Cooperative Mobility Systems and Services for Energy Efficiency

D3.2	Functional architecture and specifications for ecoSmartDriving & ecoTripPlanning

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Workpackage No.	**3.3**	**Workpackage Title**	**Architecture & System Specifications**
Task No.	**3.3.1**	**Task Title**	**Application and functional architecture and specification: ecoSmartDriving & ecoTripPlanning**
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Abstract	The ecoSmartDriving sub project is focused on helping the driver of a passenger car to plan a trip in the most energy efficient way and to drive on the planned route in the most fuel efficient way. At the end of the trip, the ecoSmartDriving helps the driver to analyse how the driving behavior influences fuel consumption of the vehicle. This document, together with the companion D3.3, defines the architecture of the ecoSmartDriving applications, which is the result of the work package 3 of SP3 sub project. It has been organized in cooperation with the work package 3 of the sub project 2, which had the role of coordinating all the other sub projects. The starting points of the architecture design were the use cases & requirements defined in the previous work package 2. The architectures of the applications were then designed sequentially, from the system level design to the architectural design. The first designs each application as a set of black boxes interacting and interfacing among them and with other black boxes provided by external applications (present on road side units and traffic control centers). The second layer of design inspected the single black boxes to show how they will be expanded in multiple functions to be then implemented in the next work package 4. The applications have been split in the two deliverables of the work package 3: this deliverable D3.2 includes the applications of the pre trip and on trip phases: ecoTripPlanning, ecoNavigation, ecoDrivingSupport, ecoInformation. Additionally, the D3.2 includes also the design of the ecoCooperativeHorizon service, which is used by all applications to retrieve the information about the vehicle neighboring.

Control sheet

Version history			
Version	**Date**	**Main author**	**Summary of changes**
0.1	16-11-2010	M. De Gennaro (Magneti Marelli)	Initial template from the common template of D2.2
0.2	01-12-2010	L. Bersiner (Bosch)	First Input to Ch.1,3,6
0.3	04-01-2011	M. De Gennaro (Magneti Marelli)	Revision of the entire deliverable: contents of Ch.1,3,5,6.
0.4	10-01-2011	F. Tosetto, M. De Gennaro (Magneti Marelli)	Revision of Business Layer, Application Layer and Technology Layer of CheckingVehicleCondition. Revision of Chapter 4 as format only (not reviewed the AL and TL diagrams of other applications).
0.5	12-01-2011	L. Bersiner (Bosch)	Text edition, AL and TL diagrams update, Traceablity update
0.6	18-01-2011	M. De Gennaro (Magneti Marelli), A. Colabufo (CRF), R. Blanco (CTAG)	Updated BL,AL, TL of ecoTripPlanning, ecoCooperativeHorizon and ecoInformation. Removed CheckingVehicleConditions because it has been integrated in ecoInformation. Updated the last available diagrams of ecoDrivingSupport and ecoNavigation, still to be closed with the applications owners.
0.7	20-01-2011	L. Bersiner (Bosch)	Revised up to Ch3.1
0.8	20-01-2011	M. De Gennaro (Magneti Marelli), S. Damiani (CRF)	Updated BL, AL, TL and traceability matrix of ecoDrivingSupport application. Inserted some comments.
0.9	20-01-2011	T. Uhrner (IKA)	Added description of ecoDriving Recommendations creator component in AL-description of ecoDriving Support
0.10	25-01-2011	F. Tosetto (Magneti Marelli)	Alignments the traceability matrix content

0.11	26-01-2011	L. Bersiner (Bosch)	ecoNavigation reviewed BL-AL-TL graphs with vehicle data collection
0.12	01-02-2011	F. Tosetto (Magneti Marelli)	Added paragraph 3.4 Use Cases covered by Applications.
0.13	01-02-2011	M. De Gennaro (Magneti Marelli)	Updated AL diagrams of ecoTripPlanning and ecoInformation, updated all diagrams of ecoNavigation.
0.14	02-02-2011	L. Bersiner (Bosch)	
0.15	02-02-2011	F. Tosetto (Magneti Marelli)	Update the ecoNavigation traceability matrix
0.16	04-02-2011	L. Bersiner (Bosch)	Appendix with references to General Object Exchange Tables. Reference to Appendix in Ch. 5
0.17	07-02-2011	M. De Gennaro, F.Tosetto (Magneti Marelli)	Update of the Appendix, Review of the entire Deliverable.
0.18	08-02-2011	P. Themann (IKA)	Review of ecoDrivingSupport
0.19	11-02-2011	M. De Gennaro (Magneti Marelli)	Update of the deliverable with the modification proposed by SP3 partners. Added a SP3 requirements table as annex C.
0.20	16-02-2011	S. Damiani (CRF), L. Bersiner (Bosch)	Update of the Terms and Definitions table
0.21	16-02-2011	M. De Gennaro (Magneti Marelli)	Review of the deliverable using comments from partners, added abstract.
1.0	11-03-2011	M. De Gennaro (Magneti Marelli)	Update of the deliverable using the peer review.
1.1	29-08-2011	L. Bersiner	Revision following annual review.
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Terms and definitions

Term	Abbr.	Definition
Application Layer	AL	Diagram used to design an application as collection of interacting functions.
Business Layer	BL	Diagram used to design an application at high layer, defining the users, the events, the processes and the services involved in the application.
Configuration Item	CI	a collective term used for referring to both software configuration items (a group of software treated as a single entity: operating systems, drivers, system software layers, databases, applications) and hardware configuration items (a set of hardware treated as a single entity: processors, storage devices, network cards, radio antennas, GPS receivers).
database	DB	an organized collection of data for one or more uses
developer		one who programs or designs the system to match the requirements of the project
eCoMove Modeling Language	eML	Modeling language used to design the architecture of the applications
eco Floating Vehicle Data	ecoFVD	Eco Data about individual vehicles, to be transmitted by V2X communications
ecoCooperativeHorizon		logical view of the road ahead of the vehicle, addresses both service and data object
ecoRecommendations		Output provided by ecoTripPlanning, ecoDrivingSupport, and ecoInformation applications
ecoRoute		Route provided by ecoNavigation application
ecoSituationalModel		Service to supply different applications with information on current and predicted vehicle and traffic states.
interface		a point of interaction between two systems
In Vehicle Data		A subset of vehicle data stored in temporary memory for two main purposes: temporary (trip) data history; exchange within applications or services
Most Probable Path	MPP	Sequence of the most likely successor links to current position
OEM Gateway		Component used for access to vehicle data
Out of Car Data		A set of data related to the trip planning out of the car.
Route advice		recommendations which parts of the road network to use or not to use, provided by TCC/TMC
service		a set of related software functionalities, together with the policies that should control its usage
situational data		Short-range data describing the local traffic situation. Current data and/or predictions for a short time scale (seconds to minutes). Received

		by V2I communications from roadside units, or computed locally by the ecoSituationalModel from ecoFVD.
system		a set of interacting or interdependent entities forming an integrated whole
Technology Layer	TL	Diagram used to design an application at lowest level as software bundle with several modules.
Traffic Control Center/ Traffic Management Center	TCC/TMC	Provider of long-range data describing flow
Traffic information		long-range data describing flow patterns and traffic events. Can be current data or predictions for a medium time scale (in the order of hours), provided by TCC/TMC
Trip Data Set		a subset on In Vehicle data or data obtained from them. The driver characteristic are also part of this data set. The purpose of these data is mainly related to a long term memory for different purposes (i.e. maintenance, ecoPoint collections, list of previous destination, other to be defined).
Vehicle data		Data obtained mainly via OEM gateway
Vehicle parameters		set of data used to describe the main vehicle characteristic that have relevance for the eco guidance

1. Scope

1.1. Identification

This deliverable D3.2, together with the companion D3.3, describes the architecture of the eCoMove SP3 applications.

In D3.2 the focus will be on preTrip and onTrip applications: they are synthetized with ecoTripPlanning and ecoSmartDriving, but then they are split in more specific applications: ecoTripPlanning, ecoNavigation, ecoDrivingSupport and ecoInformation.

In D3.3 the focus will be on the postTrip applications: ecoPostTrip and ecoMonitoring.

The set of applications described in the present deliverable is shown in the upper layer of Figure 1, where the applications themselves are colored in dark green. The representation refers to the identical view in D3.1 [1].

The current deliverable includes also the description of the ecoCooperativeHorizon service, which is a crucial service developed within SP3 and used within eCoMove also in other SPs. It is again highlighted in green in the Figure 1.

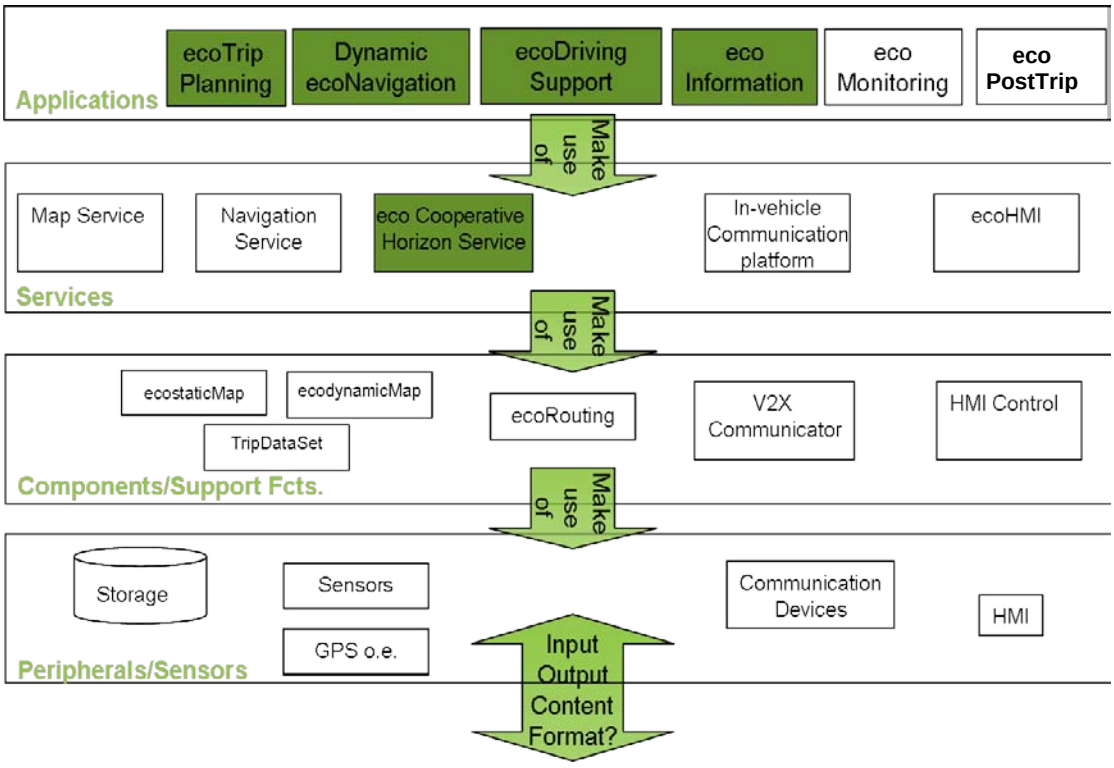


***Figure 1**: SP3 applications and components*

The deliverable D3.2 addresses the concepts and solutions of the architecture and the specifications as represented in the V - Diagram of overall eCoMove process in Figure 2, as far as used for the ecoSmartDriving & ecoTripPlanning applications. Further, this document completes the system concept description given in D3.1.

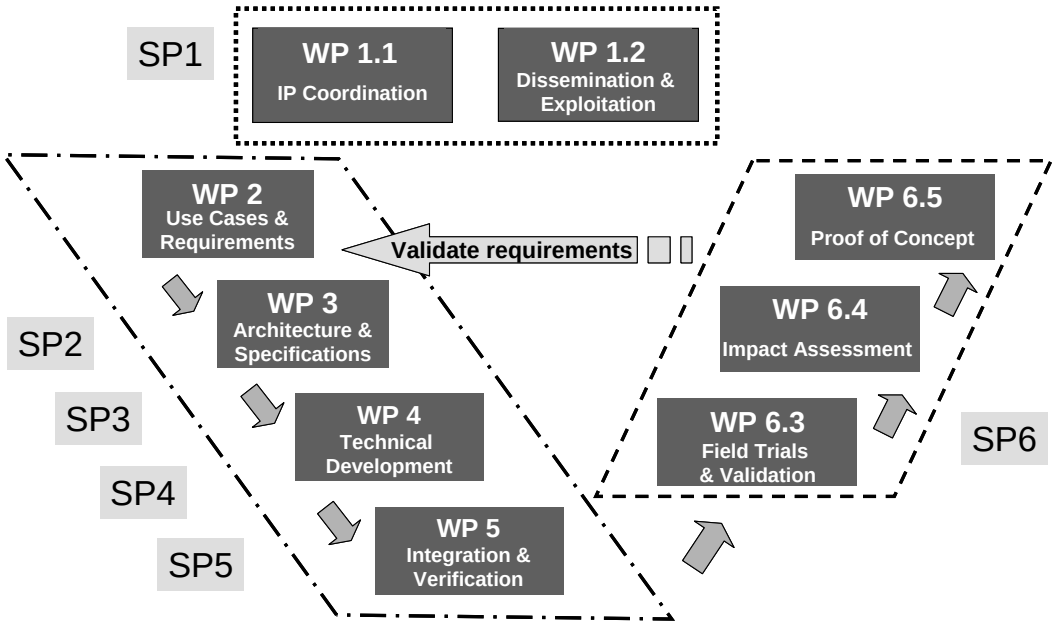


Figure 2: V-Diagram of overall eCoMove process

1.2. System overview

The ecoSmartDriving system is composed of three applications:

- dynamic **ecoNavigation** integrates the information from the traffic centre, from other vehicles, from ecoMaps and the ecoCooperativeHorizon in routing and guidance functionalities. This application not only helps the driver to find the least fuel consuming route and guide him / her to drive on this route, but also dynamically adjusts the route to changes in the road network and traffic load, as well as guides the driver on the best lane for as low as possible fuel consumption.
- **ecoDriving Support** dynamically provides suggestions to drivers how to drive eco-friendly depending on traffic situations – location – road - environment, on driving tasks and strategies, on driver's driving style, on driver's motivations, on vehicle typology and fuel usage. The essence of the system is that it is a forward looking eco driving assistance function that provides dynamic advices in a medium-to-long time perspective on how to drive (e.g. suggested advance speed, gear, acceleration, deceleration consumption prediction). The current position and the heading of the vehicle are provided by a navigation system to the ecoCooperativeHorizon; a destination is useful but not necessarily needed. Information and feedbacks will be provided via multimodal (visual,

acoustical or haptic) interfaces that may be applied to primary or secondary driving commands using for example the gas pedal or a display. The ecoCooperativeHorizon is an important information source for this application.

- **ecoInformation** supports the driver to identify and avoid inefficiencies due to non-optimal vehicle conditions when being in pre trip and on trip (e.g. check of the oil / filters, use of air conditioning, changes in tyre pressure, driving with windows open...).

ecoTripPlanning will enable ecoRouting complemented with information relevant for reduction of fuel consumption like suggested time slot. Results of the routing will be transferable to an in-car system. This application will be designed to be operational on nomadic device too, so that instead of transferring route data to an in-car system the nomadic device can be put into the car.
In more detail: for given start and destination points and for defined time window for departure or arrival the ecoTripPlanning calculates optimal start time and optimal route; the optimisation goal is to minimise impact of the journey to the environment in terms of CO_2-emissions and fuel consumption. The ecoTripPlanning is based on ecoMap, car characteristics as well as traffic predictions. Thus the ecoTripPlanning will offer:

- off-line ecoRouting, that calculates the optimal route to minimise fuel consumption based on eco map data and traffic state prediction information.
- off line information to the driver of expected journey and arrival time integrated with info from traffic predictions.

1.3. Document overview

1.3.1. Intended Audience

This document will address concepts and solutions for the development of the architecture and the specifications that will be used for the ecoSmartDriving & ecoTripPlanning applications. As such it addresses the developer for whom it provides information about the entities to be developed.

1.3.2. Document Structure

Chapter 2 lists referenced documents.

Chapter 3, System-wide design decisions, gives high level representations of the pre-trip and on-trip applications, using the Business Layer diagrams. The purpose is to give a general but complete representation in terms of roles, services, processes and objects necessary to provide the intended functionalities of the applications. From this view interfaces to other

applications also from other subprojects are identified (and specified below in this document)

Chapter 4, System Architectural Design, gives a more interior view for each application. Application internal services and processes are represented with more details in the Application Layer representations and broken down to components in the Technology Layer representations.

Chapter 5, Interface Design, gives an overview over the objects to be handled among applications from different sub-projects.

Chapter 6 gives references of use cases and requirements identified in the previous deliverable to the applications as described above. This serves to make sure of requirements coverage.

Then, three Appendices have been placed to represent the interaction of the SP3 applications.
Appendix A - List of General Object Exchange Tables, shows for each SP3 application described in the present deliverable, the set of used inputs and provided outputs.
Appendix B - Diagrams including all applications shows two general diagrams including all SP3 applications and their relations.
Appendix C - SP3 requirements, summarizes the requirements for the applications of SP3, which come from [1]

2. Referenced documents

[1] Eikelenberg, N. e.a., D3.1 Use cases and requirements for ecoSmartDriving (SP3), eCoMove-project deliverable, October 2010. https://service.projectplace.com/pp/pp.cgi/d536525587/100927-DEL-D3.1-ecoSmartDriving-Use-cases-and-System-Requirements-v08.pdf?save_as=1

[2] Schmits T., Traceability Matrix (SP2), available at: https://service.projectplace.com/pp/pp.cgi/d551990917/101213-DOC-Traceability_Matrix_template-TS.xls?save_as=1

[3] Schmits T, D2.2 High Level Architecture, in submission.

3. System-wide design decisions

The System-wide design has the objective to define the functional architecture of the SP3 applications in terms of configuration items which will be connected each other, exchanging some useful data related to the vehicle itself, and eventually to other vehicles, infrastructures, traffic information, and so on. This first design thus helps to highlight the possible connection between the vehicle applications and the applications coming from external sources. The interactions will be exploited then in Chapter *5.*

The description of the single applications has been done using a common instrument for design, which is eML(eCoMove Modeling Language). The eML tool allows showing for each function, who are the involved actors, which processes are executed with their own inputs/outputs, and how these processes are implemented using functions and finally components.

All technical SubProjects of eCoMove use eML to model their applications, thus it has been defined a color coding to represent the objects of the single subprojects.

The complete description of eML is present in [3], while in the next Figures are reported the concepts used to model the applications at all layers, Business, Application, Technology and to represent the interfaces.

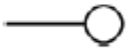
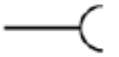
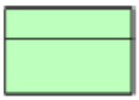
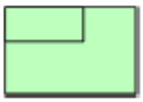
Concept	Description	Notation
Business process	A unit of internal behavior or collection of causally related units of internal behavior intended to produce a defined set of products and services.	
Business event	Something that happens (internally or externally) and influences behavior.	
Business actor	An organizational entity that is capable of performing behavior.	
Business role	A named specific behavior of a business actor participating in a particular context.	
Business service	An externally visible unit of functionality, which is meaningful to the environment and is provided by a business role.	
Business Interface, Provided	Declares how a business role can connect with its environment: provides the interface	
Business Interface, Required	Declares how a business role can connect with its environment: requires a provided interface	
Business object	A unit of information that has relevance from a business perspective.	
Product	A coherent collection of services, accompanied by a contract/set of agreements, which is offered as a whole to (internal or external) customers.	

Figure 3: eML Business Layer quick reference.

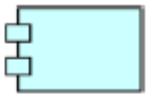
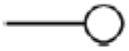
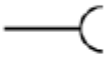
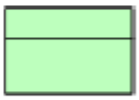
Concept	Description	Notation
Application Component	A modular, deployable, and replaceable part of a system that encapsulates its contents and exposes its functionality through a set of interfaces.	
Application Interface, Provided	An application interface declares how a component can connect with its environment: provides the interface	
Application Interface, Required	An application interface declares how a component can connect with its environment: requires a provided interface	
Data Object	A coherent, self-contained piece of information suitable for automated processing.	
Application Function	A coherent group of internal behavior of a component.	
Application Service	A unit of behavior jointly performed by two or more collaborating components.	

Figure 4: eML Application Layer quick reference.

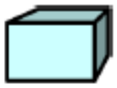
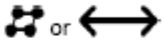
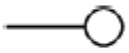
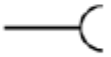
Concept	Description	Notation
Node	A computational resource upon which artifacts may be deployed for execution.	
Device	A physical computational resource upon which artifacts may be deployed for execution.	
Network	A physical communication medium between two or more devices.	
Communication path	A link between two or more nodes, through which these nodes can exchange information.	
Infrastructure Interface, Provided	A point of access where the functionality offered by a node can be accessed by other nodes and application components: provides the interface	
Infrastructure Interface, Required	A point of access where the functionality offered by a node can be accessed by other nodes and application components: requires a provided interface	
System software	A software environment for specific types of components and objects that are deployed on it in the form of artifacts.	
Infrastructure Service	An externally visible unit of functionality, provided by one or more nodes, exposed through well-defined interfaces, and meaningful to the environment.	
Artifact	A physical piece of information that is used or produced in a software development process, or by deployment and operation of a system.	

Figure 5: eML Techology Layer quick reference.

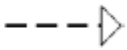
Structural Relationships		Notation
Association	Association models a relationship between objects that is not covered by another, more specific relationship.	
Access	The access relationship models the access of behavioral concepts to business or data objects.	
Used by	The used by relationship models the use of services by processes, functions, or interactions and the access to interfaces by roles, components, or collaborations.	
Realization	The realization relationship links a logical entity with a more concrete entity that realizes it.	
Assignment	The assignment relationship links units of behavior with active elements (e.g., roles, components) that perform them, or roles with actors that fulfill them.	
Aggregation	The aggregation relationship indicates that an object groups a number of other objects.	
Composition	The composition relationship indicates that an object consists of a number of other objects.	
Dynamic Relationships		**Notation**
Flow	The flow relationship describes the exchange/transfer of, for example, information or value between processes, function, interactions, and events.	
Triggering	The triggering relationship describes the temporal or causal relations between processes, functions, interactions, and events.	
Other Relationships		**Notation**
Junction	A junction is used to connect relationships of the same type.	
Specialization	The specialization relationship indicates that an object is a specialization of another object.	

Figure 6: eML Interfaces quick reference.

Src.	RGB Value	Example
Internal ('own' SP)	original RGB	
SP3	R255 G255 B102	
SP4	R248 G181 B126	
SP5	R175 G194 B218	

Src.	RGB Value	Example
SP2	R218 G151 B146	
3rd Party (optional)	R000 G176 B080	
Unknown SP	orig. RGB + red border	
Complete Unknown (int/ext)	R217 G217 B217 + red border	

Figure 7: Color coding for eCoMove SubProjects.

The Chapter is organized as follows: the description of the applications is done sequentially, starting with the preTrip application, then with the onTrip applications, and finally analysing the ecoCooperativeHorizon service, which is not an SP3 application but a common service used by all applications to retrieve the necessary information about the vehicle moving on the road at each time.

3.1. preTrip applications

3.1.1. ecoTripPlanning

The Business Layer diagram representing the ecoTripPlanning application is shown in Figure 8.

This application helps in planning the trip for the user, and will enable ecoRouting complemented with relevant information that can support the reduction of fuel consumption like suggested time slot.
The ecoTripPlanning could be done both in vehicle and out of the vehicle.

In the following of this section, first the case of *ecoTripPlanning* service outside of the vehicle is explained, followed by the *ecoTripPlanning* service within the vehicle.

The actors in the diagram are the driver, the eCoMove system, the Traffic Manager and the Traffic Control Centre (TCC/TMC).
The main process is represented by *Plan ecoTrip*, which contains many other processes and objects internally.

The process *user input (ecoHMI)* is mainly dedicated to implement the interaction between the user and the eCoMove system.
Before starting the planning, it is important to have the knowledge about the driver who is asking for planning, and for this reason there is the process *Confirm Driver ID*.
The event *Ignition On and/or Engine On* activates the process of planning the eco Trip.
Inside the *Plan ecoTrip* process, the process *PreTrip Data Entry* obtains from the *user input (ecoHMI)* the following parameters: Departure Time, Starting Point, Arrival Time, Destination Point and Present navigation preferences.
Moreover, the *PreTrip Data Entry* collects all vehicle parameters useful for the planning of the route: type of fuel, category Euro, weight, dimension, gear type, number of gears. All these parameters are collected in the dataset named PreTripDataEntered.
The process *PreTripCheckRoute* in parallel makes a check about the StoredPlannedRoute, which is useful to eventual reuse of a previously planned route for the same driver.
The PreTripDataEntered, together with the information available by the "Traffic information from the TCC/TMC, and together with the eventual Stored Planned Route, are the inputs for the process *Search for a Route*. This process uses the service *Calculate Route* to provide a list of possible routes saved in the object RouteToBeConfirmed.
The RouteToBeConfirmed is the input of the process *Show Routes(s) to the driver*. In the case that RouteToBeConfirmed is empty, the event *No Route* is generated and the procedure starts again from *the user input (ecoHMI)*. In case that one or more routes are available, the user performs a selection via ecoHMI, and the selected route is stored in RouteConfirmed, while the event *Driver accepts or updates the Route* is generated.
After the generation of the event *Driver accepts or updates the Route,* the process *Save Planned Route* saves the RouteConfirmed in PlannedRouteOutOfCar, which is then placed in Out of car Data. The Out of Car Data potentially is a USB device or a mass storage device managed by a service (here not depicted). In parallel, the process *Create Information* sends to the ecoHMI some ecoRecommendations, as for example Route accepted or Route updated.

In case of ecoTripPlanning executed within the vehicle, the Departure Time, Starting Point and Present navigation Preferences could be derived from the In-Vehicle Data (eventually proposed to the user).
Then the process follows as described above in the same way of the off – board planning.
After the event *Driver accepts or updates the Route,* the process *Save Planned Route* saves the RouteConfirmed in the plannedRoute inside the In-Vehicle Data.

Then, if the user starts immediately her/his trip, the eCoMove system leaves the preTrip situation and goes to the onTrip situation. In this case the

activated application will be the dynamic ecoNavigation, which will use the plannedRoute as its initial input.
Otherwise, if the user decides to start moving later (i.e. the day after), the plannedRoute becomes obsolete due to the potentially changed traffic situation.
For this specific case, the object Traffic information from TCC/TMC (predicted traffic) becomes relevant which will provide updated data to restart the ecoTripPlanning application.

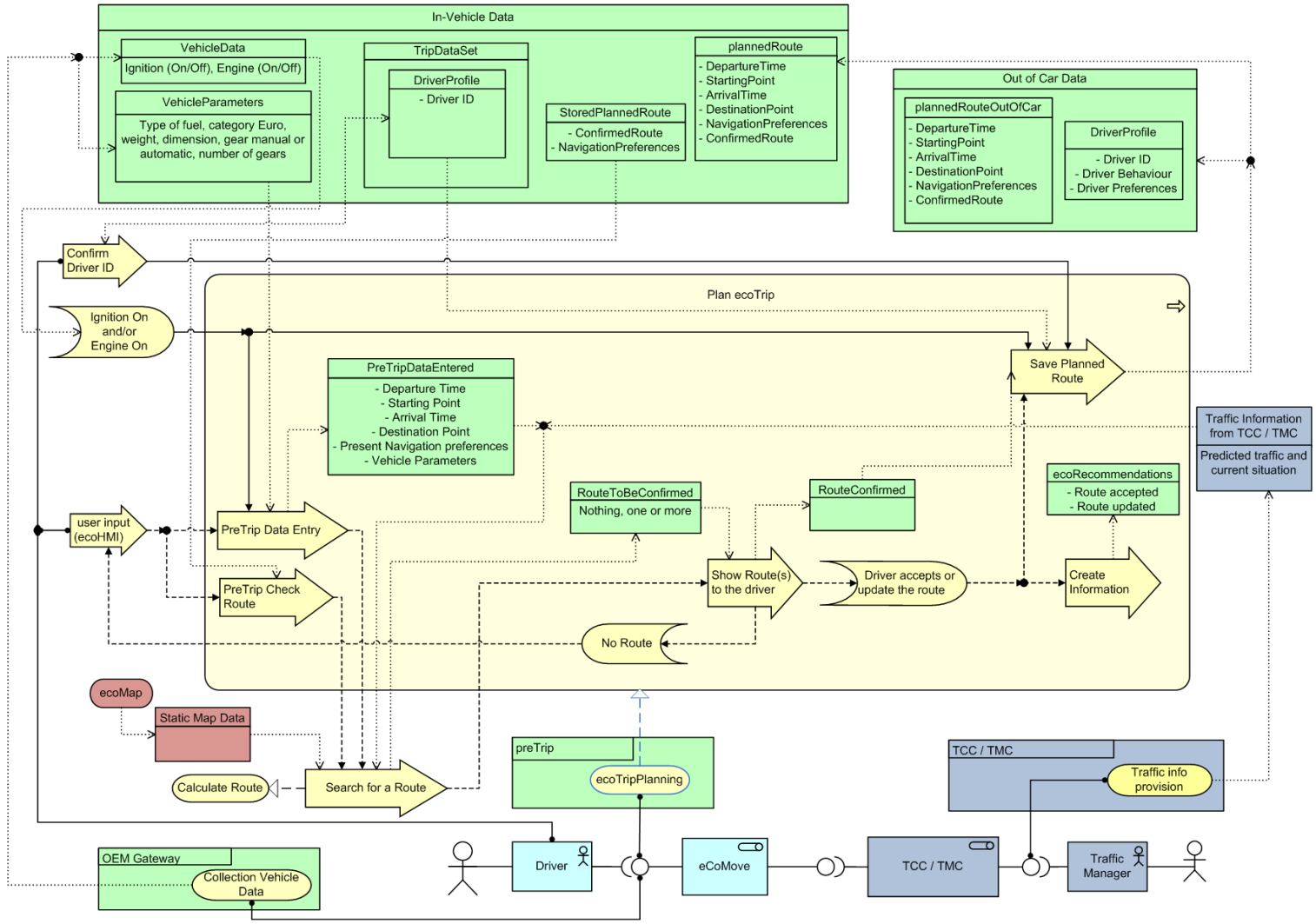


Figure 8: BL representation of ecoTripPlanning.

3.2. onTrip Applications

3.2.1. ecoNavigation

The Business Layer Diagram representing dynamic ecoNavigation is shown in Figure 9.

The diagram describes the ecoNavigation application and its interaction both with other parts of SP3 and with other SPs.

The *ecoNavigation* has two core functionalities:

- *Calculate route***,** which is realized by the Search for Route process. It takes all available information that might influence fuel usage and computes the most fuel efficient route to a given destination.
- *Guide Driver* gives turn-by-turn instructions to the driver, using the calculated route.

The *Calculate route* service is represented separate from the main process ecoNavigation because the same service is used both by the ecoNavigation and the ecoTripPlanning applications.

There is a set of auxiliary processes to collect the information relevant for fuel usage from various sources, these processes are continuously monitoring for changed data and may trigger a route recalculation. Another set of auxiliary processes distributes route information to other parts of the system as needed. Finally, an auxiliary process informs the driver when no route could be calculated or a route has been calculated that might be unusable or not legally viable.

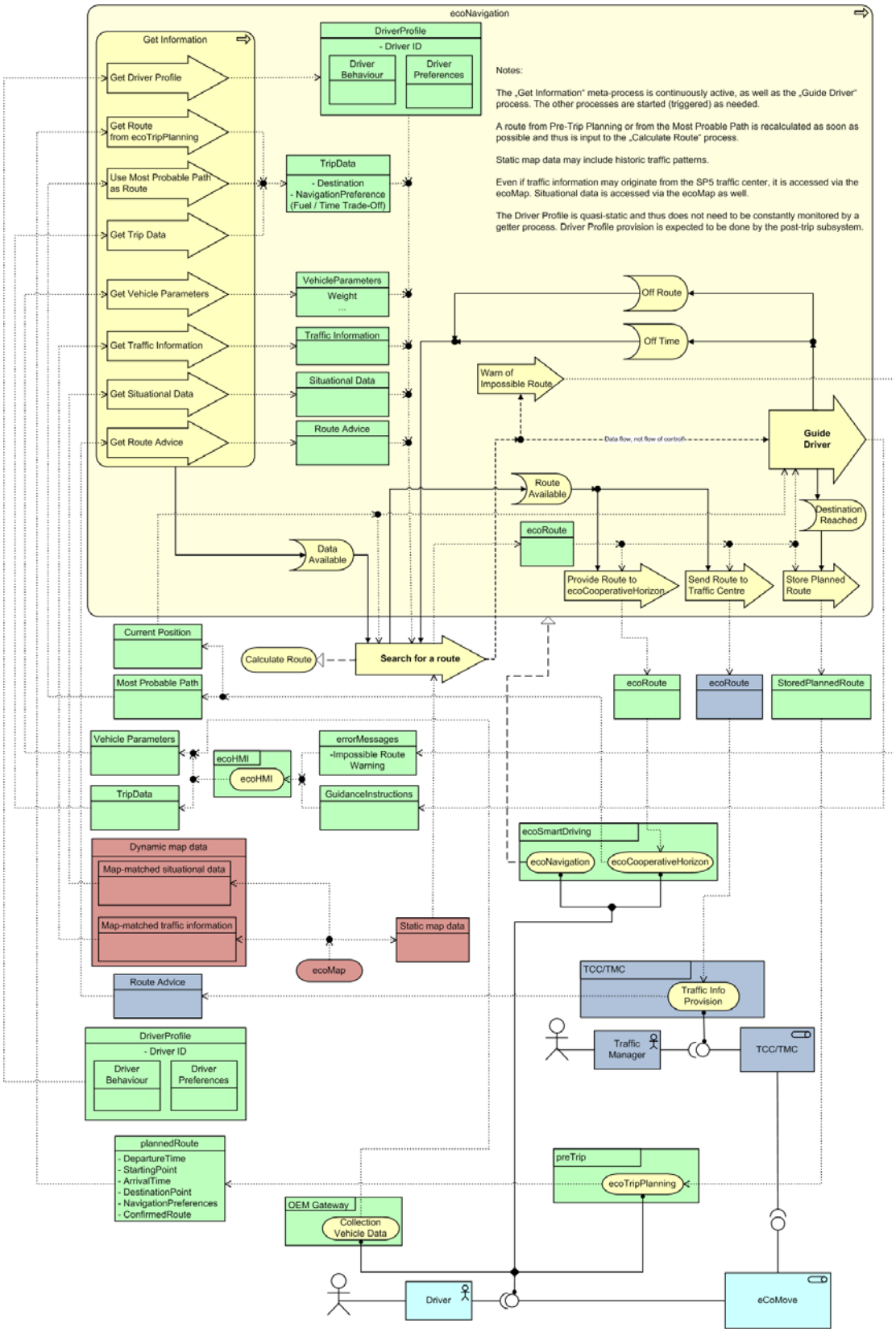


Figure 9: BL representation of ecoNavigation.

Data objects exchanged with other parts of the system:

- Driver Profile
  This contains information regarding the personal driving style of the driver relevant for calculating the fuel consumption. It is expected that this data will be provided by post-trip analysis. The exact contents are yet in definition and will probably become a topic of eCoMove research.
- Current Position
  The current position of the vehicle is used as a start point for route planning, and it is used to decide what instructions need to be given to the driver. For the start point, a more advanced implementation might use a position some distance ahead on the MPP instead to avoid the vehicle already having left the route when calculation is finished. This diagram expects to take the current position from the *ecoCooperativeHorizon* (where it is available at least as starting point of the MPP); it would be possible to take it directly from a dedicated positioning module instead.
- Most Probable Path
  The Most Probable Path from the *ecoCooperativeHorizon* is used to provide destinations for micro-routing when no destination is available otherwise.
- plannedRoute
  The planned route from *ecoTripPlanning* may be used on the one hand to extract a destination, on the other hand as base for route calculation (which might in this case just consist of copying the route).
- ecoRoute
  The calculated route is provided to other parts of the system that might make use of it. Currently known users are the *ecoCooperativeHorizon* (which will expect the vehicle to travel along the route) and TCC/TMC (which can use planned routes to estimate future road network loads). If other parts of eCoMove wish to make use of the route, it will be made available to them as well.
  The ecoRoute is computed considering all the inputs available each time: the PlannedRoute coming from the ecoTripPlanning, the MPP from the *ecoCooperativeHorizon*, the characteristics of the driver (behaviour and preferences).
- Map data
  Static map data is used at many places in *ecoNavigation*; both route calculation and driver guidance are based on it. Static map data can include historic traffic data which can be used to estimate fuel consumption in route calculation.
  Dynamic map data is used to estimate fuel consumption as well. This includes several types of data:
    - Map-matched traffic information
      describes long-range data provided by centralized services that describe flow patterns and possibly incidents. This can be current data or predictions for a medium time scale (in the order of hours).

  - Map-matched situational data
    describes short-range data describing the local traffic situation. It can be current data or predictions for a short time scales (seconds to minutes). The data might be received by V2I communications from roadside units, or it might be computed locally by the *ecoSituationalModel* from ecoFVD.

In any case, dynamic map data is not received by the *ecoNavigation* directly from the data sources described above, but it is taken from the ecoMaps which have the role of a distribution service for this data [3].

- Route advice
  This is information distributed by the TCC/TMC containing recommendations what routes to take or not to take through specific parts of the road network.
- User input and output
  This is data exchanged with the user by means of the ecoHMI. Data items include:
  - Vehicle Parameters (input)
    Information about the vehicle that is relevant for fuel consumption estimation. The list of parameters is yet in definition, as it depends on the fuel consumption estimation algorithm which will be a topic of research in eCoMove. It might include items like vehicle weight and cross-section.
  - Trip Data (input)
    This is the destination to navigate to, but can also include restrictions on arrival time or a fuel/time trade-off setting.
  - Route Warning (output)
    This is a warning to the driver that it may not be possible to follow the route to the destination.
  - Driver Instructions (output)
    These are the actual instructions for driving manoeuvres.

Vehicle Data are also collected via a vehicle gateway as an input to Vehicle Parameters and to Trip Data.

3.2.2. ecoDrivingSupport

The Business Layer diagram representation of the ecoDrivingSupport is summarizing involved processes and data objects, see Figure 10.

The ecoDrivingSupport is the application providing recommendations to the driver on how to drive more efficiently. Recommendations are derived from the current and predicted driving state including the traffic environment.

A fundamental functionality supporting the ecoDrivingSupport is the *ecoSituationalModel* [3]. Its purpose is to supply different applications with information on the current and predicted vehicle and traffic states. Therefore in a first step the current traffic and driving situation is analysed. In a second step the current traffic and vehicle state as well as information from the

ecoCooperativeHorizon is used to predict future states such as the velocity profile of a specific vehicle and the surrounding vehicles.
There are two different versions of the ecoSituational Model:

- Vehicle based: the description of the traffic situation and prediction is executed from the viewpoint of one single vehicle (host vehicle).
- Infrastructure based: the description of the traffic situation and prediction is executed from the viewpoint of a specific infrastructure element (e.g. an intersection).

Both versions are strongly dependent on each other and use communication to facilitate data exchange. As the vehicle based ecoSituational Model resides in the vehicle it is included in Figure 10, while the other infrastructure based ecoSituational Model is not visualized.
Data derived from the vehicle based ecoSituationalModel is subsumed in the TripDataSet and transferred to the *ecoMaps* process. There the data is stored in the ecoDynamicMap and in this way merged with data from other ecoSituationalModels based in other vehicles or in infrastructure elements. Every vehicle is provided with information from the ecoDynamicMap using an individual *ecoCooperativeHorizon*. This is extracting all relevant information in the surroundings from the dynamic map. Thus cooperative system architecture enables the ecoDrivingSupport application to identify all surrounding traffic participants and consider their predicted actions.

Next to this, information about the estimated preferences and behavior of the driver also needs to be provided to the ecoDrivingSupport application. This is done by a pre-trip analysis, by user inputs and by an analysis of the driver's previous behaviour, which is obtained from the TripDataSet. Detailed content of the TripDataSet is given in D3.3. The user input contains for example the driver ID, settings like sport, comfort or normal as well as navigation preferences. A manual user input (for e.g. a switch) can be used to adapt results from the pre-trip analysis and is a part of the ecoHMI. The ecoDrivingSupport then calculates an optimized velocity profile and derives recommendations on the driving style for the current and upcoming specific driving situation. These recommendations are provided to the driver by the ecoHMI.

The reactions of the driver to recommendations are observed by the *ecoSituationalModel* and used to derive the driver's preferences stored in the TripDataSet. This way the prediction of the model on the driver behavior can be improved continuously.

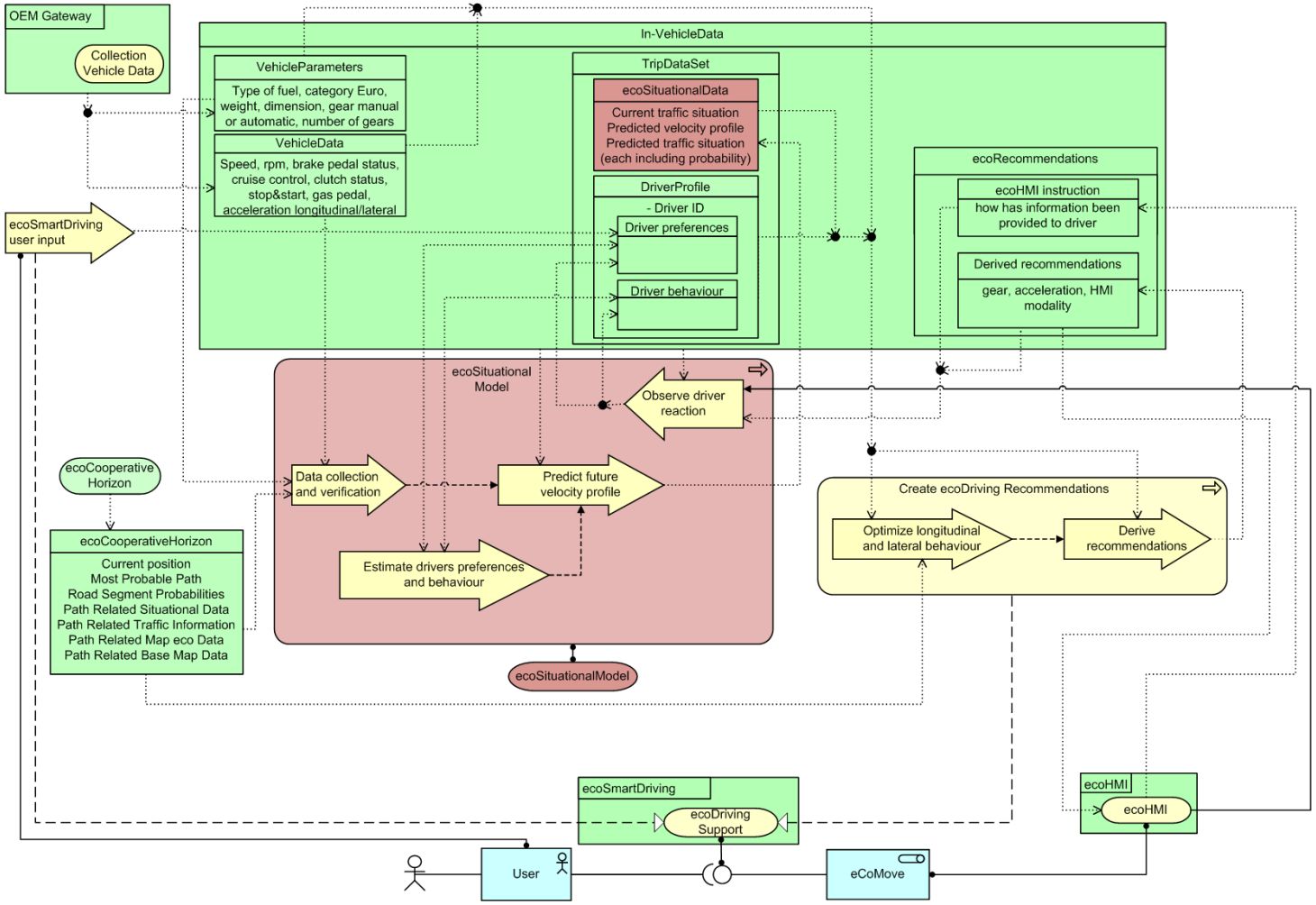


Figure 10: BL representation of ecoDrivingSupport.

3.2.3. ecoInformation

The Business Layer diagram representing ecoInformation application is shown in Figure 11.
The ecoInformation application is part of the preTrip and onTrip phase.
The driver interfaces with the ecoMove system, and uses the service called *ecoInformation.*

The parameters and data related to the vehicle are collected from two processes: *Get VehicleParameters from Vehicle* and *Get VehicleData from Vehicle.*

When data about ignition on/engine on are retrieved, the event *Ignition On and /or Engine On* happens. It activates the process *Automatic Check*.
The *Automatic Check* analyses the oil status, the pressure of the tires (this last point is done only when the TPM (Tires Pressure Management) is available onboard), the filters status, and the electrical consumers status.
The *Automatic Check* process works both during the preTrip and the onTrip phases.
It periodically checks the current driven km and computes the difference between it and the previous km when controls were done about filters, oil, tires. Then it checks the current time and computes the difference between it and the previous time when the controls were done. When one difference is equal to the related delta km control or delta time control, the *Automatic Check* sends a message to the process *Generate Recommendations*, with the parameter to be checked.

During the preTrip phase, another process runs in parallel: it is the *Vehicle Loading Check*, which controls the status of the balanced /unbalanced loading of the vehicle.

During the onTrip phase, there is also the *Aerodynamics Check* for the vehicle. This process is activated by the *Ignition On and /or Engine On* and *by the Vehicle Speed > n km/h* event, with this last event representing the condition when the driver is in the car, and he/she is driving without being stopped in some points.

The three processes send the messages about the parameters to be checked to the *Generate Recommendations to the driver* process, which collects all the messages, and provides them to the ecoHMI. The post trip application gives drivers recommendations after each trip.

All data used as inputs for the *ecoInformation* service are provided by the OEM Gateway of the vehicle, which is represented as another product of the eCoMove system.
In the diagram the action done after receiving the warnings is also reported. This is not part of eCoMove activity, in fact it is represented as third party

process (*Maintenance operation*, *Maintenance activity* and *Updating information*), But it interacts with eCoMove because it provides the updates of the information used by the ecoInformation application.

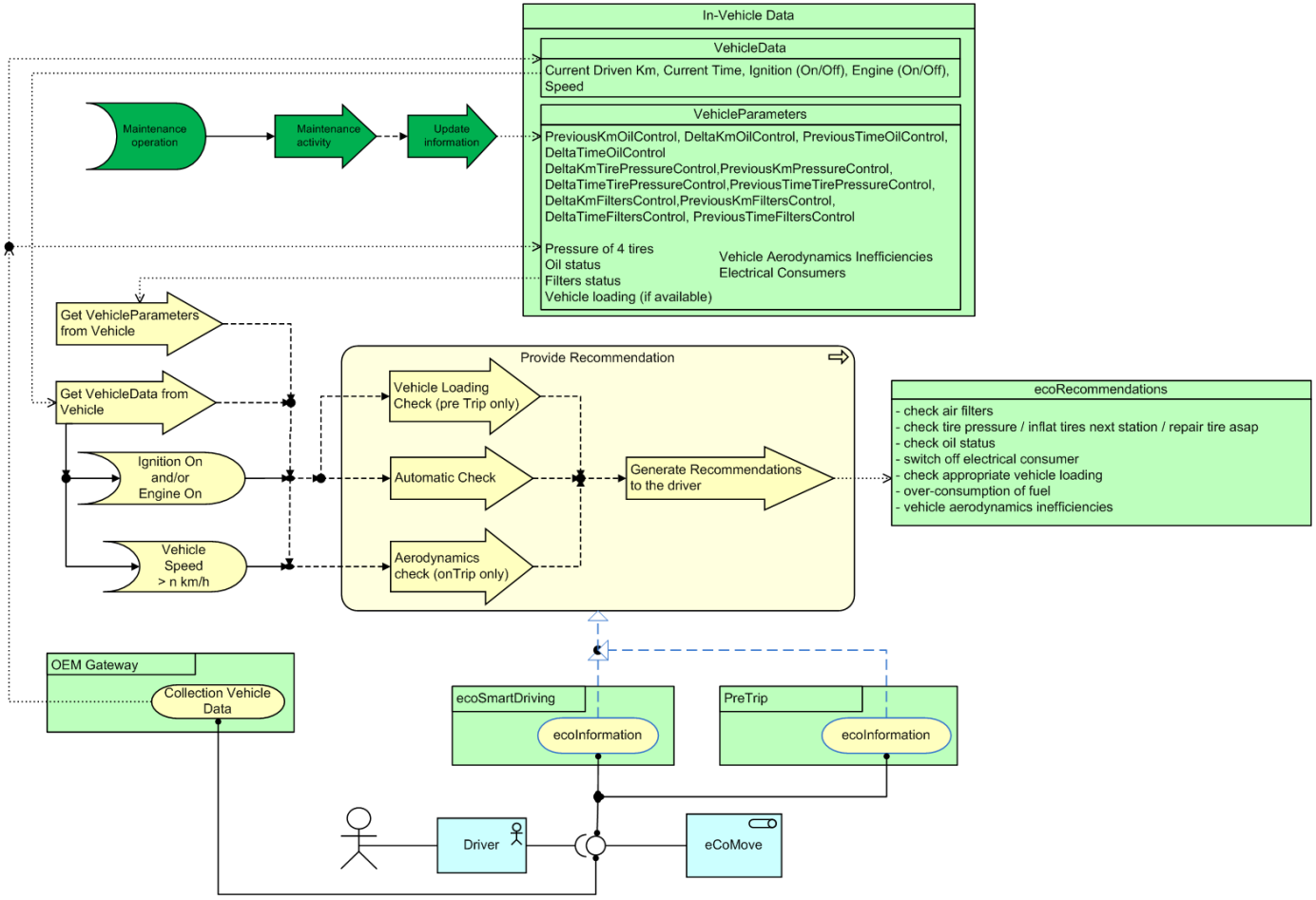


Figure 11: BL representation of ecoInformation.

3.3. ecoCooperativeHorizon

The Business Layer diagram of Figure 12 describes the ecoCooperativeHorizon service and its interactions with other parts of the eCoMove system.

The term “ecoCooperativeHorizon” describes both a service and the data provided by this service. In most cases, context makes it clear which of these is discussed; if not, the terms “ecoCooperativeHorizon service” and “ecoCooperativeHorizon data” (or “ecoCooperativeHorizon content”) need to be used.

The ecoCooperativeHorizon has the task of providing in-vehicle components with a logical view of the road ahead of the vehicle. Generally this is data extracted from the map, but organized by distance along the path of the vehicle (instead of organized by geographic position or link ID). For example, the content of the dynamic map would be something like "There's a car braking on link 137BC4, 230 m from the southern end, and it's going to turn left onto link 138CX2 in 12 seconds." The horizon would then take this information on convert it into a description referring to the ego vehicle position: "There's a car braking 170 m ahead of us, and it's going to turn left out of our path in 12 seconds."

To collect information about the road ahead, the ecoCooperativeHorizon needs to know where the vehicle is probably going, which in turn requires knowledge of the current vehicle position. This immediately results into the main flow of the *Horizon Calculation* process:
The current map-matched position is received from the *Vehicle Positioning* process which in this diagram is assumed to be a SP2 component. Thus the visualization of positioning internals in this diagram is not authoritative.
Starting from this position, the likelihood of reaching links is calculated.
The sequence of the most likely successor links is collected into the Most Probable Path (MPP); the likelihood of actually reaching each link is part of the MPP data. Possibly, in the case that likelihoods of several alternatives do not differ significantly (and are above a given threshold value which makes the alternatives enough realistic), more than one MPP candidates have to be stored.
For the links of the MPP, all information from the map, both static and dynamic information, is retrieved and organized by distance along the MPP.
This map-derived data, together with the actual MPP and the current position, is available to all in-vehicle components that wish to use it.

For calculating probabilities, a currently planned route, called ecoRoute, provided by *ecoNavigation*, is taken into account.

It may be that during eCoMove development a closer relationship between ecoCooperativeHorizon and ecoSituationalModel will evolve. Currently the in-

vehicle ecoSituationalModel uses the MPP computed by the ecoCooperativeHorizon; it is just one of the clients of the ecoCooperativeHorizon, and data generated by the ecoSituationalModel is stored into the map as dynamic data and accessed there by the ecoCooperativeHorizon. Thus the ecoSituationalModel does not need to be shown explicitly in the diagram.
But the calculation of the MPP is very much related to the calculation of a trajectory for the ego vehicle by the ecoSituationalModel. It may be possible to model not only longitudinal behaviour, but also path choice in the ecoSituationalModel for trajectory calculation, and then to use a trajectory from the ecoSituationalModel as base for the MPP instead of calculating probabilities in the ecoCooperativeHorizon.

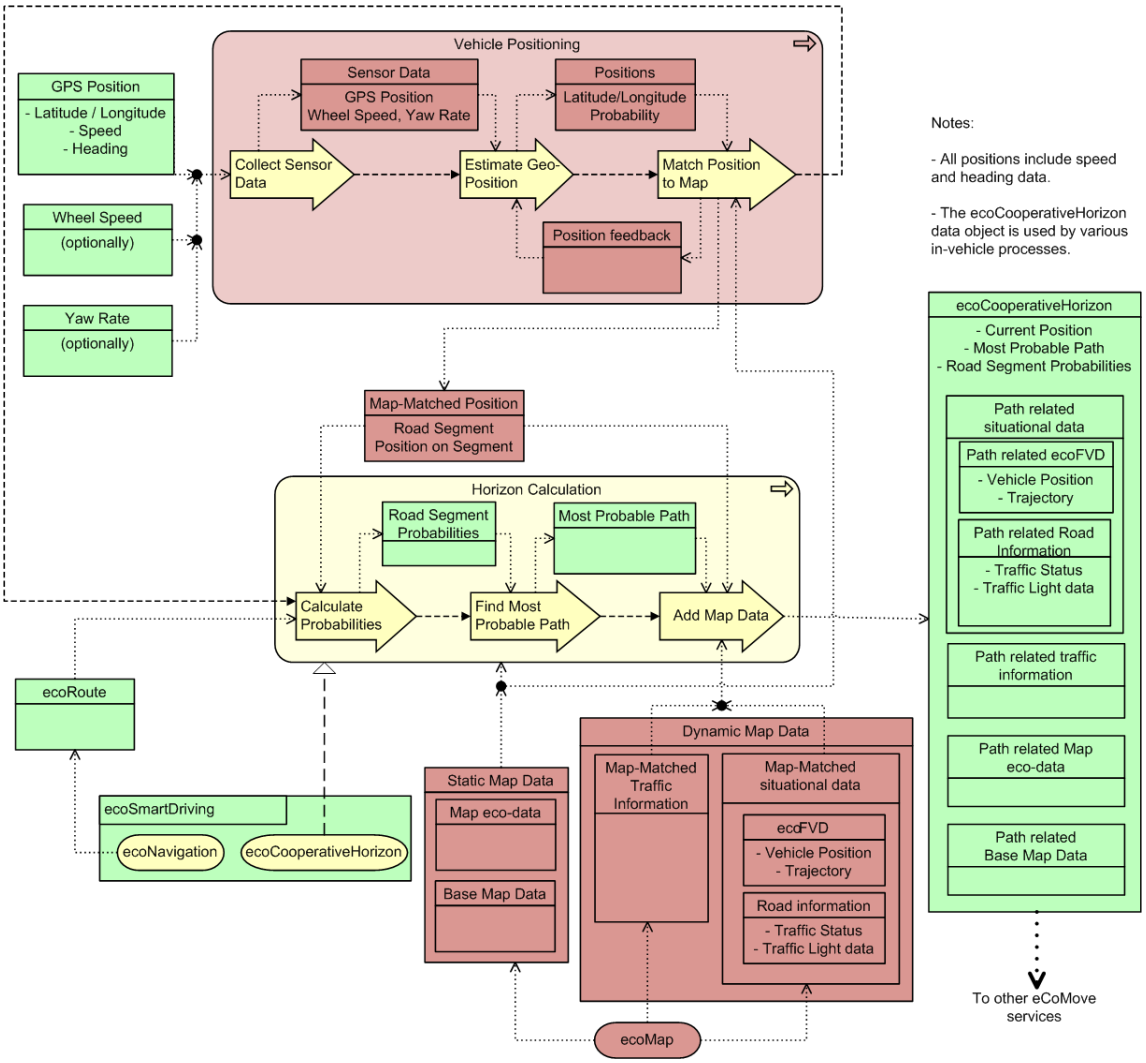


Figure 12: BL representation of ecoCooperativeHorizon

Data objects exchanged with other parts of the eCoMove system:

- Current map-matched position (in short: current position, or map-matched position)

This includes the current road segment, the position along this road segment, and the current speed, but for completeness also latitude, longitude, and heading.

- ecoRoute
  The sequence of road segments that ecoNavigation advises the driver to use.
- Map data (input from the ecoMap)
  This is data organized by road segments (links)
  - Static Map Data
    Both standard map data as usually used in navigation systems and eco-data that is added for eCoMove, e.g. traffic flow patterns.
  - Map-matched Traffic Information
    describes long-range data provided by centralized services that describe flow patterns and possibly incidents. This can be current data or predictions for a medium time scale (in the order of hours).
  - Map-Matched situational data
    describes short-range data describing the local traffic situation, both data about individual vehicles (ecoFVD) and data referring to the road infrastructure like information about traffic lights or the current local (may lane specific) traffic. It can be current data or predictions for a short time scales (seconds to minutes).
- ecoCooperativeHorizon (as data object generated by the ecoCooperativeHorizon service)
  This data object combines the current map-matched position, the Most Probable Path (as a sequence of links with their assigned probabilities) and all map data for the links of the MPP; this map data is organized by distance along the MPP.

3.4. Use Case covered by Applications

The following table shows the relationship between Use Cases of SP3, defined in [1], and the Applications designed within this deliverable.

The ecoCooperativeHorizon is a service used from many applications but not related to a specific Use Case.
UC_SP3_07 and 08 are covered by post trip applications treated in deliverable D3.3.

Table 1. Use Cases covered by Applications.

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	UC_SP3_01: Checking Vehicle Condition (pre-trip)	UC_SP3_02: Planning ecoTrip	UC_SP3_03: EcoUse of Vehicle Systems	UC_SP3_04: Dynamic ecoNavigation	UC_SP3_05: Dynamic ecoGuidance	UC_SP3_06: Support ecoDriving	UC_SP3_07: In-vehicle ecoTripFeedback	UC_SP3_08: Off board ecoTripFeedback
ecoNavigation				**x**	**x**			
ecoDriving support						**x**		
ecoInformation	**x**		**x**					
ecoTripPlanning		**x**						
ecoCooperativeHorizon								

4. System architectural design

The system architectural design analyses in a deeper way the design of the applications.
Starting from the BL diagrams shown in Chapter 3, the single processes are expanded in multiple functionalities which are software modules to be implemented during the next phase of the project, the WP4. The software modules for the single application are shown in the Application Layer diagrams of eML.
The technology diagrams are a further step of design, where all the software modules for the single application are placed in the hardware where the application will run: in vehicles, on mobile devices, on external laptops or ground station.

4.1. preTrip applications

4.1.1. ecoTripPlanning

4.1.1.1. Application Layer

The application layer diagram describes the components which need to be developed and the application services to be implemented by the business process mentioned in the business layer.

The ecoTripPlanning application (see Figure 13 below) provides off-board services that are implemented by the ecoTripPlanning Component. This component could be accessed by ecoTripPlanning Service.
It consists of sub-components to collect data from user and/or vehicle (by PreTrip Data Entry Collector component, which has many functions associated:

- the Pre-Trip Data Entry function creates the preTripDataEntered; this object contains both data from the vehicle (VehicleData, Vehicle Parameters), the data inserted by the user through the ecoHMI service of the ecoHMI Component.
- the Pre-Trip Check Route function reads the contents of the Stored Planned Route and forwards them to the Calculate Route service.
- the Confirm Driver ID function, which stores the Driver ID in the DriverProfile.
- the Ignition On and/or Engine On event, which is generated by the contents in the In-Vehicle data provided by the OEM Gateway, triggers the Pre-Trip Data Entry and the Save Planned Route functions.

The preTripDataEntered Object contains all the input data (DepartureTime, StartingPoint, ArrivalTime, DestinationPoint, NavigationPreferences, etc.) for the CalculateRoute service of the RouteEngine Component. This component also uses the StaticMapData and the TrafficInformation Data, respectively

obtained from the ecoMap service of the ecoMap component and from the TrafficInfoProvision of the TCC/TMC component.

The response of the CalculateService is the RouteToBeConfirmed data object that is shown to the user from the function Show Route(s) to the driver. If the proposed route is confirmed (represented from the event Driver accepts or updates the route), the SavePlannedRoute function stores the PlannedRoute data object on the In-Vehicle Data or on the OutOfCarData object as appropriate, and the function Create Information sends to the ecoHMI some information to the user, about the route accepted or updated.

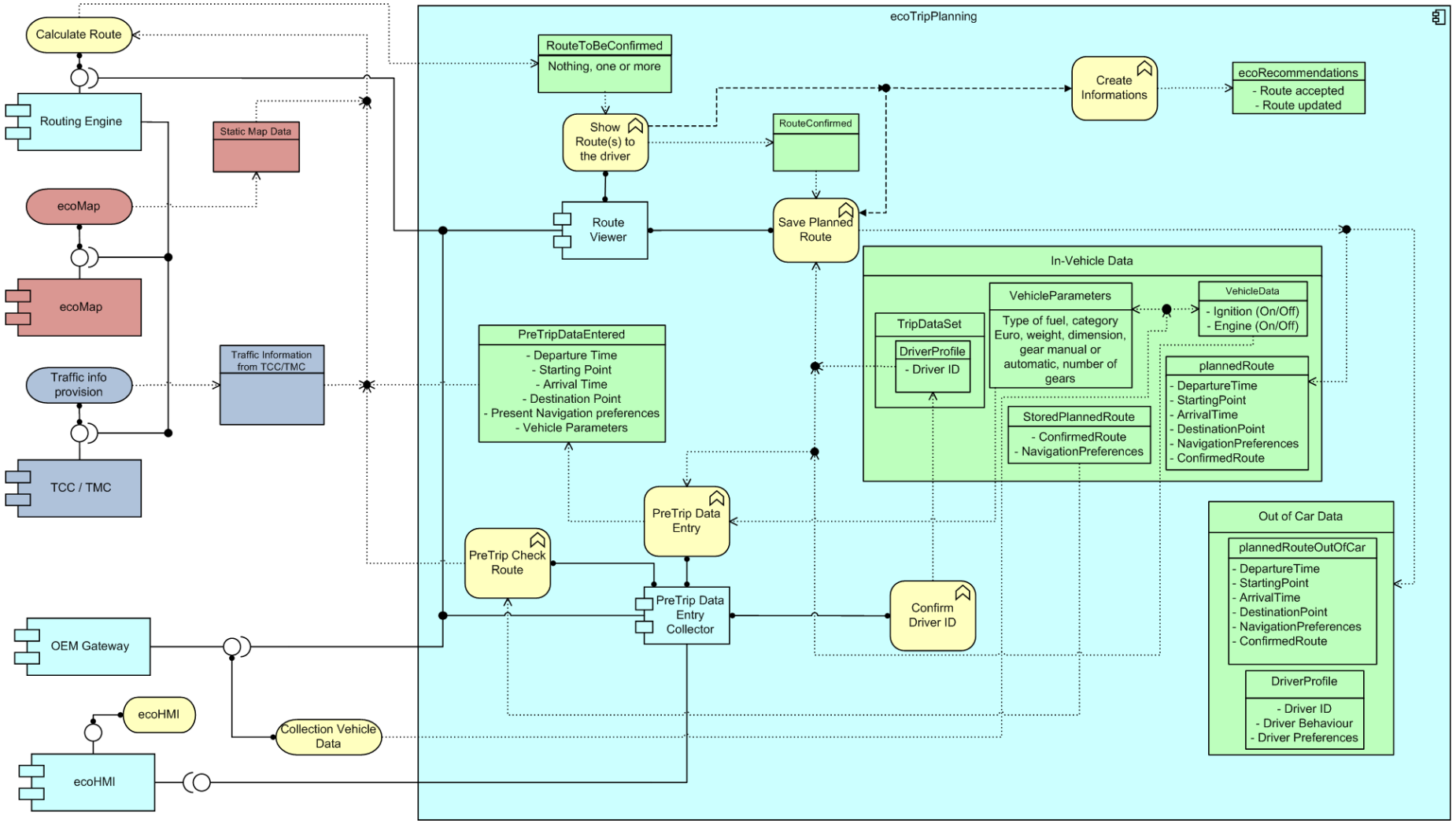

Figure 13: AL representation of ecoTripPlanning.

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4.1.1.2. Technology Layer

The ecoTripPlanning application runs on the Ground ITS Station and it can communicate with the Mobile Device and/or with the Vehicle ITS Station which could ask for the ecoTripPlanning service.

The Ground ITS Station consists of a Software Execution Platform that contains more components such as the Routing Engine, the ecoMap and the ecoTripPlanning sub-components (Route Viewer and PreTrip Data Entry Collector).
The Routing Engine Component needs traffic data and so the Ground ITS Station communicates with the Central ITS Station which includes the TCC/TMC Component.

The ecoTripPlanning service can be accessed by a Mobile Device and/or by a vehicle and so there is a communication through those nodes.
The Mobile Device Software Execution Platform will include the ecoHMI to connect the device with the eCoMove ecoTripPlanning service.
The Vehicle ITS Station includes in its Software Execution Platform also the OEM Gateway, which has to collect the In-Vehicle data and parameters, useful for the ecoTripPlanning service.

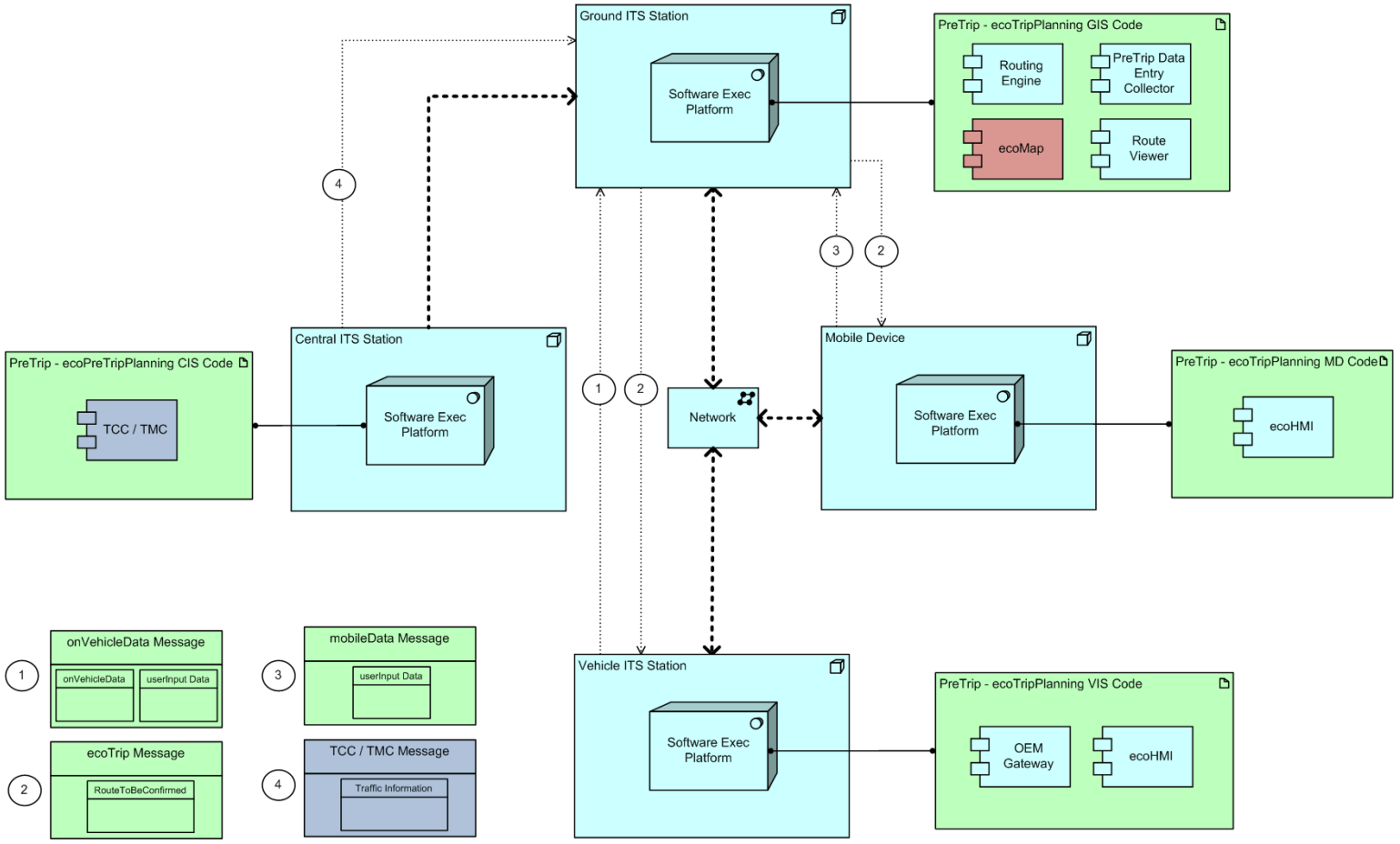

Figure 14: TL representation of ecoTripPlanning.

4.2. onTrip Applications

4.2.1. ecoNavigation

4.2.1.1. Application Layer

The application layer closely reflects the business layer. Some closely related functions are planned to be provided together by one component; this particularly affects the Routing Engine which provides some auxiliary functions besides the route calculation and the distribution of route information to other parts of the eCoMove system.

The only component introduced new at this level is the Energy Consumption Estimator which calculates the energy consumption for a single road segment which is passed to it – including all necessary information – by the Routing Engine. The routing algorithm will, beside energy consumption, take traversal time in account. The latter is obtained from the ecoMap and not explicitely shown here.

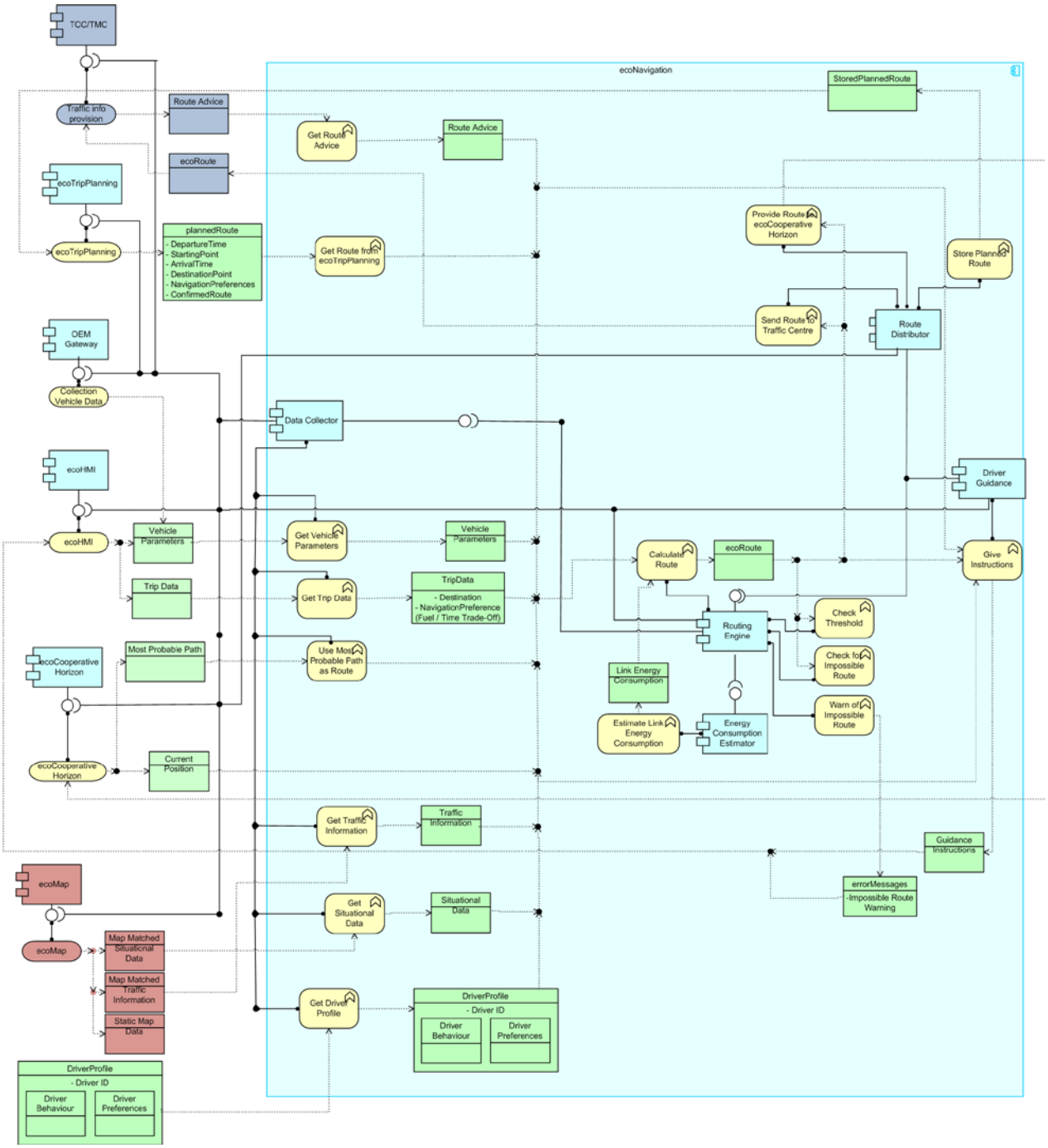

Figure 15: AL representation of ecoNavigation.

4.2.1.2. Technology Layer

The ecoNavigation itself is completely deployed in-vehicle, but components for communication are partially also deployed on central systems. Even though the diagram symbolically shows a single Central ITS Station, the Traffic Centre components usually are deployed on separate ITS stations.
The messages interchanged between the ITS stations still need to be defined in detail, currently not much more than their existence and a rough idea of the data content can be stated.

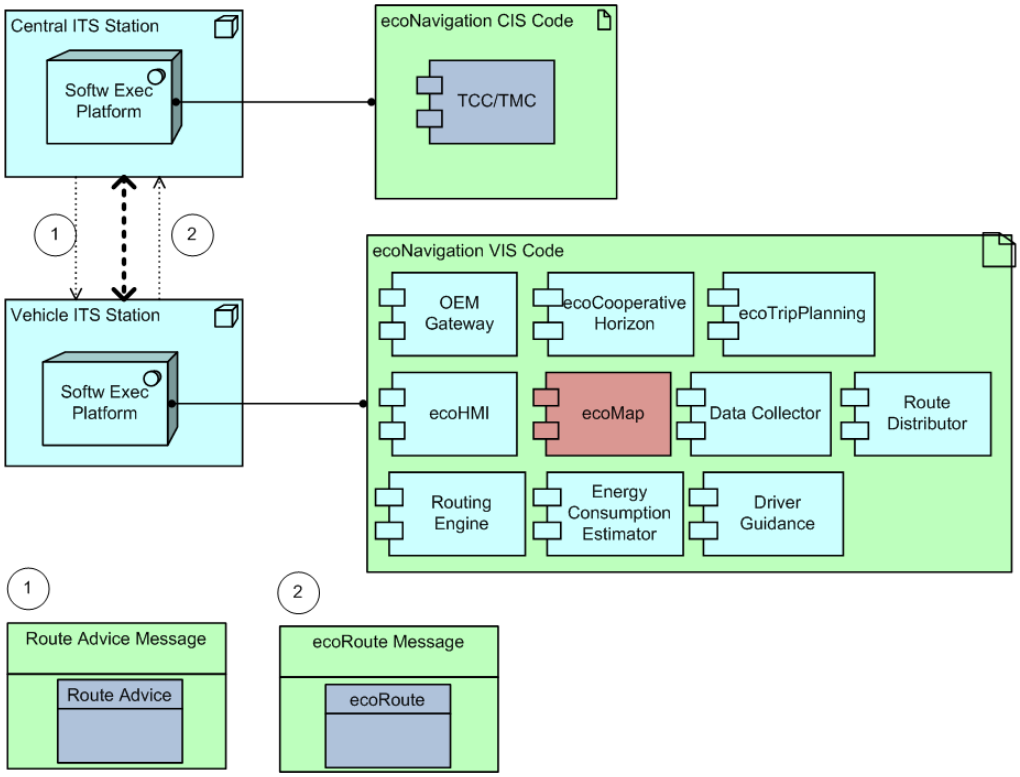

Figure 16: TL representation of ecoNavigation.

4.2.2. ecoDrivingSupport

4.2.2.1. Application Layer

The Application Layer diagram shown in Figure 17 is derived from the Business Layer diagram. It represents all necessary components and functions as well as their interfaces and relations.

According to the Business Layer diagram the two main components are the vehicle based *ecoSituational Model* and the *ecoDriving Recommendations Creator.* Both are deployed in the vehicle and can directly access the data object "In-Vehicle data". Via an interface they are connected to the ecoCooperative Horizon component so that the "ecoCooperative Horizon" data object can be accessed.

The "ecoSmartDriving user input" process, which is assigned to the ecoHMI component, allows the user to adjust the system to his preferences. These preferences are stored in the In-Vehicle data object and thus are available for all applications within the vehicle.

The vehicle based ecoSituational Model consists of four sub-components. Within the "data collector" sub-component the "Data collection and verification" function is implemented. This function consists of the two sub-functions "Retrieve data" and "Verify data".

Within the "Velocity predictor" sub-component the "Predict future velocity profile" function is executed. It consists of four sub-functions:

- Assess user need in current situation
- Description of current situation
- Composition and prioritisation
- Prediction of future situation

The "Reaction estimator" component contains the "Estimate driver preferences and behaviour" function. It has three sub-functions, "Compare behaviour to preferences", "Analyse driver behaviour data" and "Estimate driver reaction". The "Reaction observer" component contains the "Observe driver reaction" function, which is divided in the two sub-functions "Compare recommendation to driver reaction" and "Update driver behaviour data".

The "ecoDriving Recommendations Creator" component processes data from the ecoCooperative Horizon and the In-Vehicle data object using two functions. The optimization results are derived in the "Optimize longitudinal and lateral behaviour" function and the driving recommendations are provided by the "Derive recommendations" function.

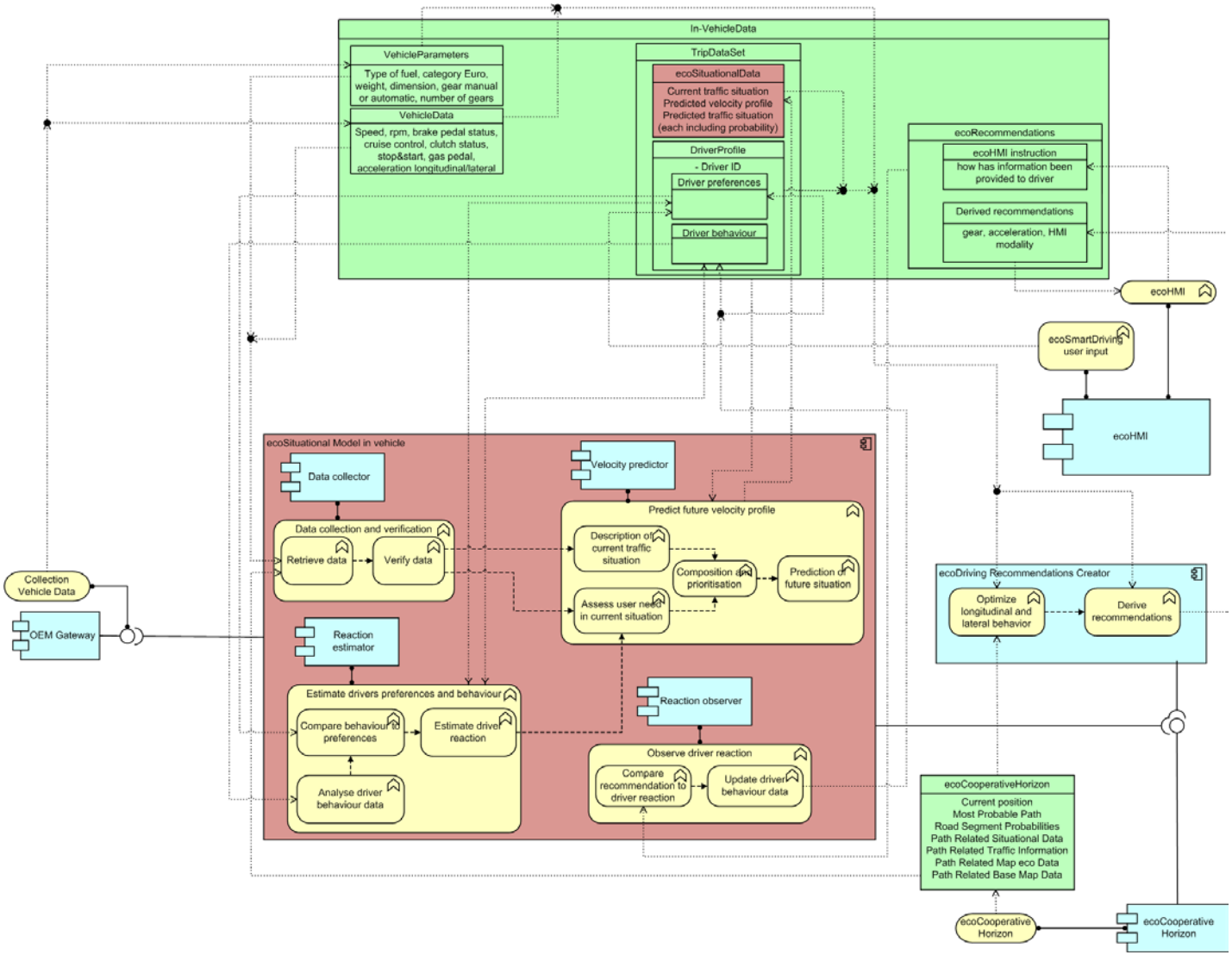

Figure 17: AL representation of ecoDrivingSupport.

4.2.2.2. Technology Layer

The ecoDrivingSupport technological layer shown in Figure 18 is clearly arranged as there is no direct communication between components on this level. There are only two modules, the “ecoDriving Recommendations code” and the “ecoSituational Model code” for the vehicle based ecoSituational Model. The technological layer for the infrastructure based ecoSituational Model is an SP5 responsibility but shown for completeness as it reuses some components.

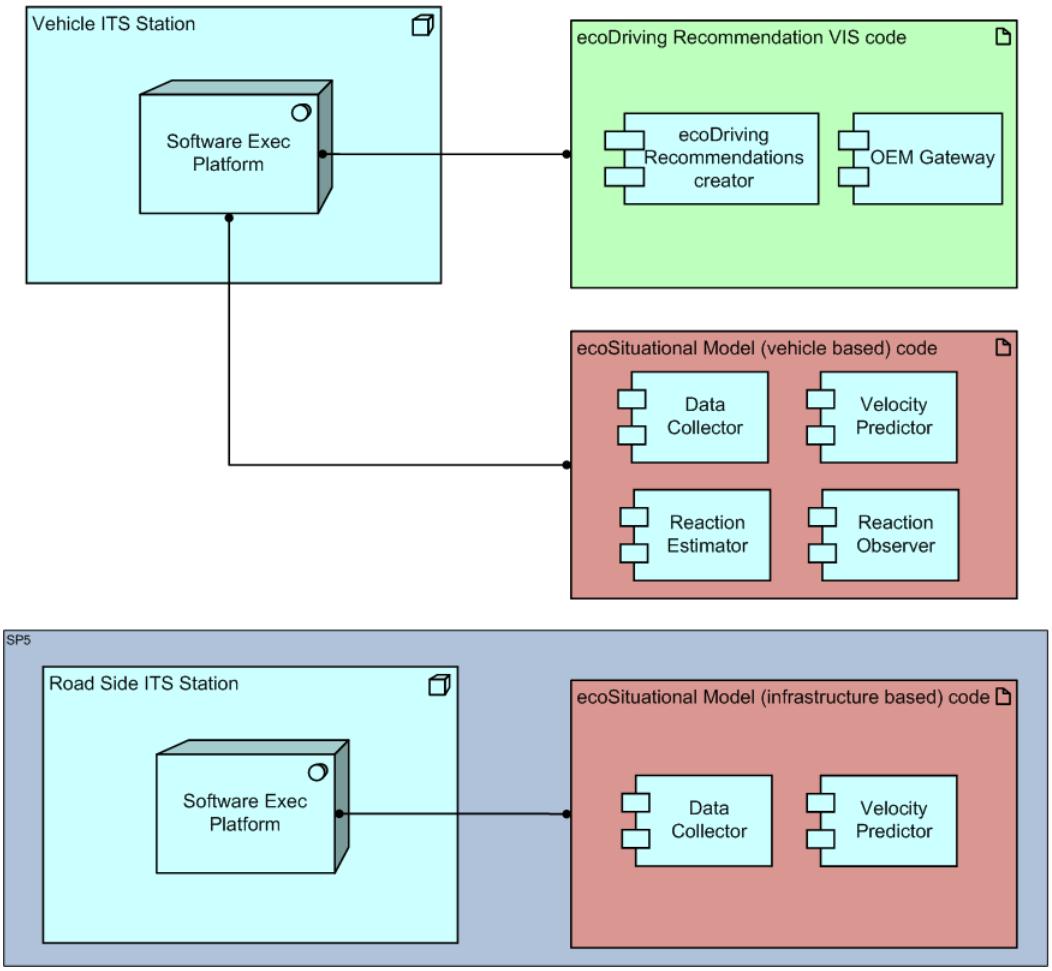

Figure 18: TL representation of ecoDrivingSupport

4.2.3. ecoInformation

4.2.3.1. Application Layer

The Application Layer diagram shown in Figure 19 describes the components which need to be developed and the application services to be implemented, related to the ecoInformation application. The diagrams are related to the BL diagram present at Chapter 3.2.3.

The ecoInformation application provides on-board services that are implemented by the Provide Recommendations component. This component is accessed by *ecoInformation* service present in the business layer (see Figure 11).

The *Provide Recommendation* component consists of sub-components to check current vehicle condition (Check Component), to check the aerodynamics of the vehicle (Aerodynamic Component) and to check the balanced load of the vehicle (Loading Component). Moreover there is the ecoHMI component which includes the *Generate Recommendations* function.

The Check Component, Aerodynamic Component and Loading Component require the In-Vehicle Data provided by the *Collection Vehicle Data* service of the OEM Gateway Component. The GetVehicleData function collects the VehicleData (current driven km, current time, ignition (on/off), engine (on/off) and the vehicle speed) and the GetVehicleParameters function collects the VehicleParameters (PreviousKmOilControl, DeltaKmOilControl, etc.).

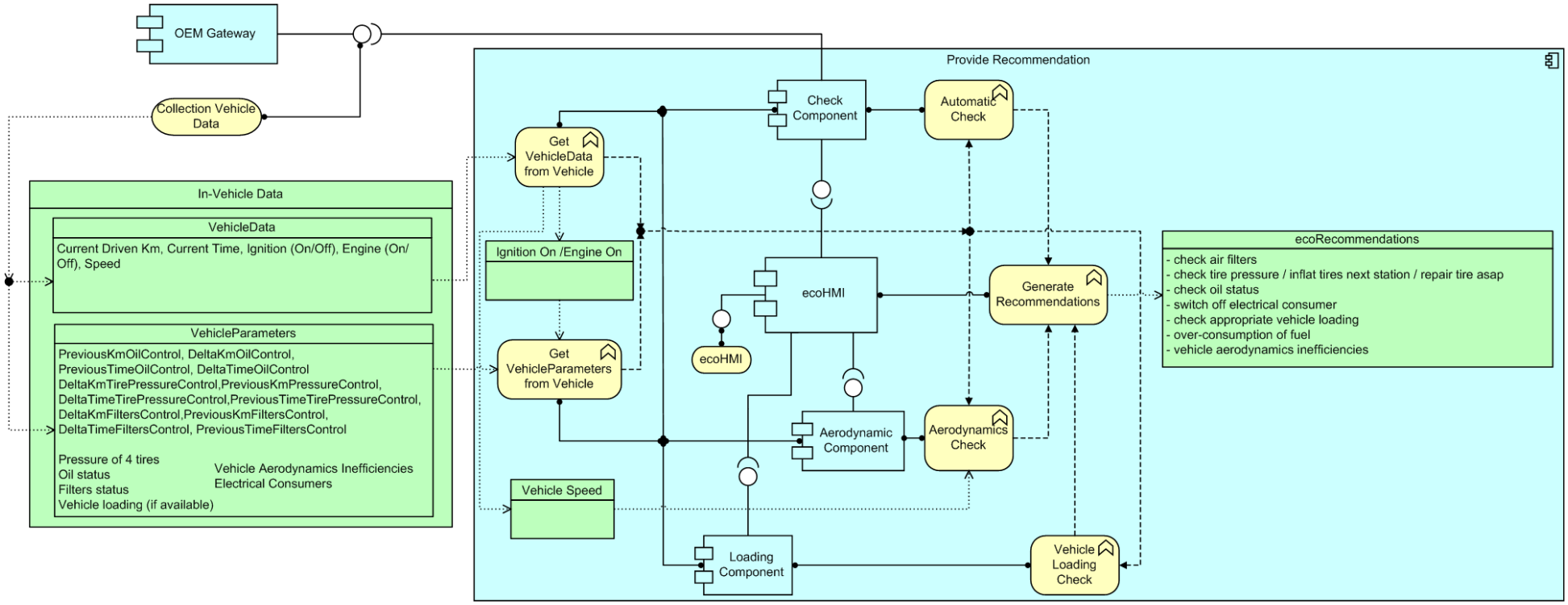

Figure 19: AL representation of ecoInformation.

4.2.3.2. Technology Layer

The Technology Layer diagram of Figure 20 clarifies how the ecoInformation application runs only on the Vehicle ITS station (On-Board Unit), without having communication with other ITS units.

The On-Board Unit consists of a software environment for the specific type of components (OEM Gateway, Check component, ecoHMI Component, Loading Component, Aerodynamic Component).

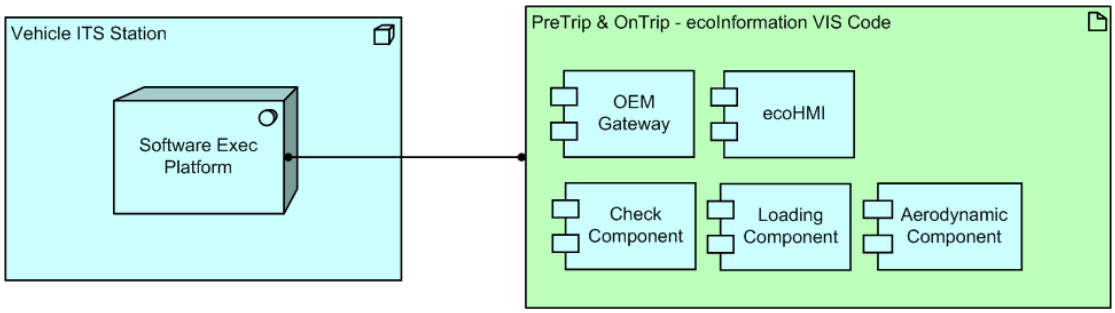

Figure 20: TL representation of ecoInformation.

4.3. ecoCooperativeHorizon

4.3.1. Application Layer

The ecoCooperativeHorizon application layer is a straightforward adoption of the business layer. As a service component, the ecoCooperativeHorizon has an open outgoing interface available for other in-vehicle components to connect to.

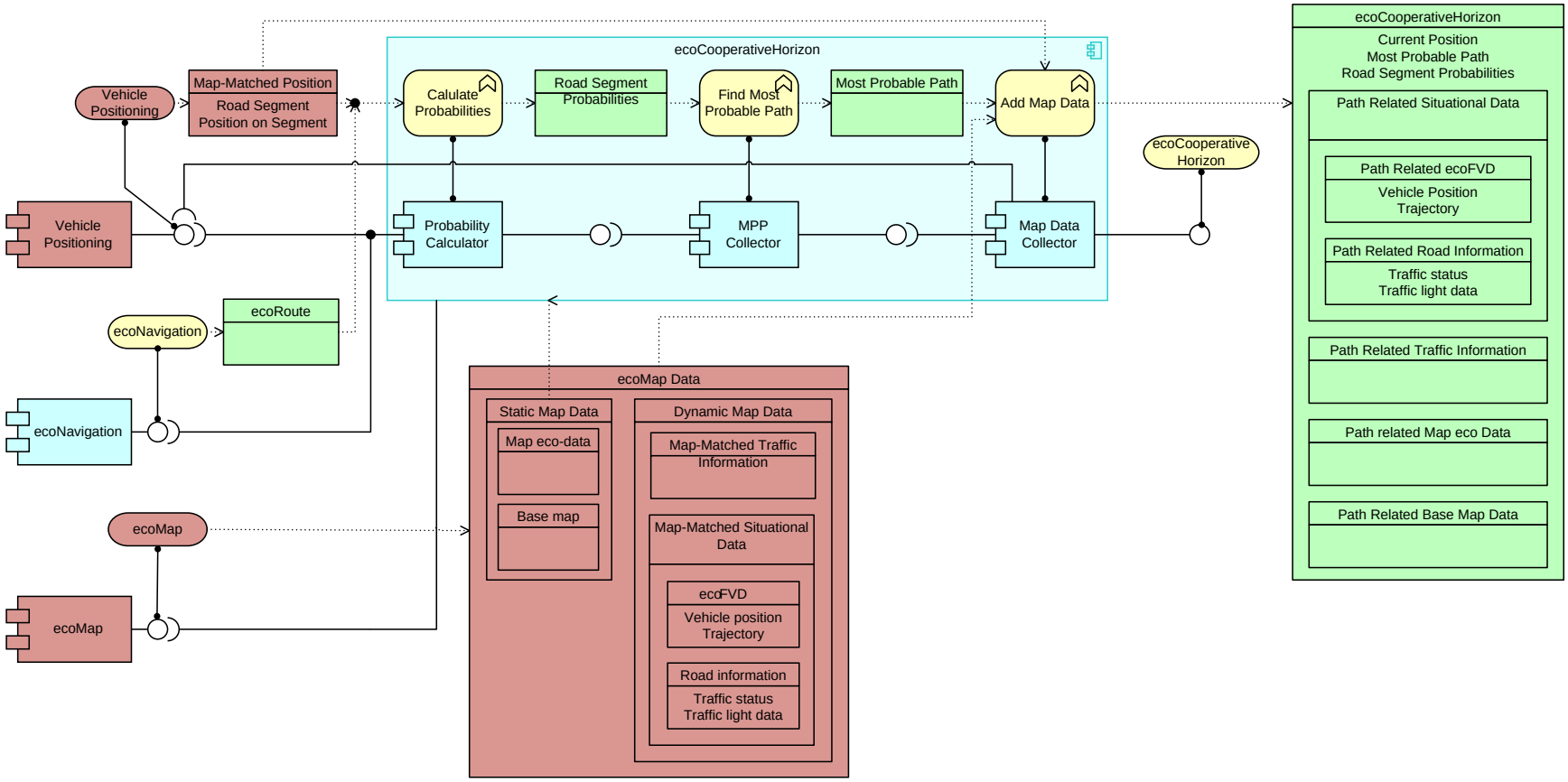

Figure 21: AL representation of ecoCooperativeHorizon

4.3.2. Technology Layer

The ecoCooperativeHorizon technical layer is very simple as there is no direct communication with components outside the vehicle.

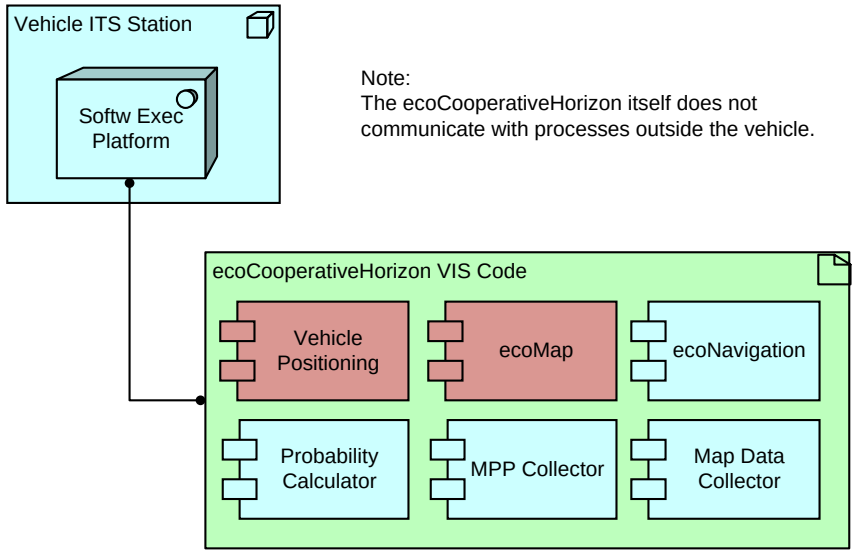

Figure 22: TL representation of ecoCooperativeHorizon

5. Interface Design

The interfaces between the SP3 applications and the other applications from SP2, SP4 and SP5 are represented in the following tables. They will be used to check with partners of the other SPs that the contents required from SP3 applications will be really available from the other SPs, and vice versa.

In addition, for each application an overall table of objects handled (also internally) has been produced which contains references to

- BL-diagrams
- Author
- Role
- Product
- Service
- Process(es)
- Event
- Data content

References to these General Object Exchange Tables are given in the Appendix A - List of General Object Exchange Tables in portrait format.

5.1. ecoTripPlanning

The ecoTripPlanning uses the Static Map Data from the ecoMap of SP2, and the Traffic Information (predicted and current) from the TCC/TMC of SP5. It will not provide any output to other SPs.

Table 2. Interfaces of ecoTripPlanning required from other SPs

REQUIRES								
SP	**Diagram**	**Author**	**Requires**	**Object**	**Required From**	**SP**	**Reference Diagram**	**Contact**
SP3	ecoTripPlanning	Elena Balocco, Sergio Damiani, Fabio Tosetto	Map eco-data Base Map Data	Static Map Data	ecoMap	SP2	ecoMap&relatedServices	Johannes Stille
SP3	ecoTripPlanning	Elena Balocco, Sergio Damiani, Fabio Tosetto	Predicted Traffic and current Information	Traffic Information	TCC/TMC	SP5	ImproveNetworkUsage	Christian Dowideit

5.2. ecoNavigation

The ecoNavigation requires the static map and dynamic map data from SP2 (ecoMap), and the RouteAdvice from SP5 (TCC/TMC).

Table 3. Interfaces of ecoNavigation required from other SPs

REQUIRES								
SP	**Diagram**	**Author**	**Requires**	**Object**	**Required From**	**SP**	**Reference Diagram**	**Contact**
SP3	ecoNavigation	Johannes Stille	map-matched situational data	dynamic map data	ecoMap	SP2	ecoMap&relatedServices	Johannes Stille
			map-matched traffic information	dynamic map data	ecoMap	SP2	ecoMap&relatedServices	
			static map	static map data	ecoMap	SP2	ecoMap&relatedServices	
			RouteAdvice	RouteAdvice	TCC/TMC	SP5	ImproveNetworkUsage	Christian Dowideit

The ecoNavigation generates the ecoRoute, which is delivered to SP5 (Traffic info provision).

Table 4. Interfaces of ecoNavigation provided to other SPs

PRODUCES								
SP	**Diagram**	**Author**	**Produces**	**Object**	**Delivered To**	**SP**	**Reference Diagram**	**Contact**
SP3	ecoNavigation	Johannes Stille	ecoRoute	ecoRoute	TCC/TMC	SP5	ImproveNetworkUsage	Christian Dowideit

5.3. ecoDrivingSupport

The ecoDrivingSupport application needs to receive from the ecoSituationalModel of SP2 the ecoSituationalData (current traffic situation, predicted velocity profile, and traffic situation).

Table 5. Interfaces of ecoDrivingSupport required from other SPs

REQUIRES								
SP	**Diagram**	**Author**	**Requires**	**Object**	**Required From**	**SP**	**Reference Diagram**	**Contact**
SP3	ecoDrivingSupport	Philipp Themann	ecoSituational Data	Current traffic situation	ecoSituational Model	SP2	ecoSituationalModel	Philipp Themann
				Predicted velocity profile				
				Predicted traffic situation				

The output of the ecoDrivingSupport regards the driver profile, which is used within SP3.

5.4. ecoInformation

The ecoInformation application requires only some vehicle parameters, provided by the gateway of the vehicle, and then it sends out some messages to the ecoHMI. For this reason it is not interfaced with other SPs applications.

5.5. ecoCooperativeHorizon

The ecoCooperativeHorizon requires several data from the ecoMap from SP2. Among others, the position of the vehicle is required from the positioning system.

Table 6. Interfaces of ecoCooperativeHorizon required from other SPs

REQUIRES								
SP	**Diagram**	**Author**	**Requires**	**Object**	**Required From**	**SP**	**Reference Diagram**	**Contact**
SP3	ecoCooperativeHorizon	Johannes Stille	Map-Matched Position	road segment position on segment	Vehicle Positioning	SP2		
SP3	ecoCooperativeHorizon	Johannes Stille	Static Map Data	Map eco-data Base Map Data	ecoMap	SP2	ecoMap	T'Siobbel, S.; Johannes Stille
SP3	ecoCooperativeHorizon	Johannes Stille	Dynamic Map Data / Map-Matched Traffic Information	-	ecoMap	SP2	ecoMap	T'Siobbel, S.; Johannes Stille
SP3	ecoCooperativeHorizon	Johannes Stille	Dynamic Map Data / Map-Matched situational data	ecoFVD Road information	ecoMap	SP2	ecoMap	T'Siobbel, S.; Johannes Stille

The results of the ecoCooperativeHorizon are all used from many services, internal to SP3, but also of SP2, SP4 and SP5.

Table 7. Interfaces of ecoCooperativeHorizon provided to other SPs

PRODUCES								
SP	**Diagram**	**Author**	**Produces**	**Object**	**Delivered To**	**SP2**	**Reference Diagram**	**Contact**
SP3	ecoCooperative Horizon	Johannes Stille	eco Cooperative Horizon	Current Position	ecoSituational Model	SP2	ecoSituationalModel	Philipp Themann
				Most Probable Path				
				Road Segment Probabilities	Truck EcoNavigation	SP4	TruckEcoNavigation	Johannes Stille
				Path related static map data				
				Path related traffic information	ecoDriverCoaching System	SP4	ecoDriverCoaching System	Vernet, Guillaume
				Path related situational data	ParkingGuidance	SP5	ParkingGuidance	Andy Rooke
				Path related Map eco-data				
				Path related Base Map Data				

6. Requirements traceability

The requirements traceability is important to verify that all requirements defined in the previous steps of the eCoMove project, within SP3, have been covered by the architecture design.

The requirements were previously collected in [1] and reported in the Appendix C - SP3 requirements for reference.
The requirements are here summarized and related to the applications using a traceability matrix, whose template is referenced in [2].
The matrix collects the requirements defined for each application, and shows which item of the application architecture covers the requirement itself.

In this deliverable the requirements related to the preTrip and onTrip applications are collected, together with the requirements of the ecoCooperativeHorizon. In the deliverable D3.3 the requirements of the postTrip applications, ecoHMI and TripDataSet are collected.

Table 8. Requirements traceability

Requirement	Design			Test Status	Note
	Application (Diagram)	(optional) eML Concept	BL|TL|AL		
ecotripplanning					
SP3-1-0001	ecoTripPlanning	VehicleParameters, PreTripDataEntered	BL, AL		
SP3-1-0002	ecoTripPlanning	Static Map Data	BL, AL,TL		
SP3-1-0003	ecoTripPlanning	Traffic Information from TCC/TMC	BL, AL, TL		
SP3-1-0004	ecoTripPlanning	Traffic Information from TCC/TMC	BL, AL, TL		
SP3-1-0005	ecoTripPlanning	Traffic Information from TCC/TMC	BL, AL, TL		
SP3-1-0006	ecoTripPlanning	Traffic Information from TCC/TMC	BL, AL, TL		
SP3-1-0007	ecoTripPlanning	ecoRecommendations	BL, AL		
SP3-1-0008	ecoTripPlanning	Component_PreTripDataEntered	BL, AL		Partially covered (not covers intermediate destination)
SP3-1-0009	ecoTripPlanning	Mobile Device, Ground IST Station	BL, AL, TL		
SP3-1-0010	ecoTripPlanning	Traffic Information from TCC/TMC	BL, AL, TL		
SP3-1-0011	ecoTripPlanning		BL		
SP3-1-0012	ecoTripPlanning		BL		
SP3-1-0013	ecoTripPlanning		BL		
SP3-1-0014	ecoTripPlanning		BL		
ecoInformation					
SP3-2-0001	ecoInformation	VehicleParameters, ecoRecommendations	BL, AL		
SP3-2-0002	ecoInformation	VehicleParameters, ecoRecommendations	BL, AL		
SP3-2-0003	ecoInformation	VehicleParameters,	BL, AL		

		ecoRecommendations			
SP3-2-0004	ecoInformation	VehicleParameters, ecoRecommendations	BL, AL		
SP3-2-0005	SP4 diagram				Strictly related to SP4, so it will be covered by ecoDriverCoachingSystem application
SP3-2-0006	SP4 diagram				Strictly related to SP4, so it will be covered by ecoDriverCoachingSystem application
SP3-2-0007	SP4 diagram				Strictly related to SP4, so it will be covered by ecoDriverCoachingSystem application
SP3-2-0008	ecoInformation	VehicleParameters, ecoRecommendations	BL,AL		
SP3-2-0009	ecoInformation	VehicleParameters, ecoRecommendations	BL,AL		
SP3-2-0010	ecoInformation	VehicleParameters, ecoRecommendations	BL,AL		
SP3-2-0011	ecoInformation	VehicleParameters, ecoRecommendations	BL,AL		
SP3-2-0012	ecoInformation	VehicleParameters, ecoRecommendations	BL,AL		
SP3-2-0013	ecoInformation		BL		
SP3-2-0014	ecoInformation		BL		
SP3-2-0015	ecoInformation		BL		
SP3-2-0016	ecoInformation		BL		

SP3-2-0017	ecoInformation		BL		
ecoNavigation					
SP3-3-0001	ecoNavigation	Get Trip Data	BL,AL		
SP3-3-0002	ecoNavigation	Calculate Route	BL,AL		
SP3-3-0003	ecoNavigation	Use Most Probable Path as Route	BL		
SP3-3-0004	ecoNavigation	Warn of Impossible Route	BL,AL		
SP3-3-0005	ecoNavigation	Energy Consumption Estimator	AL		
SP3-3-0006	ecoNavigation	Get Vehicle Parameters	BL,AL		
SP3-3-0007	ecoNavigation	Calculate Route	BL,AL		
SP3-3-0008	ecoNavigation	Get Traffic Information Get Situational Data	BL,AL		
SP3-3-0009	ecoNavigation	Get Situational Data	BL,AL		
SP3-3-0010	ecoNavigation	Get Route Advice	BL,AL		
SP3-3-0011	ecoNavigation	Data Available (Trigger)	BL		
SP3-3-0012	ecoNavigation	Off Route (Trigger)	BL		
SP3-3-0013	ecoNavigation	Guide Driver Give Instructions	BL,AL		
SP3-3-0014	ecoNavigation	Guide Driver Give Instructions	BL,AL		
SP3-3-0015	ecoNavigation	Calculate Route Energy Consumption Estimator	BL,AL		
SP3-3-0016	ecoNavigation	ecoNavigation	BL,AL		
SP3-3-0017	ecoNavigation	Get Traffic Information	BL,AL		
SP3-3-0018	ecoNavigation	Get Situational Data	BL,AL		
SP3-3-0019	ecoNavigation	Use Most Probable Path as Route	BL		
SP3-3-0020	ecoNavigation	Get Route Advice	BL,AL		
SP3-3-0021	ecoNavigation	Calculate Route	BL,AL		

SP3-3-0022	ecoNavigation	ecoNavigation	BL,AL		
SP3-3-0023	ecoNavigation	Calculate Route	BL,AL		
SP3-3-0024	ecoNavigation	Calculate Route	BL,AL		
SP3-3-0025	ecoNavigation	Calculate Route	BL,AL		
ecoDriving Support					
SP3-4-0001	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0002	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0003	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0004	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0005	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0006	ecoDrivingSupport	ecoSituational Model	BL, AL		
SP3-4-0007	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0008	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0009	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0010	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0011	ecoNavigation	ecoNavigation process	BL, AL		
SP3-4-0012	ecoDrivingSupport	ecoDriving Recommendations	BL, AL		
SP3-4-0013	ecoNavigation	ecoNavigation process	BL, AL		
ecoCooperativeHorizon					
SP3-8-0001	ecoCooperativeHorizon	Current Position	BL, AL		
SP3-8-0002	ecoCooperativeHorizon	Most Probable Path	BL, AL		
SP3-8-0003	ecoCooperativeHorizon	Path Related Base Map Data, Path Related Map eco Data	BL, AL		
SP3-8-0004					Requirement on overall system.
SP3-8-0005	ecoNavigation	ecoRoute	BL, AL		
SP3-8-0006					Requirement on ecoMap.

SP3-8-0007					Requirement on overall system.
SP3-8-0008					Requirement on ecoMap.
SP3-8-0009					Requirement on overall system.
SP3-8-0010					Requirement on ecoMap.
SP3-8-0011					Requirement on communications subsystem.
SP3-8-0012	ecoCooperativeHorizon	Most Probable Path	BL, AL		
SP3-8-0013					Requirement on communications subsystem.
SP3-8-0014					Requirement on communications subsystem.
SP3-8-0015					Requirement on communications subsystem.
SP3-8-0016					Requirement on communications subsystem.
SP3-8-0017					Requirement on communications subsystem.
SP3-8-0018					Requirement on communications subsystem.
SP3-8-0019					Requirement on communications subsystem.
SP3-8-0020					Requirement on communications subsystem.
SP3-8-0021					Requirement on communications subsystem.
SP3-8-0022					Requirement on communications subsystem.

SP3-8-0023					Requirement on infrastructure.
SP3-8-0024					Requirement on communications subsystem.
SP3-8-0025					Requirement on ecoMap and overall system.
SP3-8-0026					Requirement on communications subsystem.
SP3-8-0027					Requirement on communications subsystem.
SP3-8-0028					Requirement on communications subsystem.

Appendix A - List of General Object Exchange Tables

Tables of objects required from and provided for other SPs are given and explained per application in Chapter 5. In addition, for each application an overall table of objects handled (also internally) has been produced which contains references to

- BL-diagrams
- Author
- Role
- Product
- Service
- Process(es)
- Event
- Data content

Table 9. ecoTripPlanning table of Inputs/Outputs

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	ecoTripPlanning	Elena Balocco, Sergio Damiani, Tosetto Fabio, De Gennaro Marilina	eCoMove	preTrip	ecoTripPlanning	Plan ecoTrip	P: PreTrip Data Entry	VehicleParameters	Type of Fuel	PreTripDataEnterd	Departure Time
									Category Euro		Starting Point
									Weight		Arrival Time
									Dimension width		Destination Point
									Dimension length		Present Navigation Preferences
									Dimension height		Vehicle Parameters
									Gear Manual or Automatic		-
									Number of Gear		-
							P: Show Route(s) to the driver	RouteToBeConfirmed	Nothing	RouteConfirmed	-
									One or more		
							E: Driver accepts the route	-	-	-	-
							E: No Route	-	-	-	-
							P: Save Planned Route	RouteConfirmed	Route	Out of Car Data / plannedRouteOutOfCar	Departure Time
											Starting Point
											Arrival Time
											Destination Point
											Navigation Preferences
											Driver Profile
											Confirmed Route
										Out of Car Data / DriverProfile	Driver ID
											Driver Behaviour
											Driver Preferences
								DriverProfile	Driver ID	In-Vehicle Data / plannedRoute	Departure Time
											Starting Point
											Arrival Time
											Destination Point
											Navigation Preferences
											Confirmed Route
							P: PreTrip Check Route	StoredPlannedRoute	ConfirmedRoute	-	-
									NavigationPreferences		
							P: Create Information	-	-	ecoRecommendations	Route accepted
											Route updated

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	ecoTripPlanning	Elena Balocco, Sergio Damiani, Tosetto Fabio, De Gennaro Marilina	eCoMove								Route updated
				-	Calculate Route	-	P: Search for a Route	PreTripDataEnterd	Departure Time	RouteToBeConfirmed	Nothing
									Starting Point		
									Arrival Time		
									Destination Point		
									Present navigation Preferences		One or more Routes
									Vehicle Parameters		
								Traffic information from TCC/TMC (predicted traffic and current situation)	Historical taffic data		
				-	-	-	E: Ignition On and/or Engine On	-	-	-	-
				-	-	-	P: User Input (ecoHMI)	-	-	-	-
				-	-	-	P: Confirm Driver ID	DriverProfile	Driver ID	DriverProfile	Driver ID
				OEM Gateway	Collection Vehicle Data decouples the needed signals and data from the proprietary CAN protocol.	-	-	-	-	In - Vehicle Data / VehicleParameters	Type of Fuel
											Category Euro
											Weight
											Dimension width
											Dimension length
											Dimension height
											Gear Manual or Automatic
											Number of Gear
										In - Vehicle Data / VehicleData	Ignition (On/Off)
											Engine (on/Off)

Table 10. ecoInformation table of Inputs/Outputs

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	eco Information	Tosetto Fabio, Marilina De Gennaro	eCoMove	preTrip & ecoSmart Driving	Eco Information	Provide Recommendation	E: Ignition On and /or Engine On				
							P: Get VehicleParameters from Vehicle	In - Vehicle Data /Vehicle parameters	PreviousKmOilControl	In - Vehicle Data /Vehicle parameters	PreviousKmOilControl
									DeltaKmOilControl		DeltaKmOilControl
									PreviousTimeOilControl		PreviousTimeOilControl
									DeltaTimeOilControl		DeltaTimeOilControl
									DeltaKmTirePressureControl		DeltaKmTirePressureControl
									PreviousKmPressureControl		PreviousKmPressureControl
									DeltaTimeTirePressureControl		DeltaTimeTirePressureControl
									PreviousTimeTirePressureControl		PreviousTimeTirePressureControl
									DeltaKmFiltersControl		DeltaKmFiltersControl
									PreviousKmFiltersControl		PreviousKmFiltersControl
									DeltaTimeFiltersControl		DeltaTimeFiltersControl
									PreviousTimeFiltersControl		PreviousTimeFiltersControl
									Pressure of 4 tires		Pressure of 4 tires
									Oil status		Oil status
									Filters status		Filters status
									Vehicle loading		Vehicle loading (if available)
									Vehicle Aerodynamics Inefficiencies		Vehicle Aerodynamics Inefficiencies
									Electrical Consumers		Electrical Consumers
							P: Get VehicleData from Vehicle	In - Vehicle Data / Vehicle Data	Current Driven km	In - Vehicle Data / Vehicle Data	Current Driven km
									Current Time		Current Time
									Ignition (on/off)		Ignition (on/off)
									speed (km/h)		speed (km/h)
									engine (on/off)		engine (on/off)

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	eco Information	Tosetto Fabio, Marilina De Gennaro	eCoMove	preTrip & ecoSmartDriving	Eco Information	Provide Recommendation	P: Automatic Check	In - Vehicle Data /Vehicle parameters	PreviousKmOilControl	Eco Recommendations	check air filters / check tire pressure/ check oil status/Switch off electrical consumer /Inflat tires next station/Repair tire asap
									DeltaKmOilControl		
									PreviousTimeOilControl		
									DeltaTimeOilControl		
									DeltaKmTirePressureControl		
									PreviousKmPressureControl		
									DeltaTimeTirePressureControl		
									PreviousTimeTirePressureControl		
									DeltaKmFiltersControl		
									PreviousKmFiltersControl		
									DeltaTimeFiltersControl		
									PreviousTimeFiltersControl		
									Pressure of 4 tires		
									Oil status		
									Filters status		
									Electrical Consumers		
								In - Vehicle Data / Vehicle Data	Current Driven km		
									Current Time		
									Ignition (on/off)		
									speed (km/h)		
									engine (on/off)		
							P: Vehicle Loading Check (pre Trip only)	In - Vehicle Data /Vehicle parameters	Vehicle loading	ecoRecommendations	check appropriate vehicle loading
							P: Aerodynamics check (onTrip only)	In - Vehicle Data /Vehicle parameters	Vehicle Aerodynamics Inefficiencies	ecoRecommendations	check appropriate vehicle loading
							P: Generate Recommendations to the driver	ecoRecommendations		ecoRecommendations	Switch off electrical consumer
											Inflat tires next station
											Repair tire asap
											check air filters
											check tire pressure
											check oil status
											check appropriate vehicle loading
											over-consumption of fuel
											Vehicle Aerodynamics Inefficiencies

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	eco Information	Tosetto Fabio, Marilina De Gennaro	eCoMove	OEM Gateway	Collection Vehicle Data decouples the needed signals and data from the proprietary CAN protocol.	-	-	-	-	In - Vehicle Data /Vehicle parameters	PreviousKmOilControl
											DeltaKmOilControl
											PreviousTimeOilControl
											DeltaTimeOilControl
											DeltaKmTirePressureControl
											PreviousKmPressureControl
											DeltaTimeTirePressureControl
											PreviousTimeTirePressureControl
											DeltaKmFiltersControl
											PreviousKmFiltersControl
											DeltaTimeFiltersControl
											PreviousTimeFiltersControl
											Pressure of 4 tires
											Oil status
											Filters status
											Vehicle loading
											Vehicle Aerodynamics Inefficiencies
											Electrical Consumers
										In - Vehicle Data / Vehicle Data	Current Driven km
											Current Time
											Ignition (on/off)
											speed (km/h)
											engine (on/off)

Table 11. ecoNavigation table of Inputs/Outputs

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	ecoNavigation	Johannes Stille	eCoMove	ecoSmartDriving	ecoNavigation	ecoNavigation	E:Data Available	-	-	-	-
							P: Get Driver Profile	DriverProfile	Driver ID	DriverProfile	Driver ID
									Driver Behaviour		Driver Behaviour
									Driver Preferences		Driver Preferences
							P: Get Route from ecoTripPlanning	PlannedRoute	-	TripData	Destination
							P: Use Most ProbablePath as Route	MostProbablePath	-		NavigationPreference (Fuel/time trade-off)
							P: Get Trip Data	TripData	-		
							P: Get Vehicle Parameters	VehicleParameters	-	Vehicle Parameters	Weight
							P: Get Traffic Information	Map-matched traffic information	-	Traffic Information	-
							P: Get Situational Data	Map-matched situational data	-	SituationalData	-
							P: Get Route Advice	Route Advice	-	Route Advice	-
							P: Warn of Impossible Route	-	-	ErrorMessages	
							E: Route available	-	-	-	-
							E: Off Route	-	-	-	-
							E: Off Time	-	-	-	-
							P: Send Route to Traffic Centre	ecoRoute	-	ecoRoute	-
							P:Guide Driver	CurrentPosition	-	GuidanceInstructions	Driver Istructions
								ecoRoute	-		
							P:ProvideRoutetoecoCooperativeHorizon	ecoRoute	-	ecoRoute	-
							P: StorePlannedRoute	ecoRoute	-	StoredPlannedRoute	-

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data

SP3	ecoNavigation	Johannes Stille	eCoMove	-	Calculate Route	-	P:Search for a route	TripData	Destination	ecoRoute	ecoRoute
									NavigationPreference (Fuel/time trade-off)		
								Vehicle Parameters	Weight		
								Traffic Information	-		
								SituationalData	-		
								Route Advice	-		
								DriverProfile	Driver ID		
									Driver Behaviour		
									Driver Preferences		
								CurrentPosition	-		
								static map data	-		
				preTrip	ecoTripPlanning	-	-	StoredPlannedRoute	-	PlannedRoute	DepartureTime
											StartingPoint
											ArrivalTime
											DestinationPoint
											NavigationPreferences
											ConfirmedRoute
				ecoSmartDriving	ecoCooperative Horizon	-	-	ecoRoute	-	MostProbablePath	-
										CurrentPosition	-
				ecoHMI	ecoHMI	-	-	ErrorMessages	-	VehicleParameters	-
								GuidanceInstructions		TripData	
				-	ecoMap	-	-	-	-	Static map data	Static map data
										Dynamic map data	Map-matched situational data
											Map-matched traffic
			TCC/TMC	TCC/TMC	Traffic Info provision	-	-	ecoRoute	-	RouteAdvice	-

Table 12. ecoDrivingSupport table of Inputs/Outputs

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	ecoDrivingSupport	Philipp Themann	eCoMove	ecoSmartDriving	ecoDrivingSupport	create ecoDriving Recommendation	P: Optimize longitudinal and lateral behaviour	ecoSituational DATA	Current Traffic Situation	-	-
									Predicted velocity profile	-	-
									Predicted traffic situation	-	-
								DriverProfile	Driver ID		
									Driver preferences		
									Driver behaviour		
								VehicleParameters	Type of Fuel	-	-
									Category Euro	-	-
									Weight	-	-
									Dimension width	-	-
									Dimension length	-	-
									Dimension height	-	-
									Gear Manual or Automatic	-	-
									Number of Gear	-	-
								VehicleData	Speed	-	-
									RPM	-	-
									Brake Pedal Status	-	-
									Cruise Control	-	-
									Clutch status	-	-
									Stop & Start function	-	-
									Gas Pedal	-	-
									Acceleration longitudinal	-	-
									Acceleration lateral	-	-
								ecoCooperativeHorizon	Current Position	-	-
									Most Probable Path	-	-
									Road Segment Probabilities	-	-
									Path Related Situational Data	-	-
									Path Related Traffic Information	-	-
									Path Related Map eco Data	-	-
									Path Related Base Map Data	-	-

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	ecoDrivingSupport	Philipp Themann	eCoMove				P: Derive recommendations	DriverProfile	Driver ID	ecoRecommendations	Derived recommendations - gear, acceleration, HMI modality
									Driver preferences		
									Driver behaviour		
								ecoSituational DATA	Current Traffic Situation		
									Predicted velocity profile		
									Predicted traffic situation		
								VehicleParameters	Type of Fuel		
									Category Euro		
									Weight		
									Dimension width		
									Dimension length		
									Dimension height		
									Gear Manual or Automatic		
									Number of Gear		
								VehicleData	Speed		
									RPM		
									Brake Pedal Status		
									Cruise Control		
									Clutch status		
									Stop & Start function		
									Gas Pedal		
									Acceleration longitudinal		
									Acceleration lateral		
				ecoHMI	ecoHMI	-	-	ecoRecommendations	Derived recommendations - gear, acceleration, HMI modality	ecoRecommendations	ecoHMI instruction- How as information been provided to driver
				OEM Gateway	Collection Vehicle Data	-	-	-	-	In - Vehicle Data / VehicleParameters	Type of Fuel
											Category Euro
											Weight
											Dimension width
											Dimension length
											Dimension height
											Gear Manual or Automatic

											Number of Gear
										In - Vehicle Data / VehicleData	Speed, RPM
											Gas Pedal, Brake Pedal Status
											Cruise Control
											Clutch status
											Stop & Start function
											Acceleration longitudinal / lateral

Table 13. ecoCooperativeHorizon table of Inputs/Outputs

SP	Diagram	Author	Role	Product	Service	Main Process	Process (P) / Event (E)	Input Objects	Input Data	Output Objects	Output Data
SP3	eco CooperativeHorizon	Stille Johannes	eCoMove	ecoSmartDriving	Eco Cooperative Horizon	Horizon Calculation	P: Calculates Probabilities	Map-Matched Position	Road Segment	Road Segment Probabilities	-
									Position on Segment		
								ecoRoute	ecoRoute		
							P: Find Most Probable Path	Road Segment Probabilities	-	Most Probable Path	-
							P: Add Map Data	Most Probable Path	-	eco CooperativeHorizon	Current Position
											Most Probable Path
											Road Segment Probalities
								Map-Matched Position	Road Segment		Path related situational data: - Path related ecoFVD - vehicle position - Path related ecoFVD - trajectory - Path related Road Information - traffic status - Path related Road Information - traffic light data
									Position on Segment		
								Dynamic Map Data	Map Matched Traffic Information		Path related traffic information
								Dynamic Map Data	Map Matched Situational Data: ecoFVD - vehicle position ecoFVD - trajectory Road Information - traffic status Road Information - Traffic light data		Path related Map eco-data
											Path related Base Map Data
					ecoNavigation	-	-	-	-	ecoRoute	-
				ecoMap	-	-	-	-	-	static Map data	map eco data
											base map
										Dynamic Map Data	map matched traffic information
											map matched situational data:

											- ecoFVD - vehicle position - ecoFVD - trajectory - road information - traffic status - road information- traffic light data

Appendix B - Diagrams including all applications

This Appendix is composed by two diagrams which represent the connections among all applications.

The BL diagram shows the inputs/outputs sequence for all applications, showing how they are connected each other.

The TL diagram, in a more generic meaning with respect to the single diagrams for the single applications, shows how a generic vehicle should be equipped to be an eCoMove vehicle.

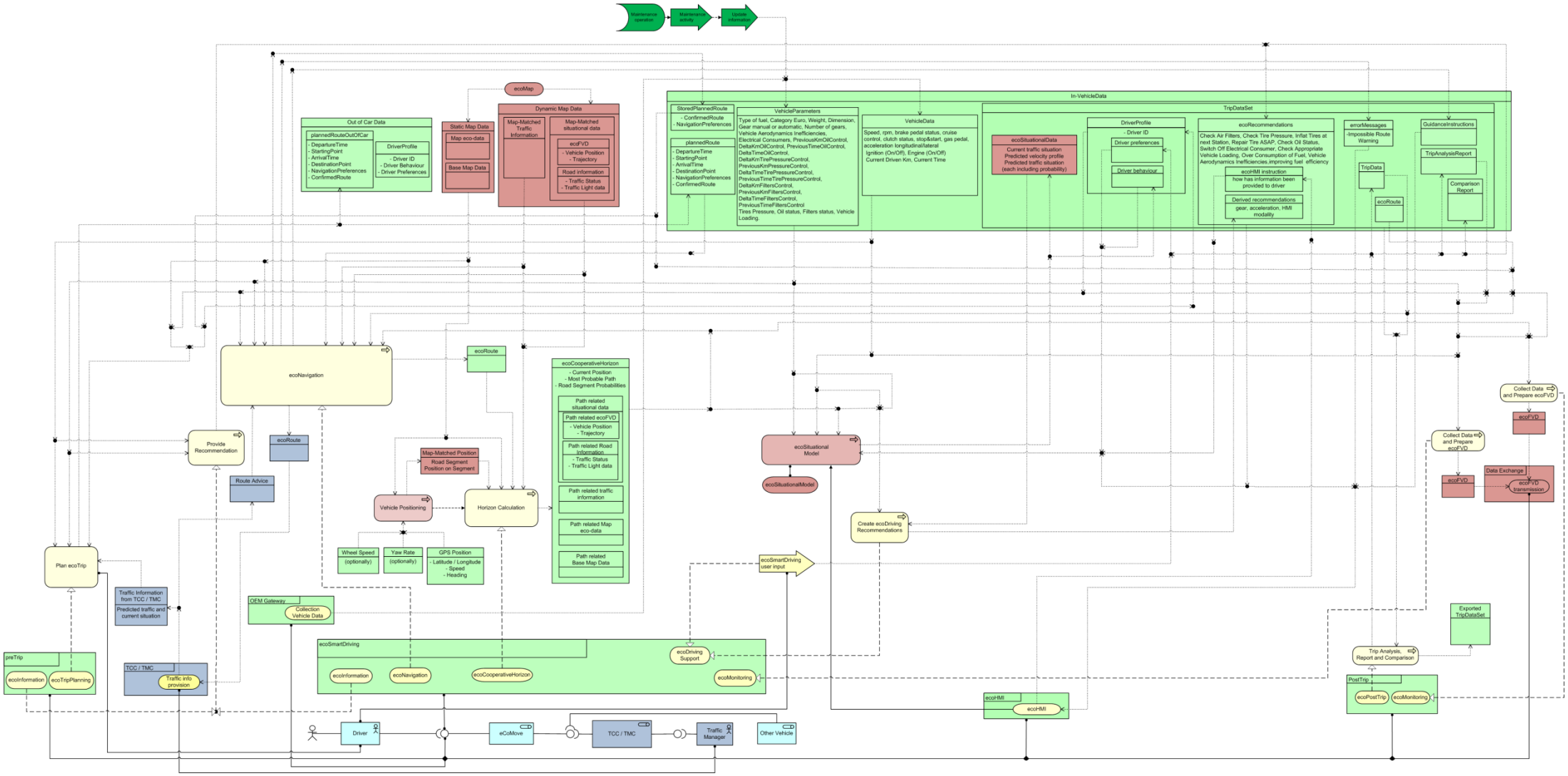

Figure 23: BL representation of all SP3 applications

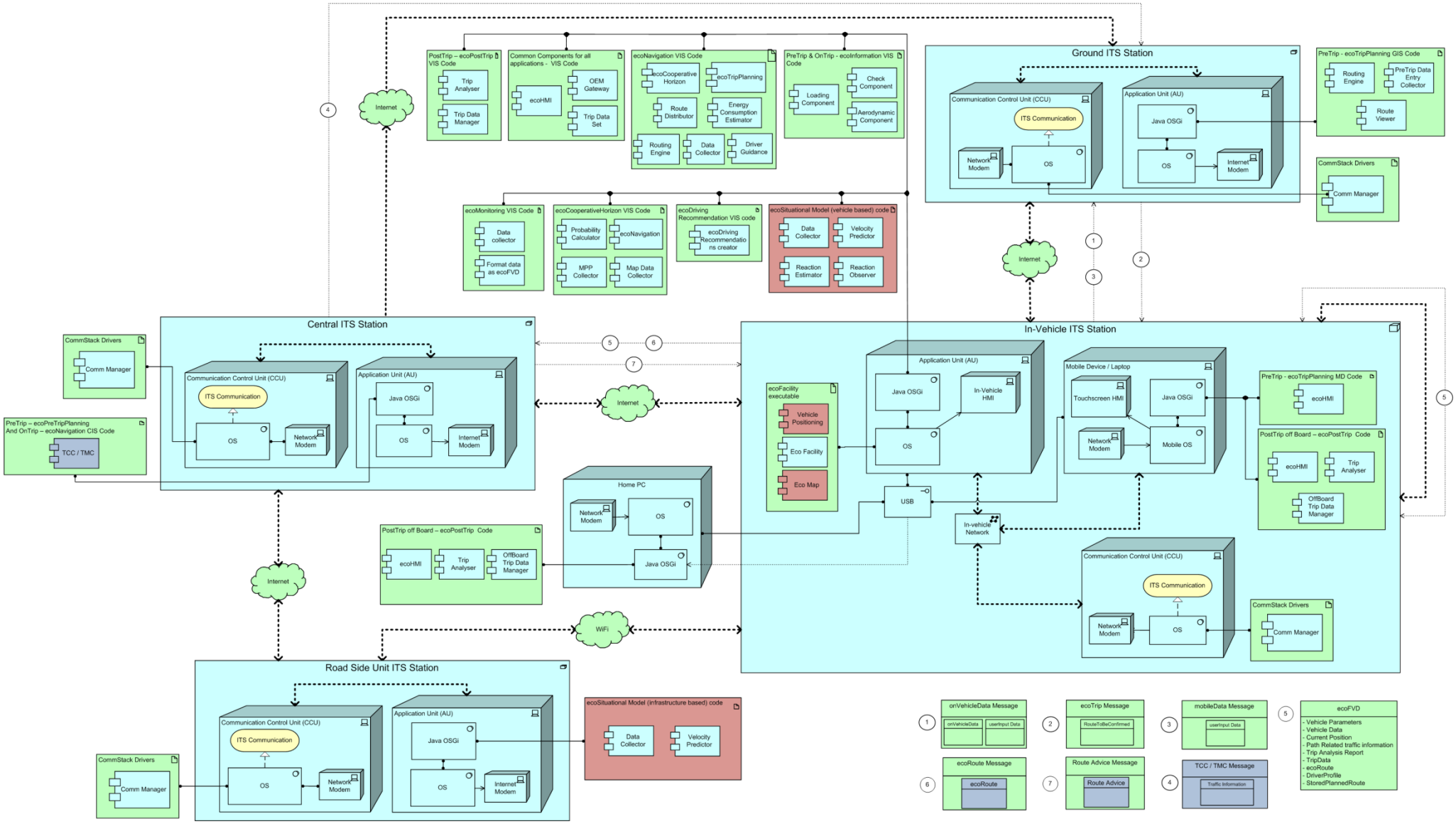

Figure 24: TL representation of all SP3 applications

Appendix C - SP3 requirements

The requirements table comes from [1] and it has been reported here for reference for the traceability matrix.

The first column consist of a requirement number of the format **SP3** - **X** - **XXXXx**

SP3 – stands for ecoSmartDriving subproject
X – the number for the application/ component
Applications: *1 – ecoTripPlanning, 2 – ecoInformation, 3 - dynamic ecoNavigation, 4 - ecoDriving Support, 5 – ecoPostTrip application, 6 – ecoMonitoring*
Components: *7 – ecoHMI, 8 – ecoCooperativeHorizon, 9 - TripDataSet*
XXXX– is the actual number of the requirement
In case several requirements are closely related then they have the same sequential number indexed by a trailing alphabet (e.g. XXXXx - 0001a)

The second column in the Table 14 consists of the type of the requirement. The possible types are shown in the Table below.

Type	Abbreviation
Cultural & Political	CP
Functional	F
Legal	L
Maintainability & Support	MS
Performance	P
Usability & Humanity	UH
Look & Feel	LF
Operational & Environmental	OE
Security	S

The third column of Table 14 has the first row, Description, which explains the intention of the requirement, and the second row, Rationale, which explains the fundamental reason of why such a requirement is needed.

Table 14. SP3 Requirement table.

SP3-1-0001	F	**Description**: The system needs to collect from the user and/or from the vehicle the necessary information in order to determine an optimal route. The necessary data are the following: • Vehicle type (in case it is a vehicle that is not enabled to drive through certain areas) • From (start location) • To (location destination) • When (date and time of the trip)
		Rationale: Building block for ecoTripPlanning
SP3-1-0002	F	**Description**: The system needs enhanced maps data to determine the ecoRoute. To determine the ecoRoute the system needs additional data from digital maps (e.g. road slope)
		Rationale: Building block for ecoTripPlanning
SP3-1-0003	F	**Description**: Availability of additional information to increase the function performance. The preTrip function will be able to perform better route computing if historical traffic data will be available for each road segment. These data potentially are provided by external service / function.
		Rationale: Building block for ecoTripPlanning
SP3-1-0004	F	**Description**: The functions should be able to take care of local traffic restrictions. Municipality frequently proposes temporary traffic restriction. The ability to consider them makes the result more useful. These data potentially are provided by external service / function.

		Rationale: Building block for ecoTripPlanning
SP3-1-0005	F	**Description**: A link to external services is necessary to provide the system with data which are not locally available. Data as historical data, traffic limitation etc. are available from external services.
		Rationale: Building block for ecoTripPlanning
SP3-1-0006	F	**Description**: In case the departure / arrival time entry of the user is not specified, the ccoTripPlanning application should enable trip timing optimisation (departure/arrival time) based on TrafficStatePrediction if fuel consumption can be reduced with an alternative timing.
		Rationale: Building block for ecoTripPlanning
SP3-1-0007	F	**Description**: In case the arrival time is fixed the ecoTripPlanning application should be able to warn the driver if the travel time changes before the trip has started.
		Rationale: Building block for ecoTripPlanning
SP3-1-0008	OE	**Description**: The ecoTripPlanning application should use the ecoRouting component to determine the least fuel consuming route based on one or more of the following entries from the user: a. Origin b. Destination c. Intermediate destination d. Arrival time e. Departure time f. Vehicle ID
		Rationale: In order to calculate the optimal route.

SP3-1-0009	OE	**Description**: The ecoTripPlanning application should be available off board and on-board of the vehicle a. Off-board availability should be enabled via a mobile device or via PC b. On-board access via TBD device
		Rationale: In order to help the user plan ahead of the trip and indpendent of the car
SP3-1-0010	OE	**Description**: The ecoTripPlanning application should be able to access TrafficStatePredictions (SP5) to enable the user to perform the following check: a. One day or more before the trip: based on historic traffic profiles – check should be done daily b. Day of the trip: prediction of traffic state based on actual traffic situation – check should be done each hour
		Rationale: For providing optimal suggestions
SP3-1-0011	UH	**Description**: Acceptance for ecoTripPlanning application: the function should represent an opportunity for the user
		Rationale:
SP3-1-0012	UH	**Description**: Usability of data input: the interface should be easy to use
		Rationale:
SP3-1-0013	UH	**Description**: Usability of data output: the result should be easy to be used
		Rationale:
SP3-1-0014	UH	**Description**: Usability the ecoTripPlanning application: the system should be easy, effective and safe to interact with
		Rationale:
SP3-2-0001	F	**Description**: The driver is informed on the tires pressure status, and receives a recommendation when necessary, encouraging to inflat tires to an optimized pressure value to reduce the rolling resistance, and thus reduce the fuel consumption.

		Rationale: Reducing the rolling resistance by over-flatted tires (+10%)
SP3-2-0002	F	**Description**: The driver is informed on the best practices related to aerodynamics influence: encouraging to dismount unused luggage racks in order to reduce the aerodynamic resistance.
		Rationale: Reducing the aerodynamic resistance by mounting (spoiler for truck) or dismounting accessory (luggage rack,..) .
SP3-2-0003	F	**Description**: The driver is informed on the best practices related to weight influence, encouraging to remove unused weights on passenger car or unused trailers on trucks in order to reduce significantly weight.
		Rationale: Reducing the extra-weight on trip
SP3-2-0004	F	**Description**: The driver is informed and encouraged when necessary to deactivated (manually) some electrical consumers (AC, electrical heater systems, radio/video, auxiliaries plugged on "car cigar-jack",...) in order to reduce the torque resistance from alternator, and thus reducing fuel consumption and/or saving battery energy during trip.
		Rationale: Reducing the torque resistance and saving battery energy.
SP3-2-0005	OE	**Description**: Outputs to: SP4 : ecoHMI interface - PreTrip ecoInformation encouraging to mount a spoiler for cockpit roof on trucks in order to reduce the aerodynamic resistance.
		Rationale: Interface required
SP3-2-0006	OE	**Description**: Outputs to : SP4 : ecoHMI interface - OnTrip ecoInformation displaying in real time the current lost of fuel in order to induce the mounting of the spoiler..

		Rationale: Interface required
SP3-2-0007	OE	**Description**: Outputs to : SP4 : ecoHMI interface - PostTrip ecoInformation displaying in real time the total lost of fuel in order to induce the mounting of the spoiler..
		Rationale: Interface required
SP3-2-0008	OE	**Description**: Outputs to: SP3 : ecoHMI interface - PreTrip ecoInformation encouraging to dismount luggeage track from the roof in order to reduce the aerodynamic resistance.
		Rationale: Interface required
SP3-2-0009	OE	**Description**: Outputs to : SP3 : ecoHMI interface - ON Trip ecoInformation :displaying in real time the current over-consumption of fuel due to aerodynamic lost.
		Rationale: Interface required
SP3-2-0010	OE	**Description**: Outputs to : SP3 : ecoHMI interface - PostTrip ecoInformation displaying in real time the total over-consumption of fuel
		Rationale: Interface required

SP3-2-0011	OE	**Description**: Inputs from : SP3 : ecoDriving - PreTrip/ OnTrip/ PostTrip Engine variables (torque, consumption, engine speed, AC switch, State of charge, engine temp...), TireGuard system variables, Vehicle sensor variables (contacts)
		Rationale: Interface required
SP3-2-0012	P	**Description**: The ecoInformation related to the tire guard function must have 3 levels of pressure. ecoLevel = Comfort Level + 10 % Comfort Level= Pressure advised by manufacturer. Safety Level = Comfort. The precision of the pressure acquisition must have an appropriate tolerance. The recurrency of the acquisition is at least every 10 secondes.
		Rationale: Precision and Measurement recurrency
SP3-2-0013	P	**Description**: The ecoInformation system related to the optimizing electrical consumers should able to measure electrical data from power net (power, current, voltage) with the precision (10% power of the smallest consumption). The measure is done before any regulation by the alternator or other regulator.
		Rationale: Precision and Measurement recurrency
SP3-2-0014	UH	**Description**: ecoInformation can display the tires pressure status, encouraging to inflat tires to an optimized pressure value to reduce the rolling resistance, and thus reduce the fuel consumption. ecoInformation can include information on potential consumption loss, money or range gain if tires are not correctly inflated. ecoInformation can inform on the nearest station for inflating tires.

		Rationale: Reducing the rolling resistance by over-flatted tires (+10% standart pressure)
SP3-2-0015	UH	**Description**: ecoInformation can inform on the best practices related to aerodynamics influence, encouraging to dismount unused luggage racks and/or to mount a spoiler for cockpit roof on trucks in order to reduce the aerodynamic resistance. ecoInformation can include information on potential consumption loss, money or range gain during pre-trip, trip and post-trip..
		Rationale: Reducing the aerodynamic resistance by mounting (spoiler for truck) or dismounting accessory (luggage rack,..) .
SP3-2-0016	UH	**Description**: ecoInformation can inform on the best practices related to weight influence, encouraging to remove unused weights on passenger car or unused trailers on trucks in order to reduce significantly weight. ecoInformation can include information on potential consumption loss, money or range gain during pre-trip, trip and post-trip.
		Rationale: Reducing the extra-weight on trip Informing the fuel saving / CO2-emission reduction estimated up to xx%.
SP3-2-0017	UH	**Description**: ecoInformation can inform and encourage when necessary to deactivated (manually) some electrical consumers (AC, electrical heater systems, radio/video, auxiliaries plugged on "car cigar-jack",...) in order to reduce the torque resistance from alternator, and thus reducing fuel consumption and/or saving battery energy during trip. ecoInformation can include information on potential consumption (money and range) loss, if non necessary loads are activated. ecoInformation can provide information in Pre-trip phase, during Trip, and on Post-trip phases as well, with different priorities and contents depending on driving conditions
		Rationale: Reducing the torque resistance and saving battery energy. Best fuel saving reduction in extreme conditions (AC on traffic jam in summer…) for passenger car (incl. hybrid) and trucks.
SP3-3-0001	F	**Description**: User must be able to select destination.

		Rationale: Routing requires a destination to route to.
SP3-3-0002	F	**Description**: dynamic ecoNavigation must generate a route to the destination.
		Rationale: This is the very purpose of routing.
SP3-3-0003	F	**Description**: dynamic ecoNavigation must check alternatives to MPP when no destination is known.
		Rationale: Even without a final destination, it's possible to find more fuel-efficient alternatives to the road ahead of the vehicle.
SP3-3-0004	F	**Description**: dynamic ecoNavigation should warn of impossible routes.
		Rationale: The system shouldn't guide the driver through illegal maneuvers without at least informing the driver.
SP3-3-0005	F	**Description**: Green route must be fuel-efficient.
		Rationale: This is what makes the route a green route. Unfortunately, there is no way to set a requirement on the actual fuel savings (compared to what?) in advance; and since routing needs some heuristics for performance reasons, it's not feasible to require the route to be the very optimum route – one at most can require a good enough route.
SP3-3-0006	F	**Description**: dynamic ecoNavigation should make use of vehicle parameters.
		Rationale: The least fuel consuming route might depend in some cases on vehicle data like mass, cw (aerodynamic drag coefficient), cross section, or motor properties.
SP3-3-0007	F	**Description**: dynamic ecoNavigation should make use of historic traffic patterns.

		Rationale: The least fuel consuming route depends on the possible speeds along the route which can be estimated from collected data.
SP3-3-0008	F	**Description**: dynamic ecoNavigation should make use of dynamic traffic information and situational data.
		Rationale: The least fuel consuming route depends on the possible speeds along the route; this information can be collected and distributed centrally. Also incidents need to be taken into account. Roadside units can distribute situational information about local traffic and near-future events like traffic light phases.
SP3-3-0009	F	**Description**: dynamic ecoNavigation should make use of floating vehicle data from other vehicles.
		Rationale: Information from other vehicles might allow conclusions on where it's currently possible to drive in a fuel efficient way.
SP3-3-0010	F	**Description**: dynamic ecoNavigation should make use of route advice from a traffic centre.
		Rationale: A traffic centre might have route advice that takes into account on the one hand planned measured like future traffic light control settings, on the other hand the effects of one vehicle on the total fuel consumption of the vehicles in the area.
SP3-3-0011	F	**Description**: When new floating vehicle data or dynamic traffic information is available, the route is recalculated. If the newly calculated route shows a significant fuel saving compared to the previous one, it replaces the previous route for further guidance.
		Rationale: New dynamic traffic information orV2V information (or even the ego vehicle moving with a different speed than assumed, for the time dependency of traffic pattern data) might outdate a route.
SP3-3-0012	F	**Description**: When the vehicle leaves the route, the route is recalculated.
		Rationale: When the driver misses some manoeuvre, new guidance is needed within a short time.
SP3-3-0013	F	**Description**: dynamic ecoNavigation guides the driver along the route and informs about impending manoeuvres.

		Rationale: Just having a route is not enough; it needs to be used to guide the driver.
SP3-3-0014	F	**Description**: dynamic ecoNavigation gives lane information to the driver.
		Rationale: Lane information enables early lane choice which improves traffic flow and thus reduces fuel consumption.
SP3-3-0015	F	**Description**: Optionally, the route can be optimized for a configurable combination of fuel consumption and travel time.
		Rationale: In real life, drivers wouldn't use a green route if that means unreasonably high travel times, so there's a trade-off between the two that should be reflected in the application.
SP3-3-0016	OE	**Description**: dynamic ecoNavigation must access the static ecoMap, the interface is TBD.
		Rationale: The map is the very base for routing. Details of the interface will be defined in task 2.4.3.1.
SP3-3-0017	OE	**Description**: dynamic ecoNavigation should access dynamic traffic information.
		Rationale: Dynamic traffic information helps avoiding traffic incidents and delivers information on possible speeds which are important for fuel consumption estimation.
SP3-3-0018	OE	**Description**: dynamic ecoNavigation should access situational data from Road-Side Units and floating car data from other vehicles via the dynamic ecoMap.
		Rationale: Situational data helps locally optimizing the route.
SP3-3-0019	OE	**Description**: dynamic ecoNavigation should access MPP from ecoHorizon.
		Rationale: Without a planned route, dynamic ecoNavigation still can propose better alternatives to the MPP.

SP3-3-0020	OE	**Description**: dynamic ecoNavigation should receive route advice from traffic centre.
		Rationale: This is the counterpart to SP5 route advice.
SP3-3-0021	OE	**Description**: dynamic ecoNavigation should use driver profiles created by TripDataSet.
		Rationale: Driver behaviour has a large influence on fuel consumption, and this influence can vary much depending on the road properties, so the most fuel-efficient route may be different for different drivers.
SP3-3-0022	OE	**Description**: ecoNavigation should be available as a component to applications; interfaces are yet TBD.
		Rationale: dynamic ecoNavigation will be used by both pre-trip planning and on-board navigation; as a modular component, it shouldn't need knowledge about the applications that use it.
SP3-3-0023	P	**Description**: A route calculation should take at most one minute for a route up to 500 km.
		Rationale: We cannot keep the user waiting too long for a route. On the other hand, dynamic ecoNavigation algorithms may be considerably more complex than the fastest/shortest route calculation in commercial navigation systems (which usually are highly optimized), so we have to allow (at least in this research project) considerably longer computing times.
SP3-3-0024	P	**Description**: A route recalculation due to new/updated information should take at most one minute for a route up to 500 km.
		Rationale: Dynamic traffic information and V2V information needs to be processed in a timely fashion to be useful.
SP3-3-0025	P	**Description**: A route recalculation after leaving the route should take at most 10 seconds.
		Rationale: When the driver has left the route, new guidance is required almost immediately; in this case, time is more important than route quality. Usually, just a way back to the previous route is calculated.

SP3-4-0001	F	**Description**: The system has to consider the driving safety in the determination of the driving strategies
		Rationale: The system has to determine a driving strategy that considers driving safety. Although hard braking maneuvers are inefficient these should be recommended when the vehicles is driven above the legal speed maximum. Also too close distances to front vehicles have to be avoided in any situation.
SP3-4-0002	F	**Description**: The system optimizes the velocity profile of the vehicle for the trip (driving strategy) dynamically. Therefore the following variables are affected: travel time, fuel consumption, driver acceptance, (electrical) power supply for different energy consumers
		Rationale: To determine an optimal driving strategy the system should consider the following information: • Velocity (current and future maximum velocity limitations) • Inclination (current and future) • Constant vehicle parameters such as engine and transmission map • Estimated inconstant vehicle parameters such as mass, rolling or aerodynamic resistant
SP3-4-0003	F	**Description**: The recommended green driving strategy considers the type of driver to reach a maximum driver acceptance. → connected to the ecoHMI.
		Rationale: The system has to assess the standard driving style of a specific driver (e.g. sporty or highly efficient driving style). Depending on this driving style recommendations for a more fuel efficient driving style have to be proceeded.
SP3-4-0004	F	**Description**: The system shold consider a holistic use function of the driver including travel time as well as fuel consumption.
		Rationale: The green driving strategies should be tunable to consider the benefits of a driver to move as well as the cost arising from fuel consumption. A faster arriving at the target destination and a lower usage of fuel is beneficial for the driver. A higher velocitiy is nearly in all situations accompanied by higher fuel consumption. Thus the driver decides on his driving behaviour in a trade off between driving time and fuel consumption. This trade off is driver specific and has to be estimated by the system to ensure optimal results.

SP3-4-0005	F	**Description**: The driving strategies consider information about the driving style of front vehicle to improve the prediction of future driving situations and thereby improve the calculation of green driving strategies. In case the host vehicle is equipped with environment sensors such as Radar or Lidar sensors the front vehicle can be detected directly within a range of approximtely 200 m. Then the front vehicle can be taken into account. If front vehicles are equipped with eCoMove systems, these vehicles can provide their vehicle states to following vehicles, which then can take the front vehicles into account. As soon as changes of front vehicles (overtaking, turning off, etc.) are detected, driving strategies need to be checked again for eventual changes.
		Rationale: The front vehicle affects the driving strategy of the following vehicle. A probable behavior of the front vehicle can be assessed taking a standard driver into account. The system should also be able to assess the driving style of the front driver using several sensor informations. If the front vehicle is equipped with a eCoMove system it should determine and predict the driving style of its driver. This information should be transmitted to the following vehicle to increase the predicion accuracy and thus the effectiveness of driving strategies.
SP3-4-0006	F	**Description**: Determination and prediction of the effectiveness of different driving strategies
		Rationale: The system has to assess the effectiveness of different driving strategies (e.g. coasting, deceleration with engine in trailing throttle mode or braking) and communicate their probable effectiveness (this is the energy consumption) to the driver. This comparison enables the driver to see the benefits of a predictive driving style.
SP3-4-0007	F	**Description**: The system considers both fuel economy and the potential trade-off with travel time while optimizing the trip and the driving strategies for a specific traffic stituation.
		Rationale: driver acceptance can only be ensured, if besides fuel consumption als other relevant parameters such as travel time and acceleration profile are considered. The holistic use function has to be adjustable by the driver
SP3-4-0008	F	**Description**: The system dynamically determines the optimal driving strategy and communicates it to the driver.
		Rationale: The ecoDriver Coaching system is aware about the vehicle status (e.g. load) and the route to be driven. Furthermore it considers the environmental conditions of the vehicle (e.g. other vehicles, infrastructure, weather, legal restrictions) to adjust driving behavior to the current driving situation. Based on all this information it supports the driver in using the vehicle in the most fuel efficient way.

SP3-4-0009	F	**Description**: System does not recommend something which is against any legal restriction (such as maximum speed)
		Rationale: The driving strategy must come up with optimization results that do not exceed the legal maximum speed.
SP3-4-0010	F	**Description**: The performance of the chosen driving strategy is analyzed and stored for further evaluation.
		Rationale: To educate the driver to a more eco friendly driving style feedback of how he performed on the trip has to be provided.
SP3-4-0011	OE	**Description**: The system estimates the travel time for the journey based on calculations considering different driving strategies. The driving strategies system thus should be equipped with an interface to support this.
		Rationale: To inform the driver about the estimated travel time this value has to be calculated dynamically. The estimated travel time of the journey also affects the behavior of the driver. For example he is willed to drive more eco friendly if he knows that he will arrive in time.
SP3-4-0012	OE	**Description**: The system stores relevant data during the trip and analyses the driving behavior/ the driving strategy of the driver to allow a post trip feedback to the driver. Therefore an interface of the driving strategies should be implemented if necessary.
		Rationale: The post trip analysis and feedback to the driver requires stored data derived from the evaluation of driving strategies. Therefore relevant data has to be stored depending on the specific hardware specificaions. For example the total amount of fuel that could have been saved driving optimally can be derived and stored.
SP3-4-0013	OE	**Description**: The on-board navigation guides the driver along the planned ecoTrip containing the application of green driving strategies.
		Rationale: The system is guiding the driver how to drive energy efficiently following the planned ecoTrip.
SP3-5-0001	F	**Description**: At the end of the trip - the application must be able to store the trip details based on the defined parameters (TBD) for a defined period of time(TBD)

		Rationale: The trip data should be stored for future analysis and reporting
SP3-5-0002	F	**Description**: At the end of the trip - the application must be able to provide a detailed analysis report of the trip (onboard) with TBD parameters such as a. Gear change behaviour b. Acceleration behaviour c. Deceleration behaviour d. Constant speed e. Anticipative driving f. Distance keeping (if possible based on vehicle sensors) g. Engine idling h. Drive style related to road geometry
		Rationale: Inform the driver how fuel efficient he / she has driven and which aspects of the drive contributed to this
SP3-5-0003	F	**Description**: The application must be able to analyze certain parameters (TBD) of the trip details and provide an advice on improving the fuel efficiency
		Rationale: To make the driver aware of the ways to save fuel
SP3-5-0004	F	**Description**: The stored trip data should be exportable to PDAs and PCs
		Rationale: For offline analysis of the data
SP3-5-0005	F	**Description**: The application should be able to compare the current trip data with the previous trip data of the same driver and provide a comparison report

		Rationale: To motivate the driver to improve from his current best
SP3-5-0006	F	**Description**: The application should be able to share the specific parameters (TBD) of the trip data to TBD-application in order to improve the green routing
		Rationale: To improve the accuracy of the fuel consumption prediction on a particular route
SP3-5-0007		**Description**: The application should enable identification of single trips
		Rationale: To compare each single trip with other trips made
SP3-5-0008		**Description**: The application should be able to identify the driver- when there is more than one driver using the same vehicle
		Rationale: to avoid ambiguities
SP3-5-0009		**Description**: the application should be able to determine the remaining saving potential of trip
		Rationale: as an awareness for the user

SP3-5-0010		**Description**: The ecoPostTrip application that is available off-board should enable a detailed analysis of a trip on fuel consumption related behaviour like for example: a. Gear change behaviour b. Acceleration behaviour c. Deceleration behaviour d. Constant speed e. Anticipative driving f. Distance keeping (if possible based on vehicle sensors) g. Engine idling h. Drive style related to road geometry
		Rationale: For offline analysis of the data
SP3-5-0011	OE	**Description**: The application should enable downlaod of trip data onto a USB-stick or other devices such as PDAs and PCs
		Rationale: For offline analysis of the data
SP3-5-0012	OE	**Description**: The ecoPostTrip application should be able to provide input to the ecoHMI on the trip evaluation including a selection of the following parameters: a. fuel saved by following system recommendations b. evaluation of selected drive style parameters (e.g. gear shift, anticipative driving or a driver preference) c. tips for better driving
		Rationale:
SP3-5-0013	OE	**Description**: The ecoPostTrip application should be able to store and retrieve trip data from the TripDataSet component

		Rationale: As a storage database
SP3-5-0014	UH	**Description**: the readability of the report should be more clear also when it is exported to an external devices
		Rationale: to be able to analyze offboard
SP3-5-0015	S	**Description**: the report should be secure enough and should not be editable by unauthorized persons
		Rationale: to maintain privacy and secure the data
SP3-5-0016	L	**Description**: Sharing of the report to others should be authorized by the user
		Rationale: to identify the willingness of the user to share his data
SP3-6-0001	F	**Description**: The ecoMonitoring system sends to the control centre (and to external vehicles if required from them to refine their pre – trip algorithms) some TBD parameters related to the last executed trip, after the post trip application. [The parameters could be: - vehicle parameters: speed, rpm, brake pedal status, fuel level, cruise control if available, clutch status, stop&start if available, external temperature, fuel consumption, gas pedal, acceleration longitudinal/lateral. - trip parameters: starting and ending position, travelling time, travelling distance, roads slope.]
		Rationale: Send to other vehicles and to the control centre the data related to the last executed trip.
SP3-6-0002	F	**Description**: The ecoMonitoring system sends to the control centre (and to external vehicles if required from their pre-trip applications) the results of the post trip application.
		Rationale: Inform the control centre and the other cars of eventual results of the post trip application.

SP3-6-0003	F	**Description**: The data sent from the ecoMonitoring to the control centre must be standardized. All OEM must make available to the ecoMonitoring the same data with the same TBD format. The ecoMonitoring can work on all the OEM vehicles in the same way.
		Rationale: The control centre must receive the data required from all the vehicles with the same standard format, independently of the OEM.
SP3-6-0004	F	**Description**: The ecoMonitoring system sends to the control centre and to external vehicles as floating car data, some TBD parameters related to the vehicle itself and to the current trip: [The parameters could be: vehicle parameters: GPS position, speed, rpm, brake pedal status, cruise control if available, clutch status, stop&start if available, gas pedal, acceleration longitudinal/lateral. - trip parameters: destination of the trip, road slope.]
		Rationale: Send to other vehicles and to the control centre the real time data related to the current trip of the vehicle.
SP3-6-0005	F	**Description**: The ecoMonitoring system sends to the insurance company the raw paratemers related to the vehicle and to the trip. [The parameters could be: - vehicle parameters: GPS position, speed, rpm, brake pedal status, fuel level, fuel consumption - trip parameters: initial position and destination of the trip.]
		Rationale: Send to insurance company data related to the trip in order to receive benefits for ecoDriving
SP3-6-0006	OE	**Description**: The ecoMonitoring application should be able to retrieve trip data from the TripDataSet.
		Rationale: Retreive the information about the vehicle (also the trip?) from the TripDataSet.
SP3-6-0007	OE	**Description**: The ecoMonitoring application should be able to provide the ecoFVD message (incl. destination information) to the communication platform

		Rationale: The ecoMonitoring should send to the communication platform the set of data to be sent out to vehicles and traffic management centre.
SP3-6-0008	OE	**Description**: The control centre defines some specific TBD parameters to be received by the ecoMonitoring system for any trip of the vehicle. [The parameters could be: vehicle parameters: speed, rpm, brake pedal status, fuel level, cruise control if available, clutch status, stop&start if available, external temperature, fuel consumption, gas pedal, acceleration longitudinal/lateral. trip parameters: starting and ending position, travelling time, travelling distance, roads slope.]
		Rationale: The control centre discriminates among all data related to a generic trip, and selects a limited set of parameters to be sent from the ecoMonitoring system.
SP3-6-0009	P	**Description**: Define an update rate for each post trip parameter to be sent to the control centre.
		Rationale: The ecoMonitoring system has to send to the control centre some data related to the post trip, but any parameter has its own update rate (ex. speed, acceleration, fuel consumption), and not all updates can be sent to the control centre, otherwise there is
SP3-6-0010	P	**Description**: The ecoMonitoring system has to collect data with a TBD precision, which is dependent from the particular parameter to be collected (as an example, the precision on speed could be at level of 0.01 m/sec, while for acceleration it could be at level of 0.01 m/sec2).
		Rationale: Set the precision of each parameter to be monitored.
SP3-6-0011	S	**Description**: Privacy requirement. The data saved by the ecoMonitoring system should contain information about the last trip performed, without any information about the car and the driver sending the data.

		Rationale: Transmit data without information about the source vehicle. Yes: speed, acceleration lateral/longitudinal, fuel type, displacement, type of vehicle (hybrid/not), windows open/closed, driving style, and similar data. No: numberplate, chassis, brand, vehi
SP3-6-0012	S	**Description**: Immunity requirement: the data sent from the ecoMonitoring should be not accessible from external programs that could modify the contents. The data format should be encrypted to be read only from an eCoMove system.
		Rationale: Immunity requirement from external illegal access.
SP3-7-0001	F	**Description**: The ecoSmartDriving HMI should provide on-board training sessions. These should be complimentary to post-trip information.
		Rationale: To ensure that the driver will use the system in the intended way, the system HMI should support the driver by offering introduction and learning sessions inside the car in standstill (e.g. "How to use“, "Learn more about your system“).
SP3-7-0002	F	**Description**: ecoSmartDriving HMI should provide a help function
		Rationale: A context specific help function will give the driver the opportunity to get more information about the indicated elements of the current ecoSmartDriving HMI view and driver’s options to operate the system, e.g. how to navigate in the menu or to change modes.
SP3-7-0003	F	**Description**: The ecoSmartDriving HMI should indicate a possible Availability or non-availability of the system. Also the indication should be given if the system is switched to on or off.
		Rationale: If the system function is not available for a certain reason, it should be indicated to the driver. In case of a system failure the driver should be informed by issuing an appropriate message.
SP3-7-0004	F	**Description**: System switches silent if there are no driver reactions

		Rationale: If the driver does not want to use the system or is in a specific situation (e.g. emergency) the system should not produce too many warnings and recommendations. This would just distract the driver.
SP3-7-0005	F	**Description**: It should be possible to configure or even to shut down the ecoHMI by the user
		Rationale: It must be taken into account, that every user has his personal preferences and wants to decide whether he wants to use a system or in which cases he wants to use it.
SP3-7-0006	F	**Description**: The ecoHMI should motivate the user to change the behaviour to a more efficient driving
		Rationale: guiding the driver how to drive energy efficiently
SP3-7-0007	F	**Description**: The ecoHMI should assist at obstacles by recommending an energy efficient driving.
		Rationale: The HMI has to inform the driver about obstacles (e.g. road works, congestion, speed limits, roundabouts etc.) and how fast he should drive and when he should start to coast.
SP3-7-0008	F	**Description**: The ecoHMI should help the driver to approach a slower vehicle in an energy efficient way
		Rationale: The driver is approaching a slower vehicle. He has to adopt the speed of the slower front vehicle
SP3-7-0009	F	**Description**: The ecoHMI should tell the driver to turn off the car if it is stopped for traffic reasons
		Rationale: The vehicle is stopped for traffic reasons. If the motor is running then it consumes fuel
SP3-7-0010	OE	**Description**: The ecoHMI should provide an interface to the information identified in the ecoDrivingSupport that has to be indicated to the driver
		Rationale: the interface is required

SP3-7-0011	OE	**Description**: The ecoHMI should provide an interface to the information identified in the ecoInformation application that has to be indicated to the driver
		Rationale: the interface is required
SP3-7-0012	OE	**Description**: The ecoHMI should provide an interface to the information identified in the Dynamic ecoNavigation application that has to be indicated to the driver
		Rationale: the interface is required
SP3-7-0013	OE	**Description**: The ecoHMI should provide an interface to the ecoPostTrip application. To indicate the analysis report
		Rationale: the interface is required
SP3-7-0014	UH	**Description**: The ecoSmartDriving HMI should indicate the driver with feedback about short term and long term efficiency performance (e.g. the indication of fuel consumption rate etc)
		Rationale: The driver's motivation and excitement to use the system regularly will work on the basis of comparing efficiency performance values. Long term efficiency performance should also be the basis for rewarding the driver, e.g. with incentives.
SP3-7-0015	UH	**Description**: The ecoSmartDriving HMI should provide consistent system reactions
		Rationale: As a basis for intuitiveness and comprehensibility of the ecoSmartDriving system the HMI should provide consistent system reactions to driver inputs, road conditions, traffic conditions and environmental conditions.
SP3-7-0016	UH	**Description**: The ecoSmartDriving HMI should provide information and warnings which are easy to understand by the user

		Rationale: Beside an easy-to-use menu navigation it is important to provide all information and warnings in the way that they are easy to recognize, to differentiate and easy to remember
SP3-7-0017	UH	**Description**: To support efficient deceleration the ecoSmartDriving HMI should communicate to the driver HOW to decelerate (Applying the brake pedal, Engine in trailing throttle mode or Coasting) and also WHEN to start decelerating. If applicable, the reason for decele
		Rationale:
SP3-7-0018	UH	**Description**: To support efficient acceleration the ecoSmartDriving HMI should communicate to the driver how to accelerate more energy efficient. If applicable, the reason for acceleration (e.g. to cross the traffic light, change in speed limit) should be provided
		Rationale:
SP3-7-0019	UH	**Description**: To avoid unnecessary stops at traffic lights the ecoSmartDriving HMI should communicate to the driver the currently appropriate target speed for passing the traffic light at green and /or the timeframe until the lights will change.
		Rationale:
SP3-7-0020	UH	**Description**: To support efficient driving in dense traffic the ecoSmartDriving HMI should communicate to the driver the currently appropriate target speed.
		Rationale:
SP3-7-0021	UH	**Description**: The ecoSmartDriving HMI should be providing visual, auditive and/or tactile information as system feedback based on the settings
		Rationale: Mapping appropriate feedback to driver input enhances the transparency and comprehensibility of the system. The frequency of erroneous driver inputs decreases.
SP3-7-0022	UH	**Description**: While navigating in the system menu the ecoSmartDriving HMI should always be showing where the user currently is.
		Rationale: Enhances the transparency and comprehensibility of the system. The frequency of erroneous driver inputs decreases.
SP3-7-0023	UH	**Description**: The ecoSmartDriving HMI should prevent the user from selecting incorrect options, avoiding unintended activation possibilities.

		Rationale: Enhances the transparency and comprehensibility of the system. The frequency of erroneous driver inputs decreases.
SP3-7-0024	UH	**Description**: The ecoSmartDriving HMI should make the possible choices menu (settings) visible for the user
		Rationale: Enhances the transparency and comprehensibility of the system. The frequency of erroneous driver inputs decreases.
SP3-7-0025	UH	**Description**: The ecoSmartDriving HMI should permit easy reversal of actions
		Rationale: Enhances the transparency and comprehensibility of the system. The frequency of erroneous driver inputs decreases.
SP3-7-0026	L	**Description**: The ecoSmartDriving HMI should be in compliance to the following standards & regulations - Commission Recommendation of 26/V/2008 on safe and efficient in-vehicle information and communication systems: Update of the European Statement of Principles on Hum
		Rationale:
SP3-7-0027	UH	**Description**: The ecoSmartDriving HMI should minimize distraction from the primary driving task. Thus the system should fulfill the following needs: - Visual feedback should be in the primary field of view - Visual / cognitive demand should be minimized - Visual inform
		Rationale: Enhances the transparency and comprehensibility of the system. The frequency and duration of glances to the driver display should be minimised.
SP3-7-0028	UH	**Description**: The ecoHMI should encourage the user to use the system
		Rationale: An ecoHMI must be accepted by the driver. If not the driver will not use (shut off) the system

SP3-7-0029	UH	**Description**: The ecoHMI should show only the most important information in the specific situation, respectively not too much information
		Rationale: The driver will possibly get much information. There has to be a solution that the driver will not get too much information.
SP3-7-0030	UH	**Description**: Easy to understand green driving strategy in energy relevant situations
		Rationale: The driver should be able to directly understand the messages of the system aiminig to realize green driving. All parts of the strategy such as coasting while approaching a STOP sign should be communicated clearly.
SP3-8-0001	F	**Description**: Information about the vehicle's own • location incl. lane information • speed • heading in the road network is available.
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0002	F	**Description**: Vehicle's most probable path ahead in the road network is available. content of MPP for further description
		Rationale: Building block for detailed information on vehicle environment

SP3-8-0003	F	**Description**: The vehicle system has information about • number and usage of lanes (is it a bus lane, turning lane etc.) • overtake prohibits • speed limits • geometrical properties • eco properties • traffic state of the most probable path MPP in the road network
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0004	F	**Description**: The system has information about vehicle specific data such as fuel consumption depending on slopes, speed, gear, and load condition. Other information may be necessary and will be defined during the project.
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0005	F	**Description**: Vehicle system has information about calculated route
		Rationale: Building block for cooperative routing
SP3-8-0006	F	**Description**: The ecoMap available in the system contains precise (accuracy tbd.) information about the slopes of the streets including altitudes, curves as well as driving attributes such as speed limits, number of lanes etc. (the precise list of needed attributes is tbd).
		Rationale: Building block for ecoDriving and ecoRouting.
SP3-8-0007	F	**Description**: The system is able to calculate a slope going out of a path (MPP) and precise geometry information

		Rationale: Building block for ecoDriving and ecoRouting. In Case slope is not available from ecoMap
SP3-8-0008	F	**Description**: The ecoMap available in the system contains precise (accuracy tbd.) information about the curvatures of the streets including altitude, slopes, as well as driving attributes such as speed limits, number of lanes etc. (the precise list of needed attributes is tbd).
		Rationale: Building block for ecoDriving and ecoRouting.
SP3-8-0009	F	**Description**: The system is able to calculate a curve radius going out of a path (MPP) and precise geometry information
		Rationale: Building block for ecoDriving and ecoRouting. In case curves not available from ecoMap
SP3-8-0010	F	**Description**: The ecoMap available in the system contains precise (accuracy tbd.) information about the geometry of the streets including altitude slopes, curves as well as driving attributes such as speed limits, number of lanes etc. (the precise list of needed attributes is tbd).
		Rationale: Building block for ecoDriving and ecoRouting.
SP3-8-0011	F	**Description**: The system is able to receive and process information via the V2V communication unit. This information include: - MPP of the sending vehicle - Next maneuver attempted by the sending vehicle - Distance to the next maneuver - Current speed and position of the sending vehicle
SP3-8-0012	OE	**Description**: The ecoCooperativeHorizon should provide the Most Probable Path to the: a. ecoDrivingSupport application; b. dynamic ecoNavigation application;

		Rationale: This information is required by other application
SP3-8-0013	OE	**Description**: The system is able to communicate with other vehicles
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0014	OE	**Description**: The system is able to communicate with oncoming vehicles
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0015	OE	**Description**: V2V communication transmits and receives • Position (WGS84) incl. lane info • Speed (km/h) • Heading (degree against north) • MPP (e.g. location reference following AGORA-C) of each communication participant within reach.
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0016	OE	**Description**: The system is able to communicate with other vehicles on ist calculated route
		Rationale: Building block for detailed information on vehicle environment

SP3-8-0017	OE	**Description**: V2V communication transmits and receives • Position (WGS84) incl. lane info • Speed (km/h) • Heading (degree against north) • MPP (location reference following AGORA-C) of each communication participant on ist calculated route.
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0018	OE	**Description**: The system is able to communicate with other vehicles queing
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0019	OE	**Description**: The system is able to communicate with traffic lights controller
		Rationale: Building block for detailed information on vehicle environment
SP3-8-0020	OE	**Description**: V2V communication transmits and receives • Position (WGS84) incl. lane info • Speed (km/h) • Heading (degree against north) • MPP (e.g. location reference following AGORA-C) of each communication participant queing.
		Rationale: Building block for detailed information on vehicle environment

SP3-8-0021	OE	**Description**: The system is able to communicate with other vehicles on ist MPP.
		Rationale: Building block for ecoDriving.
SP3-8-0022	OE	**Description**: The system is able to communicate with slower vehicles ahead
		Rationale: Building block for ecoDriving: To avoid unnecessary braking and acceleration.
SP3-8-0023	OE	**Description**: Traffic lights controller transmits • Location reference of traffic lights • Residual red display times for each driving direction to each eCoMove vehicle within reach.
		Rationale: Building block for ecoDriving: To avoid unnecessary braking and acceleration.
SP3-8-0024	OE	**Description**: V2V communication transmits and receives • Position (WGS84) incl. lane info • Speed (km/h) • Heading (degree against north) • MPP (e.g. ocation reference following AGORA-C) of each communication participant slower ahead.
		Rationale: Building block for ecoDriving: To avoid unnecessary braking and acceleration.

SP3-8-0025	P	**Description**: The accuracy of both • the measurement of position, speed and heading and • the stored map data allows the system to calculate the accurate distance to the slope (in real time).
		Rationale: General requirement on precision of the map and the position calculation and on the system performance
SP3-8-0026	P	**Description**: The location reference transmitted by the V2V communication partners is described unambiguously (e.g. AGORA-C)
		Rationale: General requirement on precision of location referencing
SP3-8-0027	P	**Description**: The Location reference transmitted by the traffic light controllers and by the vehicles at the queue is described unambiguously (e.g. AGORA-C)
		Rationale: General requirement on precision of location referencing
SP3-8-0028	P	**Description**: The Location reference is described unambiguously (e.g. AGORA-C)
		Rationale: General requirement on precision of location referencing
SP3-9-0001	F	**Description**: the application must be able to store the destination
		Rationale: To be made available for analysis
SP3-9-0002	F	**Description**: the application must be able to store the different driver profile, using the same vehicle
		Rationale: Need for the analysis

SP3-9-0003	F	**Description**: the application must be able to store the vehicle information
		Rationale: Need for the analysis
SP3-9-0004	F	**Description**: The TripDataSet should store trip data of each trip containing the TBD information for example a. Driver ID (in case more than one driver is using the vehicle) b. Date & time of trip c. Speed profile (incl. accelerations & decelerations) d. Gear choice e. Engine RPM f. Engine on/off at stop g. Road segment parameters (speed limit, slope, road signs/traffic signals, tbd.,) – the exact position where the driver has been? Or only the road characteristics? h. Fuel consumption (CAN)
SP3-9-0005	OE	**Description**: The TripDataSet should be accessible for the following applications / components: a. PostTrip analysis – on board b. PostTrip analysis – off board c. ecoMonitoring d. ecoDrivingSupport e. ecoRouting
SP3-9-0006	P	**Description**: The TripDataSet should be able to store at least TBD km of trips
		Rationale: Need for the analysis