FUTURE
INTERNET
PPP

Instant Mobility

Multimodality for people and goods in urban areas

FP7 . CP 284906

D3.5 – Instant Mobility Use Case Scenarios Functional and Non-Functional Requirements

March 2012

Principal Editor: Yanying Li / ERTICO

Instant Mobility WP3

Instant Mobility Use Case Scenarios Functional and Non-Functional Requirements

WPXX	Deliverable title
Authors	Yanying Li – ERTICO (Principal Editor) Cédric Andry - Thales Cristina Peña – TID Marco Bottero - Mizar
Short Description	This deliverable provides functional and non-functional requirements for the three development scenarios and their applications. Non-functional requirements for all applications are also provided.
Dissemination level (select)	PU Public
Date due	31 March 2012 – Delivery date (final version)
Status	Deliverable
Contributions by:	David Ferrer – TID Jean-Marie Dautelle - Thales Andrea Carlino - CRF Harri Koskinen - VTT Fabio Carabelli – TLI Marcus Enered - VOLVO
Internal review by	Sandra Borghetti (ATAC) & Jéremie Fulconis (Nice Côte d'Azur)
Internally accepted by	Paul Kompfner (WP3 leader)
Date of acceptance	2nd April 2012

Document history

Version	Date	Author /Reviewer	Description
V0	15/02/2012	Yanying Li	Setting up the template
V1	08/03/2012	All	Contributions received
V2	16/03/2012	All	Contributions from 14/15 March WP3 workshop
V3.1 V3.2	29/03/2012	Marcus Enered, David Ferrer, Andrea Carlino, Cédric Andry	Contributions from WP3 partners
V3.3	02/04/2012	Yanying Li, Paul Kompfner	Final editing
V3.4	02/04/2012	Paul Kompfner	Final version for review

Deliverable Abstract (1 page)

Instant Mobility has developed three use case scenarios: personal travel companion, smart city logistics and transport infrastructure as a service. Each of the three scenarios consists of a number of applications. This deliverable provides functional and non-functional requirements for the three development scenarios and their applications based on use case scenarios descriptions and functional analysis described in D3.3. A functional requirement defines a function of a software system or its component. A non-functional requirement defines how a system is supposed to be, such as reliability, performance, etc.

The requirements have been identified following two steps. First step is to identify non-functional requirements for all applications, i.e. all Instant Mobility services and applications should meet these requirements. Then based on the common Instant Mobility non-functional requirements, specific functional and non-functional requirements for each application are identified. Non functional requirements considered in deliverable include: reliability, efficiency, performance, scalability, expandability, interoperability, security, privacy, maintainability and resilience.

Results of this deliverable will be used for specification of Instant Mobility enablers in WP4. Development of the enablers will meet the requirements identified in this deliverable. The functional and non-functional requirements will be used to define generic requirements for future internet in WP2.

Table of Content

Table of Figures

1. Introduction

1.1 Objectives of this deliverables

This deliverable is a key deliverable of WP3 Use Case Scenarios. WP3 aims to characterize use case scenarios selected for analysis for their important potential of enhancement with Future Internet, then to derive functional and non-functional requirements that will be met through Future Internet (FI) enablers. There are five leading scenario in D3.1 "Use case scenarios definition and analysis – preliminary report". Those scenarios have been regrouped into three in D3.3 "Use case scenarios definition and analysis – final report". The three scenarios in the final report are:

- **Personal travel companion**, which pursues to provide travellers and drivers the benefits of dynamic planning and follow-up during multimodal journeys.

- **Smart city logistics**, which intends to enhance city logistics operations with respect to safety, efficiency, environmental performance and quality of service.

- **Transport infrastructure as a service**, which allows the rapid deployment of a new generation of traffic management systems by exploiting, among others, Future Internet technologies such as cloud data storage, cloud computing and virtualization.

Each scenario comprises a set of applications. The following table shows scenarios and their applications. Based on scenario and application descriptions in D3.3, this deliverable provides functional and non-functional requirements for each of the application.

Scenarios	ID	List of Applications
1. **Personal travel companion**	1A	Dynamic multi-modal journey
	1B	Dynamic ride-sharing
	1C	Optimized public transport usage
2. **Smart city logistics**	2A	Load sharing and optimizing
	2B	Dynamic time/place drop point
	2C	Itinerary booking and real time optimized route navigation
	2D	Eco-optimised driving, vehicle and driveline control
3. **Transport infrastructure as a service**	3A	Real-time traffic and route information
	3B	Floating passenger data collection
	3C	Virtualized intersection intelligence
	3D	Cooperative traffic signal control
	3E	Area wide optimization strategies

1.2   Definition of Functional and Non-Functional Requirements

1.2.1   Definition of Functional Requirements

According to definition in systems engineering, a functional requirement defines a function of a software system or its component. A function includes: inputs, the behavior/process, and outputs. Functional requirements can be various such as calculations, data manipulation and processing and other specific functionality that define what a system is supposed to achieve. Functional requirements are derived from pre-defined use cases. Functional requirements are supported by non-functional requirements, which present constraints on the design or implementation, such as performance requirements, security, reliability etc. In this deliverable, each functional requirement has a unique reference ID which is defined as:

Application ID – F – number

For example, the first functional requirement for application "Dynamic multi-modal journey" is:

1A-F-001

1.2.2   Definition of Non-Functional Requirements

In systems engineering and requirement engineering, a non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors. This should be contrasted with functional requirements that define specific behavior or functions. The plan for implementing non-functional requirements is detailed in the system architecture.

Non-functional requirements define how a system is supposed to be. Non-functional requirements are "system shall be <requirement>". Non-functional requirements are often called qualities of a system. Other terms for non-functional requirements are "constraints", "quality attributes", "quality goals", "quality of service requirements" and "non-behavior requirements". Qualities, that are non-functional requirements, can be divided into two main categories:

- Execution qualities, such as security and usability, which are observable at run time;
- Evolution qualities, such as maintainability, extensibility and scalability, which are embodied in the static structure of the software system.

For the Instant Mobility applications, the following non-functional requirements will be considered:

- Reliability, i.e. system availability to the end user at any given time
- Efficiency, e.g. throughput, response time, transit delay, latency
- Performance
- Scalability, i.e. the system is available to more users and cover wider areas
- Expandability, i.e. the system can be expanded with new types of service
- Interoperability, i.e. the system is able to interact with other external systems
- Security
- Privacy
- Maintainability
- Resilience

This deliverable provides non-functional requirements for all scenarios and applications. Each of the non-functional requirements has a unique reference ID which is defined as:

IM – NF – number

For example, the first non-functional requirement for all scenarios and applications is:

IM – NF – 001

This deliverable also provides non-functional requirements for all scenarios and applications. Each of the non-functional requirements has a unique reference ID which is defined as

Application ID – NF – number

For example, the first non-functional requirement for application "Dynamic multi-modal journey" is:

1A-NF-001

1.3 Methodology of definition of requirements

The requirements have been defined following two steps. First, common non-functional requirements for all services have been identified. Then, non-functional requirements for each scenario will be developed. After identification of non-functional requirements, functional requirements for each scenario will be developed as show below.
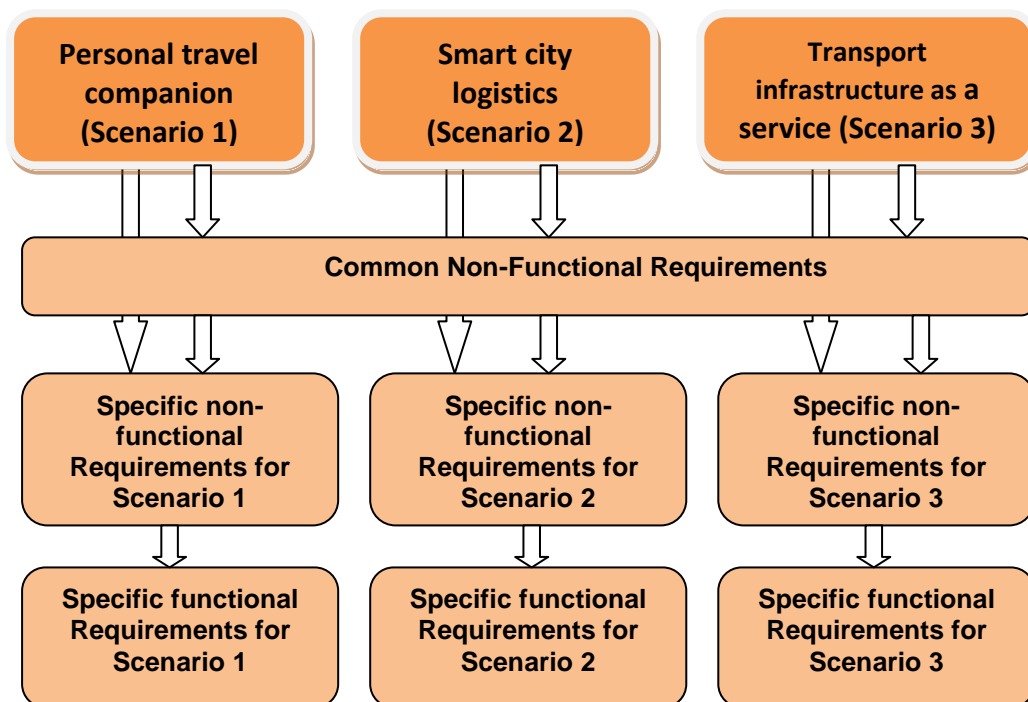

Figure 1 Methodology of definition of requirements

1.4 Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL   NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

Note that the force of these words is modified by the requirement level of the document in which they are used:

- "MUST"; this word, or the terms "REQUIRED" or "SHALL", mean that the definition is an absolute requirement of the specification.
- "MUST NOT"; this phrase, or the phrase "SHALL NOT", mean that the definition is an absolute prohibition of the specification.
- " SHOULD", this word, or the adjective "RECOMMENDED", mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
- " SHOULD NOT", this phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
- "MAY"; this word, or the adjective "OPTIONAL", mean that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item.

1.5   Use of D3.5 Outcomes

All WP4 first iteration deliverables (D4.1 – D4.8) are derived from WP3 activities. These deliverables and D3.3 were due at the same time. Those deliverables and D3.3 provide basis inputs for the functional and non-functional requirements for D3.5. Outcomes of D3.5 will also provide inputs for second iteration deliverables (D4.9 – D4.15) in specification of the enablers. D4.16 will summarise Instant Mobility functional and technical specifications based on D3.5 and D4.9 – D4.15. The workflow is shown in the following figure.

D3.5 results will also be used in Task 2.1 for preparing 2nd set of generic requirements (D2.3). Definition of the generic requirements will take into account of this deliverable.
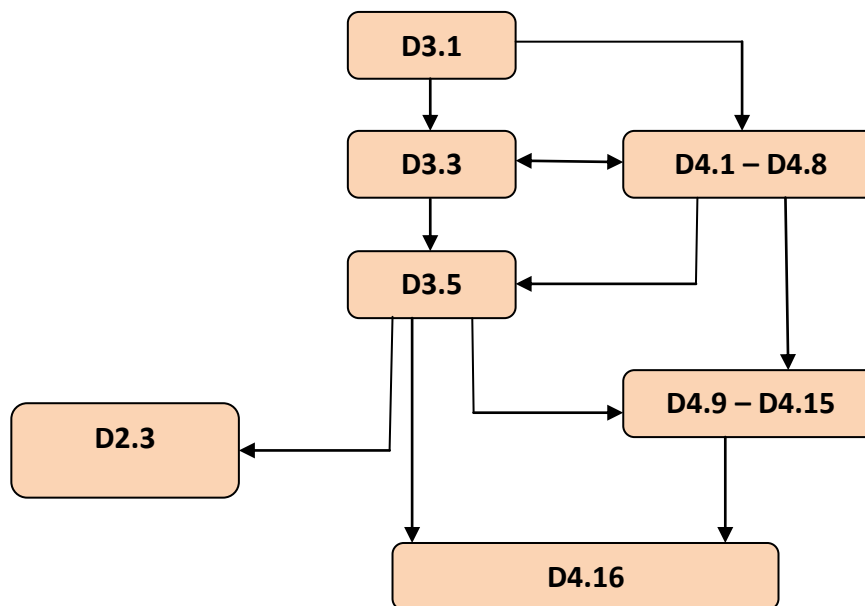

Figure 2 Use of the outcomes of D3.5

2. Non-Functional Requirements for all Instant Mobility Applications

Type	ID	Description of requirement
Security	IM-NF-001	The communication between the system and mobile device/vehicle must be secure.
	IM-NF-002	The system should provide measure to prevent unauthorised access to personal information.
Safety	IM-NF-003	The system should not generate a safety hazard for its users.
	IM-NF-004	The system should provide functionality that operates in a manner that does not encourage unsafe behaviour.
	IM-NF-005	The system should provide functionality that operates in a safe manner during degraded modes of operation.
Scalability	IM-NF-006	The system must cover areas up to the size of Europe at the same performance level.
	IM-NF-007	The system must be able to scale from 100 000 to 10 million end users at the same performance level.
	IM-NF-008	Required resources of the system should increase proportionally with the number of users.
Expandability	IM-NF-009	The system should be able to be expanded geographically, i.e. integrate data from new areas and increase coverage.
	IM-NF-010	The system should provide open interface specification to facilitate integration of new services as plug-ins.
Interoperability	IM-NF-011	The system should provide open interface specification to allow exportation of information to external systems.
	IM-NF-012	The system should provide open and standardised interface specification to facility integration of new data sources
Usability	IM-NF-013	Interaction with the user must be minimal.
	IM-NF-014	The system should be developed to be simple and efficient for the end users and easy to understand.
	IM-NF-015	The system should ensure consistency of interface and service despite of change of service provider and location.
Privacy	IM-NF-016	The system should guarantee that no single actor can correlate location and traveller's identity.
	IM-NF-017	Users' identities must not be provided without either party's consent.
	IM-NF-018	The system must obey privacy regulations for each country covered.
Reliability	IM-NF-019	The system should ensure continuity of service despite of change of service provider and location.
	IM-NF-020	The system should inform user when it operates in degraded mode.
	IM-NF-021	The system should be able to inform user about any malfunctions.
Resilience	IM-NF-022	The system should be able to handle one single point of failure.
	IM-NF-023	Communication failure should not induce inconsistency in the system.
	IM-NF-024	The system should prevent loss of information.
Efficiency	IM-NF-025	The system should not perform the same calculation more than once.

	IM-NF-026	The system should not communicate to a user, information which is irrelevant to the user.
Performance	IM-NF-027	The system should be able to provide information with a stated accuracy.
	IM-NF-028	The system should provide measures on its bandwidth consumption.
	IM-NF-029	The system should optimise its resource consumption.
	IM-NF-030	The system should be able to prioritise messages based on quality of services.
Maintainability	IM-NF-031	The system should be able to be upgraded without any disturbances to the services
	IM-NF-032	The system should provide interface to operators for administrative purpose.

3. Functional and Non-functional Requirements for Scenario 1: Personal Travel Companion

3.1 Functional Requirements for Scenario 1

Application 1A: Multi-modal journey		
ID	**Description of requirement**	**Comment**
1A-F-001	Traveller shall be able to describe his trip origin and destination in intuitive, natural language terms.	
1A-F-002	Traveller shall receive an optimal proposal itinerary.	
1A-F-003	Traveller shall be able to refuse the proposal itinerary by giving an explanation.	
1A-F-004	The traveller shall be able to travel anytime in a multi modal way with a wide range of travel and transport options.	High level
1A-F-005	The traveller shall be able to move faster, in a more comfortable way and cheaper than current situation.	High level
1A-F-006	The traveller shall have an up to date itinerary taking into account every event that could interfere with its journey in real time.	
1A-F-007	During the journey, the traveller shall be assisted to get off at the right stops, walk through a complex terminal or interchanges, find the next mode, etc.	
1A-F-008	The traveller shall have one fare ticket even if its travel included several transport means by different operators.	
1A-F-009	The traveller shall receive the information (change on itinerary due to external events, Points of Interest) just when needed.	
1A-F-010	The traveller shall receive an itinerary optimised according to a user's preference e.g. quickest, cheapest, least CO_2, preferred modes.	
1A-F-011	The traveller shall be able to describe his travel and payment preferences.	
1A-F-012	The traveller shall have a single account payment for multiple journey legs and a virtual ticket.	
1A-F-013	The traveller shall be able to display his handset when being inspected as proof of payment.	
1A-F-014	The traveller shall be able to create a profile with his/her preferences.	
1A-F-015	The traveller shall be able to rate his/her journey when finished or during the travel.	
1A-F-016	The traveller shall be able to plan his/her travel in advance.	
1A-F-017	The traveller shall be able to update his/her future journey plan.	
1A-F-018	The traveller shall be able to cancel his/her future journey plan.	
1A-F-019	The traveller shall be able to receive an alert when an external event compromises his/her future journey plan.	
1A-F-020	The traveller shall be able to receive an estimation of cost his/her future trip.	
1A-F-021	The traveller shall be able to rate his/her trip.	
1A-F-022	The traveller shall be able to subscribe to Instant Mobility Service.	
1A-F-023	The traveller shall be able to unsubscribe to Instant Mobility Service.	

1A-F-024	The traveller shall be able to request an alternative journey proposal.	
1A-F-025	The traveller shall be able to use previous future journey proposal for immediate journey.	
1A-F-026	The traveller shall be able to cancel his/her journey during the trip.	
1A-F-027	The traveller shall be able to update his/her journey during the trip.	
1A-F-028	The traveller shall be able to activate silent alarm.	
1A-F-029	The traveller shall be able to call for emergency.	
1A-F-030	System should detect any deviation of planned itinerary.	
1A-F-031	The system design should take into account special needs of disable traveller.	

Application 1B: Dynamic ride sharing		
ID	Description of requirement	Comment
1B-F-001	Driver should be able to plan an immediate road journey by describing his/her trip origin and destination in intuitive, natural language terms	
1B-F-002	Driver should be able to share his/her ride	
1B-F-003	Driver should be able to plan a common ride for a future journey	
1B-F-004	Driver should be able to accept common ride proposal in an easy way	
1B-F-005	Driver should be able to navigate safely to destination	
1B-F-006	Driver should be able to identify pick-up point	
1B-F-007	Driver should be able to identify drop-off point	
1B-F-008	Driver should be able to declare availability for common ride	
1B-F-009	Driver should be able to revoke availability for common ride	
1B-F-010	Driver may be able to activate silent alarm	
1B-F-011	Driver may be able to call for emergency	
1B-F-012	Driver may be able to activate camera tracking session	
1B-F-013	Driver should be able to receive compensation for common ride	
1B-F-014	Driver should be able to consult his/her rating	
1B-F-015	Driver should be able to rate his/her common ride	
1B-F-016	System should detect any deviation of itinerary in a common ride	
1B-F-017	Passenger should be able to check availability and select the ride	
1B-F-018	Passenger should be able to select pick-up and drop off points	
1B-F-019	Passenger may be able to be compensated if the booked ride does not arrived (e.g. cancelled by the driver)	
1B-F-020	Passenger may be able to call for emergency by tricking an alarm	

Application 1C: Optimized public transport usage		
ID	Description of requirement	Comment
1C-F-001	Public Transport Operator should be able to publish timetables and prices	
1C-F-002	Public Transport Operator should be able to update optimization transport	High Level

	strategy	
1C-F-003	Public Transport Operator should be able to consult journey rating related to its transport means	
1C-F-004	Public Transport Operator should be able to access usage transaction	
1C-F-005	Public Transport Operator should be able to optimize prices with respect to passenger load	
1C-F-006	Public Transport Operator should be able to change Public Transport Vehicle Itinerary	
1C-F-007	Public Transport Operator should be able to update Public Transport timetables	
1C-F-008	Public Transport Operator should be able to get information about each transport means belonging to him	
1C-F-009	Public Transport Operator should be able to take into account in its dynamic timetables, special events information send by organizing authorities.	

Application 1G: Ticketless Mobile Payment		
ID	**Description of requirement**	**Comment**
1G-F-001	Traveller should be able to deactivate proximity interface on mobile terminal	E.g. NFC
1G-F-002	Traveller should be able to get end of travel report	
1G-F-003	Traveller should be able to punch a ticket tapping mobile terminal	
1G-F-004	Traveller should be able to check-in tapping mobile terminal	
1G-F-005	Traveller should be able to check out tapping mobile terminal	
1G-F-006	Traveller should be able to view tickets, fares and terms of use	
1G-F-007	Traveller should be able to pay with mobile wallet	
1G-F-008	Traveller should be able to show ticket	
1G-F-009	The ticketless mobile payment must be able to validate the ticket for different ticket validation systems	

3.2   Non-functional Requirements for Scenario 1

Application 1A: Multi-modal journey			
Type	**ID**	**Description of requirement**	**Comment**
Security	1A-NF-001	The system should provide measure to ensure security between mobile device and the infrastructure	
	1A-NF-002	The system should provide measure to prevent unauthorised access to personal information	
Scalability	1A-NF-003	The system must be able to scale from 100 000 to 10 million travellers' sessions.	
	1A-NF-004	The system must cover sufficient modes and areas in Europe.	
Performance	1A-NF-005	Traveller should be able to describe his trip origin and destination with minimum interaction with the mobile device	Ergonomic system
	1A-NF-006	The system must be able to provide an optimal proposal itinerary in less than 20 seconds	

	1A-NF-007	They system should be able to provide the basic functions without access to real-time information	
Usability	1A-NF-008	Interaction with the user must beminimal.	

Application 1B: Dynamic ride-sharing

Type	ID	Description of requirement	Comment
Security	1B-NF001	The system should verify the identity of driver or passengers when they register with the system	
	1B-NF002	The system should verify the identity of driver and passengers before the common ride	
	1B-NF003	The system should allow driver and passenger to verify identity before the common ride	
Scalability	1B-NF004	The system must cover sufficient areas in Europe.	
	1B-NF005	The system must be able to scale from 100 000 to 10 million travellers' sessions	
Usability	1B-NF006	The system should provide to the driver only the necessary information	
	1B-NF007	The system should allow the driver accept a ride sharing at the minimum interaction with the system	
Privacy	1B-NF008	Drivers and passengers' identities must not be provided without either party's consent.	

Application 1C: Optimised public transport usage: No specific non-functional requirements for this application

Application 1G: Ticketless Mobile Payment

Type	ID	Description of requirement	Comment
Security	1G-NF-001	The system should provide measure to ensure security between mobile device and the infrastructure	
	1G-NF-002	The system should provide measure to prevent unauthorised access to personal information stored in the mobile device	
Scalability	1G-NF-003	The system must be able to scale to any number of users	
	1G-NF-004	The system must be able to scale to any number of tickets issued	
	1G-NF-005	The system must be able to scale to any number of ticketing machines	
	1G-NF-006	The system must be able to store on mobile terminals a minimum number of tickets.	
Performance	1G-NF-007	The system must be able to process the mobile terminal tapping and provide a feedback in a human negligible time (less than 1 second)	
Usability	1G-NF-008	The system should provide measure to ensure the willingness of the tap action	

4. Functional and Non-functional Requirements for Scenario 2: Smart City Logistics

4.1   Functional Requirements for Scenario 2

Application 2A: Load sharing and optimising		
ID	**Description of requirement**	**Comment**
2A-F-001	Transport booker should be able to identify him-/herself to the exchange portal	
2A-F-002	Transport booker should be able to provide information about the desired transport needed by the carrier (e.g. pick-up/drop-off location, size, weight, goods type) to the portal	
2A-F-003	Transport booker should be able to edit the information provided to the portal regarding the desired transport	
2A-F-004	Transport booker should be able to remove the transport request from the portal	
2A-F-005	Transport booker should be able to accept or decline an offer from a carrier	
2A-F-006	Transport planner should be able to add information about transport resources to the portal	
2A-F-007	Transport planner should be able to edit information on the portal relating to transport resources	
2A-F-008	Transport planner should be able to remove transport resources from the portal	
2A-F-009	Transport planner should be able to accept/reject itinerary update proposals from the portal	
2A-F-010	Driver may be able to accept/reject itinerary update proposals from the portal previously accepted by the transport planner.	
2A-F-011	Driver should be able to report excess capacity on the vehicle	
2A-F-012	The system should propose that requested transport missions are allocated to the most suitable vehicle taking into account preferences from transport bookers and transport planners, vehicle and driver characteristics, and characteristics of the goods already allocated.	
2A-F-013	The system should provide responsible transport planner with an updated itinerary suggestion when a transport mission is proposed to be allocated	
2A-F-014	The system, if the transport planner accepts the updated itinerary, should propose the transport mission allocation to the transport booker	
2A-F-015	The transport vehicle should be able to access information about its own allocated transport missions and the planned itinerary	
2A-F-016	The transport vehicle should be able to geocast information on excess capacity and route to other vehicles.	
2A-F-017	The transport vehicles should be able to receive information on excess capacity and route from other vehicles	
2A-F-018	The transport vehicles should be able to compare their own allocated transport missions and itinerary, to the excess capacity and route, of other vehicles and propose updated, optimized, itineraries to the involved transport planners.	

Application 2B: Dynamic time/place drop point		
ID	**Description of requirement**	**Comment**
2B-F-001	Consignee should be able to verify his/her identity to the system	

2B-F-002	Consignee should be able to track the goods	
2B-F-003	Consignee should be able to share his/her calendar with the carrier	
2B-F-004	Consignee should be able to receive and view propositions for changed drop-off time or location	
2B-F-005	Consignee should be able to accept or reject propositions for changed drop-off time or location	
2B-F-006	Consignee should be able to monitor the progress of the goods throughout the transport (tracking)	
2B-F-007	Consignor should be able to request a new pick-up time or location	
2B-F-008	Transport planner should be able to accept or reject changed pick-up time or location	
2B-F-009	System should be able to compare the calendar of the consignee to the planned route of the goods to be delivered and propose changes to drop-off time or location	

Application 2C: Itinerary booking and real time optimized route navigation		
ID	**Description of requirement**	**Comment**
2C-F-001	Transport planner should be able to view, edit, accept and reject itineraries suggested by the system	
2C-F-002	Transport planner should be able to identify him-/herself	
2C-F-003	Transport planner and driver should be able to access traffic information	
2C-F-004	Driver should be able to receive his/her itinerary	
2C-F-005	Driver should be able to indicate the start and completion of transport missions	
2C-F-006	Driver should receive directions to the next location	
2C-F-007	Traffic operator should be able to provide traffic information	
2C-F-008	Traffic operator may be able to receive planned itineraries	For optimized traffic flow planning
2C-F-009	System should be able to plan and provide optimal itineraries	
2C-F-010	System should be able to calculate optimal routes	

Application 2D: Eco-optimised driving, vehicle and driveline control		
ID	**Description of requirement**	**Comment**
2D-F-001	The traffic lights should be able to share information about when the light is about to change	
2D-F-002	Vehicles should be able to share information from the CAM bus with surrounding vehicles	
2D-F-003	The vehicle should be able to perform automatic sensor checks of vehicle status before journey starts	
2D-F-004	The vehicle should be able to provide instructions to the driver for manual checks before the journey starts	
2D-F-005	The vehicle should be able to combine received information from surrounding traffic (vehicles, traffic lights etc.), statistics and map/topology information to provide driver with eco-driving recommendations	
2D-F-006	The vehicle must be able to display recommendations to the driver on an in-vehicle mounted display	
2D-F-007	The vehicle should be able to provide haptic feedback in the throttle pedal to reinforce the recommendations on the display	
2D-F-008	The vehicle must be able to upload performance data combined with logged route to a remote server	
2D-F-009	The system should be able to compare the logged data of different journeys based on route-sections	
2D-F-010	The driver should be able to compare logged data from own journeys	

| | | to an anonymized/non-anonymized set of data from other drivers/trucks based on given parameters (such as vehicle and load characteristics) | |

4.2 Non-functional Requirements for Scenario 2

Application 2A: Load sharing and optimising			
Type	**ID**	**Description of requirement**	**Comment**
Interoperability	2A-NF-001	Vehicle communications systems from different providers must be interoperable.	
Security	2A-NF-002	The vehicle must not share information about its precise load or the value thereof with others.	
	2A-NF-003	The system must be able to verify the identities of the involved parties with high confidence.	To avoid fraud

Application 2B: Dynamic time/place drop point			
Type	**ID**	**Description of requirement**	**Comment**
Security	2B-NF-001	The system should be able to verify the identity of the consignee/consignor before updating drop-off/pick-up time or location.	

Application 2C: Itinerary booking and real time optimized route navigation			
Type	**ID**	**Description of requirement**	**Comment**
Performance	2C-NF-001	The system must be able to calculate an updated route within four seconds from the prerequisites change (e.g. to consider a new itinerary or updated traffic conditions)	

Application 2D: Eco-optimised driving, vehicle and driveline control			
Type	**ID**	**Description of requirement**	**Comment**
Reliability	2D-NF-001	The system must not prevent the driver from excess acceleration, e.g. in case of overtaking or to avoid a dangerous situation.	
	2D-NF-002	The system must not interfere with the vehicle in a way reducing the driver's control of the vehicle	
Performance	2D-NF-003	The remote database for performance statistics should be common for all systems providers in order to provide as good recommendations as possible	
	2D-NF-004	The processing of information must be fast enough to ensure that coaching and feedback is correct and timely (magnitude: hundreds of milliseconds)	
Interoperability	2D-NF-005	Systems from all providers should be interoperable in order for V2V and V2I communication to provide as much info as possible.	
Security	2D-NF-006	The system must not share the identity of individual drivers with anyone unauthorized (depending on e.g. haulier firm policies and system configuration)	
	2D-NF-007	The system should ensure the data integrity to avoid faked information.	

5. Functional and Non-functional Requirements for Scenario 3: Transport Infrastructure as a Service

5.1 Functional Requirements for Scenario 3

ID	Description of requirement	Comment
Application 3A: Real-time traffic and route information		
3A-F-001	The system should be able to collect the data coming from the vehicles	
3A-F-002	The system should be able to use the data coming from the road infrastructure (different types of sources)	
3A-F-003	The system should be able to estimate the real-time traffic conditions based on collected data	
3A-F-004	The system should be able to forecast traffic conditions based on computations both on collected data and on historical data	
3A-F-005	The system should be able to compute the route to destination for a vehicle based on the actual traffic conditions and motorist's profile	
3A-F-006	The system should take into account the forecast data when planning a route to destination for the vehicles	
3A-F-007	The system should be able to plan route taking into account accidents	
3A-F-008	The system should recognize whether a street with a high traffic level is on the route already planned for some vehicles	
3A-F-009	The system should be able to plan immediately a new route to destination based on incidents in order to avoid the generation of traffic jams	
3A-F-010	The system should plan a new itinerary in case of high traffic level on the route already planned for some vehicles	
3A-F-011	The system should be able to communicate the modifications to the route plan to the vehicles	
3A-F-012	The system should be able to manage and update the road network model	
3A-F-013	The on-board system should be able to read all the relevant car data	
3A-F-014	The on-board-system should be able to pre-process the raw data	
3A-F-015	The on-board-system should be able send the relevant data to the Traffic Manager	
3A-F-016	The on-board system should be able to ask to the Service Provider for a route planning	
3A-F-017	The on-board system should be able to receive the planned route	
3A-F-018	The on-board system should be able to receive updates to the planned route	
3A-F-019	The on-board system should be configurable with some user preferences and profile	
3A-F-020	The system should be able to identify incident	
3A-F-021	The system should be able to provide individual route planning	
3A-F-022	The system should be able to take into account planned roadwork or	

	planned events (e.g. road closure)	

Application 3B: Floating Passenger Data Collection		
ID	**Description of requirement**	**Comment**
3B-F-001	The system will be able to track passenger location during his journey	
3B-F-002	The system will be able to track vehicle location	
3B-F-003	A passenger must be able to switch being tracked or not	
3B-F-004	The system should provide registration function	
3B-F-005	A registered passenger may send his/her position	
3B-F-006	A registered passengers may send his/her destination	
3B-F-007	Registered passengers should be able to send alerts	
3B-F-008	The system should ensure that passenger's identity is not provided without passenger consent	
3B-F-009	System should be able to estimate passenger load in vehicles	
3B-F-010	System should be able to estimate passenger density at stations and stops	
3B-F-011	System should be able to collect route information	
3B-F-012	The system should be able to send real-time passenger density information to public transport operator	
3B-F-013	Public Transport operator may select information/ routes to monitor	

Application 3C: Virtualised intersection intelligence		
ID	**Description of requirement**	**Comment**
3C-F-001	The system should be able to manage traffic control for each intersection	
3C-F-002	The system should be able to manage traffic control for the entire network	
3C-F-003	The system should be able to monitor PT vehicles status	
3C-F-004	The system should be able to acquire data from infrastructure, vehicles and other data sources	
3C-F-005	The system should be able to manage traffic light control based on forecast data and apply global strategy	
3C-F-006	The system should be able to create, update, delete and validate network model	
3C-F-007	The system should be able to consolidate information from multi sources	
3C-F-008	The system should be able to create, update and delete signalling rules	
3C-F-009	The system should be able to monitor the efficiency of the system	
3C-F-010	The system should be able to monitor the status of road network	
3C-F-011	The system should provide an interface to allow traffic operator to define traffic control strategies	

Application 3D: Cooperative Traffic Signal Control		
ID	**Description of requirement**	**Comment**
3D-F-001	The vehicle should be able to communicate (send/receive messages) with infrastructure	
3D-F-002	The system should be able to process information received from vehicles	
3D-F-003	The system should be able to calculate waiting time and recommended speed based on green wave control parameters received	
3D-F-004	The system should be able to send to vehicles recommended speed and waiting time	
3D-F-005	The traffic control centre should be able to calculate the optimised green wave parameters based on global strategy	

Application 3E: Area-wide optimisation strategies		
ID	**Description of requirement**	**Comment**
3E-F-001	The system should be able to remotely manage traffic data	
3E-F-002	The system should provide an interface for traffic operator to supervise traffic	
3E-F-003	The system should be able to acquire traffic data, infrastructure data, environmental data, weather, local information and rules, events, enforcement policy	
3E-F-004	The system should be able to define optimisation strategies based on acquired information	
3E-F-005	The system should be able to execute the optimisation strategies	
3E-F-006	The system should allow traffic operator manually to create traffic events	
3E-F-007	The system should allow the traffic operator view status of the entire network	
3E-F-008	The system should be able to generate traffic charts	
3E-F-009	The system should be able to generate traffic reports	

5.2   Non-functional Requirements for Scenario 3

Application 3A: Real-time traffic and route information			
Type	**ID**	**Description of requirement**	**Comment**
Security	3A-NF-001	The on-board system must not be open to malicious attacks	
	3A-NF-002	The required interaction to the user must be minimal	
Reliability	3A-NF-003	The system should be able to evaluate quality of information provided to end users.	
	3A-NF-004	The system should be able to provide degraded mode.	
Efficiency	3A-NF-005	The system must be able to provide "normal" traffic updates every 3 minutes	

	3A-NF-006	The system should process in priority all incidents	
Performance	3A-NF-007	The system should answer to a route plan request within less than 3 minutes with a mean of 1 minute.	
	3A-NF-008	The system must process all the data in real time and internally update the traffic situation according to a pre-defined interview, up to 1 hour	
	3A-NF-009	The on-board system should send data at a pre-defined interval or by request	
	3A-NF-010	The on-board system should receive update at a pre-defined interval, by request or by incident trigged	
	3A-NF-011	The system must be able to manage minimum 50000 vehicles	
	3A-NF-012	The system must be able to manage minimum 10000 road sensors	
Maintainability	3A-NF-013	The system should be able to diagnose its own malfunction	

Application 3B: Floating passenger data collection			
Type	**ID**	**Description of requirement**	**Comment**
Security	3B-NF-001	Passengers' information must remain unknown. Only MAC address will be tracked.	
Efficiency	3B-NF-002	The system will provide an optimal solution if possible.	
	3B-NF-003	The system will try to track the user with the least energy consumption method possible (UMTS, Bluetooth, AGPS, etc.)	
Performance	3B-NF-004	The system must be able to provide a solution in the minimum period of time possible.	
	3B-NF-005	The system will use open standards in order to allow all users to access it.	
	3B-NF-006	The system will store the collected data during a specified period of time in order to have a dynamic and light system.	

Application 3C: Virtualised intersection intelligence			
Type	**ID**	**Description of requirement**	**Comment**
Reliability	3C-NF-001	The system should be able to always perform at least local optimisation	
	3C-NF-002	The system should be able to work in degraded mode in case of accidents or failures	
	3C-NF-003	The system should be always operative, even in degraded mode	
Performance	3C-NF-004	The system should increase the commercial speed of PT vehicles	
	3C-NF-005	The system should update traffic prediction continuously	
	3C-NF-006	The system should be able to accept 1 priority request	

		every specified number of cycles	
Scalability	3C-NF-007	The system interface should accept multiple connections from traffic operators	
	3C-NF-008	The system should be able to control up to a specified number of intersections	
	3C-NF-009	The system should be able to receive priority requests from up to a specified number of PT vehicles	
	3C-NF-010	The system should be able to connect with other virtual RSU systems	
Privacy	3C-NF-011	The system must ensure privacy while collecting data	

Application 3D: Cooperative Traffic Signal Control			
Type	**ID**	**Description of requirement**	**Comment**
Scalability	3D-NF-001	The system may be able to provide cooperative traffic control for different types of roads, i.e. urban and inter-urban roads.	
	3D-NF-002	The system may be able to be extended to cover a wider range of road network, i.e. including new intersections.	
Privacy	3D-NF-003	Data from vehicles cannot be used for any other purpose than traffic control. For example, the data from vehicles cannot be used for speeding enforcement.	
Reliablity	3D-NF-004	The system must be able to work with the maximum road traffic capacity.	
	3D-NF-005	Each component of the system must be able to report any malfunctions.	
	3D-NF-006	When a malfunction occurs, alternative traffic control strategy must be provided as back-up.	
Performance	3D-NF-007	The system should provide the most optimised traffic control strategy to balance traffic from different directions in order to achieve the most efficient use of the network.	
	3D-NF-008	The system should be able to meet special requirements for higher priority vehicles, e.g. emergency vehicles.	
	3D-NF-009	The system should be able to react when some vehicles fail to stop at the traffic light.	Warning to other vehicles may be sent

Application 3E: Area-wide optimisation strategies			
Type	**ID**	**Description of requirement**	**Comment**
Reliability	3E-NF-001	The system should be able to work in degraded mode in case of accidents or failures	
	3E-NF-002	The system should be always operative, even in degraded mode	
	3E-NF-003	The system should be able to detect not working devices	
Performance	3E-NF-004	The system should update traffic prediction continuously	
	3E-NF-005	The system should update network status at a specified interval	
	3E-NF-006	The system should run traffic assignment at a specified interval	
Scalability	3E-NF-007	The system interface should accept multiple connections	

		from traffic operators	
	3E-NF-008	The system should be able to control up to a specified number of road arcs	
	3E-NF-009	The system should be able to control up to a specified number of traffic sensors	
	3E-NF-010	The system should be able to control up to a specified number of environmental sensors	
	3E-NF-011	The system should be able to control up to a specified number of VMS	
	3E-NF-012	The system should be able to send info up to a specified number of vehicles equipped with V2I communication devices	
	3E-NF-013	The system should be able to send info up to a specified number of mail/SMS recipients	
	3E-NF-014	The system should be able to interface with area supervision systems	
Privacy	3E-NF-015	The system must ensure privacy while collecting data	

6. Summary

6.1   Requirements & Enablers

Each of the applications requires one or more enablers to fulfil the functionalities. The following table shows proposed enablers for each application.

Scenarios	List of Applications	Enablers involved
Personal travel companion	Dynamic multi-modal journey	Multimodal journey optimization enabler; Driver & traveller enabler; Vehicle & handheld devices enabler; Mobile payment enabler
	Dynamic ride-sharing	Multimodal journey optimization enabler; Driver & traveller enabler; Vehicle & handheld devices enabler; Mobile payment enabler
	Optimized public transport usage	Multimodal journey optimization enabler; Driver & traveller enabler; Vehicle & handheld devices enabler; Public transport operators' enabler
Smart city logistics	Load sharing and optimizing	Vehicle & handheld devices enabler; Goods transport operators' enabler
	Dynamic time/place drop point	Vehicle & handheld devices enabler; Goods transport operators' enabler; Traffic management enabler
	Itinerary booking and real time optimized route navigation	Vehicle & handheld devices enabler; Goods transport operators' enabler; Traffic management enabler
	Eco-optimised driving, vehicle and driveline control	Vehicle & handheld devices enabler
Transport infrastructure as a service	Real-time traffic and route information	Driver & traveller enabler; Traffic management enabler
	Floating passenger data collection	Multimodal journey optimization enabler; Driver & traveller enabler; Public transport operators' enabler
	Virtualized intersection intelligence	Driver & traveller enabler; Vehicle & handheld devices enabler; Traffic management enabler
	Cooperative traffic signal control	Driver & traveller enabler; Vehicle & handheld devices enabler; Traffic management enabler
	Area wide optimization strategies	Driver & traveller enabler; Vehicle & handheld devices enabler; Traffic management enabler

In summary, there are in total seven enablers whose functional and non-functional requirements will be studied. The following figure maps relationships between the enablers and the applications.
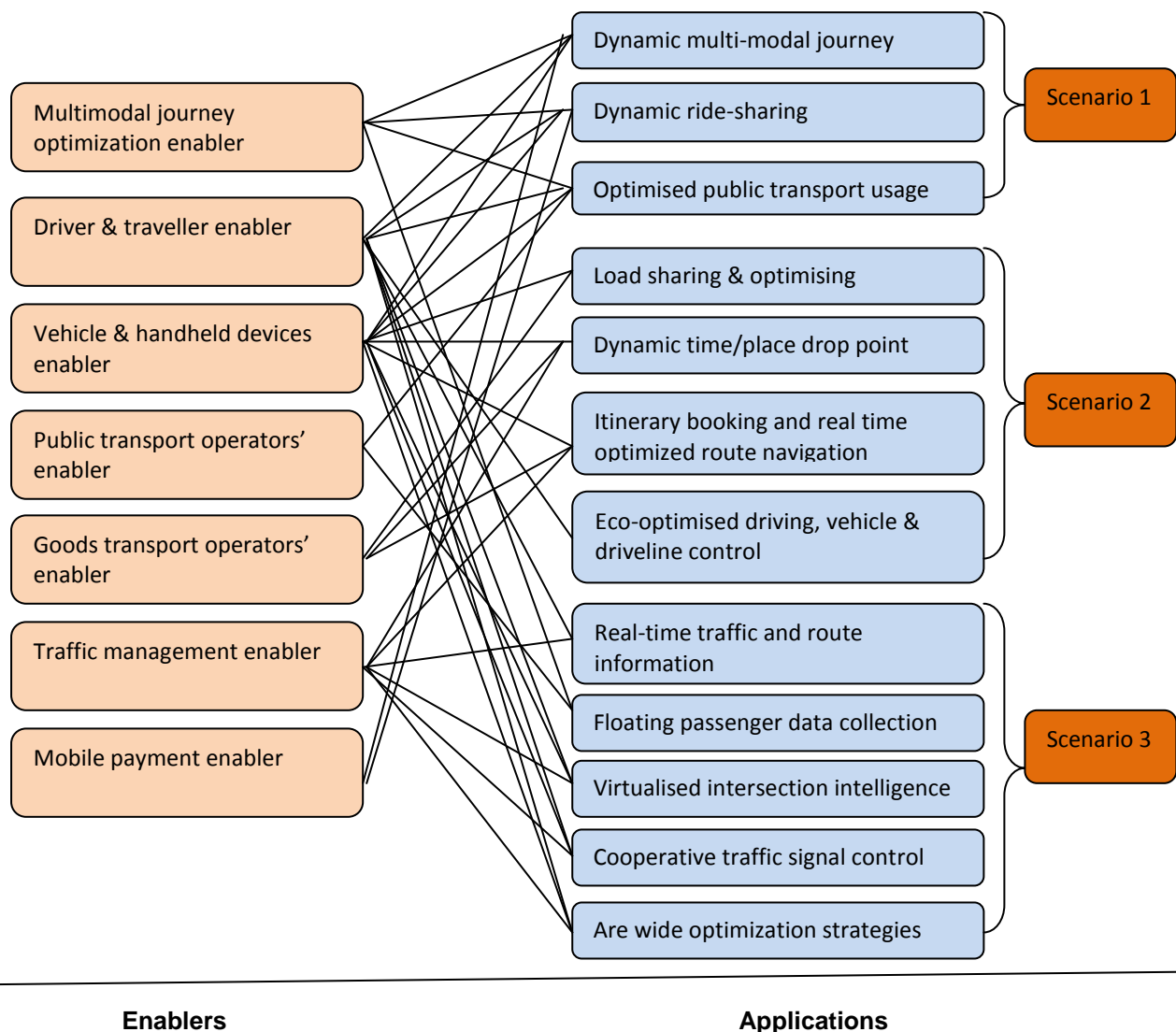

Enablers   **Applications**

Figure 3 Mapping Relationships between Enablers and Applications

When developing the enablers, functional and non-functional requirements for these applications should be taken into account. The functional and non-functional requirements will be used to define generic requirements for future internet in WP2.

6.2   Validation of Requirements by Stakeholders

The results of this deliverable have been presented at a stakeholder workshop held in Rome on 20th March in Rome. The workshop was hosted by ATAC (Rome Public Transport Company) and attended by representatives from different sectors covering local authorities, public transport operators, travel information service providers, payment service providers, mobile phone operators etc.

Stakeholders at the workshop generally agreed with the functional and non-functional requirements presented in the deliverable. The following topics have been given the most attentions by the workshop attendees:

- **Privacy**; although the workshop attendees have satisfied with several non-functional requirements addressing privacy issues, it has been highlighted that any of the Instant Mobility must not become a 'big bother' system. Privacy should be respected in both development and operation stages. A user should have no fear of privacy violence while using any of the services.

- **Cost for users**; although cost issue is not in the scope of this deliverable, there was an intensive discussion on cost. Since many of the services need continue communication between a traveller and service operators, there was a concern toward roaming cost if the traveller would use such as a service abroad.

- **Cost for the platform;** although the workshop attendees were impressed by the proposed functions of the three scenarios, a question was raised that who should pay for setting up the platform. Considering the current economic situation in many European countries, it is unrealistic to expect public funds. Although such services may have potential to increase number of public transport users, it may still difficult for public transport operators to pay the platform.

- **Personalised services for professional drivers**; although many applications for travellers provide personalised services, i.e. providing a service based on user's profile and preference, it was not the same case for professional drivers, i.e. track drivers. Track drivers may also have his own profile and preference. If an application does not take into personal preference into account, it may lead that the driver does not follow the instructions from the application, thus reducing performance of the application.

- **Floating professional driver data collection**; while the application of 'floating passenger data collection' has been appraised as an efficient way to collect information on usage and performance of public transport, 'floating professional driver data collection' was proposed. It has been noted that many professional drivers have good knowledge on the network and vehicle operations which is valuable experience to be shared with others.