C-MOBILE

Accelerating C-ITS Mobility Innovation and deployment in Europe

D2.2 Analysis and Determination of Use Cases

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Abbreviations

Abbreviation	Definition
3G	3rd generation of mobile telecommunications technology
BSD	Blind Spot Detection
C-ITS	Cooperative Intelligent Transport System
CACC	Cooperative Adaptive Cruise Control
CAM	Cooperative Awareness Message
CTLVRU	Cooperative Traffic Light for VRUs
DSRC	Dedicated short Range Transmission
EBL	Emergency Brake Light
EVW	Emergency Vehicle Warning
FI	Flexible Infrastructure
FTD	Floating Traffic Data
G5 OBU	G5 On Board Unit
GLOSA	Green Light Optimal Speed Advice
GP	Green Priority
I2V	Infrastructure to Vehicle Communication
iTLC	Intelligent Traffic Light Controller
IVS	In Vehicle Signage
MAI	Motorcycle Approaching Indication
MPA	Motorway Parking Availability
OBU	On-Board Unit
PTW	Powered Two-Wheeler
PVD	Probe Vehicle Data
R-ITS-S	Roadside ITS Station
RHW	Road Hazard Warning
RLVW	Red Light Violation Warning
RSU	Road Side Unit
RTM	Rest-Time Management
RWW	Road Works Warning
SPAT	Signal Phase and Timing
SVW	Slow or Stationary Vehicle Warning
TLC	Traffic Light Controller
TRL	Technology Readiness Level
UPA	Urban Parking Availability
V2V	Vehicle to Vehicle Communication
Vehicle ITS-S	Vehicle ITS Station
VRU	Vulnerable Road Users
WSP	Warning System for Pedestrian

Executive Summary

In recent years, there has been significant progress in the field of intelligent transport systems (ITS). Several successful cooperative mobility efforts have proven to offer potential benefits of cooperative systems for specific transport modes in increasing their energy efficiency, their safety levels, or even both. However, the design and deployment of these systems are not without problems. The large majority of cooperative applications has been designed for different goals, stakeholders or specific contexts, making them rather isolated efforts from a user perspective. The systems typically have been developed with a silo-based approach and deployed independently from each other, making them rather isolated efforts from a technology perspective. They should be serving however, at a higher level, similar goals and functionalities for the end-user by well-integrated systems. Scalability, IT-security, decentralization and operator openness are some of the most important properties that a technical and commercial successful integrated solution must provide.

C-MobILE aims to stimulate/push existing and new mobility application sites towards large-scale, real-life C-ITS deployments interoperable across Europe. Well-defined operational procedures will lead to decentralized and dynamic coupling of systems, services and stakeholders across national and organizational borders in an open, but secure C-ITS ecosystem, based on different access technologies, the usage of which is transparent for service providers and seamless and continuous for the end-users across different transport modes, environments and countries.

Being a part of Work Package 2, Task 2.1 kick starts the process of defining needs and requirements with creating correct, complete, and unambiguous definitions for each C-ITS service and describing their functionality with detailed use cases. Establishing functionality of the C-ITS services forms the initial building blocks for large scale deployment. The use cases developed in this task act as an input for succeeding tasks that are concerned with definition of technical and non-technical requirements.

1. Introduction

1.1. C-MobILE at a glance

The C-MobILE (Accelerating C-ITS Mobility Innovation and depLoyment in Europe) vision is a fully safe and efficient road transport ecosystem without casualties and serious injuries on European roads. The focus of the vision is on complex urban areas and the vision pays special attention to Vulnerable Road Users. We envision a congestion-free, sustainable and economically viable mobility environment, minimizing the environmental impact of road transport. The C-MobILE project will set the basis for large-scale deployment in Europe, elevating research pilot sites to deployment locations of sustainable services that are supported by local authorities. The project uses a common approach that ensures interoperability and seamless availability of services towards acceptable end user costs and positive business cases for all parties involved in the mobility ecosystem.

1.2. Objective

The objective of this document is to communicate the end results of task: 'T2.1 – In depth analysis and determination of use cases' as a part of the work package: 'WP2 – Needs and requirements for implementation'. In this task, first, correct, complete and unambiguous service definitions were developed for 20 C-MobILE C-ITS Services predefined in [1]. Then, an in-depth use case analysis was performed to capture the requirements for each C-ITS Service. The resulting use cases provide a high-level understanding of how these services work and objectives and the motives behind the implementation of these services. Finally, a web survey was developed to help validate the service definitions and use cases.

1.3. Intended audience

The dissemination level of D2.2: Analysis and Determination of Use Cases is public. This document is intended to be a guideline for the definition of the technical and non-technical requirements for C-MobILE C-ITS Services.

1.4. Approach

This document presents the use case analysis undertaken to develop the detailed descriptions of the behaviour of each C-MobILE C-ITS Service from a functionality perspective. Within this analysis, a complete list of service definitions and use cases for each C-MobILE C-ITS Service are developed and a web survey is conducted to validate the service definitions and use cases.

1.5. Document structure

This document is organised as follows:

- Chapter 2 describes the concept of use cases and how this concept is adapted to the context of C-MobILE.
- Chapter 3 describes the subtasks performed and the related methodologies used to define and validate the service definitions and use cases for C-MobILE C-ITS Services.
- Chapter 4 presents the use cases defined for each C-MobILE C-ITS Service. The chapter is divided into subsections according to the services. Each subsection includes a high-level definition of the related C-ITS service and the use cases defined for that service.
- Chapter 5 introduces the C-ITS Survey developed to help validate the service definitions and use cases. The chapter concludes with the analysis of the responses obtained through the survey.

2. Use Case Analysis for C-ITS Services

Each C-ITS service can have one or more use cases describing how the service can be implemented in a particular context from user's point of view. The sections below introduce the concept of use cases, and the template used for documenting the results of the use case analysis.

2.1. The Concept of Use Case

Use cases organize a set of requirements in the context of the typical scenarios of using a system [2]. The main focus of a use case is on the user goals (i.e. what does the user want to achieve by using the system). Use cases are a collection of scenarios and a typical scenario consists of a list of steps that concludes with the achievement of one or more user goals. The steps describe all externally visible behaviours of the system from the user's perspective. When it is complete, a use case reveals who the key actors are, their goals, and common tasks [2]. The advantages of using use cases to capture requirements are given below:

- Use cases replace exhaustive function lists;
- Use cases improve comprehension and reduce ambiguity;
- Writing use cases enables brainstorming on all the things that could go wrong in the scenarios.

Furthermore, use cases influence the development of a complete set of requirements of a system, set the basis for validation of system functions, and influence user manuals for systems. The use cases provided in this document act as the basis for the definition of requirements in D2.3 [3].

2.2. C-MobILE Use Cases

In the context of C-MobILE, C-ITS services target at bringing benefits to different types of users and are relevant for different types of stakeholders. The three main set of stakeholders in C-MobILE are:

- Customer / End-user: Driver, Powered Two-Wheeler (PTW), Cyclist, Pedestrian, Visually Disabled Pedestrian, Impaired Person, Non-Motorized Vehicle User, Traveler, Fleet Operator/Manager.
- Technology Provider: Car manufacturer, Telecom/Mobile Network Operator, Maps/Navigation/Data Provider, Service Providers, Parking Operator, Public Transport Operator.
- Legal Authority: Road operator and National/Local Authority, City or Municipality, European Commission.

The Customer / End-user stakeholder set represents the main actors who interact with a C-ITS service to accomplish a goal. Other than the main actors, each set of stakeholders have different expectations from C-MobILE C-ITS Services. To ensure that each service meets the expectations of the main actor and the relevant stakeholder(s), a use case analysis is performed at the individual service level. That is, a separate use case analysis targeting the main actor and the relevant stakeholder(s) is performed for each C-ITS service. As a result, a C-MobILE use case organizes a set of requirements in the context of the typical scenarios of using a C-ITS service. The typical scenarios include steps that define a main actor's interaction with a specific service with also considering the expectations of other relevant set of stakeholders.

2.2.1. Use Case Template

For the use case analysis and documenting the use cases, a use case template is designed based on the use case templates employed in relevant projects, such as C-Roads -- InterCor ([4], [5]). The template is given below with its fields and descriptions.

Service: <Service Name>

High Level Service Definition

Service introduction	
Summary	<The summary of the service (one or two lines) >
Background	<The motivation/rationale of the service>
Objective	<The intended outcome of the service>
Expected benefits	<The actor benefits of the service>
Use Cases	<A list of use cases that are related and collectively describe to the objective of the service. For each listed use case two tables (i.e. Introduction to Use Case and Use Case Description) need to be provided.>

Use Case(s)

Use Case 1: <Use Case Name>

Introduction to the Use Case	
Background	<The motivation/rationale of the use case.>
Objective	<The main function / intended outcome of the use case >
Desired Behaviour	<The expected behaviour of the primary actor of the use case>
Expected Impact	<The value proposition>
Known Implementations	<Related projects>
References	<References>

Use Case Description	
Scope	<The system under design>
Frequency of Occurrence	<i.e. only in rush hours, continuous, specific situations>
Primary Actor	<The principal actor that calls upon the service(s) to fulfil a goal>
Stakeholders and Interests	<List of stakeholders and key interests in the use case>
Preconditions	<The conditions that must be true at the start of the use case>
Post-conditions	<The conditions that must be true on successful completion of the use case.>
Main Success Scenario	<A typical, happy path scenario of success. This part provides a description of the user actions and corresponding system responses that will take place during execution of the use case under normal, expected conditions. This dialog sequence ultimately leads to accomplishing the use case objective. Show a numbered list of actions performed by the actor, alternating with responses provided by the system.>
Exceptions and Alternative Flows	<Alternate scenarios of success or failure>
Special Requirements	<Non-functional requirements (i.e., design and implementation constraints, and quality attributes, such as reliability, performance, security.)>
Technology Variations List	<Varying technological methods to implement the use case>
Open Issues	<Undecided and vague issues related to the use case which can be resolved in future/follow-up deliverables>
Illustrations, Visualizations, and Figures	<Visual elements that depict the use case>

3. Approach

An iterative approach has been undertaken to develop the use cases for the C-ITS services. Since use cases are the initial artefact that captures functionality, they act as the major input for the requirements elicitation process. Because of this relationship between the use cases and requirements, the iterative approach that started with development of the use cases has also been carried out to the elicitation of the requirements. In this section, the subtasks undertaken within 'Task 2.1 - In-depth analysis and determination of use cases' are explained in detail. Table 1 below shows an overview of these subtasks. A detailed explanation of the work carried out for each subtask is given in the following three subsections.

Subtask ID	Subtask	Objective	Technique	Outcome
S1	Development of C-ITS Service Definitions	To reach a project-wide common understanding on the objective of each service and its scope	/ Review of literature and deliverables of relevant ongoing and previous projects	C-MobILE C-ITS Service Definitions
S2	Development of the Use Cases of C-ITS Services	To define the functionality of each service from user's point of view based on the service definition	/ Review of deliverables of relevant existing and previous projects, and literature / Several bilateral meetings between partners, and workshop sessions in Amersfoort (Sep.2017), and Helmond (Oct.2017) / Expert reviews / Open contributions by all project partners	C-MobILE C-ITS Use Cases
S3	Validation of the Service and Use Cases	To validate the resulting service definitions and use cases	/ Open review of use-case descriptions by all project partners / Web based online survey (C-ITS Survey) / Grand assembly and WP2/WP4 Workshop (Bilbao Nov.2017) / Review of this document	C-MobILE C-ITS Survey

Table 1: Tasks undertaken

3.1. S1: Development of the C-ITS Service Definitions

C-MobILE targets at a large-scale deployment of a set of 20 C-ITS Services at 8 C-MobILE Cities. A thorough investigation of the services revealed that different sources and projects have different definitions for the same service. Having correct, complete, and unambiguous definitions for each service is crucial for describing how they work. Therefore, before starting, use cases service definitions are developed to avoid ambiguity and to attain a project-wide agreement. To this end, a collaborative review of academic and grey literature has been performed and documents from existing/past projects and initiatives have been reviewed.

As a result, a document in the form of a glossary has been developed with the definitions of services complemented with an extensive list of related attributes. These attributes include among others:

- the relevant impact areas (safety, efficiency, environment and comfort) at which each service aims to target;
- existing and targeted technology readiness level (TRL) of services;
- time frames (e.g. Day 1);
- relevant existing or past projects that have studied/applied/offered these services;
- relevant stakeholders that are involved in the use and provisioning of the services;
- known and/or potential technologies;
- the standards and technical specifications that are relevant in their implementations.

After the initial release of the document, it has been opened for review to all project partners and experts in the C-ITS domain and reviewed extensively. The resulting service definitions are given below in Table 2.

#	C-ITS Service	Definition
1	Rest-Time Management (RTM)	Rest time management supports managing the working hours of drivers engaged in the carriage of goods and passengers by road. The process is regulated by policies, laws or regulations (e.g., EU regulation (EC) No 561/2006 [6]) that lay down the rules on driving times, breaks and rest periods for the drivers.
2	Motorway Parking Availability (MPA)	MPA provides motorway parking availability information and guidance for truck drivers to make informed choices about available parking places. Existing solutions provide information about the location of parks, capacity, available equipment, facilities on site, security equipment and information about dangerous goods parking.
3	Urban Parking Availability (UPA)	UPA provides parking availability information and guidance for drivers to make informed choices about available parking places. This service aims to reduce congestion, time loss, pollution, and stress caused by cruising for parking.
4	Road Works Warning (RWW)	Road works warning aims to inform the drivers in a timely manner about road works, restrictions, and instructions. This allows them to be better prepared for potential works downstream on the road, therefore reducing the probability of collisions.
5	Road Hazard Warning (including traffic jams) (RHW)	The road hazard warning service aims to inform the drivers in a timely manner of upcoming, and possibly dangerous events and locations. This allows drivers to be better prepared for the upcoming hazards and make necessary adjustments and manoeuvers in advance. (This is also known as "Hazardous location notification" [7] or 'Road hazard signalling').
6	Emergency Vehicle Warning (EVW)	Emergency vehicle warning uses information provided by the emergency vehicle to inform a driver of another vehicle about an approaching emergency vehicle even when the siren and light bar of the emergency vehicle may not yet be audible or visible. This is also known as "Emergency Vehicle Alert (EVA)", which alerts the driver about the location and the movement of public safety vehicles responding to an incident so the driver does not interfere with the emergency response. The service is enabled by receiving information about the location and status of nearby emergency vehicles responding to an incident [8].
7	Signal Violation Warning (SVW)	Signal Violation Warning aims to reduce the number and severity of collisions at signalised intersections by warning drivers who are likely -due to high speed- to violate a red light. Also known as the "Signal violation / Intersection Safety" or "Red Light Violation Warning".
8	Warning System for Pedestrian (WSP)	Warning system for pedestrian aims to detect risky situations (e.g. road crossing) involving pedestrians, allowing the possibility to warn vehicle drivers. Hence, the warning is based on pedestrian detection. The scope of the service can be extended to cover other VRUs (e.g. cyclists). The service is particularly valuable when the driver is distracted or visibility is poor. (Also known as "Vulnerable road user Warning" [7])
9	Green Priority (GP)	Green priority aims to change the traffic signals status in the path of an emergency or high priority vehicle (e.g., public transportation vehicles), halting conflicting traffic and allowing the vehicle right-of-way, to help reduce response times and enhance traffic safety. This service is also known as "Traffic signal priority request by designated vehicles" [9]or "Priority Request" [10]. Different levels of priority can be applied, e.g. extension or termination of current phase to switch to the required phase. The appropriate level of green priority depends on vehicle characteristics, such as type (e.g. HGV or

		emergency vehicle) or status (e.g., public transport vehicle on-time or behind schedule). The vehicles request priority for an intersection, and the traffic light controller determines in what way it can and will respond the request.
10	GLOSA (Green Light Optimal Speed Advisory)	GLOSA provides drivers an optimal speed advice when they approach to a signalized intersection. This advice may involve maintaining actual speed, slowing down, or adapting a specific speed. If a green traffic light cannot be reached in time, GLOSA may also provide time-to-green information when the vehicle is stopped in the stop bar. Application of GLOSA takes advantage of real-time traffic sensing and infrastructure information, which can then be communicated to a vehicle aiming to reduce fuel consumption and emissions.
11	Cooperative Traffic Light for VRUS (CTLVRU)	Cooperative traffic light for VRUs aims to increase the safety of pedestrians through warranting priority or additional crossing time (i.e., extending the green light phase or lessening the red phase) based on pedestrian characteristics (or on special conditions, such as weather). The service can also be extended to cover other VRUs, such as cyclists. The service is also known as "Pedestrian Mobility" (CVRIA, 2017) or "Traffic light prioritisation for designated VRUs".
12	Flexible Infrastructure (e.g. peak-hour lane) (FI)	Flexible infrastructure aims to interchange information about the lanes provided to the traffic users according to the time of the day. It includes solutions such as reserved lane.
13	In-vehicle Signage (e.g. dynamic speed limits) (IVS)	In-vehicle signage aims to provide information to the driver about the road signs (and dynamic information, e.g., local conditions warnings identified by environmental sensors [8]). The purpose of this service is to increase the likelihood of drivers being aware of potentially dangerous conditions in case a roadside traffic sign is not noticed.
14	Mode & Trip Time Advice (MTTA)	Mode & trip time advice (e.g. by incentives) aims to provide a traveller with an itinerary for a multimodal passenger transport journey, taking into account real-time and/ or static multimodal journey information.
15	Probe Vehicle Data (PVD)	Probe Vehicle Data is data generated by vehicles. The collected traffic data can be used as input for operational traffic management (e.g., to determine the traffic speed, manage traffic flows by - for instance- alerting users in hot spots, where the danger of accidents accumulates), long term tactical/strategic purposes (e.g. road maintenance planning) and for traveller information services. Also known as Floating Car Data (FCD).
16	Emergency Brake Light (EBL)	Emergency Brake Light aims to avoid (fatal) rear end collisions, which can occur if a vehicle ahead suddenly brakes, especially in dense driving situations or in situations with decreased visibility. The driver is warned before s/he is able to realize that the vehicle ahead is braking hard, especially if s/he does not see the vehicle directly (vehicles in between).
17	Cooperative (Adaptive) Cruise Control (CACC)	Cooperative Adaptive Cruise Control represents an evolutionary advancement of conventional cruise control (CCC) and adaptive cruise control (ACC) by utilizing V2V communications to automatically synchronize the motion of many vehicles. While ACC uses Radar or LIDAR measurements to derive the range to the vehicle in front, CACC also takes the preceding vehicle's acceleration into account.
18	Slow or Stationary Vehicle Warning (SVW)	Slow or stationary vehicle warning aims to inform/ alert approaching vehicles of (dangerously) immobilized, stationary or slow vehicles that impose significant risk.
19	Motorcycle Approaching Indication	Motorcycle approaching indication informs the driver of a vehicle that a motorcycle is approaching/passing. The

	(including other VRUs) (MAI)	scope can be extended to cover other VRUs, such as cyclists and other Powered Two Wheelers (PTW). The motorcycle could be approaching from behind or crossing at an intersection.
20	Blind Spot Detection / Warning (VRUs) (BSD)	Blind spot detection aims to detect and warn the drivers about other vehicles of any type located out of sight.

Table 2: List of C-MobILE C-ITS Services

3.2. S2: Development of the Use cases

There is an existing body of knowledge regarding the use cases for C-ITS services. However, a similar problem to the one with the service definitions arises when the use cases are analysed in detail. The existing use cases emerge from specific contexts and aim to address certain project requirements and settings, and therefore may differ significantly with respect to the expectations from the C-MobILE C-ITS services. While some descriptions approach the services from the technology perspective with limited focus on how the services interact with the user, some focus on specific contexts where the service can be of use. To have a consistent definition of use cases that are also aligned with C-MobILE expectations, an extensive review of literature has been conducted, which also included on-going and prior C-ITS projects that have performed use case analysis of C-ITS services.

After identifying these projects and other initiatives, and gathering relevant source material, we performed a detailed analysis of these documents to identify use cases that can be adopted. For the services that do not have prior use case descriptions, we applied the use case analysis technique for the organisation of the functional requirements in the shape of scenarios. This analysis was performed in a collaborative way in which partners (including local sites) contributed according to their prior knowledge and experience on specific services.

Several bilateral meetings between project partners were conducted to elicit and validate use cases of services. In addition, several projects partners were involved in the (off-line) definition and review of the descriptions. A Use Case Development Plan that included the collaboration scheme for the analysis and review was prepared. Resulting descriptions are recorded in the format of the use case template described in Section 2.2.1. In order to resolve the conflicts, inconsistencies, or ambiguities in the service and use case definitions, these descriptions were discussed in two project workshops that were performed in Amersfoort (Sep.2017), and Helmond (Oct.2017).

3.3. S3: Validation of the Service Definitions and Use cases

To validate the C-MoBILE C-ITS service and use cases, four activities have been performed:

- Firstly, we published the use cases of each service separately (in the project workplace) and invited all members of the project partners – many of whom are considered experts in the C-ITS domain - for an open review.
- Secondly, an online survey[2] was developed and performed in parallel to achieve an overall understanding of the stakeholder expectations from C-ITS services, and to obtain feedback and validate the artefacts with a wider audience that includes not only project partners and associate partners, but also active stakeholders of C-ITS services around Europe. The survey took place between September 18, 2017 to November 23, 2017. The results of the survey were analysed and used also for bringing the service and use cases to their final form. Information regarding the content and results of the survey is presented in Section 5. The questionnaire is available in Annex 2: C-ITS Survey.
- Thirdly, the service and use-case descriptions, and survey results were presented at General Assembly meeting, and WP2/WP4 Workshop that took place in Bilbao (Nov 2017). In the workshop, we were able to gather feedback from a wider audience that include representatives of active projects in this domain, and local stakeholders and end-users.
- Fourthly and finally, this document went through a thorough review by project partners for verification and validation.

The verified and validated service definitions and use cases were input for the task: 'T2.2 – Technical and Non-Technical Requirements' and used as an input for elicitation of complete set of requirements for C-ITS implementation.

[1] Please visit Annex 1: List of Projects with Use cases to see the complete list of projects that have performed use case analysis of C-ITS services.

[2] C-MobILE C-ITS Survey, available at: http://c-mobile.bpmresearch.net/survey-c-its-services

4. C-MobILE Use cases

In this section, all C-MobILE C-ITS Services are presented with one or more related use cases. Each subsection presents a single C-MobILE C-ITS Service with a short summary of the service, its background, objectives, and expected benefits. Next, relevant use cases describing specific scenarios are provided. The overview of the Use cases is given below in Table 3.

ID	Service	Use Cases
1	Rest-Time Management	UC1.1 - Rest Time Indication
2	Motorway Parking Availability	UC2.1. Information on parking lots location, availability and services via internet UC2.2. Information on parking lots location, availability and services via I2V UC2.3. Information about a truck parking space released by a user UC2.4. Reservation of a truck parking space released by a user UC2.5. Guide the truck in the port (terminal or truck parking)
3	Urban Parking Availability	UC3.1. Information about a vehicle parking space released by a user UC3.2. Reservation of a vehicle parking space released by a user UC3.3. Information about on-street parking availability for urban freight (loading zones) UC3.4. Information about on-street parking availability for private car drivers
4	Road Works Warning	UC4.1- Road Works Warning
5	Road Hazard Warning (incl. jams)	UC5.1- Hazardous Location Notification UC5.2- Traffic Condition Warning UC5.3- Weather Condition Warning
6	Emergency Vehicle Warning	UC6.1- Emergency Vehicle Warning
7	Signal Violation Warning	UC7.1- Red Light Violation Warning
8	Warning System for Pedestrian	UC8.1- Safe Travelling Experience by Warning Signage
9	Green Priority	UC9.1- Green Priority for Designated Vehicles
10	GLOSA	UC10.1 - Optimized Driving with GLOSA
11	Cooperative Traffic Light for Pedestrian	UC11.1- Traffic Light Prioritisation for Designated VRUs UC11.2- Cooperative Traffic Light with VRU Counting
12	Flexible Infrastructure (peak-hour lane)	UC12.1- Dynamic Lane Management-Lane Status information UC12.2- Dynamic Lane Management-Reserved Lane (with use of probe vehicle data) UC12.3- Dynamic Lane Management-Reserved Lane (without use of probe-vehicle data)
13	In-vehicle Signage (e.g. Dyn. speed lim.)	UC13.1- In-Vehicle Signage, Dynamic Traffic Signs UC13.2- In-Vehicle Signage, Static Traffic Signs
14	Mode & Trip Time Advice	UC14.1. Mode and Trip Time Advice for Event Visitors UC14.2. Mode and Trip Time Advice for Drivers UC14.3. Mode and Trip Time Advice for Cyclists
15	Probe Vehicle Data	UC15.1- Basic Probe Vehicle Data UC15.2- Extended Probe Vehicle Data
16	Emergency Brake Light	UC16.1- Emergency Electronic Brake Lights
17	Cooperative (Adaptive) Cruise Control	UC17.1 - CACC Passenger Vehicles Approaching Urban of Semi-Urban Environment
18	Slow or Stationary	UC18.1 - Slow or Stationary Vehicle Warning

	Vehicle Warning	
19	Motorcycle Approaching Indication (including other VRUs)	UC19.1 - The Approaching Two-wheeler Warning (V2V) UC19.2 - The Approaching Two-wheeler Warning (V2V and V2I)
20	Blind Spot Detection / Warning (VRUs)	UC20.1 - Digital Road Safety Mirror (V2I) UC20.2 - Digital Road Safety Mirror for VRUs (V2I)

Table 3: Overview of the Use Cases

4.1. Rest Time Management (RTM)

4.1.1. High Level Service Definition

Service introduction	
Summary	Rest time management supports managing the working hours of drivers engaged in the transport of goods and passengers by road. The process is regulated by policies, laws or regulations (e.g., EU regulation (EC) No 561/2006) that lay down the rules on driving times, breaks and rest periods for the drivers.
Background	The regulation of resting time periods is important for both drivers engaged in the transport of goods and passengers by road and public. This service is meant to help truck drivers manage their driving and times and resting periods according to the availability of parking lots and associated services.
Objective	Enabling truck drivers to make a safer journey by assisting rest time management through the provision of information on parking availability, at a relevant frequency.
Expected benefits	/ A better compliance with driving times and resting periods. / Reduced search time for a parking space.
Use Cases	1. Rest time indication

Table 4: Rest Time Management High Level Service Definition

4.1.2. Use Case(s)

4.1.2.1. Rest time indication

Introduction to the Use Case	
Background	The use case is meant to display available parking spots along the route of a truck (or commercial vehicle) driver, at a certain frequency. The frequency could be e.g. every two hours for a light vehicle driver. For HGV drivers, the frequency could be e.g. based on the driving time already done compared to the driving / break / rest times from the regulation.
Objective	To help truck drivers manage their driving and times and resting periods according to the availability of parking lots and associated services. To encourage the truck driver to take a break time, by advising him a parking lot with available spaces.
Desired Behaviour	The truck driver will park his vehicle to get some rest after a relevant driving time, according to regulating driving times and resting periods.
Expected Impact	A better compliance with driving times and resting periods. Reduced search time for a parking space.
Known Implementations	InterCor
References	Rest time indication, InterCor

Table 5: Introduction to the Use Case: Rest Time indication

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Truck Driver
Stakeholders and Interests	Commercial vehicle driver / Truck driver: Receives advice when to rest according to available truck parking spaces and regulating driving times and resting periods. Parking lot operators: Provide information on availability of truck parking spaces and services of parking lots.
Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	Information on availability of truck parking spaces and services at parking lots are displayed on the Vehicle ITS-S.
Main Success Scenario	1. The Road Manager or the Parking Manager collects information by own means or relationships. 2. Information is broadcasted to all vehicles within a perimeter which is considered as relevant. 3. The Truck Driver is driving, parking spots are displayed along the way at a certain frequency, in a pop-up to suggest to take a break. 4. The Truck Driver adapts his route and can choose a parking area.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Truck Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Truck Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	Heavy Goods vehicles have to take into account the regulation of driving time / break time. Driving time, break time and rest time of HGV drivers (>3,5T, more than 9 seats) are defined in the European Social Regulation No 561/2006 of 15 March 2006. Parking information can be available through Motorway and Urban Parking Availability services.
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 6: Use Case Description: Rest Time indication

4.2. Motorway Parking Availability (MPA)

4.2.1. High Level Service Definition

Service introduction	
Summary	MPA provides motorway parking availability information and guidance for truck drivers to make informed choices about available parking places. Existing solutions provide information about the location of parks, capacity, available equipment, facilities on site, security equipment and information about dangerous goods parking.
Background	Information on motorway parking availability is aimed to provide efficiency and safety benefits to drivers and help to reduce emissions and congestions on motorways by

	reducing the time spent searching for parking.
Objective	/ Simplifying access to the parking lots for the driver. / Optimizing the flow of trucks in the parking lot (thus reducing congestions or traffic jams) / Reduce vehicle-kilometers driven
Expected benefits	/ Reduced search time for a parking space. / Reduced driver stress as a result of available information of parking options.
Use Cases	1. Information on parking lots location, availability and services via internet 2. Information on parking lots location, availability and services via I2V 3. Information about a truck parking space released by a user 4. Reservation of a truck parking space released by a user 5. Guide the truck in the port (terminal or truck parking)

Table 7: Motorway Parking Availability High Level Service Definition

4.2.2. Use Case(s)

4.2.2.1. Information on parking lots location, availability and services via internet

Introduction to the Use Case	
Background	The use case is meant to inform truck drivers on available truck parking spaces and extra information on parking spaces. This information can bring more comfort and security by helping the truck driver manage his/her driving times and rest periods.
Objective	The objective of the use case is to provide to truck drivers information on parking spaces. Information provided are: / the location of parking lots / the number of their available spaces. If not known, information provided is just "full" or "free". / Vehicle Types permitted to be parked / Services provided in the parking lot, and associated rates / If the parking is secured or not
Desired Behaviour	By providing information on availability of truck parking spaces and services at parking lots, truck drivers (on-trip) choose an available truck parking space taking into account driving and rest periods.
Expected Impact	/ Less trucks parked at spaces that are not meant to be parked on (illegally parked). / A better compliance with driving times and resting periods, more efficient use of driving time. / Reduced search time for a parking space.
Known Implementations	/ SCOOP@F / InterCor / Intelligent truck parking, CO-GISTICS / Parking Management > Talking Traffic Innovation Partnership (http://www.beterbenutten.nl/talking-traffic) > Brabant In-Car II ParckR project (http://www.parckr.com/en/) > Praktijkproef Amsterdam (http://www.praktijkproefamsterdam.nl/) / Transpark IRU (https://www.iru.org/apps/transpark-app)

	/ Truck Parking Europe (https://truckparkingeurope.com) / Truck-Parking (http://www.truck-parking.com/locations-map/?lang=en) / The European Truck Parking Area LABEL Project (http://truckparkinglabel.eu/assets/default.htm) / Aegean Motorway MSS locations (http://www.aegeanmotorway.gr/en/ypiresies/sea)
References	1. Information on parking lots location, availability and services via internet, InterCor

Table 8: Introduction to the Use Case: Information on parking lots location, availability and services via internet

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Truck Driver
Stakeholders and Interests	/ Vehicle driver / Truck driver: Receives information on availability of truck parking spaces and services of parking lots on the in-vehicle display. / Parking lot operators: Provide information on availability of truck parking spaces and services of parking lots. / Transport operators / Data provider: Collects information from parking space operators and aggregates them into a single data source which can be accessed at a data access point. Alternatively, information is collected from feed-back by truck drivers using a truck parking app (crowd-sourcing).
Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	Information on availability of truck parking spaces and services at parking lots are displayed on the Vehicle ITS-S.
Main Success Scenario	1. Operators of truck parking spaces provide available truck parking spaces and information on services at parking lots to a data access point. 2. In the data access point information on availability of truck parking spaces and on services at parking lots is available. 3. Anyone who wants to deliver a service for truck drivers, can collect this data at the data access point and provides this information to truck drivers. 4. Truck drivers receive information on available truck parking spaces and information on services at parking lots on the Vehicle ITS-S.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S remains idle.
Special Requirements	*None.*
Technology Variations List	*None.*
Open Issues	*None.*

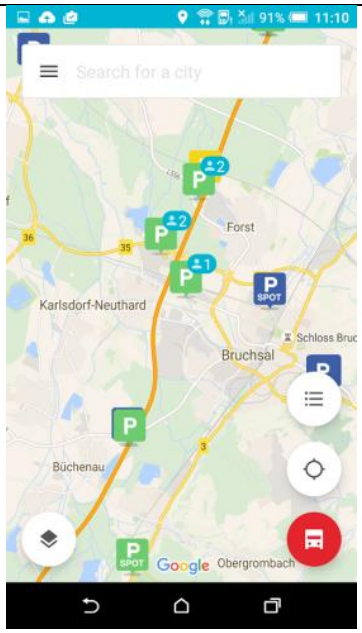
Illustrations, Visualizations, and Figures	 Figure 1: Screenshot from Truck Parking Europe which lists available parking spaces to the Truck Drivers Source: https://truckparkingeurope.com/ , Truck Parking Europe

Table 9: Use Case Description: Information on parking lots location, availability and services via internet

4.2.2.2. Information on parking lots location, availability and services via I2V

Introduction to the Use Case	
Background	The use case is meant to inform truck drivers on available truck parking spaces and extra information on parking spaces. This information can bring more comfort and security by helping the truck driver manage his driving times and rest periods.
Objective	The objective of the use case is to provide to truck drivers information on parking spaces. Information provided are: / the location of parking lots / the number of their available spaces. If not known, information provided is just "full" or "free". / Vehicle Types permitted to be parked / Services provided in the parking lot, and associated rates / If the parking is secured or not
Desired Behaviour	By providing information on availability of truck parking spaces and services at parking lots, truck drivers (on-trip) choose an available truck parking space taking into account driving and rest periods.
Expected Impact	/ Less trucks parked at spaces that are not meant to be parked on (illegally parked). / A better compliance with driving times and resting periods, more efficient use of driving time. / Reduced search time for a parking space.
Known Implementations	/ SCOOP@F / InterCor / Intelligent truck parking, CO-GISTICS
References	1. Information on parking lots location, availability and services via I2V, InterCor

Table 10: Introduction to Use Case: Information on parking lots location, availability and services via I2V

Use Case Description

Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Truck Driver
Stakeholders and Interests	/ Truck driver: Receives information on availability of truck parking spaces and services of parking lots on the in-vehicle display. / Parking lot operators: Provide information on availability of truck parking spaces and services of parking lots. / Service Provider: Provide information on availability of truck parking spaces and services of parking lots to the truck drivers. / Data provider: Collects information from parking space operators and aggregates them into a single data source which can be accessed at a data access point. Alternatively, information is collected from feed-back by truck drivers using a truck parking app (crowd-sourcing).
Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	Information on availability of truck parking spaces and services at parking lots are displayed on the Vehicle ITS-S.
Main Success Scenario	1. The Road Manager, or the Parking Operator, get the information by his/her own means or through his/her relationships (real-time data acquisition). 2. The Road Manager broadcasts it to all vehicles, in a relevant area. 3. The Vehicle ITS-S display the information to drivers, adapted to the vehicle types (e.g. Light Vehicle or Heavy Goods Vehicle). 4. Truck Drivers adapts his/her trip, and chooses a parking lot according his/her needs.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S remains idle.
Special Requirements	*None.*
Technology Variations List	*None.*
Open Issues	*None.*

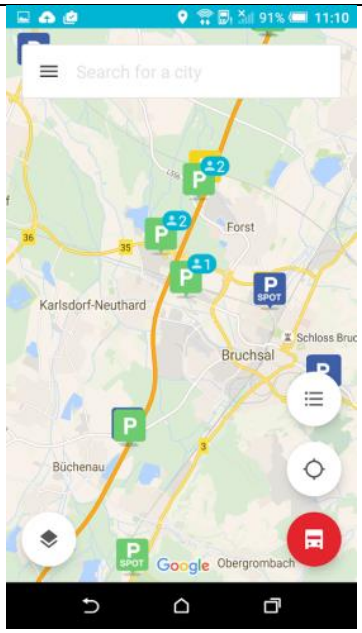
Illustrations, Visualizations, and Figures	 Figure 2: Screenshot from Truck Parking Europe which lists available parking spaces to the Truck Drivers Source: https://truckparkingeurope.com/ , Truck Parking Europe

Table 11: Use Case Description: Information on parking lots location, availability and services via I2V

4.2.2.3. Information about a truck parking space released by a user

Introduction to the Use Case	
Background	Current systems mainly focused on off-street parking management. This use case permit to optimize the on-street parking next to motorways.
Objective	The objective of the use case is to provide information on the location of a truck parking space being released to truck drivers looking for a space in a given area.
Desired Behaviour	The truck driver searching for a parking space goes to the truck parking space.
Expected Impact	Less trucks parked at spaces that are not meant to be parked on (illegally parked). A better compliance with driving times and resting periods, more efficient use of driving time. Reduced search time for a parking space.
Known Implementations	SCOOP@F InterCor
References	Information about a truck parking space released by a user, InterCor

Table 12: Introduction to Use Case: Information about a truck parking space released by a user

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Truck Driver
Stakeholders and Interests	Truck driver: / Leaving truck: Sends a message through the Vehicle ITS-S when leaving his parking space. / Searching truck: Receives a message on the Vehicle ITS-S containing information on the location of the truck parking space.

Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	Information on availability of truck parking spaces and services at parking lots are displayed on the Vehicle ITS-S.
Main Success Scenario	1. A truck driver sends a broadcast message through the Vehicle ITS-S stating that he/she is leaving a parking space. 2. A searching truck driver receives this information on the Vehicle ITS-S. 3. The truck driver goes to the released parking space.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S remains idle.
Special Requirements	*It can be considered that the unicast link is sufficient for the parking space to be reserved, but it does not guarantee that it will be free when the searching vehicle will arrive.
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 13: Use Case Description: Information about a truck parking space released by a user

4.2.2.4. Reservation of a truck parking space released by a user

Introduction to the Use Case	
Background	Current systems mainly focused on off-street parking management. This use case permit to optimize the on-street parking next to motorways.
Objective	/ To help truck drivers manage their driving times and resting periods according to the availability of parking lots and associated services. / To encourage the Truck Drivers to take a break time, by advising them a parking lot with available spaces.
Desired Behaviour	/ The searching vehicle goes to the parking space / The leaving vehicle waits for the searching vehicle before leaving its parking space
Expected Impact	/ Reduced search time for a parking space. / Guaranteed success on finding the parking space empty after reservation.
Known Implementations	/ SCOOP@F / InterCor
References	1. Reservation of a truck parking space released by a user, InterCor

Table 14: Introduction to Use Case: Reservation of a truck parking space released by a user

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous

Primary Actor	Truck Driver
Stakeholders and Interests	Truck driver: Receives a message on the Vehicle ITS-S containing information on the location of the truck parking space. / Leaving truck: Sends a message when preparing to leave his parking space. / Searching truck: Sends a message through Vehicle ITS-S, stating that he/she is looking for a truck parking space.
Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	Information on availability of truck parking spaces and services at parking lots are displayed on the Vehicle ITS-S.
Main Success Scenario	1. The Truck Driver who's searching for a parking space sends a broadcast message through the Vehicle ITS-S, stating that he/she is looking for a parking space. 2. The Truck Driver of the parked truck who is preparing to leave, sends a message (V2V Unicast*) stating that he/she is releasing its parking space. 3. The searching vehicle's Vehicle ITS-S sends to the leaving vehicle's Vehicle ITS-S its position and confirms that it is approaching (reservation). If the searching vehicle's Vehicle ITS-S has several proposals, it informs only the one chosen. 4. When the searching vehicle arrives at the destination, the leaving vehicle leaves its space.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. Vehicle ITS-S remains idle.
Special Requirements	*It can be considered that the unicast link is sufficient for the parking space to be reserved, but it does not guarantee that it will be free when the searching vehicle will arrive. An option to guarantee the reservation would be the following. / Information on the size / type of vehicles and parking spaces / This use case will not work completely in covered parking lots (positioning problem) This use case needs to use a navigation system to realise the guidance
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 15: Use Case Description: Reservation of a truck parking space released by a user

4.2.2.5. Guide the truck in the port (terminal or truck parking)

Introduction to the Use Case	
Background	This use case is meant to simplify access to the port by providing guidance to drivers.
Objective	/ Simplifying access to the port terminal for the driver. / Optimizing the flow of trucks in the port (thus reducing congestions or traffic jams)
Desired Behaviour	When the Truck Driver arrives to the port, on the Vehicle ITS-S, he/she receives and visualizes the route he/she must follow to the parking or the terminal. The truck driver follows the instructions until arrival.
Expected Impact	The guidance in the port permits:

	/ For the driver: Simplification to access terminal, gain of time, reduce early arrivals (with additional waiting time), reduce stress / For the Terminal operator: Truck flow and management on the terminal / in the port, knowing truck's position in the port / For the port: Better manage traffic flows by having the possibility to guide the truck via several paths and to several destinations (terminal, parking).
Known Implementations	/ SCOOP@F / InterCor
References	1. Multimodal Cargo Transport Optimisation, InterCor

Table 16: Introduction to Use Case: Guide the truck in the port (terminal or truck parking)

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	When Truck Driver enters to the Terminal
Primary Actor	Truck Driver
Stakeholders and Interests	/ Truck Driver: interacts with the Vehicle ITS-S to: > Indicate his/her destination > Follow an itinerary to access a terminal or truck parking in a port / Service Provider: Map Repository Platform provides circuits to access different terminals / Port: sends terminal or parking destination
Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	On the Vehicle ITS-S, a map is displayed with graphical directions (left, right, straight, etc.) on the way to take.
Main Success Scenario	1. Truck Driver enters a port 2. The Vehicle ITS-S detects the entry of the truck in the port via a geo-fence 3. The Vehicle ITS-S requests from the port manager the terminal or the parking where the Truck Driver must go 4. The Vehicle ITS-S requests the itinerary from the Map repository platform 5. The Vehicle ITS-S detects the movement of the truck via a geo-fence 6. The Vehicle ITS-S displays instructions in real time at each critical point of the Truck Driver's itinerary 7. The Vehicle ITS-S closes action at arrival
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Truck Driver, provide reason for failure. 2. Vehicle ITS-S remains idle.
Special Requirements	*None.*
Technology Variations List	*None.*
Open Issues	*None.*

Illustrations, Visualizations, and Figures	*None.*

Table 17: Use Case Description: Guide the truck in the port (terminal or truck parking)

4.3. Urban Parking Availability (UPA)

4.3.1. High Level Service Definition

Service introduction	
Summary	UPA provides parking availability information and guidance for drivers to make informed choices about available parking places. This service aims to reduce congestion, time loss, pollution, and stress caused by cruising for parking.
Background	Information on urban parking availability is aimed to provide efficiency benefits to drivers and help to reduce emissions and congestions on urban areas by reducing the time spent searching for parking.
Objective	/ Simplifying the access to the parking lots for the driver. / Optimizing the flow of vehicles in the urban areas (thus reducing congestions or traffic jams). / Reducing congestion due to parking search traffic
Expected benefits	/ Reduced search time for a parking space. / Reduced driver stress as a result of available information of parking options.
Use Cases	1. Information about a vehicle parking space released by a user 2. Reservation of a vehicle parking space released by a user 3. Information about on-street parking availability for urban freight (loading zones) 4. Information about on-street parking availability for private car drivers

Table 18: Urban Parking Availability High Level Service Description

4.3.2. Use Case(s)

4.3.2.1. Information about a vehicle parking space released by a user

Introduction to the Use Case	
Background	Current systems mainly focused on off-street parking management. This use case permit to optimize the on-street parking.
Objective	The objective of the use case is to provide information on the location of a vehicle parking space being released to vehicle drivers looking for a parking space in a given urban area.
Desired Behaviour	The vehicle driver searching for a parking space goes to the vehicle parking space.
Expected Impact	/ Security / Comfort (information on services at the parking)
Known Implementations	/ InterCor
References	1. Information about a truck parking space released by a user, InterCor

Table 19: Introduction to Use Case: Information about a vehicle parking space released by a user

Use Case Description	
Scope	C-MobILE

Frequency of Occurrence	Continuous
Primary Actor	Vehicle driver
Stakeholders and Interests	/ Vehicle driver: > Leaving vehicle: Sends a message through the Vehicle ITS-S when leaving his parking space. > Searching vehicle: Receives a message on the Vehicle ITS-S containing information on the location of the vehicle parking space. / Municipality > Reduction of congestion and pollution / Parking operator (for private parking) > Higher occupancy of parking slots
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle driver's smart phone or on-board unit and running in the background.
Post-conditions	Information on availability of vehicle parking spaces and services at parking lots are displayed on the Vehicle ITS-S.
Main Success Scenario	1. The Vehicle driver who's searching for a parking space sends a broadcast message through the Vehicle ITS-S, stating that he/she is looking for a parking space. 2. The Vehicle driver of the parked vehicle who is preparing to leave, sends a message (V2V Unicast*) stating that he/she is releasing its parking space. 3. The searching vehicle's Vehicle ITS-S sends to the leaving vehicle's Vehicle ITS-S its position and confirms that it is approaching. If the searching vehicle's Vehicle ITS-S has several proposals, it informs only the one chosen. 4. When the searching vehicle arrives at the destination, the leaving vehicle leaves its space.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle driver. 2. Vehicle ITS-S remains idle.
Special Requirements	*It can be considered that the unicast link is sufficient for the parking space to be reserved, but it does not guarantee that it will be free when the searching vehicle will arrive. An option to guarantee the reservation would be the following.
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 20: Use Case Description: Information about a vehicle parking space released by a user

4.3.2.2. Reservation of a vehicle parking space released by a user

Introduction to the Use Case	
Background	Current systems mainly focused on off-street parking management. This use case permit to optimize the on-street parking.
Objective	/ To help vehicle drivers manage their driving times and resting periods according to the availability of parking lots and associated services. / To encourage the Vehicle drivers to take a break time, by advising them a

	parking lot with available spaces.
Desired Behaviour	/ The searching vehicle goes to the parking space / The leaving vehicle waits for the searching vehicle before leaving its parking space
Expected Impact	/ Reduced search time for a parking space. / / Guaranteed success on finding the parking space empty after reservation.
Known Implementations	/ InterCor
References	1. Reservation of a truck parking space released by a user, InterCor

Table 21: Introduction to Use Case: Reservation of a vehicle parking space released by a user

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle driver
Stakeholders and Interests	/ Vehicle driver: > Leaving vehicle: Sends a message (V2V Unicast) when preparing to leave his parking space. > Searching vehicle: Sends a message (V2V Broadcast) through Vehicle ITS-S, stating that he/she is looking for a vehicle parking space. > Receives a message on the Vehicle ITS-S containing information on the location of the vehicle parking space. / Municipality > Reduction of congestion and pollution and safety increase due to rested drivers / Parking operator (for private parking) > Higher occupancy of parking slots
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle driver's smart phone or on-board unit and running in the background.
Post-conditions	Information on availability of vehicle parking spaces and services at parking lots are displayed on the Vehicle ITS-S.
Main Success Scenario	1. The Vehicle driver who's searching for a parking space sends a broadcast message through the Vehicle ITS-S, stating that he/she is looking for a parking space. 2. The Vehicle driver of the parked vehicle who is preparing to leave, sends a message (V2V Unicast*) stating that he/she is releasing its parking space. 3. The searching vehicle's Vehicle ITS-S sends to the leaving vehicle's Vehicle ITS-S its position and confirms that it is approaching. If the searching vehicle's Vehicle ITS-S has several proposals, it informs only the one chosen. 4. When the searching vehicle arrives at the destination, the leaving vehicle leaves its space.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle driver. 2. Vehicle ITS-S remains idle. *c. Pre-notification 1. The Vehicle driver of the parked vehicle can notify in advance that the parking

	space will be unoccupied 2. The Vehicle driver who's searching can plan the rest time in advance
Special Requirements	*It can be considered that the unicast link is sufficient for the parking space to be reserved, but it does not guarantee that it will be free when the searching vehicle will arrive. An option to guarantee the reservation would be the following. / Information on the size / type of vehicles and parking spaces / This use case will not work completely in covered parking lots (positioning problem) This use case needs to use a navigation system to realise the guidance
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 22: Use Case Description: Reservation of a vehicle parking space released by a user

4.3.2.3. Information about on-street parking availability for urban freight (loading zones)

Introduction to the Use Case	
Background	This use case provides professional drivers for last-mile delivery with near real-time information about the occupancy of loading zones. It also enables the optimization of the on-street loading zones, by providing insights about the use of these spaces to the administrators.
Objective	The objective of the use case is to provide near real-time information about the availability of on-street parking spaces in loading zones to inform drivers, and enable data-driven decisions about loading zones to the local administration.
Desired Behaviour	The delivery service driver will be able to check the availability of space in the loading zones that are closer to the delivery address. Maximum allowed parking time limit in loading zones is respected.
Expected Impact	/ Security: less double-parking next to loading zones. / On-street parking management: Easing analysis of loading zone usage.
Known Implementations	A previous pilot project was performed in Bilbao within the Co-gistics project. Lessons learnt from this pilot will improve the large deployment in C-MobILE.
References	*None.*

Table 23: Introduction to Use Case: Information about on-street parking availability for urban freight (loading zones)

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Last-mile delivery services
Stakeholders and Interests	/ Delivery service driver: > Drivers for last-mile delivery freight will have access to near-real-time information about occupancy in the loading zones they are allowed to use. / Municipality > Monitor the usage of loading zones in the city, to be able to manage and adapt the space to the real demand. / On-street metered Parking operator. > Enforcement when necessary. / On-street parking availability information provider.

	> Provide end-users with near real-time information. More users using App.
Preconditions	The loading zones in the city must be monitored, and the occupancy data transmitted to the traffic management centre. Sensing might come from fixed sensors, and/or from the fleet of cars equipped with ALPR cameras deployed by the metered parking, that will report occupancy data refreshed at least every 15 minutes.
Post-conditions	Information on almost real-time availability of loading zone occupancy will be available in Open data for developers information providers.
Main Success Scenario	1. The deliverer makes a request to know about the loading zones close to his delivery address, and checking their occupancy. 2. The driver's app (C-ITS) sends a request to the Open Data portal, and receives the latest information about loading zone parking availability in the requested area. 3. When the vehicle parks, its presence is detected within the next 15 minutes (maximum). 4. When the vehicle leaves, the free spot in the loading zone is detected within 15 minutes at the most. 5. Local authorities have detailed data about loading zones use, to adapt city space and regulation to real demand.
Exceptions and Alternative Flows	*a. On-street parking availability stops being refreshed. 1. Vehicle ITS-S displays an error message to the Driver. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Driver.
Special Requirements	App can support other functionalities, such as anonymized tracking, density availability monitoring and guidance, and parking operation allowance through virtual ticket.
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 24: Use Case Description: Information about on-street parking availability for urban freight (loading zones)

4.3.2.4. Information about on-street parking availability for private car drivers

Introduction to the Use Case	
Background	This use case will help drivers for finding on-street parking, and will significantly reduce the number of cars driving around in the city centre, searching for a parking spot. The service also includes specific information for disabled private drivers, that can use the parking spots exclusively dedicated to them.
Objective	/ The objective of the use case is to provide near real-time information about the availability of on-street parking spaces, both standard and reserved for disabled, to reduce the number of vehicles driving around, looking for a parking space in a given urban area.
Desired Behaviour	The car driver searching for a parking space checks availability of on-street parking close to her/his destination, and drives directly to the areas where there are parking spaces available. User of the parking spaces reserved for disabled people will be able to request specific information about these parking spaces, and will be able to drive directly to the most convenient one that is free.
Expected Impact	/ Security / Comfort (information on services at the parking)
Known Implementations	Other similar implementations use crowd-sourced data and predictions (Parknav, Parkopedia), but no implementation based on sensor-data was found. They do not

	have information about parking spaces reserved for the disabled.
References	

Table 25: Introduction to Use Case: Information about on-street parking availability for private car drivers

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Private car driver
Stakeholders and Interests	/ Car driver: > Car drivers entering the city centre that need to park the car for a short period of time in the on-street metered parking. > Cars allowed to use the parking spaces for the disabled, and will be able to access also information about the occupancy of these spaces. / Municipality > Reduction of congestion and pollution / On-street metered Parking operator (municipal concession). > End user satisfaction. / On-street parking availability information provider. > Provide end-users with near real-time information. More users using APP.
Preconditions	The on-street metered parking operator has deployed a patrolling fleet of cars equipped with ALPR cameras that will detect cars parked on-street, and thus also parking space availability per block. Information will be refreshed every 15 minutes. Parking spaces reserved for the disabled might additionally be equipped with sensors to provide real-time information.
Post-conditions	Information on almost real-time availability of on-street parking spaces will be available in Open data. Information about both standard parking spaces, as well as parking spaced reserved for the disabled, will be available.
Main Success Scenario	1. The car Driver who's searching for a parking space makes a request, stating that he/she is looking for a parking space in a certain city street/area. If she/he has the right to park in the areas reserved for the disabled, the driver can access this specific information. 2. The driver's app (C-ITS) sends a request to the Open Data portal, and receives the latest information about on-street parking availability in the requested area (standard, or reserved for the disabled). 3. When the car parks, a patrolling ALPR car detects the new parking within the next 15 minutes. Alternatively, a sensor might detect occupancy with shorter latency. 4. When a car leaves, the free parking spot is detected within 15 minutes by a patrolling ALPR car (if no other car occupies the spot). Alternatively, a sensor might detect occupancy with shorter latency.
Exceptions and Alternative Flows	*a. On-street parking availability stops being refreshed. 1. Vehicle ITS-S displays an error message to the car Driver. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the car Driver.
Special Requirements	App can support other functionalities, such as anonymized tracking, destiny availability monitoring and guidance, and parking operation allowance through virtual ticket.
Technology Variations List	*None.*
Open Issues	*None.*

Illustrations, Visualizations, and Figures	Areas of Bilbao with metered on-street parking, where C-MobILE will be available:  ALPR-equipped car, and on-street parked cars:  

Table 26: Use Case Description: Information about on-street parking availability for private car drivers

4.4. Road Works Warning (RWW)

4.4.1. High Level Service Definition

Service introduction	
Summary	Providing in-vehicle information and warnings about road works, changes to the road layout and applicable driving regulations.
Background	Road works usually affect the road layout, driving regulations, etc. Despite dedicated signage prior to road work zones, such changed conditions frequently come as a surprise to vehicle drivers. This may lead to increased risk and sometimes even accidents, both for road users and workers.

Objective	More attentive driving while approaching and passing a work zone by providing in-vehicle information and warnings about road works, changes to the road layout and applicable driving regulations.
Expected benefits	The primary expected impact is more attentive driving while approaching and passing a work zone, which improves traffic safety as it reduces the likelihood of accidents.
Use Cases	1. Roads Work Warning, including: / Situation 1: Mobile road works: planned slowly moving road works like cutting the grass or renewing the lane markings, usually secured by a moving trailer. / Situation 2: Short-term static: planned stationary road works, e.g. one night, secured by a road works safety trailer and an optional pre-warner. / Situation 3: Long-term road works: planned stationary road works for several days, weeks or months, usually having a large impact on the infrastructure layout. / Situation 4: Unplanned (ad-hoc) road works: unplanned road works, e.g. emergency repairs / maintenance to the tarmac.

Table 27: Road Works Warning High Level Service Description

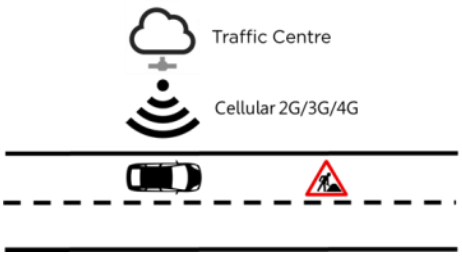
4.4.2. Use Case(s)

4.4.2.1. Roads Work Warning

Introduction to the Use Case	
Background	Road works usually secured by a moving trailer. *(Mobile Road Works, Short-term Static Road Works, Long-term road works and unplanned road works handled equally in this document)*
Objective	More attentive driving while approaching and passing a mobile work zone by providing in-vehicle information and warnings about mobile road works, changes to the road layout and applicable driving regulations.
Desired Behaviour	While approaching a road work zone, vehicle drivers receive road work related information, warnings and/or guidance on the in-vehicle display or smartphone. Instructions may include to reduce the driving velocity, to change lanes, to prepare for a steering manoeuvre, etc.
Expected Impact	The main aim of Road Works Warning RWW is to improve road safety. RWW aims at reducing the number of collisions with safety-objects near road works and to increase the safety of road work workers. RWW will alert the road user
Known Implementations	/ C-ITS Corridor / NL C-ITS Reference Architecture / ECo-AT / SCOOP@F / Car2Car-CC MoU / DriveC2X / DG MOVE / DITCM
References	1. Dutch C-ITS Corridor https://itscorridor.mett.nl/ 2. Talking Traffic Innovation Partnership http://www.beterbenutten.nl/talking-traffic 3. http://c-thedifference.eu/ 4. http://www.compass4d.eu

Table 28: Introduction to Use Case: Road Works Warning

Use Case Description

Scope	C-MobILE
Frequency of Occurrence	Specific situations
Primary Actor	Driver
Stakeholders and Interests	/ Vehicle driver: receives road works location information on the in-vehicle display or smartphone. / Road operator / Directorate of Traffic: may signal the existence of a road works location. / Service provider: disseminates the road works location information to vehicle drivers.
Preconditions	1. The in-vehicle or mobile application is installed and activated on the driver's vehicle or smart phone and running in the background. 2. The roadworks are informed by the Road Operator or the Directorate of Traffic 3. A R-ITS-S is installed in the roadworks location (for the case where the vehicles using R-ITS-S with DSRC)
Post-conditions	Vehicle drivers receive road work related information, warnings and/or guidance
Main Success Scenario	1. A vehicle approaches a road works location downstream of the current position and in the driving direction. 2. The vehicle driver receives timely an awareness message on the in-vehicle display or smartphone. This message includes: the remaining distance (or time) to reach the hazardous location and, when appropriate, a driving recommendation (e.g. lane or speed change).
Exceptions and Alternative Flows	*None.*
Special Requirements	*None.*
Technology Variations List	The warnings are transmitted using ETSI ITS-G5 DENM messages over DSRC (Dedicated Short Range Communications 802.11p) or cellular network (2G, 3G, 4G). The DENM will provide the Road Work information such as location. There are 3 possible data downstream: Downstream 1: A traffic centre knows the location of the Road Works and sends the location to the vehicles through cellular network. Downstream 2: A traffic centre knows the location of the Road Works and sends the location to the vehicles using R-ITS-S with DSRC. Downstream 3: The Road Workers setups a mobile R-ITS-S at the start of the Road Work to send the necessary DSRC (DENM) messages.
Open Issues	None
Illustrations, Visualizations, and Figures	I2V over cellular or over 802.11p  Figure 3: Downstream 1

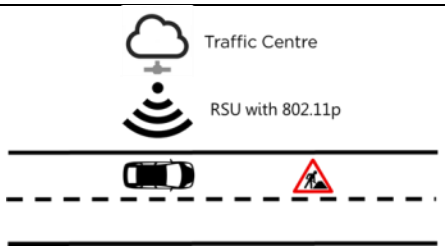
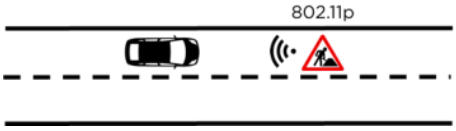
	 Figure 4: Downstream 2  Figure 5: Downstream 3

Table 29: Use Case Description: Road Works Warning

4.5. Road Hazard Warning (RHW)

4.5.1. High Level Service Definition

Service introduction	
Summary	The road hazard warning service aims to inform the drivers in a timely manner of upcoming, and possibly dangerous events and locations. This allows drivers to be better prepared for the upcoming hazards and make necessary adjustments and manoeuvres in advance. (This is also known as "Hazardous location notification" (ETSI, 2009) or 'Road hazard signalling').
Background	This service aims to give drivers an advance warning of upcoming hazardous locations in the road.
Objective	Enabling vehicle drivers to be better prepared for upcoming hazards by providing timely in-vehicle driving assistance information on hazardous locations downstream of the current position and in the driving direction of the vehicle.
Expected benefits	Improved traffic safety due to the decrease in the number of accidents.
Use Cases	1. Hazardous location notification, including: a. Situation 1: Object on the road A vehicle approaches an object on the lane or hard shoulder downstream of the current position and in the driving direction. b. Situation 2: Pothole A vehicle approaches a pothole on the lane or hard shoulder downstream of the current position and in the driving direction. 2. Traffic conditions warning, including: c. Situation 1: Traffic jam ahead warning A vehicle approaches the tail of a traffic jam downstream of the current position and in the driving direction. 3. Weather conditions warning, including: d. Situation 1: Abnormal weather conditions ahead warning A vehicle approaches a stretch of the road that has weather conditions that can have influence as regards visibility or asphalt adhesion.

Table 30: Road Hazard Warning High Level Service Definition

4.5.2. Use Case(s)

4.5.2.1. Hazardous location notification

Introduction to the Use Case	
Background	Unawareness of hazardous locations may lead to driving situations with high risk or in the worst-case accidents, especially when vehicle drivers do not anticipate appropriately to them. The in-vehicle driving assistance information improves the awareness of drivers, increases their attentiveness and allows them to better anticipate to the situation.
Objective	To provide timely in-vehicle driving assistance information on hazardous locations downstream of the current position and in the driving direction of the vehicle.
Desired Behaviour	The Vehicle Driver adapts his/her driving behaviour compliant to any advice or guidance provided.
Expected Impact	In-car information on hazardous locations is expected to improve traffic safety and reduce the risk of accidents.
Known Implementations	/ Talking Traffic Innovation Partnership (http://www.beterbenutten.nl/talking-traffic) / DriveC2X
References	1. Hazardous location notification, Dutch Profile Part A - Use case catalogue

Table 31: Introduction to Use Case: Hazardous location notification

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: receives hazardous location information on the in-vehicle display. / Road Operator: may signal the existence of a hazardous location. / Service Provider: disseminates the hazardous location information to vehicle drivers. / Other: organisations charged with repair, maintenance and/or cleaning may act on the hazardous location information.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit and running in the background.
Post-conditions	In-car information and warnings about hazards are displayed on the Vehicle ITS-S.
Main Success Scenario	1. A vehicle approaches a hazardous location downstream of the current position and in the driving direction. 2. The vehicle driver receives timely an awareness message on the Vehicle ITS-S (in-vehicle display or smartphone). This message includes: the remaining distance (or time) to reach the hazardous location and, when appropriate, a driving recommendation (e.g. lane or speed change).
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	None.
Technology	Possible ways of adding new sources of information

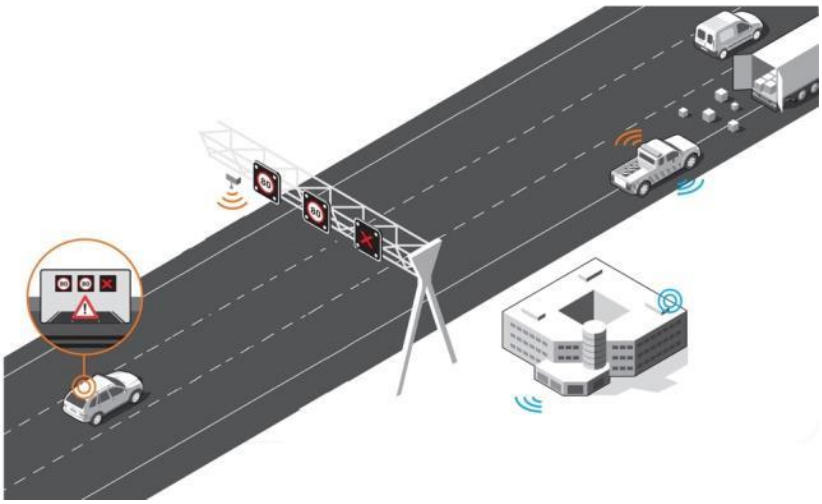
Variations List	/ ETSI ITS G5 over cellular / Manual input / Other database interaction
Open Issues	*None.*
Illustrations, Visualizations, and Figures	

Figure 6: Hazardous location illustration

Table 32: Use Case Description: Hazardous location notification

4.5.2.2. Traffic conditions warning

Introduction to the Use Case	
Background	Sudden changes in traffic conditions downstream of the current position and in the driving direction of the vehicle may have an impact on both traffic safety and efficiency.
Objective	To provide timely in-vehicle driving assistance information on traffic conditions downstream of the current position and in the driving direction of the vehicle.
Desired Behaviour	The Vehicle Driver adapts his/her driving behaviour compliant to any advice or guidance provided.
Expected Impact	In-car information on traffic conditions is expected to improve traffic safety by reducing the risk of accidents and to improve traffic efficiency (reducing delay and travel time).
Known Implementations	/ Talking Traffic Innovation Partnership (http://www.beterbenutten.nl/talking-traffic) / DriveC2X / Compass4D (Road Hazard Warning services also included traffic conditions warning)
References	1. Hazardous location notification, Dutch Profile Part A - Use case catalogue

Table 33: Introduction to Use Case: Traffic conditions warning

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: receives traffic conditions information on the in-vehicle display. / Road Operator: provides policy constraints. / Service Provider: disseminates the traffic conditions information to vehicle drivers.

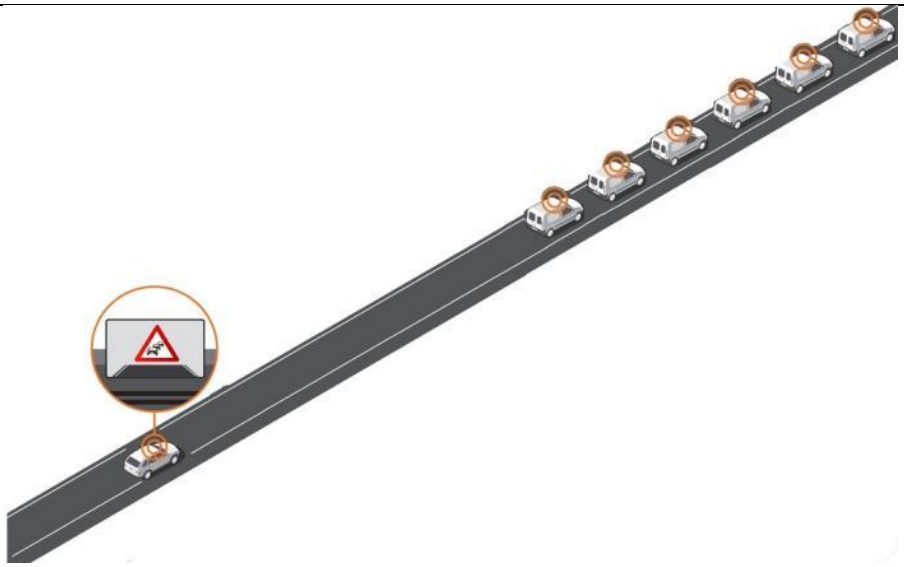
	/ End User: traffic jams information may be used by route planners.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit and running in the background.
Post-conditions	Timely in-vehicle driving assistance information on traffic conditions are displayed on the Vehicle ITS-S.
Main Success Scenario	1. A vehicle approaches a traffic condition (e.g. the tail of a traffic jam) downstream of the current position and in the driving direction. 2. The Vehicle Driver receives timely an awareness message on the Vehicle ITS-S (on in-vehicle display or smartphone). This message includes: the remaining distance (or time) to reach the traffic condition and, where appropriate, a driving recommendation (e.g. lane or speed change). The recommendations may include, where appropriate, an adjustment of the scheduled route to the destination on the basis of the designated diversion route.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	*None.*
Technology Variations List	Possible ways of adding new sources of information / ETSI ITS G5 over cellular / Manual input / Other database interaction DENM messaging standard can be utilised to provide information regarding the traffic jam conditions such as: Traffic jam slowly/strongly increasing, stationary, slightly/strongly decreasing.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	

Figure 7: Traffic condition warning illustration

Table 34: Use Case Description: Traffic conditions warning

4.5.2.3. Weather conditions warning

Introduction to the Use Case	
Background	Weather conditions downstream of the current position and in the driving direction of the vehicle may have an impact on traffic safety.
Objective	To provide timely in-car driving assistance information on weather conditions downstream of the current position and in the driving direction of the vehicle.
Desired Behaviour	The Vehicle Driver adapts his/her driving behaviour compliant to any advice or guidance provided.
Expected Impact	In-car information on traffic conditions is expected to improve traffic safety by reducing the risk of accidents.
Known Implementations	1. Talking Traffic Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
References	1. Hazardous location notification, Dutch Profile Part A - Use case catalogue 2. DriveC2X

Table 35: Introduction to Use Case: Weather conditions warning

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: receives traffic condition information on the in-vehicle display. / Road Operator: provides policy constraints. / Service Provider: disseminates the weather conditions information to vehicle drivers.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit and running in the background.
Post-conditions	Timely in-car driving assistance information on traffic conditions are displayed on the Vehicle ITS-S.
Main Success Scenario	1. A vehicle approaches a weather condition (e.g. fog, rain, snow, ice) downstream of the current position and in the driving direction. 2. The Vehicle Driver receives timely an awareness message on the Vehicle ITS-S (on in-vehicle display or smartphone). This message includes: the remaining distance (or time) to reach the weather condition and, where appropriate, a driving recommendation (e.g. speed change, mandatory equipment or deviation).
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	*None.*
Technology Variations List	Possible ways of adding new sources of information / ETSI ITS G5 over cellular / Manual input / Other database interaction

Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 36: Use Case Description: Weather conditions warning

4.6. Emergency Vehicle Warning (EVW)

4.6.1. High Level Service Definition

Service introduction	
Summary	Providing in-vehicle information and warnings about approaching emergency vehicles.
Background Objective Expected benefits	Emergency vehicles can identify themselves and inform other vehicles in the vicinity about their position, direction and speed even when the siren and light bar of the emergency vehicle may not be audible or visible. The main objective of this service is to provide an early warning indication of an emergency vehicle that is approaching and to timely give way to the emergency vehicles. The primary expected impact is more attentive driving and being aware of an emergency vehicle early to be able to quickly respond on the approaching emergency vehicle, to give way in a less hasty manner preventing risky behaviour and possible accidents, which improves traffic safety and reduces emergency vehicle response times.
Use Cases	1. Emergency Vehicle Warning, including: / Situation 1: The emergency vehicle approaching the equipped vehicle from behind and will overtake the vehicle soon. The equipped vehicle has to expect the emergency vehicle from behind and priority to the emergency vehicle has to be given to go aside or speed up in order to not block the emergency vehicle. / Situation 2: The emergency vehicle is approaching the equipped vehicle slanted from the front. The equipped vehicle has to expect the emergency vehicle passing a nearby intersection from the left or from the right. Priority has to be given. / Situation 3: The emergency vehicle is approaching from the front and will pass by soon. The equipped vehicle must be aware of an overtaking emergency vehicle and give way to it or to other vehicles trying not to block the emergency vehicle.

Table 37: Emergency Vehicle Warning High Level Service Description

4.6.2. Use Case(s)

4.6.2.1. Emergency Vehicle Warning

Introduction to the Use Case	
Background	Emergency vehicles can identify themselves and inform other vehicles in the vicinity about its position, direction and speed even when the siren and light bar of the emergency vehicle may not be audible or visible.
Objective	The main objective of this service is to sooner indicate an emergency vehicle is approaching and to timely give way to the emergency vehicles.
Desired Behaviour	While approaching an emergency vehicle, vehicle drivers receive related information, warnings and/or guidance on the in-vehicle display or smartphone. The distance, direction and speed of the emergency vehicle is received and presented on the HMI with a driving recommendation (e.g. lane or speed change) where appropriate.

Expected Impact	The primary expected impact is more attentive driving and being aware of an emergency vehicle early to be able to quickly respond on the approaching emergency vehicle to give way in a less hasty manner preventing clumsy behaviour and possible accidents which improves traffic safety and reduces emergency vehicle response times.
Known Implementations	/ C-TheDifference / DriveC2X / DG MOVE
References	/ C-TheDifference / DriveC2X / DG MOVE

Table 38: Introduction to Use Case: Emergency Vehicle Warning

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	When an emergency vehicle is on duty
Primary Actor	Vehicle Driver and Emergency Vehicle Driver
Stakeholders and Interests	/ Vehicle driver: receives warnings and/or guidance on the in-vehicle display when an emergency vehicle is approaching. / Emergency vehicle driver: disseminates the emergency vehicle location information. / Road operator: may signal the existence of an emergency vehicle location. / Service provider: disseminates the emergency vehicle location information.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit or on a dedicated server and running in the background. The emergency vehicle enables the EVW application and starts sending messages describing its position, speed and heading. Equipped vehicles receiving these messages will be able to inform the driver of the near-by emergency vehicle about its location, its direction and/or give driving guidance relative to the equipped vehicle.
Post-conditions	Vehicle drivers receive emergency vehicle related information, warnings and/or guidance
Main Success Scenario	1. A vehicle is being approached by an emergency vehicle. 2. The vehicle driver receives timely an awareness message on the in-vehicle display. This message can include: the remaining distance (or time) to reach for emergency vehicle to reach the vehicle's location and, where appropriate, a driving recommendation (e.g. lane or speed change).
Exceptions and Alternative Flows	*None.*
Special Requirements	*None.*
Technology Variations List	Emergency Vehicle shall be equipped with IEEE 802.11p and/or cellular capabilities. The warnings are transmitted using ETSI ITS-G5 DENM messages over DSRC (Dedicated Short Range Communications 802.11p) or cellular networks (2G, 3G, 4G). The DENM will provide the emergency vehicle's information such as location, speed and heading. There are 3 possible data downstreams: Downstream 1: A traffic centre is aware of the location of the emergency vehicle and sends the location to the vehicles through cellular network. Downstream 2: The emergency vehicle starts to disseminate the DENM messages using DSRC to be received by the equipped vehicles (V2V). Downstream 3: The R-ITS-Ss disseminate information of the emergency vehicle to the equipped vehicles (I2V) using DSRC.

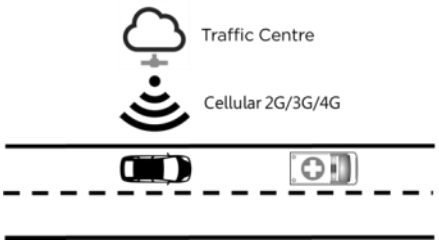
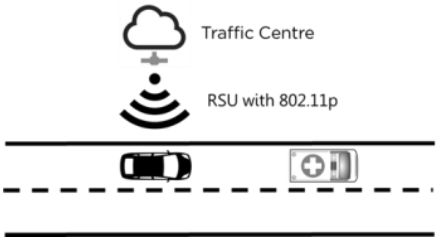
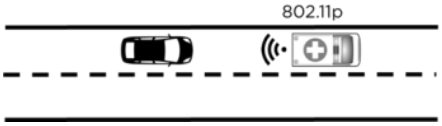
Open Issues	*None*
Illustrations, Visualizations, and Figures	The distance, direction and speed of the emergency vehicle is received and presented on the HMI as shown below:  Figure 8: HMI Concept for EVW  Figure 9: Downstream 1  Figure 10: Downstream 2  Figure 11: Downstream 3

Table 39: Use Case Description: Emergency Vehicle Warning

4.7. Signal Violation Warning (SVW)

4.7.1. High Level Service Definition

Service introduction	
Summary	Signal Violation Warning aims to reduce the number and severity of collisions at signalised intersections by warning drivers who are likely -due to high speed- to violate a red light, or when another vehicle is likely to make a red light violation. Also known as the "Signal violation / Intersection Safety" or "Red Light Violation Warning".
Background	This service aims to increase drivers' alertness at signalised intersections to reduce the number of accidents or reduce the impact of accidents when the collision is imminent.
Objective	To provide timely in-vehicle driving assistance information on a signal violation downstream of the current position and in the driving direction of the vehicle.

Expected benefits	Improved traffic safety due to the decrease in the number of accidents.
Use Cases	1. Red light violation warning, including: a. Red light warning: drivers are informed about the current and future state of relevant traffic lights. b. Red light violation warning: drivers are warned in case of probable own red light violation and drivers of other vehicles are warned for a red light violator (see Figure 1a). c. Emergency vehicle warning: drivers of other vehicles are warned to make way for an approaching emergency vehicle that will run the red light. d. Turning warning – oncoming traffic: drivers are warned while turning, to give way to possible traffic coming from the opposite direction having green in the same phase (see Figure 1b). e. Turning warning – crossing vulnerable road users: drivers are warned while turning to give way to in parallel crossing pedestrians and/or bicycles having green in the same phase (see Figure 1c).

Table 40: Signal Violation Warning High Level Service Definition

4.7.2. Use Case(s)

4.7.2.1. Red light violation warning[3]

Introduction to the Use Case	
Background	The Red Light Violation Warning (RLVW) service aims to increase drivers' alertness at signalised intersections to reduce the number of accidents at signalised intersection or reduce the impact of accidents when the collision is imminent. Although the focus of the service is on red light violation it also addresses situations involving emergency vehicles as well as right of way rules at signalised intersections in a more general sense. The advantage of a cooperative RLVW service using infrastructure-to-vehicle communication over conventional repressive solutions (e.g. enforcement cameras) is its interference before instead of after an event occurs.
Objective	To provide timely in-car driving assistance information on a red-light violation downstream of the current position and in the driving direction of the vehicle.
Desired Behaviour	The Vehicle Driver adapts his/her driving behaviour compliant to any advice or guidance provided.
Expected Impact	In-car information on red light violation is expected to improve traffic safety and reduce the risk of accidents.
Known Implementations	/ Compass4D
References	1. Red Light Violation Warning, Compass4D D2.1 User Requirements and Specifications

Table 41: Introduction to Use Case: Red light violation warning

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	In the case of a potential red-light violation
Primary Actor	Vehicle Driver

[3] In the C-MobILE WP2 meeting 26/27-09-2017 in Amersfoort, it has been decided with the pilot site leaders to only implement the case where the driver -who is about to violate a red light- receives the warning. However, this use case does not exclude the case where other drivers also receive the warning.

Stakeholders and Interests	/ Vehicle Driver: receives red-light violation information on the in-vehicle display. / Road operator / R-ITS-S: may detect and signal the presence of a red-light violation. / Service Provider: disseminates the red-light violation information to vehicle drivers.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit or on a dedicated server and running in the background.
Post-conditions	In-car information and warnings about red-light violation displayed on the Vehicle ITS-S.
Main Success Scenario	1. A vehicle approaches a signalised intersection downstream of the current position and in the driving direction. 2. The Vehicle Driver receives timely an awareness message on the Vehicle ITS-S (in-vehicle display or smartphone). This message includes: the remaining distance (or time) to reach the signalised intersection, traffic light state information (e.g. its presence, colour and time to change) and, where appropriate, a driving recommendation (e.g. speed change).
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle. 2a. The Vehicle is an Emergency Vehicle Where the limitations of RLVW are concerned, the emergency vehicle use case is an exception as for this vehicle type it is certain and known well in advance if they will run a red light. Therefore, the predictive design can be applied for this use case and other traffic can be warned much earlier than would be the case in a near collision scenario caused by red light violation of a normal vehicle. In addition to a warning for an approaching emergency vehicle, it is also intended to describe the expected response behaviour to let the emergency vehicle pass safely. One option for consideration is to use a roadside warning mechanism to also include non-equipped road users in the emergency vehicle warning use case. The simplest form of a roadside warning mechanism would be the extension of the red phase to keep the intersection clear.
Special Requirements	In case of red light violation warning, three system designs with different levels of complexity can be distinguished: informative, rule-based and predictive. With the informative system design ('red light warning') the service simply presents traffic light state information to the driver (e.g. its presence, colour and time to change). The rule-based variant focusses on the dilemma zone and monitors spatial-temporal variables (e.g. vehicle speed and time to stop line) subject to the traffic light state and warns the driver if pre-set thresholds are reached. A predictive system is the most complex of the three and predicts the trajectory of the vehicle to estimate the likelihood of red light violation. Although all designs have advantages, each has performance issues associated to them as well. For example, the information system may not be intrusive enough, the rule-based design may generate many false-positives, and the required input data may not be accurate enough for the predictive system (and also cause many false-positives). Important factors are position accuracy, communication delay, driver reaction time and deceleration time. Only on roads with speeds over 60 km/h and/or with small localisation errors the total lead time for the warning outweighs the required time budget for the deceleration phase. For this reason, Compass4D focused on an informative system design, i.e. red-light warning. However, at the Helmond-Eindhoven pilot site an intersection on a 70 km/h road with traffic regularly speeding up to 100 km/h will be equipped with cameras to accurately detect the position of potential violators. Finally, turning warnings may be static and dynamic, identical to Road Hazard Warnings. Static turning warnings are solely based on signal phase and timing information which indicates signal phases with a green light for two conflicting directions (e.g. right turning vehicles and crossing vulnerable road users – see Figure 1c). In addition, dynamic turning warnings also consider the actual presence of traffic on these directions before a warning is given. Hence, static turning warning messages are given always, while dynamic turning warnings are only given when conflicting traffic is present.
Technology Variations	SPATEM standard can be utilised to communicate the warning.

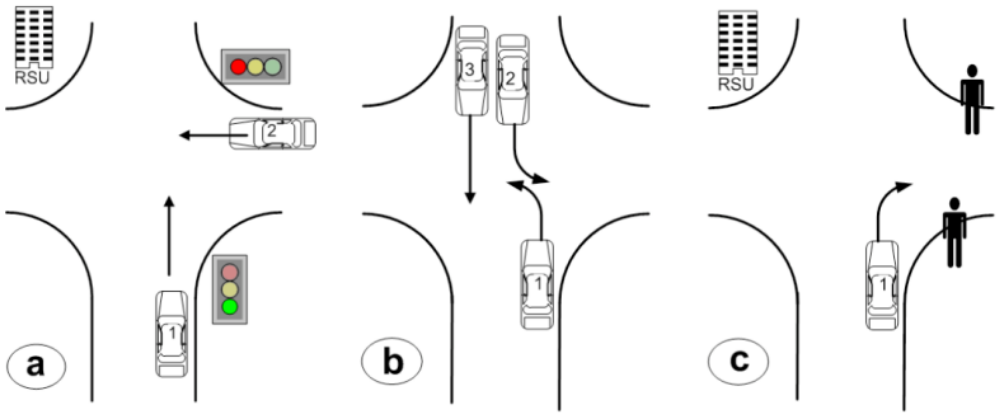
List	
Open Issues	*None.*
Illustrations, Visualizations, and Figures	 Figure 12: Illustration of different RLVW scenarios Source: Compass4D D2.1 User Requirements and Specifications

Table 42: Use Case Description: Red light violation warning

4.8. Warning System for Pedestrians (WSP)

4.8.1. High Level Service Definition

Service introduction	
Summary	Warning system for pedestrian aims to detect risky situations (e.g. road crossing) involving pedestrians, allowing the possibility to warn vehicle drivers. Hence, the warning is based on pedestrian detection. The scope of the service can be extended to cover other VRUs (e.g. cyclists). The service is particularly valuable when the driver is distracted or visibility is poor.
Background	This service signals the vehicle driver when a dangerous situation is bound to occur, either due to behaviour of the vehicle driver or due to the behaviour of vulnerable road users (VRUs, e.g. pedestrians and/or cyclists) in the vicinity of the vehicle.
Objective	The "Warning system for pedestrians (not limited to crossings)" aims to improve safe and comfortable driving for vehicle drivers.
Expected benefits	Enhanced traffic safety as a result of accidents avoided.
Use Cases	1. Safe Travelling Experience by Warning Signage

Table 43: Warning system for pedestrians High Level Service Description

4.8.2. Use Case(s)

4.8.2.1. Safe Travelling Experience by Warning Signage

Introduction to the Use Case	
Background	The use case has been defined during the Business Model Design Workshop Session in Copenhagen, Denmark. According to the business model defined in that workshop: "Safe Travelling Experience by Warning Signage" signals the vehicle driver when a dangerous situation is bound to occur, either due to behaviour of the vehicle driver or due to the behaviour of vulnerable road users (VRUs, e.g. pedestrians and/or cyclists) in the vicinity of the vehicle. The service can be implemented in different ways. Traffic lights can be connected R-ITS-Ss which can track and broadcast information with regards to traffic information (i.e., red lights, road hazard) as well as the position and behaviour of traffic users. However, user data may also be collected from on-board unit (OBU) applications. Both sources of data are consequently used to track whether dangerous scenarios may occur and

	notify the user timely to improve decision making and safety. Below, we discuss a business model scenario in which this service will be offered.
Objective	"Safe Travelling Experience by Warning Signage" aims to improve safe and comfortable driving for vehicle drivers.
Desired Behaviour	Vehicle driver will act accordingly to the warning provided.
Expected Impact	Enhanced traffic safety as a result of accidents avoided.
Known Implementations	/ SCOOP@F / VRUITS > Intersection Safety for VRU's (INS) > VRU presence warning via > VRU presence warning via VRU Beacon System (VBS) > VRU presence warning via Roadside Pedestrian Presence (RPP) > VRU presence warning via Bicycle-to-Car Communication (BCC) > VRU presence warning via Pedestrian-to-Car communication (P2C)
References	1. BMR- Warning System for VRUs - Copenhagen, Grefen and Gilsing, 2017

Table 44: Introduction to Use Case: Safe Travelling Experience by Warning Signage

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: Wants a safe and comfortable driving experience. / VRUs: Wants to avoid outrage / Service Provider: Wants to promote its safe travelling services. / City Municipality: Wants to improve its image and safety of its citizens. / Traffic Operator: Wants to decrease the number of accidents / Software Provider: Wants to promote its software.
Preconditions	The Vehicle ITS-S is installed and activated on the vehicle driver's smart phone or on-board unit and running in the background. A R-ITS-S can be installed in the crossings. VRUs can be equipped with beacons.
Post-conditions	Warning is provided to the Vehicle Driver before a potentially dangerous traffic situation occurs.
Main Success Scenario	1. Vehicle Driver gets in a situation that may result in a traffic accident involving a VRU. 2. Vehicle ITS-S detects the dangerous situation by scanning the information broadcasted by the R-ITS-Ss, other traffic users, VRUs and on-board sensors. 3. Vehicle ITS-S, provides Vehicle Driver a warning that includes information about the presence of the VRU, accident avoidance advice, and information about the detected situation. 4. With the provided warning, Vehicle Driver takes the accident avoidance advice.

Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S Fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle. 4a. Vehicle Driver fails to take the accident avoidance advice. 1. Vehicle ITS-S delegates the warning to the safety protocols of the vehicle. 2. Vehicle safety protocols handle the dangerous situation via accident avoidance measures.
Special Requirements	The scope of the VRU warning shall not be limited to the crossings or intersections. Aspects to be considered further in follow-up deliverable with more detailed requirements. 1. Information to be provided to the Vehicle Driver should be defined in detail. 2. The way that the application will distinguish between presence of VRUs in very dense scenarios and a real dangerous situation shall be defined during the design and/or implementation of the service. This could take into account the trajectory of the user with respect to the street/road and the speed of both, the vehicle and VRU. Possibly, other traffic infrastructure such as luminaires could be activated to warn drivers when pedestrians are detected. Please see: http://www.cidaut.es/evento-vruits/indexi.html and https://safety.fhwa.dot.gov/saferjourney1/library/pdf/Pedsmart.pdf
Technology Variations List	VRU positions can be transmitted using IEEE 802.11p, Wi-Fi or cellular communications.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	 Figure 13: A pedestrian warning example from an in-car safety application.

Table 45: Use Case Description: Safe Travelling Experience by Warning Signage

4.9. Green Priority (GP)

4.9.1. High Level Service Definition

Service introduction	
Summary	"Green Priority" aims to change the traffic signals status along the route of a priority vehicle (e.g., public transportation or emergency vehicles), halting conflicting traffic

	and allowing the vehicle right-of-way, to help reduce service and response times and enhance traffic safety.
Background	For safety, environment, traffic flow or other reasons it can be advantageous to give priority to specific classes of vehicles. This service allows drivers of priority vehicles to get priority at signalised junctions.
Objective	"Green Priority" aims to increase punctuality and response time of the services provided with designated vehicles and enhance traffic safety.
Expected benefits	/ Improved punctuality of public services as a result of priority given to designated vehicles. / Enhanced traffic safety for both the emergency vehicle and the general traffic as a result of removed uncertainty (due to drivers stuck between red-light and emergency vehicle coming from the back) among the drivers and to unpredictable situations.
Use Cases	1. Green Priority for Designated Vehicles

Table 46: Green Priority High Level Service Description

4.9.2. Use Case(s)

4.9.2.1. Green Priority for Designated Vehicles

Introduction to the Use Case	
Background	The use case has been defined during the Business Model Design Workshop Session in Vigo, Spain. According to the business model defined in that workshop: "Green Priority for Designated Vehicles" aims to change the traffic signal status in the path of an emergency or high priority vehicle (e.g., public transportation vehicles), halting conflicting traffic and allowing the vehicle right-of-way, to help reduce response times and enhance traffic safety. The service can be implemented as follows. The green priority request including the identification information of the high priority vehicle can be published via on-board software applications in the vehicle. Consequently, traffic light controllers can pick up this information and determine in what way they can and will respond the request. The same information may also be picked up by roadside ITS stations (R-ITS-Ss) and cooperatively communicated to other traffic light controllers on the route of the vehicle or directly to the traffic manager. Different levels of priority can be applied, e.g. extension or termination of current phase to switch to the required phase. The appropriate level of the green priority can depend on vehicle characteristics, such as type (e.g. HGV or emergency vehicle) or status (e.g., public transport vehicle on-time or behind schedule). Below, we discuss a business model scenario in which this service will be offered.
Objective	"Green Priority for Designated Vehicles" aims to increase punctuality of the services provided with designated vehicles and enhance traffic safety.
Desired Behaviour	Priority will be given to the designated vehicles.
Expected Impact	Improved punctuality of public services, reduces emergency response time and enhanced traffic safety.
Known Implementations	/ Green Priority, Compass4D, / http://www.compass4d.eu/en/home/benefits/emergency.htm / DG MOVE / Priority Request, DITCM / SCOOP@F
References	1. BMR - Green Priority for Public Transportation - Vigo, Turetken and Adali, 2017 2. BMR - Green Priority and Emergency Vehicle Warning for Emergency Vehicles - Vigo, Turetken and Adali, 2017 3. Dutch Profile Part A - Use case catalogue

Table 47: Introduction to Use Case: Green Priority for Designated Vehicles

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Designated Vehicle Driver
Stakeholders and Interests	/ Public transport services providers / Emergency services providers / Designated Vehicle Driver: Wants a safe and comfortable driving experience. / Service Provider: Wants to promote its services. / City Municipality: Wants to improve its image and safety of its citizens. / Traffic Operator: Wants to decrease the number of accidents / Software Provider: Wants to promote its software.
Preconditions	The Vehicle ITS-S is installed and activated on the designated vehicle driver's smart phone or on-board unit and running in the background. For emergency vehicles: the siren of the emergency vehicle is turned on.
Post-conditions	Warning is provided to the Vehicle Driver before a potentially dangerous traffic situation occurs.
Main Success Scenario	1. Vehicle ITS-S calculates distance to intersection based on the topology data and dependant on distance or calculated time to the stop, sends the priority request to the TLC in the vicinity and fixes its intersection ID. 2. TLC transfers the priority request with its current state information (e.g state: green, time-to-change: 9s) to the Traffic Manager. 3. Traffic Manager authenticates and authorises the Vehicle ITS-S. 4. Traffic Manager processes the priority request, creates a reply, and sends the reply to the TLC. 5. TLC decides on designated vehicle data (vehicle no, line number, punctuality, etc.) and conditions set by the road Traffic Manager that green priority is granted or not. 6. TLC sends the signal phase and timing to the Vehicle ITS-S. 7. Vehicle ITS-S receives the SPAT message and checks for active prioritizations related to its own station ID. 8. Vehicle ITS-S informs the Designated Vehicle Driver by displaying priority response status. 9. TLC realizes green priority and extension on the direction the prioritized Designated Vehicle is approaching. 10. After passing intersection (determined by ego position relative to the received topology data), Vehicle ITS-S stops the priority request. 11. TLC stops the green priority.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle. *c. After the priority request, designated vehicle leaves expected route 1. TLC removes intersection ID related prioritization status from message. 2. TLC ends the priority-handling procedure and switches to regular traffic-control. 3a. Authentication and authorization fails. 1. Traffic Manager rejects the priority request and sends the reply to the Traffic

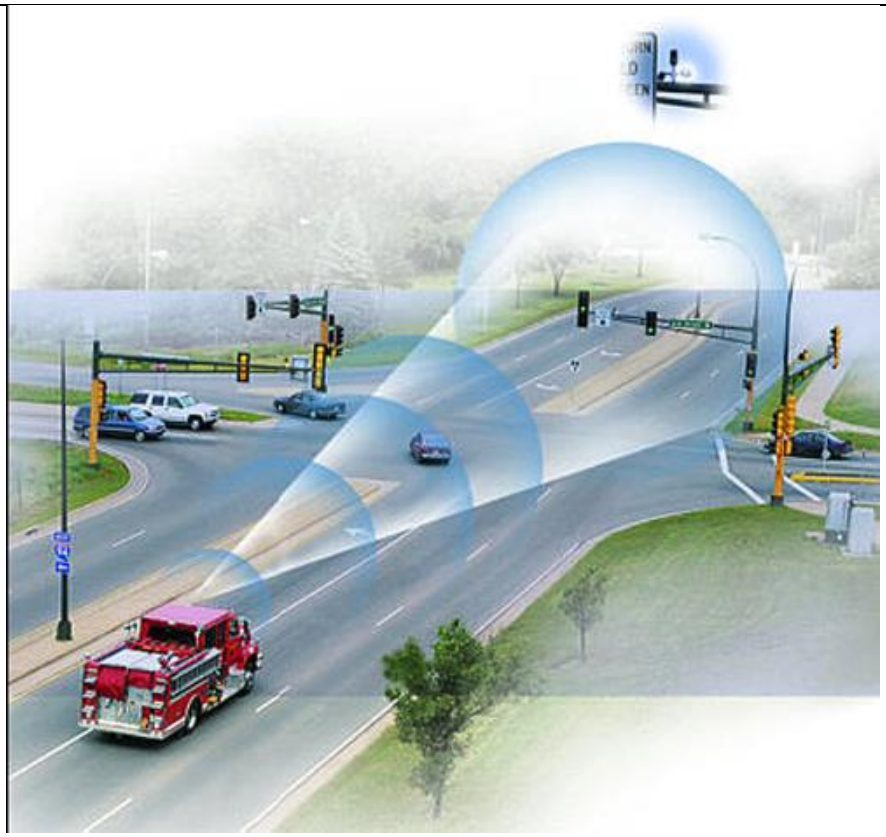
	Light. 2. Use case continues from Step 5. 5a. Priority request is denied: 1. TLC ends priority-handling procedure and switches to regular traffic-control until a new priority request comes.
Special Requirements	When responding to an emergency event, emergency vehicle drivers do not have time to activate an application and from the feedback from C-MobILE cities (Bordeux and Barcelona), drivers do not prefer having a smart phone application. Therefore, to activate the application, turn-on event for the siren is used for triggering the use case.
Technology Variations List	All Green Priority service messages can signed using a certificate which is part of the system's Public Key Infrastructure (PKI). Vehicle ITS-S messaging formats: / The Vehicle ITS-S in emergency vehicles can use CAM (Cooperative Awareness Messages) format for priority requests. / The Vehicle ITS-S in non-emergency vehicles can use SREM format for priority requests. TLC messaging formats / Intersection topology messages can use MAPEM format. / Intersection current signalling status can be sent using SPATEM format. / Intersection feedback about a signal request can be sent using SSEM format for non- emergency vehicles
Open Issues	*None.*
Illustrations, Visualizations, and Figures	 Figure 14: Emergency Vehicle Signal Preemption Example Source: https://ops.fhwa.dot.gov/publications/fhwahop08024/chapter9.htm US Department of Transportation - Federal Highway Administration

Table 48: Use Case Description: Green Priority for Designated Vehicles

4.10. Green Light Optimal Speed Avisory (GLOSA)

4.10.1. High Level Service Definition

Service introduction	
Summary	GLOSA provides vehicle drivers an optimal speed advice when they approach a controlled intersection equipped with traffic lights.
Background	Based on information on the phases and timing of traffic lights, speed change advisory can be offered to vehicle drivers or vehicle controls on the approach of and departure from a signalised intersection.
Objective	The "Green Light Optimal Speed Advisory (GLOSA)" service aims at creating an eco-friendlier and energy-efficient driving experience for vehicle drivers by providing speed advice, traffic light information and countdown to green/red, aiming to reduce energy consumption and lower the number of stops.
Expected benefits	The primary expected impact is a smoother vehicle trajectory while passing a signalised intersection, which reduces stops, CO2 emissions and fuel consumption. The second is enhanced traffic flow and comfort for the driver since he knows in advance how he is going to pass an intersection.
Use Cases	1. Optimized Driving Experience with GLOSA The vehicle driver or the vehicle controls comply with the speed change advice, maintaining that speed while passing the signalised intersection.

Table 49 GLOSA High Level Service Description

4.10.2. Use Case(s)

4.10.2.1. Optimized Driving Experience with GLOSA

Introduction to the Use Case	
Background	The use case has been defined during the Business Model Design Workshop Session in Thessaloniki, Greece. According to the business model defined in that workshop: GLOSA gives advice to vehicle drivers allowing them to optimize their approach to a traffic light (maintain actual speed, slow down, adapt a specific speed, time to green when it is permitted by legislation). The service can be implemented in different ways. For instance; the traffic light that is connected to a roadside ITS station (R-ITS-S) can broadcast information about the topology of the intersection and the signal timing and phasing schedule of each traffic light signal to approaching vehicles. Approaching vehicles can receive this information and calculate the optimal approaching speed to improve driving efficiency. Below, we discuss on blueprint business models, in which vehicle drivers use GLOSA to improve their decision making on the optimal driving speed when approaching downstream traffic lights.
Objective	"Optimized Driving Experience with GLOSA" aims at creating an eco-friendlier and energy-efficient driving experience for vehicle drivers.
Desired Behaviour	Vehicle driver will adjust the speed of the vehicle according to the speed advice given by GLOSA.
Expected Impact	/ Enhanced traffic flow and comfort. / Reduced emission and fuel consumption.
Known Implementations	/ Energy Efficient Intersection Service, **Compass4D** > Implemented in: Bordeaux, Copenhagen, Helmond, Newcastle, Thessaloniki, Verona and Vigo > (http://www.compass4d.eu/en/about/energy_efficient_intersection_service.htm) / GLOSA, DriveC2X > Tested in sites: Tampere, Gothenburg, Helmond, Frankfurt, Yvelines, Brennero, Vigo. (http://www.drive-c2x.eu/use-13)

	/ GLOSA, **DG Move** / GLOSA, **Mobinet** > Demo made in Bordeux at ITS WC 2015 (http://mobinet.eu/?q=content/green-light-optimal-speed-advice-glosa-demo-use-case) and ITS EC Glasgow in 2016 and Strasbourg in 2017 / GLOSA, **DITCM** / Eindhoven as part of the **ODYSA In-Car** SRE-funded project (http://www.odysa.nl/ODYSA_In-car.aspx) / Helmond and Bordeaux as part of the **C-TheDifference** EU tender, being a follow-up of Compass4D / **Talking Traffic** Innovation Partnership (http://www.beterbenutten.nl/talking-traffic) / Helmond, Tilburg and Breda as part of the **InterCor** EU-funded project / **Smartwayz** – Smart Mobility programme (http://www.smartwayz.nl/)
References	1. BMR- GLOSA_v1, Turetken and Gilsing, 2017 2. Dutch Profile Part A - Use case catalogue

Table 50: Introduction to Use Case: Optimized Driving Experience with GLOSA

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: Wants to reduce fuel consumption and increase travel comfort. / City Municipality: Wants to improve its image, reduce CO2 and increase traffic efficiency and safety / Road Operator (if is not the City): Wants to reduce increase traffic efficiency and safety. / Service provider: Collects and processes the information to provide the most appropriate advice to the driver always prioritizing safety
Preconditions	The Vehicle ITS-S is installed and activated on the vehicle driver's smart phone or on-board unit (OBU) and running in the background. GLOSA is compliant with the local regulation.
Post-conditions	Optimal speed advice is provided to the Vehicle Driver.
Main Success Scenario	1. Vehicle Driver approaches an intersection. 2. Traffic Light Information System (e.g. iTLC, centralized Traffic Light Management System) broadcasts the signal phase and timing information. 3. The R-ITS-S (e.g. ITS G5 RSU) receives this information through a communication channel (e.g. Ethernet link) transforms this data into a message (e.g. SPATEM). 4. The Vehicle ITS-S (e.g. ITS G5 OBU, mobile application) receives the message and provides GLOSA to the Vehicle Driver. 5. With the provided speed advice, Vehicle Driver adjusts the speed of the vehicle (if the traffic conditions allow to do it) and reaches the intersection at the beginning of the green phase or, if not possible, with the most efficient driving performance.
Extensions and Alternative Flows	*None.*
Special Requirements	The information provided to the driver should be adapted to the local regulations. Adaptive traffic light management systems can change the phases every second depending on the local strategy or priorities to certain vehicles or users. In this case GLOSA information is not reliable anymore which could be an issue for user acceptance and security.

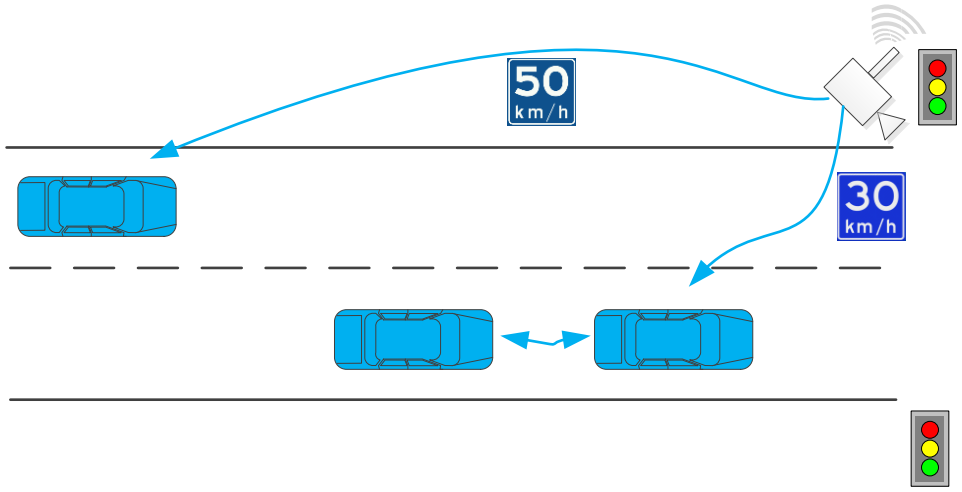
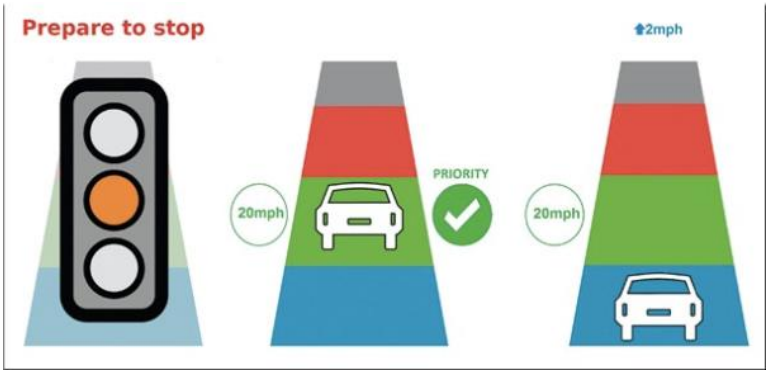
Technology Variations List	/ R-ITS-S can be replaced by a network link. In this case, the Vehicle ITS-S on the smartphone/tablet receives the required information using a cellular network. / SPATEM and MAPEM formats can be utilised for GLOSA.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	 Figure 15: Traffic light optimal speed advisory illustration Source: Dutch Profile Part A - Use case catalogue  Figure 16: Symbols from the EU's green light optimal speed advisory source: ITS International Source: *http://www.itsinternational.com/*  Figure 17: GLOSA Illustration Source: http://www.compass4d.eu/

	 Figure 4: GLOSA Application Source : http://cthedifference.eu/

Table 51: Use Case Description: Optimized Driving Experience with GLOSA

4.11. Cooperative Traffic Light for VRUs (CTLVRU) - (or Traffic Light Prioritisation for Designated VRUs)

4.11.1. High Level Service Definition

Service introduction	
Summary	Traffic signal timing and priority assignment based on detection of VRUs using fixed sensors and portable devices. Traffic light prioritisation for designated VRUs aims to increase the safety and/or the efficiency of the vulnerable road users (VRU) and their trips through the provision of priority or additional crossing time (i.e., extending the green light phase or lessening the red phase). Based on technical detection methods it is possible to adapt the green time to the number and characteristics of VRU's as well as special conditions.(such as weather). VRU's are defined here as pedestrians & cyclists.
Objective	Detection of VRUs (including groups of VRUs) waiting for and on approach to signalised intersections, and assignment of VRU phase length and priority based on the number and type of VRUs detected. / Decreasing travel time and increasing comfort and safety of VRUs in traffic. / Decrease car usage in urban environment / Reduce the need for parking spaces for cars.
Expected benefits	/ Increased VRU safety as a result of decreased red-light violations by the VRUs. / Enhanced traffic flow and comfort for VRUs: as a result of reduced travel time and shorter waiting time.
Use Cases	1. Traffic Light Prioritisation for Designated VRUs 2. Cooperative Traffic Light with VRU Counting

Table 52: Cooperative traffic light for VRUs High Level Service Description

4.11.2. Use Case(s)

4.11.2.1. Traffic Light Prioritisation for Designated VRUs

Introduction to the Use Case	
Background	The use case has been defined during the Business Model Design Workshop Session in North Brabant. According to the business model defined in that workshop: An Employer (an organization, or a business/industrial zone) endorses cycling as the choice of commuting for its employees. This is with the aim to reduce the traffic around and within its premises, and reduce the need for parking spaces for cars. To foster this, a Service Provider offers a priority crossing for cyclists via a smartphone application. The Provider delivers software activation codes to the Employer, which distributes to its Employees that commute by bike. The service should be available to all, however user recruitment will be done by approaching large employers, educational institutions, and certain groups of more-vulnerable VRUs, all of which may be able to further benefit by making this service available to their members. The operation of the service will vary based on VRU-demand and traffic conditions for other phases. Operation during peak hour, for instance, may only adjust signal timing when large numbers of pedestrians are waiting, whilst during non-peak, the service could be used to provide priority for only a small number of VRUs. The service could optionally be activated only during certain time periods (e.g., rush hours). This use case is differentiating from Use Case 2 as it only operates based on detection of (self-)selected VRUs using active sensor technology.
Objective	"Traffic Light Prioritisation for Designated VRUs (Vulnerable Road Users)" aims at increasing comfort and safety of VRUs in traffic by adjusting traffic signal timing and/or assigning priority based on VRU-data collected through an app or tag carried by individual VRUs.
Desired Behaviour	VRUs use the code provided by their employers to activate the application, which runs in the background and interacts with traffic lights (and associated systems) at intersections.
Expected Impact	Real and perceived decreases in travel time and increases in comfort for VRUs / Affecting cyclist perception may need multiple intersections. / Benefits may only be perceived if they exceed a certain threshold / Perceived advantage will depend on factors such as the number of opposing phases that receive green before you, the perceived difference in waiting times between opposing phases, etc. Increased travel time and reduced comfort for motorized vehicles Reduced VRU red light negation leads to improved VRU safety Increased VRU safety
Known Implementations	/ Intelligent Pedestrians Traffic Signal (IPT), VRUITS / Valladolid (Spain) - Intelligent pedestrian Traffic sign for vulnerable pedestrians with extended crossing time
References	1. BMR- Traffic light prioritisation for designated VRUs_v2, Turetken and Gilsing, 2017 2. Intelligent Pedestrians Traffic Signal (IPT), VRUITS, http://www.vruits.eu/

Table 53: Introduction to Use Case: Traffic Light Prioritisation for Designated VRUs

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Defined based on an algorithm taking into account: the current system, traffic streams, traffic conditions and complexity of the specific location.
Primary Actor	VRU

Stakeholders and Interests	/ General Public (VRU): Wants to gain time, increase the comfort of his or her journey and physical well-being. / Businesses and educational institutions: Wants to lessen the traffic in the premises and increase the general public satisfaction. Wants to reduce the number of parking places. Improve the environment, city life (image). Selected on benefit of the service to that business, ability to "champion" the service amongst their members on behalf of the project, and large enough to be capable of providing a sufficiently large number of users in their own right.
Preconditions	The Vehicle ITS-S is installed and activated on theVRU's smart phone and running in the background.
Post-conditions	Increased priority is given to the VRU.
Main Success Scenario	1. VRU approaches to the Traffic Light Controller (TLC) with the app or tag activated or switched on. 2. Vehicle ITS-S automatically sends the priority request at the encounter with the TLC. Depending on the actual traffic intensity and opposing priority requests (public transport vehicles, etc) a threshold is set concerning the number of requests required to trigger the TLC into action. 3. TLC transfers the priority request with its current state information (e.g state: green, time-to-change: 9s) to the Traffic Manager. 4. Traffic Manager authenticates and authorises the Vehicle ITS-S. 5. Traffic Manager processes the priority request, creates a reply, and sends the reply to the TLC. The reply is dependent on the current traffic light settings, traffic conditions, characteristics of the location and weather conditions, characteristics of entity that puts the request (e.g. approach speed). 6. TLC acts upon the reply.
Exceptions and Alternative Flows	4a. Authentication and authorization fails. 1. Traffic Manager rejects the priority request and sends the reply to the Traffic Light. 2. Use case continues from Step 6. 6a. Priority request is granted: 1. Current state of the Traffic Light for the VRU is 'Red': 1.1. TLC activates the pedestrian phase for the (group of) VRUs. 2. Current state of the Traffic Light for the VRU is 'Green': 2.1. TLC assesses whether the VRU could cross during the extension green-time and either extends the pedestrian phase, or adds an additional pedestrian phase after the next (opposing) phase. 6b. Priority request is denied: 1. TLC continues to work in its regular mode of operation until a new priority request comes.
Special Requirements	*None.*
Technology Variations List	CAM messages can be utilised to send positions of the VRUs to the TLC.
Open Issues	*None.*

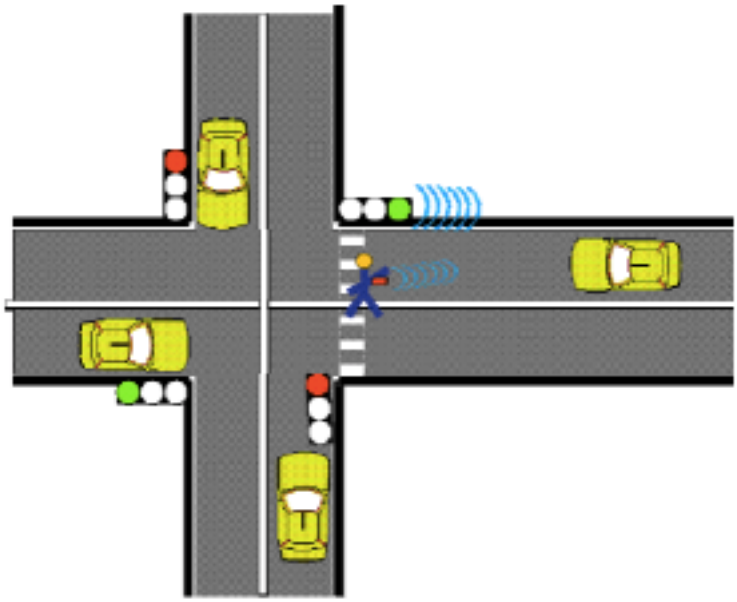
Illustrations, Visualizations, and Figures	

Figure 18: Cooperative traffic light for VRU Illustration 1 source: VRUITS, http://www.vruits.eu/

Figure 19: Cooperative traffic light for pedestrian Illustration 2 source: VRUITS, http://www.vruits.eu/

Table 54: Use Case Description: Traffic Light Prioritisation for Designated VRUs

4.11.2.2. Cooperative Traffic Light with VRU Counting

Introduction to the Use Case	
Background	The City of Eindhoven wants encourage more people to walk and take the bicycle. Especially in the pedestrianised city centre reducing waiting time at busy crossroads is one means to that end.
Objective	"Cooperative Traffic Light with VRU Counting" aims at increasing comfort and safety of VRUs in traffic by adjusting traffic signal timing and/or assigning priority based on VRU-data collected based on counting waiting VRUs, using passive sensing technology or active sensors with near-100% penetration rates. This should increase comfort and safety for VRUs by minimising wait time, and potentially also lead to fewer red-light negations. This use case is different from Use Case 1 as it operates based on the ability to detect all (or nearly all) VRUs using a given intersection, based on passive sensor technology, or active sensors with near 100% penetration rates. The necessary penetration rate for effective implementation of this use case will need to be determined.

Desired Behaviour	iTLCs count the number of VRUs at intersections and/or areas close to the intersection (i.e. for cyclists the sensors should track up to 100 meters before the intersection) and based on time to intersection, direction and the density of the VRUs, will give priority to them.
Expected Impact	Enhanced traffic flow and comfort for VRU's
Known Implementations	/ Intelligent Pedestrians Traffic Signal (IPT), VRUITS > Implemented at Valladolid (Spain) – Intelligent pedestrian Traffic sign for vulnerable pedestrians with extended crossing time / Camera software for counting pedestrian by Vinotion > Implemented at Stratumseind (project: stratumseind 2.0)
References	1. www.vinotion.nl 2. Automatic Counting of Bicycles and Pedestrians (ABI), VRUITS, http://www.vruits.eu/

Table 55: Introduction to Use Case: Cooperative Traffic Light with VRU Counting

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Based on an algorithm taking into account: the current system, traffic streams, traffic conditions and complexity of the specific location
Primary Actor	VRU
Stakeholders and Interests	/ VRU: Wants to gain time, increase the comfort of his or her journey and physical well-being. Reduction of waiting time, reducing annoyance to due avoidance of waiting time. / Local Authority: Wants to reduce local motorized traffic by positively discriminating towards sustainable modes of transport and increase VRU comfort. More pedestrians and cyclists improves the (attractiveness of) the area. This has been linked to positive economic impacts [reference Oldenziel, R., & de la Bruhèze, A. A. (2016). "Europe: A century of Urban Cycling", in". In *"Cycling Cities: The European Experience* (p. 7). Foundation for the History of Technology.]
Preconditions	Two options for VRUs counting are envisioned: 1. The counting software and hardware is installed and activated on the intersections. / Proper locations are selected (where positive effects are expected) / Optimal settings are defined / Settings are adjusted to the specific situation / System is tested on technical and behavioural level. / Programming etc. 2. VRUs are equipped with smartphones or devices capable of announcing their position or the number of persons willing to cross the intersection.
Post-conditions	Increased priority is given to the VRUs where warranted, based on real-time detection and counting of VRUs. Objective and subjective anticipated effects are met.
Main Success Scenario. Positive flow of events.	1. VRU(s) approach the Traffic Light Controller (TLC). 2. TLC detects and counts, or receives the number of VRUs entering in the target detection zone of an intersection on regular intervals. 3. When the first VRU enters the detection area, the relevant phase (bicycle, pedestrian in the relevant direction) is added to the traffic phasing (normal operation). 4. When the number of VRUs surpass the predefined threshold conditions TLC registers a priority request for the VRUs. 5. TLC / traffic management centre assesses the priority request and where approved, activates the relevant VRU phase as the next phase. 6. Sensors monitoring the crossing area or VRUs' messages, are used to provide further messages to the TLC to indicate that a VRU requires more time to clear the

	crossing, or has not crossed, and the TLC adjusts phase duration as appropriate.
Exceptions and Alternative Flows	3a. Current state of the Traffic Light for the VRU is 'Red': 1. TLC assesses the number of waiting VRUs, and determines whether to activate the relevant VRU phase in the normal sequence, or authorise a priority request and bring forward the pedestrian phase. 3b. Current state of the Traffic Light for the VRU is 'Green': 1. TLC assesses the available green-extension time, and where sufficient time available, increases the duration of the green light according to the number and the characteristics (slow moving VRU (elderly pedestrians)) of the VRUs. *For slow-moving pedestrians still crossing, the flickering-green time is extended only.
Special Requirements	1. Threshold conditions for the TLC to act. a. Policies for assigning priority for groups of VRUs over public transport vehicles need to be developed. b. Policies for assigning priority for groups of VRUs compared to peak and non-peak traffic conditions need to be developed. 2. To avoid congestion for vehicle traffic, the number of vehicles waiting at the intersection should also be counted. 3. Elimination of false positives – cyclists need to be detected in advance (up to 100m) and may be difficult to determine which direction they will choose.
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	

Figure 20: Automatic Counting of Bicycles and Pedestrians (ABI), source: VRUITS, http://www.vruits.eu/

Table 56: Use Case Description: Cooperative Traffic Light with VRU Counting

4.12. Flexible Infrastructure (FI) - (HOV, peak-hour lanes)

4.12.1. High Level Service Definition

Service introduction	
Summary	Flexible infrastructure aims to interchange information about the lanes provided to the traffic users according to the time of the day. It includes solutions such as reserved lane.
Background	This service is a variation of an in-vehicle signage that shows the allocated roads for the vehicle driver. It's a complimentary to the road signs.
Objective	Informing traffic users about the lanes provided downstream of the current position and in the driving direction of the vehicle.
Expected benefits	/ Better awareness and safer traffic
Use Cases	1. Dynamic Lane Management - Lane Status information 2. Dynamic Lane Management - Reserved Lane (with use of probe vehicle data) 3. Dynamic Lane Management - Reserved Lane (without use of probe vehicle data)

Table 57: Flexible Infrastructure High Level Service Definition

4.12.2. Use Case(s)

4.12.2.1. Dynamic Lane Management - Lane Status information

Introduction to the Use Case	
Background	Dynamic lanes are aimed at factorize sustainable way of mobility. This service enables the road manager to optimize the management of the lane knowing the real-time traffic characteristics. Currently, dynamic lanes need to be clearly identified in the field by signalization. With this service, it would be possible to implement easier dynamic lane on the networks.
Objective	Inform the user of a dynamic lane opening and and notify the user if his/her vehicle is allowed or not to use it.
Desired Behaviour	Only authorized vehicles use the reserved lane.
Expected Impact	Better awareness and safer traffic
Known Implementations	/ InterCor
References	1. Dynamic Lane Management - Lane Status information, InterCor

Table 58: Introduction to Use Case: Dynamic Lane Management - Lane Status information

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver

Stakeholders and Interests	/ Vehicle driver: Receives IVS information, warnings and/or guidance on the Vehicle ITS-S. / Road operator: Provides info on dynamic road signage / Service provider: Disseminates IVS information, warnings and/or guidance from road operator to vehicle drivers. / End user: trip planners may use IVS information, and expected delays causes by these, to optimise their trip planning.
Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	IVS information shall be displayed to the driver and shall be consistent with the actual dynamic traffic signs.
Main Success Scenario	1. IVS Information is broadcasted to all vehicles within a perimeter which is considered as relevant. 2. The Vehicle ITS-S receives the IVS information, warnings and/or guidance and displays it to the Vehicle Driver.
Extensions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	The presentation of information on the Vehicle ITS-S is not part of the service description. It is left to provider of the In-Vehicle information system with Vehicle ITS-S how information is presented. Information might be translated to the preferred language of the driver. The information presented by means of I2V is not legally binding: Information should be handled as 'convenience information' and presented accordingly to the driver, as currently done within navigation systems. Before using the system/service the driver should be asked to confirm that he is aware that the road signs on the road are legally binding, whatever the in-car systems says. This applies also for possible errors translations of messages and signs.
Technology Variations List	/ Lane status updates can be broadcasted via MAPEM messages. / MAPEM messages can be sent using cellular technologies or IEEE 802.11p.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 59: Use Case Description: Dynamic Lane Management - Lane Status information

4.12.2.2. Dynamic Lane Management - Reserved Lane (with use of probe vehicle data)

Introduction to the Use Case	
Background	The use case is to inform drivers of the presence of a reserved lane, and to notify if they can use it, according a vehicle's feature chosen by the road manager. In parallel, vehicles send its own features to the road manager. This probe vehicle data help the road manager to manage the dynamic lane according the traffic type, on the designated section.
Objective	/ Inform the user of a dynamic lane opening and notify the user if his/her vehicle is allowed or not to use it. / Get for the road manager precise information on real-time traffic on the designated section, in order to better manage the lane.
Desired Behaviour	/ Only authorized vehicles use the reserved lane. / The authorities know some key features (occupancy average rate for example), to optimize and measure the impacts of its mobility policy.

Expected Impact	/ Better awareness and safer traffic / Traffic optimization (Road operators could use in real time the information to improve the management of the dynamic lane) / Traffic statistics information
Known Implementations	/ InterCor
References	1. Dynamic Lane Management - Reserved Lane (with use of probe vehicle data), InterCor

Table 60: Introduction to Use Case: Dynamic Lane Management - Reserved Lane (with use of probe vehicle data)

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle driver: Receives IVS information, warnings and/or guidance on the Vehicle ITS-S. / Road operator: Provides info on dynamic road signage / Service provider: Disseminates IVS information, warnings and/or guidance from road operator to vehicle drivers. / End user: trip planners may use IVS information, and expected delays causes by these, to optimise their trip planning.
Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	IVS information shall be displayed to the driver and shall be consistent with the actual dynamic traffic signs.
Main Success Scenario	1. The road manager broadcasts the dynamic lane characteristics in a specific area to the Vehicle ITS-S of all vehicles (presence of a dynamic lane, status (open / close), vehicle concerned). 2. The Vehicle ITS-S of the vehicles going through the area process the information received. 3. The Vehicle ITS-S on the vehicles send information on its characteristics (PVD) relevant to the dynamic lane. Information can be occupancy rate, emissions level, etc. 4. The road manager received the PVD and decides to open / closed the dynamic lane, to adapt the features of the lane, etc.
Extensions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle. 2a. The dynamic lane is open 1. Vehicle ITS-S displays whether or not the Vehicle Driver can use it (taking into account its Station Type or its own characteristics). 2b. The dynamic lane is closed 1. Vehicle ITS-S does not show anything related to the dynamic lane.
Special Requirements	The presentation of information on the Vehicle ITS-S is not part of the service description. It is left to provider of the In-Vehicle information system with Vehicle ITS-S how information is presented. Information might be translated to the preferred language of the driver.

	The information presented by means of I2V is not legally binding: Information should be handled as 'convenience information' and presented accordingly to the driver, as currently done within navigation systems. Before using the system/service the driver should be asked to confirm that he is aware that the road signs on the road are legally binding, whatever the in-car systems says. This applies also for possible errors translations of messages and signs. Messages from infrastructure need to be broadcast upstream the dynamic lane in order to drivers to adapt their behaviour.
Technology Variations List	I2V2I, broadcast followed by unicast / I2V in broadcast: Infrastructure send in broadcast information on the presence of the dynamic lane, its status (open / closed), vehicle concerned / V2I in unicast: Vehicle send to infrastructure, in unicast, data about its type/characteristics and about its reserved lane utilization.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 61: Use Case Description: Dynamic Lane Management - Reserved Lane (with use of probe vehicle data)

4.12.2.3. Dynamic Lane Management - Reserved Lane (without use of probe vehicle data)

Introduction to the Use Case	
Background	The use case is to inform drivers of the presence of a reserved lane, and to notify if they can use it, according a vehicle's feature chosen by the road manager.
Objective	/ Inform the user of a dynamic lane opening and notify him if its vehicle is allowed or not to use it. / Get for the road manager precise information on real-time traffic on the designated section, in order to better manage the lane.
Desired Behaviour	/ Only authorized vehicles use the reserved lane. / The authorities know some key features (occupancy average rate for example), to optimize and measure the impacts of its mobility policy.
Expected Impact	/ Better awareness and safer traffic / Traffic optimization (Road operators could use in real time the information to improve the management of the dynamic lane)
Known Implementations	/ InterCor
References	1. Dynamic Lane Management - Reserved Lane (with use of probe vehicle data), InterCor

Table 62: Introduction to Use Case: Dynamic Lane Management - Reserved Lane (without use of probe vehicle data)

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle driver: Receives IVS information, warnings and/or guidance on the Vehicle ITS-S. / Road operator: Provides info on dynamic road signage / Service provider: Disseminates IVS information, warnings and/or guidance from road operator to vehicle drivers. / End user: trip planners may use IVS information, and expected delays causes by these, to optimise their trip planning.

Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit and running in the background.
Post-conditions	IVS information shall be displayed to the driver and shall be consistent with the actual dynamic traffic signs.
Main Success Scenario	1. The road manager broadcasts the dynamic lane characteristics in a specific area to the Vehicle ITS-S of all vehicles (presence of a dynamic lane, status (open / close), vehicle concerned). 2. The Vehicle ITS-S of the vehicles going through the area process the information received.
Extensions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle. 2a. The dynamic lane is open 3. Vehicle ITS-S displays whether or not the Vehicle Driver can use it (taking into account its Station Type or its own characteristics). 2b. The dynamic lane is closed 1. Vehicle ITS-S does not show anything related to the dynamic lane.
Special Requirements	The presentation of information on the Vehicle ITS-S is not part of the service description. It is left to provider of the In-Vehicle information system with Vehicle ITS-S how information is presented. Information might be translated to the preferred language of the driver. The information presented by means of I2V is not legally binding: Information should be handled as 'convenience information' and presented accordingly to the driver, as currently done within navigation systems. Before using the system/service the driver should be asked to confirm that he is aware that the road signs on the road are legally binding, whatever the in-car systems says. This applies also for possible errors translations of messages and signs. Messages from infrastructure need to be broadcast upstream the dynamic lane in order to drivers to adapt their behaviour.
Technology Variations List	I2-V-2I, broadcast followed by unicast / I2V in broadcast: Infrastructure send in broadcast information on the presence of the dynamic lane, its status (open / closed), vehicle concerned / V2I in unicast: Vehicle send to infrastructure, in unicast, data about its type/characteristics and about its reserved lane utilization.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 63: Use Case Description: Dynamic Lane Management - Reserved Lane (without use of probe vehicle data)

4.13. In-Vehicle Signage (IVS)

4.13.1. High Level Service Definition

Service introduction	
Summary	In Vehicle Signage (IVS) shows both static and dynamic information of road signs inside the vehicle.
Background	The In-Vehicle Signage (IVS) service is meant to inform drivers via in-vehicle information systems on static and dynamic road signs as indicated on physical road signs and on

	additional digital displays along the road. Both advisory and mandatory road signs are in scope of IVS. The IVS information is retrieved by means of Infrastructure-to-Vehicle (I2V) communication. IVS shows both static and dynamic information of road signs. The service contains actual and continuous information on: / Speed limits: in-vehicle information on actual speed limit > Standard speed limit (incl. time-of-the-day windows) > Dynamic speed limit during incidents, traffic jams, etc. > Adjusted speed limits during road works / Overtaking prohibition: in-car information on actual overtaking prohibition, especially for trucks / Actual travel times and other traffic information.
Objective	To improve traffic safety via additional means to provide drivers with in-vehicle signage information.
Expected benefits	The primary expected impact is more attentive driving by providing actual and continuous information on road signage (e.g. speed limits), which improves traffic safety as it increases the awareness of regulations and potentially dangerous conditions. The vehicle driver adapts his/her driving behaviour compliant to the applicable driving regulations and any advice or guidance provided. In the future the information may be used by Advanced Driver Assisted Systems for automated and autonomous driving.
Use Cases	1. In-Vehicle Signage, dynamic traffic signs 2. In-Vehicle Signage, static traffic signs

Table 64: In-Vehicle Signage High Level Service Description

4.13.2. Use Case(s)

4.13.2.1. In-Vehicle Signage, dynamic traffic signs

Introduction to the Use Case	
Background	While driving, vehicle drivers receive actual IVS related information, warnings and/or guidance on the in-vehicle display. Instructions may include to reduce the driving velocity, to change lanes, to prepare for a steering manoeuvre, etc.
Objective	More attentive driving while approaching and passing a zone by providing in-car information and warnings.
Desired Behaviour	The vehicle driver adapts his/her driving behaviour compliant to the applicable driving regulations and any advice or guidance provided.
Expected Impact	The primary expected impact is more attentive driving by providing actual and continuous information which improves traffic safety as it reduces (the likelihood and the severity of) accidents.
Known Implementations	/ DriveC2X / DG MOVE / C-ITS Corridor / SCOOP@F
References	*None.*

Table 65: Introduction to Use Case: In-Vehicle Signage, dynamic traffic signs

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Specific situations
Primary Actor	Driver

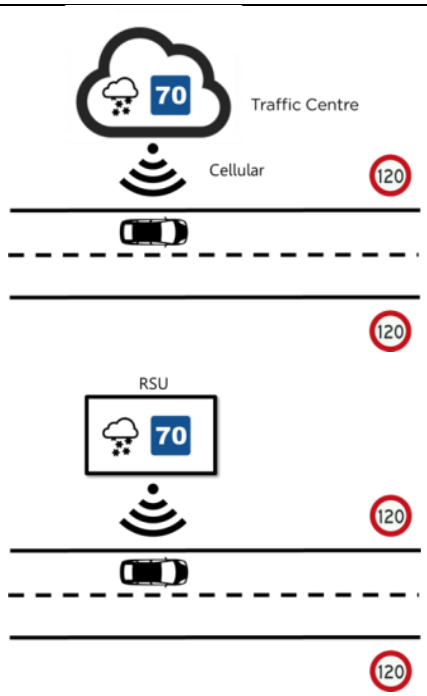
Stakeholders and Interests	/ Vehicle driver: receives information from the in-vehicle display or smartphone. / Road operator: provides info on dynamic road signage (e.g. speed advices). / Service provider: disseminates IVS related information, warnings and/or guidance to vehicle drivers. / End user: trip planners may use IVS information, and expected delays caused by these, to optimise their trip planning.
Preconditions	The in-vehicle or mobile application is installed and activated on the driver's vehicle or smart phone and running in the background.
Post-conditions	Vehicle drivers receive related information, warnings and/or guidance
Main Success Scenario	While driving, vehicle drivers receive actual IVS related information, warnings and/or guidance on the in-vehicle display. Instructions may include to reduce the driving velocity, to change lanes, to prepare for a steering manoeuvre, etc.
Extensions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	The relevant direction and area where the drivers must receive the information must be specified, no matter the communication mode. It may vary depending on the type of information.
Technology Variations List	/ I2V via 802.11p or cellular / IVS messages can be transmitted using two different data streams: > Data stream 1: A traffic centre is aware of the dynamic information and sends it to the R-ITS-Ss that disseminate the road signs information to relevant equipped vehicles using DSRC (802.11p). > Data stream 2: A traffic centre is aware of the dynamic information and transmits it to the relevant vehicles using a cellular communication.
Open Issues	None
Illustrations, Visualizations, and Figures	 Figure 21: In-Vehicle Signage, dynamic traffic signs

Table 66: Use Case Description: In-Vehicle Signage, dynamic traffic signs

4.13.2.2. In-Vehicle Signage, static traffic signs

Introduction to the Use Case	
Background	While driving, vehicle drivers receive static IVS related information (speed limits) on the in-vehicle display.
Objective	More attentive driving while approaching and passing a zone by providing in-car information.
Desired Behaviour	The vehicle driver adapts his/her driving velocity to the applicable driving regulations according to the static road signs.
Expected Impact	The primary expected impact is more attentive driving by providing actual information and warnings which improves the awareness of the drivers.
Known Implementations	/ DriveC2X / DG MOVE / SCOOP@F
References	*None.*

Table 67: Introduction to Use Case: In-Vehicle Signage, static traffic signs

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Specific situations
Primary Actor	Driver
Stakeholders and Interests	/ Vehicle driver: receives information and warnings from the in-vehicle display or smartphone. / Road operator: provides info on road signage (e.g. speed limits). / Service provider: disseminates IVS related information.
Preconditions	The in-vehicle or mobile application is installed and activated on the driver's vehicle or smart phone and running in the background.
Post-conditions	Vehicle drivers receive speed limits information and warnings due to speeding.
Main Success Scenario	While driving, vehicle drivers receive IVS related information (speed limits) and speeding warnings.
Extensions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	The relevant driving direction the drivers must receive the information must be specified, no matter the communication mode.
Technology Variations List	/ I2V via 802.11p or cellular / IVS messages can be transmitted using two different data streams: > Data stream 1: The R-ITS-Ss disseminate the road signs information to relevant equipped vehicles using DSRC (802.11p). > Data stream 2: A traffic centre transmits the speed limit information to the relevant vehicles using a cellular communication.
Open Issues	None

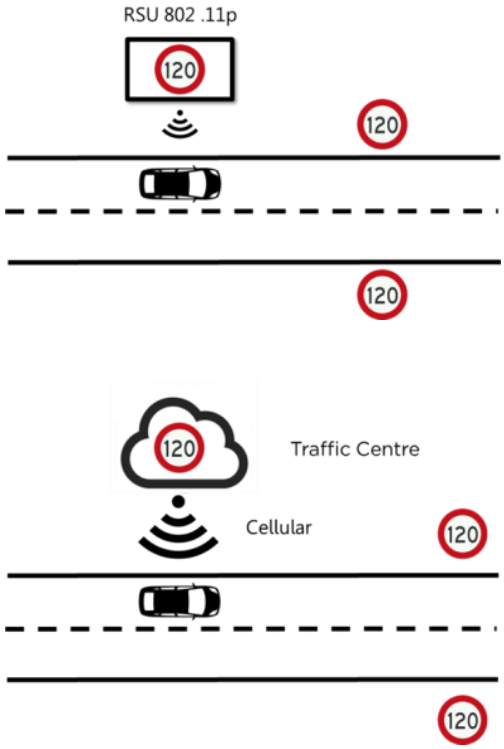
Illustrations, Visualizations, and Figures	

Figure 22: In-Vehicle Signage, static traffic signs

Table 68 Use Case Description: In-Vehicle Signage, static traffic signs

4.14. Mode & Trip Time Advice (MTTA)

4.14.1. High Level Service Definition

Service introduction	
Summary	Mode & trip time advice (e.g. by incentives) aims to provide a traveller with an itinerary for a multimodal passenger transport journey, taking into account real-time and/ or static multimodal journey information. It gives advice to its users with regards to the mode of transport, the most efficient route whilst travelling as well as the expected travel time based on floating car data (or other multi-source traffic conditions estimation technologies), allowing users to optimize their travel experience.
Background	Intermodal trip advice is useful in terms of improving traffic flow, reducing emissions and increasing comfort.
Objective	"Mode and trip time advice" aims to create an eco-friendlier, energy-efficient and more comfortable driving or travelling experience.
Expected benefits	/ Enhanced comfort as a result of given optimized travel advice. / Reduction of congestion and emission by enhancing traffic flow. / Reduction of the use of private car by promoting park&ride options and/or public transport alternatives
Use Cases	1. Mode and Trip Time Advice for Event Visitors 2. Table 71: Use Case Description: Mode and Trip Time Advice for Event Visitors 3. Mode and Trip Time Advice for Drivers 4. Mode and Trip Time Advice for Cyclists

Table 69: Mode & Trip Time Advice High Level Service Definition

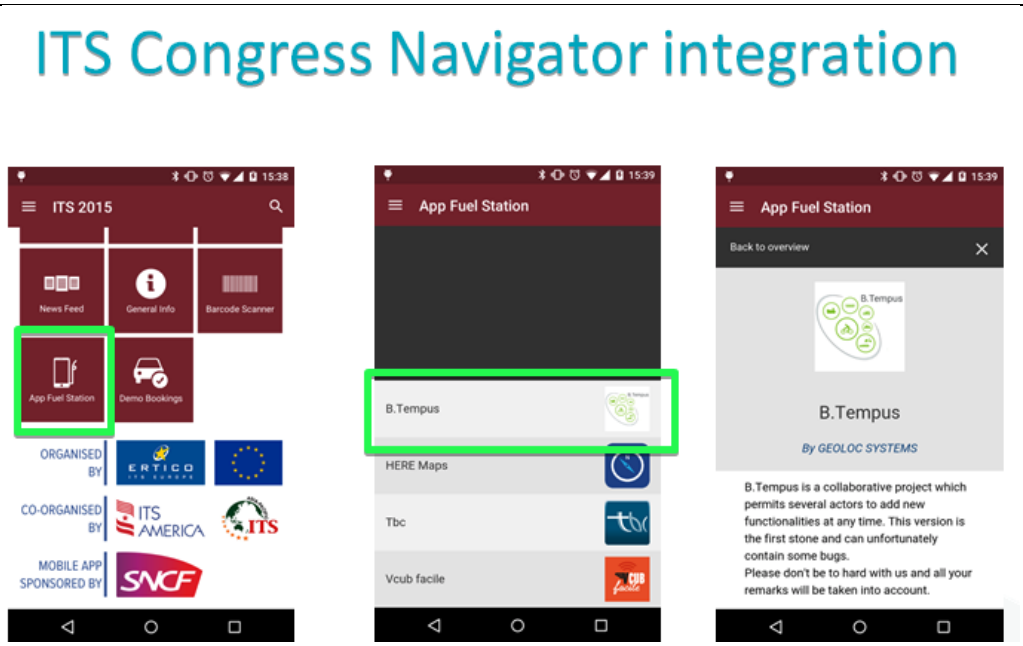
4.14.2. Use Case(s)

4.14.2.1. Mode and Trip Time Advice for Event Visitors

Introduction to the Use Case	
Background	The use case has been defined during the Business Model Design Workshop Session in Copenhagen, Denmark. According to the business model defined in that workshop: Mode and Trip Time Advice gives advice to its users with regards to the mode of transport, the most efficient route whilst travelling as well as the expected travel time based on floating traffic data, allowing users to optimize their travel experience. The service can be implemented as follows. Floating traffic data is collected either through roadside ITS stations (R-ITS-Ss) or through on-board software applications in vehicles to assess the density, throughput and congestion of traffic within a specific area. Based on these conditions, an optimal route can be calculated. Consequently, a suitable advice on mode and trip time can be presented to users wishing to venture into or through this area to improve travelling comfort and efficiency. This may be accompanied by incentives to stimulate a change in travel behaviour.
Objective	Providing "Hassle-free event experience" to the event visitors.
Desired Behaviour	Event visitor will plan his/her trip according to the advice given by the Mode & trip time advice.
Expected Impact	/ Enhanced comfort as a result of given optimized travel advice. / Enhanced traffic flow as a result of traffic level decrease in the designated areas.
Known Implementations	/ Multimodal Travel Assistant (MMTA), **MOBINET** > Demo made in in: Bordeaux, (http://mobinet.eu/?q=content/mmta-demo-use-case) / Mode & Trip Time Advice, **DITCM** / Mode & Trip Time Advice, **SCOOP@F**
References	1. BMR- Mode and Trip time advice for event visitors - Copenhagen, Grefen and Gilsing, 2017 2. Deliverable 7.15: Report on services developed for MOBiNET

Table 70: Introduction to Use Case: Mode and Trip Time Advice for Event Visitors

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	For the duration of a designated event
Primary Actor	Event Visitor
Stakeholders and Interests	/ Event Visitor: Wants comfortable event experience. / Event Provider: Wants to improve its image and the experience of the customers. / City Municipality: > Wants to improve its image and traffic flow. > Wants to reduce the level of pollution. / Public Transport: Wants to improve its image and promote public transport usage. / Service provider: Provides real-time traffic information
Preconditions	The Vehicle ITS-S is installed and activated on the Event Visitor's smart phone or on-board unit.
Post-conditions	Mode and trip time advice is provided to the Event Visitor.
Main Success Scenario	1. Event Visitor wants to get mode & trip time advice for a specific event. 2. Vehicle ITS-S provides the list of the events in the Event Visitor's area.

	3. Event Visitor selects the specific event that he/she wants to go. 4. Vehicle ITS-S connects to the Service Provider and requests for the traffic information (dynamic traffic data, parking data, static road network data etc.). 5. Service Provider collects traffic information from the Data/Content Provider(s) and sends the information back to the Vehicle ITS-S. 6. Vehicle ITS-S generates mode & trip time advice based on the traffic information and displays the advice to the Event Visitor.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S Fails 1. Vehicle ITS-S displays an error message to the Event Visitor. 2. Vehicle ITS-S restarts itself.
Special Requirements	The given advice will depend on the incentives defined by the City Municipality and the Event Provider.
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	 Figure 23: Multimodal Travel Assistant Mobile Application developed for Bordeaux World Congress, source: MOBINET

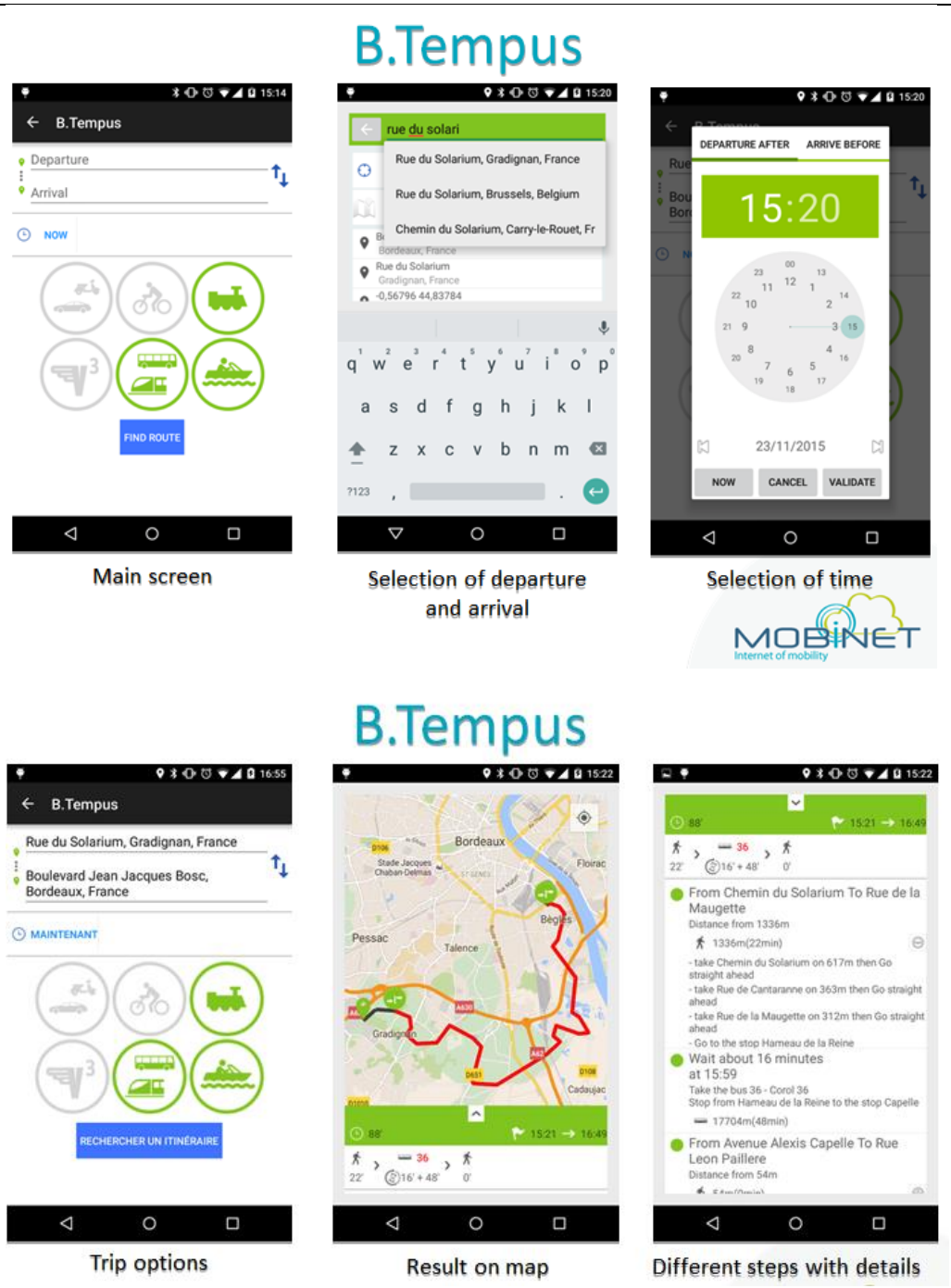


Figure 24: Demo screenshots of the Multimodal Travel Assistant Mobile Application, source: MOBINET

Table 71: Use Case Description: Mode and Trip Time Advice for Event Visitors

4.14.2.2. Mode and Trip Time Advice for Drivers

Introduction to the Use Case	
Background	The use case has been defined during the Business Model Design Workshop Session in Copenhagen, Denmark. According to the business model defined in that workshop: Mode and Trip Time Advice gives advice to its users with regards to the mode of transport, the most efficient route whilst travelling as well as the expected travel time based on floating traffic data, allowing users to optimize their travel experience. The service can be implemented as follows. Floating traffic data is collected either through roadside ITS stations (R-ITS-Ss) or through on-board software applications in vehicles to assess the density, throughput and congestion of traffic within a specific area. Based on these conditions, an optimal route can be calculated. Consequently, a

	suitable advice on mode and trip time can be presented to users wishing to venture into or through this area to improve travelling comfort and efficiency. This may be accompanied by incentives to stimulate a change in travel behaviour. Below, we discuss the application of this service on blueprint business models.
Objective	Proposing to Drivers "reliable arrival times at delivery locations using mode and trip time advice".
Desired Behaviour	Driver will plan his/her trip according to the advice given by the mode & trip time advice.
Expected Impact	/ Enhanced comfort as a result of given optimized travel advice. / Enhanced traffic flow as a result of traffic level decrease in the designated areas.
Known Implementations	/ Multimodal Travel Assistant (MMTA), **MOBINET** > Demo made in in: Bordeaux, (http://mobinet.eu/?q=content/mmta-demo-use-case) / Mode & Trip Time Advice, **DITCM** / Mode & Trip Time Advice, **SCOOP@F** / Multimodal trip planner: **mobithess.gr**, **easytrip.gr**
References	1. BMR- Mode and Trip time advice for truck drivers - Copenhagen, Grefen and Gilsing, 2017 2. Deliverable 7.15: Report on services developed for MOBiNET

Table 72: Introduction to Use Case: Mode and Trip Time Advice for Drivers

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Driver
Stakeholders and Interests	/ Driver: Wants a stress-free driving experience. / Truck Company (in case of truck driver): > Wants to improve its image and revenue. > Wants to decrease stress levels of the drivers. / Traffic Operator: Wants to decrease the number of accidents
Preconditions	The Vehicle ITS-S is installed and activated on the Truck Driver's smart phone or on-board unit.
Post-conditions	Mode and trip time advice is provided to the Truck Driver.
Main Success Scenario	1. Driver wants to get mode & trip time advice for his/her journey. 2. Vehicle ITS-S asks for the departure and the arrival locations. 3. Driver specifies the departure and the arrival locations. 4. Vehicle ITS-S connects to the Service Provider and requests for the traffic information (FTD, dynamic traffic data, urban and highway parking availability data, static road network data etc.). 5. Service Provider collects the traffic information (dynamic traffic data, parking data, static road 6. network data) from the Data/Content Provider(s) and sends the information back to the Vehicle ITS-S. 7. Vehicle ITS-S generates mode & trip time advice based on the traffic information and displays the advice to the Driver.

Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S Fails 1. Vehicle ITS-S displays an error message to the Driver. 2. Vehicle ITS-S restarts itself.
Special Requirements	In case of a truck driver, the given advice will be dependent on the incentives defined by the Retailer and the Truck Company. (i.e. If the planned delivery date is easily achievable, the advice will include routes emitting the urban areas.)
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*Please see* Table 71: Use Case Description: Mode and Trip Time Advice for Event Visitors.

Table 73: Use Case Description: Mode and Trip Time Advice for Drivers

4.14.2.3. Mode and Trip Time Advice for Cyclists

Introduction to the Use Case	
Background	Mode and Trip Time Advice for cyclists offers optimal routes from one point to another encouraging the use of cycle lanes. This use case is mainly intended for the Barcelona Pilot Site, where there are a high number of cyclists and continuous expansion of lanes dedicated exclusively to bicycles.
Objective	Enhancing the use of bicycles using dedicated lanes, reducing the environmental impact and improving mobility.
Desired Behaviour	Cyclists will plan his/her trip according to the advice given by the mode & trip time advice.
Expected Impact	/ Enhanced comfort and safety as a result of given optimized travel advice. / Enhanced traffic flow as a result of traffic level decrease in the designated areas.
Known Implementations	/ Multimodal Travel Assistant (MMTA), **MOBINET** > Demo made in: Bordeaux, (http://mobinet.eu/?q=content/mmta-demo-use-case) / Mode & Trip Time Advice, **DITCM** / Mode & Trip Time Advice, **SCOOP@F** / Multimodal trip planner: **mobithess.gr**, **easytrip.gr**
References	Deliverable 7.15: Report on services developed for MOBiNET

Table 74: Introduction to Use Case: Mode and Trip Time Advice for Cyclists

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Cyclists
Stakeholders and Interests	/ Cyclists: Wants a stress-free driving experience. / City Municipality: > Wants to improve its image and traffic flow. > Wants to reduce the level of pollution. / Traffic Operator: Wants to decrease the number of accidents
Preconditions	The Vehicle ITS-S is installed and activated on the users' smart phone
Post-conditions	Trip time and route advices are provided to the cyclists

Main Success Scenario	1. Cyclists want to get mode & trip time advice for his/her journey. 2. Vehicle ITS-S/Server asks for the departure and the arrival locations. 3. Cyclists specify the departure and the arrival locations using the map provided by the Service Provider. 4. Vehicle ITS-S/Server generates mode & trip time advice and displays the advice to the cyclist.
Exceptions and Alternative Flows	*a. At any time, the service fails 1. Vehicle ITS-S displays an error message to the cyclist. 2. Vehicle ITS-S restarts itself.
Special Requirements	*None.*
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*Please see the* Table 73: Use Case Description: Mode and Trip Time Advice for Drivers

Table 75: Use Case Description: Mode and Trip Time Advice for Cyclists

4.15. Probe Vehicle Data (PVD)

4.15.1. High Level Service Definition

Service introduction	
Summary	Probe Vehicle Data is data generated by vehicles. The collected traffic data can be used as input for operational traffic management (e.g., to determine the traffic speed, manage traffic flows by - for instance- alerting users in hot spots, where the danger of accidents accumulates), long term tactical/strategic purposes (e.g. road maintenance planning) and for traveler information services. Also known as Floating Car Data (FCD).
Background	Traffic conditions, most notably traffic densities and average speeds, are traditionally measured by road sensors, like loop detectors or cameras [10]. Instead of using road sensors to determine traffic conditions, it is also possible to use information provided by vehicles directly. Depending on the exact details on how the probe data is collected in the vehicle and aggregated, similar information as obtained from road sensors can be used, but also all kinds of additional information (road condition, sudden braking actions, etc.) can be collected. Probe Vehicle Data Collection (or Floating Car Data Collection) can be used as input for operational traffic management, but also for other usages of traffic information e.g. for tactical / strategic purposes like maintenance planning. The Probe Vehicle Data could be used as additional traffic information or as substitute for traditional traffic information from cameras or road loops. Probe Vehicle Data can be collected from connected cars, via service providers, or via cooperative cars by collecting broadcast messages from these cars in cooperative roadside units, or in-vehicle units.
Objective	To collect data about traffic conditions, road surface conditions and the surroundings.
Expected benefits	The primary expected impact is expected from indirect effects through other use cases. The collected data proves as a basis for other applications which are improved or possibly impossible otherwise. Impact of such applications include, safer road conditions (e.g. traffic jam/collision alert and adverse weather condition warnings), less CO2 emissions (resulting from a more stable traffic flow) and faster travel times (because of more optimal rerouting of traffic).
Use Cases	1. Basic probe vehicle data

	2. Extended probe vehicle data

Table 76: Probe Vehicle Data High Level Service Description

4.15.2. Use Case(s)

4.15.2.1. Basic probe vehicle data

Introduction to the Use Case	
Background	Modern vehicles or driver assistance technologies know their own position, speed and direction and often other vehicle properties (e.g. windscreen wiper status, ABS, ESP, collision sensors, etc.) as well. Vehicles can broadcast these data when in range of an R-ITS-S. This will provide the road authority with information about traffic, road surface and environment conditions around R-ITS-Ss. Examples of applications are: / While approaching a slippery (oil) spot a driver receives a warning about a slippery road surface which was determined and broadcasted by a previously passing vehicle. / A vehicle closing in on a traffic jam tail receives a warning based on the slow-moving vehicle in the tail which broadcasted its speed and location.
Objective	To collect data about traffic conditions, road surface conditions and the surroundings.
Desired Behaviour	The collected data gives insight in the traffic situation and surroundings. These are used as input for monitoring & evaluation (e.g. for policy making) and other use cases such as traffic condition warning, hazardous location notification and adverse weather condition.
Expected Impact	The primary expected impact is expected from indirect effects through other use cases. The collected data proves as a basis for other applications which are improved or possibly impossible otherwise. Impact of such applications include, safer road conditions (e.g. traffic jam/collision alert and adverse weather condition warnings), less CO2 emissions (resulting from a more stable traffic flow) and faster travel times (because of more optimal rerouting of traffic).
Known Implementations	/ Dutch C-ITS Corridor (https://itscorridor.mett.nl) / InterCor / Praktijkproef Amsterdam (http://www.praktijkproefamsterdam.nl/)
References	1. Basic probe vehicle data, Dutch Profile Part A - Use case catalogue

Table 77: Introduction to Use Case: Basic probe vehicle data

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: drives the vehicle along R-ITS-Ss and possibly gives its consent regarding sharing the vehicle's data. / Road Operator: collects the data via R-ITS-Ss / Service Provider: uses the data derived from the vehicle to provide information, warnings and advices. / End User: receives warnings to avoid dangerous situations and advice to change the driving behaviour (brake, accelerate, change routes, etc.) / Other: OEMs may act as a service provider, but also as an intermediate between the service providers and the end users.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit and running in the background.

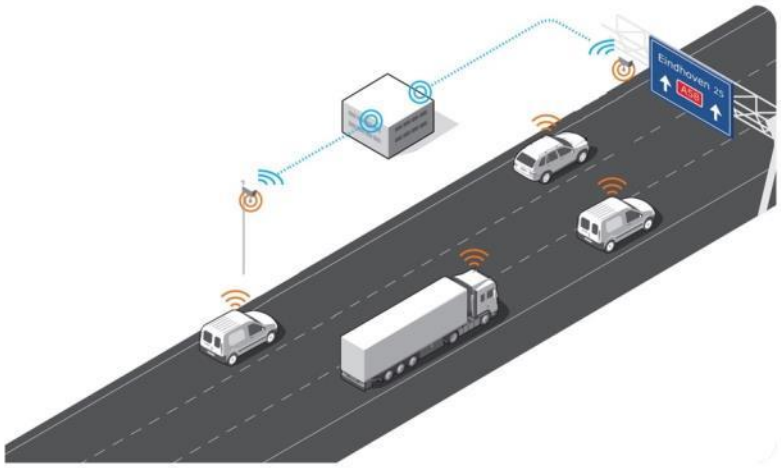
	The driver accepts to share the data generated by the vehicle.
Post-conditions	Data from the vehicle is collected.
Main Success Scenario	1. A vehicle broadcasts information/a message (e.g. CAM, DENM) containing information about the vehicle and its surroundings. 2. The data is received directly or indirectly by a central system and then is redistributed among third parties (OEMs, service providers) for other applications.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Truck Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Truck Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	*None.*
Technology Variations List	/ Unique DENM messages can be used for the communication between cars, R-ITS-Ss, and the cloud servers. / R-ITS-Ss can repeat the messages on the IEEE 802.11p channel to utilise maximum radio coverage they have.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	

Figure 25: Probe vehicle data illustration

Table 78: Use Case Description: Basic probe vehicle data

4.15.2.2. Extended probe vehicle data

Introduction to the Use Case	
Background	Modern vehicles know their own position, speed and direction and often other vehicle properties (windscreen wiper status, ABS, ESP, collision sensors, etc.) as well. Vehicles can collect and store that information for a short while. Then, when in range of an R ITS S, the vehicles can broadcast the stored information. This will provide the road authority with detailed information about traffic, road surface and environment conditions with a relatively large coverage.
Objective	To collect data about traffic conditions, road surface conditions and the surroundings.
Desired Behaviour	The collected data gives insight in the traffic situation and surroundings. These are used as input for monitoring & evaluation (e.g. for policy making) and other use cases such as traffic condition warning, hazardous location notification and adverse

	weather condition.
Expected Impact	The primary expected impact is expected from indirect effects through other use cases. The collected data proves as a basis for other applications which are improved or possibly impossible otherwise. Impact of such applications include, safer road conditions (e.g. traffic jam/collision alert and adverse weather condition warnings), less CO2 emissions (resulting from a more stable traffic flow) and faster travel times (because of more optimal rerouting of traffic).
Known Implementations	/ Dutch C-ITS Corridor (https://itscorridor.mett.nl) / InterCor / Praktijkproef Amsterdam (http://www.praktijkproefamsterdam.nl/)
References	1. Extended probe vehicle data, Dutch Profile Part A - Use case catalogue

Table 79: Introduction to Use Case: Extended probe vehicle data

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: drives the vehicle along R-ITS-Ss and possibly gives its consent regarding sharing the vehicle's data. / Road Operator: collects the data via R-ITS-Ss / Service Provider: uses the information derived from the data to provide warnings and advice. / End User: receives warnings to avoid dangerous situations and advice to change the driving behaviour (brake, accelerate, change routes, etc.) / Other: OEMs may act as a service provider, but also as an intermediate between the service providers and the end users.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit and running in the background.
Post-conditions	Data from the vehicle is collected.
Main Success Scenario	1. In range of an R-ITS-S a vehicle broadcasts information/a message (e.g. CAM, DENM) containing information about the vehicle and its surroundings. 2. The data received by the R-ITS-S is collected in a central system and then redistributed among third parties (OEMs, service providers) for other applications (See special requirements for examples).
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Truck Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Truck Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	Examples of applications are: / While approaching a slippery (oil) spot a driver receives a warning about a slippery road surface which was determined and broadcasted by a previously passing vehicle. / A vehicle closing in on a traffic jam tail receives a warning based on the slow-moving vehicle in the tail which broadcasted its speed and location.
Technology Variations List	/ Unique DENM messages can be used for the communication between cars, R-ITS-Ss, and the cloud servers. / R-ITS-Ss can repeat the messages on the IEEE 802.11p channel to utilise

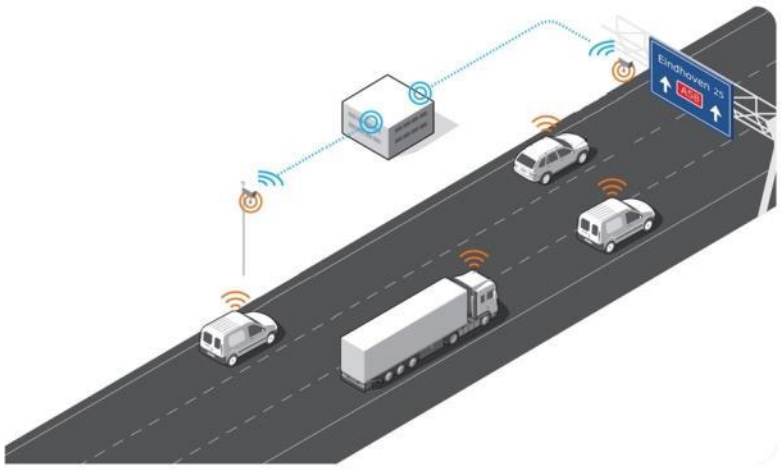
	maximum radio coverage they have.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	

Figure 26: Probe vehicle data illustration

Table 80: Use Case Description: Extended probe vehicle data

4.16. Emergency Brake Light (EBL)

4.16.1. High Level Service Definition

Service introduction	
Summary	Emergency Brake Light aims to avoid (fatal) rear end collisions, which can occur if a vehicle ahead suddenly brakes, especially in dense driving situations or in situations with decreased visibility. The driver is warned before s/he is able to realize that the vehicle ahead is braking hard, especially if s/he does not see the vehicle directly (vehicles in between).
Background	This service addresses the situation that occurs when any vehicle abruptly slows down, it switches on emergency electronic brake lights. The service warns the local followers, in due time, so they can adopt their speed to avoid collision with the vehicle [9].
Objective	Enhancing the safety of vehicles in a dense driving environments by providing timely in-car driving assistance information.
Expected benefits	Improved traffic safety due to the decrease in the number of accidents.
Use Cases	1. Emergency electronic brake lights

Table 81: Emergency Electronic Brake Light High Level Service Definition

4.16.2. Use Case(s)

4.16.2.1. Emergency electronic brake lights

Introduction to the Use Case	
Background	This use case consists for any vehicle to signal its hard breaking to its local followers. In such case, the hard braking is corresponding to the switch on of emergency electronic brake lights.
Objective	To warn all following vehicles of a sudden slowdown of the traffic so limiting the risk of longitudinal collision.
Desired Behaviour	The Vehicle Driver adapts his/her driving behaviour compliant to any advice or

	guidance provided.
Expected Impact	Improve traffic safety and reduce the risk of accidents by reducing the risk of longitudinal collision.
Known Implementations	/ Talking Traffic Innovation Partnership (http://www.beterbenutten.nl/talking-traffic)
References	1. Emergency Brake Light Warning (EBLW), DITCM 2. Emergency electronic brake lights, ETSI TR 102 638 V1.1.1 (2009-06)

Table 82: Introduction to Use Case: Emergency electronic brake lights

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	In the case of a sudden slowdown of the traffic
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: receives emergency brake light warning on the Vehicle ITS-S (in-vehicle display or smart phone). / Road Operator/Traffic Manager: may signal the existence of a sudden slowdown. / Service Provider: disseminates the emergency brake light warning to vehicle drivers. / Other: organisations charged with repair, maintenance and/or cleaning may act on the sudden traffic slowdown information.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit and running in the background.
Post-conditions	In-car information and warnings about emergency braking are displayed on the Vehicle ITS-S. Emergency braking lights of the vehicle that detected the emergency braking are activated.
Main Success Scenario	1. A vehicle automatically detects the emergency braking (according to the criteria defined by the Car-2-Car Consortium). 2. The Vehicle ITS-S displays the emergency braking warning, activates emergency brake lights and disseminates the detected emergency braking information to R-ITS-Ss and other vehicles within the range. 3. R-ITS-Ss that received the emergency braking information, sends it to the Road Operator/Traffic Manager.
Extensions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	None.
Technology Variations List	Emergency brake light information can be shared via DENM messages.
Open Issues	*None.*

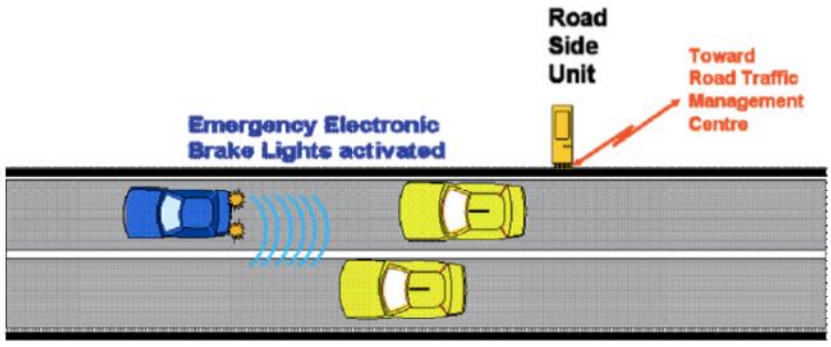
Illustrations, Visualizations, and Figures	 Figure 27: Emergency brake lights use case illustration, source: ETSI TR 102 638 V1.1.1 (2009-06)

Table 83: Use Case Description: Emergency electronic brake lights

4.17. Cooperative Adaptive Cruise Control (CACC)

4.17.1. High Level Service Definition

Service introduction	
Summary	The service ensures smooth driving of vehicles with enabled Cooperative Adaptive Cruise Control (CACC) function or platooning for driving through a (series of) C-ITS equipped intersection(s)
Background	Vehicles equipped with CACC benefit from inter-vehicle information exchange to improve the efficicency of driving and traffic flow. By adding V2I functionalities, the driving pattern of these equipped vehicles and the traffic lights on intersections can be optimized for traffic flow around intersections.
Objective Expected benefits	Improve safety, comfort and traffic flow on intersections with V2I communication between CACC and intersection traffic lights (or managed intersections). Improved traffic flow for CACC when approaching urban environments.
Use Cases(s)	1. CACC passenger vehicles approaching urban of semi-urban environment

Table 84: Cooperative Adaptive Cruise Control High Level Service Description

4.17.2. Use Case(s)

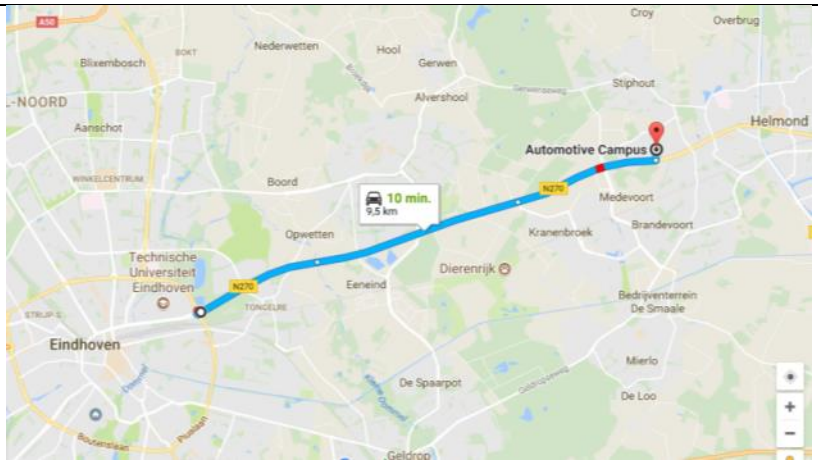
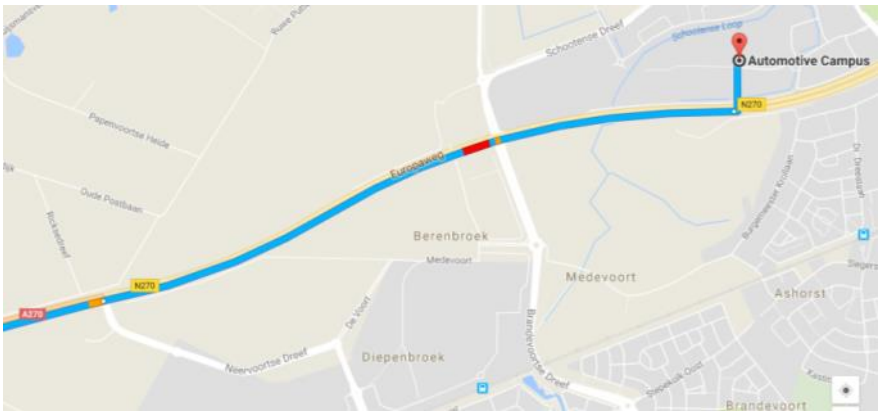
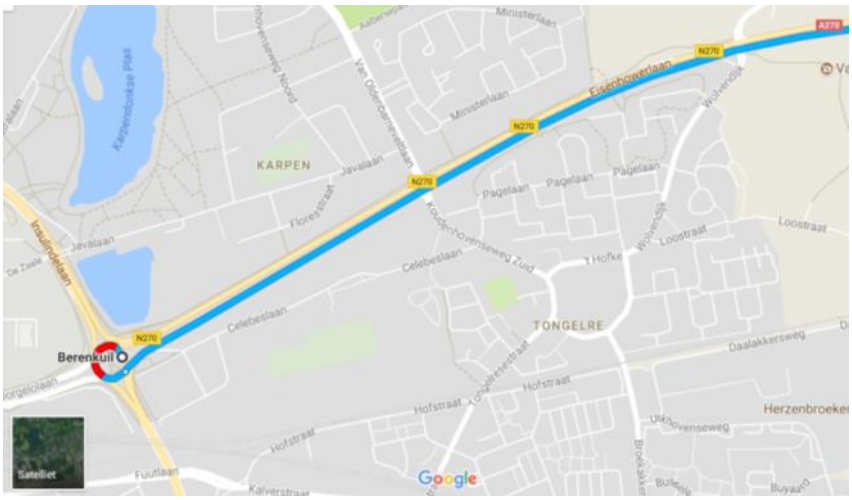
4.17.2.1. CACC passenger vehicles approaching urban of semi-urban environment

Introduction to the Use Case	
Background	A highway starts/ends with motorway stretches that includes highly automatized intersections. The short length of the highway/motorway surrounded by theses intersections represents a semi-urban environment where to demonstrate the benefit of the "urban CACC" service in terms of: / Traffic flow (thanks to the cooperative interaction with iTLC) / Safety and Comfort, thanks to the cooperative adaption of the cruise control functionality The service will be demonstrated at the end of the project during the "small-scale demonstration", being characterized by a lower maturity when compared to other well-established services. Specific public road exemption may be necessary to demonstrate the real benefit in normal traffic conditions. Two test sites will implement this use case: 1. Bordeaux:

	The use case will be deployed near the exhibition center in the north of Bordeaux. The chosen road was already used by autonomous vehicles during ITSWC in 2015. The equipped road is 1.2km long between 2 roundabouts, with 3 traffic lights in between. As the use case is working in both directions, this makes 6 different intersection crossing with a total distance of 2,5 km. 2. North Brabant: The highway connecting Helmond with Eindhoven (A270, ca. 8 Km long) starts/ends with motorway stretches (N270) including highly automatized intersections.
Objective	To demonstrate the dynamic speed/spacing adaptation to increase traffic flow as well as safety and comfort.
Desired Behaviour	CACC vehicles can improve their flow through a series of intersections by adapting their speed/spacing to the advice received from the TLC in order to approach the subsequent intersections during the green-light phase.
Expected Impact	Optimised traffic flow (thanks to the cooperative interaction with TLC) Improved safety and comfort, thanks to the cooperative adaption of the cruise control functionality
Known Implementations	Compass4D
References	*None.*

Table 85: Introduction to Use Case: CACC passenger vehicles approaching urban of semi-urban environment

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	When CACC passenger vehicles approaching semi-urban environment
Primary Actor	Intelligent Traffic Light controller, or Road operator.
Stakeholders and Interests	City's Authorities which would like to prepare their infrastructure to the arrival of autonomous vehicles. Companies selling intelligent traffic light solutions.
Preconditions	The C-ITS service is implemented both in the selected vehicles as well as on the subsequent TLC at the intersections.
Post-conditions	Increased smoothness in traffic flow for the CACC vehicle equipped with C-ITS communication system.
Main Success Scenario	Demonstrating the benefit for a set 2 - 3 passenger vehicles in terms of: / Throughput = time to drive a certain route / Comfort = number of gear changes and acceleration levels along the run / Safety = number and intensity of decelerations (braking) and acceleration
Extensions and Alternative Flows	*None.*
Special Requirements	*None.*
Technology Variations List	/ MAPEM and SPATEM messages can be used for CACC notifications. / ITS G5 with CAM and a complementary message* can be used for V2V communication. > *To exchange the motion and the static data of the vehicles to each other, standard message sets like CAM should be used jointly with another developed message, e.g. iCLCM, to enable CACC functionality
Open Issues	*None.*

Illustrations, Visualizations, and Figures	 Figure 28: North Brabant Route  Figure 29: North Brabant Route  Figure 30: North Brabant Route

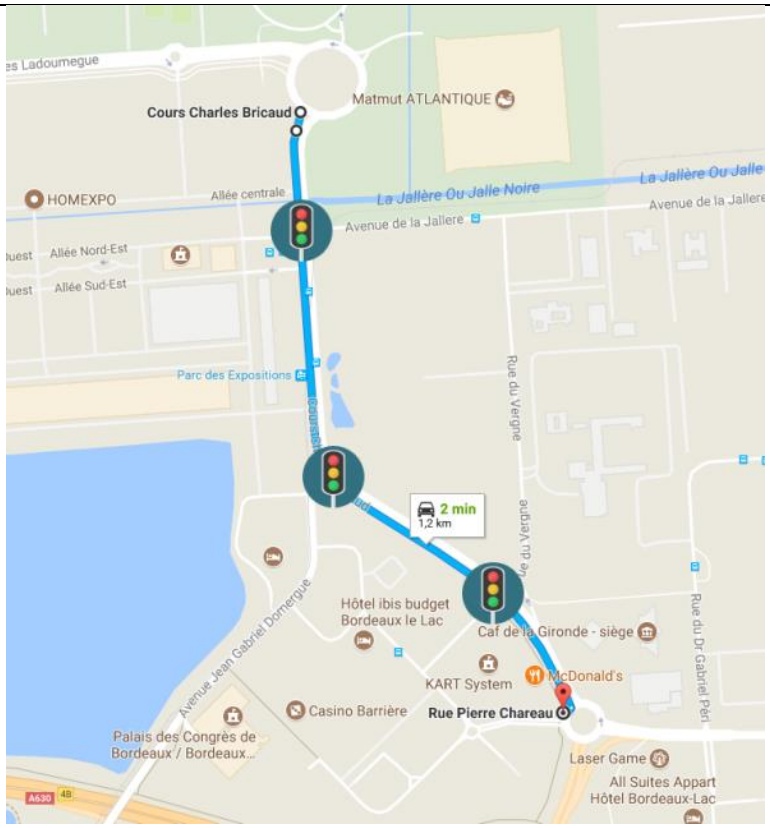


Figure 31: Bordeaux Route

Figure 32: Bordeaux Route

Table 86: Use Case Description: CACC passenger vehicles approaching urban of semi-urban environment

4.18. Slow and Stationary Vehicle Warning (SVW)

4.18.1. High Level Service Definition

Service introduction	
Summary	Slow or stationary vehicle warning aims to inform/ alert approaching vehicles of (dangerously) immobilized, stationary or slow vehicles that impose significant risk.
Background	The slow or stationary vehicle warning system is designed to aid the driver in avoiding or mitigating rear-end collisions with vehicles in front of driver's own car. The driver will be alarmed through driver notification or warning of the impending

	collision on slow vehicles. The system does not attempt to control the vehicle in order to avoid an impending collision; instead it warns the following vehicles on the potential danger of the slow vehicle.
Objective	To provide timely in-car driving assistance information on a stationary vehicle(s) downstream of the current position and in the driving direction of the vehicle.
Expected benefits	Improved traffic safety due to the decrease in the number of accidents.
Use Cases	1. Slow or stationary vehicle warning, including: a. Situation 1: Accident b. A vehicle approaches a calamity or incident downstream of the current position and in the driving direction. c. Situation 2: Vehicle Problem d. A vehicle approaches a stationary vehicle on the lane or hard shoulder downstream of the current position and in the driving direction. e. Situation 3: Road Inspector / Roadside Assistance / Emergency vehicles attending f. A vehicle approaches a highways inspector vehicle on the lane or hard shoulder downstream of the current position and in the driving direction.

Table 87: Slow and Stationary Vehicle Warning High Level Service Description

4.18.2. Use Case(s)

4.18.2.1. Slow or stationary vehicle warning

Introduction to the Use Case	
Background	Slow and stationary vehicles on the road, on the hard shoulder or next to the road may cause hazardous situations especially when they are not noticed timely by vehicle drivers passing by. This may, for example, lead to a collision with the slow or stationary vehicle or an unexpected steering or braking manoeuvre.
Objective	To provide timely in-car driving assistance information on a slow or stationary vehicle(s) downstream of the current position and in the driving direction of the vehicle.
Desired Behaviour	The Vehicle Driver adapts his/her driving behaviour compliant to any advice or guidance provided.
Expected Impact	In-car information on stationary vehicles is expected to improve traffic safety and reduce the risk of accidents.
Known Implementations	/ Talking Traffic Innovation Partnership (http://www.beterbenutten.nl/talking-traffic) / DriveC2X
References	1. Stationary Vehicle, Dutch Profile Part A Use Case Catalogue

Table 88: Introduction to Use Case: Slow and Stationary Vehicle Warning

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver

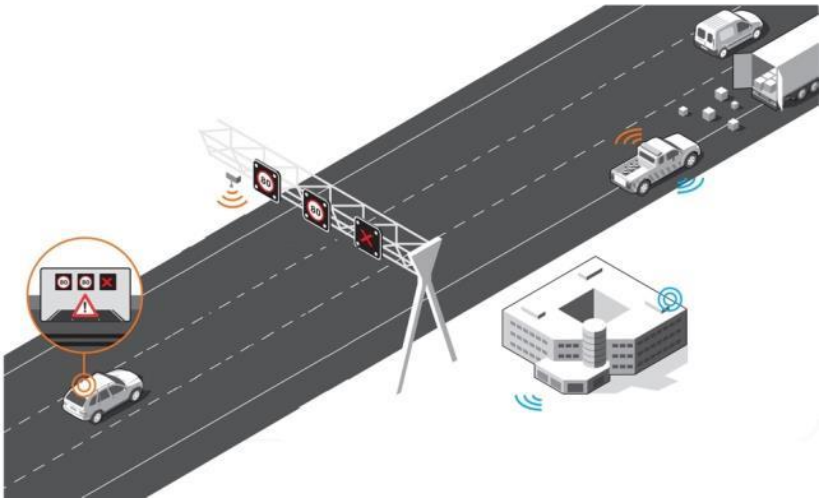
Stakeholders and Interests	/ Vehicle Driver: receives stationary vehicle information on the in-vehicle display. / Road operator: may detect and signal the presence of a stationary vehicle. Traffic safety increase. / Service Provider: disseminates the stationary vehicle information to vehicle drivers. / End User: traffic jams caused by stationary vehicles may be used by route planners.
Preconditions	The Vehicle ITS-S is installed and activated on the Vehicle Driver's smart phone or on-board unit and running in the background. Slow or stationary vehicle is equipped with a smart phone or on-boar unit able to notify his situation.
Post-conditions	In-car information and warnings about slow or stationary vehicle(s) displayed on the Vehicle ITS-S.
Main Success Scenario	1. A vehicle approaches a stationary vehicle downstream of the current position and in the driving direction. 2. The vehicle Driver receives timely an awareness message on the Vehicle ITS-S (in-vehicle display or smartphone). This message includes: the remaining distance (or time) to reach the stationary vehicle and, where appropriate, a driving recommendation (e.g. lane or speed change).
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	None.
Technology Variations List	/ Slow or stationary vehicles send their position, direction and speed in defined intervals via CAM. Reference: ETSI EN 302 637-2 / Sending a dedicated DENM would be much clearer for other vehicles to detect the presence of a slow or stationary vehicle. Therefore, DENM messages (complementary to CAM) can be used to construct and transmit a dedicated "slow vehicle indication".
Open Issues	*None.*
Illustrations, Visualizations, and Figures	

Figure 33: Stationary vehicle illustration, source: Dutch Profile Part A Use Case Catalogue

Table 89: Use Case Description: Slow and Stationary Vehicle Warning

4.19. Motorcycle Approaching Indication (MAI)

4.19.1. High Level Service Definition

Service introduction	
Summary	Motorcycle approaching indication (including other VRUs) warns the driver of a vehicle that a motorcycle is approaching/passing (the scope can be extended to cover VRUs, such as pedestrians, cyclists, or moped riders). The motorcycle could be approaching from behind or crossing at an intersection. The service assists the driver with blind spots.
Background	European In-depth motorcycle accident analyses highlights that human error, and more specifically not seeing the motorcycle coming or misinterpreting distance and speed is the primary cause of accidents involving motorcycles.
Objective	To provide timely in-car driving assistance information on an approaching motorised or powered two-wheeler in the driving direction of the vehicle.
Expected benefits	Improved traffic safety due to the decrease in the number of accidents.
Use Cases	1. Two-Wheeler Approaching Warning (V2V) 2. Two-Wheeler Approaching Warning (V2V and V2I)

Table 90: Motorcycle Approaching Indication High Level Service Description

4.19.2. Use Case(s)

4.19.2.1. Two-Wheeler Approaching Warning (V2V)

Introduction to the Use Case	
Background	The Two-Wheeler Approaching Warning aims to support both drivers and riders to compensate for the perception errors such as not seeing the motorcycle coming or misinterpreting distance and speed. Based on the broadcasted messages, the other vehicle is able to identify the two-wheelers, and both vehicles can determine whether a critical situation can occur.
Objective	To provide timely driving assistance information on an approaching two-wheeler downstream of the current position and in the driving direction of the vehicle.
Desired Behaviour	The Vehicle Driver and the Two-Wheeler Driver adapt their driving behaviour compliant to any advice or guidance provided.
Expected Impact	Information on approaching two-wheelers is expected to improve traffic safety and reduce the risk of accidents.
Known Implementations	/ CAR2CAR Consortium (https://www.car-2-car.org/index.php?id=171) / Motorcycle warning, Drive C2X (http://www.drive-c2x.eu/use-11)
References	1. The Approaching Motorcycle Warning – CAR2CAR Consortium

Table 91: Introduction to Use Case: Two-Wheeler Approaching Warning (V2V)

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	In the case of a presence of a motorised or powered two-wheeler (e.g. motorcycle, moped etc.) in the proximity of a vehicle.
Primary Actor	Vehicle Driver and Two-Wheeler Riders
Stakeholders and Interests	/ Vehicle Driver: receives awareness warning about the two-wheelers in proximity on the Vehicle ITS-S. / Two-Wheeler Rider: receives awareness warning about the other vehicles in proximity on the Vehicle ITS-S. / Service Provider: disseminates the awareness warning information to vehicle drivers.

Preconditions	The Vehicle ITS-S is installed and activated on the designated platform (smart-phone, on-board unit' bike helmet etc.) for the use of Vehicle Driver and Two-Wheeler Driver.
Post-conditions	Information and warnings about the presence of a vehicle in proximity is displayed on the Vehicle ITS-S.
Main Success Scenario	1. The Vehicle ITS-S on the two-wheeler continuously provides movement and position information to vehicles nearby. 2. The Vehicle ITS-S on the surrounding vehicles receive the information and can automatically compare their own movement data with the two-wheeler data. If a possible crossing with the two-wheeler is detected or the relative distance between the two vehicles decreases below a given safety margin, a warning is issued to the driver.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver or Two-Wheeler Rider. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver or Two-Wheeler Rider. 2. Vehicle ITS-S remains idle.
Special Requirements	/ The warning could be provided to the Vehicle Driver via an illuminated 2-wheeler icon/indication. / The warning could be provided to the Two-Wheeler Rider through: > A helmet with sound. See: http://www.bosch-presse.de/pressportal/de/en/digital-protective-shield-when-motorcycles-and-cars-talk-to-each-other-106387.html > On dashboard with light indicators. See: https://youtu.be/ztlNe9Pc-qs / The warning shall be relative to the speed or times. (seconds). / The detection sensitivity of the warning should differ according to the area that the vehicles are in. > Highway: More sensitive. > Urban area: Less sensitive.
Technology Variations List	The communication of the indication can be transmitted with CAM messages with complementary "motorcycle approaching" DENM.
Open Issues	*None.*

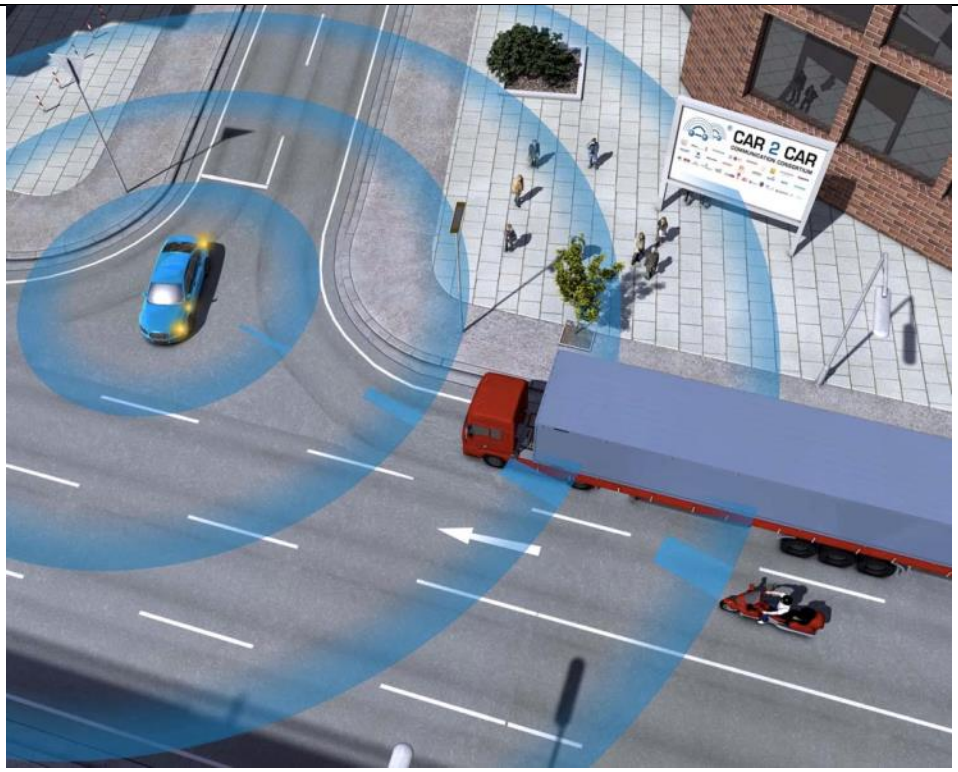
Illustrations, Visualizations, and Figures	 Figure 34: Illustration of approachin motorcycle warning, source: CAR2CAR Consortium

Table 92: Use Case Description: Two-Wheeler Approaching Warning (V2V)

4.19.2.2. Two-Wheeler Approaching Warning (V2V and V2I)

Introduction to the Use Case	
Background	The Two-Wheeler Approaching Warning aims to support both drivers and riders to compensate for the perception errors such as not seeing the motorcycle coming or misinterpreting distance and speed. Based on the broadcasted messages, the other vehicle is able to identify the two-wheelers, and both vehicles can determine whether a critical situation can occur.
Objective	To provide timely driving assistance information on an approaching two-wheeler downstream of the current position and in the driving direction of the vehicle.
Desired Behaviour	The Vehicle Driver and the Two-Wheeler Driver adapt their driving behaviour compliant to any advice or guidance provided.
Expected Impact	Information on approaching two-wheelers is expected to improve traffic safety and reduce the risk of accidents.
Known Implementations	/ CAR2CAR Consortium (https://www.car-2-car.org/index.php?id=171)
References	1. The Approaching Motorcycle Warning – CAR2CAR Consortium

Table 93: Introduction to Use Case: Two-Wheeler Approaching Warning (V2V and V2I)

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	In the case of a presence of a motorised or powered two-wheeler (e.g. motorcycle, moped etc.) in the proximity of a vehicle.
Primary Actor	Vehicle Driver and Two-Wheeler Riders
Stakeholders and Interests	/ Vehicle Driver: receives awareness warning about the two-wheelers in proximity on the Vehicle ITS-S. / Two-Wheeler Rider: receives awareness warning about the other vehicles in proximity on the Vehicle ITS-S. / Road operator / R-ITS-S: may detect and signal the messages coming from the

	vehicles. / Service Provider: disseminates the awareness warning information to vehicle drivers.
Preconditions	The Vehicle ITS-S is installed and activated on the designated platform (smart-phone, on-board unit' bike helmet etc.) for the use of Vehicle Driver and Two-Wheeler Driver.
Post-conditions	Information and warnings about the presence of a vehicle in proximity is displayed on the Vehicle ITS-S.
Main Success Scenario	1. The Vehicle ITS-S on the two-wheeler continuously provides movement and position information to vehicles nearby and the traffic infrastructure (R-ITS-S). 2. The Vehicle ITS-S on the surrounding vehicles receive the information and can automatically compare their own movement data with the two-wheeler data. If a possible crossing with the two-wheeler is detected or the relative distance between the two vehicles decreases below a given safety margin, a warning is issued to the driver.
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to the Vehicle Driver or Two-Wheeler Rider. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver or Two-Wheeler Rider. 2. Vehicle ITS-S remains idle.
Special Requirements	/ The warning could be provided to the Vehicle Driver via an illuminated 2-wheeler icon/indication. / The warning could be provided to the Two-Wheeler Rider through: > A helmet with sound. See: http://www.bosch-presse.de/pressportal/de/en/digital-protective-shield-when-motorcycles-and-cars-talk-to-each-other-106387.html > On dashboard with light indicators. See: https://youtu.be/ztlNe9Pc-qs / The warning shall be relative to the speed or times. (seconds). / The detection sensitivity of the warning should differ according to the area that the vehicles are in. > Highway: More sensitive. > Urban area: Less sensitive.
Technology Variations List	The communication of the indication can be transmitted with CAM messages with complementary "motorcycle approaching" DENM.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 94: Use Case Description: Two-Wheeler Approaching Warning (V2V and V2I)

4.20. Blind Spot Detection / Warning (BSD)

4.20.1. High Level Service Definition

Service introduction	
Summary	Blind spot detection / warning aims to detect and warn the drivers about other vehicles of any type located out of sight.

Background Objective	*None.* To provide timely in-car driving assistance information on the presence of a vehicle in a designated blind spot location in the driving direction of the vehicle.
Expected benefits Use Cases	Improved traffic safety due to the decrease in the number of accidents. 1. Digital Road Safety Mirror (V2I) 2. Digital Road Safety Mirror for VRU (V2I)

Table 95: Blind Spot Detection / Warning High Level Service Description

4.20.2. Use Case(s)

4.20.2.1. Digital Road Safety Mirror (V2I)

Introduction to the Use Case	
Background	Digital Road Safety Mirror aims to detect and warn the drivers about other vehicles of any type located in predefined blind spot locations.
Objective	To provide timely in-car driving assistance information on the presence of a vehicle in a designated blind spot location in the driving direction of the vehicle.
Desired Behaviour	The Vehicle Driver adapts his/her driving behaviour compliant to any advice or guidance provided.
Expected Impact	In-car information on the presence of a vehicle in a designated blind spot location is expected to improve traffic safety and reduce the risk of accidents.
Known Implementations	/ VRUITS / SCOOP@F
References	*None.*

Table 96: Introduction to Use Case: Digital Road Safety Mirror (V2I)

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	Vehicle Driver
Stakeholders and Interests	/ Vehicle Driver: receives the presence of a vehicle in a designated blind spot location information on the in-vehicle display. / Road Operator: may signal the presence of a vehicle in the designated blind spot location. / Service Provider: disseminates the information about the presence of a vehicle in the designated blind spot location to vehicle drivers.
Preconditions	The Vehicle ITS-S is installed and activated on the designated platform (smart-phone, on-board unit' bike helmet etc.) for the use of Vehicle Driver.
Post-conditions	In-car information and warnings about the presence of a vehicle in the designated blind spot location are displayed on the Vehicle ITS-S.
Main Success Scenario	1. The R-ITS-S located at the proximity of the designated blind spot location disseminates information about presence of a vehicle in the location. 2. A vehicle approaches to the designated blind spot location downstream of the current position and in the driving direction. 3. The Vehicle Driver receives timely an awareness message on the Vehicle ITS-S (in-vehicle display or smartphone). This message includes: the presence of another vehicle in the blind spot location and, when appropriate, a driving recommendation (e.g. braking or speed change).
Exceptions and	*a. At any time, Vehicle ITS-S fails

Alternative Flows	1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to the Vehicle Driver. 2. Vehicle ITS-S remains idle.
Special Requirements	The blind spots shall be static predefined places. This use case is based on the specific service implementation that is defined in the meeting held at Amersfoort on 26th and 27th of September. According to that definition this service is implemented with the R-ITS-Ss in-between the vehicles. In the case of an accident where the accident is not visible, the vehicle in the accident signals to the R-ITS-S (infrastructure) about the place of the accident and the R-ITS-S publishes and warns the other drivers. For this use case definition, the service is generalised for all the cars in a predefined blind spot location not just for the cars that had accident.
Technology Variations List	Instead of R-ITS-Ss in-between, the cars could communicate directly with each other (V2V) and disseminate location information. If the disseminated location information is marked as a blind spot, other vehicles in the proximity can issue a warning to the vehicle driver. Another Use Case for V2V communication can be defined.
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 97: Use Case Description: Digital Road Safety Mirror (V2I)

4.20.2.2. Digital Road Safety Mirror for VRU (V2I)

Introduction to the Use Case	
Background	Digital Road Safety Mirror for VRU aims to detect and warn the VRUs about other vehicles located in predefined blind spot locations.
Objective	To provide timely VRU assistance information on the presence of a vehicle in a designated blind spot location in the driving direction of the vehicle/VRU.
Desired Behaviour	The VRU adapts his/her driving behaviour compliant to any advice or guidance provided.
Expected Impact	Assistance information for the VRU on the presence of a Vehicle in a designated blind spot location is expected to improve traffic safety and reduce the risk of accidents.
Known Implementations	/ VRUITS
References	*None.*

Table 98: Introduction to Use Case: Digital Road Safety Mirror for VRU (V2I)

Use Case Description	
Scope	C-MobILE
Frequency of Occurrence	Continuous
Primary Actor	VRU
Stakeholders and Interests	/ Vehicle Driver: provide the actual position to the service provider / VRU: receives the presence of a vehicle in a designated blind spot location. / Road Operator: may signal the presence of a vehicle/VRU in the designated blind spot location. / Service Provider: disseminates the information about the presence of a vehicle in the designated blind spot location to VRUs.

Preconditions	The Vehicle ITS-S is installed and activated on the designated platform (smart-phone, on-board unit, etc.) for the use of Vehicle Driver/VRU.
Post-conditions	Warnings about the presence of a vehicle in the designated blind spot location are advertised on the Vehicle ITS-S.
Main Success Scenario	1. All vehicles/VRUs send their actual position to the cloud via internet. 2. A vehicle approaches to the designated blind spot location downstream of the current position and in the driving direction. 3. The VRU receives timely an awareness message on the Vehicle ITS-S. This message includes: the presence of a vehicle in the blind spot location and, when appropriate, a driving recommendation (e.g. braking or speed change).
Exceptions and Alternative Flows	*a. At any time, Vehicle ITS-S fails 1. Vehicle ITS-S displays an error message to VRU. 2. Vehicle ITS-S restarts itself. *b. Communication Failure 1. Vehicle ITS-S displays an error message to VRU. 2. Vehicle ITS-S remains idle.
Special Requirements	The blind spots shall be static predefined places.
Technology Variations List	*None.*
Open Issues	*None.*
Illustrations, Visualizations, and Figures	*None.*

Table 99: Use Case Description: Digital Road Safety Mirror for VRU (V2I)

5. C-MobILE C-ITS Survey

To gain more insight into the requirements and expectations of various stakeholders in this domain and also to validate the defined service definitions and use cases, a C-ITS Survey was conducted based on the defined services and use-cases (*available at:* http://c-mobile.bpmresearch.net/survey-c-its-services). The C-ITS Survey included two main parts: (1) questions for determining the stakeholder profile of the respondents, (2) questions on reviewing a set of five to seven C-ITS services relevant to the stakeholder profile that the participant selected.

In total, 89 respondents participated in the survey. There were four major stakeholder profiles among which respondents were expected to choose based on the profile they would like to represent. These were: *Drivers*, *Vulnerable Road Users – VRUs* (pedestrians, cyclists), *Public Authorities* (cities, municipalities, traffic managers, road operators), and *Private Companies* (private industry consisting of C-ITS technology, service, or solution providers). The distribution among these 89 respondents with respect to these 4 profiles is presented in Figure 35 below.

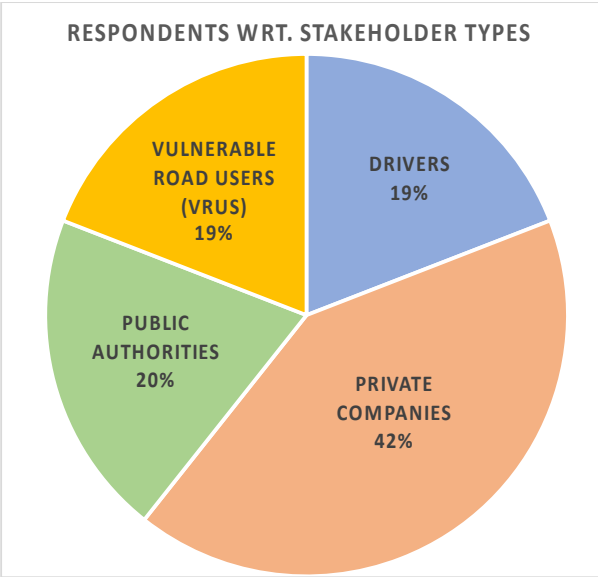


Figure 35: Respondents with Respect to Stakeholder Types

Majority of the respondents were experts in the C-ITS domain in different cities all around Europe, regardless of the profile they selected to provide their responses (e.g., an expert in a C-ITS architecture topic selecting the "driver" or "cyclist" profile and reviewing the services accordingly). The distribution of the experience levels of respondents is presented in Figure 36 below.

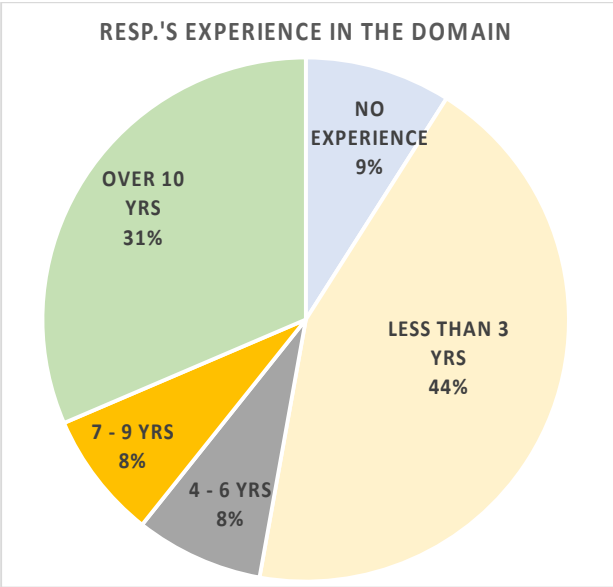


Figure 36: Respondent's Experience in the C-ITS Domain

For the second part of the survey, respondents provided a total of 508 C-ITS service reviews for 20 services, averaging around 25 reviews per C-ITS service. In this part, we asked them to review a set of C-ITS services from a set of viewpoints. The first viewpoint represented their opinions on the *impact areas* of the services. Table 4 presents the descriptions of four different types of impact areas.

Impact Area	Description
Road Safety	Increasing individual safety for all road users by informing or warning these users, or directly interacting with the vehicle.
Traffic Efficiency	Improving mobility by reducing delay and travel time. This is achieved by increasing the efficiency of the traffic flow, and preventing or reducing traffic jams by informing, advising, instructing individual road users, either directly or indirectly via applications.
Comfort	Increasing the comfort of individual road users. This can be achieved in various ways, e.g. by providing up-to-date information on traffic or route (as in navigation), or by providing priority to certain parties in the traffic.
Environmental Protection	Reducing the negative effects of traffic flow (CO_2 emission, noise, air pollutant emissions, etc.) through improved (fuel) efficiency.

Table 100: Impact areas and descriptions

We asked respondents to indicate -for each service- the extent to which the service's influences these impact areas. Respondents provided their answers on a 5-point Likert Scale with items ranging from Strongly Disagree to Strongly Agree. The results are presented in Figure 37.

Figure 37: Responses regarding the impact areas of C-ITS services

The survey participants considered all services to significantly contribute at least to one of the impact areas, which provided sufficient justifications for the implementation of all services that we have selected. The services that involve *warnings* (e.g., road hazard warning, road works warning, signal violation warning, motorcycle approaching indication/warning) were regarded as the key means to improve *road safety*. Furthermore, some services that contribute mostly to the *efficiency*, such as mode & trip time advice, green priority, and in-vehicle signage were deemed to have the most significant contributions when all dimensions are considered together.

The second viewpoint with respect to which participants reviewed the services, involved the *business* aspect. We asked respondents to give their opinions (using a 5-point Likert scale) on the *business value*, *time to value*, *usefulness* of the services they review, as well as their *intention to use* the services and *willingness to pay* for these services. These aspects are known to influence end-user's adoption of the service, and service providers' willingness to invest for its implementation and deployment. The results are summarized in Figure 38.

Accordingly, *all* services in our list were considered to be *useful*, with motorcycle approaching indication and road works warning leading in the list. When their business value is considered, some services were deemed to suffer from the lack of clear business value. Emergency vehicle warning is an example where respondents saw difficulties with respect to return on investment and profitability. While all services in our set were considered to have positive contributions to the society and deemed useful in the overall, the participants were very clear in their opinion on their *willingness to pay* for these services. Respondents were not willing to pay for majority of these services.

These results show a clear need to have well-thought and well-structured *business models* for these services in order to go beyond pilot implementations and provide self-sustaining large-scale service implementations.

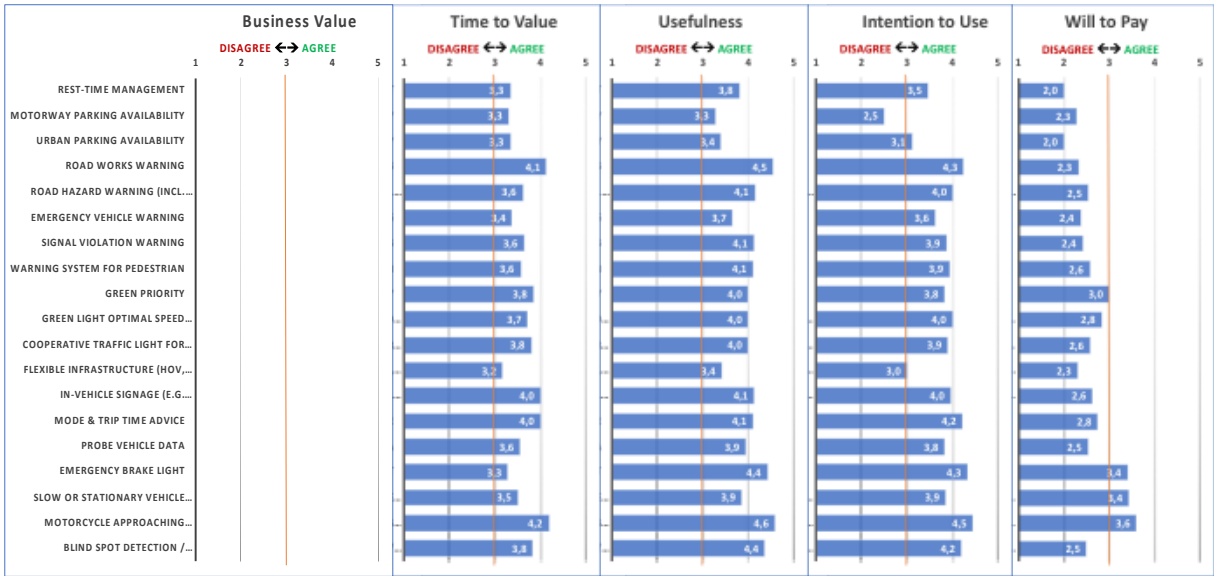


Figure 38: Responses regarding the other types of value of C-ITS services

The third part of the service reviews subsection included a grid question about bundling. The concept for bundling of services aims to ensure a seamless service to end-users by maximising impact and reducing investment costs. Regarding the bundles, we asked respondents to combine the services that they want to use or get benefit from together. In other words, we wanted them to create groups of services that complements each other in terms of functionalities. For the analysis, we divided results based on the four major stakeholder profiles of the respondents. Figure 39 below shows how many times each service was put into a bundle by a specific stakeholder profile.

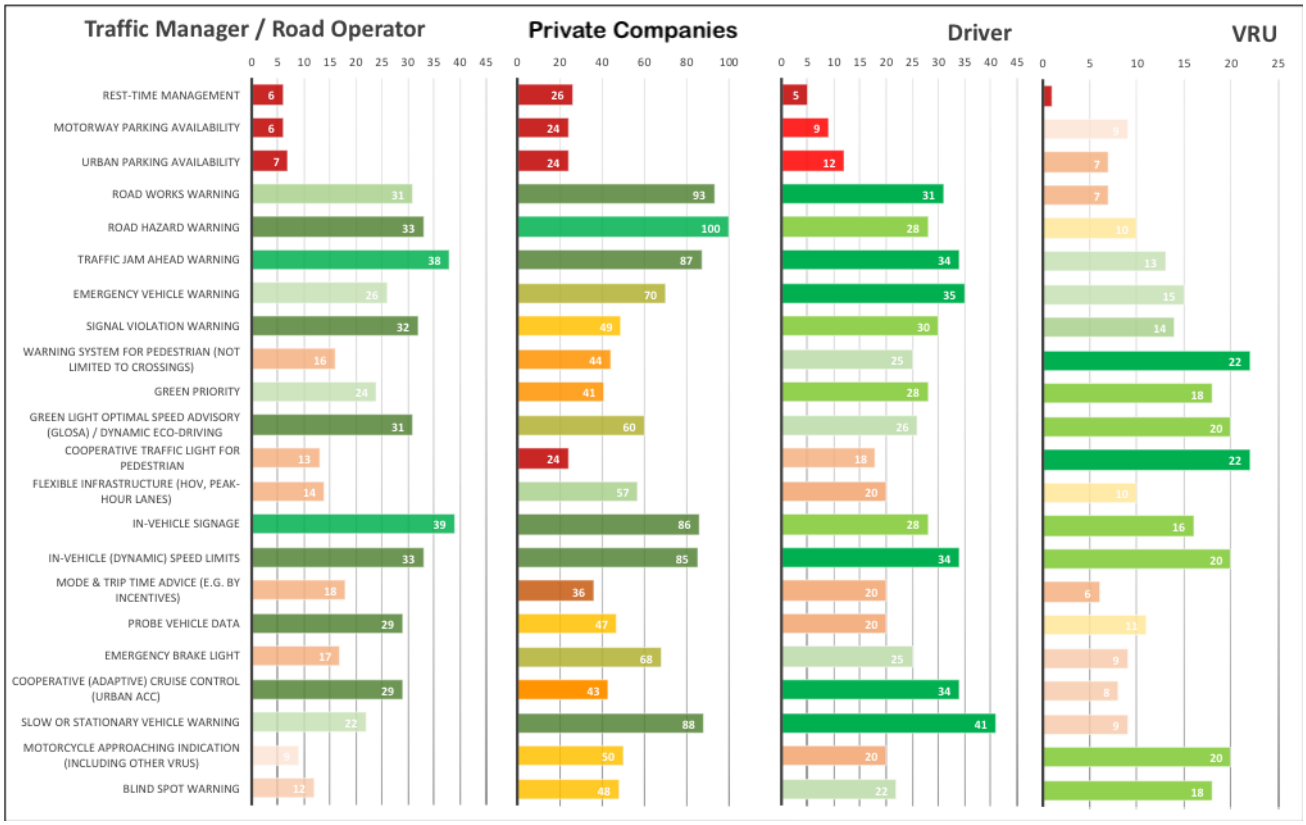


Figure 39: Number of votes given by certain stakeholder types for bundling question

Each chart in the figure is colour coded according to the frequency of the responses. Colour spectrum varies from red – representing services that are unlikely to be in the bundles to green -representing services that are most likely to be included in the bundles. The resulting preliminary bundling schemes based on the colour

coding is given below in Figure 40 and Figure 41. C-MobILE investigates the concept of bundling and aims at creating C-ITS service bundles which in turn ease the large-scale deployment throughout Europe. The consortium developed a separate report on the bundling taking these results from the survey as the initial input [11]. The reader is referred to this report for further details regarding the bundling dimensions and related services.

Impact Areas / *End-User Types*	Safety	Efficiency	Environment	Comfort
Drivers	Safe Driving	Efficient and Environmentally Friendly Driving		
Vulnerable Road Users (VRUs)	VRU Safety	Efficient and Comfortable Commuting		
Public Transportation / Commercial Fleet Operators		Efficient and Environmentally Friendly Service Provisioning		

Figure 40: Bundling Scheme: End-User Dimension

Driver Bundle-A: Safe Driving
S04- Road Works Warning
S05- Road Hazard Warning
S06- Emergency Vehicle Warning
S07- Signal Violation Warning
S08- Warning System For Pedestrian
S15- Probe Vehicle Data
S16- Emergency Brake Light
S18- Slow or Stationary Vehicle Warning
S19- Motorcycle Approaching Indication
S20- Blind Spot Detection / Warning

Driver Bundle-B: Efficient and Environment-Friendly Driving
S03- Urban parking availability
S10- GLOSA
S12- Flexible infrastructure
S13- In-vehicle signage
S14- Mode & trip time advice
S15- Probe Vehicle Data
S17- Coop. (Adaptive) Cruise Control

VRU Bundle-A: Safety
S08- Warning System For Pedestrian
S11- Coop. Traffic Light For Pedestrian
S19- Motorcycle Approaching Indication
S20- Blind Spot Detection / Warning
S15- Probe Vehicle Data

VRU Bundle-B: Efficient and Comfortable Commuting
S11- Coop. Traffic Light For Pedestrian
S14- Mode & Trip Time Advice
S15- Probe Vehicle Data
S11- Coop. Traffic Light For Pedestrian
S14- Mode & Trip Time Advice

Operator Bundle: Efficient and Environment-Friendly Service Provisioning *(for Public Transportation / Commercial Fleet Operators)*
S01- Rest-time Management
S02- Motorway Parking Availability
S03- Urban Parking Availability
S09- Green Priority
S10- GLOSA
S12- Flexible Infrastructure
S13- In-vehicle Signage
S15- Probe Vehicle Data

Figure 41: Further Decomposition of Bundling Scheme: End-User Dimension

The fourth and the final part of the service reviews subsection included a ranking grid where respondents ranked the services (using a 5-point Likert scale: not important -very important) according to their importance. As shown in the Figure 42 in overall importance none of the services was considered important. However, when importance is further investigated according to the stakeholder profiles, different results were uncovered. For Drivers, Traffic Jam Ahead Warning and Flexible Infrastructure were considered important. For Private Companies, Road Works Warning, Road Hazard Warning, Traffic Jam Ahead Warning and Emergency Vehicle Warning were considered important. For Public Authorities, Green Priority and GLOSA were considered important. Finally, for VRUs only Warning system for Pedestrian was considered important.

Figure 42: Importance of C-ITS services

All in all, the C-ITS survey resulted with no major objections to the definitions of the services and use cases. Resulting minor changes and suggestions are processed and included in the final version of the service definitions and use cases. Furthermore, the survey revealed interesting results in terms of societal and business value areas. The feedback obtained on these areas were fed into the tasks of related to validation and impact assessments.

6. Conclusions

In this deliverable, we present the end results of the part of the work carried out under task: 'T2.1 – In depth analysis and determination of use cases' under the work package: 'WP2 – Needs and requirements for implementation'. The major work items in this task were the development of definitions for the 20 C-ITS services, and in-depth use case analysis of these services to capture their user-level requirements. The resulting 36 use cases enclose a set of requirements in the context of the typical scenarios of using a C-ITS service. In turn, these scenarios capture the interaction of users with a C-ITS service and describe how the service works from its user's perspective. The service definitions are developed to avoid ambiguity and to attain a project-wide agreement. As a result, a document in the form of a glossary has been developed with the definitions of the services with their complementary attributes. The final work item under this task was the execution of the C-ITS survey which enabled a better understanding of the requirements and expectations of various stakeholders in the C-ITS domain and also used to validate the service definitions and use cases.

All the work items and resulting artefacts resulted in a better understanding of the needs and requirements for the large-scale implementation and deployment of the C-MobILE C-ITS services. This understanding was fed as input into task: 'T2.2 – Technical and Non-Technical Requirements' to facilitate elicitation of technical and non-technical requirements for the implementation of the C-ITS services.

The next steps will involve development of common operational procedures for cross-modal and seamless operation of the C-ITS services. These steps will be performed within WP2 under task: 'T2.3 - Operational procedures guidelines'. Building on previous pilot deployments, the operational procedures will be based on the use cases (which are presented in this deliverable) and architecture for implementation (i.e. 'D3.3 - Low-level implementation-ready architecture'). The resulting operational procedures will be reported in 'D2.4 - Operational procedures guidelines'.

Annex 1: List of Projects with Use cases

#	Project ID	Full Name	Service(s) and Use Case Description(s)
1	ATIS 2.0 Precursor System	A Next Generation Advanced Traveler Information Precursor System	Parking – Space Availability, Reservation, and Rates
2	C-ITS Corridor	-	1. Road Works Warning 2. In-Vehicle Signage 3. Probe Vehicle Data 4. Slow or Stationary Vehicle Warning
3	C-ITS Platform	-	1. 1.a Access management for special lanes reserved for designated vehicles (i.e. public transport, electric vehicles) V2I 2. 1.b Access management of restricted zones (low-emission, congestion control), temporary zones (following major incidents i.e. terrorist attack, traffic accident) V2I 3. 1.c Access management for tunnels and bridges with designated vehicles (HDV etc.)V2I 4. 2. Management of loading and unloading areas for freight vehicles V2I 5. 3.a Public Transport Vehicle Approaching - paused public transport vehicles/off-loading passengers V2V 6. 3.b Public Transport Vehicle Approaching - parking and intersections.V2V 7. 4. Access and speed management (i.e. near schools or identified priority zones by local authority etc.) - subset of in-vehicle signage V2I 8. 5. Management of on-street and off-street parking- subset of on-street and off-street parking information V2I 9. 6. Temporay traffic light prioritisation for designated vehicles (large events like concerts, football games etc.) - Subset of traffic light prioritisation of designated vehicles V2I 10. 7. Collaborative perception of Vulnerable Road Users (VRUs) - subset of VRU road user protection V2V 11. 8. Collaborative Traffic Management - subset of connected, cooperative navigation into and out of the city V2I 12. 9. GLOSA for cyclists V2I
4	C-ROADS	-	1. Road Works Warning 2. Use Case Closure of part of a lane, whole lane, or several lanes 3. In Vehicle Signage service 4. Use Case In-vehicle signage dynamic speed limit information 5. Other Hazardous Location Notification 6. Use Case Accident Zone 7. Service Introduction TLM – Traffic Light Manoeuvre and RLT – Road and Lane Topology 8. Green Light Optimal Speed Advisory high level description (GLOSA)
5	CIMEC	Cooperative ITS for Mobility in European Cities	1. CIMEC C-ITS USE CASE 1 - PERFORM INDIVIDUAL ROUTING OF VEHICLES 2. CIMEC C-ITS USE CASE 2 – IN-VEHICLE SIGNALLING

			3. CIMEC C-ITS USE CASE 3 - MANAGEMENT OF LOADING AND UNLOADING AREAS FOR DISTRIBUTION VEHICLES 4. CIMEC C-ITS USE CASE 4 - CONTROL THE ACCESS OF HEAVY GOODS VEHICLES WITH DANGEROUS GOODS TO TUNNELS 5. CIMEC C-ITS USE CASE 5 - REGULATION OF ACCESS TO FREE LANES FOR ELECTRICAL VEHICLES 6. CIMEC C-ITS USE CASE 6 - GIVE GREEN LIGHTS FOR POLICE AND EMERGENCY VEHICLES 7. CIMEC C-ITS USE CASE 7 – TRAFFIC LIGHT MANAGEMENT 8. CIMEC C-ITS USE CASE 8 - GIVE GREEN LIGHTS FOR PUBLIC TRANSPORT VEHICLES 9. CIMEC C-ITS USE CASE 9 – GREEN WAVES FOR CYCLISTS 10. CIMEC C-ITS USE CASE 10 - PARKING MANAGEMENT 11. CIMEC C-ITS USE CASE 11 - INFORM ABOUT INCIDENTS IN THE ROAD NETWORK AND CONTROL ACCESS TO THESE AREAS 12. CIMEC C-ITS USE CASE 12 - INFORM ABOUT EMERGENCIES IN THE ROAD NETWORK AND CONTROL ACCESS TO THESE AREAS 43 13. CIMEC C-ITS USE CASE 13 - CONTROL ACCESS TO GIVEN ROADS FOR NOT EMISSION-FREE CARS ON DAYS WITH POOR AIR QUALITY 14. CIMEC C-ITS USE CASE 14 - ENFORCEMENT OF THE SPEED OF VEHICLES RUNNING CLOSE TO SCHOOLS AND KINDERGARTENS WHEN CHILDREN ARE COMING OR LEAVING THE AREAS 15. CIMEC C-ITS USE CASE 15 - TRANSPONDER TECHNOLOGY FOR VULNERABLE ROAD USERS
6	Compass4D	-	1. Road Hazard Warning 2. Red Light Violation Warning 3. Energy Efficient Intersection Service
7	CO-GISTICS	Improving efficiency of freight and logistics through C-ITS	1. Intelligent truck parking 2. Priority and speed advice 3. Eco-drive support services 4. CO2 footprint monitoring and estimation 5. Multimodal cargo
8	CODECS	COoperative ITS DEployment Coordination Support	1. Intersection-based applications for designated vehicles 2. Floating vehicle data 3. In-vehicle information about (local) traffic rules and key infrastructure attributes
9	DITCM	Dutch Integrated Testsite Cooperative Mobility	1. Incident Warning 2. Road Works Warning 3. Hazardous Location Warning 4. Red Light Violation Warning 5. Emergency Brake Light 6. Slow Vehicle Warning 7. In Vehicle Signage 8. Cooperative Adaptive Cruise Control 9. Merging Assistant 10. Shockwave Damping

			11. Green Light Optimal Speed Advice 12. Green Wave 13. Stopping Behaviour Optimization 14. Priority Request 15. Rerouting 16. Cooperative Traffic Information Service 17. Intermodal Route Planner 18. Navigation 19. Eco Route Planner 20. Electrical Vehicle Charging Point Planner 21. Smart Parking Assistant 22. Pay How You Drive 23. Probe Vehicle Data
10	DRIVE C2X	DRIVing implementation and Evaluation of C2X communication technology in Europe	1. Traffic jam ahead warning (TJAW) 2. Roadwork warning (RWW) 3. Car breakdown warning (CBW) 4. Approaching emergency vehicle (AEV) 5. Weather warning (WW) 6. Emergency electronic brake light (EEBL) 7. Slow vehicle warning (SVW) 8. Stop sign violation (SSC) 9. Post crash warning (PCW) 10. Obstacle warning (OW) 11. Wrong-way warning gas-station (WWGS) 12. Motorcycle warning (MW) 13. In-vehicle signage speed limit (IVS/SL) 14. Green light optimal speed advisory (GLOSA) 15. Traffic information and recommended itinerary (TIRI/ DFCD) 16. Insurance and financial services (IFS) 17. Dealer management (DM) 18. Point of interest notification (POI) 19. Vehicle software provisioning and update (VSPU) 20. Local electronic commerce (LEC) 21. Fleet management (FM) 22. Transparent leasing (TL)
11	ECo-AT	Cooperative ITS Corridor – Joint Deployment NL/DE/AT	1. Use case Road Works Warning (RWW) 2. Use case In-Vehicle Information (IVI) 3. Use case CAM Aggregation 4. Use case Intersection Safety (ISS) 5. Use case Other DENM Applications
12	NordicWay	-	1. Temporary slippery road 2. Animal, people, obstacles, debris on the road 3. Unprotected accident area

			4. Reduced visibility 5. Unmanaged blockage of a road 6. Exceptional weather conditions (e.g. fog, heavy rain, heavy wind).
13	PROSPECT	Proactive Safety for Pedestrians and Cyclists	Use Cases for VRU Safety / Turning / Crossing
14	SCOOP@F	Connected vehicles and roads	1. A2 Collected Data from Road Hazard Signaling (crashes, etc.) 1.1. A2-D1: warning - temporary slippery road 1.2. A2-D4a: stationary vehicle 1.3. A2-D4b: vehicle breakdown 1.4. A2-D5: vehicle in accident 1.5. A2-D6: reduced visibility 1.6. A2-D10: warning - emergency brake 1.7. A2-D11: warning - end of queue 1.8. A2-E6: extreme weather conditions 2. A3 Collected Data from Road Hazard Signaling 2.1. A3-D2a: animal on the road 2.2. A3-D2b: people on the road 2.3. A3-D3: obstacle on the road 2.4. A3-D5: accident 2.5. A3-D8: unmanaged blockage of a road 3. B1 Roadwork Warning - planned roadwork (stationary and mobile plus salting zone) 4. B2 Roadwork Warning – road operator intervention 5. B3 Roadwork Warning - winter maintenance 6. C2 In-vehicle Speed limits 7. C3 In-vehicle signage 8. D1 Road hazard Signalling - temporary slippery road 9. D2 Road hazard Signalling - animal, people on the road 9.1. D2a: animal on the road 9.2. D2b: pedestrian on the road 10. D3 Road hazard Signalling - obstacle on the road 11. D4 Road hazard Signalling - stationary vehicles, breakdown 11.1. D4a: stationary vehicle 11.2. D4b: vehicle breakdown 12. D5 Road hazard Signalling - unprotected accident area 13. D6 Road hazard Signalling - reduced visibility 14. D7 Road hazard Signalling - vehicle travelling the wrong direction 15. D8 Road hazard Signalling - unmanaged blockage of a road 16. D10 Road hazard Signalling - emergency brake 17. D11 Road hazard Signalling - end of queue 18. E6 Road hazard Signalling - exceptional weather conditions
15	Shockwave Traffic Jams	-	Traffic Jam Ahead Warning

	A58		
16	VRUITS	Improving Safety and Mobility of Vulnerable Road Users Through ITS Applications	1. Intelligent Pedestrians Traffic Signal 2. Intersection Safety for VRU's 3. VRU warning via VRU Beacon System 4. VRU warning via Cooperative VRU Detection

Table 101: List of Projects with Reused Use cases

Annex 2: C-ITS Survey Questionnaire

C-MobILE C-ITS Survey

C-MOBILE

Welcome to the C-MobILE C-ITS Survey

About the C-MobILE Project

The C-MobILE (Accelerating C-ITS Mobility Innovation and depLoyment in Europe) vision is a fully safe & efficient road transport without casualties and serious injuries on European roads, in particular in complex urban areas and for Vulnerable Road Users. We envision a congestion-free, sustainable and economically viable mobility, minimizing the environmental impact of road transport.

The main objective of this survey is to gain an understanding of the views of the end-users and key stakeholders in the mobility domain on the C-ITS (Cooperative Intelligent Transport Systems) services that are envisioned to address their current and future transport and mobility needs. This will help us to better address these needs also with additional services.

The survey starts with questions related to your stakeholder profile. Depending on this profile, you will be asked to review 5-7 relevant services.

It takes about 20 minutes to complete the survey depending on your stakeholder profile.

Thank you for your valuable contribution,
The C-MobILE Consortium
http://c-mobile-project.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723311

Participation to the Survey

The nature of this survey is completely voluntary. Participants are not forced to take part into the project and no negative consequences will derive from declining the participation. All collected data will be securely anonymised and confidential. Participants won't be identifiable as the project ensures a complete privacy of their information.

When filling out the survey, you are free to decline to answer questions on topics and questions that you do not wish to answer/discuss. You will also be asked if you can be contacted for follow up questions, clarifications or further participation over the duration of the project.

Protection of Information

All information collected will be securely stored in the C-MobILE servers, which are equipped with security measures that guarantee the confidentiality, integrity and privacy of the information according to the General Data Protection Regulation (GDPR) 2016/679 of 27 April 2016 as well as the national legislation.

Thank you for your valuable collaboration.

TU/e
Information Systems Group
Eindhoven University of Technology (TU/e), C-MobILE Partner
Please contact here for any remark.

Important Notice: You can participate in the survey multiple times, each time selecting a different stakeholder profile that you can represent.

Figure 43: C-ITS Survey Home Page

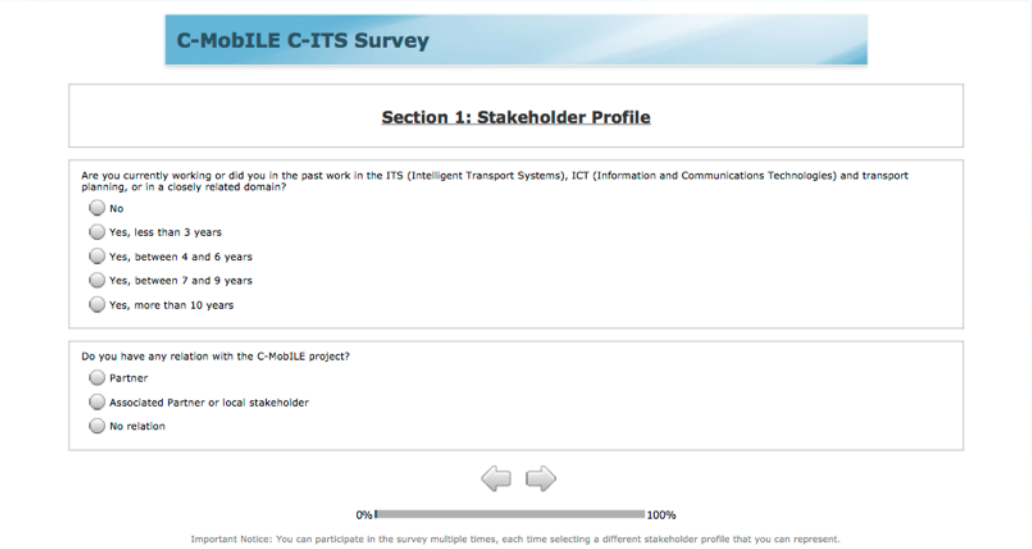
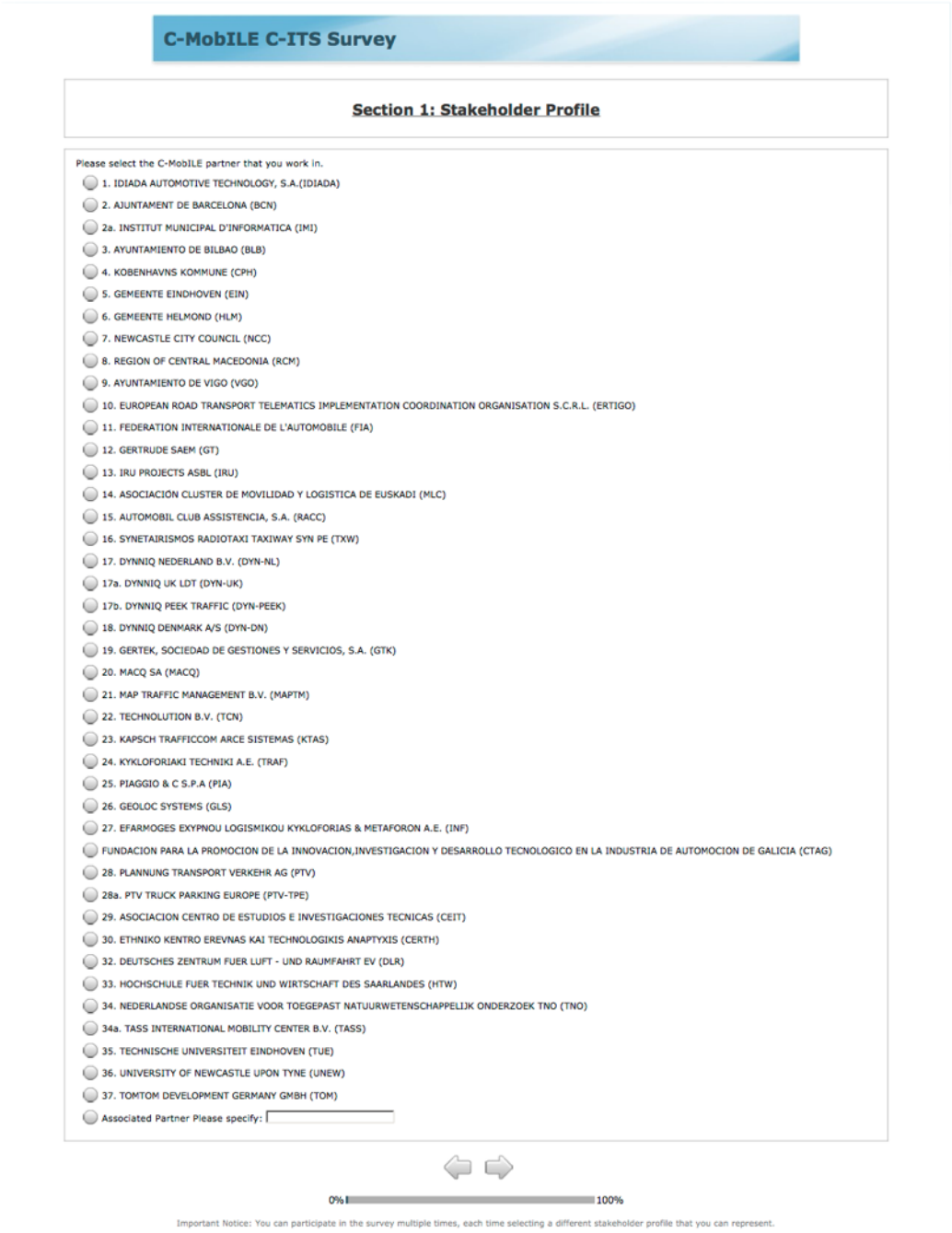


Figure 44: C-ITS Survey - Section 1: Stakeholder Profile – Page 1



C-MobILE C-ITS Survey

Section 1: Stakeholder Profile

Please select the C-MobILE partner that you work in.

- 1. IDIADA AUTOMOTIVE TECHNOLOGY, S.A.(IDIADA)
- 2. AJUNTAMENT DE BARCELONA (BCN)
- 2a. INSTITUT MUNICIPAL D'INFORMATICA (IMI)
- 3. AYUNTAMIENTO DE BILBAO (BLB)
- 4. KOBENHAVNS KOMMUNE (CPH)
- 5. GEMEENTE EINDHOVEN (EIN)
- 6. GEMEENTE HELMOND (HLM)
- 7. NEWCASTLE CITY COUNCIL (NCC)
- 8. REGION OF CENTRAL MACEDONIA (RCM)
- 9. AYUNTAMIENTO DE VIGO (VGO)
- 10. EUROPEAN ROAD TRANSPORT TELEMATICS IMPLEMENTATION COORDINATION ORGANISATION S.C.R.L. (ERTIGO)
- 11. FEDERATION INTERNATIONALE DE L'AUTOMOBILE (FIA)
- 12. GERTRUDE SAEM (GT)
- 13. IRU PROJECTS ASBL (IRU)
- 14. ASOCIACIÓN CLUSTER DE MOVILIDAD Y LOGISTICA DE EUSKADI (MLC)
- 15. AUTOMOBIL CLUB ASSISTENCIA, S.A. (RACC)
- 16. SYNETAIRISMOS RADIOTAXI TAXIWAY SYN PE (TXW)
- 17. DYNNIQ NEDERLAND B.V. (DYN-NL)
- 17a. DYNNIQ UK LDT (DYN-UK)
- 17b. DYNNIQ PEEK TRAFFIC (DYN-PEEK)
- 18. DYNNIQ DENMARK A/S (DYN-DN)
- 19. GERTEK, SOCIEDAD DE GESTIONES Y SERVICIOS, S.A. (GTK)
- 20. MACQ SA (MACQ)
- 21. MAP TRAFFIC MANAGEMENT B.V. (MAPTM)
- 22. TECHNOLUTION B.V. (TCN)
- 23. KAPSCH TRAFFICCOM ARCE SISTEMAS (KTAS)
- 24. KYKLOFORIAKI TECHNIKI A.E. (TRAF)
- 25. PIAGGIO & C S.P.A (PIA)
- 26. GEOLOC SYSTEMS (GLS)
- 27. EFARMOGES EXYPNOU LOGISMIKOU KYKLOFORIAS & METAFORON A.E. (INF)
- FUNDACION PARA LA PROMOCION DE LA INNOVACION,INVESTIGACION Y DESARROLLO TECNOLOGICO EN LA INDUSTRIA DE AUTOMOCION DE GALICIA (CTAG)
- 28. PLANNUNG TRANSPORT VERKEHR AG (PTV)
- 28a. PTV TRUCK PARKING EUROPE (PTV-TPE)
- 29. ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS (CEIT)
- 30. ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH)
- 32. DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV (DLR)
- 33. HOCHSCHULE FUER TECHNIK UND WIRTSCHAFT DES SAARLANDES (HTW)
- 34. NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO (TNO)
- 34a. TASS INTERNATIONAL MOBILITY CENTER B.V. (TASS)
- 35. TECHNISCHE UNIVERSITEIT EINDHOVEN (TUE)
- 36. UNIVERSITY OF NEWCASTLE UPON TYNE (UNEW)
- 37. TOMTOM DEVELOPMENT GERMANY GMBH (TOM)
- Associated Partner Please specify:

0% 100%

Important Notice: You can participate in the survey multiple times, each time selecting a different stakeholder profile that you can represent.

Figure 45: C-ITS Survey - Section 1: Stakeholder Profile - Page 2a (Visible when respondents choose 'Partner')

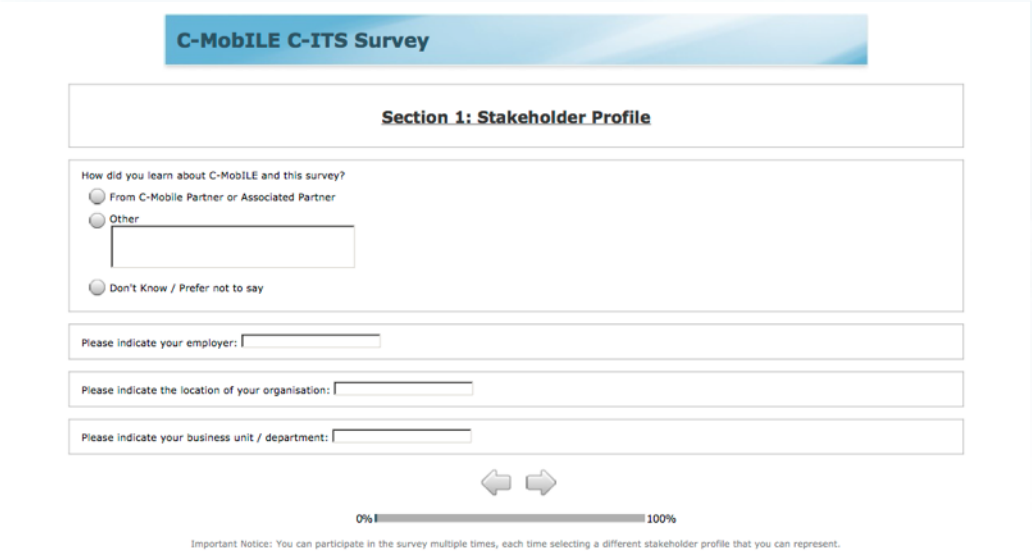


Figure 46: C-ITS Survey - Section 1: Stakeholder Profile - Page 2b (Visible when respondents choose 'Associated Partner' or 'local stakeholder')

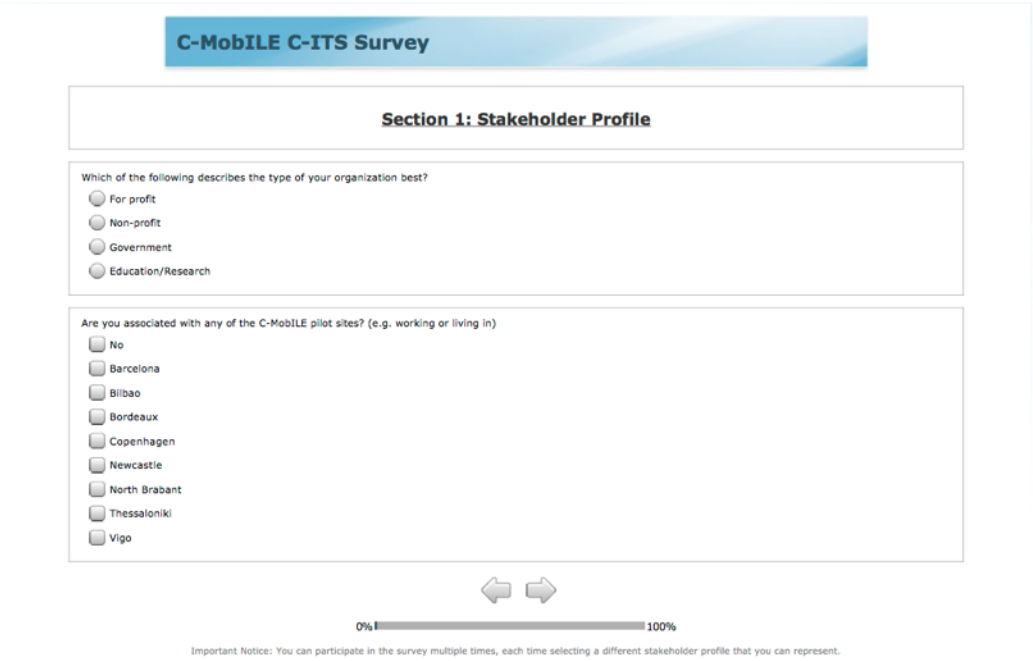


Figure 47: C-ITS Survey - Section 1: Stakeholder Profile - Page 3

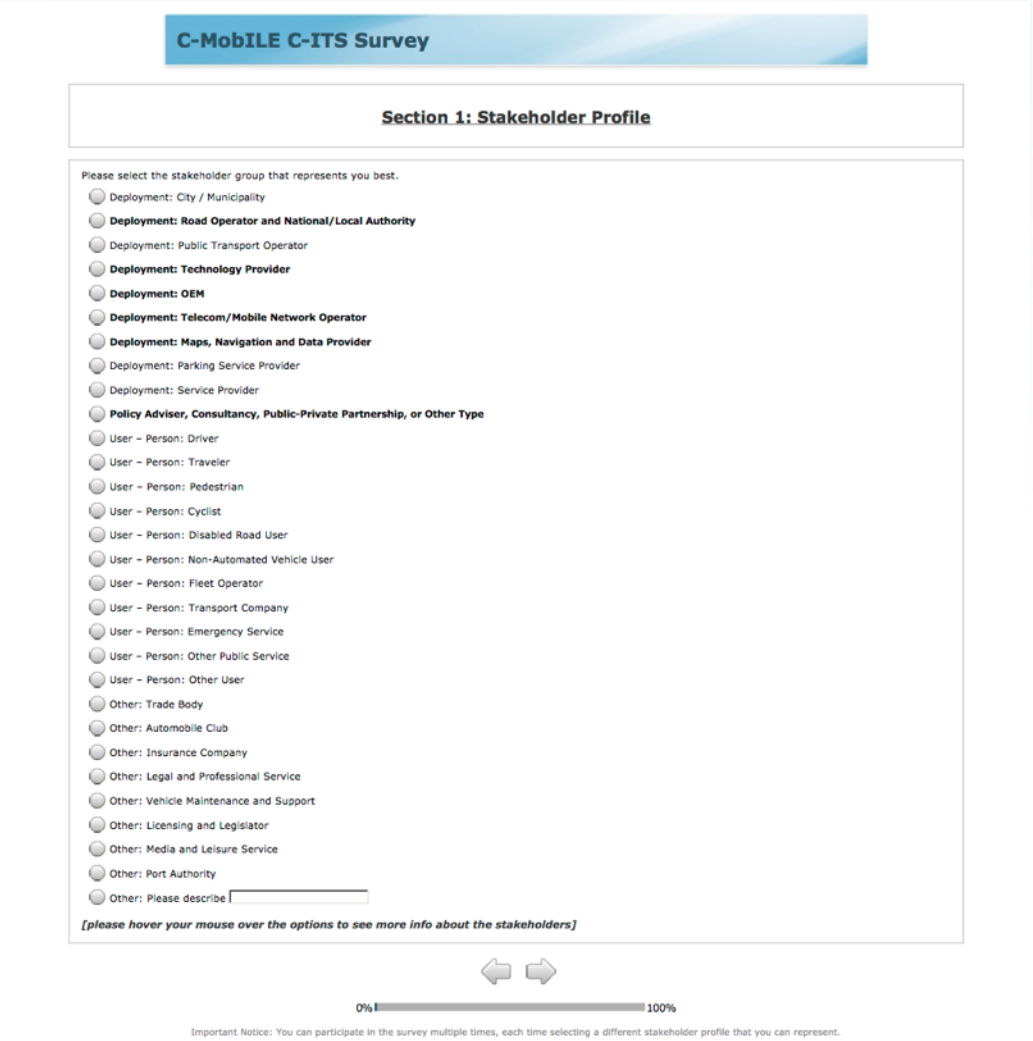
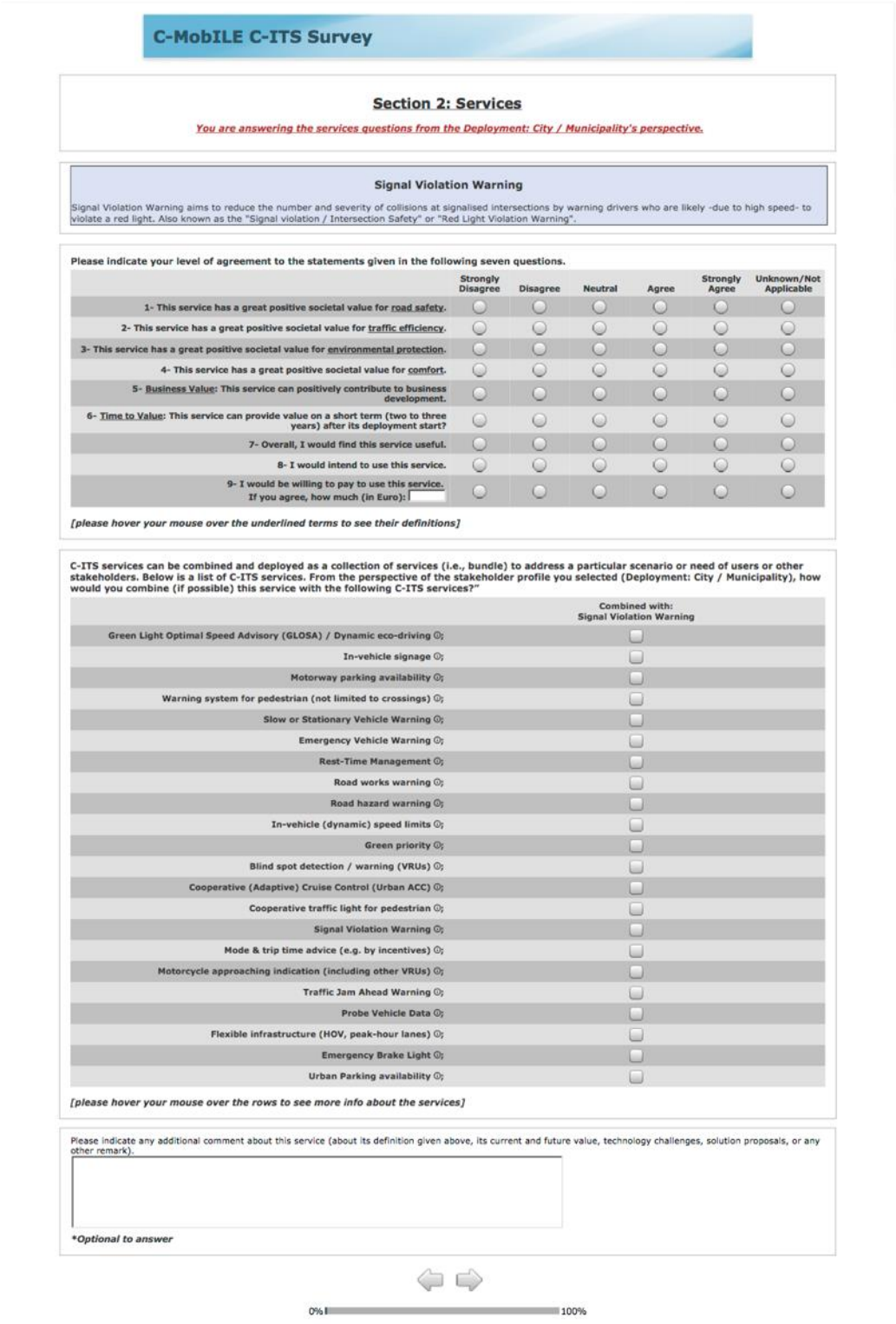


Figure 48: C-ITS Survey - Section 1: Stakeholder Profile – Page 4 (Where respondents' stakeholder profile is determined)

Figure 49: C-ITS Survey - Section 1: Stakeholder Profile – Page 5 (End of Section 1)



C-MobILE C-ITS Survey

Section 2: Services

You are answering the services questions from the Deployment: City / Municipality's perspective.

Signal Violation Warning

Signal Violation Warning aims to reduce the number and severity of collisions at signalised intersections by warning drivers who are likely -due to high speed- to violate a red light. Also known as the "Signal violation / Intersection Safety" or "Red Light Violation Warning".

Please indicate your level of agreement to the statements given in the following seven questions.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Unknown/Not Applicable
1- This service has a great positive societal value for road safety.	○	○	○	○	○	○
2- This service has a great positive societal value for traffic efficiency.	○	○	○	○	○	○
3- This service has a great positive societal value for environmental protection.	○	○	○	○	○	○
4- This service has a great positive societal value for comfort.	○	○	○	○	○	○
5- Business Value: This service can positively contribute to business development.	○	○	○	○	○	○
6- Time to Value: This service can provide value on a short term (two to three years) after its deployment start?	○	○	○	○	○	○
7- Overall, I would find this service useful.	○	○	○	○	○	○
8- I would intend to use this service.	○	○	○	○	○	○
9- I would be willing to pay to use this service. If you agree, how much (in Euro):	○	○	○	○	○	○

[please hover your mouse over the underlined terms to see their definitions]

C-ITS services can be combined and deployed as a collection of services (i.e., bundle) to address a particular scenario or need of users or other stakeholders. Below is a list of C-ITS services. From the perspective of the stakeholder profile you selected (Deployment: City / Municipality), how would you combine (if possible) this service with the following C-ITS services?"

	Combined with: Signal Violation Warning
Green Light Optimal Speed Advisory (GLOSA) / Dynamic eco-driving	☐
In-vehicle signage	☐
Motorway parking availability	☐
Warning system for pedestrian (not limited to crossings)	☐
Slow or Stationary Vehicle Warning	☐
Emergency Vehicle Warning	☐
Rest-Time Management	☐
Road works warning	☐
Road hazard warning	☐
In-vehicle (dynamic) speed limits	☐
Green priority	☐
Blind spot detection / warning (VRUs)	☐
Cooperative (Adaptive) Cruise Control (Urban ACC)	☐
Cooperative traffic light for pedestrian	☐
Signal Violation Warning	☐
Mode & trip time advice (e.g. by incentives)	☐
Motorcycle approaching indication (including other VRUs)	☐
Traffic Jam Ahead Warning	☐
Probe Vehicle Data	☐
Flexible infrastructure (HOV, peak-hour lanes)	☐
Emergency Brake Light	☐
Urban Parking availability	☐

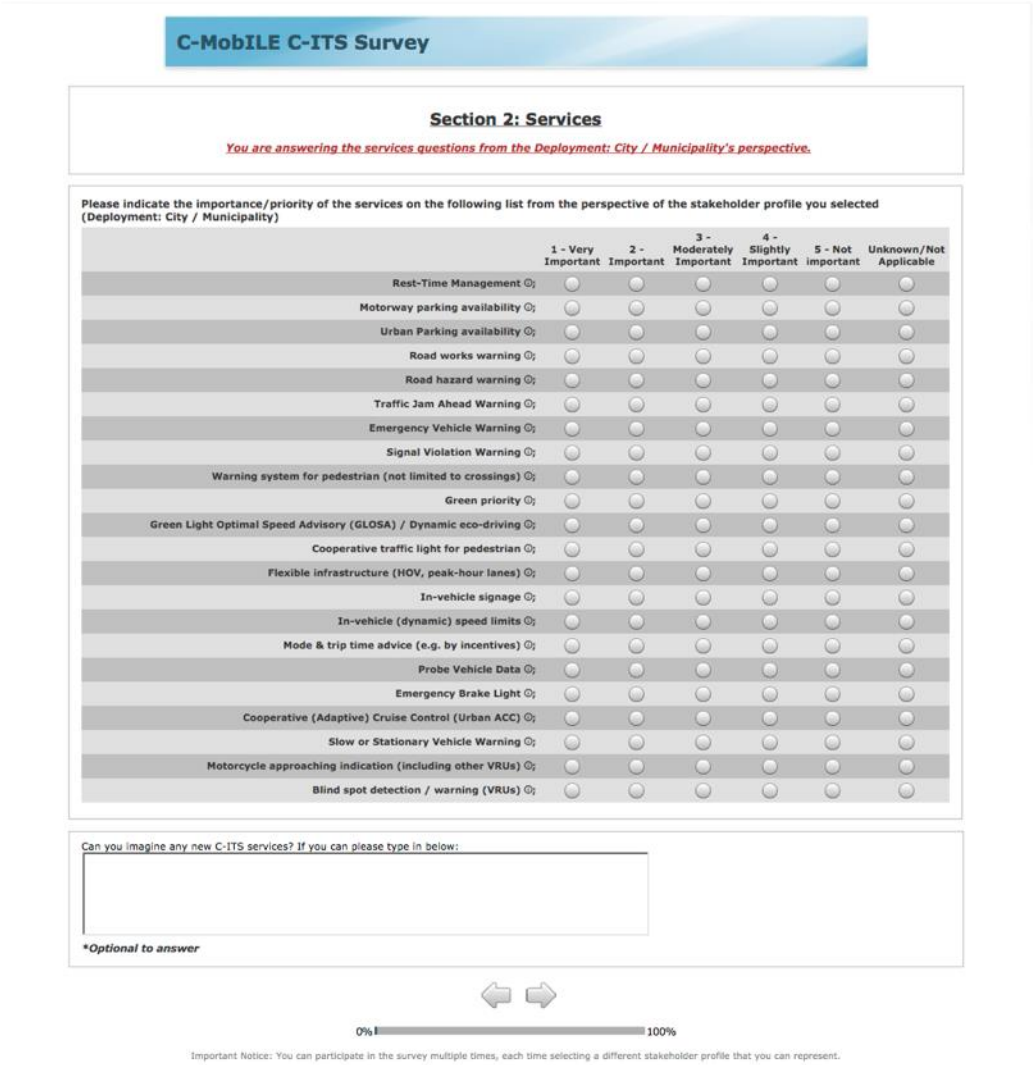
[please hover your mouse over the rows to see more info about the services]

Please indicate any additional comment about this service (about its definition given above, its current and future value, technology challenges, solution proposals, or any other remark).

*Optional to answer

0% 100%

Figure 50: C-ITS Survey - Section 2: Services – Service Evaluation Page (This page is repeated for all the 20 C-ITS Services. However, each respondent only sees 5 to 7 services according to the stakeholder profile s/he has chosen on Figure 48)



C-MobILE C-ITS Survey

Section 2: Services

You are answering the services questions from the Deployment: City / Municipality's perspective.

Please indicate the importance/priority of the services on the following list from the perspective of the stakeholder profile you selected (Deployment: City / Municipality)

	1 - Very Important	2 - Important	3 - Moderately Important	4 - Slightly Important	5 - Not important	Unknown/Not Applicable
Rest-Time Management	○	○	○	○	○	○
Motorway parking availability	○	○	○	○	○	○
Urban Parking availability	○	○	○	○	○	○
Road works warning	○	○	○	○	○	○
Road hazard warning	○	○	○	○	○	○
Traffic Jam Ahead Warning	○	○	○	○	○	○
Emergency Vehicle Warning	○	○	○	○	○	○
Signal Violation Warning	○	○	○	○	○	○
Warning system for pedestrian (not limited to crossings)	○	○	○	○	○	○
Green priority	○	○	○	○	○	○
Green Light Optimal Speed Advisory (GLOSA) / Dynamic eco-driving	○	○	○	○	○	○
Cooperative traffic light for pedestrian	○	○	○	○	○	○
Flexible infrastructure (HOV, peak-hour lanes)	○	○	○	○	○	○
In-vehicle signage	○	○	○	○	○	○
In-vehicle (dynamic) speed limits	○	○	○	○	○	○
Mode & trip time advice (e.g. by incentives)	○	○	○	○	○	○
Probe Vehicle Data	○	○	○	○	○	○
Emergency Brake Light	○	○	○	○	○	○
Cooperative (Adaptive) Cruise Control (Urban ACC)	○	○	○	○	○	○
Slow or Stationary Vehicle Warning	○	○	○	○	○	○
Motorcycle approaching indication (including other VRUs)	○	○	○	○	○	○
Blind spot detection / warning (VRUs)	○	○	○	○	○	○

Can you imagine any new C-ITS services? If you can please type in below:

*Optional to answer

0% 100%

Important Notice: You can participate in the survey multiple times, each time selecting a different stakeholder profile that you can represent.

Figure 51: C-ITS Survey - Section 2: Services – Service Ranking Page

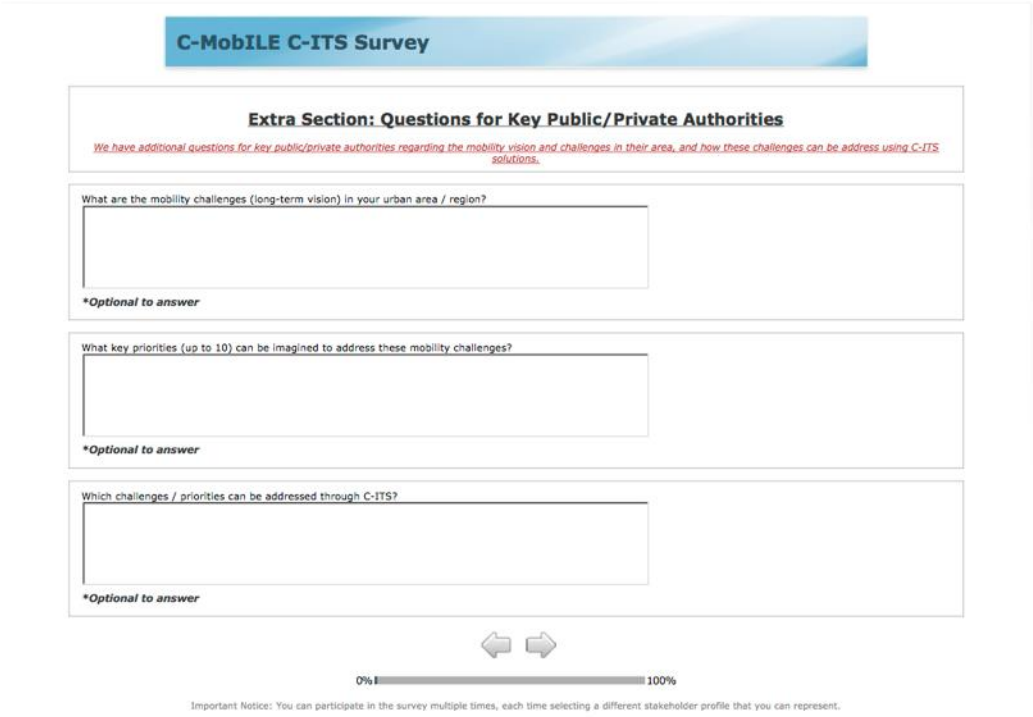
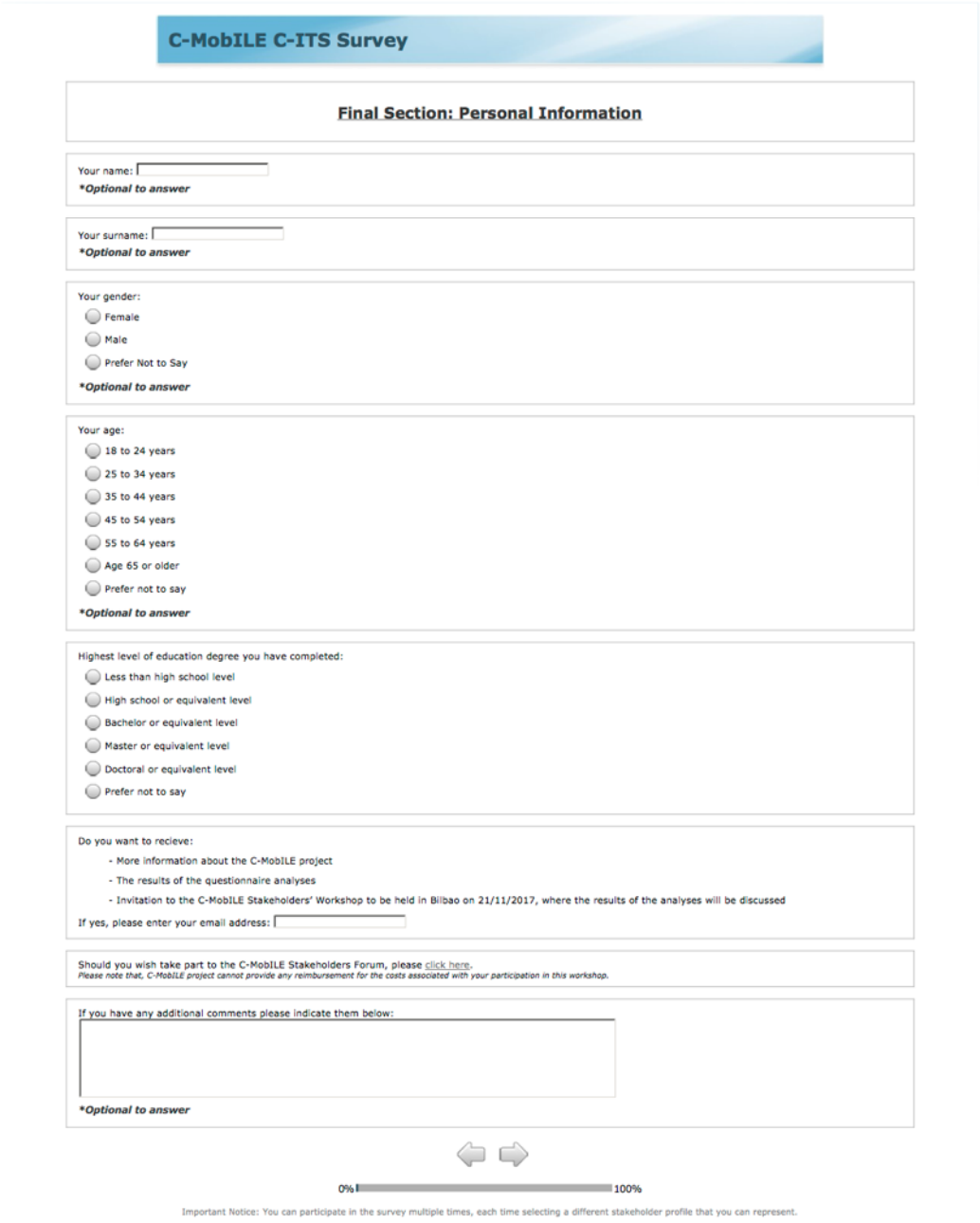


Figure 52: C-ITS Survey - Section 2: Services – Questions for Key Authorities Page (This page is only visible for respondents who have selected Key Public/Private Authorities (i.e. City / Municipality) on Figure 48)



C-MobILE C-ITS Survey

Final Section: Personal Information

Your name:
Optional to answer

Your surname:
Optional to answer

Your gender:
- Female
- Male
- Prefer Not to Say

Optional to answer

Your age:
- 18 to 24 years
- 25 to 34 years
- 35 to 44 years
- 45 to 54 years
- 55 to 64 years
- Age 65 or older
- Prefer not to say

Optional to answer

Highest level of education degree you have completed:
- Less than high school level
- High school or equivalent level
- Bachelor or equivalent level
- Master or equivalent level
- Doctoral or equivalent level
- Prefer not to say

Do you want to recieve:
- More information about the C-MobILE project
- The results of the questionnaire analyses
- Invitation to the C-MobILE Stakeholders' Workshop to be held in Bilbao on 21/11/2017, where the results of the analyses will be discussed

If yes, please enter your email address:

Should you wish take part to the C-MobILE Stakeholders Forum, please click here.
Please note that, C-MobILE project cannot provide any reimbursement for the costs associated with your participation in this workshop.

If you have any additional comments please indicate them below:

Optional to answer

0% 100%

Important Notice: You can participate in the survey multiple times, each time selecting a different stakeholder profile that you can represent.

Figure 53: C-ITS Survey – Final Section: Personal Information Page

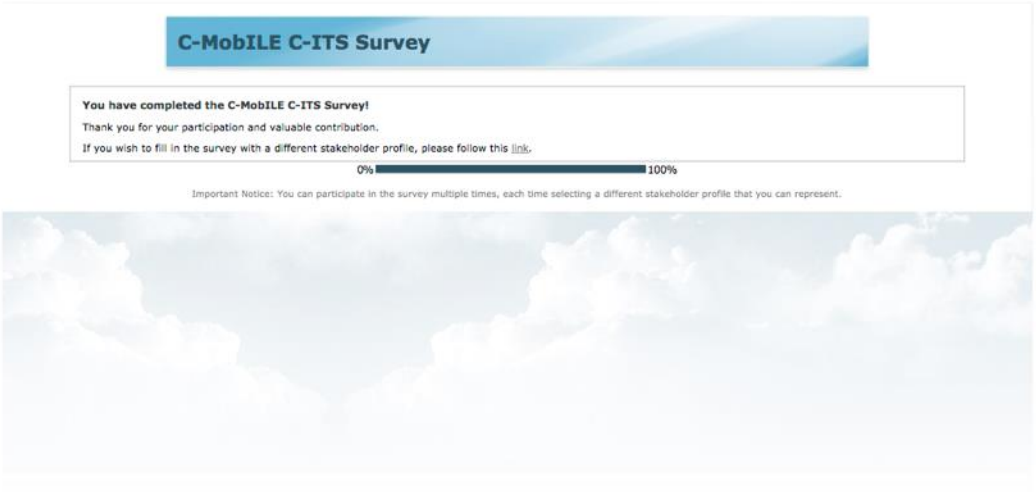


Figure 54: C-ITS Survey – End Page

7. References

[1] European Comission, “Grant Agreement number: 723311 — C-MobILE.” 2017.

[2] C. Larman, *Applying UML and Patterns: An Introduction to Object- oriented Analysis and Design and the Unified Process*, vol. 17. 2004.

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[8] ITS Joint Program Office, “Connected Vehicle Reference Implementation Architecture (CVRIA).”

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[11] C-MobILE, “Bundling of C-ITS Services,” 2018.