incoming money can only be estimated. | Having payments done and recorded on web servers it will be easy to have up-to-date income reporting. |
| **<u>Pricing</u>** Most of the times, ticket prize is only roughly proportional to travel length. | Pricing will have much more granularity and be really proportional to effective travel length ("Pay as You Go"); not-subscribing travellers will be encouraged to leave their car at home and use collective transport even for very short travels. Pricing may also change along the day, for instance prize reductions during low-traffic hours. |
| **<u>Green credits</u>** According to local policies, people may get tax discounts or other kinds of credits for using collective transport. Very often it is required to subscribe to services. | Since every single payment can be recorded, it will be possible to reward also those travellers whose profile is not compatible with fixed subscription (e.g. bikers or drivers using collective transport irregularly). It will be possible to merge travels made with a variety of collective transport means and evaluate a global green credit. |
| **<u>Co-marketing</u>** Sales of additional travel and non travel products (e.g. co-branded and aggregated services, such as tourist cards, entry to events, museums, discounted taxi rides, combination with parking tickets, etc.) | Dematerialized ticketing opens new co-marketing opportunities allowing easier and more flexible ways to combine transport services with other products. |

### 4.6.3 Service components

| Name | Description and role | Comments | Dependencies |
|---|---|---|---|
| Sensors & proximity interfaces | Access virtual tickets on travellers' terminals, send ticket, check-in and check-out events Ticketing Server. | Can be both on vehicles and in fixed infrastructure | Communicates with user mobile application through proximity technologies. |
| User Mobile Application | Enables access to service, stores virtual tickets and traveller's info. | Runs on traveller's mobile terminal, which must be equipped with proximity radio interface. | Communicates with sensors & proximity interfaces and provide access to the service. |
| Public Authorities Server | Receives policies for computing pricing and green credits. Stores green credits on archive and make them available to Public Authorities | Public authorities may merge green credits with credits from other transport operators. | |
| Ticketing Server | Creates virtual tickets, sends them to travellers, processes events from infrastructure, vehicles, payment notification, updates history archive. | Part of transport operator information system. | Communicates with all components and with Instant Mobility Ticketless Mobile Fare Payment service (scenario 1). |

### 4.6.4 Actors, their roles and relationships

| Actor | Role | Relationship between actors |
|---|---|---|
| Travellers | Receives pricing information and virtual tickets. Pays with mobile wallet. Punch/show virtual tickets, enter and leave transport means using proximity radio interface on mobile terminals. | Communicates with ticket inspectors, possibly through proximity technologies. Subscribes to Mobile Payment Processor. Service user. |
| Mobile Payment Processor | Receives payment authorization from travellers. Sends payment notification to Ticketing Server. | Links to travellers and transport operators. |
| Transport Operators | Drives ticketing fares, receives payments. | Establishes agreement to Mobile Payment Processor. |
| Ticket Inspectors | Use a mobile terminal to check travellers' virtual tickets. Send violation reports. | Communicate with travellers possibly through proximity technologies. |
| Public Authorities | Set policies for green credits. Retrieve green credits. | Cooperate with Transport Operators for green incentive and fares. |

### 4.6.5 Data: data flows, databases, Required input from other services

The Ticketless Fare Collection service will interoperate with the Ticketless Mobile Fare Payment service (Scenario 1) to provide pricing information and handle progressive charging along the route of each multi-modal travel.

From Scenario 5, Traffic Adaptive Demand Management (not shown in the picture) will send data about city-wide traffic demand to implement dynamic pricing policies aiming at optimizing and shaping traffic flows.

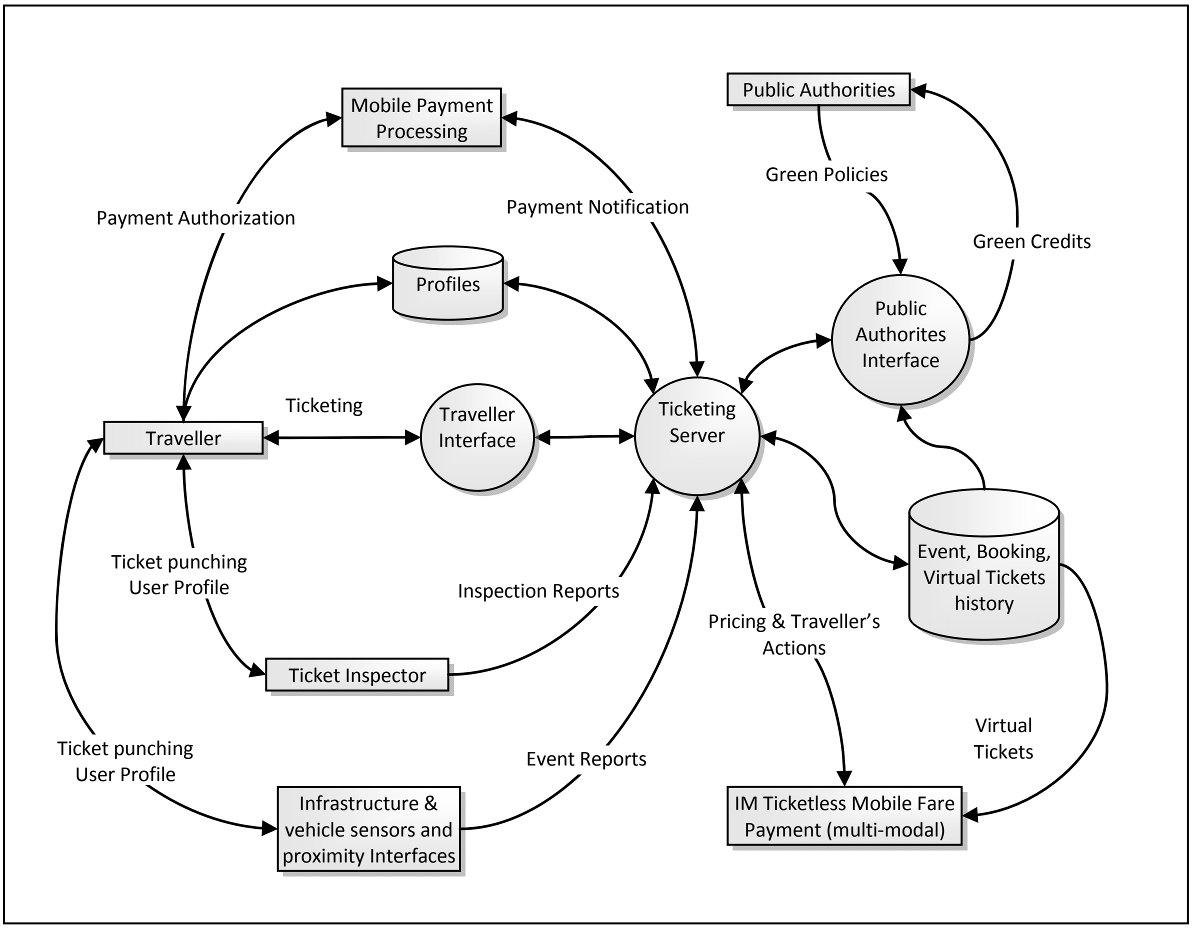



Figure 52 - Data flow of ticketless fare collection

#### 4.6.6 Expected benefits

Travel experience will be easier and simpler, especially for people using collective transport mean just occasionally or for foreign people visiting the city; more flexible, dynamic and fair pricing will be implemented. As a consequence, people will find collective transport more attracting than before, also thanks to more effective rewarding campaigns based on real and documented use of collective means.

Minor costs for transport operators and, indirectly, also for travellers, will also derive from paper ticket disappearance and continuous, accurate income monitoring.

#### 4.6.7 References: other projects, actual services etc.

Examples of advanced payment and ticketing services for public transport:

**Oyster Card** (Transport for London) is a smartcard that allows "Pay as You Go" pricing policy (http://www.tfl.gov.uk/tickets/14836.aspx#Opayg).

**SUICA** and **PASMO** are smartcards used for travelling in Tokyo and other Japanese towns (http://www.pasmo.co.jp/en/index.html, http://www.jreast.co.jp/e/pass/suica.html).

### 4.7 Service 3.f : Driver & passenger security monitoring

Security and confidence are two cardinal requirements to guarantee adoption and development of Instant Mobility services:

- Security of people (passengers and drivers, as well as transport operator staff) regarding incivilities and aggression. Security forces must be able to be alerted in case of a security issue. Investigation teams must be able to collect necessary data to identify offenders and produce related evidences in courts.
- Confidence in drivers and passenger courtesy or behaviour
- Detection of security issues will be automatic (detection of video, audio, behavioural templates) or manual (emergency call, personal security reports).
- After a careful consolidation, rating of vehicles drivers and passengers, will allow to improve global quality of service, the most virtuous actors getting the best capabilities to match their need or to provide mobility services.

A special attention will be paid to privacy, according to the potential legal diversity.

#### 4.7.1 End-to-end service chain

##### *4.7.1.1 Record Security Information*

It will be necessary to record security information in order to be able to re-use this data when a security issue is to be post-analysed.

The data to record can be:

- Video streams
- Audio streams
- Associated metadata (time, location, vehicle context, automatic patterns recognition…)
- Driver behavioural (location, speed, eco-driving …)
- Authentication data
- Emergency call data (context and content)
- Automatic security issues detection (context and content)

Storage will be either local (in the vehicle, in passenger Personal Mobility Assistant, in fixed infrastructures) or centralized (data center / back-office). Anyway a temporary local storage will be generally requested to overcome any communication disruption. Centralized storage of security data can be manage either by each Transport Service Manager, or by a centralised data centre operator, operating the service for Transport Service Managers or for the Transport Organizing Authority.

#### *4.7.1.2 Access and Analyse Security Information*

From stored security information it is necessary to get the necessary tools to extract necessary data to perform the following tasks:

- Security and legal forces investigations,
- Constitution of pieces evidences for further legal actions.
- The extraction of this necessary data will be performed thanks to :
- Manual Extraction of relevant set of streams based on the use of metadata and indexes,
- Automatic extraction of relevant set of streams from known metadata and automatic extraction algorithms.
- From extracted information, security and legal officers will select the necessary data and sequences, to feed further investigations and to constitute necessary pieces of evidence.

#### *4.7.1.3 Detect Automatically Security Issues*

Automatic detection will be performed through two complementary processes:

- Real-time processing of data issued from a single sensor, or from a set of fused sensors.
- Complex Event Processing (CEP), allowing to raise security alerts based on a contextual analysis of real-time available processed information (cf. last bullet), combined by a high performance rules-based engine with other pieces of information and any related history stack of event. It is possible with CEP to relate and combine insignificant of low-level signification events to turn security officers' attention on potentially safety-critical situations.

#### *4.7.1.4 Process Emergency Call*

Emergency calls can be generated either by passengers, drivers (individual or collective transport service providers), or more generally by transport services staff.

In case of emergency call, useful environmental data must be transferred, while a direct and interactive (voice, video, textual) communication is established with transport service managers, infrastructures manager or directly with emergency forces who will evaluate actions to be initiated to process the call. Additional information can be also automatically provided to the call centre, for example a video stream from the camera covering the Emergency Call Box used for the call.

Traditional Emergency Call Boxes are installed in fixed places or in vehicles (trains, buses). The introduction of Personal Mobility Assistants such as smartphones, with a continuous internet connection and geolocation capability, will allow passengers or drivers to raise emergency calls in any place and at any time, provided the communication network continuity is effective.

Furthermore, passenger empowerment will be able to develop, reporting easily and safely reprehensible acts or incivilities, or any other problem that can have a significant effect on people, infrastructure or service.

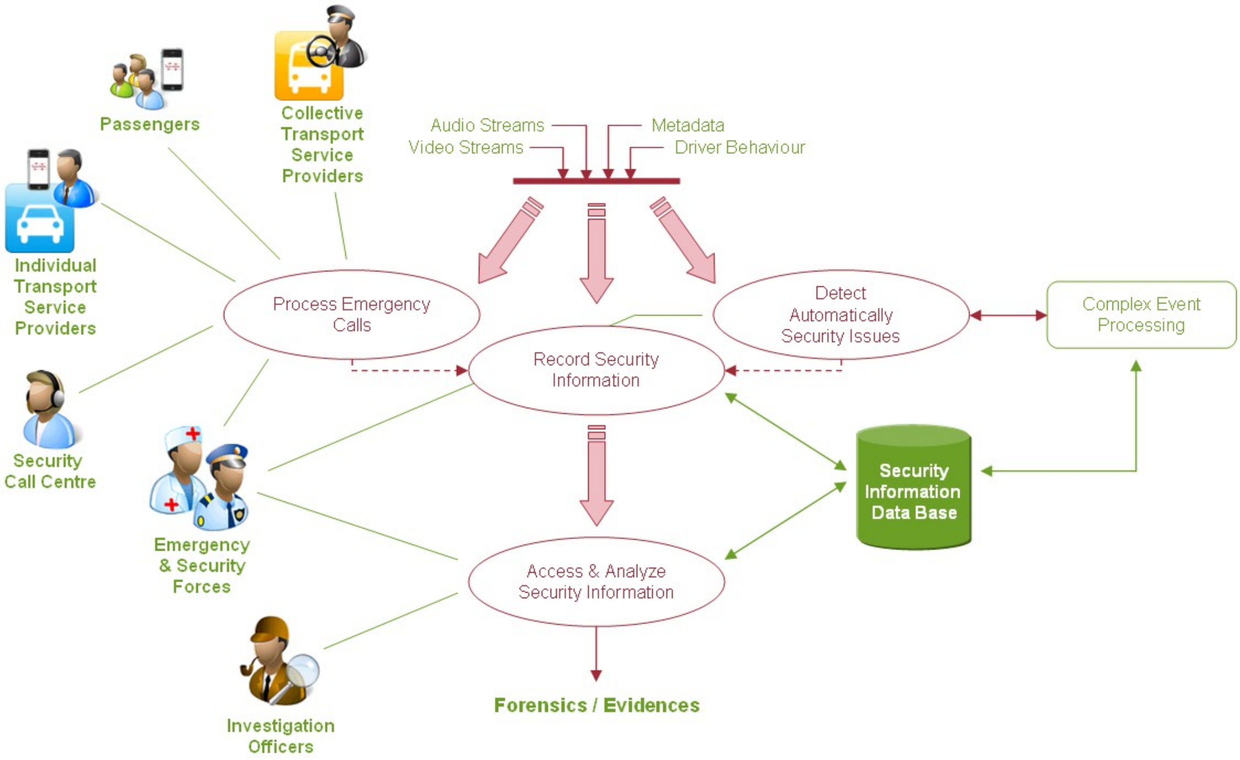



Figure 53 - Driver & passenger security monitoring

#### 4.7.1.5 *Rating*

One of the most important factor to prevent the use of a service like Instant Mobility will be linked to the reluctance people have to share their private sphere with unknown people, whatever they are a passenger or a driver, without any idea of their politeness, civility or capability to have a safe driver behaviour.


Some of these problems can be attenuated by a profile matching effort. For example women may appreciate to drive only women, or a passenger may find interesting to find as a driver who share similar interests like football, golfing or knitting.

However, even when profiles are perfectly matched, the mutual experience can be disappointing due to driver's carelessness, lateness, dirty vehicle, etc.

In today Internet world, digital confidence is efficiently supported by buyers, retailers, restaurants, hotels, etc rating. Rating shows both the percentage of positive appreciation, and the number of appreciations that have been already done. It is possible also to deliver special distinctions, to allow a quick identification of the most virtuous members of the system (e.g. the PowerSellers from ebay). Carpooling web sites also implemented rating mechanisms for drivers and passengers.

Rating will apply to drivers (individual transport services providers) and to the passengers. *It is possible to extend rating to other categories of actors (collective transport, infrastructures, service retailers…).*

Rating process should comply with the following guidelines :

- Rating must not be considered only as a way to highlight bad experiences, but also as a way to understand why an experience was negative, and how it could have been positive. A good example is again on ebay, who suggest to explain in detail why the experience was negative, and who ask the other party how the negative experience can be turned out in a positive one. Moderator will be required for the sake of rating credibility.

- It is not possible to get rating from 100% of the transactions. Either un-evaluated transactions are considered as positive, or are not used to compute rating.
- Mutual rating should be stored in profile history, in order to favour “positive” future matching and avoiding “negative” ones.
- Driver rating can be automatically affected by the detection of their ability to respect road legislation, such as speed limits. As soon as private drivers offer mobility services to passengers it should controlled whether they are safe drivers or not.

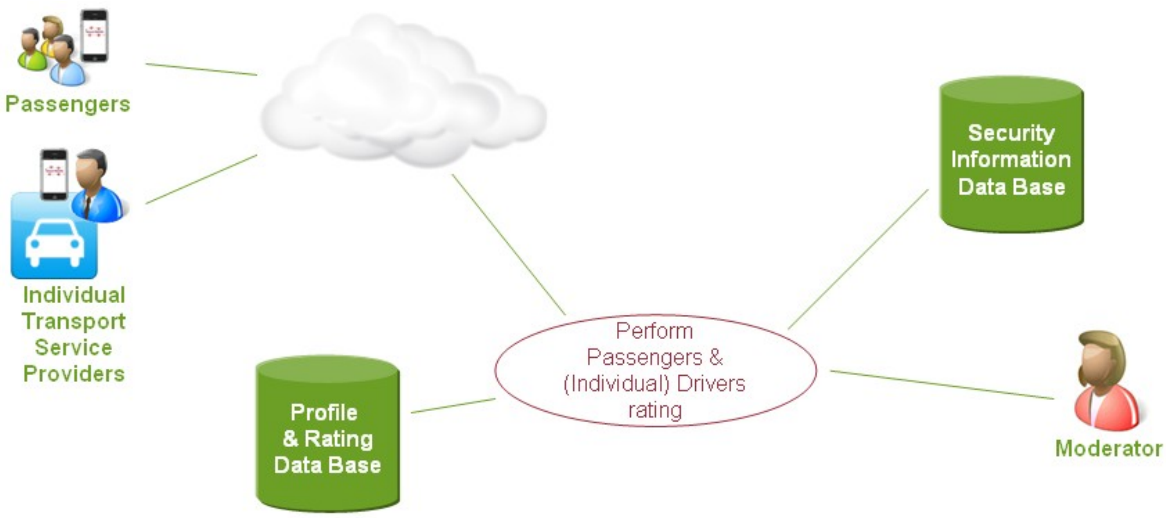



Figure 54 - Passengers and Individual Drivers Rating

#### *4.7.1.6 Privacy*

As personal data have to be recorded to feed the rating process, a special attention must be paid to privacy considerations. Conformity with local legislation will have to be implemented. Preliminary privacy terms & conditions will have to be defined and accepted by Instant Mobility users (private users: passengers & drivers), and access and modification policy will have to be defined.

Recording audio or video streams means that people may have the right to access to these streams. Limitations in the local legislations may define different rules regarding storage duration, streams authentication, rules to define who is entitled to access this data, and how to access it.

Another privacy point is related to the special case of anonymous users. Instant Mobility should be restraint the capabilities passengers have today to use public transports or taxis anonymously.

Anonymous profiles might be created, with an associated pseudo-identity, and different levels of anonymity, based for example on requirements associated payments means, or the type of mobile phone contract owned. A pre-paid account is compatible of the highest anonymity features, while a post-paid account will request at least that the financial clearing house knows about the personal account to be debited.

Different policies will be possible for these users, for instance:

- Strict limitation of mobility solutions to public transportation means (trains, buses, trams, taxis, shared bicycles…).

- Give the choice for individual transport service providers to refuse or accept to handle anonymous passengers, based on the real anonymity level.

### 4.7.2 Service capability comparison description (today, future)

Under discussion

### 4.7.3 Service components

Under discussion

### 4.7.4 Actors, their roles and relationships

Under discussion

## 4.8 Service 3.g : Taxi sharing

Taxis can pick up and drop off additional passengers along the route through online service to match potential users with actual shared taxi availability (location and destination, number of places etc.) This will require information exchange among passengers, taxis, taxi operators, road operators and operators of other transport modes.

### 4.8.1 End-to-end service chain

Taxi can be used as a sole mode for a short trip, or as a part of a multi-modal journey. The following diagram shows the end-to-end chain of the service.

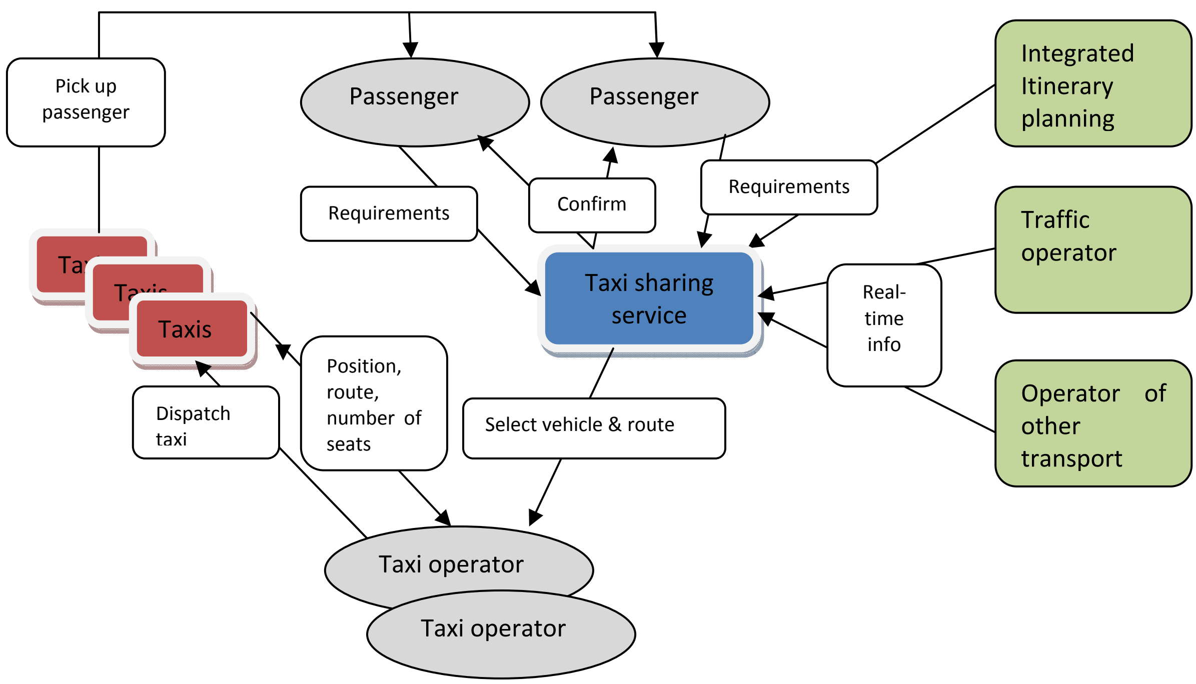



Figure 55 - Diagram of the end-to-end chain of taxi sharing service

Two use cases are shown below as example to explain how the taxi sharing service works:

- Use case 3g_1: Use taxi as sole modal for a short trip;
- Use case 3g_2: Use taxi as a multi-modal journey and sharing a taxi is part of integrated journey planning

| **Use Case ID** | UC_3g_1: Calling a taxi for a short trip |
|---|---|
| **Scenario title** | Collective transport |
| **Services name** | Taxi sharing |
| **Short Description** | Service provider's perspective<br>The service provider collects information on taxis' position, destination and number of available seats in the vehicles. The service provides hold passenger information through pre-registration. When a passenger requires a taxi, the passenger's location can be automatically reported via mobile location device. The service provider will select a taxi for the booking based on background of the passenger who required the service, current taxi's position, destination and number of available seats, information of current passengers in taxi. The service provider will confirm the booking and inform the passenger pick-up location and information of the taxi. The taxi will be sent to the pick-up the passenger.<br><br>Passengers' perspective<br>A passenger may send his/her requires via mobile device. Location of the passenger can be automatically reported to the operator if the passenger intends to take a taxi at his/her current location. The passenger will be informed when/where/what kind of taxi to pick him/her up. Basic information on existing passengers (numbers of passengers, gender etc) may be given. The payment may be done via ticketless mobile fare payment. |
| **Goal** | - To achieve high occupancy of taxis to reduce number of journeys, thus reducing total $CO_2$ emission and<br>- To make taxi operation more efficient<br>- To make taxi booking easy |
| **Potential Constraints** | Passengers may not like to share a vehicle with strangers even security can be guaranteed.<br>The service requires pre-registration. Passengers' information held by the service provider may lead concerns on privacy.<br>Passengers may expect longer waiting time and longer journey time since the taxi may pickup and drop other passenger en-route and take a small detour. |
| **Components** | Passenger registration system; passenger booking interface (via website or mobile device); passenger location unit via mobile device (optional); taxi on-board unit; taxi dispatching and operation system; taxi sharing service centre (e.g collecting information from all taxi companies and passengers, traffic information, etc) and calculate the sharing scheme |
| **Main flow** | All users of this service should register with the service. When a user searches for trip planning, there is no good public transport link and the integrated trip planning service can recommend taxi sharing. Or the user carry heavy luggage, or have difficulties to use other modes, the user can request a taxi service.<br>The user may request a taxi immediately at where he/she is, or pre-booking a taxi in advance. If the user requests a taxi to pick him/her up as where he/she is, the user can use mobile device to book a taxi, the mobile device will gives the location to the service.<br>The service will search all taxis' current position, destination, planned routes, available spaces in vehicles, and traffic information in order to select the most suitable taxi. The service will use up-to-date traffic to forecast the taxi arrival time. When a taxi is selected, the system will inform the user when the taxi will be there, and what should the user expect. |

| Use Case ID | UC_3g_2: Taxi sharing as a part of integrated multi-modal journey |
|---|---|
| **Scenario title** | Collective transport |
| **Services name** | Taxi sharing |
| **Short Description** | Service provider's perspective<br>When a user requests a journey plan through integrated mult-modal journey planner, the journey planner may give taxi as one mode for a certain part of the journey due to unavailable other modes or heavy luggage, or difficulties in travelling.<br>The service is informed by integrated multi-modal journey that a taxi for the user is needed for the certain part of his/her journey. The service will select a taxi based on other pre-bookings, traffic situation and user's characteristics. The service will then give the information to the multi-modal journey planner. The multi-modal journey planner will inform the user where and when to take the taxi.<br>If the journey is interrupted, e.g. delay of previous transport modes, the service will be informed to send the taxi earlier or later or re-calculate which taxi to be used.<br><br>Passengers' perspective<br>The passenger will be informed as part of the integrated journey plan where and when to take a taxi, and what kind of taxi and sharing with whom. If the passenger arrive the location later or earlier, the passenger will be informed changes of taxi's booking, i.e. different time or location or vehicle or shared passengers. The payment may be done via ticketless mobile fare payment. |
| **Goal** | - To achieve high occupancy of taxis to reduce number of journeys, thus reducing total $CO_2$ emission and<br>- To make taxi operation more efficient<br>- To make multimodal journey easier and smoother<br>- To maximise traveller' comfortable level of a multi-modal journey |
| **Potential Constraints** | Passengers may not like to share a vehicle with strangers even security can be guaranteed.<br>The service requires pre-registration. Passengers' information held by the service provider may lead concerns on privacy.<br>Passengers may expect longer waiting time and longer journey time since the taxi may pickup and drop other passenger en-route and take a small detour. |
| **Components** | Passenger registration system; passenger booking interface (via website or mobile device); passenger location unit via mobile device (optional); taxi on-board unit; taxi dispatching and operation system; taxi sharing service centre (e.g collecting information from all taxi companies and passengers, traffic information, etc) and calculate the sharing scheme |
| **Main flow** | All users of this service should register with the service. When a user searches for trip planning, the integrated trip planning service gives taxi sharing as one mode for a part of the journey. The journey planner will inform the taxi sharing service and ask a taxi to be booked for the journey.<br>The service will search all taxis' pre-booking, available spaces in vehicles, and historical traffic information in order to select the most suitable taxi. The service will use historical traffic to forecast the taxi journey time and inform taxi operator when the taxi should be dispatched. The system will inform the journey planner registration number of the vehicle, type of the vehicle and passengers to share the taxi.<br>The journey planner will integrate the information as part of the journey plan and deliver to the user. The user will be guided to the taxi waiting location and find the taxi. |

### 4.8.2 Service capability comparison description (today, future)

| **Service today (if it exists)** | **Service in future (with Instant Mobility)** |
|---|---|
| Taxi companies may have difficult to arrange a taxi when a booking request is received since all taxis have been occupied or booked. | A taxi can be shared and maximise its occupancy. |
| Pre-booking taxis, passenger needs to give the pick-up location | Taxi sharing service can automatically locate location of the passengers and suggest the best pick-up location |
| Pre-booking taxi normally for one passage (or one group of passengers) only | Taxi sharing service can arrange a number of passengers whose share the same route or parts of the route. The passengers may not know each other. |
| Passengers may wait for long to have a taxi arriving, he/she may see many taxis with only one passenger on board but not stop for him/her. | Passengers will have minimum delay to get on a taxi. Passengers can be picked up by an occupied taxi with available space. |
| Sometimes passengers may share a taxi involuntarily, causing concerns on security and unfair payment | Taxi sharing service hold passenger information and mitigate risks of security |

### 4.8.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Passenger registration system | Register passenger's information including age, gender, special needs, etc | taxi sharing service centre | End-to-end itinerary planning (1a); Ticketless mobile fare payment (1g) |
| Passenger booking interface (via website or mobile device); | Passenger can use the interface to submit a booking request | taxi sharing service centre | Ticketless mobile fare payment (1g) |
| taxi on-board unit | Giving real-time information on location of the taxi, planned route, destination, current occupancy | taxi sharing service centre; taxi dispatching and operation system | |
| taxi dispatching and operation system; | Giving instruction to taxis where they should go and what to do | taxi sharing service centre; taxi on-board unit | |
| taxi sharing service centre | collecting information from all taxi companies and passengers, traffic information, etc and calculate the sharing scheme;<br>Giving instruction to taxi operator how to dispatch taxis;<br>Giving information to passengers to confirm booking and where/when the taxi will be there and to share with whom | Passenger registration system; passenger booking interface (via website or mobile device); passenger location unit via mobile device (optional); taxi on-board unit; taxi dispatching and operation system; | End-to-end itinerary planning (1a);<br>Real-time traveller monitoring (2b) |

### 4.8.4 Actors, their roles and relationships

| Actor | Roles | Relationships between actors |
|---|---|---|
| **Service provider** | Collecting information from passenger via pre-registration, collecting requests, collecting positions/destination/planned routes of taxis, collect historical and real-time traffic information, calculating sharing scheme, giving instruction to taxi operator and inform users | In charge of the service; Responsible for communication with other actors in the service chain |
| **Taxi operator** | Providing introduction to taxi drivers; providing static and dynamic information of its taxi fleet | Communicating with service provider and taxi driver |
| **Taxi drivers** | Receiving instruction from operator and follow the instruction to pick up passengers | Communicating with taxi operator |
| **User/passenger** | Registering with the service; Submitting request; Receiving information; Use the service | Communicating with service provider |

### 4.8.5 Data: data flows, databases

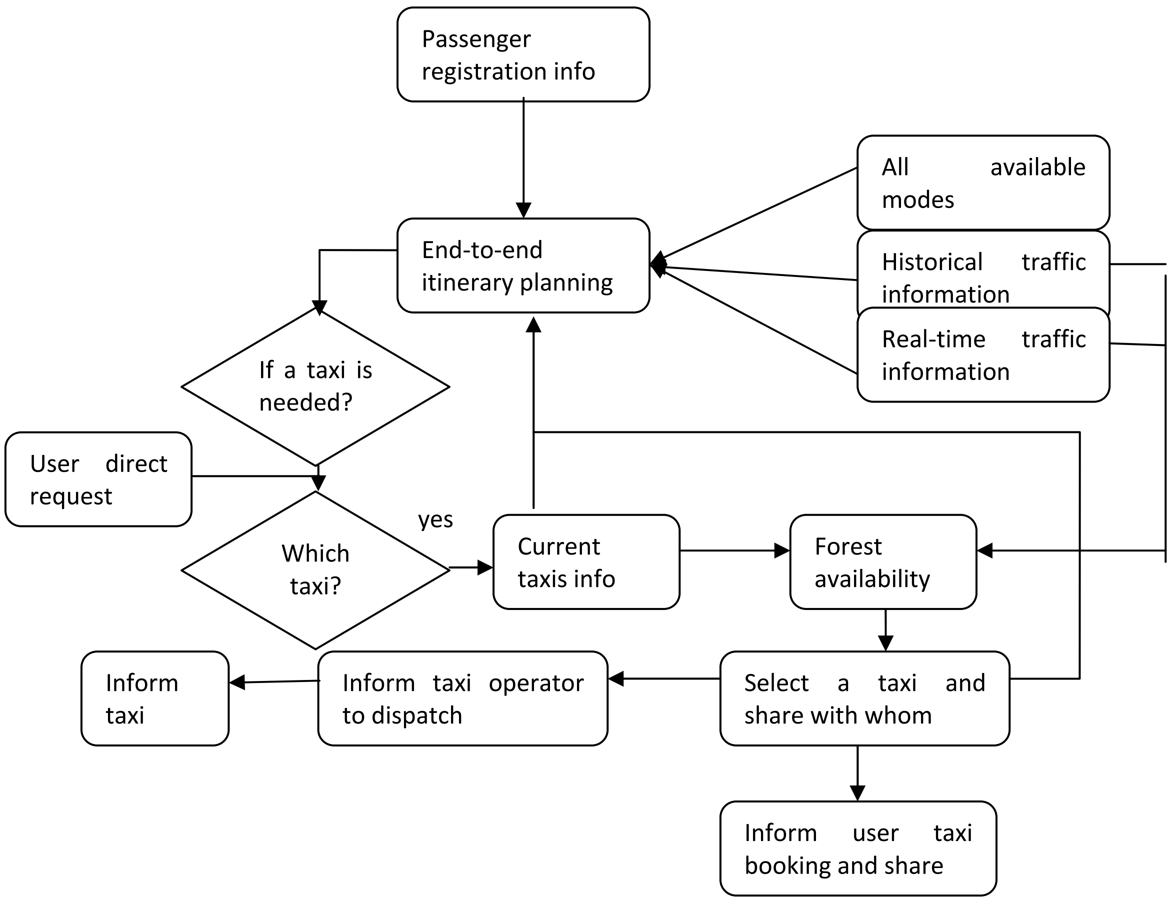



Figure 56 - Diagram of the data flow of taxi sharing service

### 4.8.6 References: other projects, actual services etc.

N/A

# 5 Scenario 4 – Trucks and the city

## 5.1 Scenario summary

The scenario starts from goods pick-up at an intermodal hub at the city perimeter or within the city with the aim of delivery at another hub or at the receiver. This scenario shows how Internet-based services can manage commercial vehicle deliveries and routing, organize drivers' shifts and synchronize vehicle movements and goods pickup and reception. In this scenario all actors, e.g. vehicle, driver, load carrier, goods, infrastructure and back-end systems, involved in commercial transport are connected to and through the future Internet.

### 5.1.1 Purpose

- The expected benefits are reduced congestion, noise and air pollution as well as increased mobility of cargo flows within the urban zones.
- The increased transport efficiency will improve competitiveness and profitability of service users (cargo owners, transporters, 3PL, cargo receivers)
- The end result will be enhanced mobility and quality of living for urban dwellers and society

### 5.1.2 Problems to be solved

- Too many vehicles in city centre (congestions, full loading/unloading spaces, security for people etc)
- Pollution (CO2, particles) and noise pollution in city centre (decreasing life quality for citizens)
- Complexity (impossible to drive everywhere with all vehicles). More congestion leads to higher uncertainty and this leads to non-optimised fleet and resources (more vehicles to deliver same cargo volume)
- Where to deliver? Information following goods is not always accessible to all stakeholders in the delivery chain
- How do authorities internalize pollution costs? (make the polluter pay)
- New shopping patterns (e-trade) create new demands on how and when to have goods delivered to its final destination

### 5.1.3 Rationale: how Future Internet solution could address the above problems

In urban and inter urban areas, delivery systems require detailed information and identification of all goods and will transform freight vehicles such as trucks and vans as components of internet of things. Freight vehicles will integrate Trucks Local Network to manage the local content (i.e. units) as associated services for logistics companies. Vehicles, goods items, containers etc. (i.e. units) will become detectable mobile things for geographical areas, targets for individual local services to manage resources, local restrictions and access as well as the available space to take new goods along the optimal route and to develop new innovative business models. Cellular technologies will propose bi directional information flows and customers and suppliers will be able to update goods profiles and characteristics in a homogeneous way. Social network services will support context aware and profiles information where B2B2C supply chain actors will describe, in real time, where they are and how they could deliver or take delivery.

The Future Internet will provide enabling technologies to allow:

- Seamless connectivity anytime/anywhere of passenger with the Instant Mobility network and resources
- Real-time transmission of measured data, real-time processing of this data, and real-time distribution of processed data
- Secure data transfer for payment and access control services
- Scalability of the system, allowing a growing number of users, without the need to review architectural fundamentals, and taking benefits from cloud resources to manage increasing needs in computing capabilities.

### 5.1.4 Short description of each service as a whole

- **4a Load sharing & balancing** - Online exchange to mash up cargo requests with available transport, eliminating empty trips. May be combined with special "city logistics" vehicles. This kind of services addresses the need of transport management.
- **4b Loading/unloading zone booking** - Online reservation service for on- or off-road loading/unloading spaces. Includes space availability info, fee payment if needed, physical access control and enforcement. This kind of services addresses the need of terminal management.
- **4c Goods Supply Chain Visibility -** Trace and tracking of connected goods to provide optimized and sustainable new services, avoiding lots of inconsistencies during last mile deliveries journeys.
- **4d Urban optimized fleet management** - Internet-based application using vehicle-infrastructure network to adapt traffic signal timings to synchronize with goods vehicle itineraries, and to update fleet planning with real-time traffic information & recommendations.
- **4e Automated access control** - Service to enhance inbound traffic to hubs such as ports and terminals. Making sure the driver has the right certificates to drive the specific load, making sure the vehicle is allowed inside the terminal.
- **4f Dynamic time/place drop point -** Increased flexibility in delivery of goods launching a service that dynamically points out the right time and place for delivering every single package. Taking feedback/info from consignee and also the traffic/other issues in the city centre (see "Urban optimized fleet management" and "Real time traffic navi") under the concept that everything and everybody is "pingable".
- **4g Traffic zone control -** This service will automatically control that the vehicles entering a specific zone is allowed to be there. Zones could be dynamic allowed to change in order to reach environmental or mobility goals of the city
- **4h Green Corridors** - Transport from larger hubs such as ports, railway stations through the city ring roads benefits from interconnected cruise control solutions (i.e. platooning) allowing a number of vehicles to adapt accelerations and decelerations in a coordinated manner.
- **4i Eco-driving support** - Online community and service to monitor truck drivers' fuel use and provide recommendations or reducing consumption based on peers' performance; managers can monitor consumption in real time and compare with other drivers, and provide incentives for improved performance. This kind of services addresses and encourages CO2 consciousness by driver.

*<u>Further concepts</u>*

- **Real time traffic optimized route navigation -** Dynamic navigation updated in real time according to traffic situation near the distribution vehicles.
- **All in-vehicle information in native tongue -** All information in vehicle shall be available in the drivers' native tongue.
- **Security** - Security features for goods, vehicles, terminals and all actors involved. "Thousand eyes" Drivers should be able to report suspicious activities, accidents, and crime and traffic regulation. Imagine if everyone spotting a forbidden vehicle and reporting it, get half of the fines charged by that vehicle

### 5.1.5 How services interact and combine within the scenario

The services within the scenario all relate to commercial distribution vehicles. Furthermore they all support the aggregation, the processing and the dissemination of information necessary to enhance the pick-up and delivery of goods within urban centres.


Figure 57 - Service interaction in Scenario 4

### 5.1.6 Summary of main actors and roles, and affected stakeholders

| Actor | Role |
|---|---|
| Cargo owner | Set requirements |
| Logistic service providers | Coordinate transport needs |
| Transport service providers | Pick-up & deliver cargo |
| Terminal/port/intermodal hub operator | Coordinating inbound and outbound cargo flows from a production/distribution perspective |
| | |
| Urban dwellers | Buyer of goods |
| City traffic authority | Responsible for securing mobility, planning and upkeep of city infrastructure and for keeping target levels for noise and air pollution |

#### 5.1.7 Expected benefits

- Increased cargo and people mobility
- Reduced pollution ($CO_2$, $NO_X$, particle emissions)
- Reduced Noise and congestions
- Better use of public funds
- Increased standard of living for urban dwellers

### 5.2 Service 4a: Load sharing and balancing

A distribution truck driver is about to execute a transport mission where three packages shall be transported from the outskirts of the city to the city centre. Before taking on this mission, the driver delivered goods to a café close to the central station which he/she has just dropped-off and the truck is now empty. The fleet operator has not received any other transport request to or from the particular part of the city outskirt where the three packages are to be picked up and therefore has unused capacity. The truck consequently risks going empty to the outskirts and merely half-full on its way back.

The transport planner has implemented a set of control mechanisms in his/her back-office system (interlinked with the fleet management system) which detects the low capacity utilization for the transport mission to be executed. Automatically, the back office system connects to the online exchange portal to search if there is any transport requests which can be accepted to enhance the truck utilization. The system detects a transport request from a warehouse about 10 minutes from the trucks current position. The warehouse operator asks for a transport to a gas station along the planned route to the city outskirts. The back-office system notifies the transport planner on the transport request who chose to accept the mission. The truck driver is immediately notified through the on-board system. By accepting the new transport mission, the transport need was efficiently and effectively fulfilled.

#### 5.2.1 End-to-end service chain

<u>Service consumption</u>

The service has two different kinds of users, the cargo senders and the transport providers.

If an actor needs to send goods but have not yet booked a transport, there is obviously an option to contact a transport provider and book the transport. Alternatively, the goods sender can report his/her transport demand to an online transport exchange portal and hope that a transport provider has excess capacity which can be utilized. The cargo sender is asked to provide the following information to be able to match the need to a transport provider's excess capacity:

- Pick-up address
- Delivery address
- Earliest and latest pick-up possible
- Earliest and latest delivery possible
- Size and weight of goods
- Goods classification
- Maximum price accepted

Other prerequisites and transport need characteristics

The transport provider with excess capacity is the other service user. To search the online exchange portal, the following information should be provided (search information can be entered either manually or automatically):

- Planned itinerary
- How much additional cargo that can be picked up (size and weight)
- Particular characteristics of the truck (e.g. refrigerated trailer)
- For how long the search query is valid
- Other goods restrictions and transport capacity characteristics

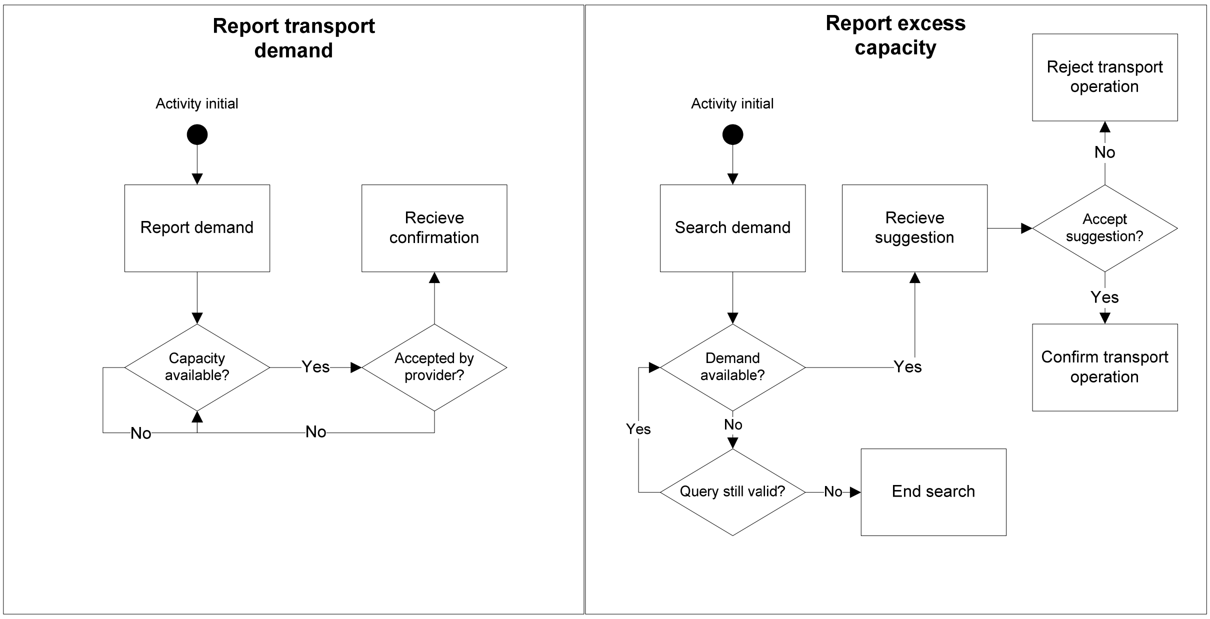



Figure 58 - Load sharing and balancing from the cargo senders' and transport providers' perspective

Below, an overview of the load sharing and balancing service is depicted:

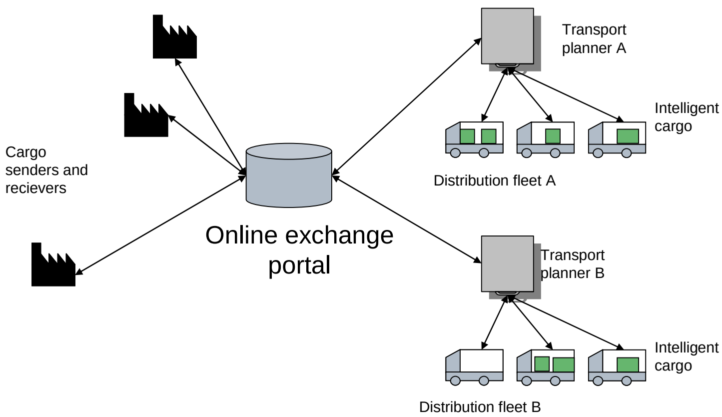



Figure 59 - Overview of the load sharing and balancing service

### 5.2.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|

| | |
|---|---|
| **Online exchange portals** exist today. Cargo owners post their transport needs several days in advance, and willing transporters bid for the contract. | Dynamic exchange based on real time transport needs and available transport capacity |

### 5.2.3 Service components

| *Nr* | *Name* | *Description and role* | *Comments* | *Involved actor* |
|---|---|---|---|---|
| *1* | *Transport exchange portal* | *It enables cargo senders and transport operators to match transport mission with excess capacity* | *It is implemented as on online service with a web interface for manual operation, and an interface for automatic interconnection with back-office systems* | *Software provider* |
| *2* | *On-board unit* | *It enables new transport missions or changes to the transport itinerary to be communicated effortlessly to the truck and its driver.* | | *Vehicle OEM* |
| *3* | *Traffic planner's back-office system* | *It can interconnect with the exchange portal to automatically search for transport missions which suit the fleet operator's current itineraries'* | *A control mechanism is added to the current back-office system which detects unused capacity and automatically tries to match this to reported transport needs.* | *Software provider* |

### 5.2.4 Actors, their roles and relationships

| *Nr* | *Name* | *Main actions* | *Relationships within the service* |
|---|---|---|---|
| *1* | *Transport planner* | *Report excess capacity to portal, search portal for suitable transport needs to fulfil* | *Service provider* |
| *2* | *Consignor* | *Post transport needs to portal* | *Service provider* |
| *3* | *Consignee* | *Post transport needs to portal* | *Service provider* |
| *4* | *Service provider* | *Provides, manages and updates the transport exchange portal* | *Transport planner, Consignor, Consignee* |

#### 5.2.5 Data: data flows, databases, required input from other services

In the figure below, the data flow of the load sharing and balancing service is depicted from the exchange portal's perspective. The circle indicates the operation performed by the system, two vertical bars indicates a database where information is stored and the rectangles depict actors with whom the exchange portal interacts.

Shippers provide information about transport missions which they want to have carried out and transport planners similarly provides information about excess capacity. If the exchange portal is able to match requested missions with excess capacity the transport planner or truck driver (depends on who has reported the excess capacity) receives notification on the identified match. The transport planner or truck driver can then chose to accept the new transport mission which in such case is being added to the itinerary. Once a match has been accepted by a transport planner or truck driver a confirmation is sent to the shipper.

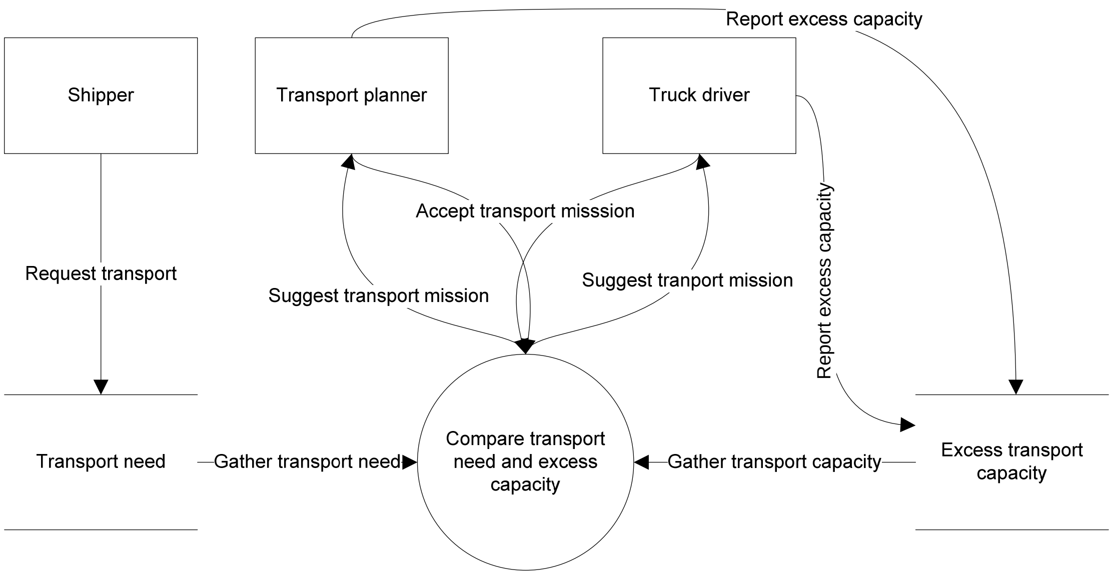



Figure 60 - Data Flow of Load Sharing and Balancing Service - exchange portal's perspective

### 5.2.6 Expected benefits

Access to the same information and ability to share spare transport capacity is expected to increase the vehicle fill rates on each vehicle entering the urban zone.

The expected benefits are reduced congestion, noise and air pollution as well as increased mobility of cargo flows within the urban zones.

For users of the system the increased efficiency and access to new customers and transport missions is expected to contribute to increased sales and profitability.

### 5.2.7 References: other projects, actual services etc.

**GoodsNet** was a project proposal to develop a common European network, a platform where future innovative network-based goods services could be deployed. The idea was to create one common area for different actors to meet and interact to exchange information. The use of ICT to communicate information about the goods and the vehicles were highlighted. One service which might have been possible to run on a platform like the one suggested by GoodsNet is the load sharing and balancing service described above.

## 5.3 Service 4b: Loading/unloading zone booking

A driver is delivering bread from a local bakery to downtown convenience stores. Through the on board navigation system the driver receives information about the itinerary; the system lets the driver know at what time he/she is expected at the different drop-off locations and what unloading zone that shall be used.

Not only does the navigation system guide the driver to the drop-off location but also updates the route in real-time to avoid e.g. congestions and road works (facilitated through the *Real time traffic optimized route navigation* service). The system further guides the driver to the proper loading bay and automatically sends an estimated time of arrival, ETA, to the staff at the unloading zone as the vehicle approaches.

By having time-slots at loading/unloading zones reserved, the driver can avoid time-consuming and polluting circulation and does not have to park in unsafe ways such as double parked in the middle of the street. This helps the driver maintain the schedule and avoid stressful and potentially dangerous situations.

### 5.3.1 End to end service chain

<u>Service consumption</u>

The service consumer is considered to be the transport provider/fleet operator who is able to plan the routes of its trucks more efficiently. When planning the routes, the transport planner's planning system accesses information about what time-slots and loading bays that are available at each of the destinations and book delivery slots according to the most efficient distribution/pick-up plan. By requesting a time-slot at a loading bay, that time-slot becomes unavailable for other potential users.

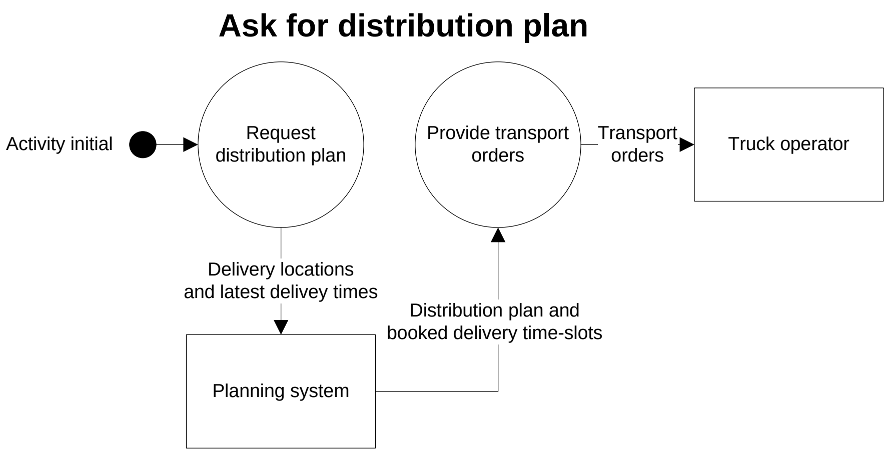



Figure 61 - The transport planner requests a distribution plan including booked time-slots

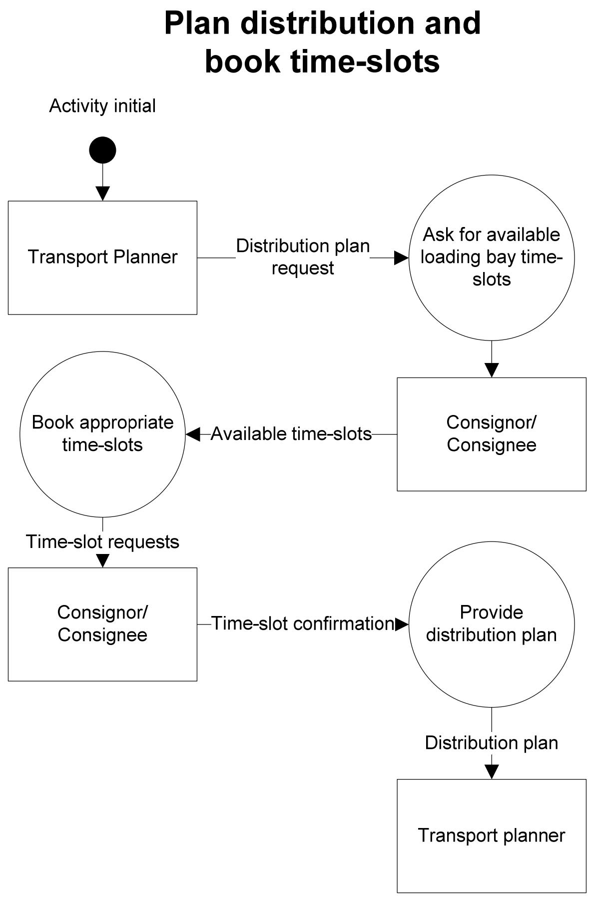



Figure 62 - The transport planning system books time-slots and provides conforming distribution plan

The truck driver receives the distribution/pick-up plan through the truck's onboard system. The built-in navigation system then provides directions to the next destination and also displays at what time the driver is expected to get there. When the truck approaches the destination an ETA is sent to the receiver and the vehicle is guided to the proper loading bay by the on board site navigation service, provided through the fleet management system.

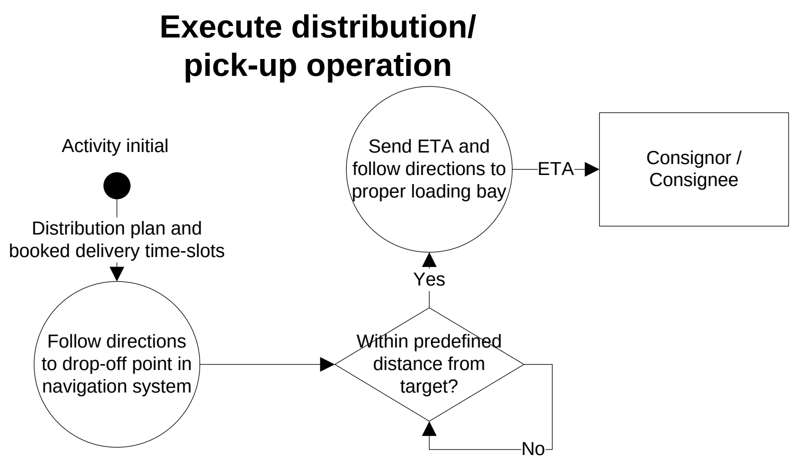



Figure 63 - The truck driver gets directed to the destinations and sends out an ETA on approach

Service delivery

The service providers are the different stores, warehouses or other actors to which deliveries are to be made. Their main role in the loading/unloading zone booking service is to provide information to transport planning systems about which loading bays and time-slots that are available for delivery/pick-up operations. When receiving a booking request for a particular time-slot, that time-slot has to be marked as unavailable for other transport providers. The staff at the loading bay receives a notification as the vehicle approaches the loading bay.

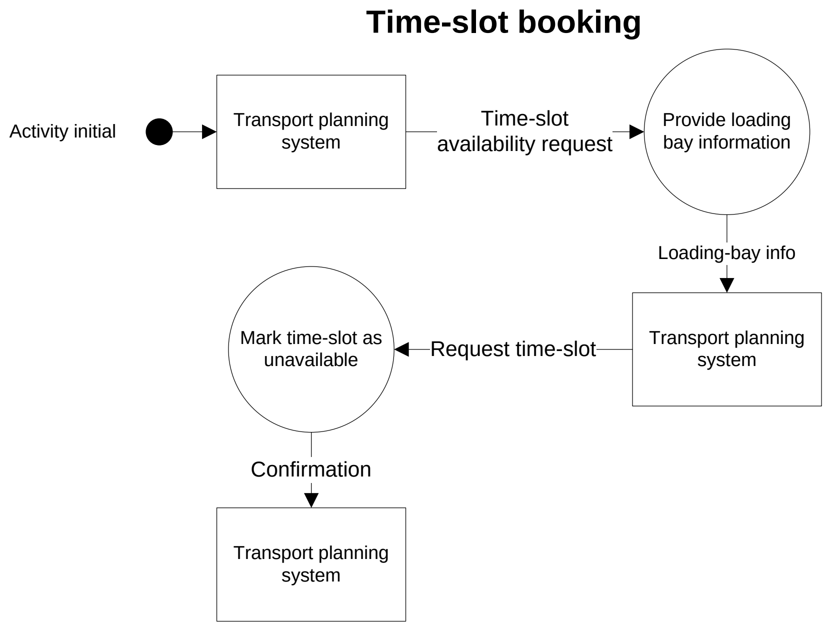



Figure 64 - Time-slot booking from the consignor's/consignee's perspective

Below, an overview of the delivery zone booking process is depicted.

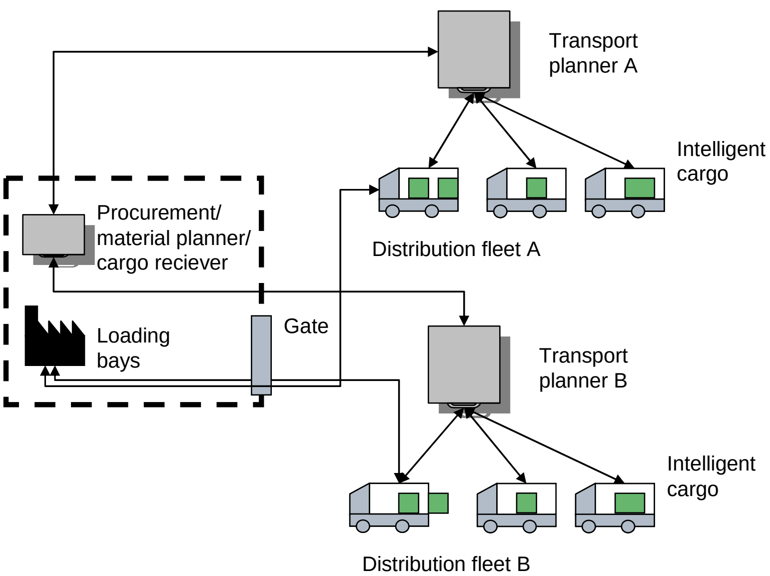



Figure 65 - Overview of the loading/unloading zone booking service

### 5.3.2 Service capacity comparison description

| Service today (if it exists) | Service in future (with Instant Mobility) |
| --- | --- |

| | |
|---|---|
| Procurement office/material planner or cargo receiver sometimes communicates preferred delivery times. Booking services are rarely used. No integration with transporters transport management systems are available | Transport providers are allowed to book the delivery times most beneficial to them, based on constraints provided by the cargo receiver. The information is available regardless of which Transporter that is delivering the final leg of the cargo's journey. Normally this is unknown to the cargo receiver who only communicates with the 3PL/logistic service provider |
| On-site navigation support today is normally just an oral instruction at the gate (if there is a gate) to follow the signs to gate NN | On site navigation support will utilize visual aid through augmented reality technology (projected on wind screen?) and will be further aided by voice support (in native language) based on the GPS position of the vehicle |

### 5.3.3 Service components

| *[Nr* | *Name* | *Description and role* | *Comments* | *Involved actor* |
|---|---|---|---|---|
| *1* | *Transport planning system* | *Plans the itinerary for the fleet operator's vehicles, requests loading/unloading zone information and makes reservations* | *It is software run on the traffic planner's computer. May be interconnected to the zone booking system for automatic booking requests.* | *Software provider* |
| *2* | *Loading/unloading zone booking system* | *Keeps track of the availability of the consignors/consignees' loading/unloading zones and processes* | *It is a system matching requests with available loading/unloading zone slot-times.* | *Software provider* |
| *3* | *Web-site interface* | *It enables traffic planners without an interconnected planning system to reserve loading/unloading zones* | *It is a web-site accessible through a computer with Internet* | *Software provider* |
| *4* | *On-board unit* | *Allows directions and itinerary to be communicated to the driver through the vehicle's HMI system..* | *It is a sw macro-component which is installed on the on-board telematic system and represents the gateway between vehicle system and Instant Mobility* | *Vehicle OEM* |

#### 5.3.4 Actors, their roles and relationships

| *Nr* | *Name* | *Main actions* | *Relationships within the service* |
|---|---|---|---|
| *1* | *Driver* | *Adhere to itinerary and Follows directions from navigation system* | *Fleet operator, Consignors/consignees* |
| *2* | *Fleet operator* | *Requests time-slots* | *Driver, Service provider* |

| | | | |
|---|---|---|---|
| | | *and plan itinerary (through planning system)* | |
| *3* | *Consignors/Consignees* | *Provides information about loading/unloading zones* | *Service provider* |
| *4* | *Service provider* | *Provides, manages and updates the loading/unloading zone booking system* | *Fleet operator, consignor / consignee* |

### 5.3.5 Data: data flows, databases, required input from other services

Service consumption

The main user of the system is considered to be transport planners. When planning the itinerary of a truck, the transport planner or transport planning system can access information about available loading zones/bays and time slots at the different pick-up/drop-off locations the trucks are going to visit. The transport planner or transport planning system puts together the itinerary and books suitable loading/unloading zones.

When the truck approaches the location for the pick-up/drop-off, information about what loading zone/bay that has been booked and at what time it is booked is communicated to the driver. The driver thereby does not have to circulate to look for a suitable place to park or wait for someone else to leave the bay. When approaching the zone or bay, an ETA is also sent so that efficient loading/unloading can be prepared by e.g. the staff of a terminal.

The figure below depicts the information flow and activities performed from the transport planner's/transport planning system's perspective. The rectangles represent actors who interact with the transport planner/transport planning system and the circle depicts the process carried out by the transport planner/transport planning system. The two horizontal lines depict a data source. Information is fed from and extracted from the data source. Some logic and functionality is also likely to be available. The data store and underlying logic and functionality can e.g. be provided by a service provider gathering information from many consignors/consignees.

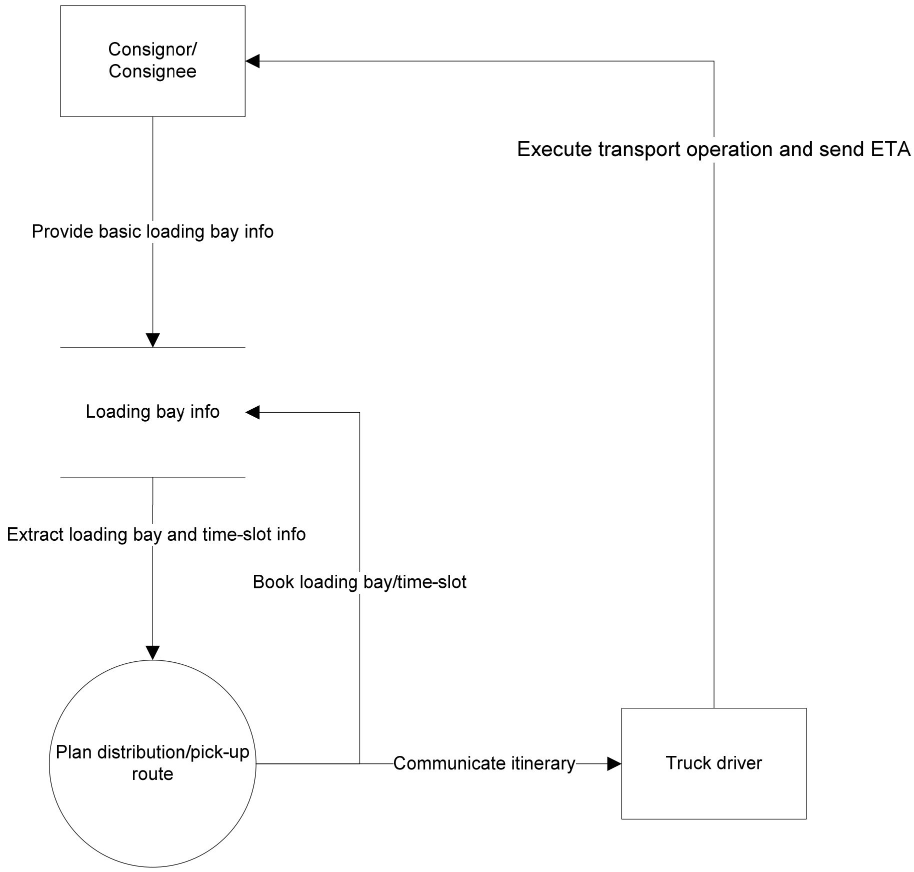



Figure 66 - Data flow of loading/loading zone booking service

Service provision

Also seen in Figure 66 above is that the consignor/consignee provides basic information about bookable loading/unloading bays. Such information can e.g. be name, location and opening hours. The service provider then keeps track of the time slots that are booked by transport planners or transport planning systems and ensures that a loading bay is not double booked for any period of time.

### 5.3.6 Expected benefits

By sharing the information on preferred delivery times between cargo receiver, 3PL and the associated transporters the transporters planning capability will be enhanced.

By allowing transporters to book a delivery slot (within permitted limits) based on their convenience.

The expected benefits are reduced congestion, noise and air pollution as well as increased mobility of cargo flows within the urban zones.

Improved safety for the drivers who can avoid parking in unsafe locations (e.g. have to stop in the middle of the street)

### 5.3.7 References: other projects, actual services etc.

FREILOT – Delivery Space Booking

The FREILOT project will pilot Delivery Space Booking functionality in Lyon, France and Bilbao, Spain. Two systems will be piloted, one in France and one in Spain. Both systems will feature a web-application for delivery space booking where the availability of the different delivery spaces used in the project is shown. A fleet operator can reserve time-slots at the various delivery spaces.

When a delivery space is booked it is in France indicated by a LED-sign put on a pole next to the delivery space. In Spain LED-lights in the street showing either green or red indicates available or occupied delivery spaces.

CVIS – Urban Parking Zones

In the CVIS project, one use case concerned Urban Parking Zones. The goal was to support the driver, fleet manager and road operator (including parking zone operator) in the booking, monitoring and management of the urban parking zones for freight driver activities.

The main information flow looked as follows:

- The Fleet Operator plans a journey.
- All parking zone reservation requests are sent to the Parking Operator. The requests include vehicle type, delivery time, delivery duration, and flexibility in the schedule.
- The Parking Operator allocates spaces and time slots to the Fleet Operator.
- When the vehicle approaches the allocated space/time, an ETA is sent to the Parking Operator who confirms the booking.
- The vehicle arrives and the Parking Operator allows the vehicle to park.
- The vehicle leaves the parking zone and reports to the Parking Operator that the bay is free.

Depending on the circumstances there may be exceptions to this main flow. Such circumstances can e.g. be:

- The Parking Operator can not accommodate the request. Alternative times are then provided so that the Fleet Operator can update the journey plan.
- The parking zone is not free at the requested ETA (e.g. due to the previous delivery running late). The Parking Operator offers an alternative parking zone or a “holding” zone whiting the premise. The vehicle system / driver accept the new parking zone.
- The parking zone is occupied by a vehicle that has not been registered. An enforcement procedure is launched and the vehicle which couldn’t load/unload is rescheduled.

## 5.4 Service 4c: Goods supply chain visibility

Total visibility of the Goods Supply Chain has the purpose to enhance the performance of all distribution and pick up operations in the city zone. The service is an enabler for many of the other services in the scenario.

Total goods supply chain visibility is about establishing an “information cloud” or a “sub-Internet” within the Internet where different supply chain actors can exchange information. The actors can feed information into this cloud or take part of information which has been shared by others.

By providing actors who today normally do not communicate with each other (usually because they do not have an established direct business relation) with a way of doing so can help them and the entire supply chain to become more efficient and effective.

### 5.4.1 End to end service chain

Service consumption

To benefit from the goods supply chain visibility service, a user (e.g. fleet operators, service providers or truck drivers) connects to the dedicated sub-internet cloud and searches the information desired. Information may be found using a common identifier such as a dispatch number, a truck's license plate number or an address. What information that can be found depends on what information that has been provided by other actors. Information may e.g. be the location of a shipment or the weather conditions of a city. The figure below illustrates a principled overview of how actors can interact through the cloud in order to facilitate goods supply chain visibility.

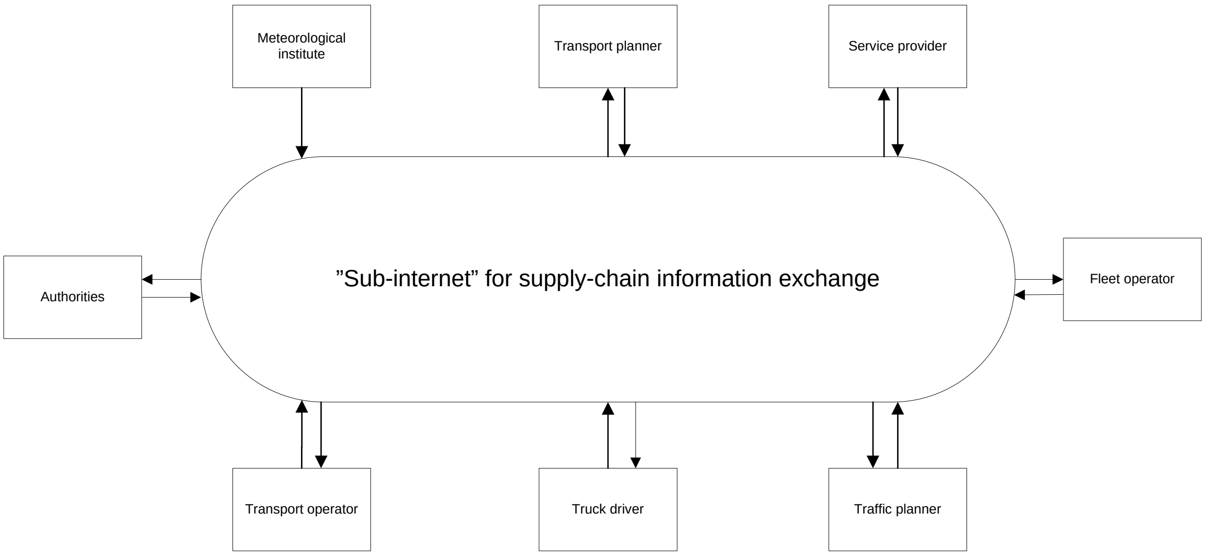



Figure 67 - A principled overview of interacting through the "sub-internet"

<u>Service provision</u>

There are two main parts in providing the supply chain visibility service; first of all a prerequisite is that someone provides the possibility to upload, look for and read information. This requires among other interfaces, common standards for how the information shall be stored and mechanisms for determining what actors that shall have access to what information. Some information may for example be public while other information shall only be available for certain actors. There may be several sub-internet cloud providers such as one for each country. Important to consider is that the provider of the sub-internet functionality will possess a lot of power, it might therefore be wise to consider charging public actors the responsibility to set up and maintain the functionality to ensure openness and fair play.

The second part of the service provision regards the feeding of information. This is performed by many different actors such as fleet operators, public authorities, truck drivers, traffic planners and service providers. The amount of information available is determinant to the usefulness of the service. It is therefore important that it is simple to provide information and that there are incentives established. Showing the usefulness of consuming the service might be enough of incentive if it can be shown that the provision helps the entire supply-chain become more efficient, effective and thereby competitive.

### 5.4.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Today actors in a supply-chain almost only communicates with such other actors in the supply-chain which they have a direct business relation with. This means that a lot of useful | Using future internet capabilities, it is easier to share relevant information among all interested stakeholders. This means that decisions can be based on more detailed, accurate and timely |

| | |
|---|---|
| information which can be used to make e.g. transport and production processes more efficient and effective is not communicated to all stakeholders who are interested in the information. | information. Transport processes and other supply-chain activities can thereby become more effective and efficient, enhancing the performance of the entire supply-chain. |
| The cargo receives bar code tags. The tags are scanned at nodes in the transport chain. The consumer and other stakeholders can verify that cargo has passed the node but can not see exactly where cargo is | The cargo is connected to the vehicle which is connected to all other devices and systems in the future internet thus it's traceable in real time. Transport owners or other stakeholders can contact the cargo to determine its location. The cargo can communicate deviations and abnormalities. |

### 5.4.3 Service components

| Nr | Name | Description and role | Comments | Involved actor |
|---|---|---|---|---|
| 1 | Information cloud / sub-Internet | Facilitates the provision and extraction of information by a multitude of stakeholders. | It consists of among others, defined interfaces, information access control and the possibilities to search for information. | SW provider |
| 2 | In-vehicle telematics system | Feeds the service with information about e.g. the vehicle and the goods which are onboard. Consumes relevant information to enhance operation. | It is macro SW implemented to the existing on-board telematics system | Vehicle OEM |
| 3 | Fleet management system | Feeds the service with information about the vehicle fleet. Consumes relevant information to enhance operation.. | | Vehicle OEM, SW provider |
| 4 | Transport management system | Feeds the service with information about e.g. transport status and itineraries. Consumes relevant information to enhance operation. | | SW provider |

### 5.4.4 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| 1 | Goods supply-chain visibility service provider | Provides, maintains and updates the sub-internet functionality | All other actors |
| 2 | Authorities | Can feed information about e.g. regulations. Consumes relevant | Service provider |

| | | | |
|---|---|---|---|
| | | information. | |
| 3 | Meteorological institutes | Feeds information about weather conditions. | Service provider |
| 4 | Fleet operators | Feeds and consumes information | Service provider |
| 5 | Truck / truck driver | Feeds and consumes information | Service provider |
| 6 | Traffic planner | Feeds and consumes information | Service provider |
| 7 | Service providers | Provides additional services based on information in the sub-internet. Feeds and consumes information | Service provider |

### 5.4.5 Data: data flows, databases, required input from other services

<u>Service consumption</u>

Consuming the service is about extracting information from the "information cloud". Such information can be used for multiple purposes depending on what actor that extracts the information. The information extractable from the cloud can for example be used to enhance the own operation or to build additional services such as many of the services suggested in this scenario.

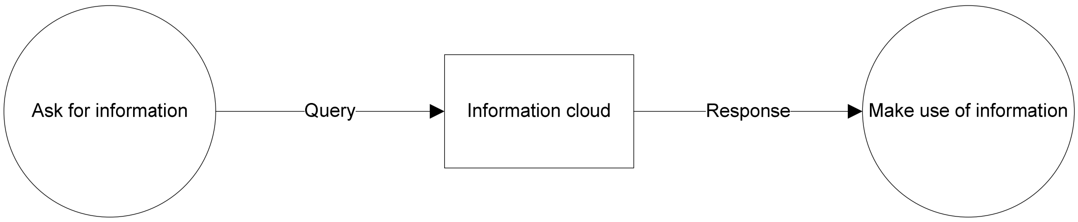



Figure 68 -Data flow when requesting information from the cloud

<u>Service provision</u>

In order to consume and make use of information there is a need for information to be submitted to the cloud. This can be done by virtually any actor such as fleet managers, truck drivers or authorities. Providing information means sending the information to the cloud using a specific pre-defined format and attaching some searchable identifier of the information. In some cases it can also be good to provide information about for how long time the submitted information is expected to be valid.

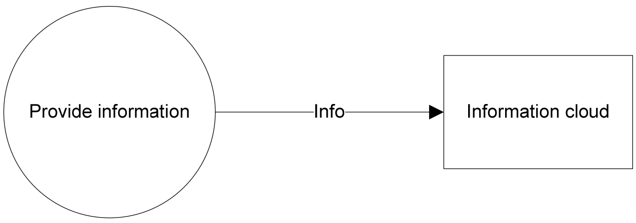



Figure 69 -Data flow when providing information

### 5.4.6 Expected benefits

The service will enable full traceability of cargo in near real time. Access to this information will enable planners and planning systems to improve vehicle fill rates and time efficiency. The end result for urban dwellers will be increased cargo mobility and reduced noise, congestions and air pollutions

### 5.4.7 References

GoodsNet

GoodsNet was a project proposal to develop a common European network, a platform where future innovative network-based goods services could be deployed. The proposal has been further described in the references for service 4a.

## 5.5 Service 4d: Automated access control & security check

The automated access control & security check is a service for streamlining the inbound traffic to hubs such as ports and terminals by eliminating the need of manual checking and authorization of access rights to restricted zones for goods, vehicle and driver.

Consider a distribution truck about to enter a restricted area e.g. a port or hub. The driver makes a request for entry on his/her on-board system. In order to avoid interruption at the gate the goods, the vehicle as well as the driver need permission for entry.

Upon the request to enter the restricted area, the terminal operator matches the goods, vehicle and driver information to the permissions in advance granted to transport planners. If everything is in order the truck is allowed to pass the gate without disruption.

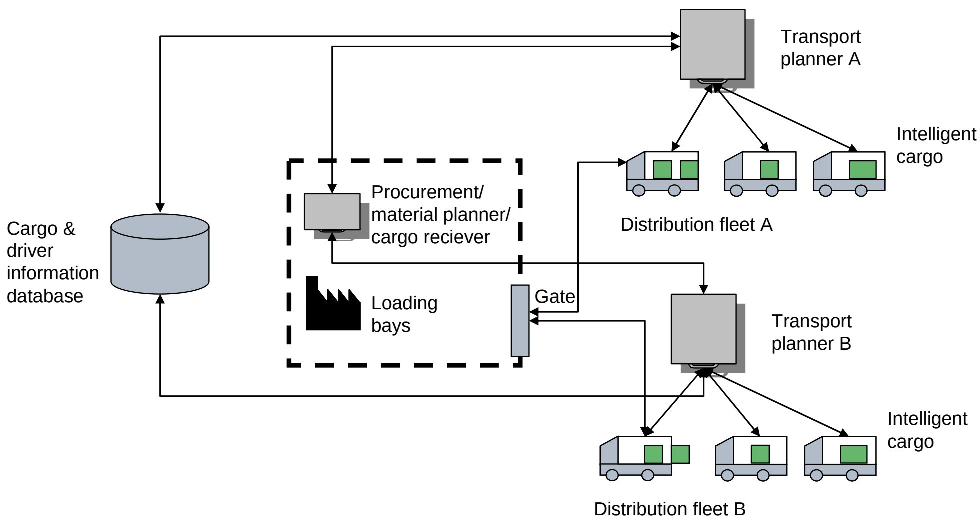



Figure 70 - Schema of automated access control

### 5.5.1 End to end service chain

Service consumption

The transport planner has in advance provided the terminal operator with information about what truck that is about to arrive, who is driving it and what cargo it is bringing. The terminal operator has granted access to the terminal on the premises that the information provided by the transport planner matches the truck, driver and cargo actually coming to the gate. Upon arrival, the truck / truck driver therefore requests permission to enter upon which the identity of the truck and driver, and the content of the vehicle is compared to granted access permissions.

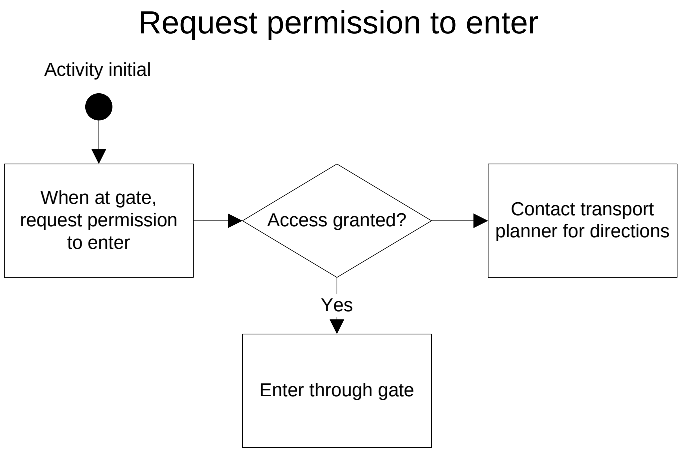



Figure 71 - Request permission to enter a restricted area, from the perspective of the truck / truck driver

Service provision

Information from three stakeholders is gathered and processed to provide the “allowed” or “denied” decision. The consignor provides the information about the goods and the transport operator provides the information about vehicle characteristics and driver; this information is communicated to the harbour through the vehicle’s on-board system. This information is by the terminal operator compared to the permissions granted to transport planners and if the particular combination has been granted, the vehicle is allowed to pass without disruption.

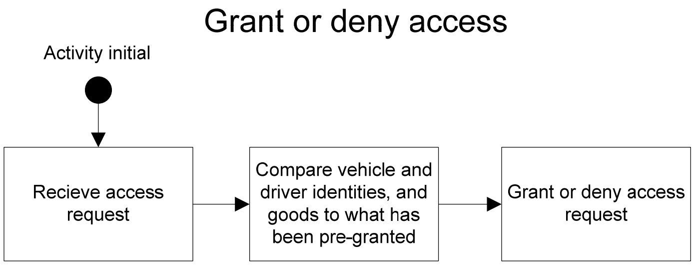



Figure 72 - Access control from the Terminal Operator’s perspective

1. Cargo owners specify content of each consignment using digital freight notes
2. Digital freight notes and other cargo information are accessible to users with permission through the cargo and driver information database.
3. Transport companies supply organisation number and driver information to database
4. The vehicle check-in digitally at the terminal gate. Communication with the gate is managed by the vehicles fleet management system

### 5.5.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Each driver stops at terminal gate and identifies him or herself. He presents all freight information (paper forms) to the security staff at the gate | Digital authentication is sent from vehicle to gate. The vehicle passes right through the gate and directly to the loading dock. |

### 5.5.3 Service components

| Nr | Name | Description and role | Comments | Involved actor |
|---|---|---|---|---|
| *1* | Intelligent cargo | *Communicates with the vehicle so that the vehicle knows what it is bringing.* | *This is not a necessity; such information can e.g. be held by digital freight notes.* | |
| *2* | Freight information standard | *It is important to use standards formats and protocols when communicating to ensure interoperability.* | | *Standards organizations* |
| *3* | Cargo and driver information database | *Stores information about the cargo and drivers.* | | *SW Provider* |
| *4* | Automatic gate control | *Comparing the information about the goods, driver and truck pre-announced by the transport planner to the truck and driver actually arriving at the gate.* | *This is performed automatically through digital identification.* | *SW/HW provider* |
| *5* | On board unit | *The onboard unit communicates information about the trucks and drivers identity to the automatic gate control.* | *It is macro SW implemented to the existing on-board system* | *Vehicle OEM* |

### 5.5.4 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| *1* | Transport Planner | *Pre-announces arrival* | *Terminal operator, truck/driver* |
| *2* | Truck/Driver | *Asks for permission to enter terminal* | *Terminal operator, transport planner* |
| *3* | 3PL | | |
| *4* | Terminal operator | *Grants or revoke requests from transport planners and trucks/drivers* | *Transport planner, truck/driver* |

### 5.5.5 Data: data flows, databases, required input from other services

<u>Service consumption</u>

The typical service users are transport planners and trucks/drivers. The transport planners provide the terminal with information about inbound trucks and receive permissions for the trucks to enter. When the truck and driver shows up at the gate, the terminal operator/service provider compares the granted permissions against the information and identities provided by the truck/driver. Information about the truck, its driver and the goods carried provided by the truck or its driver need to match the information provided by the transport planner.

Service provision

Figure 73 depicts the data flow from the terminal operator's perspective, making the assumption that the terminal operator is also the actor providing the service. It is possible that a third party actor takes care of the automated access control and security check service for the terminal. The circles illustrates actions carried out by the terminal operator/service provider, the rectangles actors with whom the terminal operator/service provider interacts, the diamond represents a point where different actions are taken depending on some criteria and the two horizontal lines denotes a data source. The process of granting or denying access to a truck begins with the transport planner requesting permission which is stored in the data store. When a truck arrives, the request to enter the terminal is compared to the permissions granted and stored in the data store.

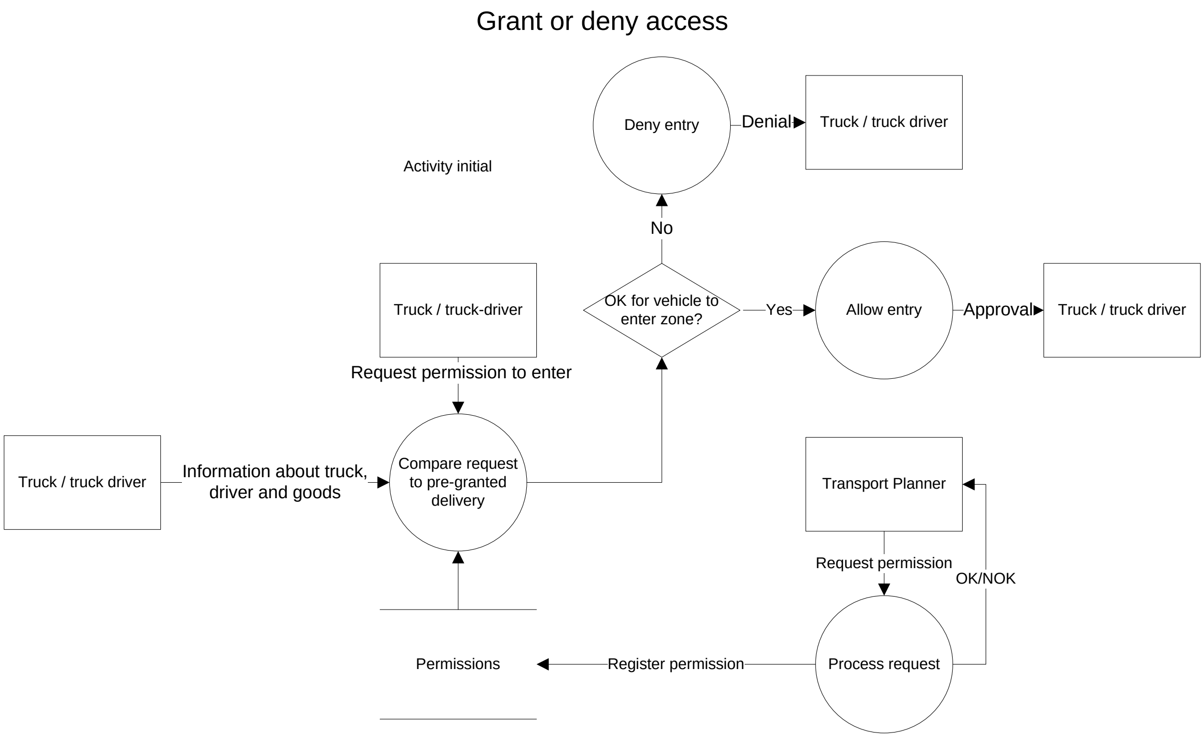



Figure 73 - Data flow from the terminal operator's perspective

### 5.5.6 Expected benefits

The check in procedure to terminals needs to be as efficient and automatic as possible (check in, identification, customs clearance, etc.) Much time can be saved by using services similar to the one presented. Studies indicate that each vehicle can save as much as 10-15 min each time it passes a gate.

Using automated access control and security check does not only save time, it can also enhance the overall security of the transport chain. By using automatic identification, information does not have to be provided in paper form. Paper documents and identification means are e.g. easier to counterfeit than control mechanisms utilizing encrypted digitally stored information.

Another security enhancing aspect is that vehicles or trailers are not left unattended, e.g. when the driver leaves the vehicle to hand over papers to the check-in in e.g. a harbour or other terminal. The reduction of time the vehicle or trailer is left unattended provides anyone who is interested in tampering with the units or stealing cargo with less time and possibilities of doing so.

#### 5.5.7 References: other projects, actual services etc.

SITS

FREILOT

## 5.6 Service 4e: Dynamic time/place drop point

The aim is to increase the flexibility in the delivery of goods by launching a service that dynamically points out the right time and place for delivering every single package. The service is using feedback/info from the consignee, traffic and other issues in the city centre (see for example the real time traffic optimized route navigation service) under the concept that everything and everybody is "pingable".

A mother on a business trip is planning parts of her daughter's birthday party using a mobile device on the train between Nice and Vienna. She orders an electric guitar and a loudspeaker system from a music store in the city. Since the gods is a gift she asks the order receiver to send the cargo not to the family home but to a drop of point somewhere in the city. Since the mother does not know exactly where she'll be that day she pay the music store extra to use the flexible delivery point option offered by most city distributors. The music store registers the order and packs the goods. The cargo is registered in the transporters planning system and receives an id and communication protocols to communicate with load carrying units and the logistics system.

The forwarding firm responsible for the transport sends an available transporter to pick up the cargo at a time of the transporters convenience. The cargo communicates with the surroundings and information about the location is forwarded through the forwarder to the mother's personal communication devise. The mother can see the status of the order and the location of the cargo. So can the music store. The mother suddenly realizes she has forgotten to order a receiver for the loudspeakers. She contacts the music store who sends the receiver. The forwarder can see the location of the original cargo. The first shipment decides on its own to wait at the forwarders terminal to wait for the extra order. A terminal worker tries to load the package on the delivery vehicle, but the vehicle alert the worker that this package is suppose to wait in the terminal. Once the packages have consolidated they board a free delivery vehicle. The mother instruct the forwarding company via her personal communication devise that she needs the cargo to be delivered to the pick up spot next to her work. The forwarders system traces the cargo to a terminal 12 km away and instructs a suitable transporter to pick up and deliver the cargo. As the cargo approaches the delivery spot the mother is alerted that she can pick up the goods within 45 minutes.

Cargo is delivered. Mother is happy. It became an excellent birthday party that year.

A month later the forwarding firm follow up this delivery and thousands of others to evaluate system performance and identify improvement potential. Each individual goods movement is analysed and the data is processed to propose improvements of the supply chain set up.

### 5.6.1 End to end service chain

<u>Service consumption</u>

When ordering or purchasing a piece of good, the buyer is not sure about at what place it is most convenient to have it delivered; some indication, such as to what city it is to be delivered is however useful to provide. The buyer can track the movement of the goods from the stock or boutique as it is transported to a suitable terminal. The buyer can at his or her convenience at any time request the goods to be delivered to a convenient location, may it be close to the home or office, or perhaps close to a mall when shopping. The transporter confirms the delivery request and provides an ETA of when the good is available at the requested destination.

In figure 74 the circle indicates an action performed by a consignor/consignee, the rectangle the actor "transport planner" with whom the consignor/consignee interacts, the diamond represents a decision point and the arrows flow of information. The activity begins in the black dot named "activity initial".

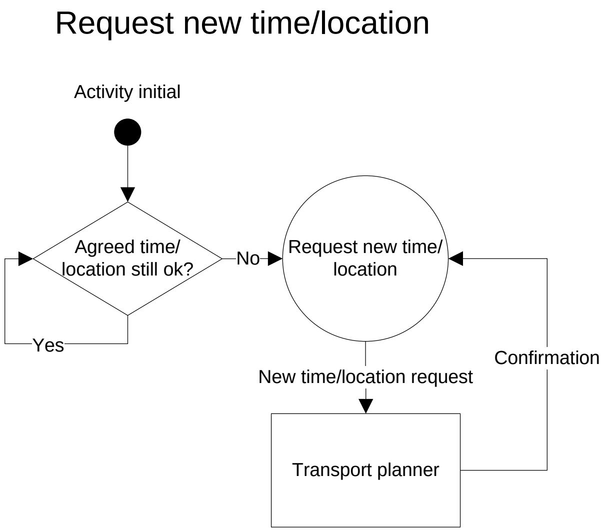



Figure 74 - Request a new drop-off / pick-up time from the Consignor's / Consignee's perspective

<u>Service provision</u>

The transport planner is in charge of planning the transport missions and updates each vehicles itinerary in accordance to customer requests. When a customer asks his/her goods to be delivered or picked up at a certain time and location, the transport planner tries to match the request to the itineraries of the available vehicles. The transport planner takes information such as the current transport missions' process and the current traffic situation into account before confirming the customer's request and provides an ETA for the delivery/pick-up operation. The information flows from the transport planners perspective is depicted in figure 75. The circle indicates the process performed by the transport planner, the rectangles other actors with whom the transport planner interacts and the arrows indicate information flows.

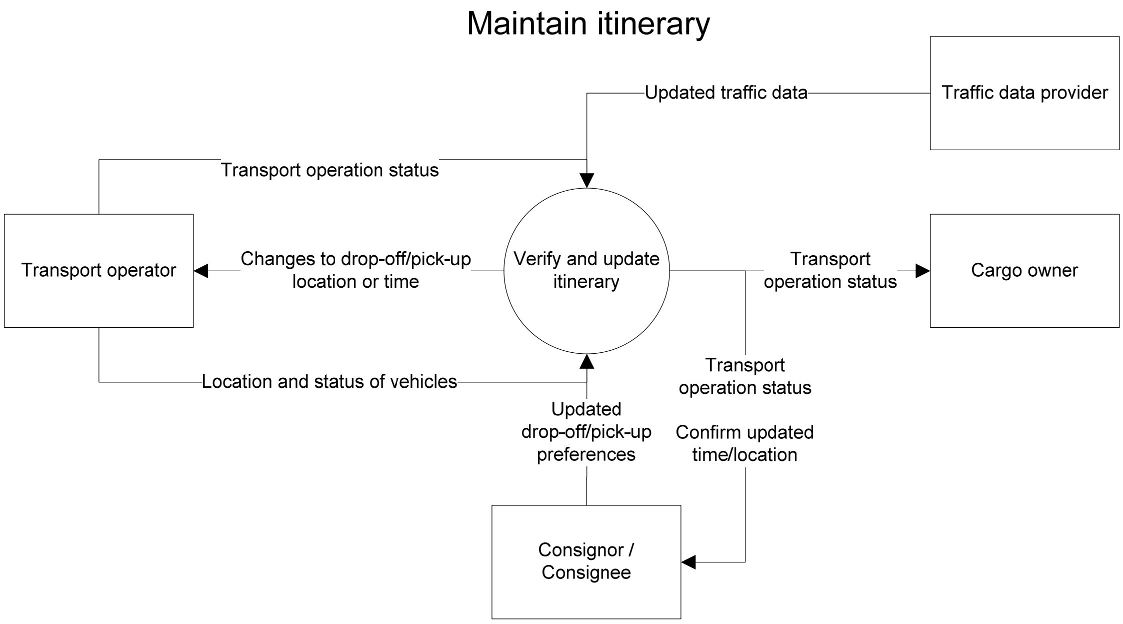



Figure 75 - Maintaining the transport itinerary from the Transport Planner's perspective

The truck and driver is in charge of carrying out the transport missions planned by the transport planner. The truck or driver regularly feeds the transport planner with information about the status of the transport missions and the location of the vehicle. Any changes to the itinerary are communicated to the truck and driver by the transport planner.

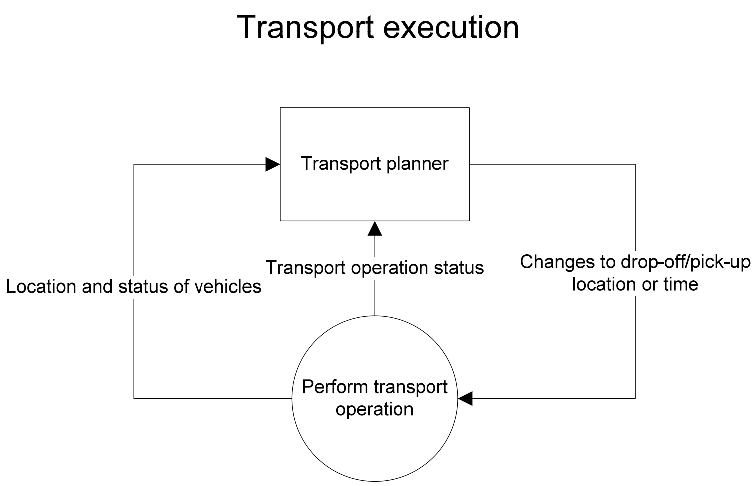



Figure 76 - Executing the transport operation from the Transport Operator's perspective

### 5.6.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Today goods can be delivered to an address or to a pick-up point. The address or pick-up point does however have to be defined in advance, when the goods is ordered. | In the future, goods can be delivered to a pick-up location most convenient to the consignee based on where the consignee is at the moment. The pick-up location can be dynamically decided with short notice. |

### 5.6.3 Service components

| *Nr* | *Name* | *Description and role* | *Comments* | *Involved actor* |
|---|---|---|---|---|
| *1* | *Intelligent Cargo* | *Cargo which can communicate with its surrounding, e.g. the truck, and holds certain information.* | *It is cargo featuring short-range communication and storing of information.* | *HW provider, SW provider* |
| *2* | *In-vehicle telematics system* | *Communicates the position of the vehicle and what cargo that is onboard to the fleet management system.* | *It is macro SW implemented to the existing on-board telematics system* | *Vehicle OEM* |
| *3* | *Fleet management system* | *Provides information about the vehicle's and its cargo's position to the transport management system.* | | *Vehicle OEM, SW provider* |
| *4* | *Transport management system* | *Communicates the cargo's and vehicle's position to the cargo owner and other stakeholders.* | | *SW provider* |
| *5* | *Cargo receiver interface* | *An interface for the cargo receiver to monitor* | *It is an application or web-site run on* | *Software provider* |

| | | | | |
|---|---|---|---|---|
| | | *the current position of the goods.* | *a cellular phone or accessed from a computer* | |

### 5.6.4 Actors, their roles and relationships

| *Nr* | *Name* | *Main actions* | *Relationships within the service* |
|---|---|---|---|
| *1* | *Truck and driver* | *Carry out transport missions* | *Transport planner, consignor/consignee* |
| *2* | *Transport planner* | *Plan transport missions and provide consignor/consignees with confirmation of time and location for drop-off/pick-up* | *Truck & driver, service provider, consignor/consignee* |
| *3* | *Traffic data provider* | *Provide real time traffic information* | *Service provider* |
| *4* | *Service provider* | *Provide, maintain and update the system used by the transport planner* | *Transport planner, traffic data provider* |
| *5* | *Consignor / consignee* | *Request preferences regarding time and location for drop-off/pick-up* | *Transport planner* |

### 5.6.5 Data: data flows, databases, required input from other services

The data flow diagram in figure 77 shall be read with start in the consignor/consignee making an initial request of delivery/pick-up. Many such requests are stored in a transport need data store and the information from the store used when planning the transport missions. Once transport mission has been planned confirmations with times and locations are sent to the consignors/consignees. The itineraries are stored and sent to the truck and driver.

If the consignor/consignee makes a request to change delivery/pick-up time or location, the new request are compared against the itineraries of the different trucks to evaluate whether or not the request can be adhered to. A response is sent to the consignor/consignee and if any updates have been made to the itineraries these are sent to the truck and driver and stored in the data store.

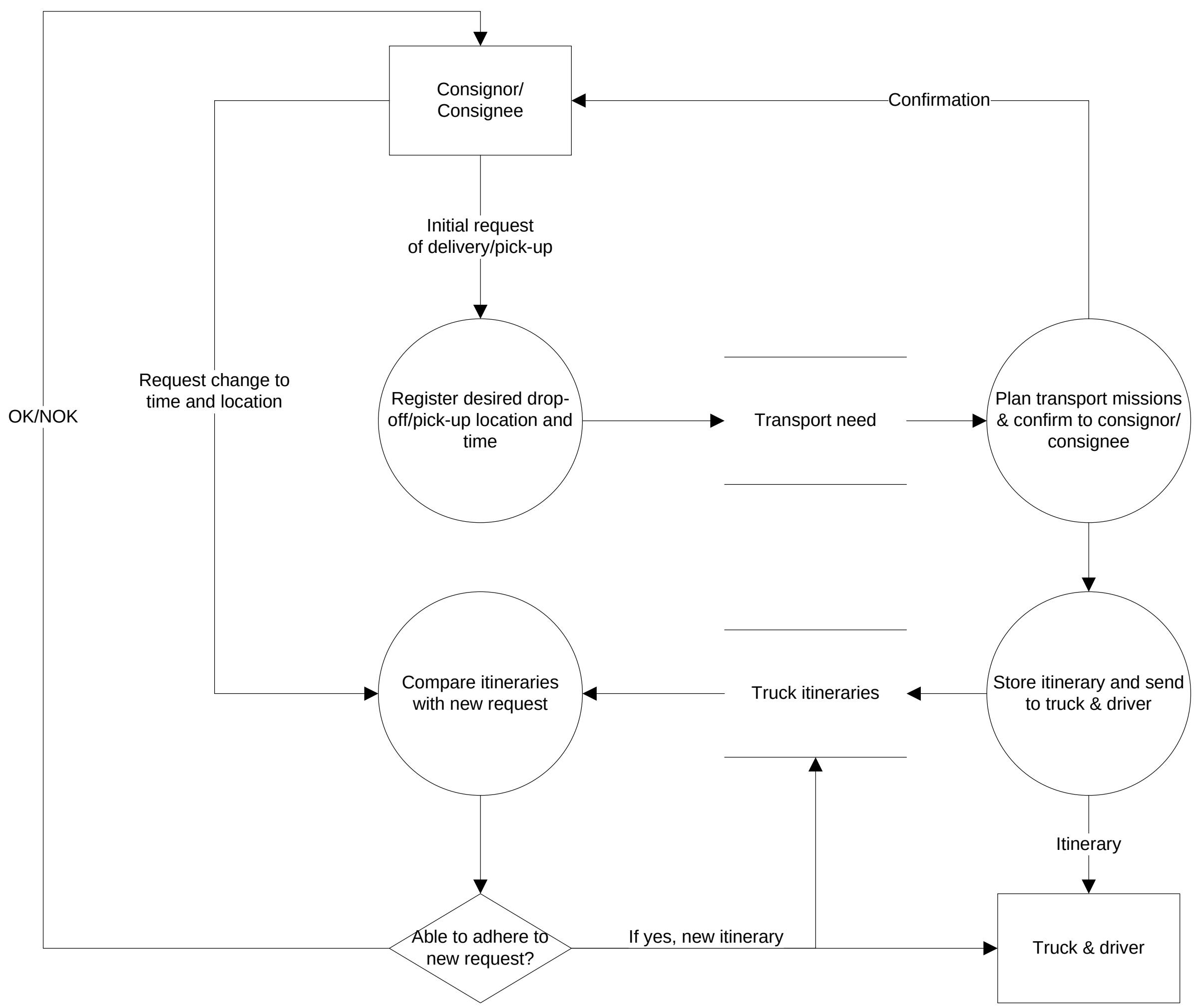



Figure 77 - Data flow diagram from the transport planners perspective

### 5.6.6 Expected benefits

The service will increase the convenience for urban dwellers by being able to adapt the delivery or pick up location of goods based on their current location and not based on their home or office address as currently often is the case.

3PL and transporters implementing the service can expect increased customer satisfaction. Customers do not want to wait at home “between 08:00- 17:00”. They want to be able to specify when and where they want to pick up their goods.

By having close to real-time information about where the goods is, the customer can make decisions on delivery location and time which suits the goods current position providing for quick delivery. If any delays occur affecting the goods availability at the agreed time and place, the customer need to be informed about this as soon as possible to make decisions of changing time or location.

The transporters implementing this kind of goods visibility and dynamic drop-off/pick-up time and location may charge an additional fee for the enhanced service.

### 5.6.7 References: other projects, actual services etc.

## 5.7 Service 4f: Traffic zone control

A delivery truck driver is carrying out transport missions within a city. The driver is currently on his/her way to drop off a package in the city-centre when suddenly a message shows up on the in-vehicle mounted display. The message is a warning that the driver is about to enter a restricted zone, where traffic is allowed only during certain hours. The time is now 07:45 and the zone is restricted for traffic from 08:00-16:00. The driver decides to enter the zone but now knows that he/she has to be out of the zone within 15 minutes.

The zone is indicated also by physical signs, but since the driver paid all his/her attention looking for street names and monitoring the surrounding traffic and pedestrians he/she missed the signs declaring the zone restrictions. The message on the in-vehicle mounted display made the driver aware of the zone.

A prerequisite for the service is that the city has defined zones with different requirements for alternative fuels, noise, etc. Zones could be dynamic, allowed to change in order to reach environmental or mobility goals of the city. Drivers willing to pay a premium should be allowed to enter zones (similar to road tolls, but for fossil fuel, noise during night etc)

The service will automatically control that the vehicles entering a specific zone is allowed to be there. If not allowed in the zone, appropriate measures will be taken; examples of such measures can be to, as in the example, notify the driver of the restrictions or perhaps issue a fine for not adhering to the restrictions.

### 5.7.1 End to end service chain

<u>Service consumption</u>

The truck is able to communicate information such as its environmental classing and the goods it is carrying. When the vehicle notices that it is about to enter a restricted zone, it notifies its presence to the service provider. From the service provider, the truck receives information about the restrictions and is asked to provide certain info in order to be allowed to enter the zone. The information asked for is sent to the service provider and an approval or rejection of the access request is received in return. The driver can chose not to obey a rejection but then has to deal with any possible consequences. Figure 78 depicts the process of service consumption where circles indicate actions performed by the truck or truck driver, rectangles actors with whom the truck/driver interacts and diamonds points where alternative actions are performed based on some criteria.

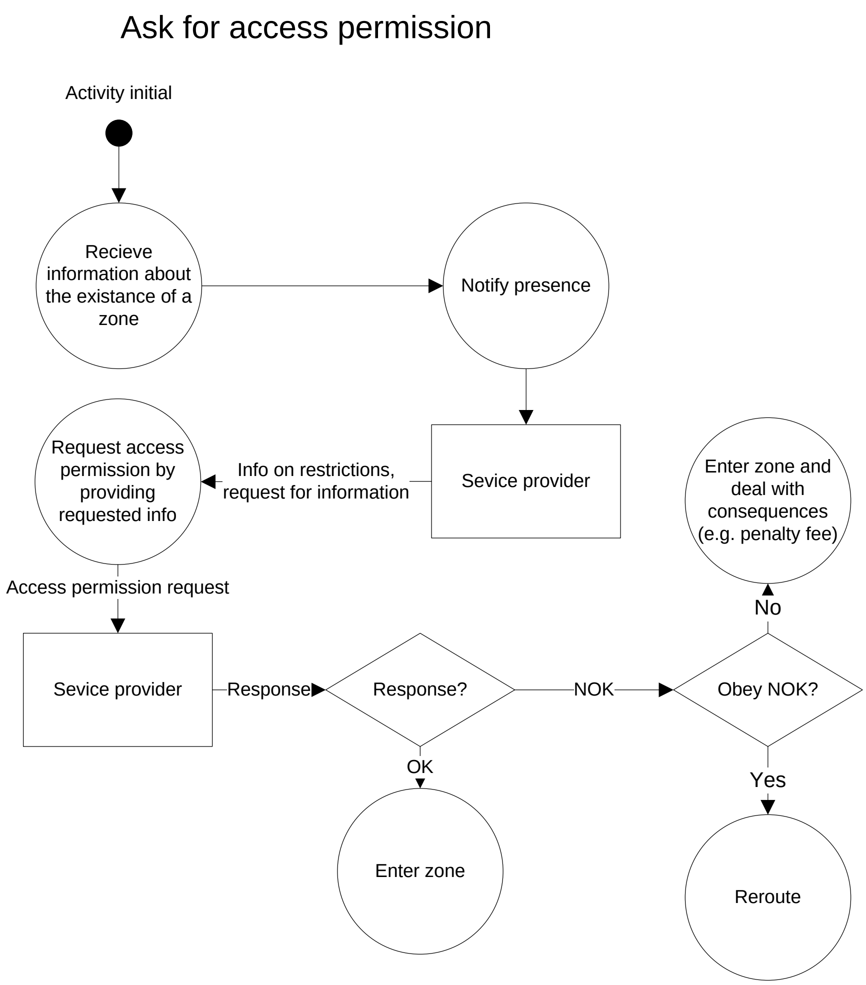



Figure 78 - Ask for access permission, from the transport trucks / truck driver's perspective

<u>Service provision</u>

Providing the traffic zone control service can be broken down into three steps:

- Defining the zones and communicating their existence
- Verifying access permission
- Take countermeasures if restrictions are not obeyed

First of all there has to be zones defined, such zones can for example be set up by the city to manage the traffic flow in order to decrease congestion during certain times of the day or to avoid vehicles that do not fulfil certain requirements, such as environmental, to enter the city centre. There is also a possibility that a fleet operator is interested in defining zones where the driver receives certain information, e.g. to maintain a speed lower than the regulated maximum speed for fuel saving.

Secondly, when a truck is approaching a zone this has to be noticed in some way. The provider has to communicate information about the existence of the zone in some way, e.g. by broadcasting messages or providing the zone boundaries through other means such as the navigation system.

Once a truck notifies its presence, the service provider shall decide whether a truck is allowed to enter a zone or not. Information about the zone shall also be sent to the truck and its driver so that decisions such as the one described in the introduction, where the driver chose to enter the zone but knew he/she had to be out within 15 minutes, can be made. To verify that the truck is allowed in the zone, information to base the decision upon is receive from the truck and compared against the zone restrictions. A response is provided to the truck and its driver. Figure 79 illustrates the process of verifying the access rights of an approaching vehicle.

Lastly, if a driver chose not to obey a zone restriction action may be taken. A warning may be issued to the driver and the fleet operator or more severe actions can be taken, such as issuing a fine to the driver or the transport operator.

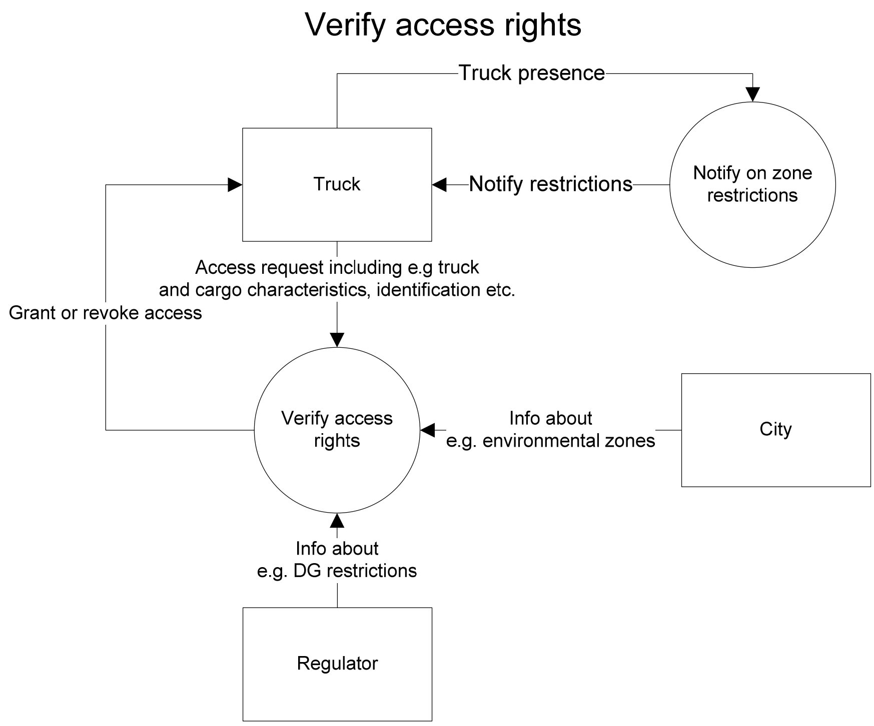



Figure 79 - Traffic zone control from Service Provider's perspective

**Requirements:**

- the vehicle need to know its cargo
- transport planners need to know what is allowed inside which city zones
- vehicles that can switch between fossil fuel and renewable fuels should be allowed to enter “green zones”
- Drivers not allow to enter should be informed of the price and options available to them – to be able to make rational decisions
- Transgressions cloud be reported to law enforcement
- Cameras to enforce traffic restrictions
- Real time monitoring of vehicles using GPS technology to control access to certain city areas

### 5.7.2 Service capability comparison description (today, future)

| **Service today (if it exists)** | **Service in future (with Instant Mobility)** |
|---|---|
| Today there are zones with restrictions such as environmental zones or urban zones only allowed for delivery during certain times of the day. There is however no automatic way of controlling that these zone rules are obeyed and there is usually little risk of being caught. | In the future, the zones can be monitored automatically using future internet technology. Vehicles are automatically identified and the information about the vehicle provided helps determine whether the truck is allowed or not. |
| Today the driver has to see the sign indicating a restricted zone in order to know that it is there. If the sign is missed, the driver can unintentionally enter a zone where the truck is not allowed and risk getting fined. | In the future the driver will receive a notification/warning when a restricted zone is being entered and can thereby choose to take another route or make sure that the restrictions are fulfilled. |

### 5.7.3 Service components

| *Nr* | *Name* | *Description and role* | *Comments* | *Involved actor* |
|---|---|---|---|---|
| *1* | *On board unit* | *Communicates zone restrictions and access permission to the driver* | *The functionality is incorporated to the truck's existing systems.* | *Vehicle OEM* |
| *2* | *In-vehicle telematics system* | *Announces the truck's presence, receives information about e.g. zone restrictions and communicates information about the truck and goods.* | *It is macro SW implemented to the existing on-board telematics system* | *Vehicle OEM* |
| *3* | *Zone information system* | *Communicates information about the zone restrictions and access permissions to the vehicle telematics system* | *Information can be centrally stored and communicated through the Internet.* | *SW provider* |

### 5.7.4 Actors, their roles and relationships

| *Nr* | *Name* | *Main actions* | *Relationships within the service* |
|---|---|---|---|
| *1* | *Zone definer* | *Define zones, provide information about the zones* | *Service provider, transport planner* |
| *2* | *Service provider* | *Communicate information about zone retrictions to approaching vehicles, grant or revoke access permission* | *Truck & driver, zone definer, enforcement* |
| *3* | *Truck & truck driver* | *Carry out transport missions while obeying zone restrictions* | *Transport planner, service provider* |
| *4* | *Transport planner* | *Take zones into consideration when planning transport missions* | *Zone definer, truck & driver, enforcement* |

| | | | |
|---|---|---|---|
| *5* | *Enforcement* | *Can issue fines if restrictions are not obeyed* | *Service provider, transport planner* |

### 5.7.5 Data: data flows, databases, required input from other services

Under discussion

### 5.7.6 Expected benefits

Establishing zones can have positive influence in terms of reduced noise, congestion and air pollution in the city centre or where else the zone has been set up. There can also be safety aspects of defining zones, such as zones with the intention of making drivers aware of nearby schools or similar. By automatically verifying a trucks right to be within a zone, the driver can be notified when entering a forbidden zone by accident, if the driver does not leave the zone a fine may be automatically issued.

Increased flexibility for transporters operating within the urban centre

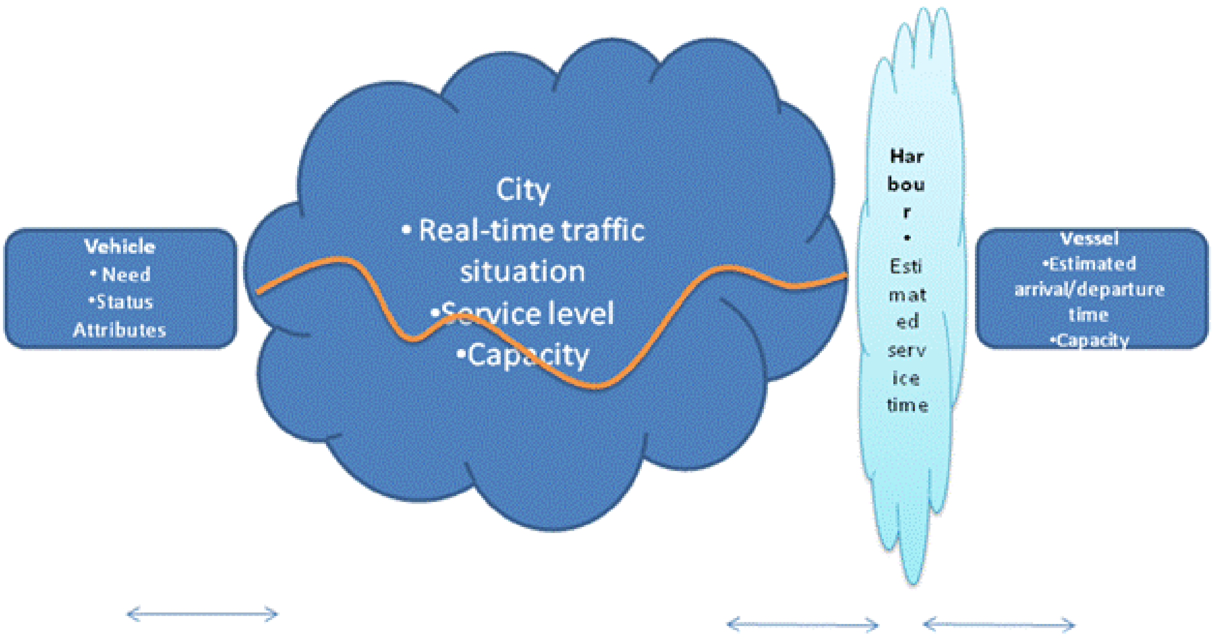
### 5.7.7 References: other projects, actual services etc.

## 5.8 Service 4g: Green corridors

*A green corridor is* a concept referring to a number of dynamic (based on need, availability and capacity) features which provide a virtual environment for green transport through/within the city to/from hubs and harbours. The GC consists of the following services:

- Optimized routes and efficient driving guidance
- Optimized flow of incoming and outgoing goods
- Efficient throughput and higher possibility for monitoring and differentiation of service level

### 5.8.1 End to end service chain




### 5.8.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| There is not much available which resembles the GC service, but in Hamburg there is a version which is mainly manual that can be used as a reference. | There will be possibility for a city to plan the traffic in totally different way than it is possible today. The current traffic management is based on history data while this approach provides possibility for planning and control based on real-time data. |

### 5.8.3 Service components

| *Nr* | *Name* | *Description and role* | *Comments* | *Involved actor* |
|---|---|---|---|---|
| *1* | Connected vehicle | Connected vehicles can provide terminals with information such as ETA and receive directions on | This requires SW updates to the current onboard units. | *Vehicle OEM* |

| | | | | |
|---|---|---|---|---|
| | | how to best approach the terminal | | |
| *2* | City cloud (aggregation of all services by a common interface) | When entering the City cloud, a number of services and information is made available to the truck and its driver. Information can regard traffic situation to base route choices upon. | The limits for when services and information from a particular city shall be made available to a truck and its driver can be delimited by geofencing. | *SW provider* |
| *3* | Harbour/terminal cloud | Services and information in addition to those provided by the city shall be made available once entering the harbour/terminal cloud. Information can regard ferry time schedules or directions on the best approach for how and when the truck shall enter the terminal. | The limits for when services and information from a particular terminal shall be made available to a truck and its driver can be delimited by geofencing. | *SW provider* |
| *4* | Connected vessel | Similar to the connected vehicle, the connected vessel can provide information such as ETA and receive information such as directions to slow down in order to allow for other vessels to complete their loading/unloading operations before arrival. | | |

### 5.8.4 Actors, their roles and relationships

| *Nr* | *Name* | *Main actions* | *Relationships within the service* |
|---|---|---|---|
| *1* | *Driver* | Asking for an optimised route for a specific transport mission to the city | *GC authority, Terminal information broker/authority* |
| *2* | *GC authority* | Providing the optimised guidance including route, departure time, speed profile and ETA. | *Terminal information broker/authority, Driver* |
| *3* | *Terminal information broker/authority* | Providing information to city cloud about optimal loading/unloading schedule and flow of goods to the harbour/terminal | *Driver, GC authority* |

### 5.8.5 Data: data flows, databases, required input from other services

In the figures below, circles represent processes performed by the actor from which perspective the flow is described, rectangles depicts other actors with whom the actor interacts and two horizontal lines indicate data stores. The arrows represent the data flows.

Figure below depicts the process and data flow from a truck's/driver's perspective when asking a terminal operator for directions.

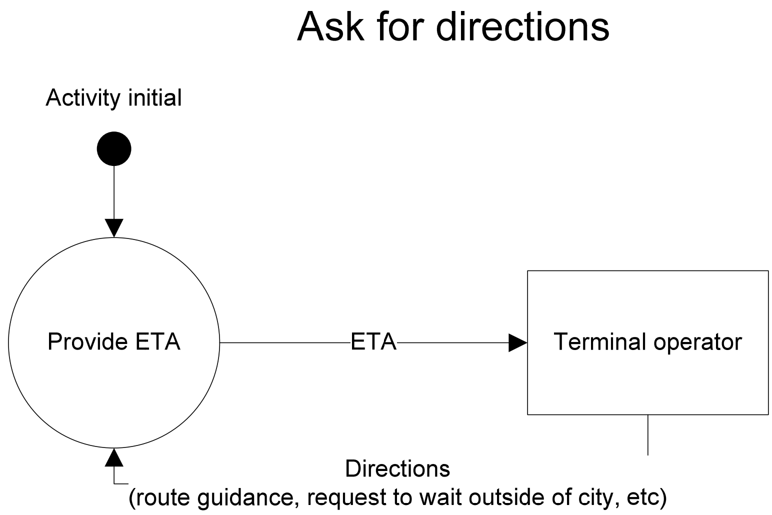



Figure 80 - Truck approaching a city with a terminal asking for directions

When the terminal operator, such as a harbour, receives a request for directions from a truck or its driver, information is gathered from many different sources and the terminal's preferences regarding the inbound traffic is sent to the traffic planner. The process of gathering this information in order to provide the traffic planner with traffic requests is shown in figure 81.

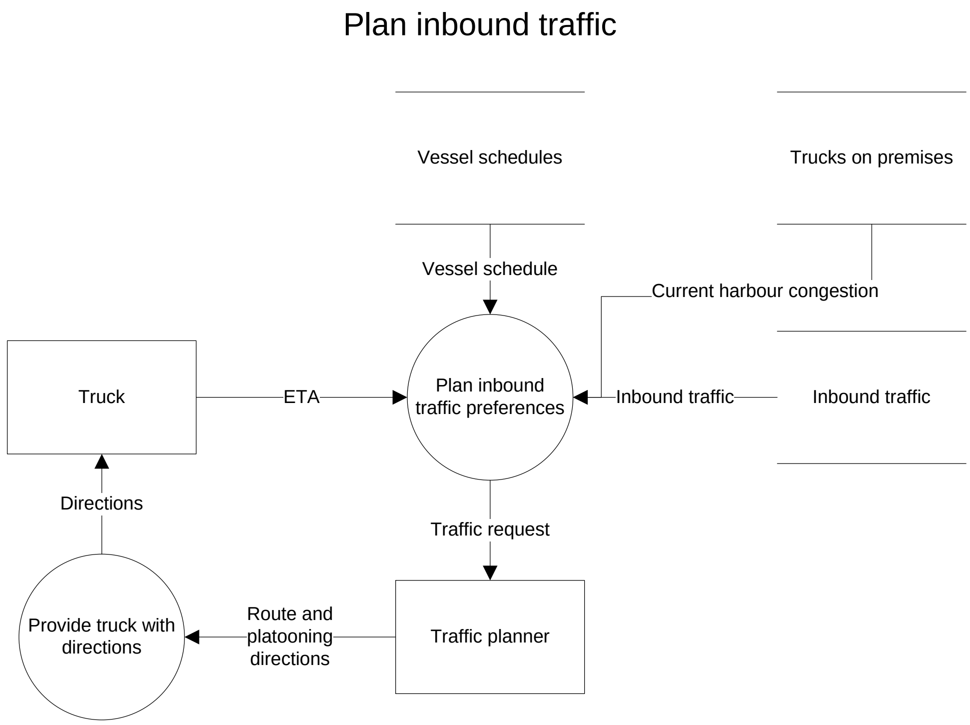



Figure 81 - Harbour request for directions plans inbound traffic and asks Traffic Planner

The traffic planner receives traffic requests from the terminal operator and consequently provides the initially requesting truck or driver with directions. These directions can be in the shape of route choices or suggestions to wait outside the city in order to avoid congestion, given that the time that the truck is expected at the terminal allows for this. The information flows are shown in figure 82.

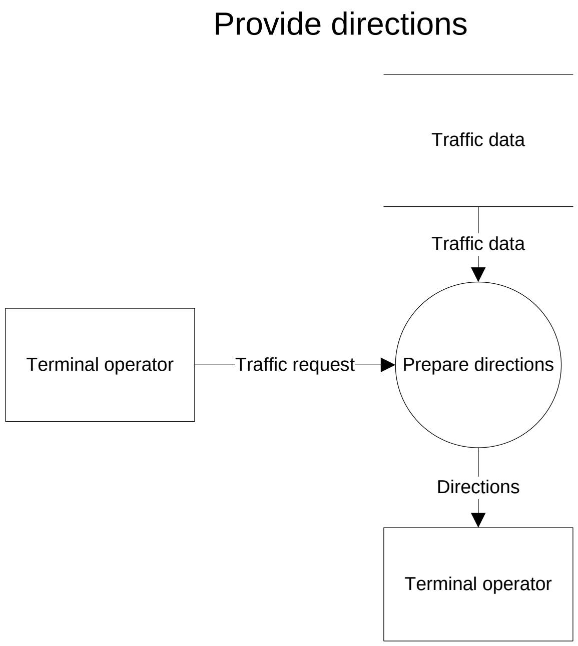



Figure 82 - Traffic planner providing harbour with directions

### 5.8.6 Expected benefits

There are many expected benefits of establishing green corridor functionality through/within cities. The traffic can be planned and routed based on real-time traffic and itinerary data, reducing congestions, noise and air pollutions. This has mainly social and environmental impacts but enhanced information can also help truck drivers and fleet operators plan the transport missions to become more safe and efficient. If a truck for example does not have to be in the harbour at its estimated ETA, the driver may stop in a safe parking place to rest.

Increased flexibility for transporters operating within the urban centre

### 5.8.7 References: other projects, actual services etc.

## 5.9 Service 4h: Real time traffic optimized route navigation

The navigation system of a distribution vehicle provides the driver with directions based on real time information about the traffic situation near the vehicle. The information which the system bases its routing decisions upon comes from various sources such as traffic planners and the emergency service, but also from other vehicles equipped with compatible systems.

The information from other vehicles in the vicinity of the distribution vehicle provides accurate information on the traffic situation. Information which the vehicles communicate is for example their average speed and break/throttle usage. The infrastructure itself can also provide useful information. The information is aggregated and used to provide the most efficient route, taking into account e.g. fuel economy, time consumption and the risk of accidents.

The transport planner has access to the same information as the navigation system regarding the real time traffic condition around the vehicle. This information can be used to make decisions on changes to the truck driver's itinerary. Ongoing missions can for example be re-planned to minimize the impact on the overall schedule. It may be possible to let another truck take care of one or some of the pick-up/drop-offs originally planned for the first truck or to skip one stop on the route and take it at the end to avoid arriving late also to all other destinations. If traffic runs smoothly it may even be possible to add stops to the original itinerary as new customer requests comes to the transport planner. The driver is notified on any changes through the on-board unit and the customer notified that the mission has been accepted.

### 5.9.1 End-to-end service chain

Service consumption

The main users of the service are the fleet operators and the drivers of distribution vehicles. The benefits of the service will mainly affect the fleet operator and its customers in terms of reduced costs and a higher probability of on-time deliveries. The fleet operator can therefore be considered the actor who is most likely to pay for this kind of service.

For using the service, the driver or fleet operator simply provides the on-board unit/navigation system (if fleet operator this is done remotely by the fleet management system) with its desired itinerary, consisting of locations, time-windows and goods characteristics. The navigation system then takes static and dynamic traffic information into account to provide the most optimized route. The usage of the service is summarized in figure 83.

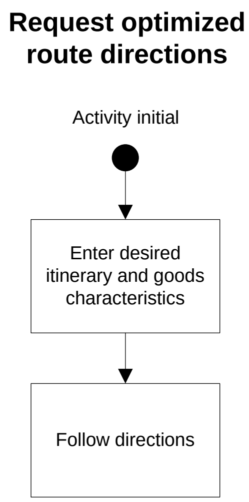



Figure 83 - Driver requests route and directions

Service provision

To provide a route optimized to minimize e.g. average mission duration, average mileage, fuel consumption, pollution etcetera, the on-board unit collect information from various sources. Some information, such as information about roads may come from map-providers and information about road-work may come from traffic authorities. All kinds of information to be taken into account are not static (e.g. the route of a road) or semi-static (e.g. planned road works) but may be dynamic and depend on factors such as the real time usage of the road or contingencies such as accidents. Such dynamic information can be gathered e.g. from other road users or directly from the infrastructure such as road sections equipped with e.g. sensors and cameras. A schematic description of how the on-board unit/navigation system can work to provide optimized directions is provided in figure 84.

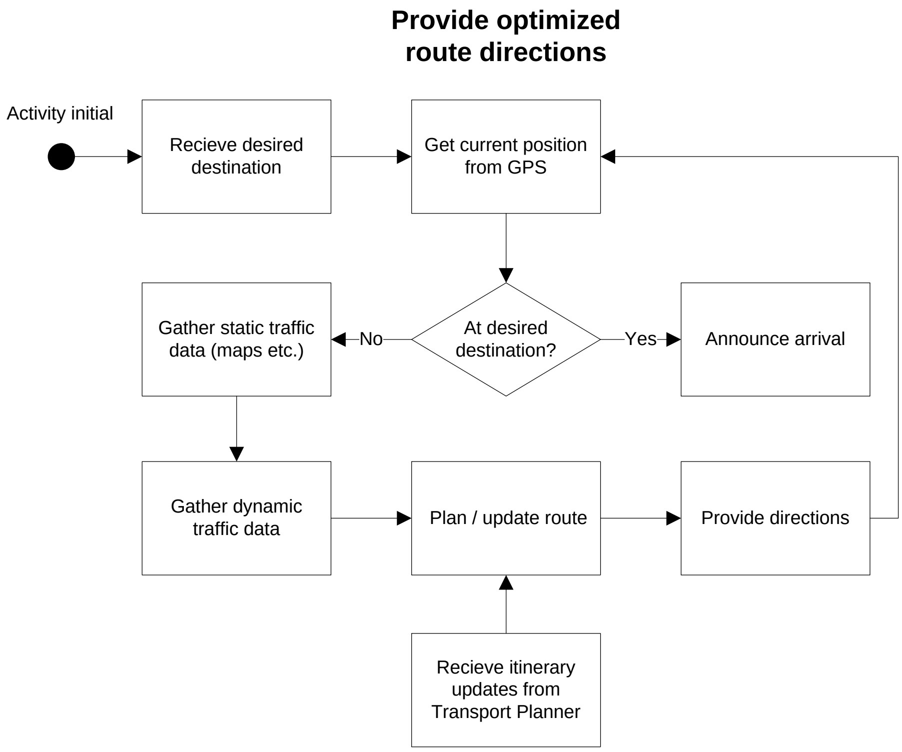



Figure 84 - The navigation system plans the optimal route and provides directions

To collect information from other road users, such information needs to be communicated. Vehicles will therefore have to continuously communicate information about their current GPS-position, their compass bearing, average speed and other useful information.

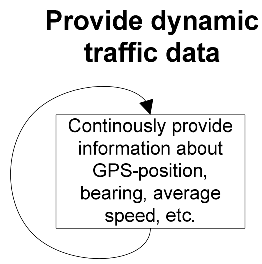



Figure 85 - Road users and infrastructure need to provide dynamic traffic data

### 5.9.2 Service capability comparison description (today, future)

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|

| | |
|---|---|
| [Real time traffic information] Real time traffic information based on data gathered from vehicles and infrastructure can be much more accurate and detailed than what today is available. This constitutes better decision support and can result in a more optimized route planning. | Information about road works, slow moving traffic and warnings such as slippery roads are today provided through navigation systems. The information is though often outdated. |
| [Road network updates] Updates to the road network can be close to immediate. Map updates can be provided online and be downloaded automatically by the navigation system. | Updates to the road network are most often not communicated to the users of GPS navigators until a new release of the navigator's maps are released; such updates then has to be purchased by the user. Exceptions to this exists, users can for some navigators share changes to the road network with each other. |
| [Route planning] Route planning using real time traffic information can be much more efficient than what is available today. Vehicles and infrastructure continuously reporting e.g. average speed can help make decisions to avoid for example congested road sections. | Navigation systems of today mainly use static information to base routing decisions upon. Some consideration is given to semi-static and dynamic information such as road works and congestions but since this information is often outdated, the alternative routes suggested are often not as efficient as the optimal route without dynamic information taken into account. |
| [General] Typically, private Fleet Management systems are detached from any centralized traffic management server. | Instant Mobility services will give to Fleet Managers the possibility to interact with urban traffic management systems, thus optimizing their vehicles' missions also taking into account overall traffic planning. |
| [General] Typically, private Fleet Management systems do not allow dynamic reconfiguration of missions. | Instant Mobility service will allow Fleet Managers to dynamically reconfigure vehicles' missions in order to meet pickup/delivery time while minimizing the impact on the overall urban traffic load. |

#### 5.9.3 Service components

| Nr | Name | Description and role | Comments | Involved actors |
|---|---|---|---|---|
| 1 | Nomadic device application / on-board system | It enables the drivers to be guided to destination and to interact with the Fleet Manager (e.g.: receiving notifications)<br><br>It further does the route planning based on various sources of information.<br><br>It provides data feedback to the Fleet Manager to track the vehicle and | It is on a nomadic device, which can be connected to the vehicle system or incorporated directly into the on-board system. | Nomadic device provider, vehicle OEM, Map provider |

| | | | | |
|---|---|---|---|---|
| | | monitor missions progress. | | |
| 2 | On-board unit | It communicates information about the vehicle to surrounding vehicles and to the Fleet Manager service centre. | It is a sw macro-component which is installed on the on-board telematic system and represents the gateway between vehicle system and Instant Mobility | Vehicle OEM |
| 3 | Fleet Manager service centre | It plans and monitors all fleet operations, including itineraries planning. | It can re-plan itineraries based on real-time traffic and transport mission data or new customer requests. | Software provider |

### 5.9.4 Actors, their roles and relationships

| Nr | Name | Main actions | Relationships within the service |
|---|---|---|---|
| 1 | Truck drivers | Provides itinerary, follows directions provided by the navigation system | Fleet managers |
| 2 | Fleet managers | Provides itinerary, reschedules itineraries | Truck drivers, System provider |
| 2 | System provider | Provides, manages and updates the route planning, its software and maps | Map provider, Provider of static/semi-static traffic information, Provider of dynamic traffic information, Vehicle OEM |
| 3 | Map provider | Provides the navigation system provider with updated maps | Navigation system provider, End-user |
| 4 | Provider of static/semi-static traffic information | Provides static/semi-static information other than the maps (e.g. road works) | Navigation system provider, End-user |
| 5 | Provider of dynamic traffic information | Infrastructure and end-users providing the navigation systems of other end users with information to base routing decisions upon. | Navigation system provider, End-user |
| 6 | Vehicle OEM | Provides the on-board unit / on-board system | System provider |

### 5.9.5 Data: data flows, databases, required input from other services

Figure 86 depicts the data flow of the real time traffic optimized route navigation service from the end-user’s perspective. The circles indicates processes or actions performed by the end-user, the rectangle indicates interaction with (in this case) the navigation system.

The service activity begins where "Activity initial" is written and then follows the flow of arrows. The end-user provides the desired destination and the navigation system then plans the optimal route using various sources of input (further described in FIGURE) and returns the route and directions. As long as the current position is not the same as the desired destination the navigation system will continue to provide directions and update the route in case changes to the traffic situation occurs.

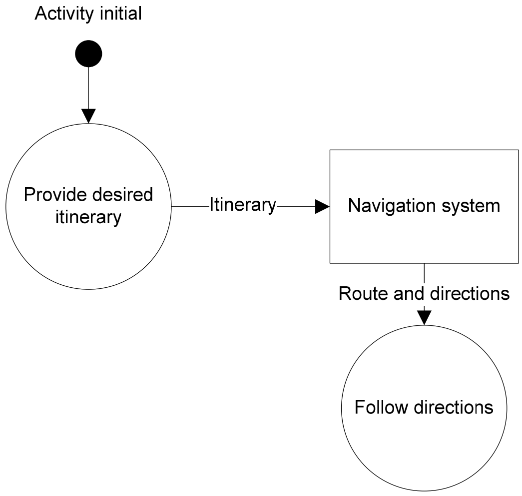



Figure 86 - Data flow of the real time traffic optimized route navigation, end-user's perspective

The information flow from the navigation system's/service provider's perspective is depicted in Figure 87. Using information from various sources, the navigation system / service provider plans an optimal route and provides the end-user with directions on how to best reach its desired destination.

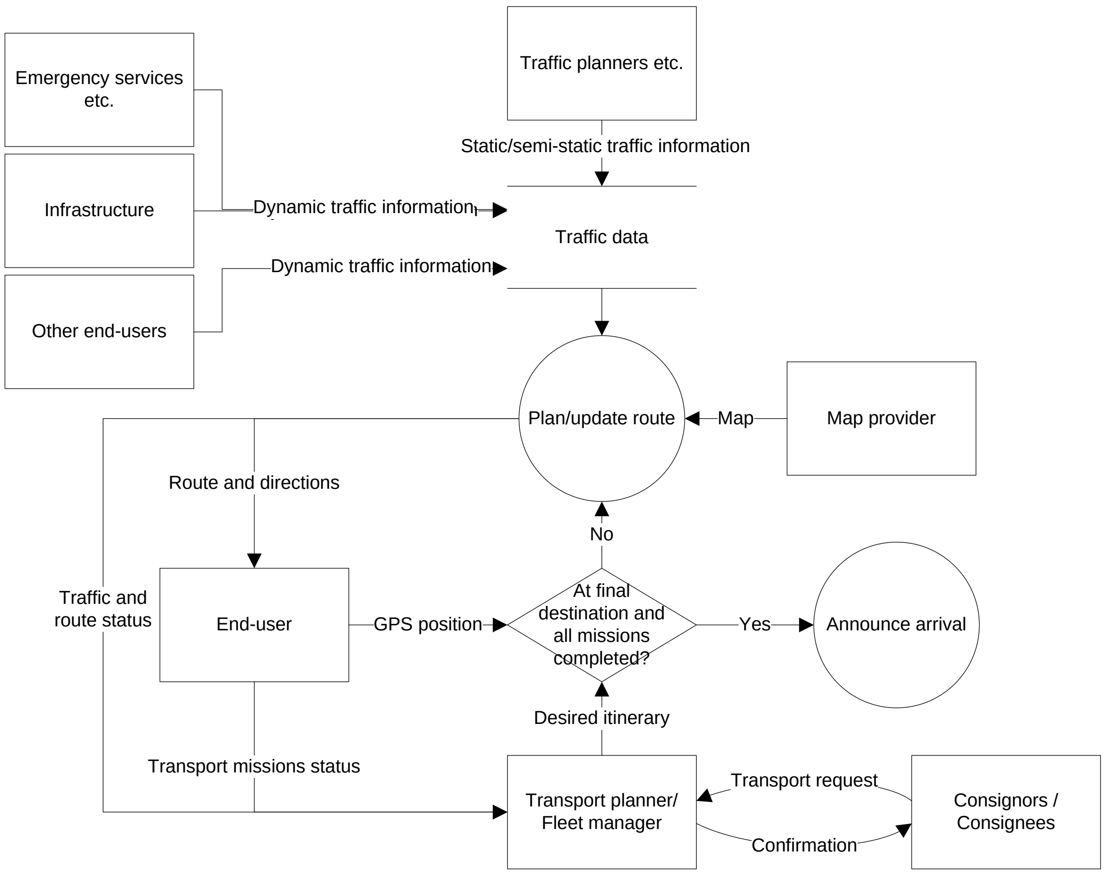



Figure 87 - Data flow of the real time traffic optimized route navigation, service provider's perspective

### 5.9.6 Expected benefits

The expected benefits of a service to optimize the route of a distribution vehicle taking real time traffic information into account are plentiful. The main benefits can be considered to be **environmental** in terms of reduced emissions as a result of the driver avoiding congestions and idling. This also has a **social** aspect since congestions in cities result in more noise and particle emissions as well as enhanced concentrations of e.g. CO2, causing poor air quality and a stressful environment.

There are also **economic** benefits for the fleet operator as a result of reduced fuel consumption. The reduced risk of getting stuck in traffic jams also increase the chance of on-time deliveries, thereby reducing the risk of fees related to late deliveries and protecting the operators reputation among its customers.

### 5.9.7 References: other projects, actual services etc.

- CityLog,
- CityMove,
- CVIS

## 5.10 Service 4i: Eco-driving support

Online community and service to monitor truck drivers' fuel use and provide recommendations or reducing consumption based on peers' performance; managers can monitor consumption in real time and compare with other drivers, and provide incentives for improved performance. This kind of services addresses and encourages CO2 consciousness by driver.

### 5.10.1 End-to-end service chain

End-to-end service chain of the eco-driving support service is rather simply. The main users fleet manager and truck driver (in light blue). The eCo-driving support consists of two components: en-route driving support and after trip driving coaching. The en-route driving support receive information from the vehicle on planned route, loading information before trip and support the driver to drive at the most energy efficient way during the trip based on location, speed, traffic signal state and real-time traffic situation. The after trip driving coaching will collect en-route driving data and compare it with the most efficient driving pattern in order to evaluate the driver's behaviour.

This service interacts with other services such as load sharing & balancing (4a), traffic-optimised fleet management (4e), area-wide optimisation strategies (5c) and cooperative traffic signal control system (5b).

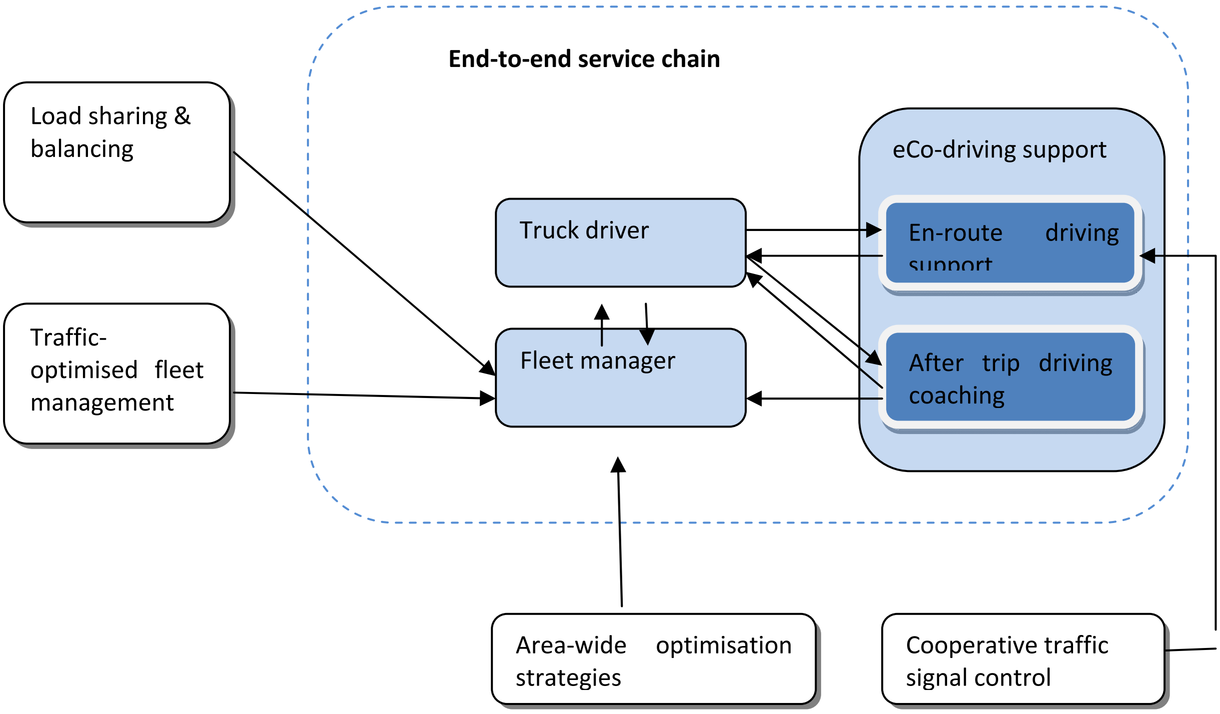


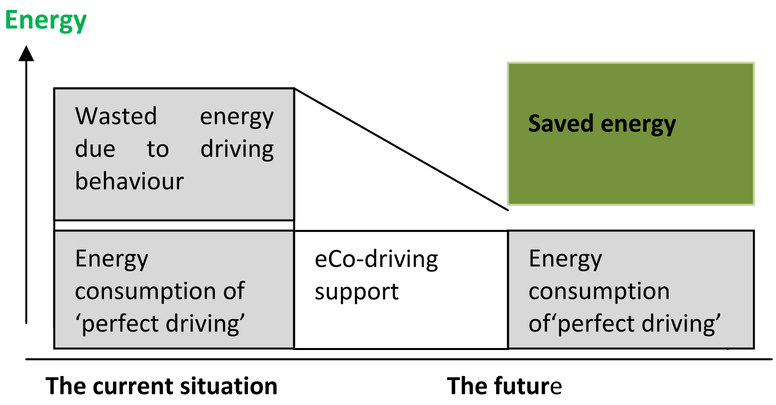

Figure 88 - End-to-end service chain of eco-driving support

Below two use cases are given as examples in order to explain the functionalities of eco-driving support.

| Use Case ID | UC_4f_2 After trip eco-driving coaching |
|---|---|
| **Scenario title** | Trucks and the city |
| **Service name** | Eco-driving support |
| **Short Description** | This system helps the driver to be aware of vehicle conditions that influence fuel consumption before starting the trip. Some inefficiencies can be detected by systems in the vehicle (if available), such as low tire pressure and maintenance interval. In this case the driver can be automatically notified that e.g. tire pressure is too low.<br>Other inefficiencies cannot automatically be detected by systems in the vehicle, like wrong vehicle maintenance (old air filters, obstruction of air outtakes, change of oil, etc…), bad tire condition, vehicle loading (unnecessary weight), unnecessary or inefficient accessories or equipment that might affect aerodynamics, etc…<br>In case it is not possible to detect an inefficient condition automatically (e.g. equipment that might affect aerodynamics, bad tire condition, etc…) the system asks the driver to check these conditions. |
| **Goal** | Fuel efficiency improvement on vehicle level - eliminate inefficient vehicles conditions: low tire pressure, wrong vehicle maintenance (old air filters, obstruction of air outtakes, change of oil, etc…), bad tire condition, vehicle loading (unnecessary weight), unnecessary or inefficient accessories or equipment that might affect aerodynamics, etc… |
| **Potential Constraints** | Data availability in the network / Possible annoyance of the driver (e.g., the driver is alerted about an additional weight on the vehicle → he might know the fact and he really need to carry this weight) |
| **Main flow** | 1- The vehicle checks the conditions that can be detected automatically (the information is in the vehicle network):<br>o Tire pressure<br>o Vehicle maintenance<br><br>2- In case an inefficient condition was detected, a recommendation is presented to the driver.<br><br>3- The driver is asked to check some conditions (difficult to check automatically):<br>o Tire condition<br>o Vehicle loading (unnecessary weight)<br>o Adjustments / equipment influencing aerodynamics |

| Use Case ID | UC_4f_2 en-route eco-driving support |
|---|---|
| **Scenario title** | Trucks and the city |
| **Service name** | Eco-driving support |
| **Short Description** | <u>Service provider's prospective</u><br>The ecoDriver Support system is aware about the vehicle status (e.g. load) and the route to be driven. In additional the following information may be also required:<br>- Vehicle configuration (length, height, width, number of axles, axle and approval weight, type of cargo, emission level<br>- Vehicle speed & Location (e.g. highway, urban)<br>- Traffic signal control state<br>- Other vehicles<br>- weather<br><br>Based on this information it supports the driver in using the vehicle in the most fuel efficient way by advising him on:<br>- correct brake usage and braking strategies<br>- Avoiding speeding, speed variations and stops<br>- Coasting<br>- Accelerating<br>- Adaptive Cruise control<br>- Gear shifting and clutch handling (only for manual gearbox)<br>- Use of onboard accessories (e.g. air condition)<br>- Avoiding unnecessary idling of the engine<br><br><u>Driver's prospective</u><br>The driver receives the above information while driving. The information is given via an interface of an on-board unit using audio or visualised message |
| **Goal** | Fuel efficiency improvement on vehicle level. |
| **Potential Constraints** | Advices issued by the system should be feasible and adapted to the current driving situation. Otherwise system will not be accepted.<br>Safety reasons do not allow optimum behaviour in all situations (e.g. speed limits that are below optimum speed and even force braking when driving downhill). Furthermore information could be outdated. By this hints are no longer accepted. Some environmental parameters require also special sensors or third party information (e.g. traffic density). Availability and quality of this data could differ. |

| | |
|---|---|
| **Main flow** | The system gather all possible information such as the vehicle characteristics, GIS, traffic situation etc to calculate the "perfect driving style"' and guide the driver to following the "perfect driving style". |




| | |
|---|---|
| **Use Case ID** | UC_4f_3 After trip eco-driving coaching |
| **Scenario title** | Trucks and the city |
| **Service name** | Eco-driving support |
| **Short Description** | <u>Service provider's prospective</u><br>The after trip eco-driving coaching system saves all en-route driving data and evaluates the driving style by comparing with the "perfect driving style" calculated by the eco-driving support system. The evaluation results are given to users, i.e. the fleet management and the driver.<br><br><u>User's prospective</u><br>The fleet manager receives the above evaluation report on each driver's. The fleet manager can use the information for the staff training and management.<br><br>The driver receives the above evaluation report after each trip. The report will help him to improve driving style in the future. |
| **Goal** | Fuel efficiency improvement on vehicle level. |
| **Potential Constraints** | Driving style may be affected by many factors. The evaluation may not take into account of the potential influencing factors. Therefore, a driver may fear that he's not fairly evaluated, thus reduce acceptance of level of the system. |
| **Main flow** | The system gathers driving data (speed, accelerate/decelerate rate, gear changing, lane changing, stops) during the trip and compares the driving data with 'the perfect driving style' to evaluate how good the driver following the eco-driving system's recommendation, compares the consumed energy with the energy consumed by 'the perfect driving style' and analyse the reason of wasted energy, and recommend corresponding training scheme. |

### 5.10.2 Service capability comparison description (today, future)

| | Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|---|
| Fleet manager | Fleet manager does not know a driver's driving style is. | Fleet manager knows how a truck is driven, how much energy is needed for a specific trip, how good driver is. |
| | Fleet manager cannot accurately estimate operation cost. | Fleet manager is able to accurately estimate operation cost by knowing energy consumption needed for a specific trip and each driver's style. |
| Driver | Driver is unaware of energy consumption due to:<br>- Vehicle condition<br>- Inefficient deceleration<br>- Excessive speed and acceleration;<br>- Wrong gear and engine speed;<br>- Poor anticipation of road condition;<br>- Poor anticipation of traffic condition; | The system will check and inform driver about the vehicle's condition.<br><br>Driver is given recommendation on speed, acceleration, deceleration and gear selection while driving. |
| | Driver is not motivated to save energy. | Driver's energy saving is evaluated by the service and evaluation is delivered to fleet manager. Fleet manager can use the evaluation results to evaluate performance of a driver. |

### 5.10.3 Service components

| Nr | Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|---|
| 1 | Vehicle condition check (pre-trip) system | Check vehicle conditions that influence fuel consumption before starting the trip. | eCo-driving support; after trip eCo-coaching | Load sharing & balancing;<br><br>Traffic-optimised fleet management |

| | | | | |
|---|---|---|---|---|
| 2 | eCo Driving support system | During the driving and taking into account the vehicle status, the route and the driving situation (traffic, infrastructure, weather, etc…), the eco-Driving Support system gives to the driver the most adequate indication about:<br>Acceleration in the most economical way.<br>Deceleration in the most economical way.<br>Recommendations to shut down the engine (vehicle without stop-start system).<br>Avoid idling.<br>Most adequate speed (adjust speed to driving situation).<br>Gear shifting.<br>Important is that the system is based on a prediction of the road ahead and therefore can support the driver to better anticipate. | Vehicle condition check,<br><br>After trip eco-coaching | Traffic-optimised fleet management;<br><br>Cooperative traffic signal control; |
| 3 | eCo-driving interface | This system is to help the driver to follow the recommended driving style and inform the driver when his driving is inefficient. | eCo Driving support system | |
| 4 | eCo-coaching system | Store relevant data speed, accelerations, fuel consumption, …) n the vehicle during a trip;<br>Give the driver some advices or compliments on the main fuel consumption related issues in his / her last drive directly after the driver ends his trip;<br>Analyse the data of each trip stored inside the vehicle drive to understand style aspects.<br>Deliver the analysis results to the driver and fleet manager with recommendations to the driver specifics and the stored data can be used to personalise the settings of the routing. | eCo Driving support system | Truck drivers' social network |

### 5.10.4 Actors, their roles and relationships

| Nr | Actor | Roles | Relationships between actors |
|---|---|---|---|
| 1 | Vehicle manufacturer or system provider (OEM) | To understand the inefficiency due to driving style;<br>To calculate the 'perfect driving style';<br>To provide connection of the eco-driving support system and vehicle components (e.g. vehicle CAN-bus);<br>To develop interface to inform drive the 'perfect driving style' while not constrain to safety; | Building the system based on drivers and fleet operators' requirements |
| 2 | Traffic operator | To provide information required for eco driving support system | Providing information to fleet operator |
| 3 | Fleet operator | To use information from eco driving support system for fleet management;<br>To use after-trip analysis from eco driving support system for drivers' training and staff management;<br>To share experiences with other fleet operators | Managing drivers;<br>Giving requirements to vehicle manufacturer or system provider;<br>Receiving information from traffic operator |
| 4 | Drivers | To following instruction from eco-driving support system while driving;<br>To use after-trip analysis for improving driving style<br>To share experiences with other drivers | Communicating with fleet operator |

### 5.10.5 Data: data flows, databases, required input from other services

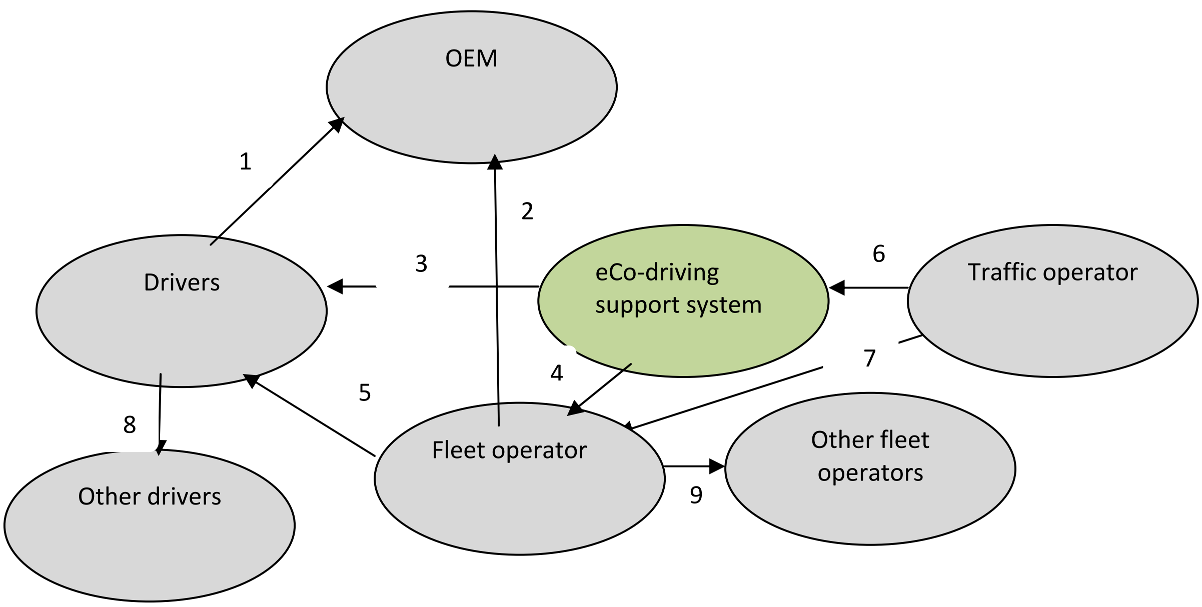


Figure 89 - Data flow of eco-driving support

| Nr | Data |
|---|---|
| 1 | OEM receives requirements for eco-driving support systems from drivers |
| 2 | OEM receives requirements for eco-driving support systems from fleet operators |
| 3 | While driving, the system instructs drivers on the most fuel efficient way of driving, based on local and current situation;<br>After a trip, the system send feedback and analysis of fuel efficiency of the trip |
| 4 | While driving, the system communicate with fleet operator to give current statues of the drivers;<br>After a trip, the system send feedback and analysis of fuel efficiency of the trip |
| 5 | While driving, fleet operators gives instruction to drivers;<br>After a trip, fleet operators gives evaluation and training to drivers |
| 6 | Traffic operator provides up-to-date information to eco-driving support system |
| 7 | Before a trip, traffic operator provides up-to-date information to fleet operator for trip planning;<br>During a trip, traffic operator provides up-to-date information to fleet operator for instructing drivers; |
| 8 | To share experiences with other drivers |
| 9 | To share experiences with other fleet operators |

### 5.10.6 Expected benefits

- Improving fuel efficiency for trucks;
- Reducing CO2 emission and operation costs of fleet;
- Giving better understanding of drivers' performance and needs of training

### 5.10.7 References: other projects, actual services etc.

eCoMove deliverable D3.1 eCoSmartDriving use cases & system requirements;

eCoMove deliverable D4.1 eCoFreight & logistics system description use cases & system requirements;

# 6 Scenario 5 – Online traffic & infrastructure management

## 6.1 Scenario summary

Road congestion is increasing and costs the EU about 1% of GDP [EC 2006a]. The daily congestion on today's roads requires an innovative solution of traffic management systems. In order to provide such solution the ITS applications for Traffic Control, Transport Management, Environmental Monitoring and Multimedia Mobility Information can cooperate fully to implement traffic management strategies.

In order to achieve efficient urban traffic management, cities need to deploy not only the technologies for traffic monitoring, but also dedicated traffic management platforms, which can integrate all the data coming from the different monitoring technologies so as to calculate and provide meaningful real time information and strategies either for their own purpose as operators or for end users. All this has an enormous cost for cities. The innovation proposed by Instant Mobility is to use the cloud capabilities of the Future Internet to create innovative services that reside in the cloud or that use the core platform capabilities. These emerging hybrids of proprietary and cloud applications will result in a new class of distributed applications, and reduce costs by eliminating the need to buy specific platforms. Transport agencies will be able to use all existing infrastructure-based technologies, such as inductive loops, dedicated short-range communication (DSRC) beacon-based technologies, closed circuit television cameras (CCTV), automatic number plate recognition systems (ANPR) etc for data collection. Alongside this data, they will also have access to information from other sources (social networks, wifi devices, etc), as all of this data will be available in the 'cloud'.

A company with a traffic management platform able to integrate multiple sources of traffic and mobility data will be able to use it to provide services such as: a complete representation of current traffic conditions over the network, travel time estimations and forecasts, wide area strategic traffic control, Real Time Traffic Information (RTTI) provision for end users and multimodal services (PT, park and ride etc depending on the kind of data provided by the city; etc), and dynamic routing guidance with different route options depending of the road network condition in real time

The area wide optimization service will be realized by extending the existing traffic management platform. The output of this service can be re-used by different services and principally by the traffic-adaptive demand management (s5.d) which will provide the policies based on the real demand of traffic in order to achieve the equilibrium of the network. These two services are complemented by the contribution of the services: cooperative traffic signal control (s5.b), traffic control in the cloud (s5a) and demand responsive parking management (s5e), because they have the aim to actuate the policies in the road.

Moreover, traffic control 'in the cloud' will be different from the existing approaches as traffic control operations will be hosted in the Internet in secure virtual traffic signal controllers and a virtual traffic centre. This will leave local systems the task of providing safety control and communications. It is here that prioritization policies can be applied, e.g. to give priority to special vehicles such as buses, trams, emergency vehicles, commercial vehicles (HGV), etc.

The cooperative traffic signal control will send approaching drivers a recommended speed, coordinated with traffic light controllers, so that they will receive a green light and avoid the need to stop at intersections.

Furthermore, demand responsive parking management will provide real time services which monitor the real-time availability of parking spaces.

One of the main characteristics of these services is their modularity. It is important to note that the services can cooperate with each other and also with other services outside this scenario. They will be able to provide input for the creation of new types of service that will improve personal mobility. This is the reason why this scenario must support the B2B "Business to Business" business model.

The complete scenario 5, presented in the following sections, has the following advantages:

For the Traffic Operator:

- Reduce the cost of local hardware installation.
- Reduce maintenance costs (local hardware currently resides in a hostile environment, so less hardware will result in less maintenance).
- In the case of faults, easy intervention in a comfortable environment (server-farm).
- Seamless configuration, installation and upgrade possibilities.
- More scalable and modular systems for traffic control centre.

For the User:

- Improved safety and fewer accidents at controlled signalised interactions.
- Reduced delays and congestion, improving the mobility of users.
- Improved energy efficiency by optimizing traffic demand.

### 6.1.1 Purpose

By exploiting the enablers provided by the FI-PPP programme, this scenario will allow the rapid deployment of a new generation of traffic management services. These will result in an improvement in the levels of mobility on the roads by acting as B2B services, for instance by providing accurate RTTI for mobility services such as routing information, personalized route guidance, eco-driving support, etc. Consequently this scenario will also need to consume services from other scenarios and services, for instance consuming floating car data, or getting data from crowd sources services.

The traffic management centres will be able to create the most suitable strategic action plans only by using available high quality data. The actuation services will run optimal policies which take into account the specific requirements of each zone, region or city.

The next sections present the principal Use Case analysis and definition of the scenario: Online traffic & Infrastructure. It will identify the problems that the envisioned services will face and how Future Internet solutions could address such problems.

The document provides a short description of each service, the way it interact with other services and can be combine within the scenario. A summary is provided which specifies the main actors, roles, stakeholders affected, and the expected benefits.

### 6.1.2 Problems to be solved

The common problems that the proposed new services need to face are listed below:

- From the point of view of a Traffic Control Manager/Local Authorities/Transport Agencies
  - Efficient maintenance of traffic control hardware is difficult and costly.

  - o It is frequently hard for a Traffic Control Centre to have full detailed knowledge of a wide area.
  - o Local authorities/Transport agencies find it difficult to reduce congestion in cities and to improve the distribution of traffic on the road network.
  - o Transport agencies often are not able to undertake effective planning, due to the lack of relevant data.
  - o The cost of obtaining precise matching information from different sources (such as: sensors, external systems, etc) is costly.
- From the point of view of the travellers:
  - o Travellers often are not able to take good decisions during trips due to insufficiently detailed or not fully reliable information (e.g. duration of congestion, consistent real time driver information and useful advice).
  - o Difficulty in planning trips, and in particular getting a reliable estimate of their time of arrival, due to the lack of customized tools with integrated real time information (e.g. which take into account possible congestion due to large events, road works, etc).

#### 6.1.3 Rationale: how Future Internet solution could address the above problems

The Future Internet solution will address the above problems by providing a machine-to-machine interaction between travellers and the control centre. Sharing information from travellers about their planned and ongoing trips can enable the control centre to process current and expected traffic to provide individual travel guidance as well as system wide optimization for travel time, costs or pollution. The provision of information sharing could be based on an OBU using mobile technology to interact with traffic control in the cloud. This should be based on FI-Ware WP5 Internet of things.

By means of the Generic Enablers provided by the FI-PP, it will be possible to collect and analyse massive amounts of data from diverse sources, as well as to classify it.

The Traffic Control Centre will be able to manage and consume FI services for improving traffic management and the high level actuation of traffic strategies.

Having high quality data measurements of traffic will allow algorithms to make high quality traffic forecasts. Such traffic forecasts will be available by means of open interfaces that will use the Service Delivery Framework which is planned to be developed in the FI-WARE project. This means that any application or service interested in the outcomes of this Scenario will be able to consume them, e.g. trip planners could use the traffic forecasting of this Scenario or route guidance for travellers will incorporate updated information of traffic. Moreover, traffic lights could be controlled by high technology techniques, using adaptive mechanisms which can fix timing phases according to the real demand of vehicles in the road.

Travellers will be able to take important decisions by having access to relevant data, such as: receiving recommended speed in order to create a green wave, comparing travels times with different transport modes, knowing in advance the availability of parking spaces, etc.

### 6.1.4 Short description of each service as a whole

## 5.a Traffic control in the cloud

Traffic control operations are hosted in the Internet, in secure virtual traffic signal controllers and a virtual traffic centre, leaving local systems the task of providing safety controls and communications. Virtual components and data are accessible anywhere to authorised personnel, while local units guarantee reliability.

### 5.b Cooperative traffic signal control

Ad-hoc networks are created in the cloud between clusters of vehicles and the traffic management infrastructure. This allows traffic signals to adapt to real demand in real time and offers drivers a recommended speed to avoid having to stop at intersections.

### 5.c Area-wide optimisation strategies

Large amounts of data on vehicle movements and on traffic control measurements and predictions are mashed up in a comprehensive optimisation process. A set of self-learning strategies are applied and, as a result, a valuable high precision traffic flow forecast will be provided for feed services of traffic demand management techniques in order to decrease emissions, least delay etc.

### 5.d Traffic Demand Management and Control policies

City-wide traffic demand is managed through adaptive physical control and pricing enabled by online services. Targeted flows are achieved through varying permitted vehicle flows and adaptive pricing. Innovative techniques and policies for actuation will work in order to obtain the best balance in the traffic network.

### 5.e Demand responsive parking management (to be improved)

Online service for controlling availability of parking spaces and their price, coupled with driver guidance to balance demand across available parking supply.

#### 6.1.5 How services interact and combine within the scenario

The interaction between services within the scenario is described below. The next diagram shows the relationship between services of the Scenario 5 as well as the connection of the Scenario 5 with other services.

There are many traffic management solutions in the market, with a common main barrier, the availability of accurate and reliable information on time of a wide area. The Area Wide Optimization Strategies called as “Service 5.c” has the aim of collect data about mobility (e.g cars speed, number of vehicle, traffic flows) from different sources and mash-up it in an intelligent way. This service will consider a wide area (urban/motorway/highways) as a whole and will be able to apply the more suitable techniques and models of traffic forecasting and self learning. As an outcome it is expected to have a complete excellent dynamic traffic forecasting for wide areas.

Considering that the current main obstacle of the ITS systems is the availability of the high quality of the data input used, because in most of the cases the data is disaggregated and no accurate. By means of the output provided by the Scenario 5.c this barrier will be overcome.

The outcome from Scenario 5.d is a valuable prerequisite for implementing high-quality traffic and travel information services achieving good user response and gaining considerable benefits in traffic throughput, safety, environment and economic efficiency.

The Scenario 5.d "Traffic Adaptive Demand Management and Control Policies" will focus in the development of a modular system that can evaluate dynamically the demand of traffic by calculating the optimal equilibrium of the network. Once the demand is known it is possible to describe an "Actuation Plan" in order to achieve the optimal free flow situation. Such actuation plan will be formed by a set of traffic control policies according to the situation. For the creation of the suitable Actuation Plan it is important to have a reliable forecast traffic system, it is here where the input from Service 5.c is valuable. Some examples of elements used for run high level actuation plans are: Feedback to OBU for personalized route guidance and real time traffic & route information Variable Message Signs, public and commercial transport priority or dynamic road pricing techniques, etc.

Moreover, the new service Demand Responsive parking management will allow to control the availability of parking spaces and their price by online services

By means of all the services of this scenario it will be possible to improve the flow-free on the roads, decrease carbon consumptions and decrease delays. It is important to notice that this Scenario is closely connected with other Services of the rest of Scenarios in Instant Mobility.

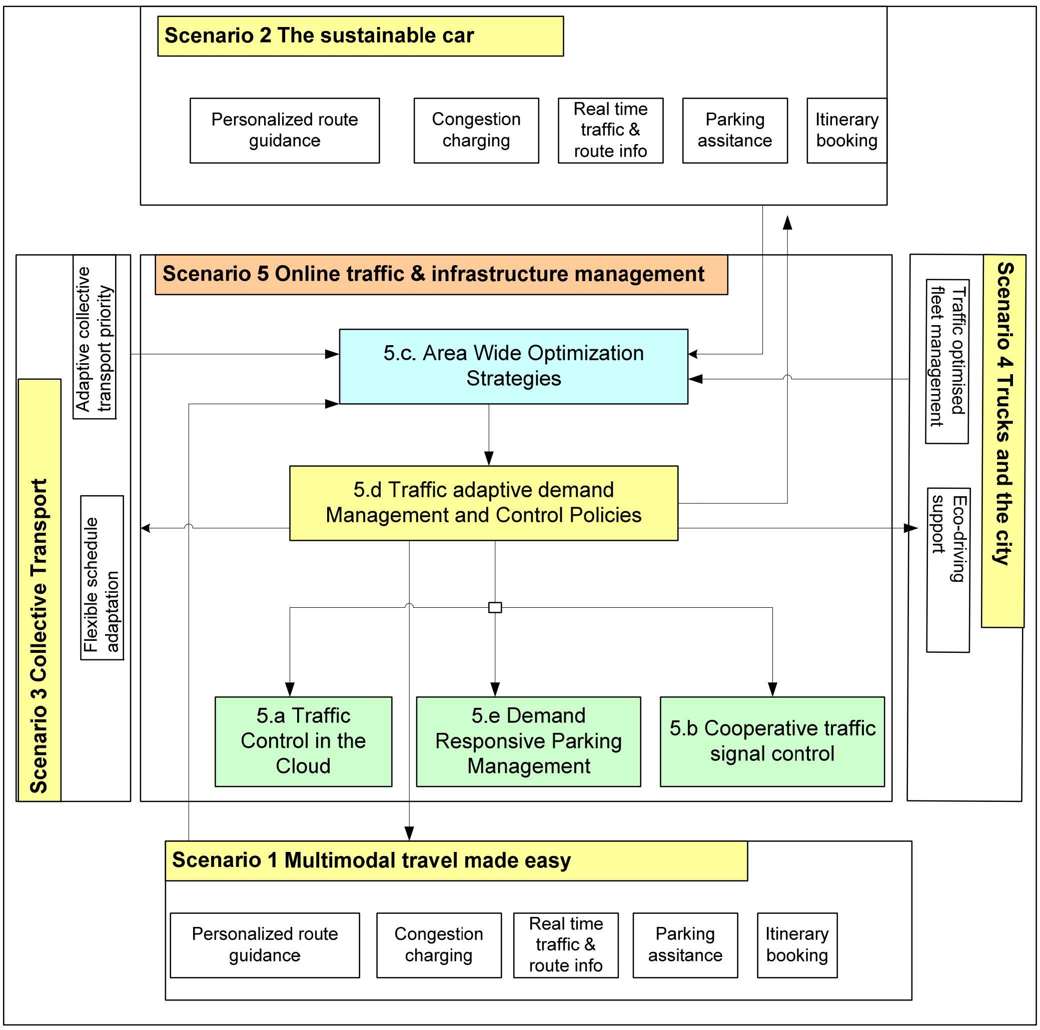



Figure 90 - Interaction of services within Scenario 5 and others Instant Mobility Scenarios

### 6.1.6 Summary of main actors and roles, and affected stakeholders

The main actors for these services are:

- Public transport authorities
- Infrastructure operator
- (Road operator)
- Service Providers
- System Integrators and Developers
- Public transport operators
- Data Providers
- Traffic Manager Operator
- Map Provider

| Main actors | Services involved | Roles |
|---|---|---|
| Public transport authorities | all SP5 services | Provide data regarding the main issues that the city faces regarding traffic and mobility.<br>Provide details about parking spaces in the city |
| Infrastructure operator | all SP5 services | Effectuate the changes needed in the road according to the traffic actuation plan developed e.g ZTL, RSU installation. |
| Road operator | | Provide complete data about disruption in the road that can affect circulation of vehicles in the city. |
| Service Providers | all SP5 services | Use the data provided by the scenario in order to actuate the recommended strategies in other services for example: route planners, route guidance, etc. |
| System Integrators and Developers | | Integrators and developers can use the data (e.g traffic information and the traffic forecast) developed within the scenario in order to provide new smart applications for mobile devices or computers with different operating systems. |
| Public transport operators | all SP5 services | Provide information regarding time tables, AVL systems, forecasting time tables, etc. |
| Data Providers | 5.d<br>5.a | Floating car data providers, social networks, prediction systems, meteo data, etc |
| Traffic Manager Operator | all SP5 services | Allow the new services of the scenario to be applied e.g: providing the access to traffic controllers of the city, and traffic information. This stakeholder will mainly benefit from the services, having the possibility to optimize its functions of management and apply the suggested strategies of the system. |
| Map Provider | all SP5 services | Providing geographic information, POI, in-door maps for specific places such as: parking areas. |

### 6.1.7 Expected benefits

The next is a list of expected benefits that the implementation of all the services of Scenario 5 can give as an outcome:

- Reduce communication costs which require extensive networks.
- To provide information to users, with alternative devices (mobile phones, table pc's, etc) to the expensive and cumbersome Variable Message Signs (VMS).
- The users can take advantage of traffic information, during their normal journey travels, having more precise information allows them to organize their normal trips in a more comfortable way.
- The traffic data centres can offer reliable forecast and real time information regarding traffic to other service providers such as: dynamic routing guidance, real time route planners, etc.
- Traffic data centres and Municipality can monitor ITS of a wide area having low costs and high performance, e.g. without installing many detectors.
- The end users can always avoid congestion by knowing in advance the situation of traffic.
- New efficient strategies of traffic control, improving the requirements of infrastructure installed on road, can be applied, reducing costs and increasing the computing power.
- Possibility of a more efficient maintaining service usage of shared skilled operators between regions and even countries offering traffic control as a service and then reducing the need of skilled human resources on-site.
- The end user can know the speed recommended in order to find the green light and to save carbon emissions.
- The municipalities can use new services of traffic control using traffic adaptive demand management. For example: in case of big events such as: football matches or big concerts that can affect the circulation of vehicles, different strategies can be adapted according to the situation.
- In most cities there is a predefined maximum capacity constrained by both available network and political ambitions like reserved lanes for bus, truck delivery paths or reserved roads for trams. Within these boundaries, the cities should provide as best as they can for its citizens.
- Traditional adaptive signalling seeks an optimal coordination through central processing and alterations based on average data for periods ranging from 5 minutes to an hour. Alternatively the signalling is based on local adaptation based on individual vehicles or platoons. The online traffic & infrastructure management should aim to take the best from both approaches to, if possible, reduce congestions and emissions. An online cooperative traffic signal control should be based on information sharing aiming at:
- Improve travel guidance for travellers by informing about delays and alternative routes and travel modes. If necessary the coordination could also provide some priority, fitted within the priority requiem used in the city.
- Inform the control centre about current and planed trips as a basis for optimization as well as demand management. The coordination will also be a basis for advice for speed adaptation towards intersections.

### 6.1.8 References: other projects or actual services

| Projects/Existing Services | Description |
|---|---|
| RENAISSANCE 2008-2012 | Energy and urban development policy. |
| PRINT 2008-2010 | Green traffic flow in urban areas through reducing pollution from commercial trucks |

| | |
|---|---|
| | by giving selective priority (demonstrate priority for post vehicles and public transport in Oslo) |

## 6.2 Service 5.a: Traffic control in the cloud

In order to understand the concept of this service it is important to give a brief introduction of how traffic control systems face the signal optimization function to control traffic flows.

There are several techniques for traffic control signalling:

- Plan selection (according to a calendar)
- Traffic response/Traffic Actuated
- Adaptive

The last one could be of two types: centralised and distributed.

Traditional centralise adaptive traffic control seeks an optimal coordination through central processing and alterations based on average data for periods ranging from 5 minutes to an hour. Top down systems like Scoot and Scats are based on central processing power to make small alterations in the current signalling to improve traffic flow.

The signalling based on an adaptive distributed technique is used by systems like Utopia, Prodyn, OPAC. In this case, the unmanageable complexity of the area optimal control problem is decomposed into different classes: the local intersection level (RSU) and the Central (area) level. A road side unit is used on each intersection to calculate of optimization algorithms locally and dynamically. This system has a Hierarchical and Distributed Architecture: optimal control strategies are determined at the higher (area) level, while traffic light control is actuated at the lower (intersection) level.

This last technique is based on complex mathematical models and detailed measurements estimations of traffic variables done locally. The effectiveness of the control algorithms depends on the coverage and on the quality of the measurement points in the controlled network. Then, the application requires a large number of sensors located in the intersections. This type of technique takes into account the real time conditions of the road such as data available on traffic counts, traffic light status, number of vehicles, travel times, number of turns. The result of the algorithm is the optimal timing phases of traffic lights, which decrease the delay caused by traffic jams dynamically.

Furthermore, an advantage of the adaptive and distributed technique is that it could be combined with a mechanism of priority for special vehicles (e.g. public transport and commercial vehicles), having a good performance of recovery time in comparison with non adaptive techniques. For instance for the public transport priority, when the adaptive control functionality is applied, the availability of a detailed traffic model permits an accurate management of the eventual traffic disruption on traffic movements conflicting with the Public transport priority request. The recovering action is based on a fine optimisation (done at the RSU level) of the waiting times on all the traffic movements.

The service 5.a “Traffic control in the cloud” will concentrate in the adaptive and distributed traffic control technique, giving the fact that is one of the most complex ones and it has demonstrated to be one of the best solutions in the case of heavy and “unpredictable” traffic conditions . The objective of service 5.a is to improve it by using the facilities provided by FI-PPP for having a high quality traffic forecasts as well as for reducing the amount of hardware required for each intersection.

In other words, this service consists of having the traffic control operations hosted in the cloud, and at the same time use the adaptive and distributed technique by means of secure virtual local traffic light controllers connected with the traffic centre, leaving local virtual systems the task of providing safety controls and communications.

By using the cloud computing solutions provided by the Core Platform in the PPP program we are able to access a pool of configurable computing resources (e.g. networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. In this way the operational costs can be lowered as the computational power is increased, allowing the traffic control covering more areas and intersections in the city with the same costs. Within the available service models, Cloud Infrastructure as a Service (IaaS) and Cloud Platform as a Service (PaaS) are the ones that will be used in this scenario. As a result, virtual components and data are accessible anywhere to authorised personnel, while virtual local units guarantee efficient and reliable adaptive actuation.

#### 6.2.1 End-to-end service chain

The Figure above shows the continue cycling process for the provision of the service “Traffic control in the cloud”. In the next figure it is possible to see the service chain with its corresponding exchange of messages. The interaction begins with the monitoring of the traffic status on the network at the intersection level and at the control centre level, this involves also the use of complex mathematical models that forecast the profile of the network.

The control policies from Service 5.d sends to the Control Centre the target to be achieved in order to find the equilibrium of traffic in the network. Therefore, these policies are applied and introduced in the strategies of the Control Centre, then the optimal timing of traffic lights is calculated and then the control function sends the proper commands, calculated by the Control Centre and the Virtual RSU, to the traffic lights controllers.

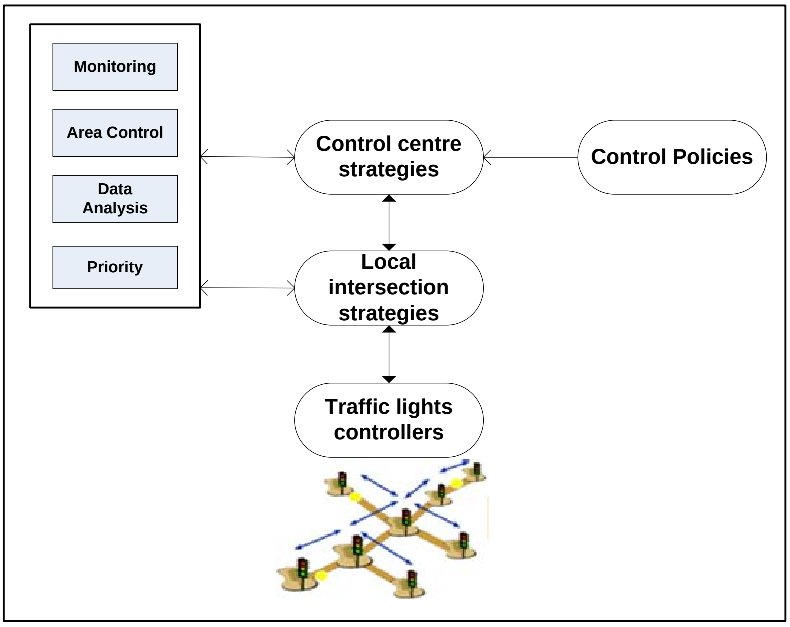



Figure 91 - End-to end Service Chain of the Service 5.a

The following is a vision of this service in different Use Cases:

**Use Case 1 (Cities with adaptive and distributed traffic control)**

Virtual intersection concept could be useful for including additional controlled intersections in the controlled network. New intersections can use the control services in the cloud and existing controlled intersections can continue working at RSU level.

This service can be used where dynamic adaptive control technique is already working. For example different cities such as: Trondheim, Oslo (Norway), Torino, Milano, Bologna (Italy), Aalborg (Denmark) and Bucharest (Romania) implement adaptive techniques by using RSU at the intersections. For all these cities a large number of hardware in the intersection is used for RSU control. Normally not all the intersections are considered because this implies high hardware costs; that is one of the reasons why the service virtual traffic control in the cloud will provide a solution.

**Use Case 2: (Cities without an adaptive and distributed traffic control)**

New cities wishing to use adaptive and distributed traffic control techniques can install virtual RSU in many intersections of a city and implement such techniques in the cloud by decreasing the costs of investment in local RSUs.

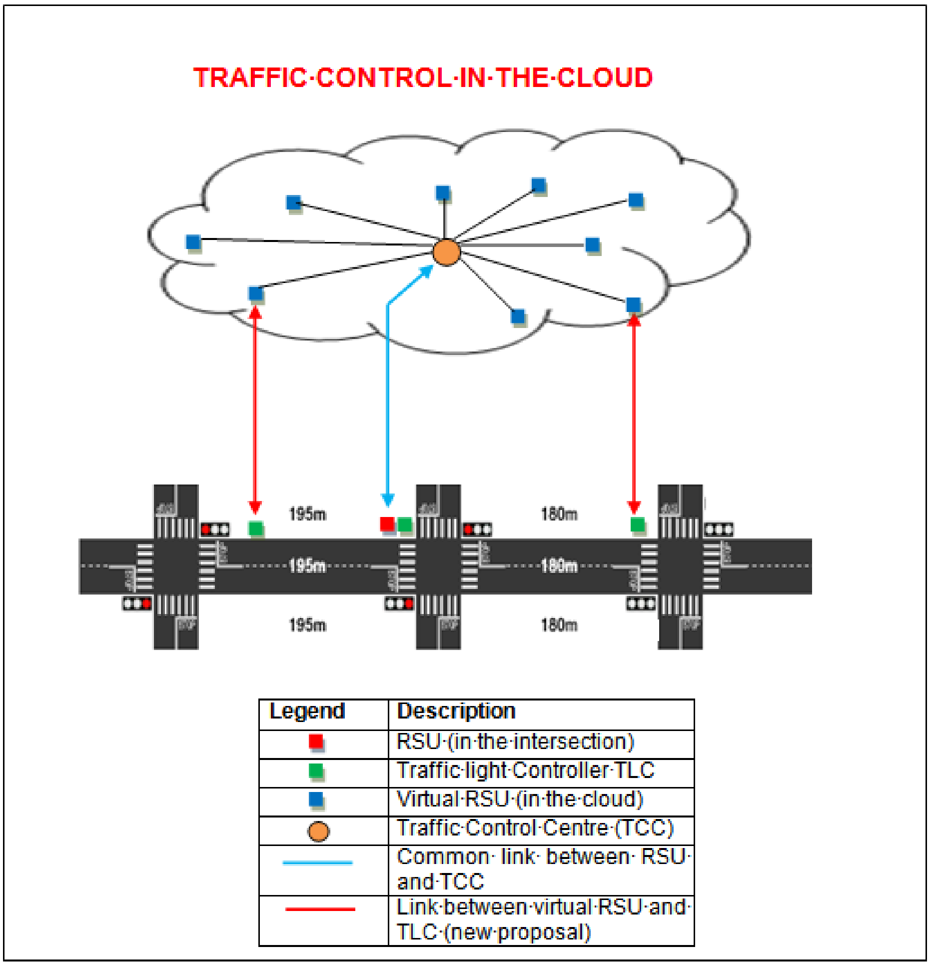



Figure 92 - Traffic control in the cloud

In the above Figure it is possible to see in a graphical way how this scenario could be implemented. The diagram shows two principal types of RSU which are: virtual RSU and normal RSU. The word “virtual” is used for saying that a PC or an RSU is in the road. The virtual RSU is exactly the same of the RSU at the intersection. The scope of this scenario is to take advantage of the facilities provided in the cloud by the enablers (provided in FIWARE) in order to replace local hardware having as a result the free-flow experience of the drivers on the road. In the figure is possible to see one blue link that represents how works the distributed and adaptative technique in the current systems. For other side the red link represents the new proposal in this scenario, which links the virtual RSU directly with the traffic controller on the road.

In the next table is shown a generic Use case for this scenario which describes how the mian advantages of this scenario and its main flow.

| **Use Case ID** | UC_5a_1: Traffic control in the cloud |
|---|---|
| **Scenario title** | Online traffic & infrastructure management |
| **Services name** | Traffic control in the cloud |
| **Short Description** | **motorist on the road**<br><br>Motorists may experience a free-flow experience on roads. The traffic jams will decrease. The motorists are stimulated to use<br><br>**Public transport motorist on the road**<br>Public transport will have traffic lights priority when achieving the intersection. Using |

| | |
|---|---|
| | public transport will motivate people because this allows them to save time.<br><br>**<u>Traffic control centre perspective:</u>**<br>**<u>users: local authorities, traffic operators, system maintenance</u>**<br><br>The traffic control in the cloud can inform users by e-mail, SMS, etc of the occurrence of any serious events and also it could use automatically mechanism for replace virtual RSU damaged. |
| **Goal** | • Minimize fuel consumption and $CO_2$.<br>• Minimize the creation and duration of traffic jams.<br>• Achieve the equilibrium of the flows of the network<br>• Increase the free-flow of the roads |
| **Potential Constraints** | • Reliability connection between Virtual RSU and traffic controllers<br>• High computing capacity for the Virtual RSU<br>• Reliability on the Virtual RSU side<br>• High speed connection between Virtual RSU and Traffic controllers<br>• Availability of high quality traffic forecasts |
| **Components** | Traffic control centre, sensors on the road, road side units, virtual road side units |
| **Main flow** | The drivers on private car experiment fluency in traffic flow.<br>They don't find traffic jams in the road because the phases of the traffic lights change according to the conditions of the road in an optimal way.<br><br>The public transport and special vehicles has priority when approaching intersections<br>Maintenance of the traffic control in the cloud will be optimal, for instance technical personnel for maintenance could receive notifications by e-mail, SMS, etc of the occurrence of any serious events, such as breakdown of traffic lights and also it could be available an automatic mechanism for replacement of virtual RSUs damaged and for monitoring them |

### 6.2.2 Service capability comparison description (today, future)

| **Service today (if it exists)** | **Service in future (with Instant Mobility)** |
|---|---|
| Frequently, the cities that use adaptive & distributed control techniques, does not cover all the intersections in the city. | Current cities that implement the adaptive control technique could extend their coverage with additional intersections using virtual RSUs with less hardware investment at the intersection. The adaptive control technique can provide a better outcome if increase the number of intersections controlled. |
| Many cities use the Plan selection control schemes (according to a calendar). | Cities that implement fixed techniques (plan selection or traffic actuated) can migrate to adaptive control technique without drastic changes in the infrastructure part ( intersection side) |

| | |
|---|---|
| The computing and process capacity at intersection level depends of the hardware capacity of the RSU hardware.<br>Normally the times of calculation of the strategies at the RSU on the intersection level are around 2 minutes and optimisation is repeated around every 3 seconds. | Higher computing capacity can be assigned at each virtual unit because resources can be extended easily in the cloud. This service within IM can improve the times of calculations done by complex algorithms. |
| Buses in Trondheim use virtual loops along fixed paths to ask for priority through mobile networks (GPSR). Utopia optimizes the signalling based on local hardware. | Not only special vehicles could ask for priority in intersections along their flexible paths but also normal vehicles can apply for priority by means of an on-board device. |
| This scenario has been tested only for simulation for basic functionality. Basic RSU/Utopia functionality has been tested for simulation purpose with a setup where local hardware was replaced by virtual servers (windows). This scenario has been tested only for simulation for basic functionality. | The Traffic Control systems optimizes its signalling technique based on the traffic control in the cloud (or local centre with high processing capacity to apply complex algorithms and adaptive strategies). |

### 6.2.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Fixed Sensors and mobile sensors | Sending number of vehicles detected, speed, position, etc e.g loops on the carriage way, mobile devices | Virtual SPOT and SPOT | Area Wide Optimization Strategies (5.c) |
| Traffic control centre | Managing the strategies of traffic control. | Virtual SPOT and SPOT | Traffic Adaptive Demand management (5d) |
| AVM system | Sending position of public transport vehicles.<br>Sending forecasts and timetables | Traffic control centre | Area Wide Optimization Strategies (5.c) |
| Virtual SPOT and SPOT | Sending the adaptive commands to the traffic lights controllers.<br>Co-operate with the adjacent virtual SPOTS and normal SPOTS units | Virtual SPOT and SPOT | Cooperative traffic signal (5b) |
| Traffic controllers | commands for timing control of the traffic lights, following the the commands send by the Virtual SPOTs and SPOTs | Traffic lights, SPOT and virtual SPOT | Cooperative traffic signal (5b) |

### 6.2.4 Actors, their roles and relationships

| Actor | Roles | Relationships between actors |
|---|---|---|

| | | |
|---|---|---|
| **Traffic operator** | Managing of traffic control centre. | Responsible for communication with other actors in the service chain |
| **Fleet operator** | Providing fleet vehicle destination, planned routes, and characteristics of vehicles;<br>Apply for PT priority by sending AVM data to the system. | Communicating with traffic operator |
| **Drivers** | Providing vehicle destination, planned routes, and characteristics of vehicles before trip;<br>Providing vehicle speed and position when approaching an interaction | Communicating with traffic operator |

### 6.2.5 Data: data flows, databases

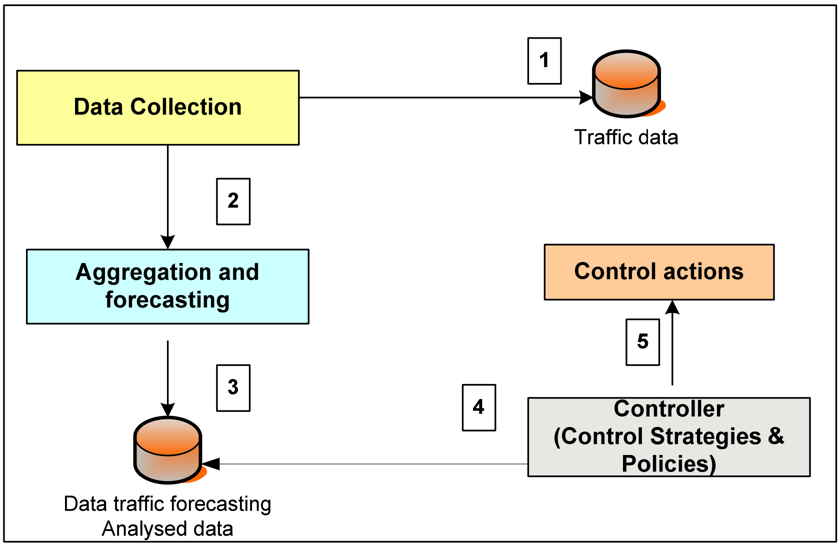



Figure 93 - Data flow for service 5.a

| ***Number shown in Figure above*** | ***Data*** | ***Input required from other services*** |
|---|---|---|
| ***1*** | Data Collection from different types of sources: WIFI, loops, floating car data | Area-wide optimisation strategies (5c) and the services which interacts with this services (Check chapter 5.4); |
| ***2 & 3*** | Aggregation and saving of forecasting of the traffic flows | |
| ***4*** | Local and Central Control Strategies.<br>Priority schemes are constructed | Traffic-adaptive demand management (5d) |
| ***5*** | Execution of the control commands on traffic lights following the optimal timing calculated with support of the control strategies | Traffic control in the cloud |

| | | |
|---|---|---|
| | Green waves and traffic priority for special vehicles is done. | |

### 6.2.6 Expected benefits

The following list the benefits this service can provide as an outcome:

- Feasibility to apply complex algorithms and adaptive strategies of traffic control by using virtual components with higher computing capacity than local hardware installed in the intersections.
- The municipality by means of the transport agency can have a cost-effective fault control and maintenance of the traffic control centre infrastructure by avoiding local hardware (in intersections) which resides in hostile environment (less hardware leads to less maintenance).
- Authorised personnel can have easy remotely access to the traffic control. They can decide to apply the more suitable strategy of control, e.g. use adaptive control techniques with bus priority. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (Broad network access).
- Seamless configuration, installation and upgrading possibilities for the traffic centre control or the service provider. The traffic centre control can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider (on-demand self-service).Feasibility to apply complex algorithms and adaptive strategies of traffic control by using virtual components with higher computing capacity than local hardware installed in the intersections. The provider's computing resources are pooled to serve multiple intersections and local units using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to the traffic control centre demand. There is a sense of location independence in that the control centre generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., city, neighbourhood, intersection, or datacenter). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines (Resource pooling).Applying dynamic and adaptive techniques of signalling together with an optimal strategy for assignation of priority, e.g: for public buses, could bring benefits of time savings for private cars, reduction in queuing time and increase of commercial speed for public transport.
- Rapid elasticity. Thanks to the use of cloud techniques, capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the control centre, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time. In this way, computational power can be balanced to intersections where it is more needed at a certain time.

### 6.2.7 References: other projects, actual services etc.

| Projects/Existing Services | Description |
|---|---|
| RENAISSANCE 2008-2012 | Energy and urban development policy. |

| | |
|---|---|
| PRINT 2008-2010 | Green traffic flow in urban areas through reducing pollution from commercial trucks by giving selective priority (demonstrate priority for post vehicles and public transport in Oslo) |

## 6.3 Service 5.b: Cooperative traffic signal control

Cooperative traffic signal control is ad-hoc networks created in the cloud between clusters of vehicles and the traffic management infrastructure, offering drivers a recommended speed to avoid stopping, and the adapting the traffic signals to the real demand in real time. The service will use information from both vehicles and infrastructure to formulate strategies to achieve the optimization of the network operation. The service makes use of traffic signal control systems available in the network. In addition to that, the systems will generate information (e.g. route or speed advice) that is sent to vehicles and back offices to inform drivers and operators of the best ways of driving to minimise delays and maximise efficiency of the network.

The service will use two main general enablers provided by the Core Platform. On one hand, cloud computing solutions are used to be able to access a pool of configurable computing resources (e.g. networks, servers, storage, applications and services). Cloud Infrastructure as a Service (IaaS) and Cloud Platform as a Service (PaaS) are the service models that will be used in this scenario.

On the other hand and in order to retrieve and filter the sensor information coming from vehicles and traffic management infrastructure, Internet of Things (IoT) infrastructures will be used. The general idea behind is that a Publish/Subscribe mechanism will be deployed so that sensors can publish their measurements while the data aggregation and filtering services, which could be running in the cloud are subscribed to those data publications receiving a copy of the raw data which they have to transform in actions to be sent to the traffic signal control.

### 6.3.1 End-to-end service chain

Cooperative traffic signal control aims at connecting traffic signal control with road operators, road users, public transport and fleet operators in order to achieve the optimised traffic signal control. The service will use all available information such as current transport operating strategies, historical/real-time/short term forecasted road network information, vehicles' position, speed, destination, etc. /drivers and fleet operators. The following figure shows stakeholders in the cooperative traffic signal control. Policy and strategies from government bodies (e.g. local authorities) will give information to road operators and road users on current policy (e.g. road charging) and strategies (e.g. road closure due to big events). The road operators will use the information and other information (e.g. incidents, weather) to operate traffic signal control systems. Traffic signal control systems receive information from road operators, public transport and fleet operators and motorists on their destinations, planned routes, current positions and speeds etc. use of the information, traffic control systems will calculate the best signalling timing in order to achieve the best balance of the network usage. The traffic signal control systems can also provide information directly to motorists and public transport and fleet operators on timing of signals, waiting time and recommended speeds.

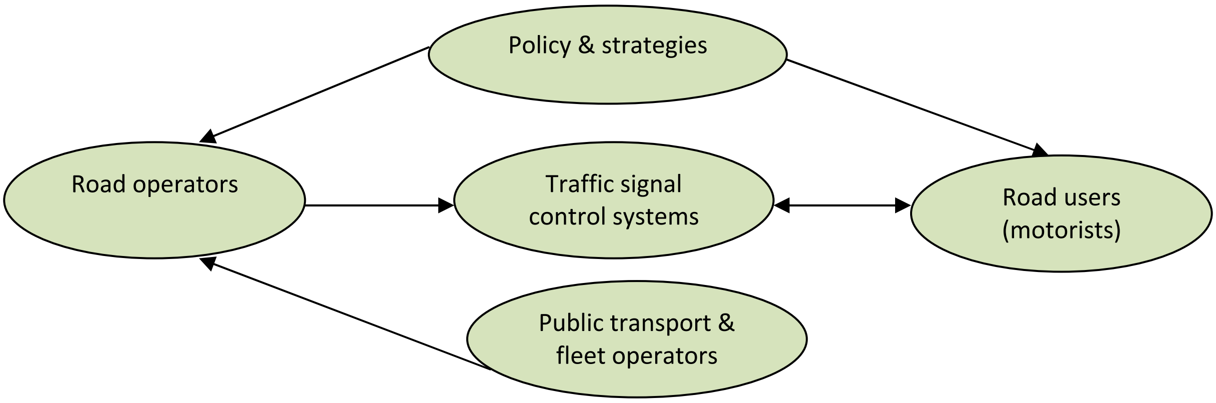



Figure 94 - Stakeholder Diagram of Cooperative Traffic Signal Control

Below two use cases are given as examples in order to explain the functionalities of the cooperative traffic signal control services.

| | |
|---|---|
| **Use Case ID** | UC_5b_1: Cooperative Green wave |
| **Scenario title** | Online traffic & infrastructure management |
| **Services name** | Cooperative traffic signal control |
| **Short Description** | road user perspective<br>Motorists may experience a green wave on a road section. They are stimulated to adjust their speed to stay within the green wave.<br><br>road operator perspective<br>Macroscopic (road side sensors) and microscopic (Floating Vehicle Data) traffic related data for a defined green wave road section is gathered in the traffic control centre, merged and processed in order to derive detailed traffic state information. A control procedure is used to dynamically define coordinated traffic light control along subsequent urban intersections that target the overall maximisation of network efficiency in this road section. The control procedure takes into account the possibility to influence the speed and behaviour of vehicles. For green wave corridors or vehicle with priority (e.g. emergency vehicles, HGV etc), information with the green wave control parameters also accompanying information (e.g. speed recommendations) is generated that will be provided to the motorists. |
| **Goal** | • Minimize fuel consumption and $CO_2$-emission for a road section of subsequent urban intersections by maintaining acceptable circumstances for all road users.<br>• Use (microscopic) vehicle generated data to get a more detailed picture of the traffic situation (e.g. the concrete shape of vehicle platoons and their evolution in time).<br>• Enable new dynamic green wave control procedures that - besides waiting times and number of stops - explicitly take into account fuel minimising objective functions.<br>• Use short range communication to inform and instruct approaching drivers about green wave coordination speed and red traffic light approaching speed in order to shape vehicle platoons and to harmonise vehicle speeds with the traffic control strategy. |
| **Potential Constraints** | • Road users might not be willing to drive in line with the speed recommendations, especially if the recommended speed is too low.<br>• The Green Wave might require huge computing capacity in the traffic control |

| | |
|---|---|
| | centre for green wave control through frequent switching of local control programs. |
| **Components** | Traffic control centre, road side unit, intersection traffic light controller, vehicles. |
| **Main flow** | While approaching a sequence of traffic light, vehicles periodically broadcast information about their position and speed. Together with detector and traffic light data from traffic light controllers a roadside unit processes the information and forwards it to a traffic control centre. The traffic control centre computes green wave control parameters and distributes them to traffic light controllers to enable coordination between controllers. Next, the road side unit computes speed advices based on the current traffic light control and sends the advices to the drivers. When following the speed advice, the vehicle drives smoothly through the green wave section. If red traffic light will be given when the vehicle is approaching, the traffic light will inform the timing of red traffic light, calculate the speed for the vehicle approach the red traffic light, and forecast the waiting time.<br><br> |

| | |
|---|---|
| **Use Case ID** | UC_5b_2: Cooperative Interaction Control |
| **Scenario title** | Online traffic & infrastructure management |
| **Services name** | Cooperative traffic single control |
| **Short Description** | <u>road operator perspective</u><br>Intersection controllers can be more efficient and safer by having them adapt to the actual traffic conditions and having them anticipate on the expected traffic conditions. Using information from the infrastructure and vehicles, the intersection controller can distribute and assign green times more efficiently to accommodate the expected demand. An intersection can furthermore reduce inefficiencies caused by the generally conservatively chosen values for minimum green time, yellow time and clearance time.<br><u>road user perspective</u><br>Approaching traffic can be informed about their estimated time of departure from the stop line. Vehicles can be provided with a speed advice or update their approach speed themselves in order to save on fuel. The motorists will be informed red light ahead, and waiting time for the red light, together with recommended speed to approaching the traffic light to make all vehicles on the road section smoothly stop for the red lights and smoothly re-start when the traffic light turning green. The information may be used by a vehicle to automatically stop the vehicle if the vehicle intents to not stop. |
| **Goal** | • Maximise safety by avoiding sudden speed decrease or violence of red traffic light through use of information between vehicles and traffic signal control units<br>• Minimize fuel consumption and $CO_2$-emission by avoiding sudden increasing and decreasing speed<br>• Use short range communication to inform and instruct approaching drivers about red traffic light approaching speed in order to harmonise vehicle speeds with the traffic control strategy. |

| | |
|---|---|
| **Potential Constraints** | • Road users might not be willing to drive in line with the speed recommendations, especially if the recommended speed is too low.<br>• Time of red traffic light should be reasonable.<br>• Time related information should not change too often to prevent negative side-effects. |
| **Components** | Traffic control centre, road side unit, intersection traffic light controller, vehicles. |
| **Main flow** | Vehicles report to the intersection how they approach the intersection, i.e. direction of the vehicles (straight ahead, left turning, right turning etc). The intersection will determine when they enter or exit conflict zones on the intersection, when they pass the stop line, etc. Based on these the controller determines an optimal distribution of green times, yellow and red times for different directions. Information with respect to the estimated time at which vehicles will be able to pass the stop line is sent to the vehicles.<br> |

### 6.3.2 Service capability comparison description (today, future)

| | **Service today (if it exists)** | **Service in future (with Instant Mobility)** |
|---|---|---|
| road operator perspective | Static green waves (without speed recommendations) can often not be formed or do not achieve optimal capacity over both directions as they cannot influence the speed of the vehicles while they are driving in the green wave and the shape of the platoons. | Vehicles undergo less braking and accelerating manoeuvres.<br><br>The green waves are much better tuned with respect to both driving directions. |
| | Intersections are unaware of approaching traffic and are thus unable to determine at which times turning movements can best be served so as to minimise delay of traffic flow on all approaches. | Intersections are aware of approaching traffic as they are informed by upstream traffic signals and by approaching vehicles. This information includes, but is not limited to, information regarding the direction of travel, the estimated arrival time, and the characteristics of the vehicle (e.g. vehicle type). |

| | | |
|---|---|---|
| | | |
| | Intersections are unaware of the clearance times, minimum green times and amber times that are actually needed | Intersections are able to determine appropriate clearance times, minimum green times and amber times dynamically. The intersection controlled can thus significantly reduce $CO_2$ emission in a way that is considered reasonable by traffic participants. |
| road user perspective | Motorists do not have real information about the coordination speed within the green wave. | Motorists can be informed with coordination speed within the green wave |
| | Motorists who are approaching the traffic light) are unaware of the time when it will be able to pass the interaction. | Motorists can be informed with the waiting time and/or recommended speed. |

### 6.3.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|
| Traffic control centre | Receiving information from traffic signal control, vehicles and fleet operators on routing of vehicles and traffic flows; Sending information to fleet operator and traffic signal control on signal control strategies | Cooperative traffic signal control unit;<br>Cooperative in-vehicle unit;<br>Fleet operator | Traffic control in the cloud (5a)<br>Area-wide optimisation strategies (5c);<br>Traffic-adaptive demand management (5d) |
| Roadside unit | Collecting information on traffic flow for traffic control centre and cooperative traffic signal control unit | Traffic control centre;<br>Cooperative traffic signal control unit | |
| Cooperative traffic signal control unit | Receiving information from vehicle on position, speed, routing, characters of the vehicle;<br>Receiving information from traffic control centre;<br>Sending information to vehicles on waiting time, recommended speed;<br>Sending information to traffic control centre on current approaching vehicles and signal control state | Cooperative in-vehicle unit;<br>Traffic control centre | Personalised route guidance (2a);<br>Adaptive collective transport priority (3f);<br>Eco-driving support (4f) |
| Cooperative in-vehicle unit | Sending vehicle positioning, speed, routing (to inform the turning), characterises of the vehicles, priority | Cooperative traffic signal control unit;<br>Traffic control centre | Personalised route guidance (2a);<br>Eco-driving support |

| | | | |
|---|---|---|---|
| | | | (4f) |
| Fleet operator | Sending vehicle positioning, speed, routing (to inform the turning) and priority requires before trip | Cooperative traffic signal control unit;<br>Traffic control centre;<br>Cooperative in-vehicle unit; | Traffic-optimised fleet management (4e)<br>Eco-driving support (4f) |

### *6.3.4 Actors, their roles and relationships*

| Actor | Roles | Relationships between actors |
|---|---|---|
| **Traffic operator** | Calculating strategies of traffic signal control unit, providing and maintain cooperative traffic signal control unit and other road site units | In charge of the service;<br>Responsible for communication with other actors in the service chain |
| **Fleet operator** | Providing fleet vehicle destination, planned routes, and characteristics of vehicles;<br>Apply for priority before trip when needed (e.g. emergency vehicle) | Communicating with traffic operator |
| **Drivers** | Providing vehicle destination, planned routes, and characteristics of vehicles before trip;<br>Providing vehicle speed and position when approaching an interaction | Communicating with traffic operator |

### *6.3.5 Data: data flows, databases, Required input from other services*

Figure 94 shows stakeholders of the service chain. The diagram can also be used to show the data flow of the service.

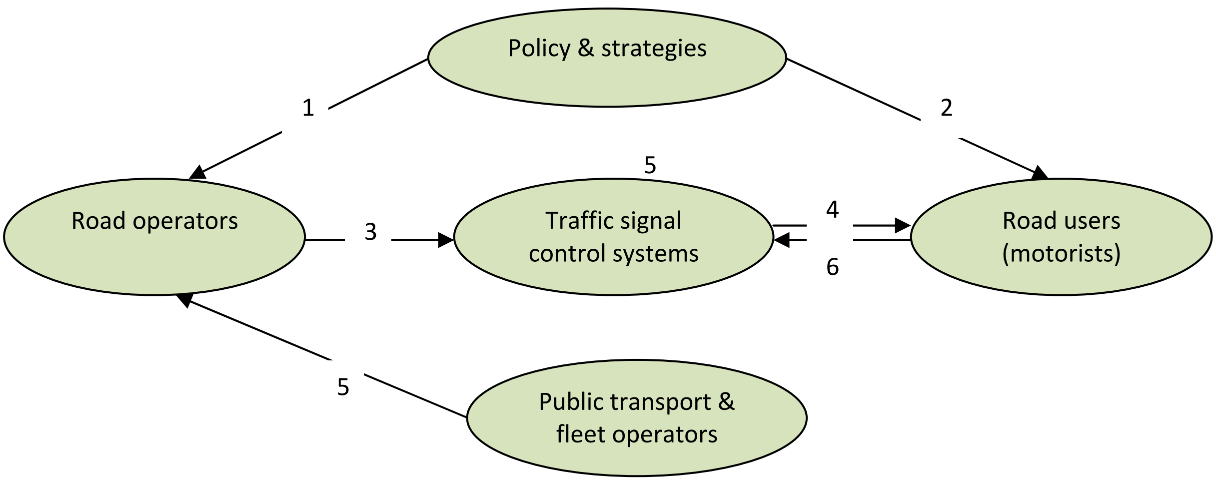



Figure 95 - Stakeholders and Dataflow of cooperative traffic signal control

| *Number shown in* ***Figure 95*** | *Data* | *Input required from other services* |
|---|---|---|
| ***1*** | Current policy and control strategies for the area or road section for road operators | Area-wide optimisation strategies (5c); Traffic-adaptive demand management (5d) |
| ***2*** | Current policy and control strategies for the area or road section for individual vehicles | |
| ***3*** | Green wave time and other corresponding | Traffic control in the cloud (5a) |

| | | |
|---|---|---|
| | traffic signal control units' statue | |
| ***4*** | Status of traffic light, green time, red light waiting time and recommended speed; | |
| ***5*** | Planned trips for the fleet, destination, planned route, characteristics of the vehicles and required priorities | Traffic-optimised fleet management (4e)<br>Eco-driving support (4f), |
| *6* | Position, speed, planned route and characteristics of the vehicle | Personalised route guidance (2a);<br>**Eco-driving support (4f)** |

### *6.3.6 Expected benefits*

- Better management of signal controlled interaction;
- Improve safety and reduce number of accidents at signal controlled interaction;
- Minimise delays and congestion;
- Improve energy efficiency by avoiding sudden changes of speed and number of stops

### *6.3.7 References: other projects, actual services etc.*

| **Projects/Existing Services** | **Description** |
|---|---|
| Coopers<br>(2006-2010) | Improved road safety through real time V2V and I2V information exchange |
| CVIS<br>(2006 – 2010) | Cooperative vehicle infrastructure system for transport efficiency. Cooperative network monitoring, V2V and V2I communications (CALM). |
| eCoMove | deliverable D5.1 user cases & system requirements for eCoTraffic Management and control |

## 6.4 Service 5.c: Area wide optimisation strategies

Accurate real-time and accurate traffic flow information is valuable for traffic network managers. There are on the market many algorithms for traffic network flow forecasting, that have a common obstacle for their successful which is "the precision and correctness of the data input". Thanks to the development of traffic monitoring technologies, various methods of collecting data are available nowadays, like automatic number plate recognition (ANPR) technology, which allows recognizing individual vehicles. Today in Europe such approaches are common. However, such approaches deduce final traffic information, coming from smaller area of the traffic network of the city basically from the area where the infrastructure is available. As a result the Traffic management centre provides estimated information in areas with no dedicated infrastructures

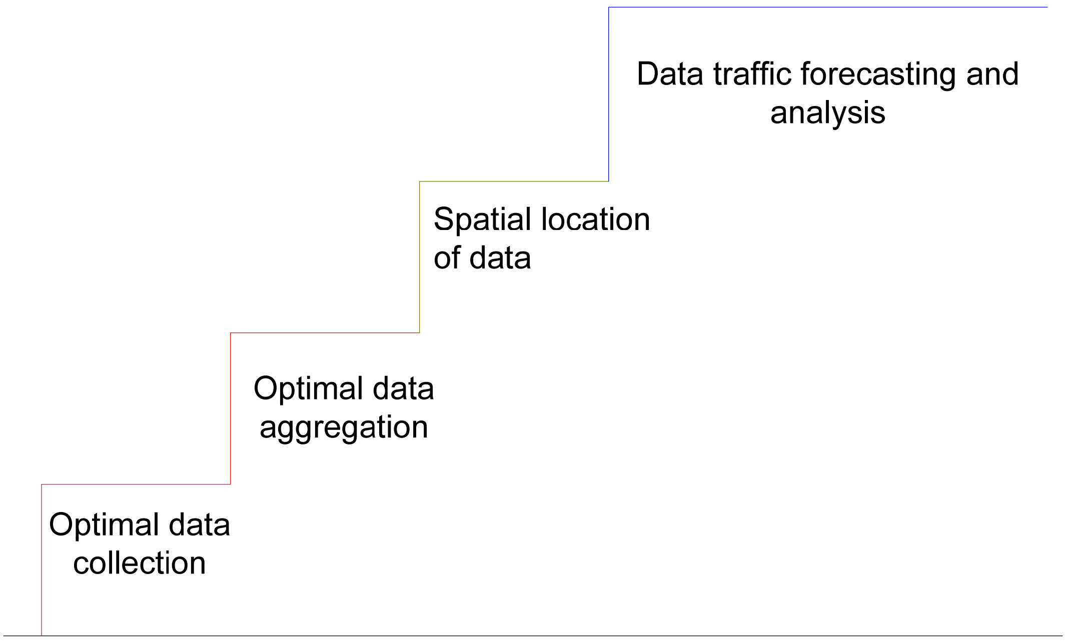
That is why this scenario will focus in the provision of a modular solution that can collect data from different sources and mash-up it by applying different strategies of aggregation. Furthermore, this service will concentrate into provide as an outcome analyzed data from different perspectives and summarizing it into useful information that can feed algorithms and strategies of traffic management. Strategies of self–learning will be applied and algorithms for traffic network flow prediction.

The data involved will be provided by any machine that can provide data about mobility; this means that this service will aggregate in a proper way the data coming from existing and new sources of sensors e.g: inductive loops, closed circuit technologies, closed circuit television

(CCTV), automatic number plate recognition (ANPR), Road Side Units, WIFI devices, smart phones, Bluetooth devices, social networks, t etc.

### 6.4.1 End-to-end service chain

In the next diagram it is possible to see the set of steps of the end-to-end service chain of the service 5.c: Area wide optimisation strategies.




**S5.c Area wide optimisation strategies**

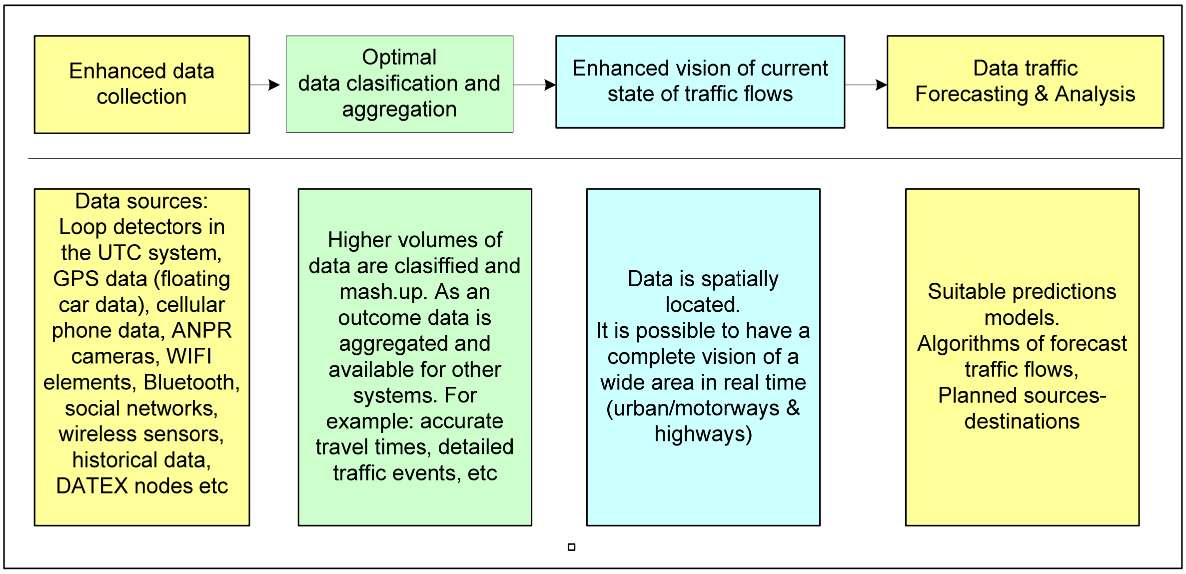
The first and most important step part of this service is the function of collection. This is the function which collects data from different sources that can provide relevant measurements of traffic, such as: travel times, speed data, turning percentages, etc.

The next step is the aggregation phase; it focuses on the quality of the data. This will classify the data considering the reliability of the source and the accuracy of the measurement. The outcome of this service will be the traffic data aggregated and available for be used by other services. The speed and latency of this process will be an important requirement.

Then, the spatial location of the data aggregated should be done in parallel with the aggregation phase, because it is here where the data classified is spatially located.

The last step of this chain is the “Data traffic forecasting and analysis”, this tasks will be done by means of algorithms of prediction and considering the extra information collected by means of the FI-PPP enablers such as: the intentions of the road users, planned trips, etc.

Considering that this service is of the type “B2B”, it means that the outcome done in this last step will be published for be consumed from different external entities by means of open interfaces. So any service that will need the data outcome of this service should be able to get it. The outcome of this service will be used principally by the service: Traffic adaptive demand management (S5.d) in order to calculate the good distribution of traffic in the road and then distribute the results to different services e.g. routing algorithms of route planners, navigation systems. A summary, of the main steps of this service are described in the picture below:




**S5.c Area wide optimisation strategies**

### 6.4.2 Service capability comparison description (today, future)

There are many sources of data that can provide relevant information about traffic. That information can have many applications such as: real-time system management, monitoring of traffic and travel conditions on the highways, share information of address congestion problems and facilitate travel information.

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| There are many types of networks, which use various available sources regarding traffic measurements. Very few of these networks are integrated, and there is not a common way to share this data. | All the networks will provide data from their different data sources. Such data will be aggregated in a proper way in order to provide high quality and consistent data for other services such as: forecasting, monitoring, info-mobility, travel assistance, etc. |
| There are many projects and services whose aim is to collect data in a unique data bank.<br>One of the main difficulties for providing this service in a wide area is that each area or city has their own specific structures, public transport modes, systems and traveller behaviours. | Within the help of future services it will be possible to face the issues regarding the differences between systems by means of new aggregation techniques. |

### 6.4.3 Service components

| Service component | Functionality | Interdependencies with other component of this service | Interdependencies with other services |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Traffic control centre | Receiving information from traffic. Sharing information with the aggregation services. | Aggregation services | Traffic control in the cloud (5a)<br>Traffic adaptive demand management (5d) |
| Fixed and mobile sensors & data sources | Providing data regarding number of vehicles, turning percentages, vehicles speeds, etc. | Aggregation services | Personalised route guidance (2a)<br><br>end-to end itinerary planning (1a) |
| Aggregation Services | Classifying and aggregating of the data collected by different sources considering the reliability of the sources and the accuracy of the measurement | Traffic control centre<br>Fixed and mobile sensors & data sources<br>geo-localization services | Traffic adaptive demand management (S5.d) |
| Geo-localization services | It will provide the spatial location of the data aggregated | Aggregation Services | |
| Traffic forecasting services | Computing the traffic forecasting by analysing the data aggregated | Aggregation services | Traffic adaptive demand management (S5.d) |

### 6.4.4 Actors, their roles and relationships

| Actor | Roles | Relationships between actors |
|---|---|---|
| Traffic operator | Calculating strategies of traffic signal control unit, providing and maintain cooperative traffic signal control unit and other road site units | In charge of the service;<br>Responsible for communication with other actors in the service chain |
| Fleet operator | Providing fleet vehicle destination, planned routes, and characteristics of vehicles;<br>Apply for priority before trip when needed (e.g. emergency vehicle) | Communicating with traffic operator |
| Drivers | Providing vehicle destination, planned routes, and characteristics of vehicles before trip;<br>Providing vehicle speed and position when approaching an interaction | Communicating with traffic operator |

### 6.4.5 Data: data flows, databases, Required input from other services

Innovative data collection approaches different than the state-of the art, that brings data not only from dedicated infrastructures- based technologies such as inductive loops, beacons, closed circuit television (CCTV) and ANPR in a city but also from:

a. Floating Car Data: The Floating Car Data (FCD) is a relevant source of information for part of the network which is not equipped with traditional sensors and also to validate/assess the network models. Only in recent years this source of data became a real opportunity as a data source for traffic management systems thanks to the deployment of navigation devices and anti-theft black boxes related to insurance contracts. The floating car data (FCD) allows to measure accurately the travel time on a route, but does not allow direct measurements of the network state in terms of traffic flows and congestions. In order to proceed with the evaluation of the network state it is therefore necessary to use a reference model representing the basic physical entities and which allows to calculate the network state by integrating the information provided by traditional detecting subsystems. The FCD data is defined in terms of position data and instantaneous time, as aggregated data, in terms of travel time on an arc or between two nodes (TDP), in terms of number of vehicles between two points of the network (OD), or as historical data of the average travel time or OD flows (profiles). This greatly improves both travel time and the delay time measurements along a planned route or through traffic, respectively. An additional advantage is the improved routing due to time specific data. So far, routes may vary with respect to the day of the week, time of the day, traffic information delays or other major dependencies by weather or events, for example.

b. **Bluetooth:** Bluetooth based data collection different from state-of the art in order to provide a sound road traffic state, both flow and travel time. Using network model the measurement can be extended to provide time dependent road traffic information to the whole network. Bluetooth has now become very interesting in the field of traffic data acquisition. Traffic planners and traffic operators can equally use the technology to directly determine travel times, time losses and route qualities. The highly sensitive Bluetooth scanners read the worldwide unique MAC addresses of active Bluetooth devices within a range of 100 to 400 m. They also catch the signal strength of in-car navigation systems and hands-free kits. At traffic peak periods, up to 40% of the motor vehicles carry Bluetooth devices with them that are switched on and thus are “visible” to the scanners. Almost all modern devices have got integrated Bluetooth (smart phones, navigational devices, cars etc. that can be easily used as a source for data collection

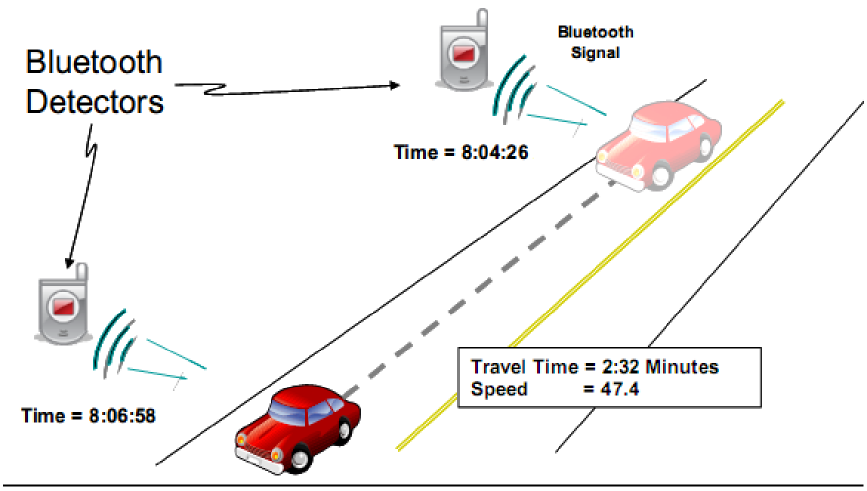



Figure 96 - Bluetooth Traffic Monitoring Concept

The anonymous nature of this technique is due to the use of MAC addresses as identifiers. MAC addresses are not associated with any specific user account (as is the case with cell phone probes) or any specific vehicle (as with automated toll tags).

c. **Crowd-sourcing:** crowdsourcing service is invoked to generate data, aggregate and/or fuse data, to process data or information, or more directly to develop transportation applications or planning and design of transportation solutions. A key enabling factor for the emergence of crowd-sourcing strategies within transportation is the recent main-streaming of communal communications platforms, most notably Web 2.0 technologies, which have provided a platform and intelligence engine for engaging the 'crowd' and enabling active participation and multi-path communications between the masses and transportation agencies.

Finally, and possibly most notably, the recent market saturation of key mobile technologies such as GPS-enabled Smart-phone and other mobile devices have provided additional key components in establishing a fertile, functional framework for crowd-sourcing in the transportation community.

Crowd-sourcing principles can be used for attaining traffic and congestion data, to get feedback on service acceptance. Several different models have been deployed to source and aggregate data from mobile field devices, most notably GPS-enabled Smart-phone The end-user initiates the collaborative relationship by downloading the vendor's application to their Smart-phone The application provides the end-user with traffic information related to their location and in turn the vendor's application uploads the end-user's location and traffic data (anonymous) to the vendor's central software application. Within the Measure a feedback mechanism will be elaborated in order to get important information on service quality, willingness to change mode and user acceptance.

Crowd-sourcing is also being used to generate informational mash-ups for a wide variety of transportation-related products. The crowd typically provides data and/or information through an existing central resource, such as a mapping tool or central software application. The value in this form of crowd-sourcing is also attained when a critical mass of participants is realized, providing hyper local data to form a big-picture product.

### 6.4.6 Expected benefits

The expected benefits of the Service 5.c will be:

- To control a complete area, covering areas that currently the traffic is unmonitored or forecasted
- Provide high quality of data for the appliance of high level strategies and policies.
- Overcome the common issue of using many different data format and geo-referencing systems
- Making available reliable data

### 6.4.7 References: other projects, actual services etc.

| 1.1.1 **Projects/Existing Services** | 1.1.2 **Description** |
|---|---|
| Trapster<br><br>http://trapster.com/ | Trapster is a social networking mobile application and website, provided for free, that maps out and alerts users in real time to the presence of live police speed traps, red light cameras, speed cameras, and areas where police often hide. |
| UK's<br>Freeflow project | It fuses GPS and UTC loop data to give more accurate predictions of journey times, benefiting network |

| | |
|---|---|
| | managers and travellers alike. |
| Waze | It is a social mobile application providing free turn-by-turn navigation based on the live conditions of the road. It is an example of Crowd-sourcing solution. |
| NL-National Data Ware House Project | This project has the aim of create a reliable, widespread and accessible data bank for traffic information, monitoring and control of road networks. |
| INRIX | US Microsoft spin-off company<br>It created a data bank based on floating car data which covers a large number of network links with respect to fixed sensors and with less costs than |
| PeMS<br>(UC Berkeley) | The Freeway Performance Measurement System (PeMS) provides an easy-to-access source of historical and real-time traffic<br>PeMS extracts various performance measures, such as vehicle miles travelled or average daily traffic, from real time and historic freeway detector data. |

## 6.5 Service 5.d: Traffic adaptive demand management and control policies

One of the principal objectives of the traffic management is to maximise the capacity of existing roads, by minimizing investment of building of new roads and considering the increasing demand of traffic in towns and cities.

The aim of this service is to have a system that can evaluate the real demand of traffic of a wide area which is able to design and apply the necessary actuation plans (short term and for long term) for achieving the optimal equilibrium flow in the network.

Nowadays there are different promising systems developed for traffic adaptive demand systems, the common issue in all of them is related with the lack of high quality data input which is uncompleted and disaggregated. Many approaches have been implemented on local test sites which cover specific limited areas. Considering this fact it is difficult for current systems to evaluate a real demand on roads, and also to perform actuation tasks. Therefore, in order to overcome the main barrier regarding low quality of data input the Service 5.c will provide the proper input data for this scenario (check Section “Scenario 5.c” for more details). Within the service 5.d will be possible to create a system that permits harmonized operation of actuation plans between all networks, urban and interurban.

Therefore, it is expected to have within this service the following advantages:

- Improve the traffic flow on the network, using techniques that avoid saturation on roads which can re-direct the traffic to roads with higher capacity.

- Improve traffic safety in roads, considering a deep analysis of the conditions of the road and by identifying the high risks zones.
- The calculation of the equilibrium state of the network will provide the details for provide as an output the target flows and the sub-sequent actuation plans.

All the objectives mentioned above can be achieved having as a set of accurate traffic actuation policies. The traffic actuation policies can be classified in two types: long term and short term policies.

The short term actuation plans will consider techniques for immediately reaction that permits to achieve the equilibrium of the network in a short time. For example: it is possible to redirect the traffic from saturated motorways to alternative quickest routes by means of advice messages sent by the traffic centre to the VMS installed on the road or to personal or in-car devices. Another example is the capacity of a network to control fatal situation such accidents in the road, fires on the road, etc.

The long term actuation plans will be based on historic traffic information. The service 5.d will focus into simplify the data retrieval system. By providing high quality data is possible to deploy a deep analysis for developing long term traffic policies and for providing more optimal planning and design of new management strategies. One of the new strategies can include encouraging people to travel at different times or to use less congested routes, maybe choosing different destinations by using adaptive road user pricing.

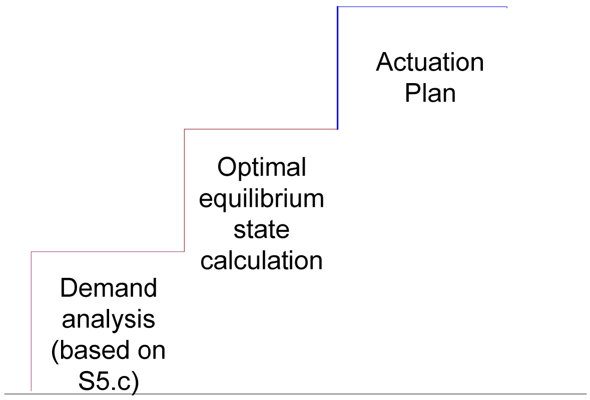
### 6.5.1 End-to-end service chain

| | |
|---|---|
| **Use Case ID** | UC_5d_1: Traffic adaptive demand management-alerting |
| **Scenario title** | Online traffic & infrastructure management |
| **Services name** | Traffic adaptive demand management |
| **Short Description** | <u>road user perspective</u><br>Motorists may experience a free-flow experience on roads. They will be alerted on-time about possible traffic jams. The traffic jams will decrease in length and number of vehicles. The motorists are stimulated to use in-car or personal devices.<br><br><u>traffic control centre perspective</u><br><br>The traffic control centre will be able to send proper advices to the road users by having accurate data information input. It will generate the proper actuation plans, addressing the flows in such a way that congestion decrease. |
| **Goal** | • Minimize fuel consumption and $CO_2$.<br>• Minimize the creation and duration of traffic jams.<br>• Achieve the equilibrium of the flows of the network<br>• Increase the free-flow of the roads |
| **Potential Constraints** | • The data needed for this scenario regarding position, length, growth speed of the traffic jams as well as the calculation algorithms of the equilibrium state will need high computing capacity and it should be very precise.<br>• Road users might not be willing to follow the advices cause difficulties to realize the possible advantages of the service |

| Components | Traffic control centre, sensors on the road, road side units, vehicles, VMS |
|---|---|
| Main flow | There is a traffic jam in a motorway, meanwhile a set of vehicles is approaching to it. The control centre is aware about the traffic congestion, because it is consuming the aggregation services provided by the area wide optimisation strategies (Service 5.c) which rapidly aggregate data gathered from different sources in the road. As a result the traffic centre knows detailed information such as: location of the traffic jam, length and growth rate as well as position of the vehicles that are highly likely incoming in the congested motorway.<br>Then the centre by knowing the equilibrium condition of flows, sends the corresponded actuation plan to all possible receivers components in order to alert drivers about the congested motorway and to promote the use of alternatives motorways or highways. For example two principal means used for distribute the actuation plans are:<br>- By sending messages to the Variable Message Signs installed in the road,<br>- By sending messages to the interested in-vehicle units or personal devices in the vehicles which are approaching the traffic jam, in order to alert them about the congestion.<br><br>Later, the incoming vehicles follow the advices received and decide to choose the free-flow alternative roads. Then the traffic jam does not increase and disappears in a few minutes. |

| Use Case ID | UC_5d_2: Traffic adaptive demand management- pricing |
|---|---|
| Scenario title | Online traffic & infrastructure management |
| Services name | Traffic adaptive demand management - pricing |
| Short Description | road user perspective<br>Motorists may experience less congestion on the roads. They will know the traffic cost before approaching a pricing area.<br>Thanks to the pricing applied it will be possible to have good conditions of traffic in the road. Drivers may change their normal habits of driving and they can be motivated to use alternative transport modes.<br><br>traffic control centre perspective<br><br>The traffic control centre will be able to send proper measurements of the network to the congestion charge modules. The adaptive pricing will allow to change the behaviour of the network, and achieve the targets flow<br><br>Municipality<br><br>It will be able to reduce congestion on the road, and to manage the behaviour of the network in order to decrease emissions and fuel consumption in different areas, regions and cities. The appliance of charging will not depend on the area.<br>The application area will no be limited by the cost of infrastructure installed on the road, because mobile devices and in-vehicle devices will be used for inform drivers and as a mechanism for paying. |
| Goal | • Minimize fuel consumption and $CO_2$.<br>• Minimize the creation of traffic jams.<br>• Achieve the equilibrium of the flows of the network<br>• Increase the free-flow of the roads |
| Potential Constraints | • The algorithms for compute the target flows will need high computing capacity and the data input such as position of the vehicles should be very precise. |

| | |
|---|---|
| **Possible cross Services** | • Service 2.g Congestion charging |
| **Components** | Traffic control centre, sensors on the road, road side units, vehicles, VMS |
| **Main flow** | The traffic centre is aware about the detailed traffic conditions of the road. When the level of traffic achieves certain levels of traffic flows density, it will alert the corresponded modules of congestion charge about the state of the traffic and the target flows to be achieved which are calculated by sophisticated techniques of traffic modelling<br><br>Those modules of congestion charge will apply the actuation policy of the area, region or city by calculating the price to be charge according to the traffic conditions of each area with the aim to achieve the target flows established.<br><br>In areas without infrastructure hardware installed will be possible to apply the cost or bonus to the drivers by means of mobile devices or road side units installed on vehicles. |

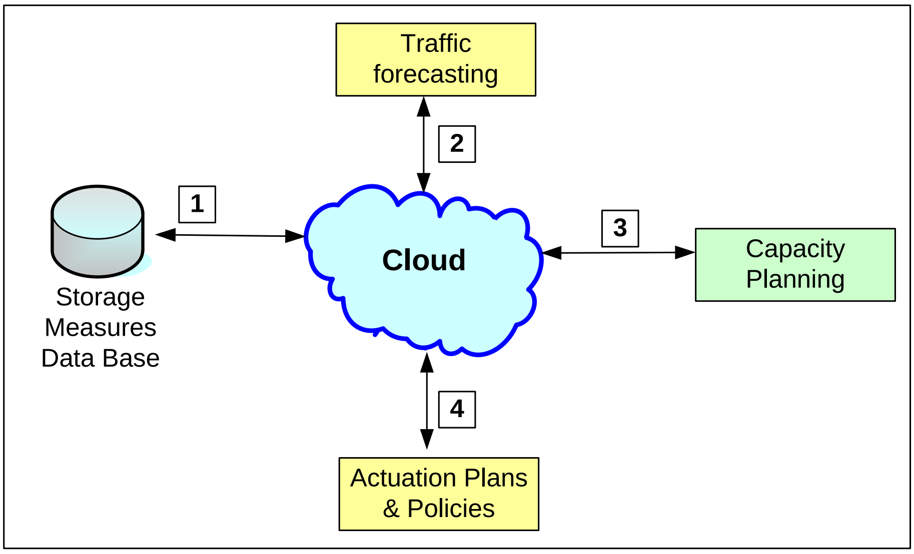



**S5.d Traffic adaptive demand management and Policies**

### 6.5.2 *Service capability comparison description (today, future)*

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| Today is difficult to have an optimal calculation of the equilibrium state of the network because there is not high quality and aggregated information of traffic data. | An optimal calculation of the equilibrium of the capacity of the network is done using high quality of aggregated data as well as optimal forecasting services. |
| | The actuation plans can be designed an applied using different devices for distribute information such as: VMS, in car devices, personal devices, mobile phones, etc |
| | |

### 6.5.3 *Service components*




### 6.5.4 *Actors, their roles and relationships*

| Main actors | Role | Relationships |
|---|---|---|
| Public administrations | Provide the access to the data about main measurements tools of the urban and interurban roads. | Data provider<br>Consumer of the Actuation Plans and Policies |
| Road operators | Provide complete data about disruption in the road that can affect circulation of vehicles.<br>Provide information and measurements of the area controlled | Data provider<br>Service consumer |
| Service Providers (For creation of new services) | Use the traffic data provided by the scenario, following the actuation and control policies plans in order to integrate the data in mobility services for example: route planners, route guidance, etc. | Service consumer<br>Data consumer |
| Service Providers (for contribute to the scenario | Providing services such as calculations of traffic models that can calculate the equilibrium of the area network<br><br>Providing services of aggregated data measurements of the network and accurate forecasting | |
| System Integrators and Developers | Integrators and developers can use the data for the distribution of information in different devices, by developing new smart applications for mobile devices or computers with different operating systems. | Service consumer<br>Data consumer |

| | | |
|---|---|---|
| Public transport operators | Provide information regarding time tables, AVL systems, forecasting time tables, etc. | Data provider |
| Traffic Manager Operator | Allow the new services of the scenario to be applied e.g: providing the access to the current traffic management system in order to be able to use the current infrastructure to execute the actuation plans such access to the VMS. | Data provider |
| Map Provider | Providing geographic information, POI, enhanced maps with completely coverage of the roads with carriageway detail data | Data provider |

### 6.5.5 *Data: data flows, databases, required input from other services*

Under discussion

### 6.5.6 *Expected benefits*

Therefore, it is expected to have within this service the following benefits:

- Improve the traffic flow on the network
- Improve traffic safety in roads by designing and applying optimal actuation plans
- Increase the network performance of a wide area (urban and interurban)

### 6.5.7 *References: other projects, actual services etc.*

| Projects/Existing Services | Description |
|---|---|
| OPENGATE<br>2006-2010 | • To demonstrate use of GPS for the access control in urban area, using an open vehicle platform. |
| Stadium<br><br>2009-2012 | • Smart Transport Applications Designed for large events with Impacts on Urban Mobility.<br>• The STADIUM project aims to improve the performance of transport services and systems made available for large events hosted by big cities.<br>• Aim to prepare an electronic Handbook to be used as information source for Olympic Games in London 2012 and others. |
| | |

## 6.6 Service 5.e: Demand responsive parking management

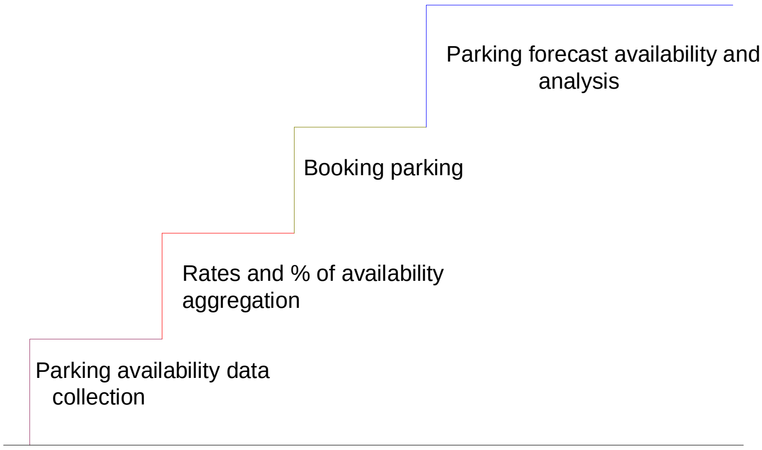
Real-time service for controlling availability of parking spaces and their price, coupled with driver guidance to balance demand across available parking supply.

The user can check their trip before it begins and he can check the traffic congestion, the time expected for the trip and booking a parking near his destination.

Balance demand and parking will be possible because planning resources will be real-time updated and user forecasted parking duration will help next users with a algorithms and planning tool to help end users with alternative parking and forecast cost in terms of economical view, CO2 and time.

The forecast of the expected time spend in the parking could be an input in the area traffic optimization and proactive action could be taking to help a future congestion.

### 6.6.1 End-to-end service chain




**S5.e Demand responsive parking management**

| | |
|---|---|
| **Use Case ID** | UC_5e_1: Demand parking management |
| **Scenario title** | Demand responsive parking management |
| **Services name** | Traffic adaptive demand management |
| **Short Description** | Road user perspective<br>User can plan his trip taking into account traffic and parking availability booking his parking space from device. User knows the real traffic and the parking booked, so trip cost, parking cost and CO2 will be reduced.<br><br>Parking perspective<br>Parking manager can balance their parking location and rates from the different days and hours during the week.<br><br>Traffic control centre perspective<br>Traffic is checked with users, users can modify their plans to a valley timetable due traffic and parking will be available and cheaper. Forecast parking reserves can help traffic to take into account proactive polices to prevent traffic congestion. |
| **Goal** | • Minimize fuel consumption and $CO_2$.<br>• Minimize trip duration and use of traffic valleys.<br>• Balance supply and demand parking<br>• New data input for traffic management |
| **Potential Constraints** | • Forecast time duration for parking can be difficult with the user plan and the algorithm used to balance parking locations.<br>• Private and public parking companies must be willing to be in a booking shared service for users.<br>• New public parking road systems should be installed in cities to get information about availability. |
| **Components** | Traffic control centre, sensors on the parking road, user terminal with GPS, parking |

| | |
|---|---|
| | management systems |
| **Main flow** | Road user will plan his trip. To get a forecast time to the destination and the different parking locations available.<br>Road user can check a different timetable for his trip to get a better trip with low congestion or accept the trip done before.<br>Road user can booked a parking with a forecast time to be checked.<br>Parking will be booked and road user knows his location at parking.<br>GPS device will manage the route to the parking or will check the parking availability when road user will be near the destination to re-route it to the final parking location.<br><br>Forecast duration can be taking into account for a discount on rates if user accuracy is good. This will help next user to be taking into account the forecast of available parking in the destination.<br><br>If road user checked his trip and traffic road is congested and parking availability low, then user can try to modify his trip to get an alternative transport (public, shared car, etc.). |

### *6.6.2 Service capability comparison description (today, future)*

| Service today (if it exists) | Service in future (with Instant Mobility) |
|---|---|
| | User will plan his travel within his terminal, and he can book a parking during the time forecasted, he can cancel the trip if the user think that it is congestion and he can planning again in a different timetable. |
| | GPS guidance and terminal will be connected to get best route and it will be real time update with parking availability and cost of it. |
| | On-line parking availability and users looking for it (like a offer-demand web site), connected with GPS guidance. |

### *6.6.3* Service components

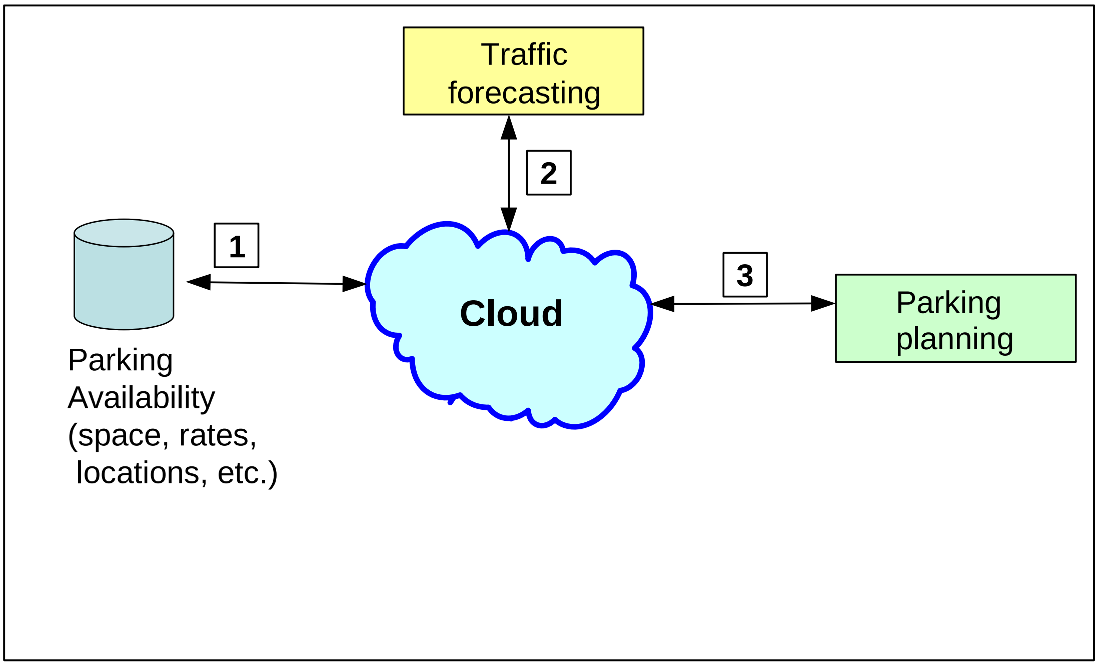
Under discussion

### 6.6.4 Actors, their roles and relationships

| Main actors | Role | Relationships |
|---|---|---|
| Public administrations | Provide the access to the data about public parking (parking, availability and rates). | Data provider and service supplier |
| Private parking infrastructure | Provide the access to the data about parking (parking, availability and rates). | Data provider and service supplier |
| Traffic Service Providers | Use the traffic data provided by the scenario, following the actuation and control policies plans in order to generate a parking forecast and trip forecast for the | Service and data supplier |

| | | |
|---|---|---|
| | user. | |
| System Integrators and Developers | Integrators and developers can use the data for the distribution of information in different devices, by developing new smart applications for mobile devices. | Service consumer<br>Data consumer |
| Map Provider | Providing geographic information, POI, enhanced maps with completely coverage of the roads parking information and public and private parkings | Data provider |

### 6.6.5 Data: data flows, databases, Required input from other services




### 6.6.6 Expected benefits

Planning trip per user can balance not only parking uses, traffic trip will be updated with the expected booked parking in the city.

User can book a parking before start the trip with a forecasted time, parking balance demand will be possible and dynamic parking rates will help to the traffic management, taking into account proactive polices instead of reactive traffic polices.

Real time parking availability can provide users the best parking for them, even if they have not booked before, user goes directly to the available parking, fuel consumption and traffic will be reduce.

Parking planning will be useful for traffic and users, demand can be balance not only for parking.

### 6.6.7 References: other projects, actual services etc.

N/A

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