FUTURE
INTERNET
PPP

Instant Mobility

Multimodality for people and goods in urban areas

FP7 . CP 284906

WP4 – D4.4 Vehicle & handheld devices enablers specifications - iteration 1

December 2011

SEVENTH FRAMEWORK PROGRAMME

Project funded by the European Commission under the 7th European Framework Programme for RTD - ICT theme of the Cooperation Programme.

Instant Mobility WP4

D4.4 Vehicle & handheld devices enablers specifications - iteration 1

WP4	**D4.4 Vehicle & handheld devices enablers specifications - iteration 1**
Authors	Andrea Carlino - CRF Michele Provera – CRF Michael Boc - CEA
Short Description	This document is a draft description of the enablers specifications related to the vehicle platform and the handheld device. It describes the public interface of the entire on-board system (vehicle platform + handheld device) and a description of the architecture in terms of modules and exchanged data
Dissemination level (select)	PU
Date	31 December 2011
Status	Deliverable (final version 1.0)
Contributions by:	
Internal review by	Marcus Enered, Volvo Patrick Constant, Pertimm
Internally accepted by	Patrick Gatellier (WP4 leader)
Date of acceptance	17 January 2012

Document history

Version	**Date**	**Author /Reviewer**	**Description**
0.1	2011-12-12	Andrea Carlino	ToC and first draft of main contents
0.2	2011-12-19	Andrea Carlino Michael Boc	ToC finalization, Component diagram and description of each content Mobile router module description
0.3	2012-01-10	Andrea Carlino	Modifications according to internal peer review (by Volvo and Pertimm). Integration of CEA part on Mobile Router
0.4	2012-01-13	Andrea Carlino	Content integration, changes in the names of modules

Abstract

In the contemporary world there is a continuous increasing demand of mobility, increasing number of cars which cannot be supported by any similar increase of roads infrastructures, due to limited areas that can be used for this purpose; thus the solution is the improvement of the mobility experience of the drivers by means of smarter techniques and strategies, aimed at optimizing the limited resources.

In order to implement these strategies some particular algorithms are needed, in addition to the strong Public Administration will and a set of technological enablers. In particular, it is important that all the people (driver, passengers, etc…) are informed or even supported in their optimization decisions. In order to implement different types of services for the users, either people moving with public transport means or driving with a car or truck, all the involved actors should be informed and this can be done through the personal device or handheld device, which is owned by all the people nowadays. Moreover for the driver, the consignor of a delivery company could benefit from additional data they, or their applications, can obtain from the car itself. These data can, in turns, be useful to the service centres which need as much information sources as possible.

Anyway, in order to implement a wide variety of services both the vehicle and the handheld device need to satisfy some specific requirements and should be provided with specific enablers.

For the vehicle platform, that is the On-Board Unit (OBU) embedded in the car, the enablers required are:

- the Vehicle Data module;
- the Geolocation module;
- the Cooperation module;
- the Touch Screen display;
- the NFC technology;
- the Security module;
- the Mobile Router.

For the handheld device, which can be a smartphone or any similar PND, the enablers required are:

- the Sensors module;
- the Cooperation module;
- the NFC technology;
- the Internet connection module.

Table of Content

Table of Figures

1. Introduction

This document contains a draft description of the enablers of the OEM in-vehicle infotainment device, also known as On-Board Unit (OBU) or vehicle platform, and of the handheld devices (or nomadic device) enablers, which are required by services in all the three scenarios (Scenario 1, 2 and 3). This document is divided in four sections.

In this section a brief introduction is given, setting the context and the objectives of the deliverable.

The second section describes the main Use Cases functional decomposition (based on the work of WP3).

The third section is meant to describes the public interface and the interaction with external services and components. It defines the environment in which the platform will be deployed and the requirements of these external actors to interact and take advantage of the platform. It is the outside view of the platform.

The fourth section provides the enablers description. It is the inside view of the platform. It presents a description of the modules which need to be integrated in the overall system in terms of high level specifications and role.

1.1 Preliminary information

In order to be more aligned to the name of the other Deliverables and to keep a sort of correspondence between the task name and the name of the deliverable, the title of this deliverable has been modified: instead of “Vehicle sharing enablers specifications – iteration 1” it was changed to “Vehicle & handheld devices enablers specifications - iteration 1”.

The task T4.4, “Vehicle and handheld devices enabler set”, is strictly related to task T4.3, “Driver and traveller enabler set” and in the same way this deliverable, D4.4, “Vehicle and handheld devices enablers specifications – iteration 1”, is related to the D4.3, “Driver and traveller enablers specifications – iteration 1”.

T4.3 and D4.3 deal more with the software enabler set, investigating and considering the software needed to enable the service provisioning, while T4.4 and D4.4 focus more on the hardware architecture, the hardware components and the related high level specifications needed to realize the scenarios described in WP3.

1.2 WP4 objectives in Instant Mobility

In work package WP3, “Use Case Scenarios”, the main use case scenarios have been identified and analysed and, based on these outcomes, the Future Internet technologies roadmap has been produced.

Taking into account these results and outputs of WP3, the work package WP4, “Future Internet Enablers”, aims at deriving the detailed technical specifications of the components necessary to implement these scenarios. These components, called Future Internet enablers, can be either physical hardware modules (either generic or domain-specific) or services build on top of these enablers.

1.3 Objectives of Deliverable D4.4

The purpose of D4.4 "Vehicle and handheld devices' enablers specifications - Iteration 1" is to identify and describe both the generic enablers and the domain specific enablers necessary to implement the three scenarios identified in WP3: "Personal travel companion", "Smart city logistics operations" and "Traffic infrastructure as a service".

The enablers will be described in terms of hardware architecture, with the identification of all the needed components and with special attention to the communication properties within the in-vehicle system and between the in-vehicle system and the external world. The in-vehicle system is the overall architecture including the vehicle platform, that is the embedded board of the vehicle, and the handheld device, which is the personal electronic device of the actor using the different services.

This document, like the other WP4 first iteration deliverables, is derived from WP3 activities. Since this deliverable and D3.3 are due at the same time, the results included here are primarily based on D3.1, while the integration of D3.3 results will be performed in the second iteration of Vehicle and handheld devices' enablers. The second iteration, in which the set of requirements definition will be refined, is expected by month 15 (June 2012) and will be finalized in D4.11, in which the features of the components will be deepened and the detailed specifications will be provided.

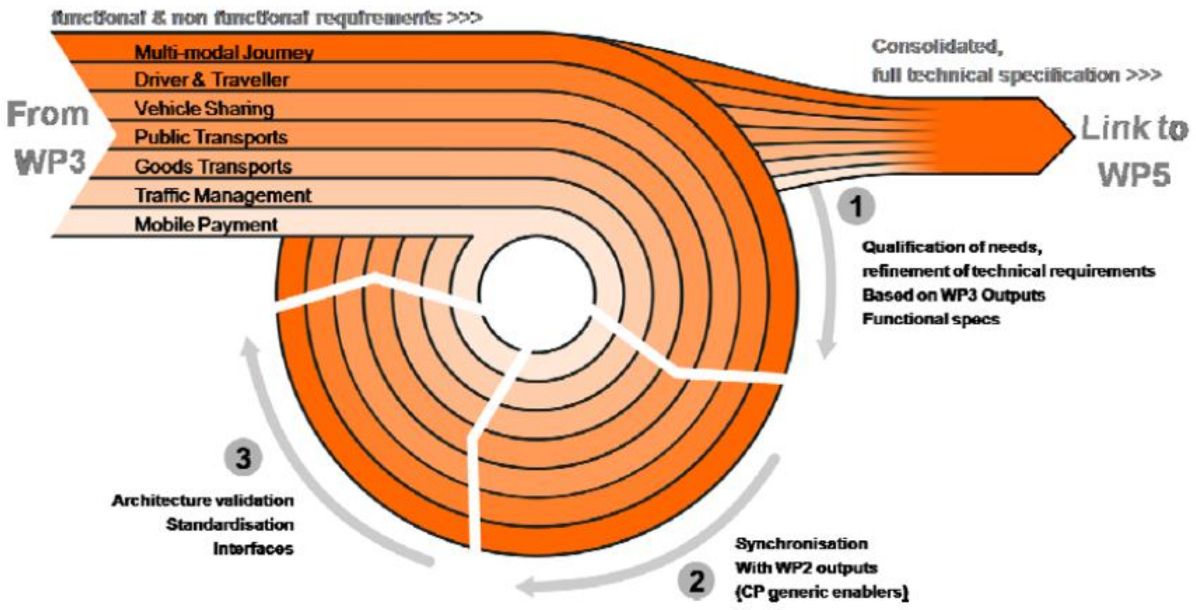

Figure 1: Iterative specifications of enablers in WP4

In the evolution from the first iteration to the second one, the refinement of the enablers will be carried on; this means, as already said, that the specifications will be more detailed and the descriptions more precise. Anyway from an analysis of the results of D3.3, whose outcomes strongly influence the content of this deliverable it could stand out that some other changes could be necessary: for example some enablers identified up to the delivery of this document could be no more necessary or some other solution could be designed. On this matter it should be pointed out that especially two aspects described in the next chapters should be further verified: the MirrorLink and the Security module, where the integration of a camera recording the inside of the vehicle should be discussed after the finalization of the applications of D3.3.

This document will serve as an input to the prototype implementation in WP5 and the second iteration of the WP2 “Program collaboration” deliverable, which provides input to the FI-WARE project.

1.4 Abbreviations

CAN	Controller Area Network
CP	Core Platform
ECU	Electronic Control Unit
FI	Future Internet
GE	Generic Enabler
IaaS	Infrastructure as a Service
IoT	Internet of Things
IP	Intellectual Properties
IP	Internet Protocol
OBU	On-Board Unit
PaaS	Platform as a Service
PND	Portable Navigation Device
TMC	Traffic Management Centre
VANET	Vehicular Ad-hoc Network
VDC	Virtual Data Centre
VM	Virtual Machine

1.5 Definitions

In this small paragraph the main component of the overall architecture are simply and briefly described; this will be the names used to identify the different physical components in the rest of the deliverable.

In-vehicle system: this name identifies the overall architecture of the vehicle, which is composed by the On-Board Unit and by the handheld device of the user.

On-Board Unit or **vehicle platform**: this is the electronic board which is embedded and highly integrated with the vehicle. It is connected to vehicle network, on which all the ECUs writes their data, and to the HMI of the car, like for example the steering wheel buttons, the integrated microphone, the loudspeakers and the dashboard matrix display.

Handheld device or **nomadic device**: this is the term used to indicate the device of the user, which has the basic peculiarity to be personal and portable.

2. Applications summary

The enablers that will be described in chapter 4 have been collected by taking into account the use cases identified by WP3 activities. In this chapter all the applications for the three different scenarios will be listed and then a brief summary for the most relevant Use cases will be presented, in order to give an idea of the applications envisaged in Instant Mobility.

The WP3 scenario "Personal travel companion" includes 3 applications:

1. "Dynamic multimodal journey";
2. "Dynamic private & professional car sharing";
3. "Optimized public transport usage".

"Smart city logistics operations", related to goods transport, defined four main applications:

1. "Load Sharing and Optimizing";
2. "Dynamic Booking Time/Place Drop Point";
3. "Itinerary and Real Time Optimized Route Navigation";
4. "Eco-optimized Driving, Vehicle and Driveline Control".

The scenario "Transport infrastructure as a service" is composed by five applications:

1. "Real time traffic & route info";
2. "Floating passenger data collection";
3. "Virtualized intersection intelligence";
4. "Cooperative traffic signal control";
5. "Area-wide optimization strategies".

Among all these services there are two of them, which involve the vehicle system and/or the handheld device; this section contains the use case decomposition for each of them.

2.1 Dynamic private & professional car sharing

This application has been designed both for private and professional usage, regarding ride sharing and car sharing.

In the case of ride sharing service for private drivers, initially, each private driver provides its destination to a central system and its availability to share its vehicle. The system answer with a best possible itinerary for the driver destination and add its vehicle to the available sharable vehicle set. During the trip, shared rides (for parts or all of the driver itinerary) with traveller(s) are proposed to the driver with the rating of the proposed traveller(s). If the driver and the traveller both agree, the application manages all the shared rides, the meeting points, , the check-in and check-out, the in-journey security and the billing.

This application aims at managing also car sharing, that means that the system will manage the sharing of a vehicle by allowing the rendezvous between a previous and a next to come driver, the handover of the car, the various checks, etc.

As far as it concerns the professional driver, the car and ride sharing aspects are also designed to allow fleet cars and taxi drivers to manage the specific car sharing and ride sharing aspects of their work.

In both private and professional case both the vehicle platform and the handheld devices are needed to implement such kind of services; in case of ride sharing, also the traveller could have extremely clear advantages by the use of a handheld device which can keep him/her up-to-date in real-time.

2.2 Load sharing and optimizing

This service aims at optimizing the available transport resources by means of a better allocation of goods. It involves both centralized and decentralized load sharing and optimizing.

In the first case there is a centralized system which receives all the transport requests from the different transport bookers and then allocates the transport requests to the most suitable available transport resource (truck or delivery van).

In the second case, the decentralized solution, the vehicles themselves communicate directly with each other, since they their respective load and itinerary. If it is detected that reloading goods from one vehicle to another could provide benefits, such a suggestion is sent to the involved vehicles’ transport planners for making such decision.

This application can of course benefit from the usage of the in-vehicle system, for more automated and optimized procedures.

2.3 Itinerary Booking and Real Time Optimized Route Navigation

The itinerary booking and real time optimized route navigation is focused on the transport planner and the driver. The system helps the transport planner by suggesting itineraries and assignment of itineraries to vehicles, taking into account traffic information and the progress of the on-going transport missions. The driver receives the itineraries in the in-vehicle system and is guided to the destination by the navigation system.

The main goal of this service is to optimize the movements of the vehicles, avoiding them to be blocked in traffic jams and taking, when possible, the shortest routes. This service implies route planning based on historical traffic data for the specific day of the week and time of delivery and re-routing of vehicles based on real-time traffic updates within the city in case of particular and unpredictable events (like accidents for example). In addition to the road infrastructure sensors, the vehicles are used as probes to help the Traffic management centre in the traffic estimation.

The functionalities needed on the in-vehicle system to implement this service are:

- Reading the vehicle data that can be related to its movements and the road conditions;
- Filtering and pre-processing these data in order to obtain useful information for the traffic estimation;
- Dispatching useful vehicle information to the Traffic Management Centre (TMC);
- Receiving traffic info updates from the TMC;

- Receiving variations to the booked itinerary due to special events (accidents, car breakdowns, …).

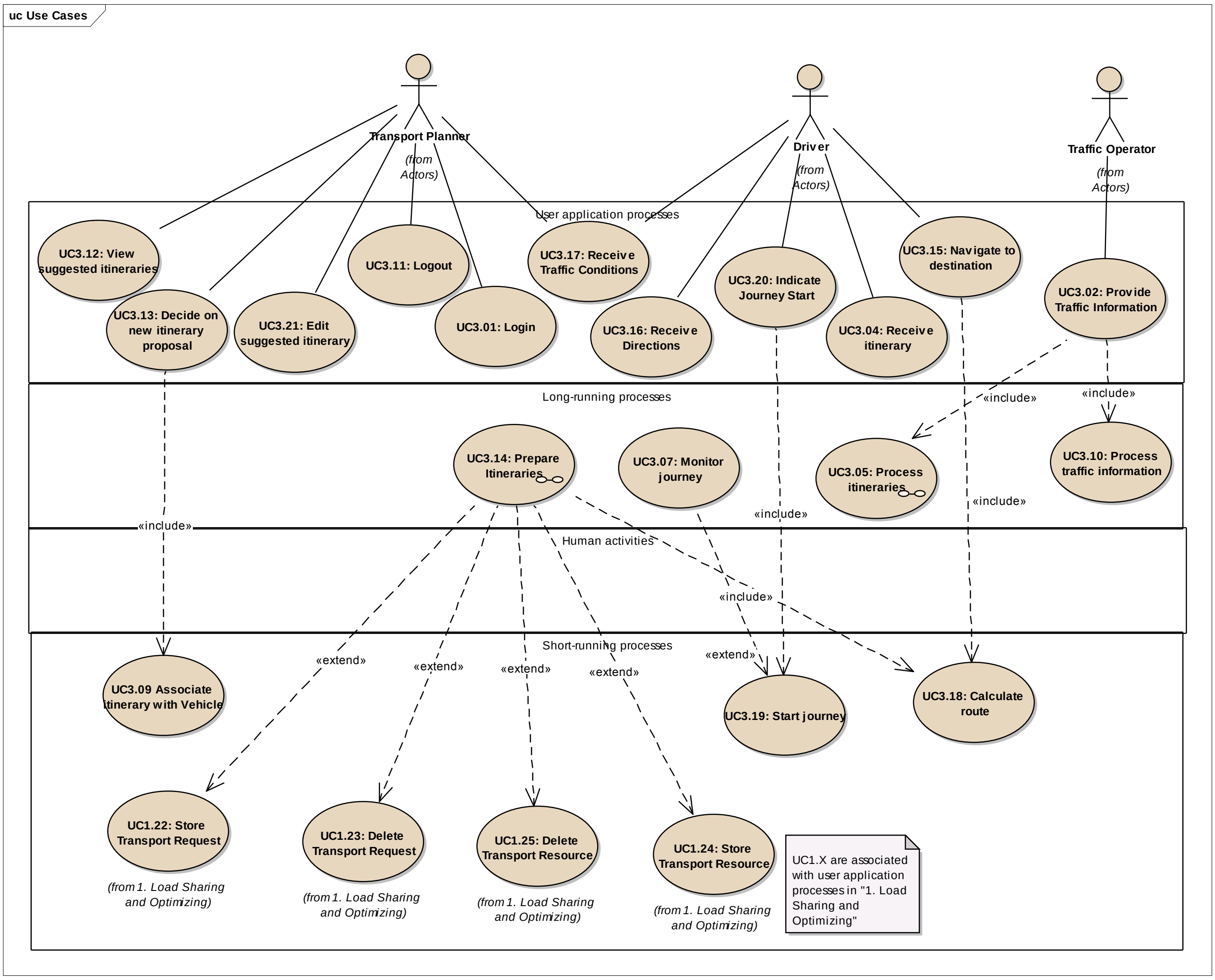

Figure 2: Use case diagram of the itinerary booking and real-time optimized route navigation

2.1 Eco-Optimized driving, vehicle and driveline control

The goal of this application is the optimization of the vehicle movements, minimizing the fuel consumption and thus the pollution production. Using vehicle CAN data, information from surrounding vehicles and information from the infrastructure, highly accurate eco-driving support can be provided to the driver. The support can be provided by means of eco-driving tips through the in-vehicle display or by adding inertia to the throttle pedal if accelerating is not recommended from an eco-driving perspective.

The application can also include functionalities for pre-trip coaching, making sure that the vehicle is in good condition, and after-trip coaching where the performance of the driver can be compared to the performance of other drivers.

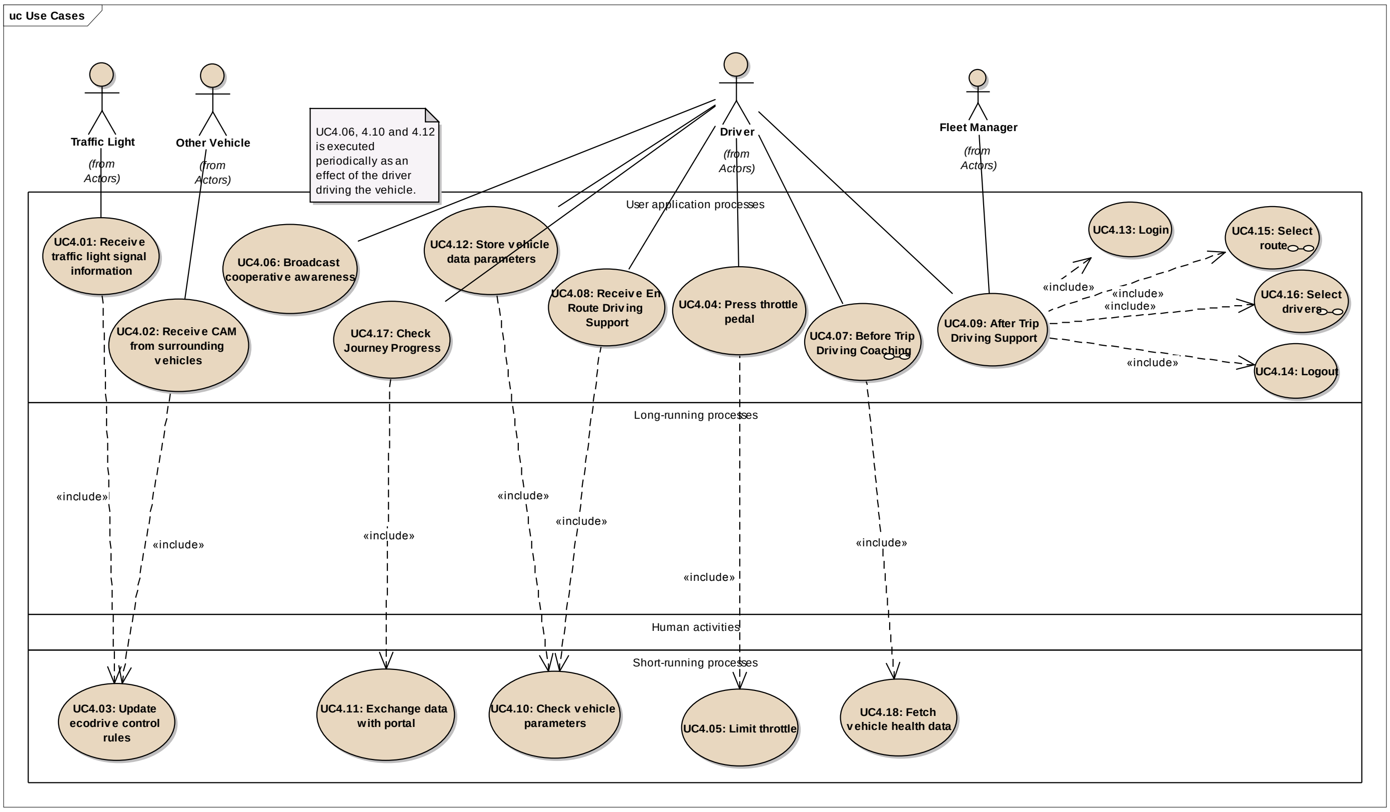

Figure 3: Use Case diagram of the Eco-optimized driving, vehicle and driveline control

2.2 Real time traffic & route info

The vehicle acts as a probe for traffic estimation sending data to a traffic service on the Internet; these data are mashed-up with other sensor data coming from the road infrastructure to give real-time traffic conditions over the full road network. The drivers can receive this information using their personal device through an on-line and updated map including traffic data (continuous map download and updates).

From the vehicle perspective the functionalities needed on the In-vehicle system to implement this service are similar to the ones listed for the previous service and include:

- Reading the vehicle data that can be related to the its movements and the road conditions;
- Filtering and pre-processing these data in order to obtain useful information for the traffic estimation;
- Dispatching useful vehicle information to the Traffic Management Centre (TMC);
- Receiving traffic info updates from the TMC.

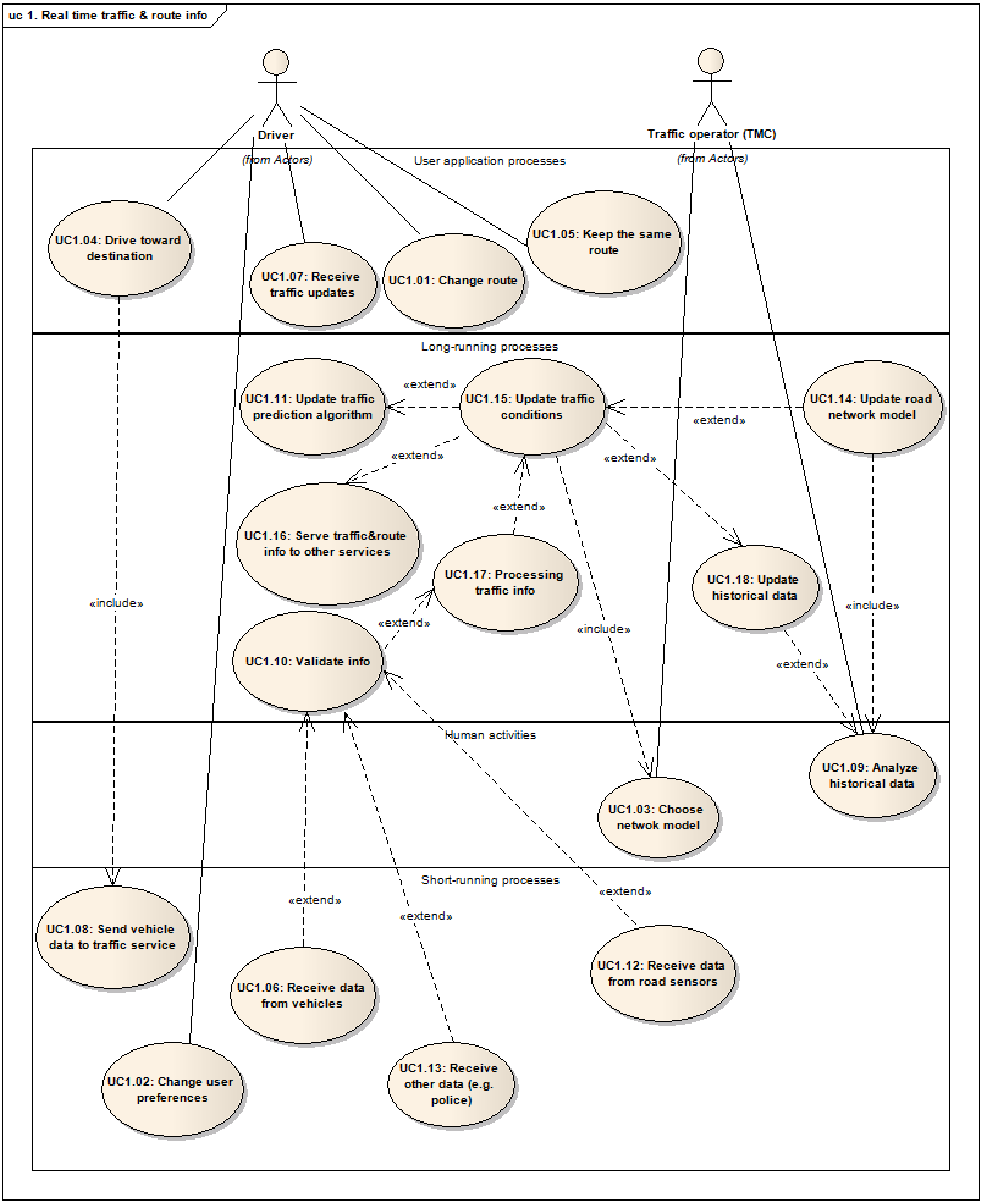

Figure 4: Use case diagram of the Real-time traffic & route info

3. Public interface and interaction with external services

In order to complete this section the outcomes from WP3 should be completed; this section will be described in the second iteration of the identification process of the vehicle and handheld devices enablers specifications.

4. Enabler description

Nowadays, the in-vehicle use of Internet-based services is very limited: typically, drivers are provided only with few information services, made available through "connected" on-board devices (i.e. having an embedded modem offering mobile connectivity). Examples of these are the available traffic information services, that could be used to provide drivers with warnings and suggestions or to feed the on-board navigation system with quasi real time information enabling dynamic navigation features.

Furthermore, these services are offered either through the vehicle platform or through the handheld device (PNDs, smartphones, etc.). In the first case, a basic interaction between the vehicle and the on-board application is realized, offering – for instance – dead reckoning capabilities to get a more reliable position information with respect to the GPS output (suffering of the well-known urban canyon effect).

In case of nomadic devices, the only active interactions with resources available in the vehicle can be found in Consumer Electronics-oriented applications (e.g.: entertainment applications). These active interactions are limited to enable the use of standard phone functionalities through the HMI (steering wheel buttons, voice recognition, integrated loudspeakers…) of the infotainment On Board Unit.

The "Vehicle and Handheld devices enabler set" relies upon the following basic assumptions:

1. Most of services available to the users are usually structured with a client side, the one of the customers which is the fundamental topic of this document, and a server side, the one of the service centers, which process all the information, and eventually the requests, coming from the users.
2. The nomadic device will play the main role as for the client side, since it will:
    - Act as data collector and aggregator
    - Implement and execute the main logics
    - Manage the connectivity options available
    - Implement and run all client applications needed
3. The vehicle will be active part of the planned services (mainly as source of information), but will be seen as a "black box": it will be up to the handheld device to receive (process, if needed) and forward this information to the other actors involved. This will allow a clear separation between the vehicular environment (vehicle networks, on-board units, etc.), where carmakers need to protect their Intellectual Properties (IPs) and use them to differentiate their products from competitors, and the rest of the ecosystem.

There are good reasons to maintain the handheld device as the main player in the system and the most important ones are:

- Ease of implementation of applications on standard mobile OS;

- Open environment for application development, which can be carried on by community (car makers can make available the car-specific tools to implement more car-related applications);
- Handheld device lifecycle is much shorter than car lifecycle, thus making easier to have new and powerful hardware on handheld device than on car (obsolescence of on-board platform);

In addition to the IP protection of each carmaker, the OBU has to act as a “black-box” and it should not be open to any kind of interaction for another reason: since the vehicle platform is directly connected to car network (like the CAN) and since all the different car ECUs read and write their data on it, it is forward to image that an application of a malicious developer having free access to this information could become extremely unsafe and dangerous.

Functional and technological breakthrough provided by “Vehicle and Handheld devices enabler set” will be the possibility to make available to developers (and, of course, to the developed Internet services) the huge amount of information owned by the overall in-vehicle system about:

1. the vehicle itself: typically available in the On-Board Unit networks;
2. the external environment: retrieved from handheld device sensors or calculated through data fusion mechanisms.

This information will be then brought into the cloud thanks to the interactions between the On-Board Unit and the nomadic device and the internet connection of the nomadic device.

Finally, this will enable the development, as well as enrich, the offer of Automotive-oriented mobility services based on the Future Internet.

Hence, the basic requirement that should be met by “Vehicle and Handheld devices enabler set” in order to let this innovative approach be possible is the availability of standard, well defined and easy to use mechanisms to:

- make the nomadic devices and On-Board Unit interact in an extended way;
- allow developers (not necessarily automotive specialists) to easily access these functionalities when writing applications to be installed and used on the nomadic device.

The purpose should be to provide the community of developers with a development framework, offering standard ways to access the in-vehicle system information, coming both from the vehicle platform and from the handheld device, while taking care of the communication with the OBU (including security issues).

This framework should include also all the functionalities natively offered by next generation mobile devices.

From the analysis of the services described in WP3 where a specific role for the In-vehicle system, either for the On-Board Unit or for the handheld device, has been identified, and from the Use Case decomposition, it is possible to summarize the following functionalities for the in-vehicle system:

- Reading of the vehicle data that can be related to its movements and to the road conditions;

- Filtering and pre-processing of these data in order to obtain useful information for the traffic estimation;
- Dispatching of useful vehicle info to the Traffic Management Centre (TMC);
- Reception of traffic info updates from the TMC;
- Reception of variations to the booked itinerary due to special events (accidents, car breakdowns, …).

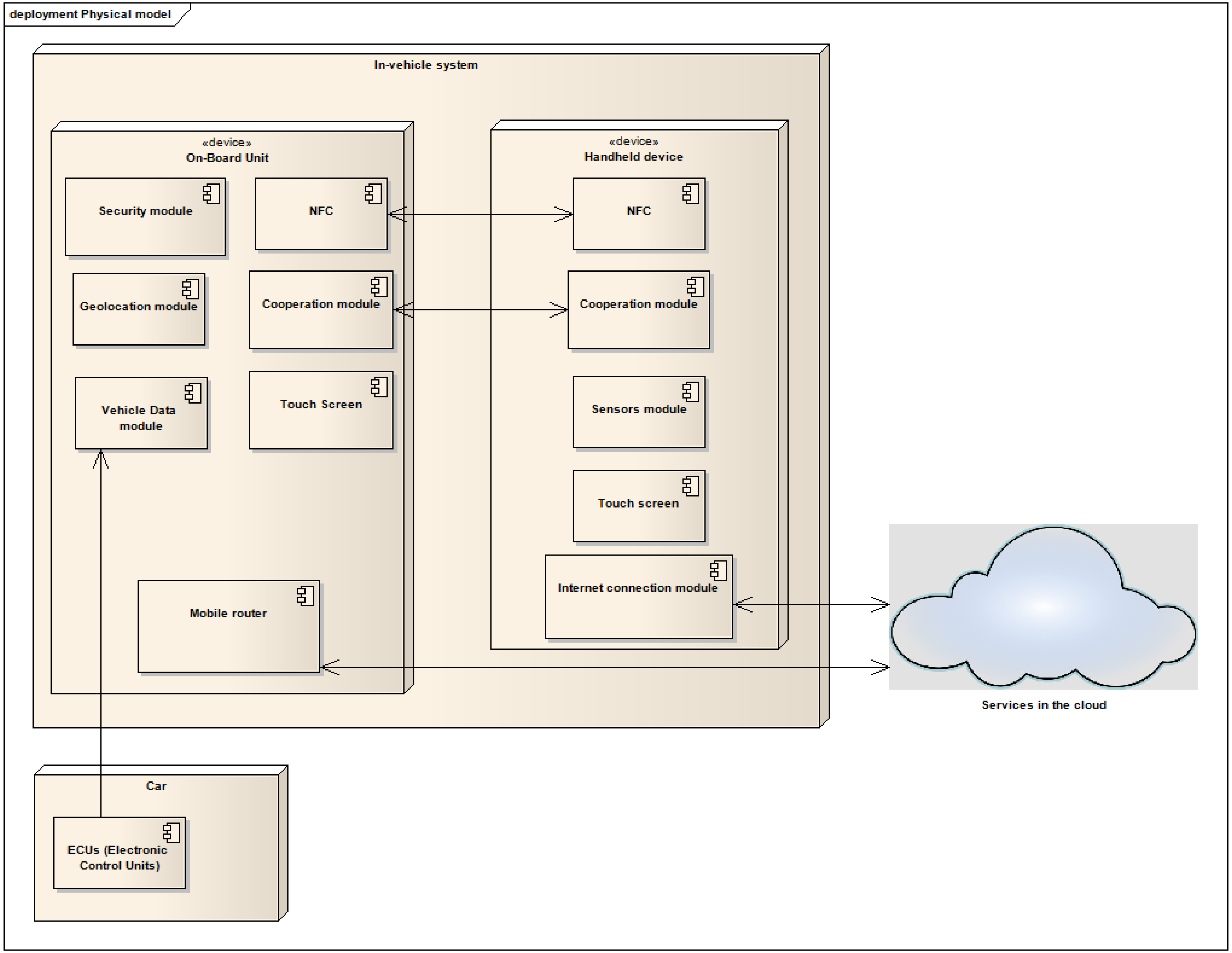

Figure 5: Main enablers of the On-Board Unit and the handheld device

4.1 On-Board Unit

In this section the enablers required on the On-Board Unit will be analyzed; according to the objective of this deliverable they correspond mainly to a set of hardware modules or basic software components.

4.1.1 Vehicle Data module

Input: raw vehicle data (from the vehicle), request for updated data (by the client application on the mobile)

Output: Vehicle Speed, Engine Speed, Gear Indication, Fuel Consumption, Tires Pressure, Engine Temperature, Fuel in use (gasoline, alternative, etc.), Vehicle Description (vehicle type, engine type, weight, etc.), Vehicle health status, throttle and brake pedal usage, …

The Vehicle Data module has a twofold purpose:

1. receive from the in-vehicle OBU through a defined communication bearer (e.g.: Bluetooth, USB, …) a set of defined vehicle-related parameters. This task includes:
   - management of communication link, at least at Session level
   - implementation of security mechanisms needed to:
     - grant the access to user-related confidential information only to authorized consumers (client applications);
     - protect carmakers IPs in terms of data fusion algorithms, communication protocols, data formats, …
2. expose a set of standard, documented APIs that could be used by SW developers to get updated data from the vehicle when needed, without having special competencies in automotive technologies such as in-vehicle networking.

4.1.2 Geolocation module

Input: request for updated data

Output: position information (e.g. latitude/longitude according to WGS84 standard and altitude) and other derived data (speed, …), accuracy

The Geolocation module shall take care of managing the different location technologies available on the On-Board Unit and on the nomadic device (GPS, mobile network based techniques) and provide the most accurate information available together with an estimation of the related accuracy.

The on-board module should preferably exploit different satellite constellations available now or in the short term, like the Galileo and GLONASS system, in addition to the well-known GPS. This approach help to improve the precision of the positioning system and can allow the development of application which rely on low geo-location errors. Another solution to get a better positioning result, is the use of a multi-sensor approach: in addition to the satellite receiver it is possible to use inertial sensors, video cameras, odometers and scanning lidar. Of course all these sensors are too expensive to be used together and especially for the specific scenarios identified in Instant Mobility, but a solution with an integration of the GNSS sensor could provide a better experience for some applications. Behind the higher position accuracy, the improvement of the stability could play an important role: with the use of inertial sensors or of the odometer is possible to eliminate the positioning error when the receiver is still or when the satellites are not visible, for example for the urban canyon effect or in case of tunnels, garages, …

4.1.3 Cooperation module

Input: MirrorLink - display data

Output: vehicle data, user input from car HMI (microphone, steering wheel keys, , …) and embedded touch screen commands.

This component is needed in order to let the OBU to communicate with the handheld device.

This is needed for the data exchange between them, especially for the vehicle data transfer from the OBU to the handheld device.

Moreover this connection can be used for the implementation of the MirrorLink functionality, which needs a communication channel between the OBU and the handheld device. At a first stage this could be simply implemented on a wired connection, like the USB, and then ported on a wireless one, like Bluetooth or WiFi or any other similar short-range connection.

This is the module that enables the realization of an architecture composed by two physically different devices, but is perceived like a unique system.

4.1.4 Touch Screen

Input:

Output:

The OBU follows MirrorLink specifications to replicate the handheld device display (typically the user’s smartphone) on the vehicle embedded screen.

This solution has some immediate advantages:

- The application can be developed on the personal mobile device, with reduced problems for the developer which should take care of the limited number of OS available on the handheld devices, possibly using multi-platform programming languages. Developing the applications only on the handheld device, the software developers do not have to deal with the specific vehicle platform which can be different among car makers;
- The mobile device screen can be replicated on a larger screen, with easier access for the driver. In particular while driving, the user has to look at the road ahead and the in-vehicle system should help him/her minimizing the distraction for any operation;
- The connection with the car enables the possibility to control the device applications with integrated and safer HMI, which is easily accessible and specifically designed for the user

not to lose attention while driving. This means that the inputs, like for example the steering wheel button, the integrated microphone and additional buttons and knobs allow the user to interact with the application, and the output capabilities of the car, like the loudspeakers and additional dashboard displays, can be accessed by the handheld device applications.

As described in the previous paragraph, the vehicle and the handheld devices will be connected firstly with USB, then probably with BT or WiFi or some other wireless communication, which will be managed by the Communication module.

4.1.5 NFC

Input: authentication data either of the car owner (in case of usage of private car) or of a user in case of car sharing

Output:

This module is needed for registration/authentication by means of the NFC on the handheld device, the user can be authenticated and authorized to enter and drive the car; in case of pay-per-use services the authentication is used also for the computation of the total amount due by the user. This implies also that the user, besides registering when starting to use the service, should do the same even when stopping to use it, in order to let the service administrators know that the car is free and someone else can use it.

In case of private car the NFC module is used for the owner authentication: this is the basic concept of the smart key, which allows the user to open the car and to switch the engine on simply having the key in a very short range around the car.

In case of buses it is needed for the Mobile payment and all the related aspects, like the pricing billing and virtual-ticketing; in this case, the NFC reader, or readers if more than one is installed, of the in-vehicle system should be connected to the On-Boar Unit, but physically placed along the bus cabin, such that the user could approach his/her handheld device when getting on the bus, informing the system that the billing can start, and when getting off, to stop the counter of the virtual ticket price.

Since NFC is a standard and it will be almost surely integrated in the in-vehicle system, both on the On-Board Unit and on the handheld device, its main technical specifications can be described already in the first iteration of the enablers specifications of the vehicle and handheld devices.

The NFC is a short range communication standard working at the frequency of 13.56 MHz and transferring data between two devices, an initiator and a target, at a distance equal or less than 4 cm. This standard is compatible with the RFID standard, that means that can read RFID tag; the main functional difference between these two technologies is that the NFC is designed for a bidirectional communication, while typically, in the RFID communication, there is a reader and a tag that "is read" from the device.

The possible communication modes are the "passive mode" and the "active mode"; in the first case the initiator generates an RF field on the RFID passive tag. Since this is not powered by an internal battery, it answers simply by modulating this electromagnetic field. In general the object investigated by the initiator is called target and when it is battery-powered it can instantiate a peer-to-peer communication with the initiator. In the second case both the initiator and the target communicate each other by alternating the transmission and reception phases.

The NFC tags are usually read-only but they can be re-writable, especially if protected by custom-specific security codes; they can securely store personal data, like for example the payment references for applications related to the virtual ticketing, networking contacts but also product related information.

According to the standard, the maximum data transfer rate reachable with NFC is 424 Kbit/s.

4.1.6 Security module

Input:

Output:

This module should act as a black-box, recording the cockpit area and in general the inside of the car for safety purposes and ciphered storing for security and privacy reasons; it is composed by a camera and a ciphering block, since the video could contain private information that should be accessible only to authorized people or to the public authorities.

This module could be used in case of shared cars, private cars and even public transport means.

4.1.7 Mobile Router

Input: Data from handheld device(s) and in-vehicle equipment to be transmitted to the infrastructure

Output: Data routing and transmission

The mobile router module ensures efficient and reliable transmission of Instant Mobility application data from the handheld device (check-in, check-out, geo-location, etc.) and/or the vehicle (sensing output) to the Instant Mobility infrastructure. Considering ITS and IETF standardization activities, the overall in-vehicle system may host several communication equipment having interfaces towards the infrastructure: Dedicated Short-Range Communications (DSRC), Wi-Fi, WiMax, LTE, 3G, IEEE 802.11p, Bluetooth on the OBU and LTE, 3G, Wi-Fi, Bluetooth on the handheld device. However, data transmission failures could occur if one relies exclusively on the 3G interface of the handheld device (signal drop in tunnels, reduced cellular bandwidth, etc.). The mobile router function ensures that Instant Mobility data can rely on the right and best set of in-vehicle interfaces to enable communications resilience and to meet bandwidth requirement. Furthermore, the module handles the Internet Protocol (IP) coexistence (IPv4 and IPv6) between the vehicle and the infrastructure as well as seamless session handover from one interface to another. The mobile router can thus act as the interconnection between the vehicle CAN bus, by means of the Vehicle module, and other data bearers with its own and/or handheld device(s) interfaces towards the infrastructure.

Among the required functionalities, the mobile router should ensure:

- Hardware independency (software stack)

- Multiple mobile radio links may be used simultaneously (Wi-Fi a/b/g/n, 3G+, WiMax, satellite, 802.11p/Geonet)
- Multi-operator
- Automatic and transparent handovers and switching of radio link. Application software does not need to be aware of those context switching
- Radio links monitoring
- Automatic failover
- Load sharing
- Quality of Service with dynamic prioritization
- Bandwidth usage

4.2 Handheld device

The handheld device or nomadic device is generically a personal electronic system which the user has with him/her and can interconnect with the vehicle platform in order to provide a sort of continuity between the usage of the application outside and inside the vehicle or the public transport mean. Moreover the OBU and the handheld device, which is most likely to be the user's smartphone, can interact to share their features in order to have a most complex, flexible and powerful platform.

According to the main expected functionalities, the handheld device should:

- Receive vehicle data from on-board system;
- Receive input data from the in-vehicle HMI;
- Forward vehicle data to the service centers (Traffic Management Center, Data collector, …);
- Download maps with updated traffic and other mobility-related information;
- Share screen with On-Board Unit through MirrorLink.

4.2.1 Sensors module

Input: request for updated data

Output: (linear) acceleration, ambient temperature, gravity, gyroscope, light, magnetic field, pressure, relative humidity, rotation vector, internal temperature.

The Sensors Module shall provide information as read by the HW sensors installed on the nomadic device, like, for example, accelerometer, gyro, and magnetometer. Outputs availability will depend from the HW configuration of the device. Some of these sensors are already available on some personal devices, providing information regarding, for example, the humidity, acceleration in the three axis, magnetic field, etc…

4.2.2 Cooperation module

Input: vehicle data, user input from car HMI (microphone, steering wheel keys, , …) and embedded touch screen commands.

Output: MirrorLink - display data.

This module is the counterpart of the one with the same name on the OBU and it has to communicate with it; these two devices should interact in order to extend their respective functionalities and to appear together as a single unit. In order to reach a seamless cooperation, which is absolutely transparent to the user, the vehicle platform and the handheld device need a common communication channel which will be physically realized on a USB cable first and then using a short/medium range wireless technology, like for example Bluetooth or WiFi.

In order to improve the user perception of the integration of the two devices into one single system, the connection between them should be automatically established when the user approaches the car (or as soon as the vehicle platform is turned on).

4.2.3 NFC

Input:

Output: authentication data either of the car owner (in case of usage of private car) or of a user in case of car sharing

In order to realize many use cases foreseen in the three scenarios described in WP3 activities it is fundamental to have the technological enabler which allow the interaction between the user device and the vehicle platform; the proposed solution in IM is the use of the Near Field Communication (NFC), as already mentioned for the On-Board Unit; this standard was designed for the near proximity communication and is highly suitable here for the authentication of the user using a car, either private or shared, or entering on a public transport means. Since the handheld device of the user is strictly personal and the NFC communication occurs typically within more or less 5 cm of distance, the successful communication corresponds to the recognition and identification of the user.

Another good reason for using this technology is the availability on some new smartphone, which could turn into a fast and wide diffusion of this technology among the users.

Extending the usage of NFC in other cases related to mobility , but not always strictly or directly integrated into the vehicle, it is possible to use it in other applications where a sort of payment or warranty is needed, like car and bike sharing, car rental, parking and access to restricted areas. In particular when considering applications where such sensible data have to be protected, the proximity communication is already an important protection factor.

4.2.4 Touch Screen

Input:

Output:

The touch screen on the handheld device is the first HMI that the user can normally adopt to interact with the applications. Thanks to the adherence to the MirrorLink specifications it will be possible to replicate the handheld device display on the larger embedded display of the On-Board Unit, thus having an easier to use interface, which could be controlled even by the in-car HMI, when the user enters his/her vehicle.

Anyway the presence of a touch screen on the handheld device is fundamental also because of the usage of the handheld device also outside the car, thus independently from its functionalities and its HMI.

4.2.5 Internet connection module

Input: data from service centers, like traffic data, modifications to planned meetings for car sharing/car riding, …

Output: data sent to service centers, like vehicle specific data needed for traffic estimation, car sharing preferences changes, …

The main added value that the handheld device brings onto the car is the internet connectivity, which will allow the connection of the in-vehicle system to a large set of cloud services, both for data collection and for communication of the vehicle data to the service center and for the reception of useful traffic and other aggregated data, results of a complex processed information.

Most probably for this purpose a long range connection is needed, but the nomadic device could also exploit WiFi spots since a WiFi receiver is nowadays available on most of handheld devices. Anyway these logics could be implemented and tested but in the end they should be configured by the user according to the personal preferences.

For the physical realization of the communication channel it is desirable to use 4G (LTE?) technology, since it provides a very fast internet connection through the mobile phone network.

5. Conclusions and next steps

This document has provided a high level description of the vehicle and handheld devices enablers. After the harmonization among the enablers required by all the other tasks (from 4.2 to 4.8) and after the finalization of D3.3, the description of the identified enablers will be better specified and fixed in D4.11.