



Tomorrow's Elastic
Adaptive Mobility

SP4 Deliverable 4.3.1

Requirements of DIALOGUE components, enablers and applications

Dissemination level	Public
Version	1.7
Due date	30.06.2013
Version date	04.09.2014

www.collaborative-team.eu

This project is co-funded by the
European Union – DG Connect



Document information

Authors

Francesco Bellotti – UniGe

Riccardo Berta – UniGe

Alessandro De Gloria – UniGe

Florian Häusler – Fokus

Sergio Damiani – CRF

Filippo Visintainer – CRF

Luisa Andreone – CRF

Rafael Basso – Volvo

Francesco Alesiani – NEC

Filip Frumerie – Volvo

Kay Massow – DCAITI

Marco Bottero – SWARCO

Panagiotis Lytrivis – ICCS

Angelos Amditis – ICCS

Ioanna Mesogiti – COSMOTE

Nicolas Gay – INTEL

Coordinator

Dr. Ilja Radusch

Head of department Automotive Services and Communication Technologies,

Fraunhofer Institute for Open Communication Systems FOKUS

Kaiserin-Augusta-Allee 31, 10589 Berlin

Tel: +49 30 914 26 36 474

Email: ilja.radusch@fokus.fraunhofer.de

Project funding

7th Framework Programme

FP7-ICT-2011-8, objective ICT-2011.6.7.a

Large scale integrating project (IP)

Grant Agreement No. 318621

Revision and history chart

Version	Date	Comment
0.1	13.06.2013	Insertion of information from the DIALOGUE Internal requirements document and from IR 3.3.1 (requirements from SP3 FLEX). The SG_CB's full example is provided
0.2	26.06.2013	Revision of the requirements. Enablers defined from several applications
0.3	03.07.2013	Revisions based on previous comments. Graphic representation of requirements added from the Conav application.
0.4	08.07.2013	Graphic representation of requirements added from Park and SG_CB applications. Co-plan req.t added
0.5	12.07.2013	Graphic representation of requirements added from CM and C-ACC applications. Added relationship with serious game/community building from several applications
0.6	14.07.2013	Abstract, introduction, conclusions
1.0	15.07.2013	Delivery to peer review
1.1	22.07.2013	Comments by Clemens Dannheim review, to be addressed by all the app leaders
1.2	24.07.2013	Some comments addressed also by Marco Bottero review. Summary, introduction, methodology and conclusion sections revised
1.3	25.07.2013	Final updates from all the applications
1.4	26.07.2013	Final release after final proofing
1.5	24.04.2014	Revised after the year1 review comments. UniGe, Volvo and DCAITI
1.6	30.04.2014	Added CRF and Fokus updates
1.7	04.09.2014	Addressed the remarks from the 1.5 review

Table of contents

Summary	1
1 Introduction	3
1.1 WP4.3 workflow	3
1.2 Structure of the deliverable	4
2 Methodology	5
2.1 Template for identifying the requirements	5
2.2 Identification of the enablers	7
3 Description of the applications	8
3.1 SP4 Dialogue applications	8
3.1.1 Collaborative ACC	8
3.1.2 Collaborative Parking	10
3.1.3 Collaborative Driving and Merging	11
3.1.4 Collaborative eco-friendly navigation	13
3.1.5 Green, safe and collaborative serious game and community building	16
3.2 SP3 Flex applications	20
3.2.1 Collaborative pro-active urban/inter-urban monitoring and ad-hoc control	21
3.2.2 Collaborative co-modal route planning	22
3.2.3 Co-modal coaching with support from virtual/avatar users	27
3.2.4 Collaborative smart intersection for intelligent priorities	28
3.2.5 Collaborative public transport optimization	30
3.2.6 Dynamic collaborative corridors	32
4 Requirements from the DIALOGUE applications	35
4.1 Collaborative ACC	35
4.1.1 Requirements related to HMI	35
4.1.2 Application-specific	37
4.1.3 Requirements related to user and environment data	48
4.2 Collaborative Parking	51
4.2.1 Requirements related to user input via HMI	52

4.2.2 Requirements related to input data from TEAM to EFP application	60
4.2.3 Requirements related to data processing	69
4.2.4 Requirements related to system actions	78
4.2.5 Requirements related to data types	84
4.2.6 Requirements related to data storage	90
4.2.7 Requirements related to EFP and Collaborative Gaming	94
4.3 Collaborative Driving and Merging	102
4.3.1 Overview of the Requirements	102
4.3.2 Requirements related to interaction	102
4.3.3 Requirements related to app specific functionalities	105
4.3.4 Requirements related to provision of information	115
4.3.5 Requirements related to the gaming application	126
4.4 Collaborative eco-friendly navigation	129
4.4.1 Requirements related to the HMI of TEAM	129
4.4.2 Requirements related to the routing algorithm	134
4.4.3 Requirements related to the gaming application	147
4.5 Green, safe and collaborative driving serious game and community building	151
4.5.1 Requirements related to vehicle signals connectivity and processing	151
4.5.2 Requirements related to community support for all the TEAM applications	161
4.5.3 Specific serious gaming requirements	167
4.5.4 Requirements related to social networking	172
4.5.5 Requirements related to HMI	179
5 Requirements from the FLEX applications	183
5.1 Collaborative pro-active urban/inter-urban monitoring and ad-hoc control	183
5.1.1 Requirements related to vehicular data	183
5.2 Collaborative co-modal route planning	184
5.3 Co-modal coaching with support from virtual/avatar users	185
5.3.1 Requirements related to serious gaming	186
5.4 Collaborative smart intersection for intelligent priorities	188
5.4.1 Requirements related to vehicular data	188
5.4.2 Requirements related to driver coaching	189
5.4.3 Requirements related to relationships with the other applications	190
5.5 Collaborative public transport optimization	192
5.5.1 Requirements related to HMI	192

5.5.2 Requirements related to data availability	195
5.5.3 Requirements related to community building/serious gaming	197
5.6 Dynamic collaborative corridors	198
5.6.1 Requirements related to driver coaching	198
5.6.2 Requirements related to vehicular data availability	199
5.6.3 Requirements related to the serious game application	201
6 DIALOGUE Enablers	203
6.1 Human-Machine Interaction (HMI)	203
6.2 Vehicle signals and data processing and connectivity	206
6.3 Driver/passenger and vehicle models	209
6.4 Social networking	211
6.5 Miscellaneous	213
7 Conclusions	214
List of abbreviations and acronyms	215

List of figures

Figure 1: High level overview of the WP4.3 workflow	4
Figure 2 Application specific requirements for CACC	38
Figure 3: Requirements related to User Input via HMI from EFP	52
Figure 4: Requirements related to input data from TEAM to EFP	60
Figure 5: Requirements related to data processing from EFP	69
Figure 6: Requirements related to system actions from EFP	78
Figure 7: Requirements related to data types from EFP	84
Figure 8: Requirements related to data storage from EFP	90
Figure 9: Requirements related to EFP and Collaborative Gaming from EFP	94
Figure 10: CDM application requirement overview	102
Figure 11: Requirements related to the HMI from CONAV	129
Figure 12: Requirements related to the routing algorithms of CONAV	135
Figure 13: Requirements related to gaming from CONAV	147
Figure 14: Requirements on connectivity and signal processing from SG_CB	152
Figure 15: Homogeneous interface among the TEAM applications and SG_CB	161
Figure 16: Requirements for the TEAM apps from SG_CB	162
Figure 17: Requirements on social networking from SG_CB	173
Figure 18: Requirements related to the HMI from SG_CB	180

Summary

The goal of the D4.3.1 deliverable is to provide the TEAM applications' requirements that are related to SP4 (i.e. to mobile sub-systems, such as vehicles and smartphones). The requirements come from both SP4 applications (mainly related to vehicles) and SP3 applications (mainly related to the infrastructure). In particular, 113 requirements were collected from the five SP4 applications and 18 from the six SP3 applications. The requirements have been collected on the basis of a template that we have defined exploiting the partners' experience, in particular in automotive-related projects, and relying on well established software and system engineering models. The template has been used jointly in SP3 and SP4. The template include descriptive and speculative information, also including criticality level, validation methods, acceptance criteria, risk analysis.

In order to provide an immediate overview of the requirements and of their relationships, all the requirements are grouped in significant clusters, for each application, and, for SP4 applications, graphic representations are provided either through SysML Requirements diagrams or through simpler graphic representations.

All requirements have been described at a high level and mostly consider the point of view of end-users and stakeholders. They represent an intermediate state between the use cases provided in D1.0 (TEAM users, stakeholders and use cases) and the actual specifications (IR4.3.3).

Once the requirements were ready for every single application, we performed an aggregation and harmonization step, through the identification of enablers, that are modules grouping sets of homogeneous functionalities that could be shared among different TEAM applications. We have identified enablers in four main areas, such as Human-Machine Interaction (HMI), vehicle signals and data processing and connectivity, driver/passenger and vehicle modelling and social networking. A total of 31 enablers have been identified (6 of data type, 8 of algorithm type and 17 of tool type), and the mapping with the originating requirements has been reported.

This deliverable represents a fundamental intermediate step between the definition of the applications' use cases – which was done in IR4.2.1 (Internal Report) and D1.0 – and the definition of the SP4 specifications, that is being done in WP4.3 (IR4.3.3), and the overall architecture and application design, that will be done in WP4.4 (D4.4.1 DIALOGUE components, enablers and application design, and D2.0 TEAM system specification and architecture).

The structure of this deliverable is organized as follows. Section 1 provides an introduction, also presenting the workflow followed in WP4.3. Section 2 describes the main

methodological aspects we addressed in the preparation of this deliverable. Section 3 is devoted to a short overview of all the TEAM applications (both SP3 and SP4). Sections 4 and 5 provide the SP4-related requirements for all the SP4 and SP3 applications respectively. Section 6 presents the identified SP4 enablers, while section 7 draws the final conclusions.

1 Introduction

The goal of the D4.3.1 deliverable is to provide the TEAM applications' requirements that are related to SP4 (i.e. to mobile sub-systems, such as vehicles and smartphones). The requirements come from both SP4 applications (mainly related to vehicles) and SP3 applications (mainly related to the infrastructure).

This deliverable represents a fundamental intermediate step between the definition of the applications' use cases – that have been done in IR4.2.1 (Internal Report) and D1.0 (TEAM users, stakeholders and use cases) – and the definition of the SP4 specifications, that is being done in WP4.3 (IR4.3.3), and the overall architecture and application design, that will be done in WP4.4 (D4.4.1 DIALOGUE components, enablers and application design, and D2.0 TEAM system specification and architecture). More detail on the WP4.3 workflow is provided in the 1.1 sub-section.

A twin deliverable has been produced in parallel by SP3 (D3.3.1 FLEX requirements and initial specifications), which focuses on SP3 applications and on aspects related to infrastructure support. A similar deliverable has been produced also by SP2 (D2.3.1 EMPOWER requirements and initial specifications), which focuses on the requirements about the TEAM basic technological areas (e.g., positioning, security, local dynamic maps) and the relevant modules, that will be used by both SP3 and SP4. These deliverables have been prepared in a close collaboration among the respective leader, sharing methodologies, structures and data, in order to guarantee synergies and favour a common understanding for all the partners.

1.1 WP4.3 workflow

This deliverable is part of the work being carried out in WP4.3. Figure 1 provides a high level overview of the workflow. The first step consisted in the definition of the template for the collection of the requirements (Internal Report IR 4.3.2), which was then shared and used also by the SP3 applications.

Based on the template, the requirements for all SP4 applications were defined and then split in two documents. The "internal requirements" (i.e., the requirements from the SP4 applications concerning SP4-typical functionalities, that is, involving the mobile sub-system – vehicle and smartphones) were kept together with the requirements to SP4 coming from the SP3 applications (that are infrastructure-oriented). This corpus of requirements is the subject of this deliverable, constituting in particular section 4 and 5, respectively, of this document. While the requirements from the SP4 applications that are related SP2 technologies (e.g., positioning, maps, etc) and SP3 (infrastructure) were put in IR4.3.1 ("DIALOGUE requirements

to EMPOWER and FLEX”) that was delivered to SP2 and SP3 and included in their relevant deliverable (D2.3.1 and D3.3.1, respectively).

The final step of this deliverable consisted in a harmonization of the SP4 requirements, through the definition of “enablers”, that are modules grouping sets of homogeneous functionalities that could be shared among different TEAM applications.

The final step of this WP, which is preliminary to the system architecture and design (WP4.4), consists of the definition of the SP4 specifications based on this document, which will go in IR4.3.3 “Specifications for the DIALOGUE applications and enablers” and then in D2.0 “TEAM system specification and architecture”.

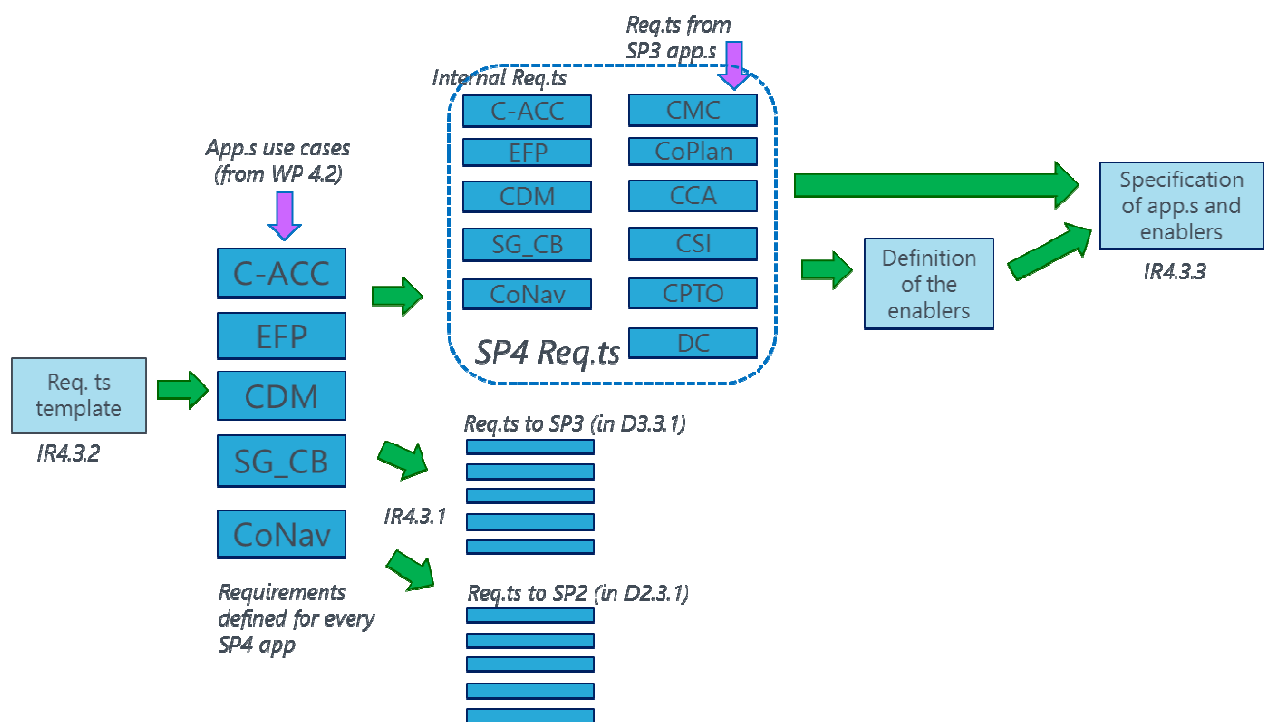


Figure 1: High level overview of the WP4.3 workflow

1.2 Structure of the deliverable

The structure of this deliverable is organized as follows. Section 2 describes the main methodological aspects we followed in the preparation of this deliverable. Section 3 is devoted to a short overview of all the TEAM applications (both SP3 and SP4). Sections 4 and 5 provide the SP4-related requirements for all the SP4 and SP3 applications respectively. Section 6 presents the identified SP4 enablers, while section 7 draws the final conclusions and shows the next steps for the work.

2 Methodology

The preparation of the SP4 Requirements deliverable involved two main methodological aspects – the definition of the template to describe the application requirements, and the definition of the enablers – that we describe in the following.

2.1 Template for identifying the requirements

The first step consisted in WP4.3 consisted in the definition of a template for the description of the requirements for all the TEAM applications. This activity led to the preparation of an Internal Report, namely IR4.3.2 “Common format and defined processes for requirements engineering”. The template was agreed also by SP3, and all the SP3 and SP4 TEAM applications’ requirements have been described accordingly.

The template has been defined exploiting the partners’ experience, in particular in automotive-related projects, and relying on well established software and system engineering models¹. The requirement description covers several aspects ranging from source to validation method and the acceptance criteria. The next table shows the template entries, together with their corresponding explanation.

<i>Item in the Requirement Template</i>	<i>Description/explanation</i>
<i>Requirement ID</i>	SPx_REQ_y_vZ.z (x is the SP name, y is the serial number of the requirement, and Z.z is the version number)
<i>Name of requirement</i>	A title assigned by the author
<i>Created by</i>	Person/Partner that created the requirement
<i>Assigned partner</i>	Partners to which the requirement has been assigned
<i>Source (TEAM application or enabler)</i>	From which application/enabler the requirement has been created
<i>Requirement category</i>	Functional or non-functional <ul style="list-style-type: none"> - General architectural and equipment requirements - Connectivity and communication requirements - Application requirements

¹ Ian Sommerville, Software Engineering. Ninth Edition. Addison-Wesley, 2010

	<ul style="list-style-type: none"> - Security requirements - User acceptance - Technological and development requirements
Goal	Short description for why this requirement is specified
Definition	Self-explanatory
Critical level (priority)	Define the importance of the requirement
Validation Method (tests, indicators, performance bounds)	e.g. function availability
Acceptance criteria	The acceptance criteria identified at this stage are from the users'/stakeholders' perspective; what will make them to say that the related use case will be accepted. Can be either functional (what the module/application/systems should provide) or non-functional (properties of a module/application/systems), and their role is to complement a high-level system requirement in a way that will promote user acceptance.
Relationship with other requirements	<p>Self-explanatory</p> <p>Same level relationship or hierarchical relationship</p>
Potential conflicts	Conflicts with other requirements
Risk analysis	Identify the risks if this requirement is not met. Also identify the risks for meeting this requirement.
Status	<p>New: The requirement has been named. It does not necessarily have all fields filled in. Especially the target release does not need to be set for new requirements.</p> <p>Working: The work has started to meet the requirement. All fields have to be filled in. Further requirements may be yielded during the course of work for the requirement.</p> <p>Closed: The work has been finished to meet the requirement. The requirement is regarded as being met by the development.</p> <p>Rejected: The requirement is rejected for some reason. Most of</p>

	the time, the reason is that a requirement actually is a duplicate to some other requirement.
Other	Anything that could not fit in the above fields is mentioned here.

In order to provide an immediate overview of the requirements and of their relationships, all the requirements are grouped in significant clusters, for each application, and, for SP4 applications, graphic representations are provided either through SysML Requirements diagrams or through simpler graphic representations.

All requirements have been described at a high level and mostly consider the point of view of end-users and stakeholders. They represent an intermediate state between the use cases provided in D1.0 and the actual specifications (IR4.3.3).

2.2 Identification of the enablers

After the requirements have been identified for all the TEAM applications, an aggregation and harmonization step was performed, which led to the identification of the SP4 enablers (the same procedure has been followed also in SP3 for their enablers). This is a fundamental homogenization step between the definition of the requirements for each single application and the specification of the overall system architecture.

Requirements can be logically divided into two types. The first type concerns modules that are application-specific. The second one involves generic modules supplying functionalities that may be shared among different applications. This second is the class of the "enablers". Enablers are modules grouping sets of homogeneous functionalities that could be shared among different TEAM applications.

The SP4 enablers are described in section 6. The template for their description includes, beside the actual description of the module, a list of references to the originating requirements and a classification. In particular, we defined three types of enablers:

- Data format/model enablers
- Algorithm enablers
- Tool enablers

As it will be shown in section 6, we grouped enablers in five main areas, ranging from signal processing to Human-Machine Interaction.

3 Description of the applications

In this section we provide a brief overview of all the TEAM application as a reference in order to allow a proper contextualization and understanding of the requirements that will be presented in sections 4 and 5.

3.1 SP4 Dialogue applications

A short overview of the DIALOGUE applications is given below. A detailed description of these applications with the relevant use cases can be found in deliverable D1.0.

3.1.1 Collaborative ACC

An overview of this application is given in the table below:

Application name	Collaborative adaptive cruise control
Application short name / Identifier	C-ACC
Application short description	<p>The assumption is that vehicles shall communicate with other vehicles and infrastructure and share position and speed information. This information can be used to extend the foresight range of ACC Systems (Adaptive Cruise Control), allows appropriate reaction to adapt vehicle longitudinal speed and ultimately improve traffic flow.</p> <p>Addressing TEAM innovation points "Group-centric acceleration and deceleration", "Elimination of string instability", "Estimating traffic density in real-time based on in-vehicle estimation", "safe and green driving speeds", "Using map", "data Green MMI"</p>
Platforms implementing the application	Smartphone/Vehicle-API, Fully vehicle-integrated, Backbone (traffic management centre)
Application objective	<ul style="list-style-type: none"> increase the dynamics on the roads and lead to a more stable traffic flow with decreased accelerations and decelerations (improve highway platooning) decrease traffic jams and adapt vehicles speed in order to get back to an uncongested situation as fast as possible; adapt vehicle speed to optimize emission traffic throughput; adapt vehicle speed to current weather conditions; promote safety <p>acting as a ACC safety margin assistant, which detects potentially</p>

	dangerous traffic hindrance situations before their location is reached
Basic functioning	<p>The main assumption that we make in this application is that a part of the road users are using a smartphone which is running the TEAM framework and through this their position, average speed per distance, average idle time per distance and optionally their direction (could be the next map point towards their destination) is communicated to the rest of TEAM users. In addition, traffic data information from the TEAM cloud server is available per road segment (e.g. avg. speed per road segment, queuing locations) and can be combined with information from other users in/heading to a specific area of interest (before a traffic jam) in order to better predict traffic density ahead and adjust ACC speed accordingly.</p> <p>Basically, each ACC strategy aims on calculating a certain velocity, the ego vehicle is supposed to drive in order to meet the use case relevant goals (see use cases below). This velocity, once calculated, can be used as input in three different ways to make the ego vehicle accelerate or decelerate respectively.</p> <ol style="list-style-type: none"> 1. Speed advisory: the calculated velocity can be shown to the driver via in vehicle HMI or Smartphone, so the driver can accelerate or decelerate. 2. Road speed limit adaption: The speed limits of the road can be adapted, so the road users are forced not to exceed this limit. This approach assumes that drivers always drive as fast as possible. 3. Cruise control: The ACC value of the vehicle is overridden and the vehicle adjusts the speed on its own.
Application's use cases	<ul style="list-style-type: none"> • Cooperative adaptive cruise control • Collaborative adaptive cruise control • Collaborative Road Budget Compliance • Green light optimizing cruise control • Slow driving with close distances in dense traffic

	<ul style="list-style-type: none"> • Road infrastructure awareness • Traffic data used to influence vehicle speed when Cruise Control is active. • Situational speed
Required lower layer components	<p>“V2X-VehicleNetwork-Bridge”: Required is a bridge between our collaborative infrastructure (that might be a certified/authorized/trusted application running in the OBU or an application running in the cloud) and the built-in ACC system of the car, where for instance, the collaborative application makes suggestions that the ACC system might take into account or not considering its own safety policy. So, a component in this case would be a “V2X-CAN-Bridge” that allows interaction between our collaborative infrastructure and the car ACC system including the automatic emergency brake system.</p> <p>HMI: Graphic elements as those probably being considered in serious gaming applications, for instance the optimal speed indicator found in newer BMWs in eco-driving mode, could be an option, say, to keep the driver at a safe distance from the next driver.</p> <p>Smartphone: Addresses the same elements as described by “HMI”, but displayed on a Smartphone instead.</p> <p>Map Data: from Smartphone or Backbone</p>

3.1.2 Collaborative Parking

An overview of this application is given in the table below:

Application name	Collaborative eco-friendly parking
Application short name / Identifier	EFP
Application short description	Vehicles are connected to a cloud service that enables the distribution of information about available parking slot to individual TEAM users (vehicle drivers, but also any other user who is equipped with a TEAM device and system). Through this cloud service TEAM users can thus receive, on demand, , information about available parking slots.

Platforms implementing the application	<p>Smartphone and Vehicle-API</p> <p>Fully vehicle-integrated (including access to positioning system)</p> <p>Back-office (traffic management centre)</p>
Application objective	To enable connected vehicles to access real time information about parking availability in the surrounding of the destination (automatically or on user request).
Basic functioning	Collaborative parking application offers real time information of location of free parking spaces either in the surrounding of the navigator destination or in the most probable destination (based on driving storyboard). Via manual trigger or autonomous parking/leaving detection the vehicle sends relevant data when entering /leaving a parking slot so that the cloud-based application can constantly monitor the availability of free parking slots.
Application's use cases	<p>Use cases are described in detail in D1.0. here we just provide the list of their names.</p> <ol style="list-style-type: none"> 1. Send and receive parking slot messages 2. User community management 3. User reputation management 4. User rewarding management 5. Data Validation <p>Connection to parking garages</p>
Required lower layer components	<p>LDM++</p> <p>Vehicle data (e.g. GPS vehicle physical dimensions, ...)</p> <p>Internet connectivity</p> <p>Driving style monitoring (enabler)</p> <p>-</p>

3.1.3 Collaborative Driving and Merging

An overview of this application is given in the table below:

Application name	Collaborative driving and merging
Application short name / Identifier	SP4_CDM
Application short description	This application aims at controlling safety and improving energy efficiency. It refers to the case where two or more vehicles need to interact among themselves and/or with the road infrastructure for driving in specific situations. The application addresses the challenges in the collaboration among the vehicles. The most representative use case is lane change or lane merging; other relevant situations include roundabout driving, emergency braking or hazardous situation in front, intersection start and stop including vehicle-infrastructure collaboration, highway entrance or exit and speed limit adaptation. The application is implemented by the vehicle/driver and the TEAM backend.
Platforms implementing the application	<ul style="list-style-type: none"> • Vehicle+Driver • TEAM backend • Optionally a mobile device
Application objective	<ul style="list-style-type: none"> • Control and improve safety • Improve energy efficiency
Basic functioning	<p>This application is mainly focus on coordinating the collaborative driving and merging of vehicles. This application provides a:</p> <ol style="list-style-type: none"> 1) Action for the driver or vehicle 2) Support to the driver/vehicle for decision making <p>The Use Cases describe the various situations where the application is applied.</p>
Application's use cases	<p>Use cases are described in detail in D1.0. Below the list of the UC names.</p> <ol style="list-style-type: none"> 1. Road restriction, reduction in number of lanes 2. Lane changing 3. Roundabout driving 4. Emergency braking

	<ol style="list-style-type: none"> 5. Emergency slowdown and stop 6. Intersection optimization 7. Speed limit adaptation 8. Highway entrance or exit 9. Custom clearance 10. Lane Advice 11. Overtaking
Required lower layer components	<ul style="list-style-type: none"> • Communication Facilities • Incentive Facility • Map Facility • Crowd sourcing • Cloud aggregation service

3.1.4 Collaborative eco-friendly navigation

An overview of this application is given in the table below:

Application name	Collaborative eco-friendly navigation
Application short name / Identifier	CONAV
Application short description	<p>The application is a turn-by-turn navigation application running on Smartphones and on a vehicle-integrated platform. It does routing and navigation for vehicles considering individual user's needs and community (system-centric) needs.</p> <p>This application provides the interface to the user while he is driving and makes turn-by-turn instructions. It monitors the user eco-friendly behaviour and triggers new route calculations (both in case he/she behaves different to the instructions or if traffic conditions have changed).</p> <p>Different to today's navigation systems, it provides route recommendations, which are optimized based on multi-fold needs</p>

(environment, traffic load balancing, robustness, queuing at gas stations, balanced pollution levels, safety). The application will consider real-time traffic information provided by the infrastructure. We explicitly consider the reaction of non-planned events. We distinguish two stages of expansion.

The first stage includes the applications features below. The character of stage one is that it works with static (traffic) data.

1. Route calculation incorporating vehicle-specific constraints

The calculation would be basically the same as today. We will make use of vehicle info (accessed through vehicle networks, such as data providers or even OBD2) to find routes such as routes along gas stations (in case fuel level is low) or low energy routes. We may also circumnavigate dirty vehicles from environmental hotspots, while we let clean vehicles pass.

2. Routes to balance traffic load on road network

Stochastic routing to avoid local congestion at hotspots, queuing at gas stations etc. Vehicle-specific information is incorporated.

3. Personalized routing

We assume that drivers who are not familiar with the environment make navigation mistakes at complex crossings. We find routes, where this is considered in a way, where such mistakes are not bad and where such crossings are avoided. We call such routes robust. We may also find known routes – these are routes which pass known environments (or in general individually preferred environments, such as safe routes where few accidents happen, non-complex crossings etc.).

The second stage of expansion incorporates V2X (and/or communicating smartphone app). Moreover, we assume that real-time environment data could be processed, such that non-expected events could be sensed and considered in route planning. Demonstrating the application with stage two features is more complex than in stage one. The following features are added to the ones above:

4. Adaptive stochastic routing and balancing to handle real-

	<p>time events</p> <p>Assume a not-foreseen event occurs. Stochastic routing is adapted accordingly to adapt routes. We could react now to events. Varying penetration rate has a big impact on the employed models and algorithms.</p> <p>5. Adaptive routing based to handle real-time events/conditions with help of price information</p> <p>Assume a not-foreseen event occurs. We'll implement routing with feedback control with help of edge pricing to protect important routes. As before varying penetration rate has a big impact on the employed models and algorithms (open/closed loop, feedback control, ...).</p> <p>In the final step, the application will implement a global optimization method:</p> <p>6. Globally optimized navigation</p> <p>Here we assume that drivers share their desired destinations, relevant preferences and constraints. This information is collected in a central or infrastructural server, which calculates routes for every TEAM user optimizing the overall benefit.</p> <p>In all stages, we will realize sequential routing, which implements short-term decision making within the TEAM-specific time window. Approaches are highly variable to control various (and also multidimensional) variables, e.g. pollution, congestion, etc.</p>
Platforms implementing the application	<ul style="list-style-type: none"> • Smartphone with access to Vehicle-API (assume cloud integration for step two and three) • Fully vehicle-integrated platform (assume cloud integration for step two and three)
Application objective	<p>Different to today's navigation and routing applications, we develop an application which respects individual preferences (not only desired destination) and constraints but also needs from other users, or the traffic system in general (e.g. balancing of traffic on the road network).</p>
Basic functioning	<p>Similar to today's navigation system, the user defines the</p>

	<p>destination he/or she wants to go. The user defines the route calculation method (another possibility is to calculate all in parallel and let the user choose afterwards).</p> <p>The selected method is applied and the route is calculated and presented including some meta-information, e.g. calculated length, time, CO-emission, network-balancing-index etc.</p>
Application's use cases	<p>Use cases are described in detail in D1.0. here we just provide the list of their names.</p> <ol style="list-style-type: none"> 1. Enter route start location and time 2. Enter route destination location and time 3. Enter vehicle characteristics 4. Enter personal preferences, e.g. fear from complex crossings, etc. (may include predefined profiles and weights) 5. Initiate route calculation incorporating vehicle constraints and characteristics 6. Initiate route calculation incorporating driver constraints and characteristics 7. Initiate route calculation to balance traffic load 8. Initiate route calculation according to user preferences 9. Initiate route calculation incorporating real-time traffic information 10. Initiate route calculation with open loop control and feedback control 11. Initiate route calculation with global optimization
Required lower layer components	LDM++, Positioning, User profile

3.1.5 Green, safe and collaborative serious game and community building

An overview of this application is given in the table below:

Application name	Green, safe and collaborative serious game and community building
------------------	-------------------------------------------------------------------

Application short name / Identifier	SG_CB
Application short description	<p>This application intends to promote and favour a proper driver behaviour, with a particular attention to collaborative applications that are being developed in TEAM. The SG-CB application consists of a gamified social network environment where drivers and passengers can share their information and improve their use of collaborative TEAM applications (and also 3rd parties, in an open and scalable perspective), in a pleasant and compelling way and featuring a map-based user interface.</p> <p>Given this support to a good use of the other TEAM applications, SG-CB may be thought of as a "meta-application", a user-centred user-interaction based layer aimed at incentivising the use of every connected TEAM application.</p> <p>The application includes also a serious game (SG) that exploits vehicle's data in order to create a challenge so that drivers are motivated to collaboratively reach high levels of green driving and low levels of traffic in their zones (typically a city or a city area).</p>
Platforms implementing the application	<p>Smartphone (typically connected to the application server) /Vehicle-API (connection to the car bus)</p> <p>Backbone (traffic management centre)</p> <p>Extensions can be considered, in a long-term perspective, using infrastructure in a cloud-computing based approach</p>
Application objective	<p>The general goal of the application is to promote and favour a proper driver behaviour. This will be achieved in various ways. The gamified map-based social environment will allow people to share in real-time information about their driving, also spurring and favouring a proper use of the collaborative TEAM applications (and also from 3rd parties, in an open architecture).</p> <p>The SG will offer a challenge to stimulate drivers to achieve two main goals:</p> <ul style="list-style-type: none"> • Green driving • Traffic reduction/avoidance (fluid traffic)

Basic functioning

While the user is driving, the application processes vehicular data about the travel in real-time.

Each user may be able to insert geo-referenced messages inside the social map environment, when the vehicle is not moving. Other messages could be automatically sent by the car (e.g., windscreen wipers, temperature, airbag, speed) also during the drive, if the user allowed it. This will allow creating and displaying on the map integrated information collected through the vehicles (this is an enhancement of the current Waze.com social driving application, which only relies on cell-phone data).

Selected (i.e. relevant to the driver/passenger) notifications may appear on the map during the drive.

From a technical point of view, the SG-CB is a TEAM meta-application, in the sense that it also exploits data communicated by the other TEAM applications in order to incentivize their use and support a good user behaviour.

The green driving SG will process vehicle data about the travel in real-time. This is important, since the driver will be playing (even if with a very limited impact on the cognitive workload) with the green/safe driving SG. The user interface will be very simple (and configurable by the user), limited to a very simple feedback about the current level of performance of the driver's team. The driver's team may be identified by all the drivers in a city or in a city area. The goal is to improve the position of the team with respect to all the other teams. The driver will receive feedback about his relative contribution to achieving the team goal of an overall high driving quality (measured along the two axes: green driving and traffic reduction/avoidance).

The driver may also be coached in real-time by the system, exploiting information from other drivers (from his team), on how to improve his performance.

While not driving, the user will be able to access a menu through which he can see several analytics about his performance, also checking variations with respect to previous travels by himself.

Beside the specific SG, the community building (CB) gamification

	<p>will involve a scoring system, with points gained from the quantity and quality of information provided to the system and from a proper use of the TEAM collaborative applications (specifications are to be defined with the various application leaders). Badges will be assigned to good performers, based on various criteria (e.g., time, space/area, friends, common interest, type of vehicle, etc.).</p> <p>Incentives may be provided in terms of virtual gadgets/facilities and of real-world rewards, such as access to pool lanes, discounts for parking costs, free bus tickets, etc.</p> <p>The system will exploit a user model for driving and information and a user credibility management system.</p> <p>The application involves significant privacy and security aspects.</p>
Application's use cases	<p>Use cases are described in detail in D1.0. Here we just provide the list of their names. The requirements in this deliverable consider some upgrades in the application, which have been iteratively defined in subsequent steps.</p> <ol style="list-style-type: none"> 1. Playing the green/safe driving serious game 2. Computation of the driver performance 3. Create a challenge for the SG 4. Watching the performance – general 5. Watching the performance – diary view 6. Thematic competitions 7. Provision of incentives 8. Setting preferences 9. Automatic transmission of geo-referenced data 10. Sending messages for the collaborative map 11. Proper collaborative behaviour, based on the other TEAM applications 12. Watching the collaborative map 13. Community building gamification 14. Log-in 15. Friendliness 16. Friend suggestion 17. Collaborative driving and serious game data validation 18. User reputation management 19. User rewarding management
Required lower layer components	<ul style="list-style-type: none"> • Smartphone-vehicle communication for receiving data in real-time about the vehicle

	<ul style="list-style-type: none"> • Telecom's ITS 2.0 for user management • User profiling module • Data about user performance from all the TEAM collaborative applications • A map renderer (e.g., Nokia's Feed and Road Book) • The Enhanced Local Dynamic Map (LDM++), with custom layers • Real-time eco-drive assessment • Ontology for describing the driving context (operations, destinations, means of transport, road-works, etc.) • Application database • Accurate in lane positioning • Receiving data from infrastructure elements (e.g., traffic lights, cross-roads, etc.) • Normalization of the data from the car (e.g., eco-drive, RPM, speed, etc.), in order to allow comparisons in different scenarios (e.g., types of roads, weather conditions, etc.) • Data aggregator (on a space and time scale) at different granularity levels, for different values (e.g., speed, fuel consumption, eco-drive level) • A comparison module able to compare driver performance to show performance variations for the same driver and to enable collaborative coaching (see next bullet) • A coaching module in order to provide suggestions to the driver on how to improve his performance based on the comparison with other drivers (advanced feature) • Social network engine with friend, group and interest management
--	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

3.2 SP3 Flex applications

A short overview of the FLEX applications is given below. A detailed description of these applications with the relevant use cases can be found in the D1.0.

3.2.1 Collaborative pro-active urban/inter-urban monitoring and ad-hoc control

An overview of this application is given in the table below:

Application name	Collaborative pro-active urban/inter-urban monitoring and ad-hoc control
Application short name / Identifier	CMC
Application short description	TEAM equipped vehicles monitor urban roads and recognize incidents or special events (road closures, work zones) while driving, provide real-time information to the TMC which validates the reliability of this information and optimizes the traffic efficiency. Such innovative paradigm is based both on the information that comes from the vehicle side as a monitoring sensor and proactive traffic management centre through a V2I communication and information from other data sources (e.g. crowd sourcing, mobile devices, ...) and existing monitoring system.
Platforms implementing the application	<ul style="list-style-type: none"> • Smartphone/Vehicle-API • Backbone (traffic management centre) • Third party (data providers, public authorities) (to be further investigated in next project phases and/or next applications specification iterations)
Application objective	This application will become a B2B base for the TEAM categorized application. Since the info will be gathered from different corners thanks to the cars used as sensors and also from existing monitoring systems, this application will provide an helicopter view information and control at a wide area network level, that supports other TEAM application to take advantages to the dynamic nature of the information to be used in a real time to coordinate collaborative traffic control in order to reduce congestion, fuel consumption and consequently emissions level.
Basic functioning	Data coming from xFCD enabled collaborative vehicles and mobile devices are collected and mashed up. Traditional road sensors data are included in this fused data set. Then, algorithms for reliable network status forecast are applied. Specific related control policies are actuated, evaluating the impact of these by implementing a double feedback loop approach.
Application's use	<ol style="list-style-type: none"> 1. Collaborative data collection 2. Data set completion

cases	<ol style="list-style-type: none"> 3. Network observation 4. Definition of multi-layered policies 5. Application of collaborative pro-active control 6. B2B info publication
Required lower layer components	<ul style="list-style-type: none"> • Collaborative vehicles xFCD interface adapter • Traffic status estimation and forecast module • Actuation components (to be defined in the next steps of the project) • Web services for B2B information publication

3.2.2 Collaborative co-modal route planning

An overview of this application is given in the table below:

Application name	Collaborative co-modal route planning
Application short name / Identifier	COPLAN
Application short description	<p>The TEAM multi-modal planner, in addition to providing multimodal information, has an omni-comprehensive system view integrated into global network optimization (coming from the "Collaborative pro-active urban/inter-urban monitoring and ad-hoc control" application) and user-centric route planning methods and is able to connect to advanced services like the "Co-modal coaching with support from virtual/avatar users".</p> <p>This application has a high environmental impact, thanks to the inclusion of the more eco-efficient modes (increase in the usage of public transportation), and routes, and through more optimized usage of the whole transportation system.</p>
Platforms implementing the application	<ul style="list-style-type: none"> • Smartphone/Vehicle-API • Backbone (traffic management centre)
Application objectives	<p>COPLAN will provide</p> <ul style="list-style-type: none"> • Collaborative multi-modal route planning as a service for deployed collaborative applications by fusing and aggregating information coming from multiple FLEX and DIALOGUE applications. These include heterogeneous data from e.g. the Collaborative pro-active urban/inter-urban Monitoring and Ad-Hoc Control application such as environmental sensor and

traffic-related data, or even information from 3rd parties relevant to real time or/and to predicted/forecasted/planned road incidents, etc. as well as serious gaming aspects from applications such as "co-modal coaching";

The stakeholders/sources from which information can be collected can be:

- (a) Public Safety Answering Points (PSAP), police or fire brigade: providing information about an emergency incident that took place on the road, or at a specific location,
- (b) Municipality services, road operators etc.: e.g. providing information regarding planned civil works that will be performed on a part of the road at specific dates, thus rendering specific roads or lanes inaccessible.
- (c) Historical traffic related data (e.g. any kind of info gathered from TEAM users).

Based on this information, the application will provide end-users with alternative routes and transportation modes based on user-centric info (e.g. origin and destination, Departure time, User preferences (travel time, cost, environmental criteria, number of changes, transportation type, etc.))

- **Statistical information for specific geo-locations upon request**, for instance by generating dynamic statistics (e.g. moving average) of a given road intersection or location, or even along a computed route. Statistical information can be derived from processing historical traffic related data, gathered from TEAM users or other stakeholders/sources as described above. In this way, in-vehicle routing algorithms can decide to avoid specific locations (i.e. dangerous crossings, problematic traffic areas, etc.) → link to application CONAV;
- **Real-time evaluation and computation of predictive traffic development** based on information regarding real-time events as well as on information provided by TEAM users regarding their preferences and decisions (origin, destination, travel time, selected co-modal route); COPLAN uses this predictive information on computed routes to determine whether the current route should be considered or alternatives must be computed. The basic assumption is that the vehicle needs time to arrive up to the event, which is changing over time and therefore alters the time-of-arrival continuously.

	<p>In this context, depending on the interest expressed (e.g. based on origin-destination) and taking into account any kind of available info (3rd parties, historical data), the TEAM system may come up with an additional, more appealing, co-modal route, e.g. a new bus line from A->B or a car-sharing option, and communicate it to the interested TEAM stakeholders/users.</p> <ul style="list-style-type: none"> • Evaluation of location-specific multi-vehicle routing data to provide feedback information for truly collaborative navigation, i.e. global optimization of a fleet of vehicles collaborating to compute individual routes in a coordinated way, for instance providing additional routing constraints; → link to SP4's CONAV • Optionally, in case a TEAM user selects its own car option and requests a parking space at destination, the system should investigate the possibility to offer a parking upon arrival so as to reduce the travel time, cost, traffic at destination area and environmental impact and the passengers' stress level. → link to SP4's COPARK
Basic functioning	<p>COPLAN receives requests either to evaluate or compute multi-modal routes. It combines information coming from a number of sources, including other FLEX and DIALOGUE applications, in order to provide accurate predictions regarding time-of-arrival and other predictive information and makes suggestions for specific co-modal routes based on specific optimisation criteria.</p> <p>COPLAN complies with metrics-annotated requests of the sort being proposed by SP4 Collaborative Application Framework, so that the application can prioritize requests according to currently available information / resources and can generate adequate constraints for the optimization engine.</p>
<p>Application's use cases</p> <p>[+ DRAFT DESCRIPTIONS]</p>	<p>1. Heterogeneous data and service requests collection, aggregation and compilation</p> <p>COPLAN issues requests to different TEAM services and applications to collect diverse data on traffic state for all supported routing modes available in the region. COPLAN uses a layered processing scheme to aggregate data at different granularity levels, i.e. assessing traffic state at different</p>

geographic scales. After analysing and bringing heterogeneous data to a common format, COPLAN employs a scoring system for particular locations, paths and regions, according to the supported routing modes. This scheme enables a simpler multi-modal route optimization in a later stage. Annotations are dynamic and contribute to the creation of statistical data (see UC 4)

2. Map data annotation

COPLAN annotates maps (e.g. using concepts introduced in LDM++) to enable faster multi-modal route optimization. Map data annotation should be a centralized operation, in order to avoid map inconsistencies. This use-case also involves the actual management of the multiple layers being kept in the LDM++ database.

3. Multi-modal route planning

A user request (e.g. complying with SP4 Collaborative Application Framework message protocol) triggers the calculation of a route. The message contains information related to user preferences such as the optimisation criteria e.g. travel time, cost, environmental criteria, number of changes, desired traffic modes (perhaps even with a given priority), etc. COPLAN considers requests made by other traffic actors to optimize traffic even further.

4. Statistical / historical geo-location specific data collection

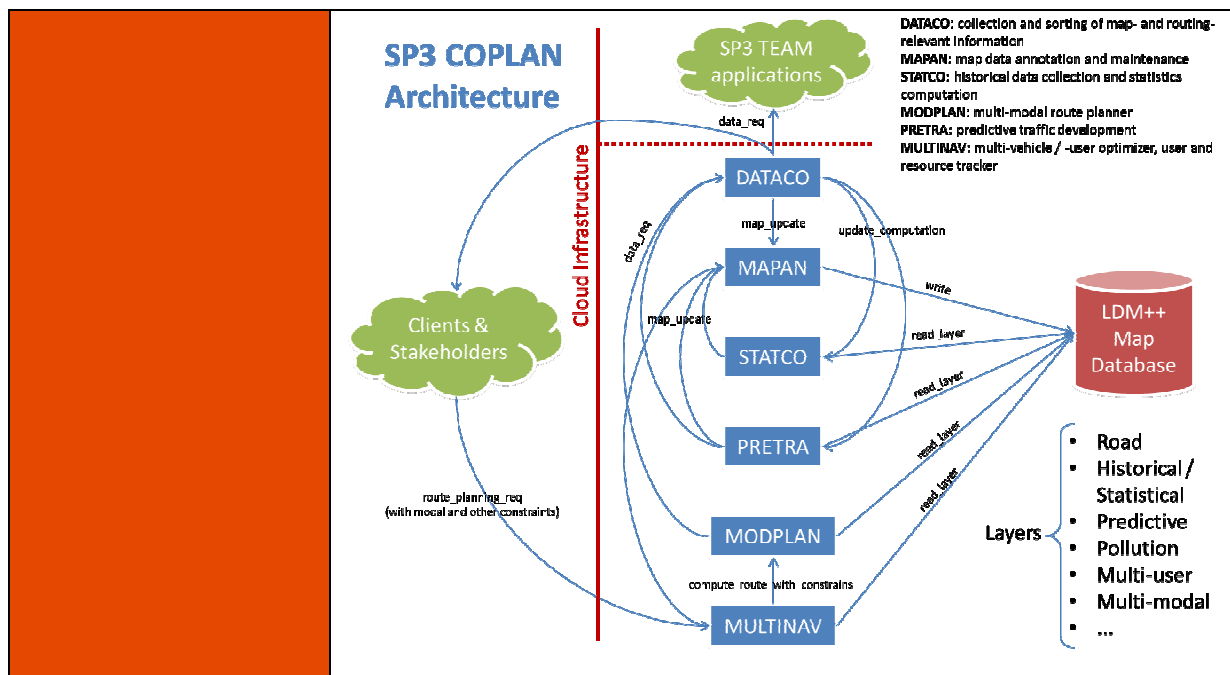
COPLAN collects data in an event- or time-triggered fashion building e.g. a running average of significant traffic data. This information is delivered to other TEAM applications or used to compute routes considering the history of particular locations, roads or regions. Thus, COPLAN will avoid or inform the user of particularly dangerous or problematic locations, roads and areas. The computation of co-modal routes should include links / elements from serious gaming applications.

5. Real-time evaluation and computation of predictive traffic development

COPLAN can recognize dynamic events from the periodically collected data / historical data (this functionality can also be part of other applications or be in itself an application).

Dynamic events may have a geometrical form (point, line, area)

	<p>and a dynamic evolution (change over time, stored as snapshots at specific time intervals). Such events can be bottlenecks, slow moving traffic, etc. This information can be used to compute predictive behaviour to be involved in the route computation (i.e. the multi-objective, multi-variable optimization algorithm).</p> <p>6. Multi-vehicle routing data evaluation, computation and large-scale coordination for collaborative navigation</p> <p>COPLAN considers multiple routing requests and previous calculated routes (e.g. based on user preferences and selected tentative travel plans that have been sent to the application) to deliver new routes. Thus avoiding sending too much traffic over the same routes. This UC introduces additional constraints in the optimization algorithm.</p>
Required lower layer components	<p>COPLAN is made up of the following modules (we take each use case specified above as a module performing an specific function):</p> <ul style="list-style-type: none"> + DATACO: collection of map- and routing-relevant information + MAPAN: map data annotation and maintenance + STATCO: historical data collection and statistics computation + MODPLAN: multi-modal route planner + PRETRA: predictive traffic development traveller + MULTINAV: multi-vehicle / -user optimizer, user and resource tracker <p>The following diagram establishes relations among the different modules:</p>



3.2.3 Co-modal coaching with support from virtual/avatar users

An overview of this application is given in the table below:

Application name	Co-modal coaching with support from virtual/avatar users
Application short name / Identifier	CCA
Application short description	This is a co-modal app with post trip cost/benefit analysis functionalities, made through a comparison of the behaviours of the real user and the "virtual" avatar user. The proposed idea does not aim on vague pre-trip forecasts but reliable and exact post-trip information about realized trip alternatives a user would have had for the same origin-destination pair including monitoring and displaying their true costs, travel times and CO ₂ emissions based on real-time knowledge about occurred traffic jams or delays in public transport, private transport etc.
Platforms implementing the application	<ul style="list-style-type: none"> Smartphone/Vehicle-API Backbone (traffic management centre)
Application objective	The idea in here is that to provide a co-modal real-time route recommendations, that integrates environmental footprint costs on post planned journey, offering travellers the opportunity to choose

	the most environmental friendly alternative of mode for their journey by making a cost-benefit-ratios and environment.
Basic functioning	A comparison will be made through real time monitoring the individual route of a user and the encountered trip alternatives of an avatar travelling by optimal transport modes from the same origin to the same destination at mostly the same time. Such cost-benefit analysis can create good understanding on a user in taking decisions about a real mobility options on his next trips. The integration of this app with collaborative and social aspects of TEAM will further increase its end-user impact.
Application's use cases	<ol style="list-style-type: none"> 1. O/D recognition 2. User/Avatar preferences setting 3. Avatar trip simulation 4. On-trip Avatar coaching 5. Post-trip Avatar coaching
Required lower layer components	<ul style="list-style-type: none"> • Components related to application "Collaborative pro-active monitoring and ad-hoc control" to get all the traffic information needed to perform the coaching function • Vehicle HMI (for in-vehicle coaching) – this components belongs to DIALOGUE enablers • Smartphone HMI (for public transport on-trip and post-trip travellers coaching)

3.2.4 Collaborative smart intersection for intelligent priorities

An overview of this application is given in the table below:

Application name	Collaborative smart intersections for intelligent priority
Application short name / Identifier	Smart Intersections / CSI
Application short description	<p>This is an integrated application for intersections. One of the main objectives is to optimize public transport, giving priority to buses. Priority techniques can generate improvements in service regularity, which usually means alignment with nominal time-tables and headways. A regular service guarantees a good level of transport capacity (expressed in terms of "passengers per hour"): the major goal of transport management. Moreover it makes service planning easier, reduces the time lost by passengers at bus or tram stops, increases user satisfaction and reduces driver stress. The priorities can also be considered based on the vehicle type</p>

	<p>(e.g. truck, bus, tram, car, motorcycle, pedestrians, cyclists etc) and on other factors (truck with dangerous goods, ambulance, disabled person wanting to cross the street, etc).</p> <p>This application also includes communication and synchronization of multiple traffic lights in a region to optimize traffic flow. The vehicles will send their intended destination to the current intersection and that one will communicate with the next ones to help regulate the traffic flow, based on the number of vehicles that will follow in each direction. The vehicles will receive a speed recommendation in order to get to the next traffic light in green.</p> <p>Additionally, the application includes start and stop functionality based on information that comes from smart and pro-active RSUs (i.e. how long do they have to turn off the engine, when to turn on the engine, duration of the red light phase, when the lights will be green, position in a queue etc.)</p>
Platforms implementing the application	<ul style="list-style-type: none"> • Smartphone/Vehicle-API, • Fully vehicle-integrated, • Backbone (traffic management centre), • Road side
Application objective	<p>The goal of this application is to have fully collaborative intersections that can dynamically optimize the traffic flow by giving priorities to certain vehicles, but at the same time taking into account the current traffic conditions.</p>
Basic functioning	<p>The intersections broadcast time and phase information for all traffic lights.</p> <p>The vehicles send relevant information about themselves to the intersection.</p> <p>The intersection then can prioritize and change time and phase for different traffic lights accordingly and then communicate the new information to the vehicles.</p> <p>The in-vehicle HMI coaches the driver to cross the intersection in green or to brake eco-friendly with smart start-stop.</p>
Application's use cases	<ol style="list-style-type: none"> 1. Intersection broadcast information 2. Vehicle sends information 3. Intersection adapts to priority and flow

	<ol style="list-style-type: none"> 4. Green Light Optimal Speed Advisor 5. Smart start-stop and braking recommendation 6. Statistics collection 7. Dynamic speed limit
Required lower layer components	<ul style="list-style-type: none"> - LDM++ - Communication components - Prioritization algorithms - Vehicle data provider - GLOSA component - In-vehicle HMI

3.2.5 Collaborative public transport optimization

An overview of this application is given in the table below:

Application name	Collaborative public transport optimization
Application short name / Identifier	CPTO
Application short description	<p>This application is closely related to the concept of “elastic transport infrastructures” which intend to serve the needs of modern cities.</p> <p>A public transport operator taking into account the origin and destination information from the travellers together with information about the current traffic situation or even information regarding aspects such as the number of passengers that will take the bus at every stop or the estimated time that a bus will spend in a stop, dynamically adapts the timetables and the routes in order to achieve a specific goal. For example, the optimization of the overall network efficiency which in turn will lead to CO₂ emissions reduction.</p>
Platforms implementing the application	<ul style="list-style-type: none"> • Third party (e.g. public transport operator) • Smartphone/Vehicle
Application objective	<p>The goal of this application is to highlight the flexibility of the transport infrastructure serving dynamically the demand of the cities and the citizens (adapted to their needs). This application will focus mainly on buses but can be extended to other means of transport such as trams, trains, metros taking into account the specific constraints of these transport means. Actually the main</p>

	<p>restriction in the latter case is that these means have fixed infrastructure (i.e. rails) but the timetables and the stops could be adapted dynamically based on the demand.</p> <p>It would be desirable TEAM to be capable of proposing changes to the schedules (even routes) of the public transportation means (buses, etc.) in order to flexibly serve the demand (based on historical data, user information, etc.), although it should be considered that the reliability of such suggestions implies wide adoption of the TEAM apps.</p>
Basic functioning	<p>The main assumption that we make in this application is that the majority – ideally all – users/travellers are using a smartphone which is running the TEAM framework and have installed this specific application and that they are using it to communicate their position (start point) and their intended destination (end point) to this framework and possibly “declare” the selected bus line(s) and the departure time in order to provide the TEAM system with valuable information towards both the short and the long term bus scheduling optimization.</p> <p>Taking into account this information together with information about the traffic (current situation on the road) or even information regarding aspects such as the number of passengers that will take the bus at every stop or the estimated time that a bus will spend in a stop, the public transport operator dynamically adapts the timetables and the routes in order to achieve a specific goal. In our case an example of such goal could be the optimization of the overall network efficiency which in turn will lead to CO₂ emissions reduction. Another example could be to avoid sending out buses travelling around without actual demand at a certain point in time minimizing the cost for the operator (as well as the environmental impact), or to make speed recommendations to further increase the efficiency of the network.</p> <p>This is an interactive application and the dynamic rescheduling can be done within an interactive window of at least 5 sec to 5 min based on real time traffic data, available historical/statistical data and the dynamic requests of the travellers (current demand). Of course the interactive time window may be greater and varies depending on the incident and the actual infrastructure restrictions</p>

	<p>(e.g. speed of vehicles/buses, time to withdraw a train from a lane etc.).</p> <p>Real time information from the public transport operator (or the bus itself) will be also communicated to the travellers to keep them informed about the current location of the bus of interest, the time they have to wait at the stop for the bus, their current position when they are on the move, info on the forthcoming stations, the estimated time to their destination, considerable delays on the route of interest, suggestions on alternative routes, etc.</p> <p>In future it might be possible also to adapt the route in order to dynamically create new stations/stops when there is a high demand.</p>
Application's use cases	<ol style="list-style-type: none"> 1. Accident or traffic based route adaptation 2. Event-based route adaptation 3. Adding and/or skipping bus stops 4. Headway adaptation 5. Input data from the travellers 6. En-route information to the travellers 6a. En-lane information to the travellers 7. Pre-trip information to the traveller
Required lower layer components	<ul style="list-style-type: none"> • LDM++ with cloud • Vehicle data or phone data provider • Communication components (LTE, 802.11p) • HMI components for bus drivers and travellers

3.2.6 Dynamic collaborative corridors

An overview of this application is given in the table below:

Application name	Dynamic Corridors
Application short name / Identifier	Corridors / DC
Application short description	<p>This is an application of the concept of transport corridors with an ITS perspective.</p> <p>The application could be understood as a set of digital services the infrastructure provider (or someone contracted by the provider) offers to users of the road infrastructure. It will be the digital infrastructure of the smart highway. Some of these services might</p>

	<p>be free i.e. they are paid through the tax bill, others might be premium services paid by road users on demand.</p> <p>The main objective is to establish corridors for heavy vehicles, being trucks or buses, in a dynamic way. Certain lanes could be reserved for certain vehicles during a certain period. For example, a bus lane could be assigned in the city centre only for buses during the period of peak in traffic, in order to prioritize public transportation schedule. Another example is to have lanes dedicated to distribution vehicles during the early morning to deliver goods in an efficient way. As a last example, inter-urban roads could have dynamic dedicated lanes only for heavy trucks.</p> <p>The collaborative aspect of this application is the possibility of dynamically start or finish a dedicated lane depending on the traffic conditions and priorities. Additionally, drivers could be motivated by serious games to improve their travellers and increasing their priority in accessing those lanes.</p> <p>Another way to create a more dynamic traffic environment is to have dynamic vehicles that can adapt to local regulations. An example could be low noise zones where vehicles can choose different strategies to fulfil the regulation that allow them to enter the area; a hybrid vehicle can turn into full electric mode while a diesel truck can prevent heavy accelerations or high number of revolutions.</p> <p>Access control is an important feature and should be monitored in real-time. The vehicles could have lane position to determine if they are using the lanes inappropriately and also could require access remotely and be granted via in-vehicle HMI.</p> <p>For this application, there is the possibility of connecting with the SP4 "Cooperative Driving" application with the merging feature, which can help the drivers of heavy vehicles to access the corridor lanes. The assistance should be given both to the heavy vehicle driver and to the nearby car drivers in order to merge in an eco-friendly and safe way.</p>
<p>Platforms implementing the application</p>	<p>Smartphone/Vehicle-API, Fully vehicle-integrated, Backbone (traffic management centre), Third party (e.g. public transport operator)</p>

Application objective	The goal of this application is to have fully collaborative dynamic transport corridors focused on heavy vehicles to optimize the utilization of lanes, assist the drivers to access and leave those lanes and enable monitoring and control of usage.
Basic functioning	
Application's use cases	<ol style="list-style-type: none"> 1. Dynamic Dedicated Lanes for Corridors 2. Dynamic Vehicle Adaption to Local Regulations 3. Serious games for eco driving 4. Intelligent Access Control 5. Lane merge assistance 6. Data logging
Required lower layer components	<ul style="list-style-type: none"> - LDM++ - Communication components - Lane level positioning - Prioritization algorithms - Vehicle data provider - Vehicle controlling and adaptation component - Data logging - Serious gaming component - Merge assistant - In-vehicle HMI

4 Requirements from the DIALOGUE applications

The "internal" requirements from the DIALOGUE applications and their specific needs are reported in this section. There is one subsection per application with the relevant requirements in the tabular format provided by IR4.3.2.

4.1 Collaborative ACC

4.1.1 Requirements related to HMI

Requirement ID:	SP4_REQ_CACC_HMI_v0.1
Name of requirement:	HMI for Collaborative Adaptive Cruise Control (CACC)
Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 HMI Group
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	HMI
Goal	Interaction between CACC and the driver
Definition:	<p>HMI should be enabled to provide:</p> <ol style="list-style-type: none"> 1. CACC is enabled/disabled, setup desired ACC Speed 2. Speed advisory: the calculated ACC velocity can be shown to the driver via in vehicle HMI or Smartphone, so the driver can accelerate or decelerate. A graphic should illustrate the quantity (+/-) so that it can be captured through a short look. 3. See UC#3: Current pollution level of the region in which the vehicle is driving, and the current emission level of the vehicle 4. See UC#4: time to green light on the next

	<p>intersection</p> <p>5. See UC#5: Dense traffic driving with auto start stop is engaged or not</p> <p>6. See UC#6: Approaching road infrastructure incident -> beginning to slow down</p> <p>7. See UC#7: Approaching Traffic Jam -> beginning to slow down/ adapting vehicle speed</p>
Critical level (priority)	Med
Validation Method (tests, indicators, performance bounds)	HMI tests with users
Acceptance criteria	Acceptance of the developed HMI
Relationship with other requirements	Other application's HMI
Potential conflicts	no
Risk analysis	Needed for driver acceptance of CACC functionality
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_ARBITER_v0.1
Name of requirement:	Vehicle actors arbitration
Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 CACC & CDM
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Application requirements

Goal	A component is needed, which arbitrages the input for acceleration, deceleration, emergency braking, coming from all CACC use cases as well as from CDM and passes it to the vehicle.
Definition:	An interface including desired speed, acceleration, deceleration, priority, emergency braking, needs to be provided.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Proper functioning: pass the most relevant input to the vehicle
Relationship with other requirements	SP4_CDM_R_00009
Potential conflicts	no
Risk analysis	High, wrong values passed to the vehicle might cause conflicts. Check plausibility e.g. leverage watchdog
Status	New
Other	No

4.1.2 Application-specific

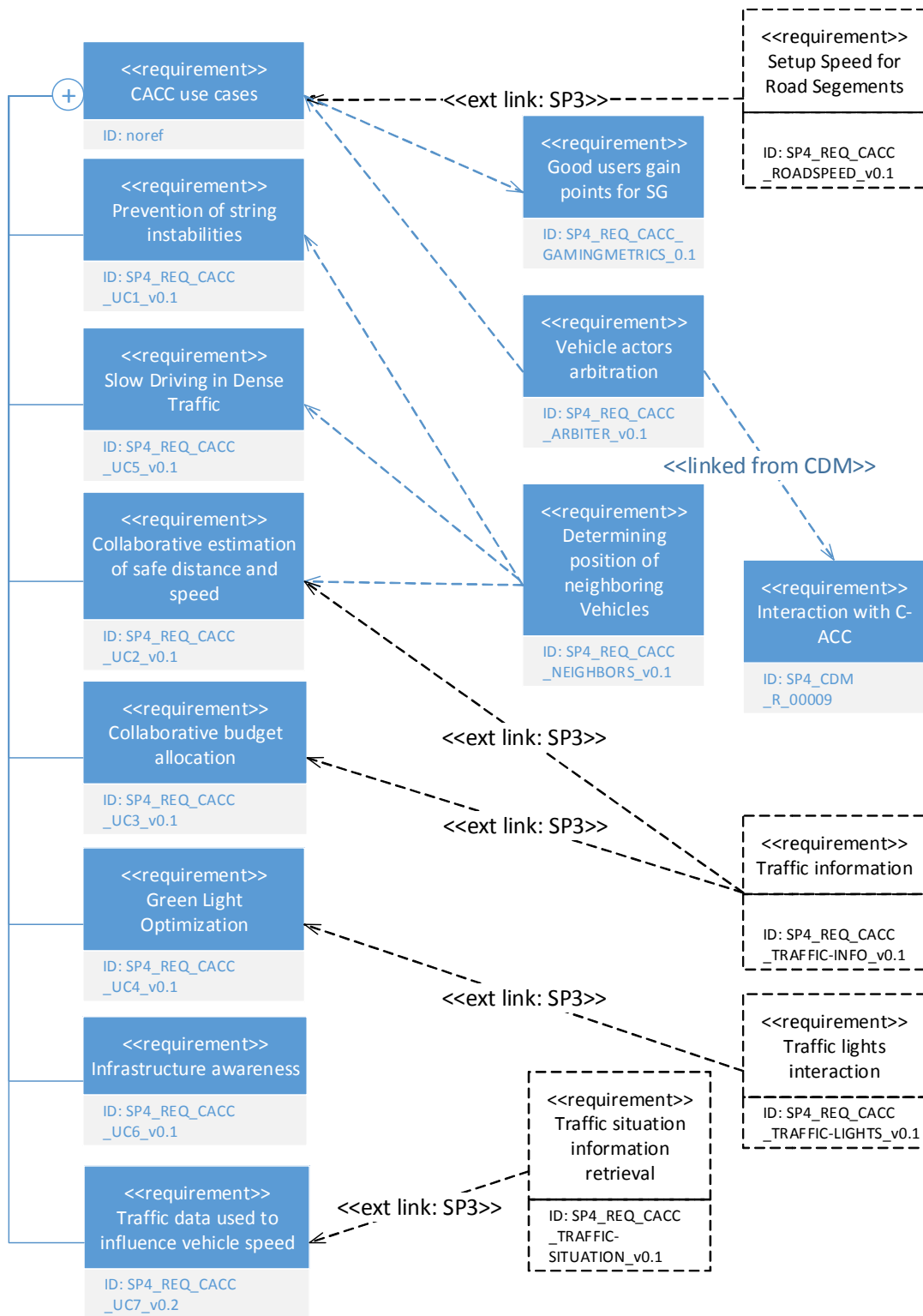


Figure 2 Application specific requirements for CACC

Requirement ID:	SP4_REQ_CACC_NEIGHBORS_v0.1
Name of requirement:	Determining position of neighboring Vehicles
Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 CACC , maybe LDM++ Group of SP2
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Positioning
Goal	Determine order of vehicles in a platoon, in order to enable in platoon communication among the vehicles, and spatial coordination
Definition:	Computation of which Vehicle is the predecessor of the vehicle driving in the same lane and its predecessor etc. (3 vehicles in front) and the same for the 3 successors.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Compare platoon order in user tests. Test cases are Communication, Collaboration and spatial coordination
Acceptance criteria	Correct relative positions of all vehicles around
Relationship with other requirements	SP4_REQ_CACC_UC4_v0.1
Potential conflicts	no
Risk analysis	The entire CACC application will fail without this requirement
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_GAMINGMETRICS_v0.1
Name of requirement:	Good users gain points for SG

Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 CACC
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Application requirement
Goal	Gain good user metrics for rewarding the user with virtual coins, when following the proposals coming from CACC logic.
Definition:	Count the time when CACC is active and the driver is accepting the CACC recommendations. Put a higher weight on the time when CACC overrides the user's desired speed with a lower speed due to collaborative aspects.
Critical level (priority)	Low
Validation Method (tests, indicators, performance bounds)	Functional test, user acceptance
Acceptance criteria	Time and weight is counted correctly
Relationship with other requirements	SP4_REQ_CACC_UC4_v0.1
Potential conflicts	no
Risk analysis	critical for using CACC as aspect for SG
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_UC1_v0.1
Name of requirement:	Prevention of string instabilities
Created by	CACC (Kay.Massow@fokus.fraunhofer.de)

Assigned partner	SP4 CACC
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Application requirements
Goal	Prevent string instabilities in a platoon, in order to realize CACC use case 1
Definition:	Calculation of acceleration and deceleration when acc is engaged considering speed and acc/dec of the vehicles in front, in order to prevent string instabilities
Critical level (priority)	Med
Validation Method (tests, indicators, performance bounds)	Check string stability in functional lab tests
Acceptance criteria	Platoon is string stable
Relationship with other requirements	Needed by all other CACC use cases
Potential conflicts	no
Risk analysis	String instability causes problems for all other CACC use cases when applying the recommended speed directly to the vehicle
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_UC2_v0.1
Name of requirement:	Collaborative estimation of safe distance and speed
Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 CACC

Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Application requirements
Goal	estimation of traffic density and safe distance and speed in a collaborative way
Definition:	Calculation of safe distance and safe driving speed collaboratively taking the current speed limit into account, as well as the density of vehicles driving around. The latter might be needed to be computed also.
Critical level (priority)	Med
Validation Method (tests, indicators, performance bounds)	Check if traffic density estimation is correct and if safe speed and inter vehicle distances are reasonable. Functional user tests. Environmental conditions should be taken into account. Like Weather, accidents, etc.
Acceptance criteria	Calculated distance and speed are reasonable
Relationship with other requirements	no
Potential conflicts	no
Risk analysis	Environmental conditions may influence the computation of safe speed and distance.
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_UC3_v0.1
Name of requirement:	Collaborative budget allocation
Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 CACC
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)

Requirement category	Application requirements
Goal	Allocation of specific emission budgets to the vehicles in a low emission zone
Definition:	<p>According to the current pollution level of a certain area and its maximum pollution level (e.g. in low emission zones) a certain road budget needs to be calculated for each vehicle in this area, taking its emission parameters into account. On this basis, a certain speed profile needs to be calculated for each vehicle. Current speed, emission rate, situation (e.g. whether driving in a platoon or not) needs to be communicated frequently to enable calculation</p> <p>Grant higher budget to user who gained points on SG.</p>
Critical level (priority)	Med
Validation Method (tests, indicators, performance bounds)	Check if speed, emission rate, situation (e.g. whether driving in a platoon or not) is communicated constantly and correctly. Check if calculated budgets match overall budget. Check allocation. Functional user tests.
Acceptance criteria	Sum of the budgets of all vehicle match the overall budget
Relationship with other requirements	no
Potential conflicts	no
Risk analysis	Availability of Communication
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_UC4_v0.1
Name of requirement:	Green Light Optimization

Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 CACC
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Application requirements
Goal	Determination of time/speed optimized driving and switching of traffic lights in order to establish a green wave
Definition:	<p>Calculate time/speed optimum to reach the next traffic lights in a collaborative way in order to establish a continuous phase of green lights. Traffic light switching can be requested within certain time slots provided by the traffic lights.</p> <p>Prefer user who gained points on SG.</p>
Critical level (priority)	Med
Validation Method (tests, indicators, performance bounds)	simulation, Real world testing e.g. in Holland on basis of WLAN traffic lights
Acceptance criteria	Check if calculation is reasonable
Relationship with other requirements	no
Potential conflicts	no
Risk analysis	Communication, coverage of WLAN traffic signals
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_UC5_v0.1
Name of requirement:	Slow Driving in Dense Traffic

Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 CACC
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Application requirements
Goal	Enable automated platooning in dense traffic with very close distances
Definition:	Special parameters belonging to the vehicle's power train should be provided in order to early estimate acc/dec and so to reduce the inter vehicle gap in dense traffic to a minimum. Relevant parameters among others are: longitudinal acceleration sensor, engine torque request, gear shift request, braking force, environmental parameters like weather.
Critical level (priority)	Med
Validation Method (tests, indicators, performance bounds)	Simulation: no rear end accidents
Acceptance criteria	Check if inter vehicle gap is constant
Relationship with other requirements	no
Potential conflicts	no
Risk analysis	communication
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_UC6_v0.1
Name of requirement:	Infrastructure awareness
Created by	CACC (Kay.Massow@fokus.fraunhofer.de)
Assigned partner	SP4 CACC
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)

enabler)	
Requirement category	Application requirements
Goal	Recognition of upcoming infrastructure elements, which imply deceleration in order to be able to start deceleration of the vehicle early.
Definition:	Calculation of suitable speed to pass upcoming infrastructure elements like intersections, highway ramps, hilltops, sags, long curves, speed limit zones. This includes a check, which of these elements are located on the current route of the vehicle and environmental influences such as weather, incidents.
Critical level (priority)	Med
Validation Method (tests, indicators, performance bounds)	Check if incidents on the current navigation route are recognized. Functional tests
Acceptance criteria	Recognized infrastructure element is correct, speed difference is reasonable, vehicle reaches expected speed when reaching the infrastructure element
Relationship with other requirements	no
Potential conflicts	no
Risk analysis	Communication and infrastructure awareness
Status	New
Other	No

Requirement ID:	SP4_REQ_CACC_UC7_0.2
Name of requirement:	Traffic data used to influence vehicle speed when Cruise Control is active
Created by	Mikko.Leimio@nokia.com
Assigned partner	

Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Detect when a vehicle is approaching traffic ahead and automatically adjust its speed to compensate when cruise control is active. E.g if vehicle is approaching a traffic jam, ACC starts decreasing speed.
Definition:	Actual logic of ACC should be implemented on application as backend service (Traffic API) just provides information of current status of traffic and flow. This information then can be used in application level where logic of balancing traffic and avoiding congestion. The main purpose here is to recognize traffic jams ahead and adapt the ACC speed in order to approach slower. This should decrease the growing rate of the traffic jam and reduces the risk of rear accidents.
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Traffic information flow to be verified, but to be tested on real environment or simulated environment. Speed is adjusted so that it is not confusing for driver.
Acceptance criteria	Traffic information is received, and cruise control speed is adjusted accordingly. Changing speed should not be distractive for driver and driver need to be notified before speed is adjusted.
Relationship with other requirements	Requires online connectivity to cloud services. Navigation Use Case (this should be part of normal navigation use cases)
Potential conflicts	no
Risk analysis	SP4_REQ_CACC_UC#7 will fail without this requirement
Status	New / Traffic API is existing
Other	Through careful management of the vehicles speed through an understanding of the traffic on-route, we

	<p>allow sufficient time for the traffic ahead to dissipate, thus greatly reducing the possibility that the user has to confront any level of traffic congestion, which is often such a frustrating experience and enhances driving safety</p> <p>Measurable benefits depend upon the vehicles that participate in such a system, including those drivers who comply. From an idealistic perspective, this could drastically reduce traffic levels.</p>
--	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

4.1.3 Requirements related to user and environment data

Requirement ID:	SP4_REQ_CACC_UC#8_database
Name of requirement:	User profile database
Created by	Ramboll (timo.hanninen@ramboll.fi)
Assigned partner	To be defined
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Technological and development requirements
Goal	Create, load and save different user profiles for all riders.
Definition:	Database
Critical level (priority)	Low
Validation Method (tests, indicators, performance bounds)	Functional tests, simulations
Acceptance criteria	Availability of user profile data
Relationship with other requirements	no
Potential conflicts	no
Risk analysis	Not priority

Status	New
Other	no

Requirement ID:	SP4_REQ_CACC_UC#8_map data
Name of requirement:	road geometry, road properties, speed limit, traffic, infrastructure
Created by	Ramboll (timo.hanninen@ramboll.fi)
Assigned partner	To be defined
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Technological and development requirements
Goal	Applications gets needed information.
Definition:	Application gets data which is used to give proper warnings and speed recommendations.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Functional check
Relationship with other requirements	SP4_REQ_CACC_UC#8_database, SP4_REQ_CACC_UC#8_location data,
Potential conflicts	no
Risk analysis	SP4_REQ_CACC_UC#8 will fail without this requirement
Status	new
Other	no

Requirement ID:	SP4_REQ_CACC_UC#8_location data
------------------------	---------------------------------

Name of requirement:	Location data
Created by	Ramboll (timo.hanninen@ramboll.fi)
Assigned partner	To be defined
Source (TEAM application or enabler)	Collaborative Adaptive Cruise Control (CACC)
Requirement category	Technological and development requirements
Goal	Applications gets location, direction and speed
Definition:	Own speed, locations and direction
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Functional check
Relationship with other requirements	SP4_REQ_CACC_UC#8_database, SP4_REQ_CACC_UC#8_map_data,
Potential conflicts	no
Risk analysis	SP4_REQ_CACC_UC#8 will fail without this requirement
Status	new
Other	no

4.2 Collaborative Parking

Note: in the ID, INT means internal requirement (to avoid ID mismatching, as we have similar requirements and ID's given to SP2 SP3). The acronym of the application is EFP (Eco-friendly Parking).

Today numerous smart phone apps are already available to enable people to find parking places (if not even slots, communicated by the crowd) in different context. Obviously it is expected that these kind of apps will become more and more popular and will rapidly change on user demand basis. An easy step to take is also to correlate parking availability with navigation destination, whereby the navigation system can be either on board the vehicle or on a smart phone.

However, navigation systems are only very rarely used by drivers as more that 70% of the trips are recurrent trips to known destinations. Still, the most critical and annoying problems related to parking availability are related to destinations that are often used and do not offer easy parking availability. This can happen close to work, home, shopping centres, etc.

The collaborative parking app has two innovation aspects: one is related to the fact that the vehicle automatically relates its parking search in the area that is nearby the estimated destination (independently from the availability of the information on the navigation system or not). Secondly, the collaborative aspect, which is interlinked with serious gaming mechanisms: parking information is filtered/surfaced selectively to the users, depending not only on state-of-art parameters such as user preferences or vehicle type, but also on a degree of collaboration and reliability of each end user.

4.2.1 Requirements related to user input via HMI

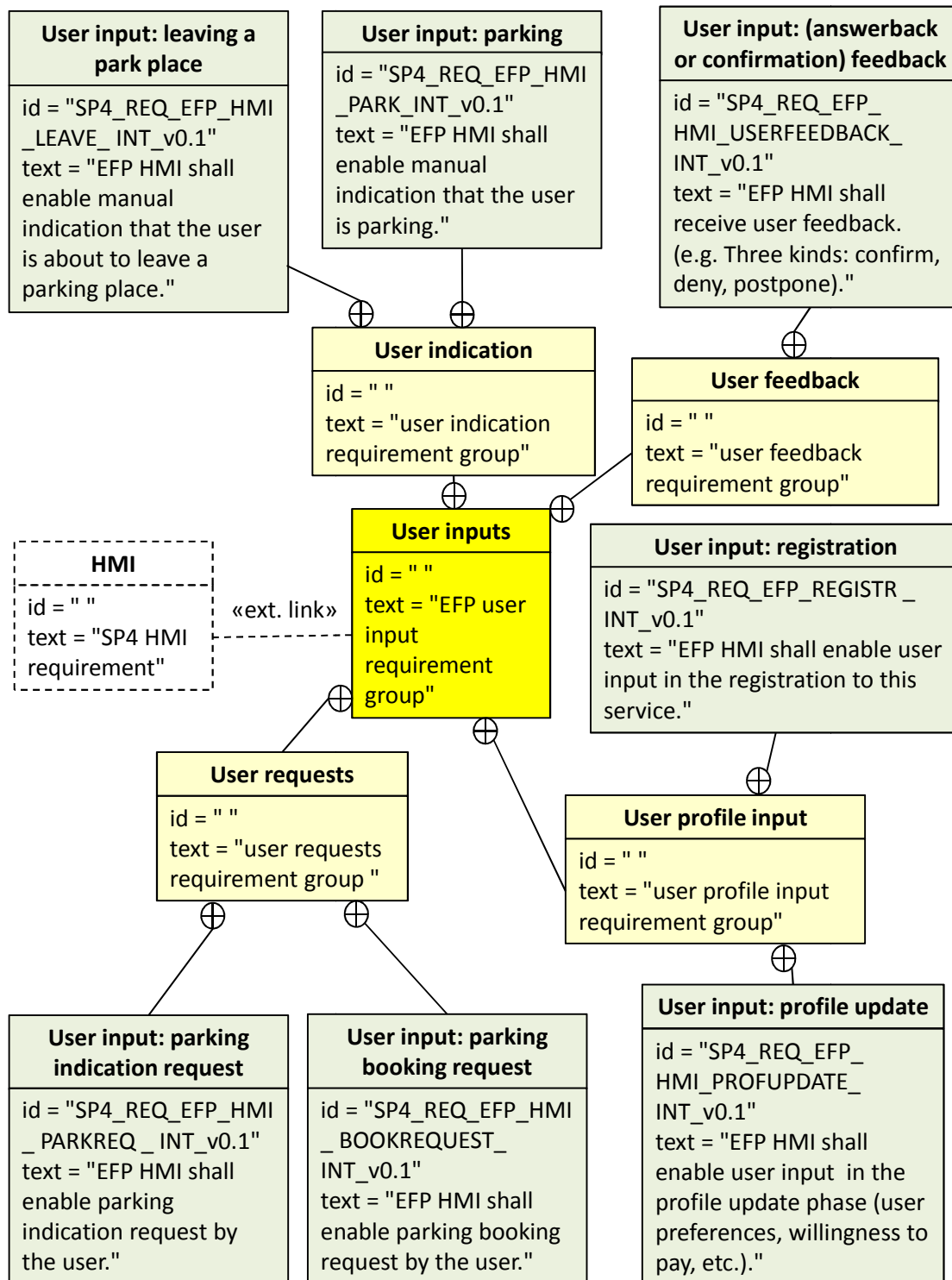


Figure 3: Requirements related to User Input via HMI from EFP

Requirement ID:	SP4_REQ_EFP_HMI_PARK_INT_v0.1
Name of requirement:	User input: parking
Created by	EFP, Filippo Visintainer, Sergio Damiani
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	HMI
Goal	Inform the cloud that the user is parking, through simple manual indication by the user (collaborative indication).
Definition:	EFP HMI shall enable manual indication that the user is about to park.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Ease of use: simple interface
Relationship with other requirements	HMI requirements of other applications
Potential conflicts	No
Risk analysis	Driver acceptance of HMI type and/or input operation: although the driver should have collaborative attitude, the need for manual input each time he/she is parking might eventually annoy him. The solution might be to leverage on gaming and raise the user's enthusiasm through the virtual coins gaining perspective.
Status	New
Other	We should keep differentiated the situations: user about to park (having found parking), user looking for parking (and requesting indications, now), user booking a parking

	(and requesting indications, later)
--	-------------------------------------

Requirement ID:	SP4_REQ_EFP_HMI_LEAVE_INT_v0.1
Name of requirement:	User input: leaving a park place
Created by	EFP, Filippo Visintainer, Sergio Damiani
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	HMI
Goal	Foresee possibility of manual indication that the driver is leaving a park place
Definition:	EFP HMI shall enable manual indication that the user is about to leave a parking place
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Ease of use: simple interface
Relationship with other requirements	HMI requirements of other applications
Potential conflicts	No
Risk analysis	Driver acceptance of HMI type and/or input operation: same kind of risk as SP4_REQ_EFP_HMI_PARK_INT_v0.1.
Status	New
Other	No

Please duplicate as needed.

Requirement ID:	SP4_REQ_EFP_HMI _ PARKREQ _ INT_v0.1
Name of requirement:	User input: parking indication request
Created by	EFP, Filippo Visintainer, Sergio Damiani
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	HMI
Goal	The goal is to enable the following request by the User to the EFP application, through HMI: "search for a parking place in the vicinity of intended destination and indicate where to go". This is namely a parking indication request. The scenario concerning a parking indication request is typically when the user is near the intended destination, i.e. this could be 5 minutes to 30 seconds before arriving.
Definition:	EFP HMI shall enable parking indication request by the user.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Ease of use: simple interface
Relationship with other requirements	HMI requirements of other applications
Potential conflicts	No
Risk analysis	Driver acceptance of HMI type and/or input operation. As in SP4_REQ_EFP_HMI _PARK_INT_v0.1 there is a risk of overloading the user with tasks related to EFP, however, in this case the risk of annoying the user is quite low, since the user receives tangible advantage by requesting parking indication (unlike the aforementioned collaborative input, which gives more an indirect advantage and must leverage on other factors like

	gaming).
Status	New
Other	Parking indication by user should then be translated into parking information request to SP3 : reference SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1.

Requirement ID:	SP4_REQ_EFP_HMI _ BOOKREQUEST_ INT_v0.1
Name of requirement:	User input: parking booking request
Created by	EFP, Filippo Visintainer, Sergio Damiani
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	HMI
Goal	Foresee possibility of booking a parking through a request to the system, via on board HMI. The scenario concerning a parking indication request is typically when the user has not yet arrived to destination, i.e. this could be 10 minutes to a few hours before arriving at destination, including pre-trip.
Definition:	EFP HMI shall enable parking booking request by the user.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Ease of use: simple interface
Relationship with other requirements	HMI requirements of other applications

Potential conflicts	No
Risk analysis	Driver acceptance of HMI type and/or input operation, analogously to SP4_REQ_EFP_HMI_PARKREQ_INT_v0.1. (low risk).
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_HMI_USERFEEDBACK_INT_v0.1
Name of requirement:	User input: (answerback or confirmation) feedback
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	HMI
Goal	Foresee possibility of confirming, denying, ignoring system request
Definition:	EFP HMI shall receive user feedback. (e.g. Three kinds: confirm, deny, postpone).
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Ease of use: simple interface
Relationship with other requirements	HMI requirements of other applications. Also depends on SP4_REQ_EFP_ACT_USERFEEDREQ_INT_v0.1
Potential conflicts	No

Risk analysis	Driver acceptance of HMI type and/or input operation. Quite a high risk of user annoyance. Could be mitigated by limiting the amount of confirmation requests, and by leveraging on gaming (ref. SP4_REQ_EFP_HMI_PARK_INT_v0.1).
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_REGISTR _ INT_v0.1
Name of requirement:	User input: registration
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	HMI
Goal	Foresee registration phase
Definition:	EFP HMI shall enable user input for the registration to this service.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Not applicable
Relationship with other requirements	Other SP4 applications
Potential conflicts	No
Risk analysis	Not applicable

Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_HMI_PROFUPDATE_INT_v0.1
Name of requirement:	User input: profile update
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	HMI
Goal	Foresee possibility of the user to update his/her profile
Definition:	EFP HMI shall enable user input in the profile update phase (user preferences, willingness to pay, etc.).
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Not applicable
Relationship with other requirements	Other SP4 applications
Potential conflicts	No
Risk analysis	N/A
Status	New
Other	No

4.2.2 Requirements related to input data from TEAM to EFP application

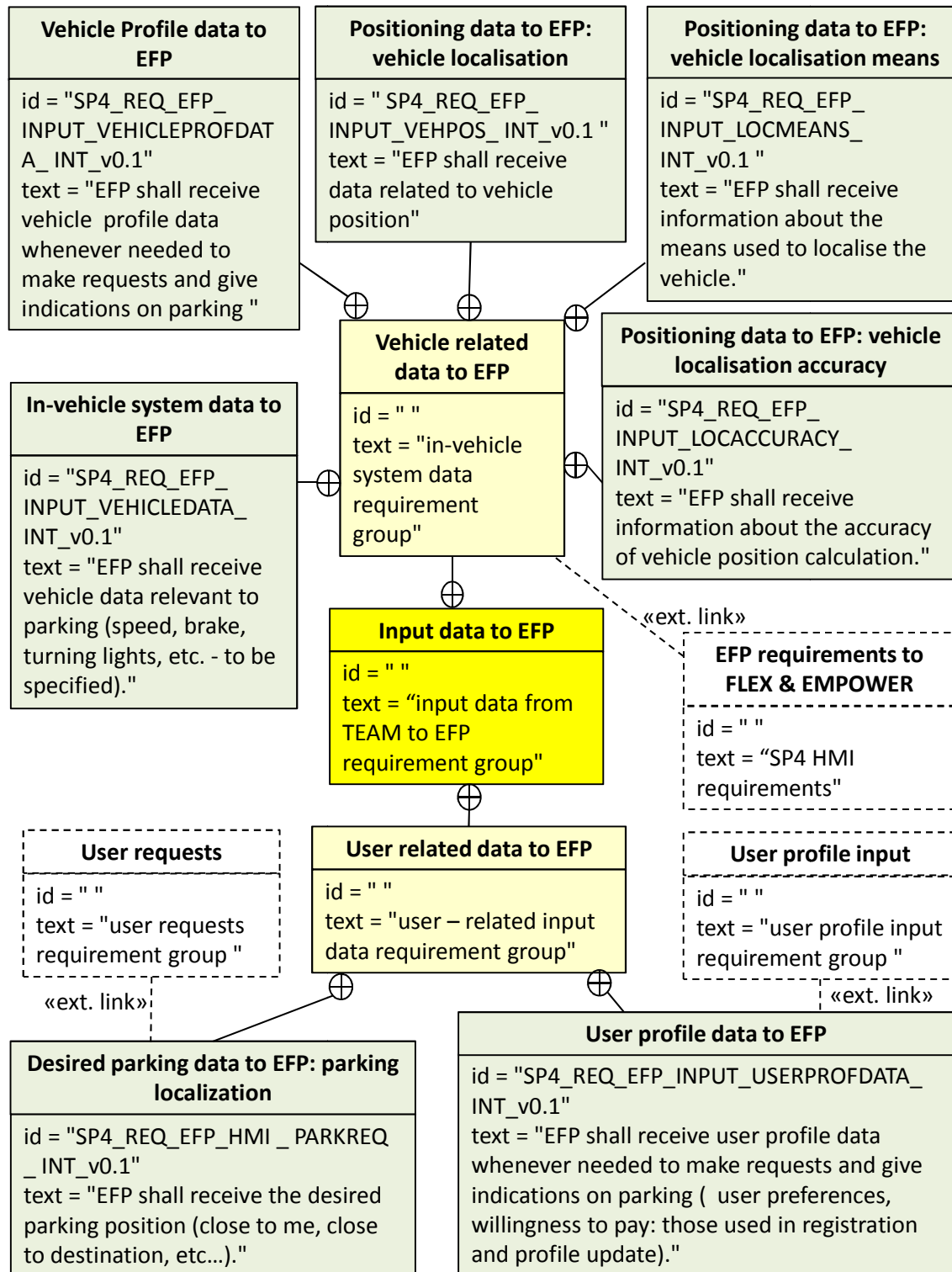


Figure 4: Requirements related to input data from TEAM to EFP

Requirement ID:	SP4_REQ_EFP_INPUT_VEHICLEDATA_INT_v0.1
Name of requirement:	In-vehicle system data to EFP
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4, EFP group
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	Input data to application
Goal	To achieve a highly responsive EFP which utilizes input data related to driving
Definition:	EFP shall receive vehicle data relevant to parking (speed, brake, turning lights, etc. – to be specified)
Critical level (priority)	Medium-High
Validation Method (tests, indicators, performance bounds)	Prototype system tests. Log the data and verify that they are correctly logged.
Acceptance criteria	At least a minimum set of data are sent.
Relationship with other requirements	No
Potential conflicts	Privacy
Risk analysis	Common format definition among OEM's. This would impact on a common EFP design and implementation. To mitigate this risk, vehicle data specifications should be tackled across all applications in harmonized way, so that OEM's currently not interested in one applications can nevertheless integrate it later, thanks to the common data format.
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_INPUT_USERPROFDATA_INT_v0.1
Name of requirement:	User Profile data to EFP
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4, EFP group
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	Input data to application
Goal	To achieve an user tailored EFP which utilizes input data related to user profile (habits, history, preferences, etc.)
Definition:	EFP shall receive user profile data whenever needed to make requests and give indications on parking (user preferences, willingness to pay: those used in registration and profile update)
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Field tests with different user profiles created ad hoc. Evaluate EFP dependence on profile in sample use cases.
Acceptance criteria	Profiles is taken into account.
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	We may not achieve a profile based service, as priority is the basic service functionality. However, we should carry out this effort at least within the specification phase.
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_INPUT_VEHICLEPROFDATA_INT_v0.1
Name of requirement:	Vehicle Profile data to EFP
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	Input data to application
Goal	To take into account the vehicle type when searching for parking place
Definition:	EFP shall receive vehicle profile data whenever needed to make requests and give indications on parking (vehicle type, size : those used in vehicle registration?)
Critical level (priority)	Medium-Low
Validation Method (tests, indicators, performance bounds)	Verify that the implementation reflects the design specifications concerning vehicle profile data. There will be no field tests with different types of vehicle.
Acceptance criteria	Development vs design verification is successful.
Relationship with other requirements	Depends on SP4_REQ_EFP_REGISTRATION_INT_v0.1 SP4_REQ_EFP_HMI_PROFUPDATE_INT_v0.1
Potential conflicts	No
Risk analysis	We may not achieve a profile based service, as priority is the basic service functionality, and we'll most likely demonstrate the concept on cars. Nevertheless, the specifications should already foresee all the relevant parameters related to occupancy and parking maneuvers (e.g. size, trailer, etc.), so that what is developed can be scaled up to a profile-based use-cases after the TEAM project.

Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_INPUT_DESPARKINGLOC_INT_v0.1
Name of requirement:	Desired parking data to EFP: parking localization
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	EFP, Collaborative Parking
Requirement category	Input data to application
Goal	To take into account user request of location , when searching for a parking place
Definition:	EFP shall receive the desired parking position (close to me, close to destination, etc...)
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Laboratory and field tests on use cases, which should cover scenarios of relevance (close to driver, far from driver, etc.) and with different level of accuracy in the request (this area, this address, this position, close to here, etc.).
Acceptance criteria	System should be flexible, in that it should be able to work with different kinds of indications.
Relationship with other requirements	Depends on SP4_REQ_EFP_HMI_PARKREQ_INT_v0.1 SP4_REQ_EFP_HMI_BOOKREQUEST_INT_v0.1
Potential conflicts	No
Risk analysis	EFP may not be flexible enough to account for different kind of desired parking position input (e.g. may search

	only in macro area, or may find only if precise address is given). The suggestion is anyway to keep it simple, as the SP4 focus is not to demonstrate flexibility thanks to a new parking search engine, but to demonstrate flexibility thanks to users' collaboration and social gaming.
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_INPUT_VEHPOS_INT_v0.1
Name of requirement:	Positioning data to EFP:: vehicle localisation
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, EFP group
Requirement category	Input data to application
Goal	When EFP is operational, it should ideally know instantaneous positions and heading of all equipped vehicles concerned with parking
Definition:	EFP shall receive data related to vehicle position
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Field tests, also in critical conditions for positioning (urban canyons). Measure the number of failure in service provision due to positioning and set an acceptance threshold.
Acceptance criteria	Failure percentage threshold is not passed.
Relationship with other requirements	Top level requirement within SP4. It depends on EFP requirements to SP2 concerning vehicle position

	availability and update.
Potential conflicts	Privacy
Risk analysis	Service not available due to lack of vehicle position. Quite high impact risk. In fact, the addition of the following requirements on localization means are intended to mitigate this risk, foreseeing the possible usage of all kinds of localization means available, even with lower quality than GPS.
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_INPUT_LOCMEANS_INT_v0.1
Name of requirement:	Positioning data to EFP:: vehicle localisation means
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Input data to application
Goal	To enable flexibility of EFP, taking localization means into account. EFP could provide different quality of service depending on the type of input data. E.g. with one vehicle coming and one leaving, precise indication could be given to the coming one if both vehicles are localized via GPS, more generic indications if both are just "seen" by a local wi-fi spot .
Definition:	EFP shall receive information about the means used to localise the vehicle.
Critical level (priority)	High

Validation Method (tests, indicators, performance bounds)	Field tests with different localization means. Data are correctly provided by on board positioning sources to EFP.
Acceptance criteria	EFP works at least with 2 different means: e.g. GPS and Wi-Fi
Relationship with other requirements	Depends on SP4_REQ_EFP_INPUT_VEHPOS_INT_v0.1 and on positioning requirements to SP2.
Potential conflicts	Privacy
Risk analysis	Service is not flexible if it works only with GPS. On the other hand there might be problems preventing from adding other means of localization, such as roaming availability, Signal quality is also of high importance - parking in hilly place could be difficult in case of low signal (due to reflections).
Status	New
Other	Possible means: GPS, Wi-Fi spot, 802.11p beacon from infrastructure, Cell-ID.

Requirement ID:	SP4_REQ_EFP_INPUT_LOCACCURACY_INT_v0.1
Name of requirement:	Positioning data to EFP:: vehicle localisation accuracy
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Input data to application
Goal	To enable flexibility of EFP, foreseeing different quality of service depending on localization accuracy (see requirement on localization means)

Definition:	EFP shall receive information about the accuracy of vehicle position calculation.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	See requirement on localization means for the kinds of tests.
Acceptance criteria	EFP works at least in two modalities: e.g. accurate position known, generic position known.
Relationship with other requirements	Depends on SP4_REQ_EFP_INPUT_LOCMEANS_INT_v0.1 and on positioning requirements to SP2.
Potential conflicts	No
Risk analysis	Service not flexible if it works only with highly accurate data.
Status	New
Other	Strictly related to localization means requirement.

4.2.3 Requirements related to data processing

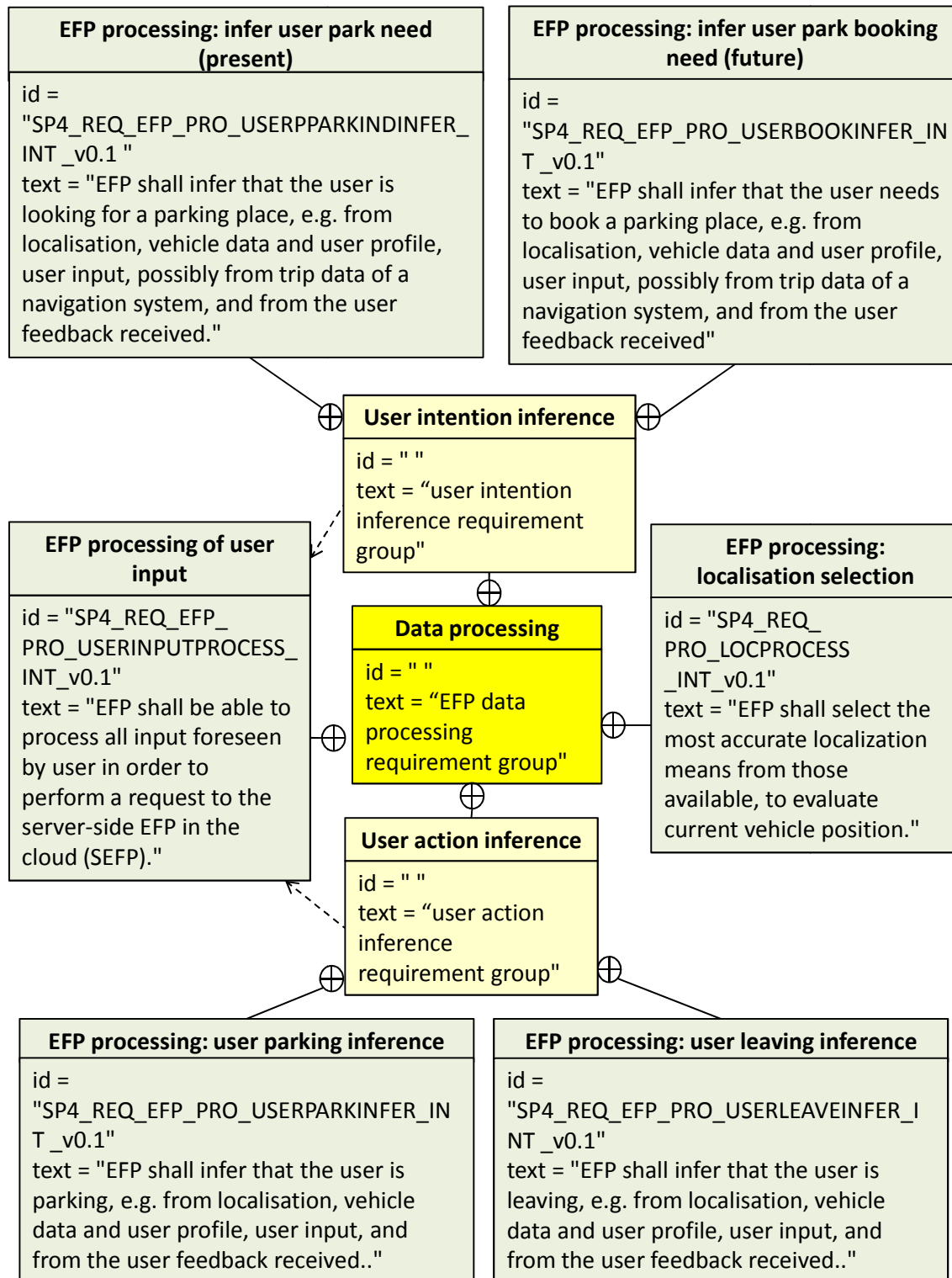


Figure 5: Requirements related to data processing from EFP

Requirement ID:	SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1
Name of requirement:	EFP processing of user input
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application processing/ application working principle
Goal	To design proper on board processing algorithms which give as output proper requests/indications to the server-side EFP in the cloud (SEFP).
Definition:	<p>EFP shall be able to process all input foreseen by user in order to perform a request to the server-side EFP in the cloud (SEFP).</p> <p>Type of input is reported in HMI requirements and regards</p> <ul style="list-style-type: none"> - Parking/leaving manual indications - Parking indication requests - Parking booking requests - User feedback (confirm/deny/ignore) - User registration and profile update
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Laboratory and field tests on all the kinds of user input foreseen. The output request to the server-side EFP in the cloud (SEFP) is checked against the user input. The indicator is the consistency of output request with respect to the user original input and the actual user need.
Acceptance criteria	The output of EFP processing should always be consistent with the user original input/intentions (e.g. parking indication by user, reference SP4_REQ_EFP_HMI_PARKREQ_INT_v0.1 should be translated into parking

	information request to SP3). In the demo case, some margins of imprecision could be acceptable e.g. in the correlation of user input with user profile.
Relationship with other requirements	Depends on all HMI requirements.
Potential conflicts	No
Risk analysis	A failure of this requirement has high negative impact (system would not respond as desired) but basic functionality should be achievable without risks.
Status	New
Other	Key aspect is a clear division of roles and definition of interfaces between DIALOGUE and FLEX. Indicatively DIALOGUE should take care of the data fusion within the single vehicle (HMI+vehicle data+feedback+profile, etc.) ending-up in clear requests/indications to FLEX, while the latter should manage the ensemble of multiple vehicles and multiple parking spaces, and respond with indications of parking space, booking confirmations, etc., depending on the overall situation.

Requirement ID:	SP4_REQ_PRO_LOCPROCESS_INT_v0.1
Name of requirement:	EFP processing: localisation selection
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application processing/ application working principle
Goal	To achieve an EFP application which is able to retrieve the best data of vehicle position, based on localization means information and localization accuracy information
Definition:	EFP shall select the most accurate localization means

	from those available, to evaluate current vehicle position.
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Laboratory and field tests on all the kinds of user input foreseen. Test localization means independently and then together (with prioritization) and verify that the system works as planned.
Acceptance criteria	A selection without failure can be done among 2 (or more) different localization means.
Relationship with other requirements	Depends on SP4_REQ_PRO_LOCPROCESS_INT_v0.1 SP4_REQ_EFP_INPUT_LOCMEANS_INT_v0.1 SP4_REQ_EFP_INPUT_LOCACCURACY_INT_v0.1
Potential conflicts	No
Risk analysis	We may not achieve a good decision making, but this would not affect the basic EFP functionalities.
Status	New
Other	We must not enter into data fusion subject, rather just have a simple decision based on localization means availability and accuracy.

Requirement ID:	SP4_REQ_EFP_PRO_USERPARKINFER_INT_v0.1
Name of requirement:	EFP processing: user parking inference
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application processing/ application working principle

Goal	To achieve an EFP which autonomously detects that the user is parking
Definition:	EFP shall infer that the user is parking, e.g. from localisation, vehicle data and user profile, user input, and from the user feedback received.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Field trials. Measure false positive and missing detections compare results with proper error acceptance threshold.
Acceptance criteria	System behavior is below error acceptance thresholds
Relationship with other requirements	Depends on SP4_REQ_EFP_INPUT_VEHICLEDATA_INT_v0.1 SP4_REQ_PRO_LOCPROCESS_INT_v0.1 SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1
Potential conflicts	Privacy
Risk analysis	Low performance of inference algorithms could lead to false positives. In this case the user would receive an annoying set of continuous requests for feedback which he/she has to deny/ignore. The risk can be kept low if proper vehicle data are specified as EFP input data in the design phase, and the algorithms are tested early enough to be later fine-tuned.
Status	New
Other	Requirement to be carefully discussed: EFP may be woken up by navigation service or another service when the vehicle is close to the destination. Then a sequence of inferences is made and user feedback is requested. Moreover, emergency parking and short stop (for unload and load) and other possible parking intentions should be also taken into account, either as false positives when not relevant to EFP, or as additional information source of information when relevant. As ultimate solution the HMI

	will do proper filtering of this event, though it should not overload the driver. This analysis will be carried out in specification phase.
--	---------------------------------------------------------------------------------------------------------------------------------------------

Requirement ID:	SP4_REQ_EFP_PRO_USERLEAVEINFER_INT_v0.1
Name of requirement:	EFP processing: user leaving inference
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application processing/ application working principle
Goal	To achieve an EFP which autonomously detects that the user is leaving
Definition:	EFP shall infer that the user is leaving, e.g. from localisation, vehicle data and user profile, user input, and from the user feedback received.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Field trials. Measure false positive and missing detections compare results with proper error acceptance threshold.
Acceptance criteria	System behavior is below error acceptance thresholds
Relationship with other requirements	Depends on SP4_REQ_EFP_INPUT_VEHICLEDATA_INT_v0.1 SP4_REQ_PRO_LOCPROCESS_INT_v0.1 SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1
Potential conflicts	Privacy
Risk analysis	Same as SP4_REQ_EFP_PRO_USERPARKINFER_INT_v0.1.
Status	New

Other	No
--------------	----

Requirement ID:	SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT_v0.1
Name of requirement:	EFP processing: infer user park need (present)
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application processing/ application working principle
Goal	To achieve an EFP which autonomously detects that the user is going to park shortly and needs an indication
Definition:	EFP shall infer that the user is looking for a parking place, e.g. from localisation, vehicle data and user profile, user input, possibly from trip data of a navigation system, and from the user feedback received.
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Field trials. Measure false positive and missing detections compare results with proper error acceptance threshold.
Acceptance criteria	System behavior is below error acceptance thresholds
Relationship with other requirements	Depends on SP4_REQ_EFP_INPUT_VEHICLEDATA_INT_v0.1 SP4_REQ_PRO_LOCPROCESS_INT_v0.1 SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1
Potential conflicts	Privacy
Risk analysis	Same as SP4_REQ_EFP_PRO_USERLEAVEINFER_INT_v0.1, but in this case the back-up without this park need inference functionality could be acceptable for EFP.

Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_PRO_USERBOOKINFER_INT_v0.1
Name of requirement:	EFP processing: infer user park booking need (future)
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application processing/ application working principle
Goal	To achieve an EFP which autonomously detects that the user needs to book a parking place
Definition:	EFP shall infer that the user needs to book a parking place, e.g. from localisation, vehicle data and user profile, user input, possibly from trip data of a navigation system, and from the user feedback received.
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Field trials. Measure false positive and missing detections compare results with proper error acceptance threshold.
Acceptance criteria	System behavior is below error acceptance thresholds
Relationship with other requirements	Depends on SP4_REQ_EFP_INPUT_VEHICLEDATA_INT_v0.1 SP4_REQ_PRO_LOCPROCESS_INT_v0.1 SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1
Potential conflicts	Privacy
Risk analysis	Same as SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT_v0.1.

Status	New
Other	No

4.2.4 Requirements related to system actions

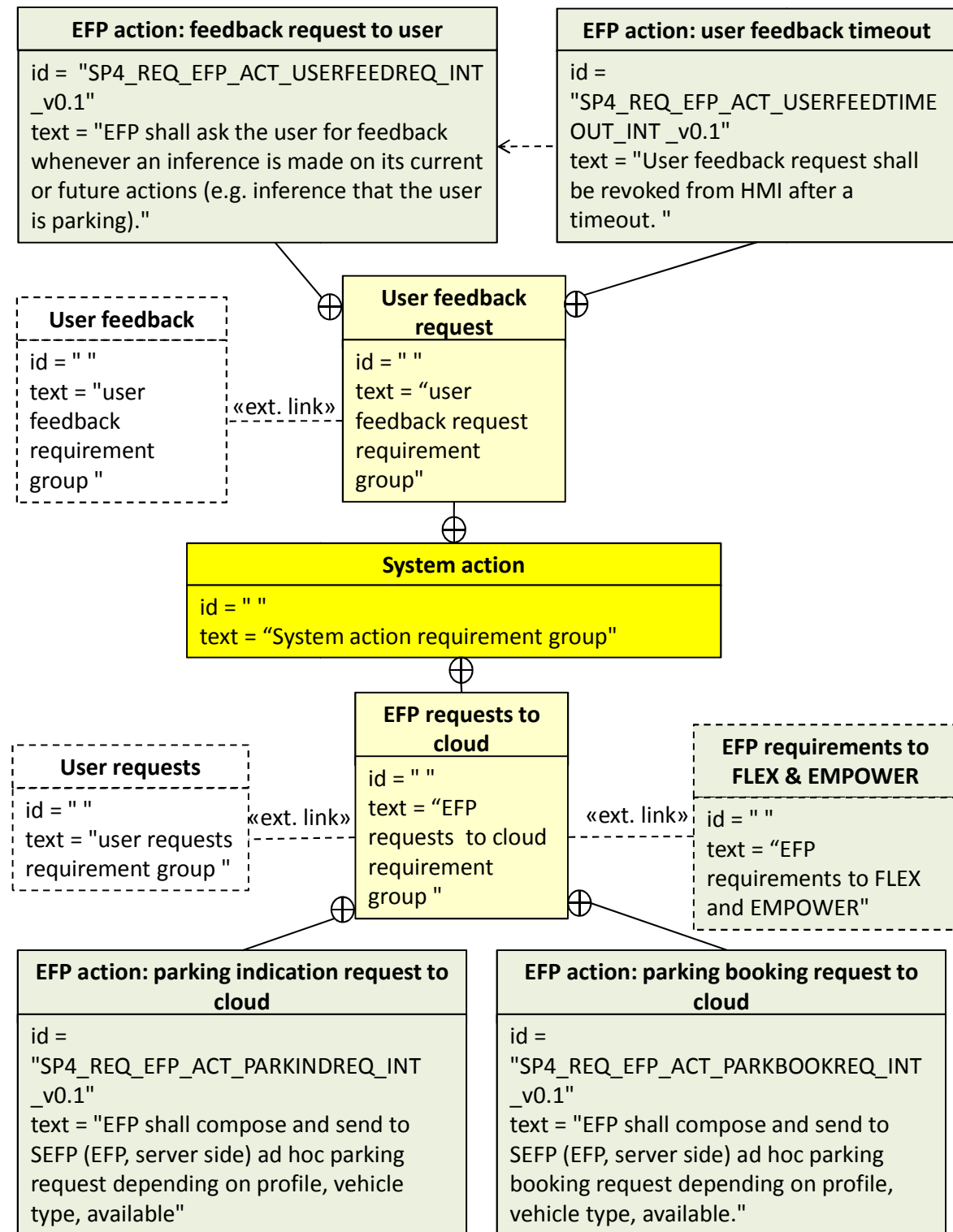


Figure 6: Requirements related to system actions from EFP

Requirement ID:	SP4_REQ_EFP_ACT_PARKINDREQ_INT_v0.1
Name of requirement:	EFP action: parking indication request to cloud
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application action
Goal	To enable composition and transmission of a request to EFP server side (FLEX) concerning parking availability and indication
Definition:	EFP shall compose and send to SEFP (EFP, server side) ad hoc parking request depending on profile, vehicle type, available
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Field trials with different scenarios and different input data, leading to a parking request composition by EFP. E.g. possible scenarios: manual user request, autonomous request by EFP with user confirmation, autonomous request by EFP with no user feedback. Evaluate that the issued parking request responds to user needs.
Acceptance criteria	User-profile-tailored requests may not be accurate, but at least basic functionality should be guaranteed (acceptance threshold to be discussed).
Relationship with other requirements	Depends on SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1 SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT_v0.1
Potential conflicts	Privacy
Risk analysis	Requests may not be specific enough to receive useful indications by FLEX.

Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_ACT_PARKBOOKREQ_INT_v0.1
Name of requirement:	EFP action: parking booking request to cloud
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application action
Goal	To enable composition and transmission of a request to EFP server side (FLEX) concerning parking booking
Definition:	EFP shall compose and send to SEFP (EFP, server side) ad hoc parking booking request depending on profile, vehicle type, available
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Field trials with different scenarios and different input data, leading to a booking request composition by EFP. E.g. possible scenarios: manual user request, autonomous request by EFP with user confirmation, autonomous request by EFP with no user feedback. Evaluate that the issued parking request responds to user needs.
Acceptance criteria	User-profile-tailored requests may not be accurate, but at least basic functionality should be guaranteed (acceptance threshold to be discussed).
Relationship with other requirements	Depends on SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1 SP4_REQ_EFP_PRO_USERPBOOKINFER_INT_v0.1

Potential conflicts	Privacy
Risk analysis	Requests may not be specific enough to receive useful indications by FLEX. To mitigate this, the server part of EFP should be designed in constant synergy with FLEX.
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_ACT_USERFEEDREQ_INT_v0.1
Name of requirement:	EFP action: feedback request to user
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application action
Goal	To enable user feedback, thus ensuring more confidence in inference mechanisms. Deliberate feedback could be e.g.: confirm, deny, ignore.
Definition:	EFP shall ask the user for feedback whenever an inference is made on its current or future actions (e.g. inference that the user is parking)
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Laboratory test of functionality
Acceptance criteria	System works as designed
Relationship with other requirements	Depends on SP4_REQ_EFP_PRO_USERPARKINFER_INT_v0.1 SP4_REQ_EFP_PRO_USERLEAVEINFER_INT_v0.1

	SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT_v0.1 SP4_REQ_EFP_PRO_USERBOOKINFER_INT_v0.1
Potential conflicts	No
Risk analysis	User acceptance of feedback requests (see related risks to inference requirements).
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_ACT_USERFEEDTIMEOUT_INT_v0.1
Name of requirement:	EFP action: user feedback timeout
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Application action
Goal	To foresee a maximum time for user response.
Definition:	User feedback request shall be revoked from HMI after a timeout.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Laboratory test of functionality
Acceptance criteria	System works as designed
Relationship with other requirements	Depends on SP4_REQ_EFP_PRO_USERPARKINFER_INT_v0.1 SP4_REQ_EFP_PRO_USERLEAVEINFER_INT_v0.1

	SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT_v0.1 SP4_REQ_EFP_PRO_USERBOOKINFER_INT_v0.1
Potential conflicts	Privacy
Risk analysis	Same as SP4_REQ_EFP_ACT_USERFEEDREQ_INT_v0.1.
Status	New
Other	Time modifiable in the settings. To be discussed if no feedback is considered by default equal to feedback "ignore", or if it should be considered separately, as additional information (e.g. the user did consider the message but for some reason could not respond).

4.2.5 Requirements related to data types

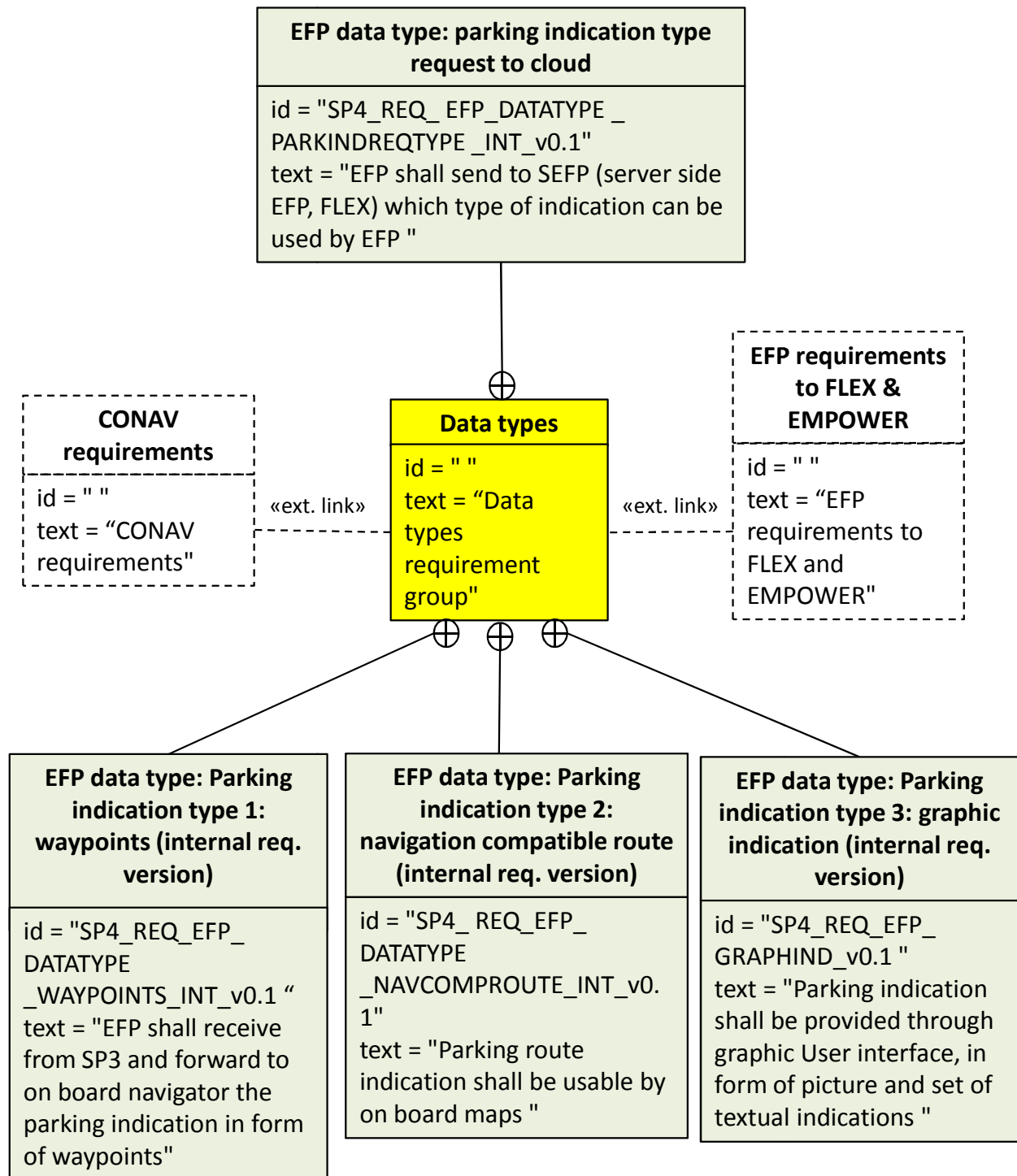


Figure 7: Requirements related to data types from EFP

Requirement ID:	SP4_REQ_EFP_DATATYPE _ PARKINDREQTYPE _INT_v0.1
Name of requirement:	EFP data type: parking indication type request to cloud
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Data type and format
Goal	<p>To enable EFP indication in different ways depending on the availability and type of navigation system. This should be discussed in detail, however preliminary hypotheses can be</p> <ul style="list-style-type: none"> • bare graphic interface if vehicle has no maps onboard • route if the vehicle has maps and GPS but no routing <p>waypoints if the vehicle has navigation system</p>
Definition:	EFP shall send to SEFP (server side EFP, FLEX) which type of indication can be used by EFP (waypoints, navigation compatible route, graphic indication, GPS destination coordinate because there is a navigation on board....for this case a specific req is to pass the coordinate and consequently activate the navigation.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests.
Acceptance criteria	User of a vehicle without on board navigation can receive parking information
Relationship with other requirements	A similar requirement has been written toward FLEX, in particular SP4_REQ_EFP_PARKINDREQTYPE_v0.1

Potential conflicts	No
Risk analysis	Sound agreement SP3-SP4 on EFP implementation: low risk, but high impact
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_DATATYPE_WAYPOINTS_INT_v0.1
Name of requirement:	EFP data type: Parking indication type 1: waypoints (internal req. version)
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Data type and format
Goal	To feed the on board navigation with off-board parking indications
Definition:	EFP shall receive from SP3 and forward to on board navigator the parking indication in form of waypoints
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Field tests with different routes
Acceptance criteria	User is routed to parking destination through the on board navigation
Relationship with other requirements	Depends on req. to FLEX: SP4_REQ_EFP_WAYPOINTS_v0.1
Potential conflicts	Low accuracy indications may not be suitable to provide waypoints

Risk analysis	Sound agreement SP3-SP4 on EFP implementation: low risk, but high impact.
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_DATATYPE_NAVCOMROUTE_INT_v0.1
Name of requirement:	EFP data type: Parking indication type 2: navigation compatible route (internal req. version)
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Data type and format
Goal	To receive an off board parking route indication which can be referenced through on board maps
Definition:	Parking route indication shall be usable by on board maps
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	User of a vehicle with on board maps can receive routing information which can be displayed through these maps
Relationship with other requirements	Depends on req. to FLEX SP4_REQ_EFP_NAVCOMROUTE_v0.1
Potential conflicts	To receive an off board parking route indication which is displayed or

Risk analysis	Low accuracy indications may not be suitable to provide a route
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_GRAPHIND_v0.1
Name of requirement:	EFP data type: Parking indication type 3: graphic indication (internal req. version)
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Data type and format
Goal	To obtain indications on a graphic user interface, e.g. a map picture and a set of indications (e.g. like browsing on Google map)
Definition:	Parking indication shall be provided through graphic User interface, in form of picture and set of textual indications
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Field tests. Assessment of correct interpretation by user of the parking indication displayed on the map (since there is no on board navigation aid)
Acceptance criteria	Indication on map graphic user interface is useful to the driver
Relationship with other requirements	Depends on req. to FLEX SP4_REQ_EFP_GRAPHIND_v0.1
Potential conflicts	No
Risk analysis	Indications not sufficient, because there is no navigation.

Status	New
Other	<p>The access to the cloud should be defined through standard interfaces, so to allow independence and interoperability with different map vendors.</p> <p>Could be used also in case of indications which are not inaccurate enough to be fed to a navigation system.</p>

4.2.6 Requirements related to data storage

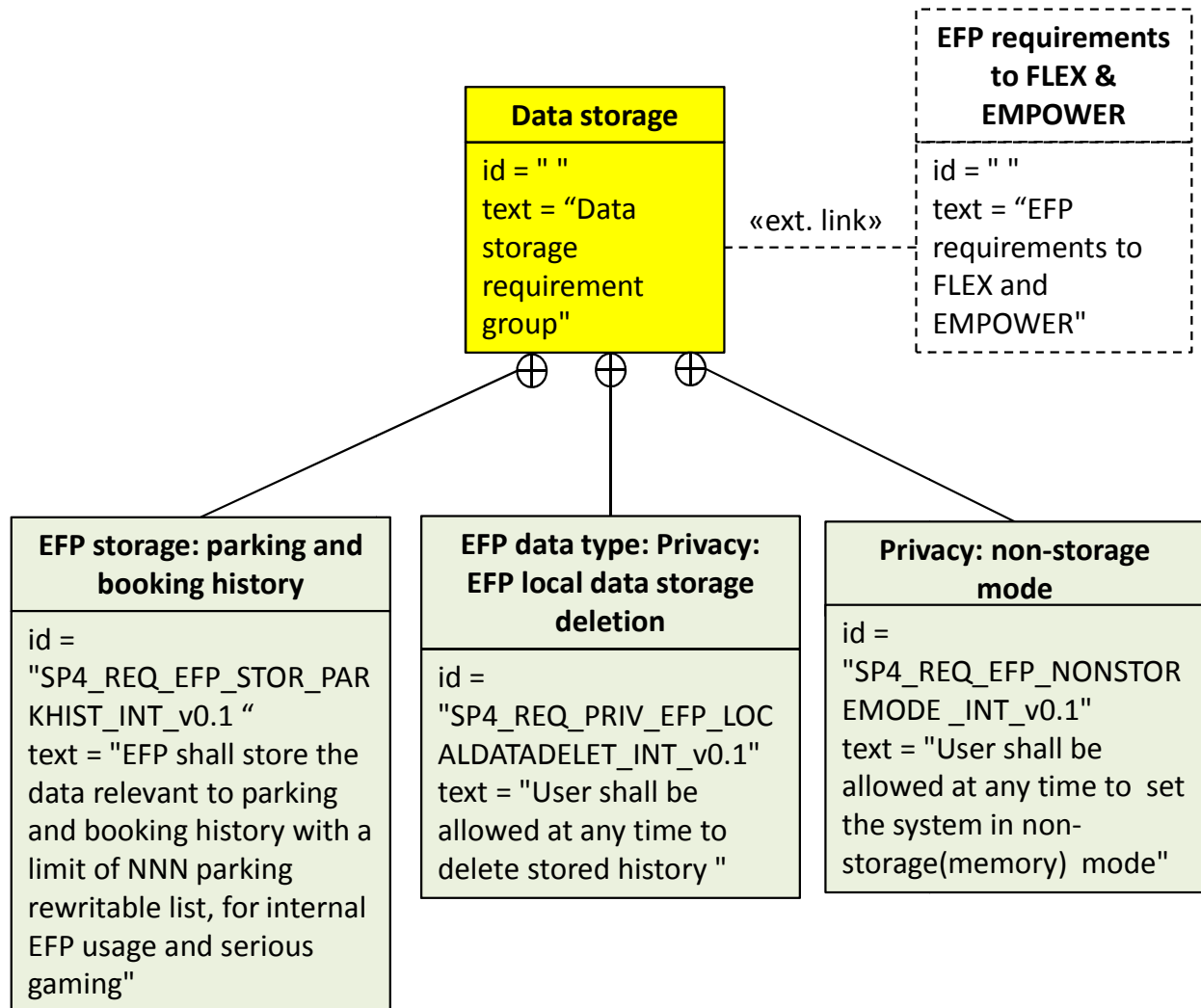


Figure 8: Requirements related to data storage from EFP

Requirement ID:	SP4_REQ_EFP_STOR_PARKHIST_INT_v0.1
Name of requirement:	EFP storage: parking and booking history
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking

Requirement category	Storage
Goal	To improve inferences mechanisms, profile-base requests and enable serious gaming by keeping the history of EFP usage by the driver
Definition:	EFP shall store the data relevant to parking and booking history with a limit of NNN parking rewritable list, for internal EFP usage and serious gaming
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Laboratory verification that data are stored according to specifications (to be defined).
Acceptance criteria	System works as designed.
Relationship with other requirements	No
Potential conflicts	Privacy
Risk analysis	No relevant risk identified. This requirement is important but relatively easy to satisfy.
Status	New
Other	No

Requirement ID:	SP4_REQ_PRIV_EFP_LOCALDATADELET_INT_v0.1
Name of requirement:	Privacy: EFP local data storage deletion
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	Privacy
Goal	Allow the user to delete parking history

Definition:	User shall be allowed at any time to delete stored history
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Laboratory verification that data can be deleted.
Acceptance criteria	System works as designed.
Relationship with other requirements	Depends on SP4_REQ_EFP_STOR_PARKHIST_INT_v0.1
Potential conflicts	No relevant risk identified. This requirement is important but relatively easy to satisfy.
Risk analysis	N/A
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_NONSTOREMODE_INT_v0.1
Name of requirement:	Privacy: non-storage mode
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4
Source (TEAM application or enabler)	SP4, Collaborative Parking
Requirement category	SP4, Collaborative Parking
Goal	Allow the user to set the system in non-storage mode
Definition:	User shall be allowed at any time to set the system in non-storage(memory) mode
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Laboratory verification that such functionality works correctly.

Acceptance criteria	System works as designed.
Relationship with other requirements	Depends on SP4_REQ_EFP_STOR_PARKHIST_INT_v0.1
Potential conflicts	No
Risk analysis	No relevant risk identified. This requirement is important but relatively easy to satisfy.
Status	New
Other	It is suggested to give a limit to the amount of stored data. This limit should be changeable via the user settings. If limit=0 the system will be in non-storage mode.

4.2.7 Requirements related to EFP and Collaborative Gaming

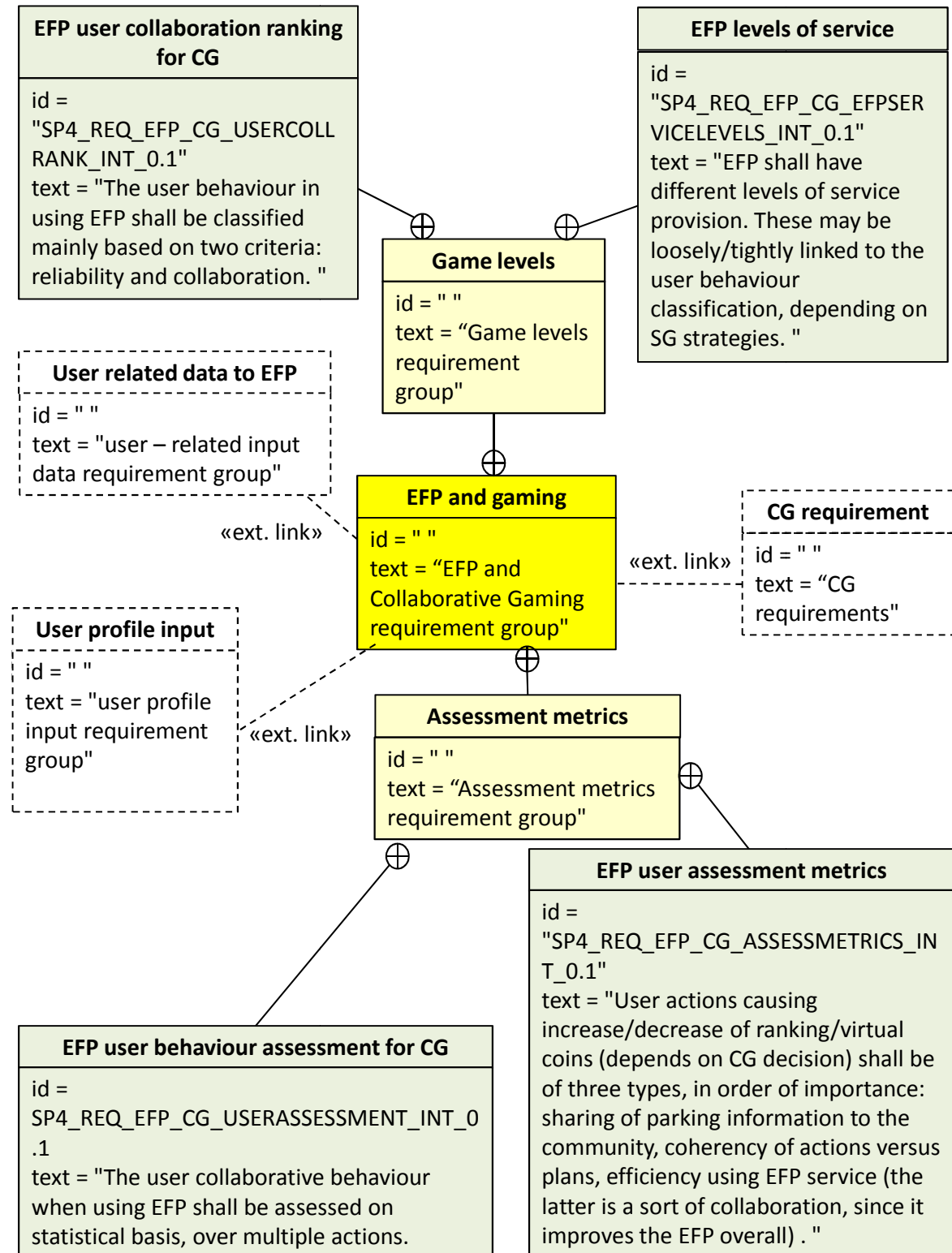


Figure 9: Requirements related to EFP and Collaborative Gaming from EFP

Requirement ID:	SP4_REQ_EFP_SG_USERASSESSMENT_INT_0.1
Name of requirement:	EFP user behaviour assessment for SG
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4: EFP Group, CG Group
Source (TEAM application or enabler)	EFP
Requirement category	Functional
Goal	To state the basic approach for the assessment of user collaborative behavior when using EFP service.
Definition:	<p>The user collaborative behavior as well as the gaming score achieved when using EFP shall be assessed over multiple actions.</p> <p>The orders of magnitude may range between 10 and 100.</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Shall be evaluated from the CG point of view.
Acceptance criteria	Shall be assessed by CG application.
Relationship with other requirements	SP4_REQ_EFP_SG_USERCOLLRANK_INT_0.1; SP4_REQ_EFP_SG_ASSESSMETRICS_INT_0.1
Potential conflicts	No
Risk analysis	The user behavior might not be assessed properly or is not assessed at all by the system, due to insufficient elements to judge.
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_SG_USERCOLLRANK_INT_0.1
Name of requirement:	EFP user collaboration ranking for SG
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4: EFP Group, CG Group
Source (TEAM application or enabler)	EFP
Requirement category	Functional
Goal	<p>To define a high-level approach for the classification of user type in terms of trust and collaboration, based on EFP ultimate goal: more efficient parking based on this service.</p> <p>The approach should be further refined together with SG_CB and other applications.</p>
Definition:	<p>The user behavior in using EFP shall be classified mainly based on two criteria: reliability and collaboration.</p> <p>Reliability: behavior consistent/coherent with statements, (e.g. user requests for parking and then parks, etc.) ;</p> <p>Collaboration means specific behavior bringing advantages service and the community (e.g. user notifies a parking space to the community).</p> <p>Example of user types:</p> <p>User type 1. Fake user/disturbance to service/noise: the service (and consequently the other users) is disturbed by fake messages of a user. The latter could even be an automated thread causing noise. Users persisting in this level my eventually be excluded from the list.</p> <p>User type 2. Unreliable EFP user: user using inefficiently the service and sometimes even causing noise to the service</p> <p>User type 3. Ordinary EFP user (ENTRY level). User</p>

	<p>behavior not particularly outstanding in terms of collaboration, may even be unreliable but on acceptable level. It is the default entry level of new users.</p> <p>User type 4. Trusted EFP user. User behavior is totally reliable, with an inclination to collaborate.</p> <p>User type 5. Collaborative EFP user: User behavior is totally reliable, with excellent collaboration improving the service provision and bringing advantage to the community.</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Shall be evaluated from the CG point of view.
Acceptance criteria	Shall be assessed by CG application.
Relationship with other requirements	SP4_REQ_EFP_SG_USERASSESSMENT_INT_0.1; SP4_REQ_EFP_SG_ASSESSMETRICS_INT_0.1
Potential conflicts	No
Risk analysis	Possibility of speculating (see next requirement).
Status	New
Other	The evaluation and the ranking of user should be merged with other services by CG to obtain an overall ranking for the user in terms of collaboration

Requirement ID:	SP4_REQ_EFP_SG_ASSESSMETRICS_INT_0.1
Name of requirement:	EFP user assessment metrics
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4: EFP Group, CG Group
Source (TEAM application or enabler)	EFP shall
Requirement category	Functional
Goal	<p>To define the basic criteria for assessment, i.e. the type of actions which increasing/decreasing user ranking (or gain/lose virtual coins)</p> <p>These criteria should be further refined in collaboration between EFP, CG and other applications.</p>
Definition:	<p>User actions causing increase/decrease of ranking/virtual coins (depends on CG decision) are of three types, in order of importance: sharing of parking information to the community, coherency of actions versus plans, efficiency using EFP service (the latter is a sort of collaboration, since it improves the EFP overall) .</p> <p>E.g. Collaboration/efficiency</p> <p>Plus Plus Plus: User shares its plans with the system (I will leave parking space at 4 PM)</p> <p>Plus Plus: User almost always signalizes when leaving a park place</p> <p>Plus: a commuter requesting very simple indications, not needing navigation to go there.</p> <p>Minus: User often books parking too early.</p> <p>E.g. Reliability</p> <p>Plus: user almost always requests and receives booking/parking indications and parks in (the vicinity of)</p>

	<p>indicated parking</p> <p>Minus/neutral (depending on occurrence): user often cancels booking</p> <p>Minus (depending on occurrence): user often requests an indication and ignores it</p> <p>Minus-Minus: user often cancels its plans for the future, without informing the system (e.g. planned to leave at 4 PM and then not leaving)</p> <p>Minus Minus Minus: user often makes fake requests (noise introduced into the service)</p>
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Shall be evaluated from the CG point of view.
Acceptance criteria	Shall be assessed by CG application.
Relationship with other requirements	SP4_REQ_EFP_SG_USERCOLLRANK_INT_0.1; SP4_REQ_EFP_SG_USERASSESSMENT_INT_0.1
Potential conflicts	No
Risk analysis	Game theory should be considered carefully when quantifying the coins, in order to avoid speculation such as users behaving well to gain credits that allow them to behave badly in the future.
Status	New
Other	No

Requirement ID:	SP4_REQ_EFP_SG_EFPSERVICELEVELS_INT_0.1
Name of requirement:	EFP levels of services
Created by	EFP (Filippo Visintainer, Sergio Damiani)
Assigned partner	SP4: EFP Group, CG Group

Source (TEAM application or enabler)	EFP
Requirement category	Functional
Goal	<p>To foresee different levels of service provision, that can be accessed by spending the virtual coins gained in good user behavior when using EFP.</p> <p>"levels of service" regards how the service is provided, and is different from "user types"</p> <p>(SP4_REQ_EFP_SG_USERCOLLRANK_INT_0.1) which regards the ranking of user for credibility/inference purpose</p>
Definition:	<p>Definition:</p> <p>EFP shall have different levels of service provision. These may be loosely/tightly linked to the User type, depending on SG strategies.</p> <p>Example of service levels:</p> <p>Service level 1. (linked to Fake user/disturbance to service/noise) the service is disabled until new registration</p> <p>Service level 2. (linked to Unreliable EFP user): basic functionalities of parking indication enabled, booking disabled</p> <p>Service level 3/ ENTRY level. (linked to Ordinary EFP user): basic functionalities of parking indication and booking enabled</p> <p>User type 4. (linked to Trusted EFP user) enhanced functionalities of parking indication and booking enabled (maybe improved HMI look and feel)</p> <p>User type 5. (linked to Collaborative EFP user) Level 4 privileges plus priority at parking booking service or parking indications reserved for the good driver</p>
Critical level (priority)	Mandatory

Validation Method (tests, indicators, performance bounds)	Shall be evaluated from the CG point of view.
Acceptance criteria	Shall be assessed by CG application.
Relationship with other requirements	No
Potential conflicts	-No
Risk analysis	-Risk of improper service offer.
Status	New
Other	Important points to discuss with SG group in the specification phase: level versus service benefits, link between user type and service provision, mechanisms underlying the virtual coins gaining and spending within EFP

4.3 Collaborative Driving and Merging

4.3.1 Overview of the Requirements

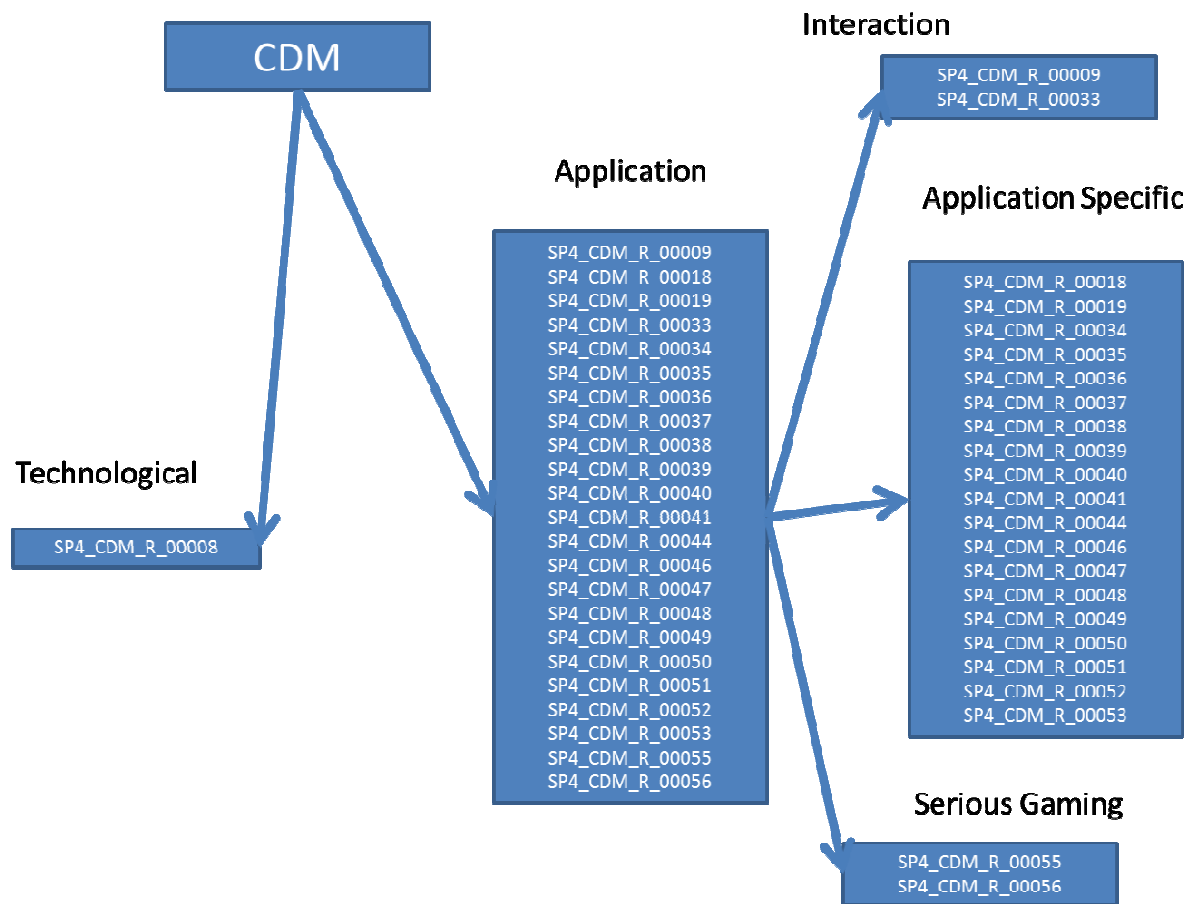


Figure 10: CDM application requirement overview

4.3.2 Requirements related to interaction

Requirement ID:	SP4_CDM_R_00009
Name of requirement:	Interaction with C-ACC
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Technological and development requirements

Goal	Acceleration and braking controls for assisted and automated vehicle driving/filtering in manoeuvres shall be permitted
Definition:	An interface towards the vehicle is needed in order to support assisted driving.
Created by	F.Alesiani, R. Basso (Francesco.Alesiani@neclab.eu , rafael.basso@volvo.com)
Assigned partner	To be defined
Critical level (priority)	High
Validation criteria (tests, indicators, performance bounds)	Follows the command/recommendation, however, the required value will only be actuated if possible, vehicle control base feasibility on perception data. The commands can be tested in different condition, with the C-ACC active/deactivated or in manoeuvring and different use type.
Acceptance criteria	The vehicle is following the command/recommendation when it's feasible/safe.
Relationship with other requirements	C-ACC requirements
Potential conflicts	There is a potential conflict between the vehicle's control system and CDM application, if the input data is corrupted or if the required command is outside of the boundaries.
Risk analysis	In a case of incorrect data from the CDM application can affect the comfort and efficiency of the ride, since the safety critical decision is located in vehicle control, incorrect data cannot result in incidents.
Status	New
Other	Note that the input to the vehicle's control system will be used as a recommendation with a level of priority connected to it. The command will only be actuated if it is considered to be valid and within the bounds of the vehicle control.

Requirement ID:	SP4_CDM_R_00033
Name of requirement:	Interface with the driver to get driving intention and collaboration preferences
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Interface with the driver to get driving intention and collaboration preferences
Definition:	<p>Collaboration Functionality:</p> <ul style="list-style-type: none"> - Simple and ergonomic HMI of user client application (OBU or ND) should support recording driver intention through fixed trajectory choices (e.g. request for keep in the lane, change lane to the left, change lane to the right, exit/entrance). Getting collaboration preferences from each user in order to initialize collaboration profile should also be supported. - Keep history of past choices/decisions <p>Communicating these data to the users' collaboration management server.</p>
Created by	F.Alesiani, A. Bolvinou (Francesco.Alesiani@neclab.eu , abolov@iccs.gr)
Assigned partner	To be defined
Critical level (priority)	High
Validation criteria (tests, indicators, performance bounds)	Verification that the calculated driver intention matches with the real actions taken by the driver.
Acceptance criteria	Ergonomic HMI design
Relationship with other requirements	Other HMI related Application requirements SP4_CDM_R_00036
Potential conflicts	None
Risk analysis	None identified
Status	New

Other	This requirement covers HMI aspects; it relates with REQ00035 collaborative priorities handling; it also relates with REQ00036, recording of driver's collaborative profile for driver intention detection, see REQ 00037.
--------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

4.3.3 Requirements related to app specific functionalities

Requirement ID:	SP4_CDM_R_00008
Name of requirement:	Side/Rear object tracking
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Technological and development requirements
Goal	Side/Rear object tracking on the opposite side of the vehicle should be available in order to perform the lane exit manoeuvre to filter into the traffic flow
Definition:	Need for perception in close proximity of the vehicle, providing object tracking and information.
Created by	F.Alesiani, R. Basso (Francesco.Alesiani@neclab.eu , rafael.basso@volvo.com)
Assigned partner	To be defined
Critical level (priority)	High
Behaviour	Periodically provide object and distance of rear/side objects
Output	Object info and distance of rear/side objects
Data model	Continually updating of tracker objects, target selection needed to filter valuable object to focus on.
Validation criteria (tests, indicators, performance bounds)	Verification that the correct number, location and type of objects matched with reality.
Acceptance criteria	Correct number, type and size of objects and distance (90% probability)
Relationship with other requirements	SP4_CDM_R_00007

Potential conflicts	The function may use the position of other vehicles as communicated via short range systems; in case it does not, the information shall be integrated later.
Risk analysis	The ability of identifying obstacles is relevant, to avoid suggestion of manoeuvre that are not actually feasible. The driver is the ultimate responsible for the driving.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00018
Name of requirement:	Safe navigation rerouting to avoid a road restriction
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Safe navigation rerouting to avoid a road restriction
Definition:	<p>When the vehicle approaches a road restriction, it should have a new suggestion of a safe route to avoid the restriction.</p> <p>The rerouting has to be done in a way that on the alternative routing traffic congestion will not be caused due to rerouting.</p>
Created by	F.Alesiani, R. Basso (Francesco.Alesiani@neclab.eu , rafael.basso@volvo.com)
Assigned partner	To be defined
Critical level (priority)	Medium
Validation criteria (tests, indicators, performance bounds)	<ul style="list-style-type: none"> • Proper navigation that avoids the road restriction • Test under the assumption of proper collaboration • Test with collaboration failure • Check effect on rerouting paths / roads
Acceptance criteria	<ul style="list-style-type: none"> • Proper navigation that avoids the road restriction • Communication and collaboration in the means of avoidance of congestions at rerouting bottle necks.
Relationship with other	<ul style="list-style-type: none"> • LDM++ • CDM

requirements	<ul style="list-style-type: none"> • CACC • Any rerouting request coming from other apps. An example may be the rerouting request based on an already detected traffic congestion at a certain location/area
Potential conflicts	Rerouting may lead to a traffic congestion on the suggested new route/path and has to be resolved prior issuing a rerouting. In this case the TEAM algorithms will identify the best route with a holistic approach, in order to not suggest all vehicles to follow the same route resulting in congestions.
Risk analysis	Missing communication will lead to a missing collaboration. It might influence the proper operation of the function in its complex environment. To manage the risk: Enable a message queue and deliver relevant data when communication is available again.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00034
Name of requirement:	Overtaking / lane changing manoeuvre computation
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Overtaking / lane changing manoeuvre computation
Definition:	The system should be able to compute an optimal and safe overtaking or lane change manoeuvre taking into account the current traffic situation, road layout and the other vehicles nearby. In case the situation doesn't allow a safe overtaking or lane change, the system should suggest the user to not perform that manoeuvre.
Created by	F.Alesiani, R. Basso (Francesco.Alesiani@neclab.eu , rafael.basso@volvo.com)
Assigned partner	To be defined
Critical level (priority)	High, this is one of the main tasks of the application
Behaviour	See input/output

Output	Overtaking/lane change manoeuvre
Data model	State of the vehicle; state of other vehicles; state of the overall traffic; road regulations (overtaking for that kind of vehicle allowed); weather conditions;
Validation criteria (tests, indicators, performance bounds)	Validation that the advised manoeuvre is safe and effective.
Acceptance criteria	See validation
Relationship with other requirements	No relation
Potential conflicts	C-ACC application
Risk analysis	The advice generated by the system must be accurate in order for the driver to trust the service and continue to use it.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00035
Name of requirement:	Computation of the priority of vehicles, based on the state/type of vehicle (emergency vehicle)
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Computation of the priority of vehicles, based on the state/type of vehicle (emergency vehicle)
Definition:	When a vehicle is approaching an intersection, roundabout or traffic light, priority is useful in order to get an optimal flow and fuel efficiency from the traffic system, hence computation of priorities is required. Other situations that can benefit from priorities include merging, road restrictions and in congestion.
Created by	F.Alesiani (Francesco.Alesiani@neclab.eu)
Assigned partner	To be defined

Critical level (priority)	Medium
Validation criteria (tests, indicators, performance bounds)	Validate that the vehicles receive a priority when approaching intersection or similar traffic situation when priority is required. One example is emergency vehicle get priority over other vehicle type.
Acceptance criteria	Vehicles are receiving priority with a satisfying accuracy.
Relationship with other requirements	No relation
Potential conflicts	One conflict among a few is that the priority needs to be re-computed periodically, therefore, given priorities can change over time when the vehicle is approaching the target point.
Risk analysis	The risk of excluding vehicle priority or lacking information result in an inefficient fuel usage and for emergency vehicles an increased risk of wasting time.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00036
Name of requirement:	Define the user collaborative profile
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Define the user collaborative profile
Definition:	Each TEAM user has a profile of collaboration that includes past records and preferences. The preferences refer to the willingness to adhere to the suggestion for collaboration and the readiness to give feedback to the system. The preferences can be set also during the trip, as for example depending on the type of travelling, as for example business or leisure travel.

Created by	F.Alesiani (Francesco.Alesiani@neclab.eu)
Assigned partner	To be defined
Critical level (priority)	Medium
Validation criteria (tests, indicators, performance bounds)	Validate the ability to store and retrieve the user profile; security of data present; application be able to use the information;
Acceptance criteria	See validation
Relationship with other requirements	SP4_CDM_R_00033
Potential conflicts	In the scope of TEAM it is not possible for enforce collaboration, but only stimulate it. Road rules on the contrary should always be followed. As the settings are entered by the user, it is not possible to guarantee that they will be correct (users might set values to get priorities or benefits)
Risk analysis	The information is used by the application; the risk the application is not working without this function is low
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00037A
Name of requirement:	Define the intention of the driver in a roundabout (entrance and exit locations)
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Define the intention of the driver to enter/exit a roundabout
Definition:	Based on the itinerary of the vehicle the system should be able to identify the entrance and exit points in a roundabout
Created by	F.Alesiani, R. Basso, S.Damiani (Francesco.Alesiani@neclab.eu , rafael.basso@volvo.com , sergio.damiani@crf.it)

Assigned partner	To be defined
Critical level (priority)	Medium (In case that an itinerary is not available the entrance is the most probable on the basis of the Most Probable Path (MPP) and the exit is any possible roundabout exit)
Validation criteria (tests, indicators, performance bounds)	Driver not distracted; Delay small with respect to application requirements;
Acceptance criteria	Validate that the enter/exit points is correctly determined.
Relationship with other requirements	No relation
Potential conflicts	None identified
Risk analysis	The exit point can be challenging to predict if there is no information about planned itinerary
Status	New
Other	Similar requirement of detecting driver intention applies to the use cases of intersection, highway entrance/exit and lane change intention.

Requirement ID:	SP4_CDM_R_00039
Name of requirement:	Computation of smooth slow down or lane change in safety condition
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Computation of smooth slow down or lane change in safety condition
Definition:	Path control functionality for safe longitudinal and lateral trajectory estimation in road hindering or lane changing situation
Created by	F.Alesiani, A. Bolovinou (Francesco.Alesiani@neclab.eu , abolov@iccs.gr)
Assigned partner	To be defined
Critical level (priority)	High

Behaviour	Path control functionality
Output	Slowdown or lane change
Data model	Vehicle path control model
Validation criteria (tests, indicators, performance bounds)	Validate that the advice produced is safe in the given situation.
Acceptance criteria	Smooth slow down or manoeuvre functions
Relationship with other requirements	All application requirements not dealing with HMI design. SP4_CDM_R_00040
Potential conflicts	None identified
Risk analysis	It is a common situation to have hindering due to small congestions and the system must be able to react fast enough.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00040
Name of requirement:	Identification of an emergency braking / unexpected braking condition
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Identification of an emergency braking /unexpected braking condition
Definition:	Any deceleration obtained with the use of brake and greater then 2.5 m/s ² in absolute value must be considered as unexpected (not planned)
Created by	F.Alesiani, S.Damiani (Francesco.Alesiani@neclab.eu , sergio.damiani@crf.it)
Assigned partner	To be defined
Critical level (priority)	High
Validation criteria (tests,	Data input speed or deceleration: when the derived or direct value of the acceleration is negative and the

indicators, performance bounds)	absolute value is greater than 2.5 m/s ² the variable STRONG_BRAKE must change from FALSE to TRUE until the deceleration criteria are satisfied..
Acceptance criteria	Emergency braking condition is identified with enough time in advance to broadcast further to other vehicles behind.
Relationship with other requirements	No relation
Potential conflicts	None identified.
Risk analysis	This is a safety critical requirement that is very dependent on fast communication between all vehicles involved. It is necessary to identify correctly the distance to the braking vehicle and how many vehicles are in-between.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00047
Name of requirement:	Check occupancy of exit/entrance lanes
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Check occupancy of exit/entrance lanes
Definition:	In order to get a merge in an effective way and plan the route beforehand, information about the occupancy of exit/entrance lanes is very useful. The density of traffic and behaviour of the vehicles should be included (e.g. vehicles not letting others merge).
Created by	F.Alesiani (Francesco.Alesiani@neclab.eu)
Assigned partner	To be defined
Critical level (priority)	Medium
Validation criteria (tests, indicators, performance	Test the availability, feasibility and accuracy of the lane occupancy, within area with right environmental

bounds)	preconditions.
Acceptance criteria	Occupancy information is available when planning route, starting to merge from onramp or leave on an exit. This information should be available in real-time.
Relationship with other requirements	No relation
Potential conflicts	TBD
Risk analysis	If the CDM doesn't get any information about the occupancy of the lanes, it affects the ability to perform an effective lane merging and accurate manoeuvre planning. Naturally there is also a risk if incorrect occupancy data is communicated, with a big negative effect on CDM application.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00048
Name of requirement:	Compute acceleration/deceleration for entering/exiting highway
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Compute acceleration/deceleration for entering/exiting highway
Definition:	The speed profile for the vehicle is computed, when it needs to enter/exit the highway.
Created by	F.Alesiani (Francesco.Alesiani@neclab.eu)
Assigned partner	SP4
Critical level (priority)	Medium (if use case is selected)
Validation criteria (tests, indicators, performance)	Validate that the driver advice generated is relevant and useful in the given traffic situation.

bounds)	
Acceptance criteria	See above
Relationship with other requirements	SP4_CDM_R_00009: "uses" SP4_CDM_R_00034: coordination required
Potential conflicts	None identified
Risk analysis	High: the application will lose some relevant feature if it doesn't provide the speed profile of the vehicle
Status	New
Other	None

4.3.4 Requirements related to provision of information

Requirement ID:	SP4_CDM_R_00038
Name of requirement:	Provide information on the vehicle characteristics (breaking/accelerating capabilities)
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Provide information on the vehicle characteristics (breaking/accelerating capabilities)
Definition:	Provide information on the vehicle characteristics (breaking/accelerating capabilities). Basic information shall be available, as speed, emission, fuel consumption, travelled distance, engine speed, energy consumption, fuel status, gear ratio, tyre types (if possible including friction coefficient), type of braking system etc.
Created by	F.Alesiani (Francesco.Alesiani@neclab.eu)
Assigned partner	To be defined
Critical level (priority)	High
Validation criteria (tests, indicators, performance bounds)	Verify the availability of the above mentioned basic information

Acceptance criteria	Minimum information about vehicle characteristics is provided, including at least speed and braking capability.
Relationship with other requirements	No relation
Potential conflicts	None identified
Risk analysis	The braking capability is essential to calculate the moment to give a warning to the driver when it's necessary to brake. Other factors can influence this parameter, such as tyre wear, that is difficult to read from sensors.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00041
Name of requirement:	Generation of warning for other vehicles, traffic management centre, road authorities
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Generation of warning for other vehicles, traffic management centre, road authorities
Definition:	The ability to generate targeted information for nearby vehicle and external entities as TMC and road authorities when the vehicle is undertaking a driving manoeuvre. The warning is to inform about the manoeuvre and to allow the other actors to take counteraction in case of potential high risk.
Created by	F.Alesiani (Francesco.Alesiani@neclab.eu)
Assigned partner	To be defined
Critical level (priority)	Medium: the application can work without, but is an important feature
Validation criteria (tests, indicators, performance bounds)	Information sent to other vehicle; information sent to TMC
Acceptance criteria	Information is relevant to other vehicle/TMC

Relationship with other requirements	No relation
Potential conflicts	None identified.
Risk analysis	Low: the application can work without this feature
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00044
Name of requirement:	Coaching driver to adopt speed or/and give way / selection of lane
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Coaching driver to adopt speed or/and give way / selection of lane
Definition:	When performing a lane merging the driver of the ego vehicle and the drivers of the surrounding vehicles should be coached to collaboratively perform a safe manoeuvre
Created by	F.Alesiani, R.Basso (Francesco.Alesiani@neclab.eu , rafael.basso@volvo.com)
Assigned partner	To be defined
Critical level (priority)	High
Input or event	The event of merging
Validation criteria (tests, indicators, performance bounds)	Validate that the coaching information is displayed correctly to the driver in a way that is easy to understand.
Acceptance criteria	A safe merging manoeuvre
Relationship with other requirements	SP4_CDM_R_00033
Potential conflicts	None identified
Risk analysis	High since the application is focused on merging scenarios.

Status	New
Other	None

Requirement ID:	SP4_CDM_R_00019
Name of requirement:	Warning of the driver prior approaching the road restriction
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Warning of the driver prior approaching the road restriction. Creating awareness for the driver. Initiating communication and collaboration among each other. Enhancing driver's safety.
Definition:	<ul style="list-style-type: none"> • The driver should be notified before reaching a road restriction in order to enable a smooth and safe manoeuvre. • Incident awareness • Initiating communication for a sustainable collaboration among drivers and their vehicles. • Sharing best practice prior reaching restriction
Created by	F.Alesiani, R. Basso, C.Dannheim (Francesco.Alesiani@neclab.eu , rafael.basso@volvo.com , clemens.dannheim@objective.de)
Assigned partner	To be defined
Critical level (priority)	Medium
Validation criteria (tests, indicators, performance bounds)	<ul style="list-style-type: none"> • Proper visualization of the warning prior approaching the problem zone • Proper navigation that avoids the road restriction • Test under the assumption of proper collaboration • Test with collaboration failure • Check effect on rerouting paths / roads
Acceptance criteria	<ul style="list-style-type: none"> • driver acceptance <p>Communication and collaboration in the means of avoidance of congestions at rerouting bottle necks.</p>
Relationship with other	<ul style="list-style-type: none"> • LDM++

requirements	<ul style="list-style-type: none"> • CDM • CACC • RSU Infrastructure communication <p>Any rerouting request coming from other apps. An example may be a rerouting request based on an already detected traffic congestion at a certain location/area</p> <p>Incidents like changing traffic lights, sudden traffic flow slowing down and others have to be considered for issuing warning messages prior approaching road restrictions.</p>
Potential conflicts	<p>Rerouting may lead to a traffic congestion on the suggested new route/path and has to be resolved prior issuing a rerouting</p> <p>Avoid distraction to the actual traffic condition.</p>
Risk analysis	<p>Missing communication might lead to a missing collaboration. It might influence the proper operation of the function in its complex environment. To manage the risk: Enable a message queue and deliver relevant data when communication is available again.</p>
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00046
Name of requirement:	Communication intention of entering/exiting highway
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Communication intention of entering/exiting highway
Definition:	When a vehicle is entering the highway communication is required to perform a smooth and effective merge.
Created by	F.Alesiani (Francesco.Alesiani@neclab.eu)
Assigned partner	To be defined
Critical level (priority)	High
Validation criteria (tests, indicators, performance)	In relevant scenarios the system communicates if its

bounds)	intension is to enter/leave highway.
Acceptance criteria	The vehicle communicate planned and intended route.
Relationship with other requirements	SP4_CDM_R_00033
Potential conflicts	TBD
Risk analysis	If the vehicle doesn't report its intension, the merging cannot be performed in an effective and safe way.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00049
Name of requirement:	Provide vehicle characteristics: type, weight, length Speed profile Weather profile
Source (TEAM application or enabler)	SP4_CDM LDM++
Requirement category	Application requirements
Goal	Provide vehicle characteristics: type, weight, length <ul style="list-style-type: none"> • Speed profile • Weather profile • Routing profile • ABS, ESB preferences, zones of activity • Typical energy consumption (CO2 efficiency) • Acceleration / deceleration details/profile • Manoeuvre profile (e.g. turn-radius)
Definition:	Provide vehicles characteristic (through an API) for applications having a strong need in getting this individual attributes of a particular vehicle.
Created by	F.Alesiani (Francesco.Alesiani@neclab.eu) Contributed: C.Dannheim

Assigned partner	To be defined
Critical level (priority)	High
Input or event	<ul style="list-style-type: none"> • Origin of the (API-) Call (Info about whom to server) • Purpose • Subscription of a service
Behaviour	<p>Dependant on the input/event the function will return particular attributes necessary to serve as input for other highly sophisticated function.</p> <p>A subscription of a dedicated value in case of exceeding a limit can be issued too.</p>
Output	Vehicle characteristics delivered either through a function (API call) or through a message which will be sent from this function to a consumer. The consumer has to add its request before.
Data model	<p>Entities (Classes):</p> <ul style="list-style-type: none"> • Static dimensions of the vehicle • Dynamic dimensions of a vehicle • Performance data • Eco-Data • Subscriber structure • Environmental interface • Communication interface
Validation criteria (tests, indicators, performance bounds)	<p>API test cases assuring the proper functioning of the interface in the above described way.</p> <p>The subscriber interface needs to be populated with specific subscribers containing their attributes of interest.</p> <p>In case the subscribed values are exceeding limits, the appearance of messages at the subscribers has to be checked.</p>
Acceptance criteria	Functionality is available based on the validation criteria (see above)
Relationship with other requirements	<p>This is a low level requirement. There are more than 3 hierarchy levels above using this particular (basis) functionality</p> <p>SP4_CDM_R_00038</p>
Potential conflicts	None
Risk analysis	Low level requirement, the functioning is essential for the project as a whole. To overcome the risk, particular

	attention has to be paid for validation of this basic function.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00050
Name of requirement:	Generation of custom clearance message from authority vehicle
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Generation of custom clearance message from authority vehicle. The objective is to allow passage for high priority vehicles.
Definition:	Authority vehicles should generate a message and broadcast it to the surrounding vehicles in order to start the collaboration for custom clearance
Created by	F.Alesiani, R. Basso (Francesco.Alesiani@neclab.eu , rafael.basso@volvo.com)
Assigned partner	To be defined
Critical level (priority)	Medium
Validation criteria (tests, indicators, performance bounds)	Message generated accordingly
Acceptance criteria	The custom clearance message is generated by the authority when there is a need for that
Relationship with other requirements	No relation
Potential conflicts	None identified
Risk analysis	Low risk. Basic functionality, which can easily be verified.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00051
Name of requirement:	Generation of manoeuvre based on authority message
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Generation of manoeuvre based on authority message
Definition:	Compute safe slow/down and manoeuvre path in order to yield priority to a nearby passing vehicle
Created by	F.Alesiani, A. Bolvinou (Francesco.Alesiani@neclab.eu , abolov@iccs.gr)
Assigned partner	To be defined
Critical level (priority)	Medium
Validation criteria (tests, indicators, performance bounds)	Validate the quality of the manoeuvre advice.
Acceptance criteria	Local traffic enhancement
Relationship with other requirements	R00033 SP4_CDM_R_00034: uses
Potential conflicts	None identified
Risk analysis	Presence of complexity when multiple road users are affected.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00052
Name of requirement:	Provide information on the itinerary of the vehicle
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Provide information on the itinerary of the vehicle

Definition:	For a wide range of applications the planned (to be driven) and the current route (which was driven) to destination will be made available by this function.
Created by	F.Alesiani (Francesco.Alesiani@neclab.eu) Contributed: C.Dannheim
Assigned partner	To be defined
Critical level (priority)	Medium
Validation criteria (tests, indicators, performance bounds)	Test cases for validation of the following functions have to be made available: <ul style="list-style-type: none"> • Subscriber Handle • Route (current, planned) • Route (historical, already passed) Check accuracy of the position and route information
Acceptance criteria	Validation of the above test cases. This requirement is medium level in the requirement hierarchy. So more complex requirements have to verify this functionality in the context of proper interaction.
Relationship with other requirements	SP4_CDM_R_00049: overlap/specialization
Potential conflicts	None
Risk analysis	Low risk. The basic application functionality must work even in the case where no route is known, since the drivers of several vehicles in a given traffic situation might not use route planning to reach their destination.
Status	New
Other	None

Requirement ID:	SP4_CDM_R_00053
Name of requirement:	Provision of lane recommendation
Source (TEAM application or enabler)	SP4_CDM
Requirement category	Application requirements
Goal	Provision of lane recommendation
Definition:	In case that the information of SUGGESTED_LANE is different from the information of PRESENT_LANE a lane

	recommendation will be provided
Created by	F.Alesiani, S.Damiani (Francesco.Alesiani@neclab.eu , sergio.damiani@crf.it)
Assigned partner	To be defined
Critical level (priority)	Low
Validation criteria (tests, indicators, performance bounds)	Functional tests to evaluate recommendation of lanes
Acceptance criteria	The suggested lane information is presented when it's needed
Relationship with other requirements	SP4_CDM_R_00034: part of
Potential conflicts	None identified
Risk analysis	The system should take a holistic approach to identify situations further away in the vehicle itinerary
Status	New
Other	None

4.3.5 Requirements related to the gaming application

This section contains information on requirements related to incentives and the interface with the serious gaming application.

The CDM application complies with the generic TEAM schema according to which each application defines (1) good (collaborative) user behaviour metrics for rewarding the user with virtual coins (metrics) and (2) different levels of service that could be acquired by the user by spending virtual coins gained in this or other applications. Further details beyond the requirements expressed in the following two tables will be defined in the design phase.

Requirement ID:	SP4_CDM_R_00055
Name of requirement:	Assess user behaviour after and during the driving
Created by	NEC
Assigned partner	CDM Partners
Source (TEAM application or enabler)	CDM
Requirement category	Functional
Goal	The CDM application shall provide tool to assess the quality of the driving according to the metrics established by the serious gaming framework.
Definition:	In order to receive virtual coins, it is required to assess the behavior from the user in the CDM context.
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	The assessment should be provided to the SG application.
Acceptance criteria	User behavior assessed according to metrics.
Relationship with other requirements	SP4_REQ_SGCB_PMET
Potential conflicts	None seen so far.
Risk analysis	Drivers might not be willing to be monitored and have their data logged. In this case incentives and a solid

	privacy scheme should be considered.
Status	New
Other	None.

Requirement ID:	SP4_CDM_R_00056
Name of requirement:	Interface with the Serious Gaming Application
Created by	NEC
Assigned partner	CDM Partners
Source (TEAM application or enabler)	CDM
Requirement category	Functional
Goal	Serious Gaming application needs to interface with each application for the use of virtual coins.
Definition:	The serious gaming framework should have an interface with the CDM application in order to evaluate the driver behavior and reward the drivers that follow the guidelines. The CDM should provide information to SG to quantify the compliance of the driver. In return the SG application should indicate the current score or virtual coins of the driver to give benefits.
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Functional test
Acceptance criteria	Functional test.
Relationship with other requirements	SP4_REQ_SGCB_PMET
Potential conflicts	No
Risk analysis	Medium/low risk. Serious gaming integration is not crucial for the basic CDM functionality. This risk is instead

	that the serious gaming application itself won't provide any value for its users if the other applications are unable to provide input to it.
Status	New
Other	None

4.4 Collaborative eco-friendly navigation

In the following, we outline the requirements reasoned by the CONAV application. We identified three subgroups: (1) requirements related to the CONAV routing algorithms, (2) requirements related to the HMI, and (3) requirements related to the gaming integration.

4.4.1 Requirements related to the HMI of TEAM

We start with an overview on the requirements related to the HMI. An overview is shown in the next figure. In-detail description of each requirement in this figure are provided hereafter.

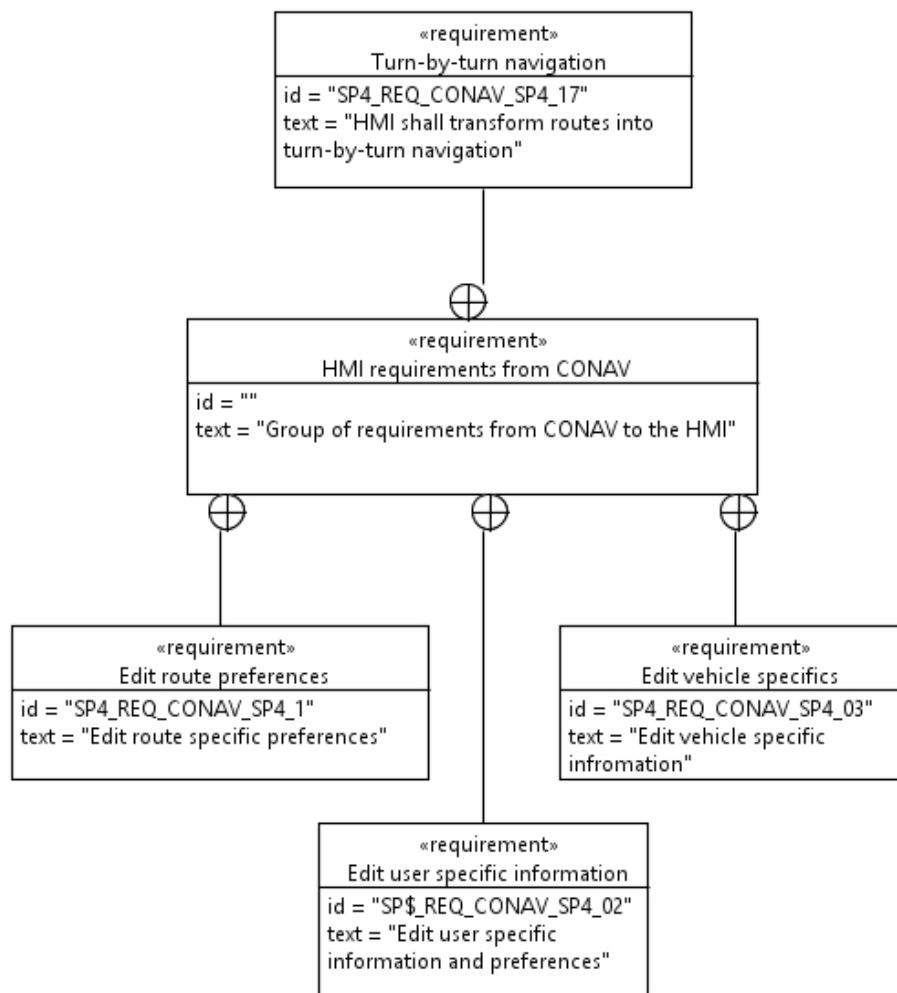


Figure 11: Requirements related to the HMI from CONAV

Requirement ID:	SP4_REQ_CONAV_SP4_01
Name of requirement:	Enter route specific preferences relevant for routing via HMI

Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	HMI Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	The goal is that the user is able to enter, edit, review or delete relevant information that is needed in the CONAV context via HMI.
Definition:	<p>The user in charge (driver) needs to be able via HMI (we assume that this needs to be implemented in all HMI setups, e.g. Smartphone, Vehicle-integrated platform, touchscreen, cursor, voice control, etc.) to review, edit, delete the relevant information, that is until now:</p> <ul style="list-style-type: none"> • Start location • Destination location • Start time • Desired arrival time • Vehicle characteristics if not implemented on a vehicle-integrated platform (emission class, weight, engine type e.g. electric, hybrid, diesel). Could come from a vehicle profile database. • Route preferences (preferences for highways, risky roads, complex crossings) • Amount of virtual money (from the context of serious games) the user is willing to invest.
Critical level (priority)	Essential for the use of the application
Validation Method (tests, indicators, performance bounds)	HMI test, no complex testing necessary. Edit the preferences and test if they are sustainable stored and if the calculated routes has been changed.
Acceptance criteria	HMI test and user acceptance of HMI.

Relationship with other requirements	Relates to all CONAV requirements.
Potential conflicts	No conflicts expected.
Risk analysis	No risks expected, there may be some challenges to secure private data.
Status	First draft.
Other	No.

Requirement ID:	SP4_REQ_CONAV_SP4_02
Name of requirement:	Edit user specific information/preferences from user profile relevant for routing (incl. algorithmic..) via HMI
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	HMI Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	The goal is that the user is able to enter, edit, review or delete relevant information about himself/herself that is needed in the CONAV context via HMI.
Definition:	<p>The user in charge (driver) needs to be able via HMI (we assume that this needs to be implemented in all HMI setups, e.g. Smartphone, Vehicle-integrated platform, touchscreen, cursor, voice control, etc.) to review, edit, delete the relevant information, that is until now:</p> <ul style="list-style-type: none"> • Driver characteristics (Driving habits, driving style, driving capabilities, age, preferences for navigation algorithm, area familiarities, etc.). We may divide here between a self-assessment and an automatic profiling.

	<ul style="list-style-type: none"> Individual POIs (home, work, ...) General routing preferences (preferences for highways, risky roads, complex crossings). The information is reasoned by automatic deduction or user input. <p>Algorithm preferences (we may edit a default user profile, which is independent of a specific trip)</p>
Critical level (priority)	See SP4_REQ_CONAV_HMI_01
Validation Method (tests, indicators, performance bounds)	HMI test, no complex testing necessary. Edit the preferences and test if they are sustainable stored and if the calculated routes has been changed.
Acceptance criteria	See SP4_REQ_CONAV_HMI_01
Relationship with other requirements	Very similar to SP4_REQ_CONAV_HMI_01. The difference is that we wish to edit here driver specific (and less dynamic information) relevant for CONAV.
Potential conflicts	See SP4_REQ_CONAV_HMI_01
Risk analysis	The user would need to correct the preferences and constraints each time they are used.
Status	See SP4_REQ_CONAV_HMI_01
Other	See SP4_REQ_CONAV_HMI_01

Requirement ID:	SP4_REQ_CONAV_SP4_03
Name of requirement:	Edit vehicle specific information relevant for routing via HMI
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	HMI Group from SP4
Source (TEAM application or enabler)	CONAV

Requirement category	Functional
Goal	The information must be made available since we wish to implement vehicle-type specific routing. This requirements targets this need.
Definition:	<p>Via HMI, the user (driver) shall be available to review and edit (if applicable) vehicle specific information. He may choose from a list of predefined vehicle types (vehicle type database) but could edit relevant information also manually. The information include information such as: EURO classes, CO2 emission, weight, max speed, acceleration, size.</p> <p>The editing could be done in a different context of the HMI – the main requirement here is, that this kind of information is made available to the routing algorithm.</p>
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	HMI test, no complex testing necessary. Edit the preferences and test if they are sustainable stored and if the calculated routes has been changed.
Acceptance criteria	<p>Successful functional test</p> <p>User acceptance</p>
Relationship with other requirements	None.
Potential conflicts	Vehicle info is not available in general.
Risk analysis	No vehicle specific routing.
Status	New.
Other	None.

Requirement ID:	SP4_REQ_CONAV_SP4_17
Name of requirement:	Turn by turn navigation
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)

Assigned partner	CONAV group from SP4, HMI
Source (TEAM application or enabler)	CONAV
Requirement category	Technological, Functional
Goal	Having the route calculated with help of the routing algorithms, the driver shall be navigated through this route (from one segment to the next)
Definition:	Turn-by-turn navigation needs to be implemented. Map is needed for visual support, audio output is required.
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Functional test. Review if turn-by-turn works., User acceptance
Acceptance criteria	Functional test, acceptance test.
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	No turn by turn navigation.
Status	New
Other	None

4.4.2 Requirements related to the routing algorithm

We start with an overview on the requirements related to the routing algorithms. An overview is shown in **Fehler! Verweisquelle konnte nicht gefunden werden..** In-detail description of each requirement in this figure are provided hereafter.

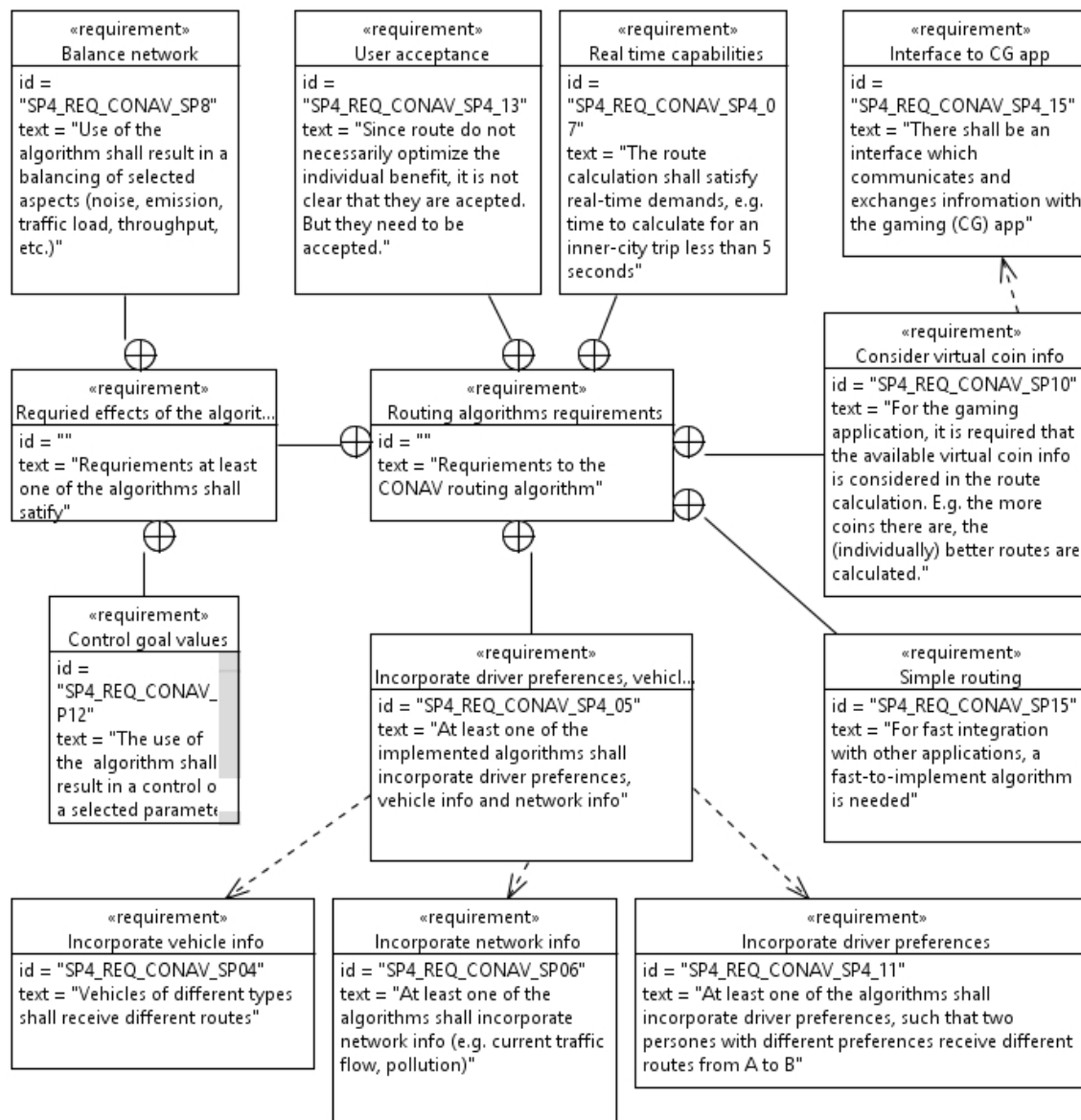


Figure 12: Requirements related to the routing algorithms of CONAV

Requirement ID:	SP4_REQ_CONAV_SP4_04
Name of requirement:	Route calculation algorithm, which incorporates vehicle information
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV Group from SP4
Source (TEAM application or	CONAV

enabler)	
Requirement category	Functional
Goal	<p>There should be a route calculated, which respects vehicle features.</p> <p>If some areas are very much polluted (carbon monoxide, fine dust, noise), we wish to adapt routing based on vehicle emission classes (or other features of the vehicles which are relevant to emission here). For instance, we wish that noisy vehicles are circumnavigated from housing areas during the night if there is another potential route acceptable to the user.</p> <p>The vehicle features may include also features like winter equipment (tires).</p>
Definition:	<p>The routing algorithm takes into account vehicle features. That means that two vehicles of different kinds do have a different algorithms (or parameterization) which leads to (potentially) different route recommendations. The algorithm must be transparent to the user and he shall be aware of "ordinary" route recommendations. That means that the user is aware of what kind of algorithm has been used to calculate the route and what kind of route would have been recommend if an "ordinary" routing algorithm would have been employed.</p> <p>At this point in time, we assume, that common edge weights are manipulated with help of a vehicle specific factor.</p>
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Functional test
Acceptance criteria	Successful functional test: Change the vehicle characteristics and review if the calculated route has been adapted.

	User acceptance Simulation
Relationship with other requirements	Vehicle-specific information must be available, see SP4_REQ_CONAV_SP4_03
Potential conflicts	None.
Risk analysis	No vehicle specific routing.
Status	New
Other	None.

Requirement ID:	SP4_REQ_CONAV_SP4_05
Name of requirement:	Route calculation algorithm, which incorporates driver info, preferences, vehicle features, and network info
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	<p>There should be a route calculated, which respects driver features, vehicle characteristics, and network info (which integrates social/communities' and also environmental information like weather)</p> <p>That means, for instance, that a the system know, that a certain driver is not familiar with some environment – thus, we wish to recommend routes which circumnavigates complex crossings etc.</p> <p>At the same time the algorithm shall respect vehicle features, e.g. when a vehicle is of EURO-norm 3 and there is a zone, where such vehicles are not permitted, the routing engine respects that. Another example is that it shall be respected that a vehicle is equipped with winter</p>

	<p>tires for instance.</p> <p>Finally, we wish to take into account the network needs, e.g. we wish to take into account pollution hotspots, industry zones, traffic flow information etc.</p>
Definition:	<ul style="list-style-type: none"> The algorithm shall take into account (1) driver preferences, see SP4_REQ_CONAV_SP4_11, (2) vehicle features, see SP4_REQ_CONAV_SP4_04, and (3) network needs, see SP4_REQ_CONAV_SP4_06. The algorithm uses the three features requests, which are described in the SP4_REQ_CONAV_SP4_04, SP4_REQ_CONAV_SP4_11, SP4_REQ_CONAV_SP4_06.
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Functional test: The vehicle characteristics, the network info and the vehicle characteristics and review of the calculated route has been adapted accordingly.
Acceptance criteria	<p>Successful functional test:</p> <p>User acceptance</p> <p>Simulation</p>
Relationship with other requirements	<p>Vehicle-specific information must be available, see SP4_REQ_CONAV_SP4_03</p> <p>SP4_REQ_CONAV_SP4_04, SP4_REQ_CONAV_SP4_11, SP4_REQ_CONAV_SP4_06</p>
Potential conflicts	Privacy concerns
Risk analysis	Only one-dimensional routing – meaning that it incorporates only one of the following aspects: individual preferences, vehicle aspects or network aspects.
Status	New
Other	None

Requirement ID:	SP4_REQ_CONAV_SP4_11
Name of requirement:	Route calculation algorithm, which incorporates driver preferences
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	<p>There should be a route calculated, which respects driver features, vehicle characteristics, and network info (which integrates social/communities'</p> <p>That means, for instance, that a the system know, that a certain driver is not familiar with some environment – thus, we wish to recommend routes which circumnavigates complex crossings etc.</p>
Definition:	<p>The routing algorithm takes into account driver features. That means that two drivers of different kinds do have a different algorithms (or parameterization) which leads to (potentially) different route recommendations. The algorithm must be transparent to the user and he shall be aware of "ordinary" route recommendations.</p> <p>At this point in time, we assume, that common edge weights are manipulated with help of a driver specific factor.</p> <p>Examples for driver features, which may play a role here are:</p> <ul style="list-style-type: none"> • Knowledge about environments • Driving capabilities • Driving style (manually defined and automatically deduced') • Preferences for highways, freeways, rural roads, urban

	<p>areas</p> <ul style="list-style-type: none"> • Preferences for/against time efficient routes, green routes, system-optimal routes, shortest routes • Preferences to pass POIs
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	<p>Functional test: Edit the driver characteristics and review if the calculated route has been changed accordingly.</p> <p>Simulation</p>
Acceptance criteria	<p>Successful functional test</p> <p>User acceptance</p>
Relationship with other requirements	Vehicle-specific information must be available, see SP4_REQ_CONAV_SP4_03, child of SP4_REQ_CONAV_SP4_05
Potential conflicts	Privacy concerns
Risk analysis	No driver preferences included in the navigation.

Requirement ID:	SP4_REQ_CONAV_SP4_06
Name of requirement:	Route calculation algorithm, which incorporates network info (e.g. broadcasted from the traffic management centre)
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	Information from the traffic management center (or any other central stakeholder) shall be respected and considered in the routing algorithms. This information refers to SP4_REQ_CONAV_SP3_01,

	SP4_REQ_CONAV_SP3_02, and SP4_REQ_CONAV_SP3_03. As a result the users (with or without respecting individual information about vehicles and drivers) will potentially adapt routes.
Definition:	See Goals.
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Functional test: Calculate route from A to B under different network characteristics and review if the route has changed accordingly. Simulation
Acceptance criteria	Successful functional test
Relationship with other requirements	The information given from the infrastructure refers to <ul style="list-style-type: none"> • SP4_REQ_CONAV_SP3_01 • SP4_REQ_CONAV_SP3_02 • SP4_REQ_CONAV_SP3_03
Potential conflicts	No
Risk analysis	No network info incorporated in CONAV.
Status	New
Other	None.

Requirement ID:	SP4_REQ_CONAV_SP4_07
Name of requirement:	Route calculation shall be possible in real-time (e.g. less than 5 sec)
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Non-Functional

Goal	User Acceptance
Definition:	All routing algorithms should be done in real time (e.g. under 5 seconds)
Critical level (priority)	Desired
Validation Method (tests, indicators, performance bounds)	Performance test
Acceptance criteria	Time threshold
Relationship with other requirements	Relates to the performance of the algorithms, see SP4_REQ_CONAV_SP4_04, SP4_REQ_CONAV_SP4_05, SP4_REQ_CONAV_SP4_06
Potential conflicts	None seen.
Risk analysis	Users will not accept CONAV.
Status	New
Other	No

Requirement ID:	SP4_REQ_CONAV_SP4_08
Name of requirement:	Route calculation shall be balancing the network
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Performance
Goal	The network should be controlled (here balanced). The balanced feature might be of various kind, traffic density, and pollution.
Definition:	The route recommendations from various users shall be aligned with the routes from other vehicles. A stochastic approach shall be used.

Critical level (priority)	Desired
Validation Method (tests, indicators, performance bounds)	Simulation results Analysis User acceptance
Acceptance criteria	Performance, relevant feature of the system is controlled (balanced)
Relationship with other requirements	Is closely related to SP4_REQ_CONAV_SP4_06
Potential conflicts	None
Risk analysis	CONAV brings no added value to the traffic flow.
Status	New
Other	None

Requirement ID:	SP4_REQ_CONAV_SP4_10
Name of requirement:	Provide virtual coin budget info
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CG Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	<p>CONAV shall use one interface of the CG application, which gives information about the budget of coins the driver has earned already. These coins should be "beneficial" in to CONAV user.</p> <p>One idea here is that the driver may spend some coins to "buy" a better emission class for his vehicle to affect routing.</p>
Definition:	Related to SP4_CONAV_COINS from Deliverable D1.0.

Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Functional test Approval by CG User acceptance
Acceptance criteria	Must be given from CG
Relationship with other requirements	Shall be integrated with the routing algorithms, SP4_REQ_CONAV_SP4_04, SP4_REQ_CONAV_SP4_05, SP4_REQ_CONAV_SP4_06, SP4_REQ_CONAV_SP4_07, SP4_REQ_CONAV_SP4_08
Potential conflicts	No
Risk analysis	None
Status	CONAV does not interwork with SG-CB application.
Other	None

Requirement ID:	SP4_REQ_CONAV_SP4_12
Name of requirement:	Algorithm should lead to control of variable goal values
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	<p>The goal is to have routing as a powerful instrument to control network features. Features may be traffic flow, emission, noise etc.</p> <p>Variable goals means that we might want to have different goal values in different regions, e.g. in some areas we want (relatively) high traffic throughput (e.g. highways) and others, where we wish to have few (e.g. city centers).</p>

Definition:	The algorithm routes vehicles in such a way, that variable goal values are met. That means, that some vehicles may be routed in a way that is closely related to the route choice of another vehicle.
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Analysis, simulation
Acceptance criteria	Must be given from CG User acceptance
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	CONAV could not be used to actively control traffic.
Status	New
Other	None

Requirement ID:	SP4_REQ_CONAV_SP4_13
Name of requirement:	Recommended routes shall be accepted by users
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV group from SP4, CG group, HMI group
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	The routes recommended by the CONAV application do not necessarily optimize the drivers utility. Therefore, it is clear that we recommend only those routes which – by chance – are accepted by the end user. The acceptance may be increase through HMI

	instruments or gaming features.
Definition:	(A high percentage of) Recommended routes shall be accepted by users.
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	User study
Acceptance criteria	A certain percentage of recommended routes are accepted. The percentage might be calculated by finding some overall optima.
Relationship with other requirements	SP4_REQ_CONAV_SP4_11
Potential conflicts	No
Risk analysis	CONAV is not accepted by end users.
Status	New
Other	None

Requirement ID:	SP4_REQ_CONAV_SP4_16
Name of requirement:	Interface to GP application
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV group from SP4, CG group
Source (TEAM application or enabler)	CONAV
Requirement category	Technological, Functional
Goal	There are two basic types of information to be exchanged with the gaming application. Information about the driver behavior (coming from CONAV) and "budget" information (coming from the gaming app). The interface shall make the exchange of information easy.

Definition:	Clear definition of the information exchange and the interface.
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Functional test
Acceptance criteria	Functional test.
Relationship with other requirements	SP4_REQ_CONAV_SP4_09
Potential conflicts	No
Risk analysis	No interwork with the SG-CG application.
Status	New
Other	None

4.4.3 Requirements related to the gaming application

We start with an overview on the requirements related to the routing algorithms. An overview is shown in **Fehler! Verweisquelle konnte nicht gefunden werden..** In-detail description of each requirement in this figure are provided hereafter.

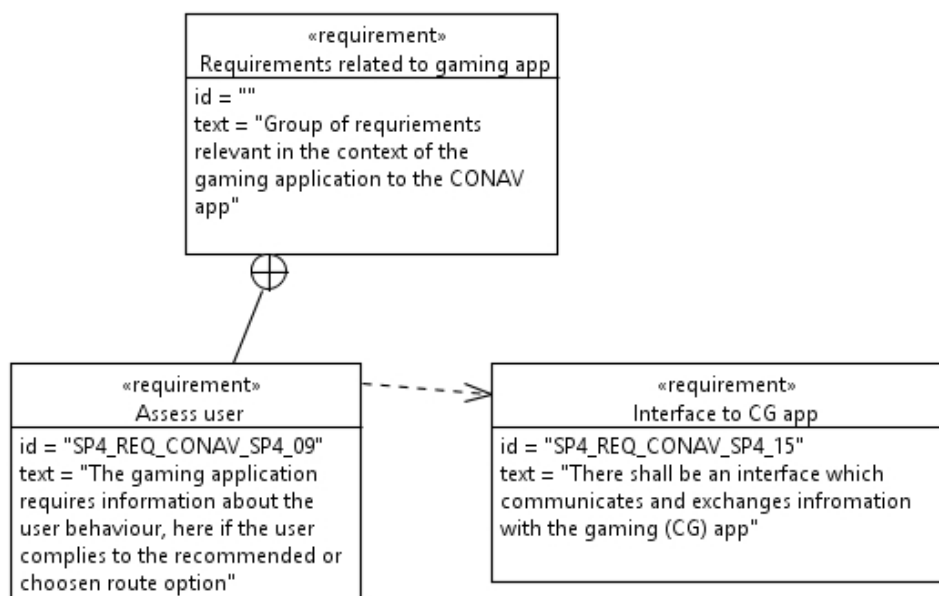


Figure 13: Requirements related to gaming from CONAV

Requirement ID:	SP4_REQ_CONAV_SP4_09
Name of requirement:	Assess user behaviour after the trip and during the trip (for gaming application)
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV Group in SP4 CG Group from SP4
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	The CONAV application shall interwork with the CG application. In order to receive some "coins" in the gaming context, it is required to assess the behavior from the user in the CONAV context.
Definition:	<p>Related to SP4_CONAV_SIGNAL.</p> <p>The basic idea here is to assess the driver and its behavior (independent from the vehicle). Thus, it is measured to which extend the drivers follows the navigation recommendations (complies with the recommendations).</p> <p>Moreover, the driver is able to define parameters of the routing algorithms, this should also be evaluated and communicated to the CG application (e.g. to what extend the drivers "prefers green2 routes).</p> <p>The parameters to define depend on the routing algorithms used, see related requirements.</p>
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Shall be evaluated from the CG point of view.
Acceptance criteria	Shall be assessed by CG application.
Relationship with other	SP4_REQ_CONAV_SP4_04, SP4_REQ_CONAV_SP4_05,

requirements	SP4_REQ_CONAV_SP4_06, SP4_REQ_CONAV_SP4_11
Potential conflicts	None seen so far.
Risk analysis	Data privacy and security. No interwork with the SG-CB application.
Status	New
Other	None.

Requirement ID:	SP4_REQ_CONAV_SP4_15
Name of requirement:	Classic routing for fast deployment
Created by	FOKUS (florian.haeusler@fokus.fraunhofer.de)
Assigned partner	CONAV group from SP4, CG group
Source (TEAM application or enabler)	CONAV
Requirement category	Functional
Goal	A lot of applications require routing. A classic routing services should be deployed fast for integration.
Definition:	There shall be a (classic/easy to deploy) vehicle routing service implemented.
Critical level (priority)	Mandatory
Validation Method (tests, indicators, performance bounds)	Functional test
Acceptance criteria	Functional test.
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	Should be there very soon as a lot of TEAM applications require routing.

Status	New
Other	None

4.5 Green, safe and collaborative driving serious game and community building

The SG_CB application represents a novelty in the automotive landscape. Social GPS applications like Waze provide free navigation and allow the user to become part of the local driving community in his area, joining forces with other drivers nearby to outsmart traffic, save time and improve everyone's daily commute. Waze use cell phone data. Thus, a major innovation by TEAM is given by the integration and exploitation of the actual vehicle data. The Nokia "Driving Miss Daisy" app includes car data, but the TEAM application will make a much more extensive use of vehicle signals and try to devise vehicle-independent assessment techniques, so to the evaluate the real capabilities of the driver, independent of the actual driven car. The black box solutions recently appeared for driver profiling are very interesting and we will develop a similar approach, with the added value of real-time coaching.

Finally, a major innovation consists in the virtuous cycle, which intends to incentivize a proper use of the other "elastic mobility" TEAM applications (e.g., collaborative parking, collaborative navigation, etc.) through a comprehensive, gamified social mobility environment.

4.5.1 Requirements related to vehicle signals connectivity and processing

An overview of the requirements related to connectivity and signal processing is provided in the following figure.

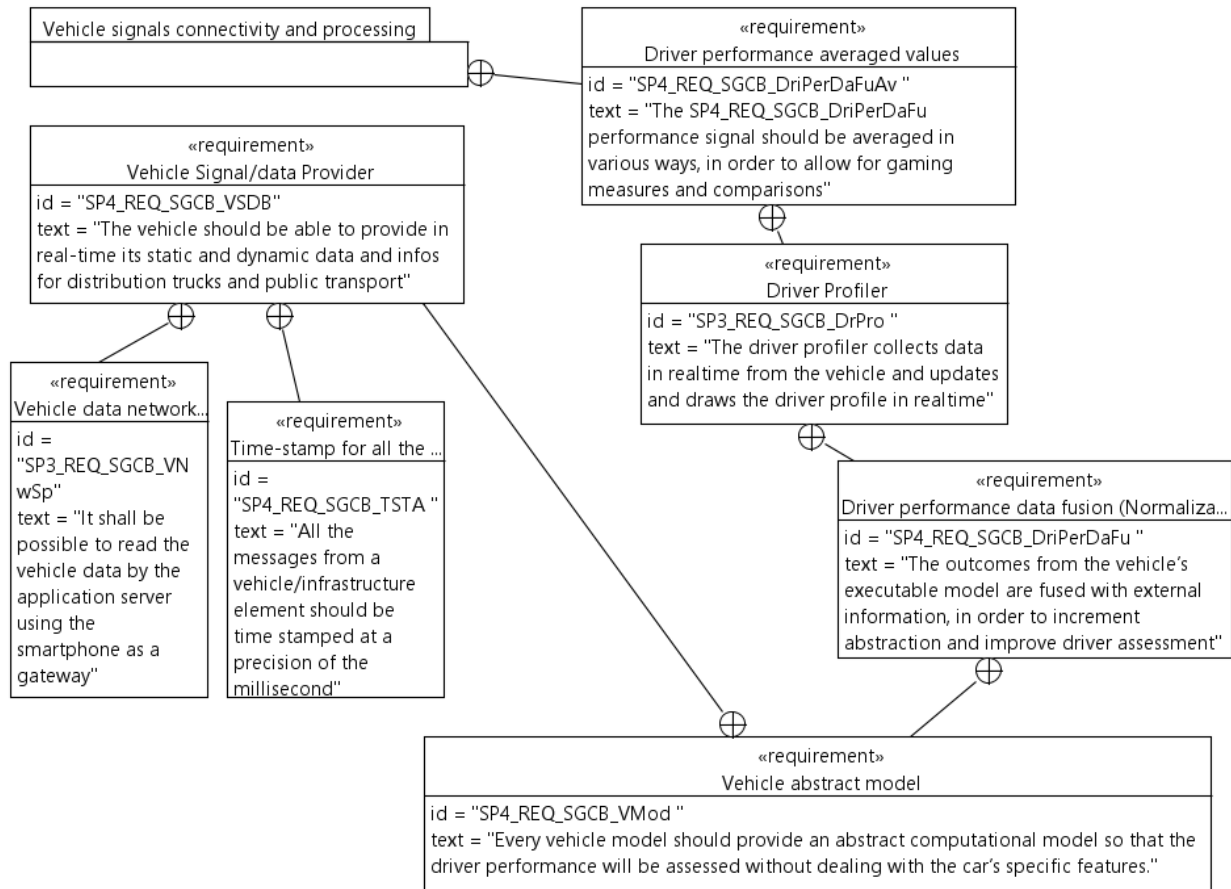


Figure 14: Requirements on connectivity and signal processing from SG_CB

Requirement ID:	SP3_REQ_SGCB_VNwSp
Name of requirement:	Vehicle data network-smartphone communication
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Car manufacturers
Source (TEAM application or enabler)	Serious Game and Community Building (CB)
Requirement category	Connectivity and communication requirements
Goal	To ensure that the vehicle data (available on the CAN or other vehicle network) are sent to the application server through a smartphone.
Definition:	There will be a communication link between the vehicle

	<p>and the application servers through a smartphone as a gateway. Through this link, it will be possible to read the vehicle data by every application.</p> <p>Vehicle data include: speed, RPM, gear, pedal activity, fuel consumption, eco-friendliness, indicators, signals from the ADAS, position, etc.</p> <p>The read frequency should be at least 1Hz.</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Test the connection between the vehicle and the smartphone (functional tests). Test connection between the smartphone and the server.
Acceptance criteria	The functional tests should show real-time communication (signals should be available every 1 sec, with a 0.1 maximum delay) and availability of vehicle data on the cell-phone
Relationship with other requirements	This requirement is used by SP4_REQ_SGCB_VSDB (which aims at providing seamless access to these data)
Potential conflicts	No
Risk analysis	Lack of reliable and real-time communication will prevent the operation of the CB application
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_VSDB
Name of requirement:	Vehicle signal/data provider
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Car manufacturers
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)

Requirement category	Vehicle Signals
Goal	To ensure that the all the vehicle data (SP3_REQ_SGCB_VNwSp) can be accessed by the TEAM applications in a seamless way (typically through a database, such as the vehicle signal/data provider), independent of the specific Intellectual Property (IP)/format of the single car manufacturer
Definition:	<p>The signal/data provider should be able to provide, in an abstract and manufacturer-independent way, the following information about a vehicle:</p> <p>Static data (vehicle type, size, number of axels, fuel, etc), that do not need transmission, but are simply saved in the database</p> <p>Real time dynamic data about the vehicle (speed, position, fuel consumption, etc.), and its content (weight, load, number of passengers, etc.)</p> <p>Schedules and timing information for trucks and public transport (stops, time behind or ahead, etc.)</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Availability of the database with a real-time behaviour
Relationship with other requirements	<p>Signals come from SP3_REQ_SGCB_VNwSp</p> <p>All the signals should be time-stamped</p> <p>SP4_REQ_SGCB_TSTA</p>
Potential conflicts	No
Risk analysis	Lack of the provider would force applications to access vehicle data in a vehicle-specific format, which would be problematic both for the technical implementation (scalability, open-ness) and from the point of view of IP.

Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_TSTA
Name of requirement:	Time-stamp for all the vehicle data
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Car manufacturers and infrastructure data providers
Source (TEAM application or enabler)	Serious Game (SG)
Requirement category	Vehicle Signals
Goal	To ensure that all the vehicle/infrastructure signals can be evaluated in a time perspective
Definition:	All the messages from a vehicle element should be time stamped at a precision of a millisecond, using the GPS timing
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Availability of millisecond precision time stamps
Relationship with other requirements	The vehicle signal realtime data provider must be available SP4_REQ_SGCB_VSDB
Potential conflicts	No
Risk analysis	Lack of time stamp would make the vehicle/infrastructure signal processing unfeasible. Time synchronization of different actors is not trivial.
Status	New

Other	No
--------------	----

Requirement ID:	SP4_REQ_SGCB_Vmod
Name of requirement:	Vehicle abstract model
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Car manufacturers
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Vehicle Signal processing
Goal	To abstract the driver's assessment from his vehicle type.
Definition:	<p>Since the drivers will use vehicles that differ in various aspects (e.g., in term of engine power, fuel consumption, numbers of gears, etc.), it is necessary to abstract a model that is independent of the specific features of a particular vehicle.</p> <p>The executable model shall indicate in real time how the vehicle is used by the driver in terms of different dimensions (initially, green driving, but other could be added, such as safe driving). Thanks to the model, it will be possible a fair assessment of the performance and of the green driving contribution (in the collaborative team) of different players driving, say, a 1800 cc diesel and a 1200 cc unleaded respectively.</p> <p>The executable model should provide a scale from 0 to X, that describes how the driver is correctly using the car in the current environment.</p> <p>Every vehicle model (identified by proper manufacturer model codes, are there are several FIAT Pandas, Volkswagen Passats, etc.) should provide an abstract computational model so that the driver performance will</p>

	<p>be assessed with respect to such a model, without dealing with the car's specific internal features.</p> <p>Existing automotive systems may be suited to implement this model (see also SP4_REQ_SGCB_VmodInst). But, at least, the model will need to define harmonized outcomes (e.g., the performance levels) from the different manufacturers.</p> <p>This requirement is necessary in order for the serious game application to consider the driver behavior without any bias from the vehicle characteristics.</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests.
Acceptance criteria	<p>Availability of the different targeted vehicle models.</p> <p>Capability of the system to assess the driver independent of the actual vehicle used</p>
Relationship with other requirements	SP4_REQ_SGCB_VmodInst, which is the vehicle-specific implementation, for each single vehicle model, of the abstract model defined here.
Potential conflicts	No
Risk analysis	Lack of the model would make it impossible to compare drivers using different vehicles. Also, some car manufacturers may mandate a decoupling of the driver performance from the actual used vehicle.
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_DriPerDaFu
Name of requirement:	Driver performance data fusion (Normalization)
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Car manufacturers
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Vehicle signal processing
Goal	Abstracting driver assessment from road type and environment conditions.
Definition:	<p>Integration of the data coming from the sensors, the maps, the environment and the vehicle's model (SP4_REQ_SGCB_Vmod), in order to seamlessly assess the behaviour of the driver, also independent of the context (e.g., road steepness, type of road, traffic, weather, etc.), not only the vehicle model. This allows a much more precise, continuous and situation-independent assessment of the driver.</p> <p>In particular, the outcomes from the vehicle's executable model (SP4_REQ_SGCB_Vmod) are fused with external information, in order to increment its abstraction. This is the basis for the participation (driver assessment) at the TEAM cooperative serious game.</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Capability of the system to assess the driver in the context he is operating
Relationship with other requirements	SP4_REQ_SGCB_VmodInst is used

Potential conflicts	No
Risk analysis	Lack of the module would make the performance assessment and comparison less effective.
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_DriPerDaFuAv
Name of requirement:	Driver performance averaged values
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Serious Game and Community Building (SG_CB)
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Vehicle signal processing
Goal	The SP4_REQ_SGCB_DriPerDaFu performance signal is an instantaneous signal. The SG_CB application may need averaged values as well for its score computations.
Definition:	The SP4_REQ_SGCB_DriPerDaFu performance signal should be averaged in various ways, in order to allow for gaming measures and comparisons. For instance average could be in a temporal window (mobile: e.g., the last 5 minutes; or fixed: e.g., since the beginning of the travel) or in a space window (e.g., in an area).
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Availability of the different average values . Capability of the system to assess the driver in various averaging windows

Relationship with other requirements	SP4_REQ_SGCB_DriPerDaFu
Potential conflicts	No
Risk analysis	Lack of the module would make the SG score computation much less effective.
Status	New
Other	No

Requirement ID:	SP3_REQ_SGCB_DrPro
Name of requirement:	Driver Profiler
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SP4
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Signal processing
Goal	To ensure that the profile of the driver is kept by processing his driving data in real time
Definition:	The driver profiler collects data in real-time from the vehicle and updates and draws the driver profile (driving styles) in real-time
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests showing an ability to track the driver
Acceptance criteria	Proper driver style tracking
Relationship with other requirements	Requirements about vehicle signal processing the are necessary SP4_REQ_SGCB_DriPerDaFu and SP4_REQ_SGCB_DriPerDaFuAv
Potential conflicts	No
Risk analysis	The risk is represented by the need for accurate profiling and real-time performance. This may require finding a trade-off during the implementation tests.
Status	New
Other	No

4.5.2 Requirements related to community support for all the TEAM applications

This sub-section provides the requirements about the relationship among all the TEAM applications and the SG_CB application. The idea is to implement a “virtuous cycle”, through which the SG_CB can promote a proper use of all the TEAM collaborative applications (and of independent third party applications as well). In particular, every application should define a metrics for assessing good (and bad) collaborative user behavior, so that the SG_CB can manage an amount of virtual coins (winnable by the user across the various applications) that, in turn, may be spent by the user to get better levels of services in each one of the TEAM applications. The “virtual coins” interface has been defined for allowing seamless addition of new applications, thus supporting system’s openness and scalability. More details are provided in the following.

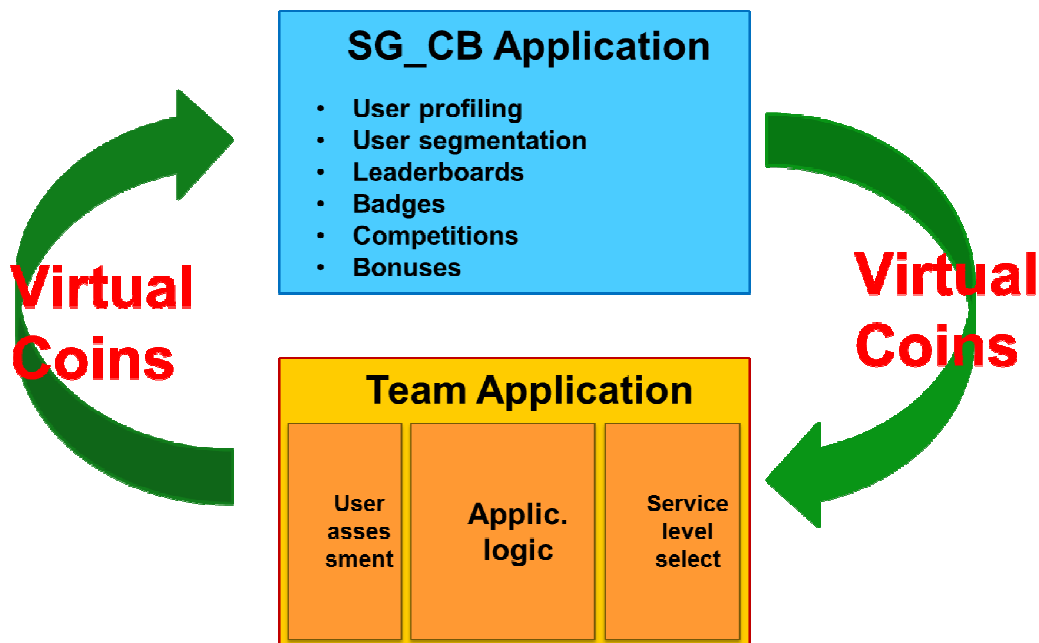


Figure 15: Homogeneous interface among the TEAM applications and SG_CB

The goal of the virtual coin mechanic is to enhance the use of any involved (i.e., subscribed) application. This is why the mechanic rewards (through virtual coins) a user’s good interaction with any application and allows spending virtual coins for acquiring (temporarily) better levels of services by any application. Every application is responsible for defining the metrics and the available services, thus considering in particular their target groups. Quantification of the rewards and costs will be discussed with the SG_CB design team, for ensuring homogeneity across different applications. Beside this, the virtual coin balance mechanic’s implementation will integrate a module for dynamically favoring a smooth use of all the applications (i.e., avoiding users to accumulate coins from a single application).

So, the virtual coin balance mechanic's perspective is inherently internal and location-independent (i.e., a virtual cycle to support the participant applications). However, the virtual coin mechanics may have also significant externalities, meaning that the virtual coins could be spent to gain benefits in the physical world (and in specific locations), such as discounts on public parking or access in restricted lanes/areas. This would be a specific business model and may be considered in TEAM in SP5, in particular within the EcoChallenge.

A graphic overview of the SG_CB requirements related to all the other TEAM applications is provided in the following figure.

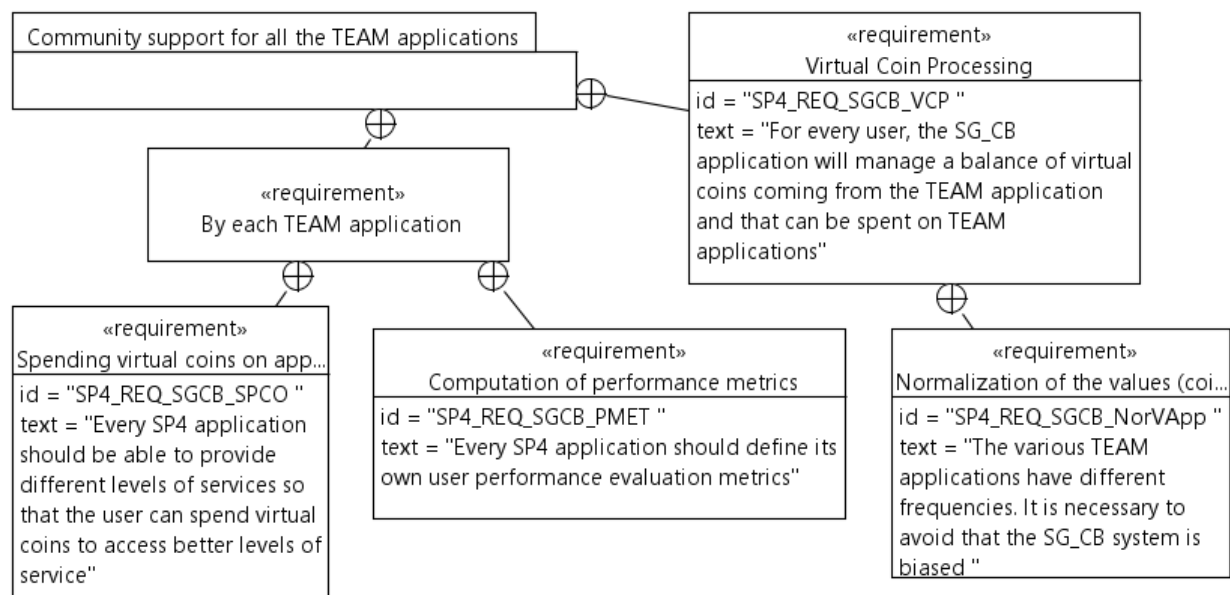


Figure 16: Requirements for the TEAM apps from SG_CB

Requirement ID:	SP4_REQ_SGCB_PMET
Name of requirement:	Computation of performance metrics
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SP4 Applications
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Serious gaming and community building
Goal	To ensure that all the SP4 applications interact with the SG_CB, so that they are in a virtuous cycle promoting

	proper collaborative behaviors by drivers
Definition:	Every SP4 application should define its user performance evaluation metrics, so that, during the drive, positive feedback can be given to the SG_CB application so that it can incentivize proper usage of each SP4 application. The SG_CB application shall convert the user feedback coming from the SP4 (and 3) applications into virtual coins that, in turn, could be spent on acquiring higher quality of services in the SP4 (and 3) applications, thus building a virtuous cycle.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional and user tests
Acceptance criteria	Verify the quality/relevance of the real-time user performance assessment implemented by each SP4 application
Relationship with other requirements	SP4_REQ_SGCB_SPCO SP4_REQ_SGCB_VCP
Potential conflicts	No
Risk analysis	Lack of link to the SG/Community Building application would deprive the driver of a compelling way of continuously verifying and improving his performance in using an SP3 and SP4 application
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_SPCO
Name of requirement:	Spending virtual coins on application quality levels
Created by	DITEN UniGe - Ref: franz@elios.unige.it

Assigned partner	SP4 Applications
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Serious gaming and community building
Goal	To ensure that all the SP4 applications interact with the SG
Definition:	Every SP4 application should be able to provide different levels of services (e.g., in terms of contents, look & feel, quality and timeliness of information, etc.) so that the user can spend virtual coins to access better levels of service. (Different levels of services could be enabled also through other means, such as real money)
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional and user tests
Acceptance criteria	Verify the quality/relevance of the differentiation among the various access levels within an application
Relationship with other requirements	SP4_REQ_SGCB_PMET SP4_REQ_SGCB_VCP
Potential conflicts	No
Risk analysis	Lack of link to the SG/Community Building application would deprive the driver of a compelling way of continuously verifying and improving his performance in using an SP3 application
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_VCP
Name of requirement:	Virtual Coin Processing

Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SG_CB application
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Serious gaming and community building
Goal	To ensure the presence of a module which is able to make a global management, for each user, of the virtual coins that can be gained from good driver behaviors in the TEAM collaborative applications and spent in acquiring higher quality levels of those applications
Definition:	<p>For every user, the SG_CB application will manage a balance of virtual coins coming from the TEAM application and that can be spent on TEAM applications.</p> <p>The virtual coin processing will involve also some chance and other mechanics, like "happy hour" (especially for traffic) or "happy application", in order to add fun and incentivize the use of all the applications, in an overall, collaborative perspective. This requires, in turn, that a picture of the use and relevance of all the applications is kept, with possible suggestions based on traffic/weather conditions and on the friends' use of the applications.</p> <p>Discounts may be given for people who frequently spend coin on TEAM applications</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests of whole compliance and user tests on a medium-long period, given the need to consider different applications, etc.
Acceptance criteria	Proper functioning and achievement of good levels of user satisfaction
Relationship with other requirements	SP4_REQ_SGCB_SPCO SP4_REQ_SGCB_PMET SP4_REQ_SGCB_NorVApp

Potential conflicts	No
Risk analysis	Lack of a virtual coin processing module would prevent a significant competition aspect
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_NorVApp
Name of requirement:	Normalization of the values (coins) from the applications
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SG_CB application
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Serious gaming and community building
Goal	To ensure a fair utilization and rewarding for the use of the various TEAM applications
Definition:	<p>The various TEAM applications (and their rewards) have different frequency of use/occurrence by the drivers/travellers. It is necessary to avoid that the SG_CB system is biased by one (or a set) of such applications.</p> <p>A roof and weights for balancing the coin rewards has to be defined for each application, so that the driver does not make an excessive use of it in order to increase his virtual coin balance.</p>
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Functional tests of whole compliance and user tests on a medium-long period, given the need to consider different applications, etc.
Acceptance criteria	Proper functioning and achievement of good levels of user satisfaction

Relationship with other requirements	SP4_REQ_SGCB_VCP
Potential conflicts	No
Risk analysis	Lack of the module would make the SG_CB application more prone to biases towards some applications
Status	New
Other	No

4.5.3 Specific serious gaming requirements

Requirement ID:	SP4_REQ_SGCB_FtrSco
Name of requirement:	Fluid traffic serious game score computation
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Serious Game and Community Building (SG_CB)
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Serious gaming
Goal	To ensure a score computation in the fluid traffic SG application, that is able to meet the TEAM's collaborative goals
Definition:	<p>The SG score is a fundamental enabler of user performance incentives. Thus, the score computing algorithm should take into account the actual targets set by TEAM. In the case of the traffic fluidity goal, the SG will reward users driving their vehicle at a speed close to the speed limit (which is assumed as the best possible value for traffic fluidity – we call it the target speed).</p> <p>Higher speed (with respect to the speed limit) will be penalized or leveled.</p> <p>Given the cooperative nature and goal of the SG</p>

	<p>application, the goal will be, for every driver in a given area (or city) to contribute the more to the collective achievement.</p> <p>The score will be computed as an assessment of the aggregated divergence, in that area, of the actual speed from the target speed.</p> <p>Beside this cooperative evaluation, the specific contribution of each driver will also be computed and displayed.</p> <p>The driver's team will be identified by all the drivers in a city or in a city area. The game goal is to improve the position of the team with respect to all the other teams.</p> <p>The driver will receive feedback about his relative contribution to achieving the team goal of a overall high driving quality (measured along the traffic fluidity axis).</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional and user tests
Acceptance criteria	Verify the quality/relevance of the computed scores with respect to the TEAM targets. Proper score computation, according to the TEAM targets
Relationship with other requirements	SP4_REQ_SGCB_GdrSco
Potential conflicts	No
Risk analysis	Improper score computation is likely to lead to improper driver behavior
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_GdrSco
Name of requirement:	Green driving serious game score computation
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Serious Game and Community Building (SG_CB)
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Serious gaming
Goal	To ensure a score computation in the green driving SG application, that is able to meet the TEAM's collaborative goals
Definition:	<p>The SG score is a fundamental enabler of user performance incentives. Thus, the score computing algorithm should take into account the actual targets set by TEAM. In the case of the green driving goal, the SG will reward users driving their vehicle with green performance values (SP4_REQ_SGCB_DriPerDaFu, SP4_REQ_SGCB_DriPerDaFuAv) close to the optimal values.</p> <p>Given the cooperative nature and goal of the SG application, the goal will be, for every driver in a given area (or city) to contribute the most to the collective achievement.</p> <p>The score will be computed as an assessment of the aggregated divergence, in that area, of the actual speed from the target speed.</p> <p>Beside this cooperative evaluation, the specific contribution of each driver will also be computed and displayed.</p> <p>The driver's team will be identified by all the drivers in a city or in a city area. The game's goal is to improve the position of the team with respect to all the other teams.</p> <p>The driver will receive feedback about his relative contribution to achieving the team goal of an overall</p>

	high driving quality (measured along the green driving axis).
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional and user tests
Acceptance criteria	Verify the quality/relevance of the computed scores with respect to the TEAM targets
Relationship with other requirements	SP4_REQ_SGCB_FtrSco as a similar SG SP4_REQ_SGCB_DriPerDaFu and SP4_REQ_SGCB_DriPerDaFuAv as the data sources
Potential conflicts	No
Risk analysis	Improper score computation is likely to lead to improper driver behavior
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_DisPer
Name of requirement:	Display of performance
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Serious Game and Community Building (SG_CB)
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Serious Gaming/HMI
Goal	To show the results of the collaborative SG on a map-based user interface
Definition:	In the (mobile) web map-based application, the user will be able to see the current collaborative score of his team(s) and his own contribution. Results will be

	<p>instantaneous and averaged, also on different time/space windows. Scores are displayed on a map because they concern different geographic areas where there are different drivers.</p> <p>Variations with respect to previous performance by himself and his teams will be shown for comparison.</p> <p>Display of results in different road conditions, days, etc. will also be available</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional and user acceptance tests.
Acceptance criteria	Availability of the maps with the aggregated dynamic scores. Good results from user acceptance tests
Relationship with other requirements	This requirement exploits SP4_REQ_SGCB_Cmap, SP4_REQ_SGCB_GdrSco, SP4_REQ_SGCB_FtrSco
Potential conflicts	No
Risk analysis	Risks are represented by the amount of information/animation to be displayed, that could distract the driver. A trade-off will need to be defined, also considering the gaming nature of the application.
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_Co
Name of requirement:	Driver coaching
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Serious Game and Community Building (SG_CB)
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)

Requirement category	Serious Gaming
Goal	To coach, possibly in real-time, the driver about green driving so to improve his performance
Definition:	<p>The driver may be coached by the system, exploiting information from other drivers (from his team), on how to improve his performance.</p> <p>Coaching will be offline and possibly online as well. The driver will be notified about better performance by other drivers (possibly friends of him). Suggestions may also be provided, based on a knowledge system. The system may compare drivers in road segments.</p>
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Functional tests. User acceptance tests.
Acceptance criteria	Availability of the coaching module. Good results from user acceptance tests
Relationship with other requirements	This requirement exploits SP4_REQ_SGCB_DriPerDaFu
Potential conflicts	No
Risk analysis	Realtime coaching is complex to implement, because of the need for recognizing the driver behavior in a variety of situations. It is important not to startle the driver, especially with false positives. Summative coaching will be examined as a possible trade-off solution.
Status	New
Other	No

4.5.4 Requirements related to social networking

An overview of the requirements related to social networking is provided in the following figure.

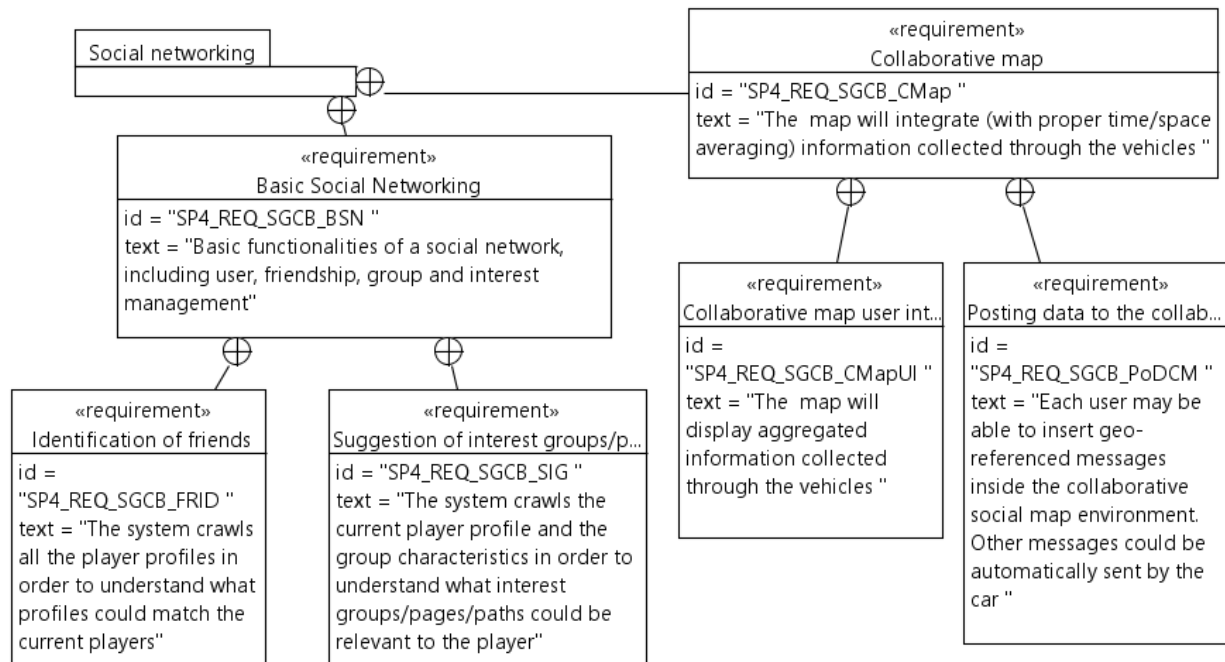


Figure 17: Requirements on social networking from SG_CB

Requirement ID:	SP4_REQ_SGCB_BSN
Name of requirement:	Basic Social Networking
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SP4
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Social networking
Goal	To ensure that the system can provide the basic functionalities of a social network, including user, friendship, group and interest management
Definition:	The SG_CB application needs to exploit the basic functionalities of a social network, including user, friendship, group and interest management. In this way, it will be possible for the SG_CB application to have registered users that can have friends, share interests and participate in groups.

Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional and user tests
Acceptance criteria	Verify the availability of the social management modules and of their functionalities. Quality and relevance should be assessed through user tests.
Relationship with other requirements	This requirement is exploited by SP4_REQ_SGCB_FRID
Potential conflicts	No
Risk analysis	Implementing reliable social network modules from scratch is very expensive, but it is difficult to find usable open source components. It will be necessary to find a trade-off adapting existing modules.
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_FRID
Name of requirement:	Identification of friends
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SP4
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Friendship management
Goal	To ensure that the system can propose proper possible friends to all the players
Definition:	The system crawls all the player profiles in order to understand what profiles could match the current players. Matching could be based on common interests, routes, type of vehicle, etc.

Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	Functional and user tests
Acceptance criteria	Verify the quality/relevance of the proposed friends
Relationship with other requirements	This requirement relies on SP4_REQ_SGCB_FRID
Potential conflicts	No
Risk analysis	Lack of friend proposals could prevent the player to further engage in the SG
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_SIG
Name of requirement:	Suggestion of interest groups/pages/routes
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SP4
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Friend management
Goal	To ensure that the system can propose interest groups/pages/routes that should be of interest to the player
Definition:	The system crawls the current player profile and the group characteristics in order to understand what interest groups/pages/paths could be of interest/relevant to the player
Critical level (priority)	Medium
Validation Method (tests,	Functional and user tests

indicators, performance bounds)	
Acceptance criteria	Verify the quality/relevance for the player of the proposed groups
Relationship with other requirements	This requirement relies on SP4_REQ_SGCB_FRID
Potential conflicts	No
Risk analysis	Lack of interesting proposals could prevent the player to further engage in the SG
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_Cmap
Name of requirement:	Collaborative map
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Serious Game and Community Building (SG_CB)
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Social networking
Goal	To have a map aggregating information from the various users of the SG_CB application
Definition:	<p>The map will integrate (with proper time/space averaging) information collected through the vehicles (this is an enhancement of the current Waze social driving application, which only relies on cell-phone data).</p> <p>Example data may be speed, fuel consumption level, pedal activity, temperature, etc.</p> <p>Filters could be added for selecting the information sources (e.g., friends, people sharing some interests, etc.)</p>

Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Availability of the map aggregating information from various users
Acceptance criteria	Availability of the maps with the aggregated dynamic information. Good results from user acceptance tests
Relationship with other requirements	This requirement is used by SP4_REQ_SGCB_CmapUI
Potential conflicts	No
Risk analysis	Difficulty in aggregating information from various dynamic sources. Possible holes (lack of vehicles in an area in a period) are to be considered. Caching and hysteresis solutions may be considered and evaluated.
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_CmapUI
Name of requirement:	Collaborative map user interface
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Serious Game and Community Building (SG_CB)
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Social networking
Goal	To have a map-based user interface for the SG_CB application
Definition:	<p>The map will display aggregated information collected through the vehicles (this is an enhancement of the current Waze social driving application, which only relies on smartphone data).</p> <p>Selected (i.e. relevant to the driver/passenger)</p>

	notifications/messages may appear on the map during the drive.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional and user tests
Acceptance criteria	Availability of the maps with the aggregated dynamic information. Good results from user acceptance tests
Relationship with other requirements	This requirement exploits SP4_REQ_SGCB_Cmap
Potential conflicts	No
Risk analysis	Difficulty in representing and presenting information aggregated from various dynamic sources. User acceptance tests (also since lab prototypes) are important to devise proper solutions.
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_PoDCM
Name of requirement:	Posting data to the collaborative map
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Serious Game and Community Building (SG_CB)
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	Social networking
Goal	To allow drivers (and the vehicles automatically themselves) to post messages and data to the CB collaborative social map

Definition:	Each user may be able to insert geo-referenced messages inside the collaborative social map environment. Other messages could be automatically sent by the car (e.g., windscreen wipers, temperature, airbag, speed) also during the drive, if the user allowed it. This will allow creating and displaying on the map integrated information collected through the vehicles (SP4_REQ_SGCB_Cmap).
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional and user acceptance tests.
Acceptance criteria	Possibility for the driver and for the vehicle to post information on the collaborative social map. Good results from user acceptance tests
Relationship with other requirements	This requirement is used by SP4_REQ_SGCB_Cmap and SP4_REQ_SGCB_CmapUI
Potential conflicts	No
Risk analysis	There is the risk to distract the driver with non-relevant information. Attention is needed to support information filtering, and to make verification and acceptance tests since the lab.
Status	New
Other	No

4.5.5 Requirements related to HMI

An overview of the requirements related to HMI is provided in the following figure.

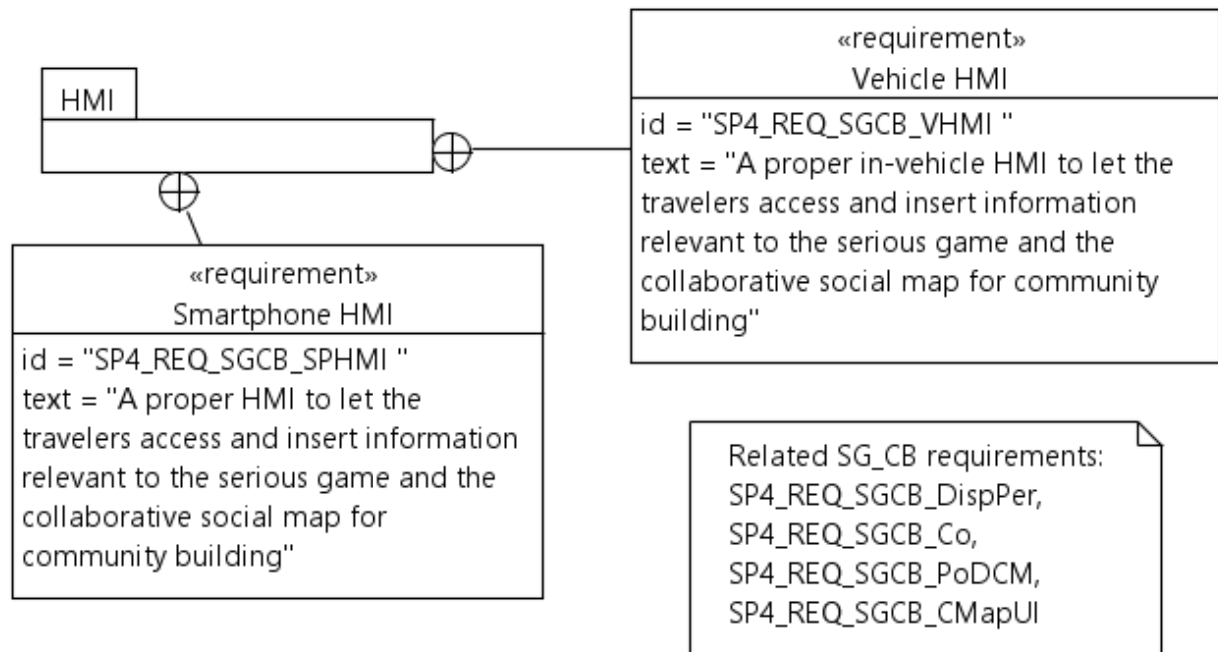


Figure 18: Requirements related to the HMI from SG_CB

Please consider that beside the requirements listed below, also some others, already described in the previous SG_CB are relevant to HMI, which are the following:
 SP4_REQ_SGCB_DisPer, and SP4_REQ_SGCB_PoDCM and SP4_REQ_SGCB_CmapUI (from the Social networking cluster).

Requirement ID:	SP4_REQ_SGCB_SPHMI
Name of requirement:	Smartphone HMI
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SP4/HMI group
Source (TEAM application or enabler)	Serious Game and Community Building (SG_CB)
Requirement category	HMI
Goal	To ensure that the user will be able to properly interact with the SG_CB application through a proper smartphone HMI
Definition:	A proper smartphone HMI to let the travellers access and insert information relevant to the serious game and the collaborative social map for community building. Vocal interface is considered important in order not to overload the driver.

Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Perform functional tests with the smartphone. Perform acceptance user tests
Acceptance criteria	The traveler can easily provide the needed information as input and get the expected output
Relationship with other requirements	SP3_REQ_SGCB_VHMI
Potential conflicts	No
Risk analysis	HMI usability (effectiveness, efficiency, pleasantness of use, usefulness) is a key factor to the success of the application. The risk is related to match usability with safety, especially for the driver. The smartphone will be used as a docked device, with no interaction needed, which imposes severe constraints on the application.
Status	New
Other	No

Requirement ID:	SP4_REQ_SGCB_VHMI
Name of requirement:	Vehicle HMI
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	SP4/HMI group
Source (TEAM application or enabler)	Serious Games and Community Building (SG_CB)
Requirement category	HMI
Goal	To ensure that the user will be able to properly interact with the SG_CB application through a proper in-vehicle HMI
Definition:	A proper in-vehicle HMI to let the travellers access and insert information relevant to the serious game and the collaborative social map for community building. Vocal interface is considered important in order not to overload the driver.
Critical level (priority)	Medium (this could be superseded by a smartphone interface)
Validation Method (tests, indicators, performance)	Perform functional tests. Perform acceptance user tests

bounds)	
Acceptance criteria	The traveler can easily provide the needed information as input and get the expected output
Relationship with other requirements	SP3_REQ_SGCB_SPHMI
Potential conflicts	No. The risk is related to match usability with safety, especially for the driver. The game should not distract the driver, which imposes severe constraints on the application (especially a gaming application).
Risk analysis	HMI usability (effectiveness, efficiency, pleasantness of use, usefulness) is a key factor to the success of the application
Status	New
Other	No

5 Requirements from the FLEX applications

The requirements to DIALOGUE which derive from FLEX applications and their specific needs are reported in this section. There is one subsection per application with the relevant requirements in the tabular format provided by IR4.3.2. We received the SP3 requirements within IR3.3.1 ("Requirements to EMPOWER and DIALOGUE") and we asked WP4.3 partners to check their suitability to SP4.

5.1 Collaborative pro-active urban/inter-urban monitoring and ad-hoc control

5.1.1 Requirements related to vehicular data

Requirement ID:	SP3_REQ_CMC_06
Name of requirement:	Collaborative vehicle data provider
Created by	Marco Bottero (Swarco Mizar)
Assigned partner	
Source (TEAM application or enabler)	Collaborative pro-active urban/inter-urban monitoring and ad-hoc control
Requirement category	Application requirements
Goal	To have all vehicle information needed for the application
Definition:	<p>Collaborative private vehicles should be able to provide the following information:</p> <p>Real time dynamic data (speed, position, current fuel consumption, hazard status, ABS/ESP activation, ...)</p> <p>Static data (vehicle type)</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Availability of the information
Relationship with other	No

requirements	
Potential conflicts	No
Risk analysis	Few vehicles may be equipped. This is not a problem for the experiments, but for the real uptake.
Status	New
Other	No

5.2 Collaborative co-modal route planning

Requirement ID:	SP3_REQ_COPLAN_01_v0.1
Name of requirement:	TEAM Messaging Protocol (TMP) compliance for TEAM inter-application communication and data exchange
Created by	Nicolas Gay (nicolas.a.gay@intel.com)
Assigned partner	All
Source (TEAM application or enabler)	COPLAN requires from SP4 applications that they are able to communicate and exchange data using the TMP facility
Requirement category	Application requirements
Goal	To ensure that data exchange and event signaling are accomplished using a unique basis (e.g. TMP)
Definition:	All SP4 applications will comply with TMP and will therefore include a module (code) to interface with the TMP facility. This will enable all TEAM applications to exchange messages and data using a common interface and defined / pre-established communication rules. In particular, COPLAN needs to be able to communicate with several SP4 applications, including CONAV.
Critical level (priority)	High

Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	All compliance tests to interface the TMP facility (communication architecture) are passed successfully. COPLAN can communicate with CONAV by issuing requests and receiving responses adhering to TMP requirements.
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	The TMP provides a common communication facility for all the TEAM applications as well.
Status	New
Other	No

5.3 Co-modal coaching with support from virtual/avatar users

The requirements of this application may be partially covered by the requirements of the "Collaborative co-modal route planning" application, because of the logical relationship among the two applications (planning -> coaching). Additional specific requirements follow.

Requirement ID:	SP3_REQ_CCA_02_v0.1
Name of requirement:	Avatar in-vehicle coaching HMI
Created by	Marco Bottero (Swarco Mizar)
Assigned partner	To be defined
Source (TEAM application or enabler)	Co-modal coaching with support from virtual/avatar users
Requirement category	Application requirements
Goal	To ensure that the driver will be coached by the Avatar when driving a private vehicle
Definition:	The coached drivers of the collaborative vehicles should

	be able to receive real-time information from the Avatar on the display of the car.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests and user acceptance
Acceptance criteria	The drivers should understand Avatar suggestions while driving
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	Integration in-vehicle is effective, but always involves a cumbersome operation. A secondary, less invasive option, considered in TEAM, is presented by performing the coaching through a mobile device (e.g. smartphone).
Status	New
Other	No

5.3.1 Requirements related to serious gaming

Requirement ID:	SP3_REQ_CCA_Rew
Name of requirement:	Assess the user's collaborative behaviour (for the gaming/community building application)
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Swarco
Source (TEAM application or enabler)	CCA
Requirement category	Relation with serious gaming and community building
Goal	To assess the user's collaborative behavior using the

	<p>application</p> <p>To allow the user to participate at the TEAM serious gaming and community building</p>
Definition:	<p>Different rewards (virtual coins) are awarded for different events/situations recognized by the use, like accidents, road closures, work areas, etc.</p> <p>Rewarding parameters may also include time of the day, timeliness, type of the road, etc.</p>
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	User tests
Acceptance criteria	User acceptance
Relationship with other requirements	SP3_REQ_CCA_Spe
Potential conflicts	No
Risk analysis	Lack of the functionality would leave the application without any serious game/community building component
Status	New
Other	None.

Requirement ID:	SP3_REQ_CCA_Rew
Name of requirement:	Assess the user's collaborative behaviour (for the gaming/community building application)
Created by	DITEN UniGe - Ref: franz@elios.unige.it
Assigned partner	Swarco
Source (TEAM application or enabler)	CCA

Requirement category	Relation with serious gaming and community building
Goal	Allow the user to spend some amounts of virtual coins (managed by the serious game/community building application) in order to access better application levels
Definition:	<p>The user can spend some amounts of virtual coins (managed by the serious game/community building application) in order to access better application levels</p> <p>Examples of acquirable levels include:</p> <ul style="list-style-type: none"> • Better bandwidth • Suggested directions for possible discovery • Better UI
Critical level (priority)	Medium
Validation Method (tests, indicators, performance bounds)	User tests
Acceptance criteria	User acceptance
Relationship with other requirements	SP3_REQ_CCA_Rew
Potential conflicts	No
Risk analysis	Lack of the functionality would leave the application without any serious game/community building component
Status	New
Other	None.

5.4 Collaborative smart intersection for intelligent priorities

5.4.1 Requirements related to vehicular data

Requirement ID:	SP3_REQ_CSI_7_v0.1
------------------------	--------------------

Name of requirement:	Vehicle data provider
Created by	Rafael Basso (VTEC)
Assigned partner	SP4
Source (TEAM application or enabler)	Collaborative Smart Intersections for Intelligent Priorities
Requirement category	Application requirements
Goal	To have all vehicle information needed for the application
Definition:	<p>The vehicle should be able to provide the following information:</p> <p>Real time dynamic data (speed, position, weight, load, number of passengers, etc)</p> <p>Static data (vehicle type, size, number of axels, fuel, etc)</p> <p>Schedule for distribution trucks and public transport (stops, time behind or ahead, etc)</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Satisfaction of the definition
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	This requirement is compulsory for the application.
Status	New
Other	No

5.4.2 Requirements related to driver coaching

Requirement ID:	SP3_REQ_CSI_6_v0.1
Name of requirement:	HMI
Created by	Rafael Basso (VTEC)
Assigned partner	SP4
Source (TEAM application or enabler)	Collaborative Smart Intersections for Intelligent Priorities
Requirement category	Application requirements
Goal	To ensure that the driver will be coached to drive eco-friendly
Definition:	The drivers of the vehicles should receive information about optimal speed range to cross the intersection in green, braking coaching and any additional information to optimize their driving in an eco-friendly way.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests and user acceptance
Acceptance criteria	The drivers should understand what is expected of them.
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	This requirement is compulsory for the final application. If it is not met, the application will still work in specific locations.
Status	New
Other	No

5.4.3 Requirements related to relationships with the other applications

Requirement ID:	SP3_REQ_CSI_8_v0.1
Name of requirement:	Collaborative ACC
Created by	Rafael Basso (VTEC)
Assigned partner	SP4
Source (TEAM application or enabler)	Collaborative Smart Intersections for Intelligent Priorities
Requirement category	Application requirements
Goal	To integrate this application with the C-ACC application
Definition:	The information about C-ACC mode, number and type of vehicles driving together should be available
Critical level (priority)	Low
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Integration of the C-ACC application
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	This requirement is optional for the application.
Status	New
Other	No

Requirement ID:	SP3_REQ_CSI_9_v0.1
Name of requirement:	Serious Games
Created by	Rafael Basso (VTEC)
Assigned partner	SP4
Source (TEAM application or enabler)	Collaborative Smart Intersections for Intelligent Priorities

enabler)	
Requirement category	Application requirements
Goal	To integrate this application with the Serious Games application
Definition:	The information about the driver points and priority should be available
Critical level (priority)	Low
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Meeting the definition
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	This requirement is optional for the application.
Status	New
Other	No

5.5 Collaborative public transport optimization

5.5.1 Requirements related to HMI

Requirement ID:	SP3_REQ_CPTO_10_v0.1
Name of requirement:	Smartphone HMI
Created by	ICCS
Assigned partner	SP4/HMI group
Source (TEAM application or enabler)	Collaborative Public Transport Optimization
Requirement category	Application requirements
Goal	To ensure that relevant information will be presented to the traveller (updated route, updated schedule etc.) and

	that also the traveller can input relevant information to the system via his/her smartphone device.
Definition:	A proper HMI (or GUI) on the traveller smartphone device to let the travellers enter/edit/review or delete relevant information about themselves that is needed in the CPTO context (Origin/Destination information incl. desired time of departure or arrival) and vice versa, let the cloud system display information about changes in the schedule and estimated time needed to reach their final destination etc.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	<ul style="list-style-type: none"> - Perform functional tests with the smartphone. - User acceptance tests.
Acceptance criteria	<ul style="list-style-type: none"> - The traveller can easily provide the needed information as input and get the expected output with travel recommendations. Hence an intuitive and easy to use smartphone HMI should be implemented. Fast entering of information through displaying of user's past preferences would be a nice feature if supported. - A connection to the cloud system status icon should be available in the smartphone HMI in order for the traveller to be aware whether sending/receiving of data is ongoing and if the connection is not possible.
Relationship with other requirements	No
Potential conflicts	Not yet identified
Risk analysis	<ul style="list-style-type: none"> - Responses of the HMI on traveller inputs should be very fast otherwise the traveller will stop using the CPTO application - CPTO HMI on the smartphone should be simple and easy to use in order not to increase significantly the traveller's workload.
Status	New
Other	No

Requirement ID:	SP3_REQ_CPTO_11_v0.1
Name of requirement:	Vehicle/Bus HMI

Created by	ICCS
Assigned partner	SP4/HMI group
Source (TEAM application or enabler)	Collaborative Public Transport Optimization
Requirement category	Application requirements
Goal	To ensure that relevant information will be presented to the public transport driver (updated route, updated schedule etc.)
Definition:	A proper HMI to communicate information from the public transport operator to the driver. The information to the driver will be the new routes and stops, possibly the number of passengers that will board the bus at the upcoming station, speed recommendations, expected time to the next and/or final destination etc. (alternatively this could be done with a smartphone like the one the travellers have which is running a slightly different application).
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Perform functional tests
Acceptance criteria	<ul style="list-style-type: none"> - The driver can easily understand what is the next action he/she should perform - A connection to the cloud system status icon may be available in the vehicle HMI in order for the driver to be aware whether receiving of data is on going and if the connection is not possible.
Relationship with other requirements	Related with SP4 HMI application requirements dealing with vehicle HMI (the relation is stronger if a single vehicle HMI should be shared among different SP3, SP4 applications).
Potential conflicts	Not yet identified
Risk analysis	<ul style="list-style-type: none"> - The HMI should help the driver understand easily the next action he should perform or it would be difficult to provide an elastic infrastructure application at the end - CPTO HMI in the vehicle should be simple and with intuitive design in order not to increase significantly the driver's workload.

Status	New
Other	No

5.5.2 Requirements related to data availability

Requirement ID:	SP3_REQ_CPTO_12_v0.1
Name of requirement:	Passenger data provider
Created by	NUIM
Assigned partner	Not yet defined
Source (TEAM application or enabler)	Collaborative Public Transport Optimization
Requirement category	Application requirements
Goal	To have all passenger information needed for the application
Definition:	<p>The following data should be obtained from all passengers:</p> <ul style="list-style-type: none"> • Location (where in the city are they and which travelling mode/ public transport vehicle are they using) • Destination, temporal restrictions • User preferences (static information: e.g. preference for open-air transport)
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	<p>The information provided by the passengers is dynamically and reliably updated.</p> <p>Privacy and security issues are taken into account in passenger data management system.</p>

Relationship with other requirements	<p>SP3_REQ_CPTO_10_v0.1 (HMI to get passenger data)</p> <p>Related to SP4 smartphone Application and Communication requirements.</p> <p>Possible relationship with other similar requirements from other applications</p>
Potential conflicts	No
Risk analysis	This requirement is compulsory for the application.
Status	New
Other	No

Requirement ID:	SP3_REQ_CPTO_13_v0.1
Name of requirement:	Public transport vehicle data provider
Created by	NUIM
Assigned partner	Not yet defined
Source (TEAM application or enabler)	Collaborative Public Transport Optimization
Requirement category	Application requirements
Goal	To have all vehicle information needed for the application
Definition:	<p>The following data should be obtained from all public transport vehicles:</p> <ul style="list-style-type: none"> • Available passenger spaces • Location, Speed and direction of vehicle • Available fuel and time
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests

Acceptance criteria	The information provided by the public transport vehicle is dynamically and reliably updated
Relationship with other requirements	Related to SP4 in-vehicle Application and Communication requirements
Potential conflicts	No
Risk analysis	This requirement is compulsory for the application.
Status	New
Other	No

5.5.3 Requirements related to community building/serious gaming

Requirement ID:	SP3_REQ_CPTO_14_v0.1
Name of requirement:	Social network integration
Created by	ICCS
Assigned partner	SP4 Serious gaming and community building group
Source (TEAM application or enabler)	Collaborative Public Transport Optimization
Requirement category	Application requirements
Goal	To integrate CPTO application with "Green, safe and collaborative serious game and community building" application
Definition:	<p>The information about the current status and the profile of the 197raveler/bus driver should be available.</p> <p>Reward (e.g. virtual coins) to the 197ravelers/bus drivers in case they are following the recommendations of the TEAM system and/or they are actively participating during their trip etc. should be defined.</p>
Critical level (priority)	Low/optional
Validation Method (tests, indicators, performance)	Functional tests

bounds)	
Acceptance criteria	The profile of the travellers (and possibly the bus drivers) has to be up to date. Also relevant information which is important for the gaming/social network aspects should be continuously updated e.g. virtual coins. The privacy aspects of the data shared among the involved people should be properly handled (this should be handled in "Green, safe and collaborative driving serious game and community building" together with SP2 security and privacy group)
Relationship with other requirements	Similar requirements will be provided by other TEAM applications for integrating the social network aspect
Potential conflicts	There are no conflicts foreseen at the moment for the integration of the social network aspect in this application
Risk analysis	This requirement is optional for the application and there is no risk for the rest of the CPTO functionalities if this is not implemented at the end
Status	New
Other	No

5.6 Dynamic collaborative corridors

5.6.1 Requirements related to driver coaching

Requirement ID:	SP3_REQ_DC_6_v0.1
Name of requirement:	HMI
Created by	Rafael Basso (VTEC)
Assigned partner	
Source (TEAM application or	Collaborative Dynamic Corridors

enabler)	
Requirement category	Application requirements
Goal	To ensure that the driver will be coached to drive eco-friendly and safely
Definition:	The drivers of the vehicles should be coached to perform lane merges in a safe and eco-friendly way.
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests and user acceptance
Acceptance criteria	The drivers should understand what is expected of them.
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	This requirement is compulsory for the application.
Status	New
Other	No

5.6.2 Requirements related to vehicular data availability

Requirement ID:	SP3_REQ_DC_7_v0.1
Name of requirement:	Vehicle data provider
Created by	Rafael Basso (VTEC)
Assigned partner	
Source (TEAM application or enabler)	Collaborative Dynamic Corridors
Requirement category	Application requirements
Goal	To have all vehicle information needed for the application

Definition:	<p>The vehicle should be able to provide the following information:</p> <p>Real time dynamic data (speed, position, weight, load, etc)</p> <p>Static data (vehicle type, size, number of axels, braking capacity, fuel, etc)</p> <p>Schedule for distribution trucks and public transport (stops, time behind or ahead, etc)</p>
Critical level (priority)	High
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Availability of data
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	This requirement is compulsory for the application.
Status	New
Other	No

Requirement ID:	SP3_REQ_DC_8_v0.1
Name of requirement:	Collaborative ACC
Created by	Rafael Basso (VTEC)
Assigned partner	
Source (TEAM application or enabler)	Collaborative Dynamic Corridors
Requirement category	Application requirements
Goal	To integrate this application with the C-ACC application

Definition:	The information about C-ACC mode, number and type of vehicles driving together should be available
Critical level (priority)	Low
Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Application integrated
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	This requirement is optional for the application.
Status	New
Other	No

5.6.3 Requirements related to the serious game application

Requirement ID:	SP3_REQ_DC_9_v0.1
Name of requirement:	Serious Games
Created by	Rafael Basso (VTEC)
Assigned partner	To be defined
Source (TEAM application or enabler)	Collaborative Dynamic Corridors
Requirement category	Application requirements
Goal	To integrate this application with the Serious Games application
Definition:	The information about the driver profile, driver points and priority should be available
Critical level (priority)	Low

Validation Method (tests, indicators, performance bounds)	Functional tests
Acceptance criteria	Integrated applications
Relationship with other requirements	No
Potential conflicts	No
Risk analysis	This requirement is optional for the application.
Status	New
Other	No

6 DIALOGUE Enablers

This section shows the enablers that have been identified based on the above requirements for SP4 (from both SP3 and SP4 applications) and the requirement-enabler mapping, according to the methodology described in subsection 2.2.

A short description of each identified enabler is provided, highlighting the originating requirements. Enablers are grouped in four main areas:

- Human-Machine Interaction
- Vehicle signals and data processing and connectivity
- Driver/passenger and vehicle models
- Social networking

An additional "miscellaneous" area has been added as well.

6.1 Human-Machine Interaction (HMI)

Type	Enabler	Associated requirements
Algorithm Enablers	HMI prioritization: a component to prioritize the different messages to the driver (also collaborative map information) and suppress/delay less important information in order not to overload the driver	SP4_REQ_SGCB_CmapUI SP4_REQ_EFP_DATATYPE _WAYPOINTS_INT_v0.1 SP4_REQ_EFP_DATATYPE _NAVCOMPROUTE_INT_v0.1 SP4_CDM_R_00019 SP4_CDM_R_00033 SP4_CDM_R_00036 SP4_CDM_R_00044 SP4_CDM_R_00051
	Driver coaching: a component that takes all TEAM applications active and based on their input calculates driver coaching parameters such as recommended speed.	SP4_CDM_R_00019 SP4_CDM_R_00033 SP4_CDM_R_00036 SP4_CDM_R_00044 SP4_CDM_R_00051

		SP4_CDM_R_00053 SP4_REQ_SGCB_Co SP3_REQ_DC_6_v0.1
Tools Enablers	Interactive collaborative map , where travellers can post and read various types of aggregated data	SP4_REQ_SGCB_CmapUI SP4_REQ_SGCB_PoDCM SP4_REQ_EFP_DATATYPE _WAYPOINTS_INT_v0.1 SP4_REQ_EFP_DATATYPE _NAVCOMPROUTE_INT_v0.1
	Map visualization: visualization of data about the drive and from travellers (also including geo- tagging and geo-messaging by drivers and passengers)	SP4_REQ_SGCB_CmapUI SP4_REQ_SGCB_DisPer SP4_REQ_CONAV_SP4_17 SP4_REQ_EFP_DATATYPE _WAYPOINTS_INT_v0.1 SP4_REQ_EFP_DATATYPE _NAVCOMPROUTE_INT_v0.1
	Appealing Human-Machine Interaction consistent with the other TEAM applications, including vocal interface, on a vehicle (also a bus for applications related to public transport). This includes the possibility of showing new types of information, such as status of the TEAM applications, area pollution levels, timing of the next green light at the traffic-light, accident warning messages, the animated figure of an avatar coaching the driver, etc. It also includes the possibility for the user to enter, edit and review	SP4_REQ_SGCB_VHMI SP4_REQ_CACC_HMI_v0.1 SP4_REQ_CONAV_SP4_01 SP4_REQ_CONAV_SP4_02 SP4_REQ_CONAV_SP4_03 SP4_REQ_CONAV_SP4_13 SP3_REQ_CCA_02_v0.1 SP3_REQ_CPTO_11_v0.1 SP4_CDM_R_00019 SP4_CDM_R_00033 SP4_CDM_R_00036

	vehicle/driver/route characteristics and preferences.	SP4_CDM_R_00044 SP4_CDM_R_00051
	Virtual coin account interface module in order for the user to see his amount of virtual coins and spend them to acquire upgraded levels of service	SP4_REQ_CONAV_SP4_10
	Appealing Human-Machine Interaction consistent with the other TEAM applications, including vocal interface, on a smartphone. It also includes the possibility for the user to enter, edit and review traveller/route characteristics through the smartphone	SP4_REQ_SGCB_SPHMI SP4_REQ_SGCB_DisPer SP3_REQ_CPTO_10_v0.1 SP4_REQ_EFP_HMI_PARK_INT_v0.1 SP4_REQ_EFP_HMI_LEAVE_INT_v0.1 SP4_REQ_EFP_HMI_PARKREQ_INT_v0.1 SP4_REQ_EFP_HMI_BOOKREQUEST_INT_v0.1 SP4_REQ_EFP_HMI_USERFEEDBACK_INT_v0.1 SP4_REQ_EFP_INPUT_DESPARKINGLOC_INT_v0.1 SP4_REQ_EFP_ACT_USERFEEDREQ_INT_v0.1 SP4_REQ_EFP_ACT_USERFEEDTIMEOUT_INT_v0.1 SP4_REQ_EFP_GRAPHIND_v0.1
	Map Graphics. Possibility of building the SGCB applications seamlessly above existing map graphics (e.g., Nokia, google maps)	SP4_REQ_SGCB_CmapUI SP4_REQ_EFP_DATATYPE_WAYPOINTS_INT_v0.1 SP4_REQ_EFP_DATATYPE_NAVCOMPROUTE_INT_v0.1

		SP4_REQ_EFP_GRAPHIND_v0.1
	Turn-by-turn navigation. For routing applications, turn-by-turn navigation is required. The enabler would receive a route from a navigation application and translates it to turn-by-turn instruction.	SP4_REQ_CONAV_SP4_17

6.2 Vehicle signals and data processing and connectivity

Type	Enabler	Associated requirements
Algorithms enablers	GLOSA (Green light optimized speed advisory) algorithm that helps to find the optimal speed to pass the next traffic lights during a green phase	SP3_REQ_CSI_6_v0.1
	Safe routing: Algorithm to calculate routes based on different inputs and constraints.	SP4_CDM_R_00018 SP4_CDM_R_00034 SP4_CDM_R_00035 SP4_CDM_R_00039 SP4_CDM_R_00044 SP4_CDM_R_00051 SP4_CDM_R_00052
Tools enablers	Data distribution module: Module which transmits the vehicle data to a hub and the hub distributes them to the relevant applications (in order to optimize wireless bandwidth consumption)	SP4_REQ_SGCB_VSDB SP3_REQ_CMC_06_v0.1 SP4_REQ_EFP_INPUT_VEHICLEDATA_INT_v0.1 SP4_REQ_EFP_INPUT_VEHPOS_INT_v0.1 SP4_REQ_EFP_INPUT_LOCMEANS_INT_v0.1

		<p>SP4_REQ_EFP_INPUT_LOCACCURACY_INT_v0.1</p> <p>SP4_REQ_PRO_LOCPROCESS_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERPARKINFER_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERLEAVEINFER_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERBOOKINFER_INT_v0.1</p> <p>SP4_REQ_EFP_ACT_PARKINDREQ_INT_v0.1</p> <p>SP4_REQ_EFP_ACT_PARKBOOKREQ_INT_v0.1</p> <p>SP4_REQ_EFP_DATATYPE_PARKINDREQTYPE_INT_v0.1</p> <p>SP3_REQ_DC_8_v0.1</p>
	CAN-smartphone gateway in order to get real-time signals from the vehicle	<p>SP3_REQ_SGCB_VNwSp</p> <p>SP4_REQ_EFP_INPUT_VEHICLEDATA_INT_v0.1</p> <p>SP4_REQ_EFP_INPUT_VEHPOS_INT_v0.1</p> <p>SP4_REQ_EFP_INPUT_LOCMEANS_INT_v0.1</p> <p>SP4_REQ_EFP_INPUT_LOCACCURACY_INT_v0.1</p> <p>SP4_REQ_PRO_LOCPROCESS_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERPARKINFER_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERLEAVEINFER_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT_v0.1</p>

		<p>SP4_REQ_EFP_PRO_USERBOOKINFER_INT_v0.1</p> <p>SP4_REQ_EFP_ACT_PARKINDREQ_INT_v0.1</p> <p>SP4_REQ_EFP_ACT_PARKBOOKREQ_INT_v0.1</p> <p>SP4_REQ_EFP_ACT_USERFEEDREQ_INT_v0.1</p> <p>SP4_REQ_EFP_ACT_USERFEEDTIMEOUT_INT_v0.1</p> <p>SP4_REQ_EFP_DATATYPE_PARKINDREQTYPE_INT_v0.1</p>
	<p>Vehicle data collector and provider: A signal real-time database providing access to vehicle data from the vehicular networks. Sample signals include: longitudinal acceleration sensor, engine torque request, current gear, gear shift request, braking force, fuel consumption, etc. It should avoid direct access to the CAN (or other vehicular signals/networks), preventing IPR issues. Signals must be time-stamped.</p>	<p>SP4_REQ_SGCB_VSDB</p> <p>SP4_REQ_SGCB_TSTA</p> <p>SP4_REQ_CACC_UC5_v0.1</p> <p>SP4_REQ_CONAV_SP4_04</p> <p>SP3_REQ_CMC_06_v0.1</p> <p>SP3_REQ_CSI_7_v0.1</p> <p>SP2: SP2_REQ_OTH_9</p> <p>SP4_REQ_EFP_INPUT_VEHICLEDATA_INT_v0.1</p> <p>SP4_REQ_EFP_INPUT_VEHPOS_INT_v0.1</p> <p>SP4_REQ_EFP_INPUT_LOCMEANS_INT_v0.1</p> <p>SP4_REQ_EFP_INPUT_LOCACCURACY_INT_v0.1</p> <p>SP4_REQ_PRO_LOCPROCESS_INT_v0.1</p> <p>SP3_REQ_DC_7_v0.1</p> <p>SP4_REQ_EFP_PRO_USERPARKINFER_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERLEAVEINFER_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT</p>

		_v0.1 SP4_REQ_EFP_PRO_USERBOOKINFER_INT _v0.1 SP4_CDM_R_00040
	Vehicle actuator arbiter A component which arbitrages the input for acceleration, deceleration, emergency braking, coming from all CACC use cases as well as from CDM and passes it to the vehicle.	SP4_REQ_CACC_ARBITER_v0.1 SP4_CDM_R_00009
	Object Tracking and prediction: this tool support the application of driving and merging by determining the presence of object and predicting the time when the vehicle will meet a road restriction. The function also shall detect need for emergency break	SP4_CDM_R_00011 SP4_CDM_R_00014 SP4_CDM_R_00028 SP4_CDM_R_00040 SP4_CDM_R_00042 SP4_CDM_R_00045 SP4_CDM_R_00047
	Driver route and intention prediction: A component that is able to predict the route of the driver based on the planned route and on the driving behaviour.	SP4_CDM_R_00037

6.3 Driver/passenger and vehicle models

Type	Enabler	Associated requirements
Data Enablers	Driver model a model of the driver so that all his features relevant to safe and green driving can be stored and processed also	SP4_REQ_SGCB_DriPerDaFu SP4_REQ_CONAV_SP4_09 SP4_REQ_CONAV_SP4_11

	for a performance evaluation	SP4_CDM_R_00036
	Passenger data provider (PDP): a module for storing and transmitting data from passengers on public transport means.	SP3_REQ_CPTO_12_v0.1 SP3_REQ_DC_9_v0.1
	Public transport means data provider: a module for collecting and transmitting information from the public transport vehicle.	SP3_REQ_CPTO_13_v0.1
	Vehicle model a parametric, rule-based abstract model of the vehicle so that driver coaching for green/safe driving can be made vehicle-independent. The abstract model should be instantiated in executable instances (one for each vehicle type), reflecting the actual features of that vehicle	SP4_REQ_SGCB_Vmod SP4_REQ_SGCB_VmodInst SP4_REQ_SGCB_GdrSco SP4_REQ_CONAV_SP4_03 SP4_REQ_CONAV_SP4_04 SP3_REQ_CMC_06_v0.1 SP4_REQ_EFP_INPUT_VEHICLEPROFDATA_INT_v0.1 SP4_CDM_R_00038 SP4_CDM_R_00049
Algorithm Enablers	User profiling and assessment module able to quantitatively assess in real-time the driver performance, with respect to some particular targets, such as green and safe driving	SP4_REQ_SGCB_DriPerDaFuAv SP3_REQ_SGCB_DrPro SP4_REQ_CONAV_SP4_09 SP4_REQ_EFP_HMI_LEAVE_INT_v0.1 SP4_REQ_EFP_HMI_PARKREQ_INT_v0.1 SP4_REQ_EFP_HMI_BOOKREQUEST_INT_v0.1 SP4_REQ_EFP_HMI_USERFEEDBACK_INT_v0.1 SP4_REQ_EFP_INPUT_USERPROFDATA_

		INT_v0.1 SP4_REQ_EFP_ACT_USERFEEDREQ_INT_v0.1 SP4_REQ_EFP_ACT_USERFEEDTIMEOUT_INT_v0.1
	Driver coaching module able to give the driver formative feedback in real-time about his driving performance (according to green and safe drive criteria)	SP4_REQ_SGCB_Co
	Vehicle Manoeuvre Computation: algorithms that compute vehicle manoeuvres in different conditions; while this module is application specific, it may need to interface various system part; it include lane choice, speed profile; breaking	SP4_CDM_R_00031 SP4_CDM_R_00032 SP4_CDM_R_00034 SP4_CDM_R_00035 SP4_CDM_R_00039 SP4_CDM_R_00048 SP4_CDM_R_00051 SP4_CDM_R_00054
Tools Enablers	Eco-profiler/evaluator. A tool for measuring and assessing in real time the driver's ecological performance	SP4_REQ_SGCB_DriPerDaFu SP4_REQ_SGCB_VmodInst SP4_REQ_CONAV_SP4_09 SP3_REQ_CMC_06_v0.1 SP4_REQ_EFP_INPUT_USERPROFDATA_INT_v0.1

6.4 Social networking

Type	Enabler	Associated requirements
Data Enablers	Map data aggregation module: A mapping system able to aggregate and collaboratively	SP4_REQ_SGCB_Cmap SP4_REQ_EFP_HMI_PARK_INT_v0.1

	manage highly dynamic social information layers in the cloud (also including geo-tagging and geo-messaging by drivers and passengers)	SP4_REQ_EFP_HMI_LEAVE_INT_v0.1 SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1 SP4_REQ_EFP_PRO_USERPARKINFER_INT_v0.1 SP4_REQ_EFP_PRO_USERLEAVEINFER_INT_v0.1 SP4_REQ_EFP_ACT_USERFEEDREQ_INT_v0.1 SP4_REQ_EFP_ACT_USERFEEDTIMEOUT_INT_v0.1
Algorithm Enablers	Matching module A module that scouts the users' profiles in order to identify common interests and suggest friends	SP4_REQ_SGCB_SIG SP4_REQ_SGCB_FRID SP4_REQ_EFP_PRO_USERINPUTPROCESS_INT_v0.1
Tools Enablers	Collaboration management system identification of common interests by users. Possibility of shared annotation/comments	SP4_REQ_SGCB_BSN SP4_REQ_EFP_HMI_PROFUPDATE_INT_v0.1 SP4_CDM_R_00036
	User/friendship management system (for which state of the art open source solutions may be integrated and adapted, such as elgg)	SP4_REQ_SGCB_BSN
	Credibility management system (for which the ITS 2.0 solution by the Telecom Italia TEAM partner could be a proper starting point)	SP4_REQ_SGCB_Cmap SP4_REQ_SGCB_PoDCM SP4_REQ_EFP_HMI_PARK_INT_v0.1 SP4_REQ_EFP_HMI_LEAVE_INT_v0.1 SP4_REQ_EFP_REGISTRATION_INT_v0.1 SP4_REQ_EFP_HMI_PROFUPDATE_INT_v0.1 SP4_REQ_EFP_INPUT_USERPROFDATA_

		<p>INT_v0.1</p> <p>SP4_REQ_EFP_ PRO_USERINPUTPROCESS_INT_v0.1</p> <p>SP4_REQ_EFP_PRO_USERPARKINFER_INT _v0.1</p> <p>SP4_REQ_EFP_PRO_USERLEAVEINFER_INT _v0.1</p> <p>SP4_REQ_EFP_PRO_USERPPARKINDINFER_INT _v0.1</p> <p>SP4_REQ_EFP_PRO_USERBOOKINFER_INT _v0.1</p> <p>SP4_REQ_EFP_ACT_USERFEEDREQ_INT_v0.1</p> <p>SP4_REQ_EFP_ACT_USERFEEDTIMEOUT_INT _v0.1</p>
--	--	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

6.5 Miscellaneous

Type	Enabler	Associated requirements
Data Enablers	Multimodal transport ontology as basis for the communication and collaboration	<p>SP4_REQ_SGCB_Cmap</p> <p>SP4_REQ_EFP_ACT_PARKINDREQ_INT _v0.1</p> <p>SP4_REQ_EFP_ACT_PARKBOOKREQ_INT _v0.1</p> <p>SP4_REQ_EFP_DATATYPE_ PARKINDREQTYPE_INT_v0.1</p>

7 Conclusions

The work in this WP started from the high level application and use case descriptions that were provided in D1.0 and continued with an ever more in depth reflection on the single applications and analysis of the implications in terms of requirements about data, protocols, storage and functionalities.

This deliverable has defined the TEAM applications' requirements that are related to SP4. In particular, 113 requirements were collected from the five SP4 applications and 18 from the six SP3 applications. This unbalance can be explained by the fact SP4 applications are more related to vehicular and mobile technologies, while SP3 to infrastructure.

Once the requirements were ready for every single application, we performed an aggregation and harmonization step, through the identification of enablers, that group sets of homogeneous functionalities that could be shared among different TEAM applications. We have identified enablers in four main areas, such as HMI, vehicle signals and data processing and connectivity, driver/passenger and vehicle modelling and social networking. A total of 31 enablers have been identified (6 of data type, 8 of algorithm type and 17 of tool type), and the mapping with the originating requirements has been reported.

Integration with SP3 applications requirements and specifications is critical and shall be adequately addressed (both from SP3 and SP4 side) in the forthcoming phases of the project, in particular in view of a common architecture definition, also including the SP2 technological modules. The work in WP4.3, particularly through the IR4.3.1 ("Requirements to SP2 and SP3") and the definition of the enablers, has represented a first significant step moving from several "single-application-centric" views to a more concrete "TEAM-system-centric" view.

The work done insofar has been necessary to enable and feed the next steps of the project, that will concern the specification of the system's actual modules and functionalities (WP4.3) and, thus, the architecture design (WP4.4).

In this view, this deliverable represents a fundamental intermediate step between the definition of the applications' use cases – which was done in IR4.2.1 (Internal Report) and D1.0 – and the definition of the SP4 specifications, that is being done in WP4.3 (IR4.3.3), and the overall architecture and application design, that will be done in WP4.4 (D4.4.1 and D2.0).

List of abbreviations and acronyms

Abbreviation	Meaning
ACC	Autonomous Cruise Control
ADAS	Advanced Drive Assistance Systems
API	Application Programming Interface
C-ACC	Collaborative ACC
CAN	Controller Area Network
CB	Community Building
CCA	Co-modal coaching with support from virtual/avatar users
CDM	Collaborative Driving and Merging
CMC	Collaborative pro-active urban/inter-urban monitoring and ad-hoc control
CONAV	Collaborative eco-friendly navigation
COPLAN	Collaborative co-modal route planning
CPTO	Collaborative public transport optimization
CSI	Collaborative smart intersections for intelligent priority
DC	Dynamic Corridors
EFP	Eco-Friendly Parking
FCD	Floating Car Data
HMI	Human-Machine Interface
IP	Intellectual Property
ITS	Intelligent Transportation System
LDM++	Local Dynamic Map, enhanced
LTE	Long Term Evolution
OBU	On Board Unit
RPM	Revolutions per minute
RSU	Road Side Unit
SG	Serious game
SG-CB	Serious gaming and community building
SP	Sub-project
TMC	Traffic Message Channel
UML	Unified Modelling Language
UTMC	Urban Traffic Management and Control
V2X	Vehicle-to-X (Vehicle or Infrastructure)
WP	Work Package
xFCD	Extended Floating Car Data