FESTA

D4: Common Vision regarding cooperative systems FOTs

21 May 2008

Grant agreement no.:	214853
Workpackage:	WP4 Cooperative Systems & Infrastructure
Tasks:	T4.3 Common vision regarding cooperative systems FOTs
Deliverable no.:	D4
Document title:	FESTA – D4 Cooperative Systems
Deliverable nature:	Public
Deliverable status:	Final to consortium leader

Consortium:

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Disclaimer:

The FESTA Support Action has been funded by the European Commission DG Information Society and Media in the 7th Framework Programme. The content of this publication is the sole responsibility of the project partners listed herein and does not necessarily represent the view of the European Commission or its services.

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Glossary

Subject	Definition
function	implementation of a set of rules to achieve a specified goal
	Unambiguously defined partial behaviour of one or more electronic control units.
system	a combination of hardware and software enabling one or more functions
	Set of elements (at least sensor, controller, and actuator) in relation with each other according to design. An element of a system can be another system at the same time. Then, it is called subsystem which can be a controlling or controlled system or which can contain hardware, software and manual operations.
use case	target condition in which a system is expected to behave according to a specified function
situation	a combination of certain characteristics of a use case. Situations can be derived from use cases compiling a reasonable permutation of the use cases characteristics
scenario	a use case in a specific situation
research question	general question to be answered by compiling and testing related specific hypotheses
hypothesis	specific question which can be tested with statistical means by analysing measures and performance indicators.
baseline	scenario with system under evaluation "turned off".
performance indicator	Performance Indicators are quantitative or qualitative measurements, agreed on beforehand, expressed as a percentage, index, rate or other value, which is monitored at regular or irregular intervals and can be compared to one or more criteria.
event	"Singularities" based on a combination of measures and/or pre-processed measures. Can extend over time. One or several preconditions must be fulfilled.

trigger	"Marker" in the data, indicating instances that can be of interest for research.
metric	
measure	A measure can either be direct or pre-processed. A direct measure is logged directly from a sensor, while a pre-processed measure is a combination of different direct or other pre-processed measures. A measure does not have a "denominator" which makes it comparable to other instances of the same measure or to external criteria.
FOT aka Field Operational Test	fleet of vehicles vehicles DO have some kind of data acquisition system onboard (consequence: pure questionnaire based analysis without online data acqu. System is NOT an FOT)
on-vehicle sensors data	Data collected via on-vehicle sensors.
subjective data	Data collected from the drivers/passengers.
Situational Variable	Situational Variables are not necessarily directly relevant for Performance Indicators or Derived Measures, but they provide key background information that complements the driver behaviour data and is sometimes needed to derive the driver behaviour data.
data acquisition	The process of sampling or recording data (real world data) for computer processing. Includes acquisition of pure sensor data, as well as acquisition of data from real-time and off-line services, and subjective data.
latency	A latent period: the time between stimulus and response. In data acquisition generally the time between real world event (or stimulus) and the recording of that event.
sensor	A device that responds to a physical stimulus (as heat, light, sound, pressure, magnetism, or a particular motion) and transmits a resulting impulse which can be read by an instrument/observer.
Vehicle bus	An in-vehicle internal communications network that connects different components and modules.
trip	Includes the sequence from the vehicle ignition key being turned on until it is turned off (even if the vehicle is not moving during this time frame).
event data recorder	A logging device that, when triggered by an event such as a crash, stores the information about the few seconds leading up to the event (and throughout the event).
upload	Transfer of data from client to a server.
download	Transfer of data from server to a client.

1 Introduction

The objective of an FOT is to evaluate in-vehicle functions based on Information Communication Technology (ICT) in order to address specific research questions. These research questions can be related to safety, environment, mobility, traffic efficiency, usage, and acceptance. By addressing the research questions, FOTs promise to furnish the major stakeholders (customers, public authorities, OEMs, suppliers, and the scientific community) with valuable information able to improve their policy-making and market strategies. Individuating the most relevant functions and connected hypothesis to successfully address the above-mentioned research questions is one of the major challenges in an FOT. In this deliverable, the process of individuating the vehicle functions to be tested in an FOT and the relevant connected hypotheses will be elucidated. Specifically, the reader will be guided in the process of 1) selecting the vehicle functions to be tested, 2) defining the connected use cases to test these vehicle functions, 3) identifying the research questions related to these use cases, 4) formulating the hypothesis associated to these research questions, and 5) linking these hypothesis to the correspondent performance indicators. The FOT chain shows specifically the steps reported above (see Figure 1.1).

Eliminato: Figure 1.1

In the last few years, the number of ICT functions available on standard vehicles has been rapidly increasing. ICT functions are intrinsically designed to provide the driver with new, additional information. However, the extent to which this increased amount of information from these ICT functions results in clear and positive effects on safety, environment, mobility, usage, and

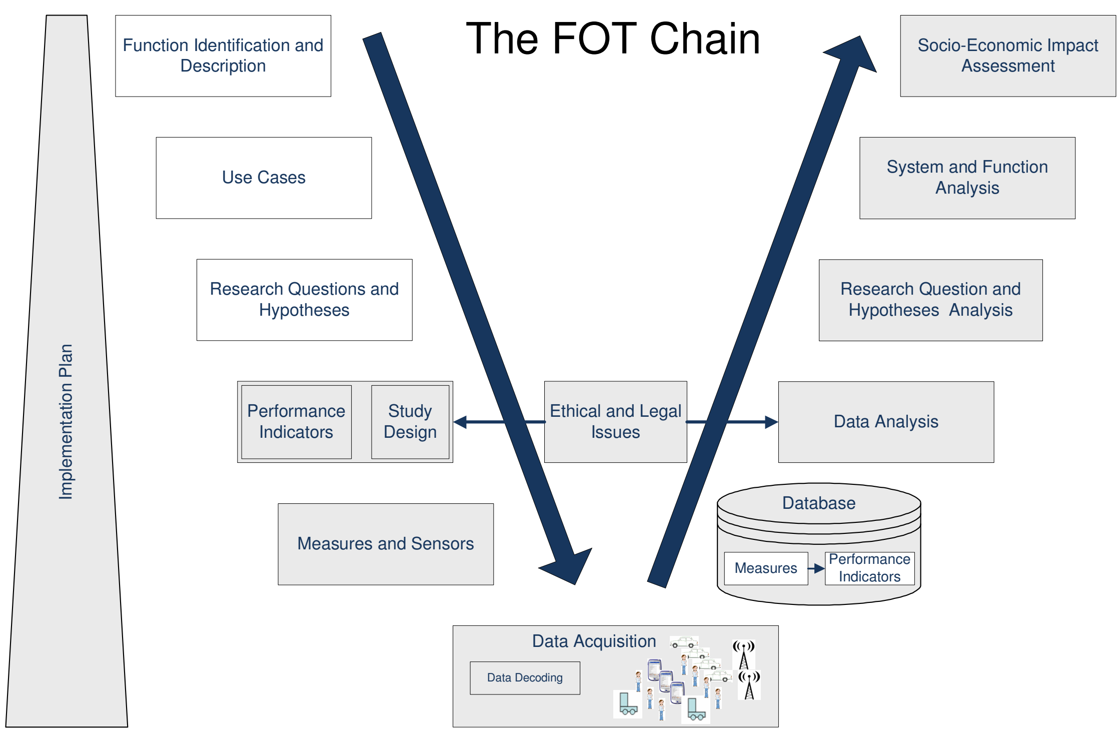

Figure 1.1: The FOT chain and the relevant steps from function identification to hypotheses covered by this deliverable.

acceptance in real traffic situation is unknown. FOTs warrant to evaluate, for the first time, these ICT functions in a real traffic situation during naturalistic driving. In this handbook we refer to 1) in-vehicle, 2) cooperative, and 3) nomadic systems intended as a combination of hardware and software enabling one or more ICT functions. Depending on the different systems implementing a specific function, different challenges may have to be faced during the FOT design.

1.1 The case of Cooperative Systems

Communication technology has enabled a new class of information and warnings in cars witch are more precise in terms of time and location. Infrastructure based information tells the driver for example what is the appropriate speed or warns the driver in case of ice on the road or fog behind the corner. The applications described in the attached XLS file are developed in several C2X projects under the 6th Framework Programme. Namely: CVIS, PReVENT, SAFESPOT and WATCHOVER.

The main initial objective for C2X was to increase road safety. The development of safety-critical C2C systems in Europe has been mainly promoted by the Car-to Car Communication Consortium (C2C-CC) which supports Dedicated Short Range Communication (DSRC) systems operating at 5.9 GHz on the IEEE 802.11p standard. A wider variety of information into vehicles will be available with CALM (Continuous Air interface for Long and medium range communication) architecture. The CALM architecture supports multiple communication channels and it manages seamless handover between channels to ensure continuous connectivity to the vehicle. For example, if a car is connected to the internet using WIFI and travels to a region where WIFI is no longer available, the CALM architecture is automatically switching over to 3G. The latest version of CALM, used by CVIS supports also C2C-CC safety-critical communication using the 5.9 GHz channel.

C2X communications requires a large number of technical systems and sub-systems, including both in-vehicle and roadside architecture, to work together in harmony. These systems can be grouped in three areas:

- Collecting data from vehicles

For C2V and C2I applications, data needs to be collected from vehicles in order to provide real-time support.

- Transmitting data to vehicles

For vehicles to act in response to al live event, data must be transmitted to them from another vehicle or from roadside infrastructure.

- Presenting relevant information to the driver

In vehicle information has to be presented according to the ESOP guidelines, it should be reliable and valid.

2 General Methodology adapted to cooperative systems FOT

The main advantage of an FOT is that it has the potential to give insight in system performance in naturalistic driving situations, as free as possible from any artefact resulting from noticeable measurement equipment or observers in the car. Therefore the first step when planning an FOT is to identify systems and functions where considerable knowledge about their impacts and effects in realistic (driving) situations is of major interest, but is still lacking (see Section 2.1). Another domain for FOTs is the area of systems and functions which need a certain penetration rate to work at all, like especially cooperative system.

After the identification of the functions and system, which should be tested in an FOT, the goal is to define statistically testable hypotheses and find measurable indicators to test the hypotheses. To reach this goal, several steps need to be taken, starting from a description of the functions down to an adequate level of detail (see Section 2.1). This means that the main aspects of the functions, its intended benefits and the intrinsic limitations have to be described to fully understand objectives and limitations and to derive reasonable use cases.

Secondly, these use cases need to be defined (see Section 2.2). Use cases are a means to describe the boundary conditions under which a function is intended to be analysed. A general starting point is given by the functional specifications from the function description part. But it might also be of interest how a function performs when certain preconditions are not met and to identify unintended and unforeseen effects.

Starting from the use case definitions specific research questions need to be identified (see Section 2.3). Research questions are general question to be answered by compiling and testing related specific hypotheses. While research questions are phrased as real questions ending with a question mark, hypotheses are statements which can either be true or false. This will be tested by statistical means (see Chapter 9). One might already have a very clear idea from the beginning which hypotheses are to be tested in a very specific situation during the FOT. However, this very focused view might result in an extreme limited experimental design, where important unintended effects will not be considered. The process to define hypotheses developed in FESTA aims to prevent these potential issues (see Section 2.4).

Finally, hypotheses can only be tested by means of reasonable indicators (see Section 2.5).

These steps are shown as parts of the complete FOT and are elaborated further in the following sections. The Annex consists of the results of the FESTA methodology to identify functions and systems and to develop hypotheses for the experimental design. All steps, from the description of the systems and functions, the development of use cases and scenarios, as well as the research questions and hypotheses and the proposal of related performance indicators have been accomplished. This Annex2 shall provide an example on how to proceed according to the proposed FESTA methodology.

2.1 Step 1: Selection of Functions/Systems relevant for Cooperative System FOTs

Usually it is quite clear from the beginning what functions or at least what type of functions will be the object of an FOT. However, to select the specific functions but also in case the type of functions has not yet been decided, a Stakeholders Analysis is recommended. During this analysis, the needs of the different stakeholders need to be identified and merged into a common requirements description. Stakeholders are those whose interests are affected by the issue or those whose activities strongly affect the issue, those who possess information, resources and expertise needed for strategy formulation and implementation, and those who control relevant implementations or instruments, like customers, public authorities, OEMs, suppliers, and the scientific community. It is of vital importance that all relevant stakeholders are included in the analysis to guarantee that the selection process will not itself bias from the beginning the appraisal of the gained results.

It is recommended to evaluate the stakeholders' needs by means of questionnaires, workshops or well documented interviews of stakeholders' representatives. It is also quite important to describe the selection process sufficiently to prevent from misjudgement.

The basis for all following steps is a sufficient description of the selected functions. For these purposes a spreadsheet template has been prepared and is presented in the Annex[2] to collect the necessary information. It provides two main parts: First, the functional classification, where a short high level description of the main aspects of the function should be given. This information is usually provided through the system specifications given by the system vendor or OEM. The second part of the description comprises of limitations, boundary conditions and additional information which is necessary to understand how the function works.

The boundary conditions part describes where and under which circumstances the system/ function will operate according to its specifications, where the FOT should take place and which type of data needs to be recorded during the FOT to enable a good interpretation of the results. It consists of:

- Infrastructure requirements, cooperative systems and nomadic device requirements. Here all required actors besides the actual system need to mentioned, which might have an impact on system performance, service availability or similar. It is intended to trigger the consideration of factors which are external to the system/ function under evaluation;
- Demographical Requirements/ Driver Requirements: Especially the user or driver recruitment needs to take into account, whether a function is particularly designed for a specific group of users or drivers. Drivers differ on a large variety of characteristics, which may all have an influence on how they drive and use different systems and services. These differences may be important to take into account when planning a FOT. Four categories of driver characteristics may be distinguished:
    - Demographic characteristics: gender, age, country, educational level, income, socio-cultural background, life and living situation, etc.;
    - Driving experience, and driving situation and motivation: experience in years and in mileage, professional, tourist, with or without passengers and children etc.;
    - Personality traits and physical characteristics: sensation seeking, locus of control, cognitive skills, physical impairments or weaknesses etc.;
    - Attitudes and intentions: attitudes towards safety, environment, technology etc.
- Geographical Requirements/ Road Context: This description is necessary for systems which, concerning their functionality, depend strongly on the horizontal or vertical curves of the road layout or on the road type. For example, certain speed limit information systems depend largely on the availability of speed limit information in a digital map, which is up to now only commercially available on high class roads.

- Geographical Requirements/ environmental restrictions: Certain systems are especially designed for specific environmental conditions or, on the other hand, specifications might indicate that the system under evaluation will not work under certain environmental conditions. In this case the location of the FOT needs to be selected carefully and the relevant data must be recorded during the FOT. e. g., most of the functions using perception system will be affected by adverse weather conditions. If this is the case it is necessary to log respective data and take it into account for later data analysis.
- Geographical Requirements/ Traffic Context: The performance of certain systems might depend on the traffic context, that is, the traffic density (e. g. given by the Level of Service) or might even be designed to work in specific traffic densities only. Like the other geographical requirements, this needs to be taken into account when an FOT is planned, performed and the data is analysed.
- Other Limitations: All other limitations need to be mentioned, which might have considerable impact on the performance of functions or systems, since these limitations have major impact on the experimental design and data analysis.

2.2 Step 2: Definition of use cases and situations

FOTs will test technically mature ICT systems. Therefore, systems and functions to be tested are on the market or close to market and can be easily implemented. But the list grows too long if all possible implementation variations and technologies are considered separately. The use cases are putting the systems and functions at a suitable level of abstraction in order to group technology-independent functionalities and answer more holistic research questions described later.

Table 2.1: Use Cases, Situations, Scenarios, and their mutual dependence.

Subject	Definition	Comment	Example
Use Case	Target condition in which a system is expected to behave according to a specified function	A use case is a system and driver state, where “system” includes the road and traffic environment.	Road Intersection Safety
Situation	A combination of certain characteristics of a use case. Situations can be derived from use cases compiling a reasonable permutation of the use cases characteristics.	Thus a situation is a state of the environment or system.	Speed above 50Km/h + foggy day
Scenario	A use case in a specific situation	Use case + situation = scenario	Car crossing with speed below 50Km/h + foggy day

A use case is a textual presentation or a story about the usage of the system told from an end user’s perspective. Jacobson et al (1995) defined the use cases: “When a user uses the system, she or he will perform a behaviourally related sequence of transactions in a dialogue with the system. We call such a special sequence a use case.” Use cases are technology-independent and the implementation of the system is not described. Use cases provide a tool for people with different background (e. g. software developers and non-technology oriented people) to communicate with each other. Use cases form the basic test case set for the system testing. There are number of different ways to define a use case. Use cases in FESTA are very general descriptions, like e. g. “car following”. This general description needs to be refined to a reasonable level of detail. This refinement is done by describing so called situations (see Table 2.1). It is the detailed scenario description which triggers the development of specific hypotheses for later analysis.

Eliminato: Table 2.1

The situational descriptors are selected in a way that relevant information can be gathered to distinguish between main differences while evaluating systems. The situational descriptors can be distinguished in static and dynamic, while the static describe attributes which will not change significantly during one ride of the vehicle, like age or gender of the driver. Nevertheless this information needs to be stated, since it is one of the main inputs to filter the huge amounts of data in the later stage of data analysis. The second part of attributes is dynamic, since it can change during a ride of the vehicle, like the system action status (system on or off), the traffic conditions, road characteristics or the environmental situation.

The situations are defined as a combination of certain characteristics of a use case. Situations can be derived from use cases compiling a reasonable permutation of the use cases characteristics. The identification of possible situations was covered from three viewpoints:

1. systems and vehicle specification,
2. environmental conditions specification and
3. Driver characteristics and status specification.

The situational descriptors in FESTA conforms the following structure:

IDENTIFICATION AND DESCRIPTION

Use case name	A name for identification purposes.
Description	General description of the use cases with necessary depth of information to get a quick overview.
Occurrence	Information about the anticipated quantity of occurrences has implications for the amount of data to analyse.

SYSTEMS AND VEHICLES

System status	Depending on the hypotheses the analysis might concentrate on situations where the system is activated or present. *Example: ON/OFF (baseline) or IDLE/ON/OFF*
System action status	Depending on the hypotheses the analysis might want to compare the driving performance between different system statuses, e. g. whether the system is actively controlling the vehicle or not. *Example: acting/ not acting (meaning e. g. ACC controlling car speed or not)*
System/ function characteristics	Depending on the hypotheses an analysis of system or driver performance with respect to special system/ function characteristics might be conducted, e. g. differences in system performance between nomadic devices (phone, Smartphone, PND,...) or depending on the vehicle type. *Example: passenger vehicle/ truck/ bus*
Interaction between	System and especially driver behaviour might change depending on

systems	whether the system under evaluation is the only active support system or whether interactions between two or more systems are foreseen. *Example: interaction between Blind Spot Warning and Lane Departure Warning.*
ENVIRONMENTAL CONDITIONS	
Traffic conditions	Performance of some systems might differ depending on traffic density. Others might only be reasonable with a minimal traffic density. *Example: Level of Service A and B*
Environmental situation	System performance differs depending on lighting and weather conditions like rain/ snowfall/ icy roads, etc. *Example: normal/ adverse weather conditions*
Road characteristics	e. g. type of road gradient, super elevation, curvature, curviness, …, since some systems are dedicated to improve driving performance in curves etc. *Example: urban roads/ rural roads/ highways*
Geographical characteristics	Information about geographical characteristics relevant for testing the systems. *Example: mountained/ flat areas, metropolises with high street canyons.*
DRIVER CHARACTERISTICS AND STATUS	
Driver specification	Characteristics of the users have an impact on the driving performance. Even if no specific impacts are expected of certain characteristics, some outcomes may be explained better with more knowledge about the participants. A minimum set of data such as age, gender, income group and educational level is easy to gather from participants. Information about driving experience is also important. For further understanding of driver behaviour one may consider to use questionnaires on attitudes, driving behaviour and personality traits. A well-known questionnaire about (self-reported) driving behaviour is the Driver Behaviour Questionnaire (DBQ). Some widely used personality tests are the Five Factor Model (FFM) test and the Traffic Locus of Control (T-LOC) test. Special attention may be given to the personality trait of sensation seeking, which is correlated with risky driving. The Sensation Seeking Scale (SSS) measures this trait. These questionnaires are available in many different languages, but they are not always standardized, and cultural differences may play a role. Personality traits are very easy to measure, just by administering a short questionnaire. However, the concepts and interrelations of factors are very complex, and results should be treated with caution. When evaluating the acceptance and use of new systems in the car, drivers' acceptability of technology is important. Both social and practical aspects play a role. Technology acceptance has different dimensions, such as diffusion of technology in the drivers' reference group, the intention of using the technology, and the context of use (both personal and interpersonal). Measuring acceptability can be realized via (existing) standardized questionnaires, in-depth interviews

	before and after "use" (driving), and focus groups.
Driver status	Mindset of the driver *Example: attentive/ distracted/ impaired*
Purpose, distance, duration	Describes the different attributes of a trip (time between ignition on and ignition off). All three aspects have an impact on driver behaviour and hence on patterns in the data.

A set of basic rules has been set for the design of the situations for an FOT:

1. Complementary: situations are not allowed to overlap.
2. Entirety: the sum of all situations should describe the complete use case.
3. Baseline: The same situation without the use of the systems (system off or non-present) is defined as the baseline. The baseline is the basis for the benefit assessment of the system and the comparison between systems. Therefore, for the same use case, there can be many baselines depending on the number of situations.
4. Comparability: functions compared in an FOT need to have the same use case and therefore same baseline and situations.
5. Variability of situation parameters: depending on the point of view (user, trip, vehicle, single FOT, multiple FOTs, etc…), attributes describing a situation can vary considerably or not.

This list is non-exhaustive and might be extended if necessary.

Finally, out of all the possible situations, one will need to select the relevant ones for scenarios of interest in an FOT. The scenarios are defined as a use case in a specific situation and therefore one or more scenarios should be considered from each use case. All other situations should be considered out of the scope of the FOT study. However, if possible data should still be collected in all situations in case an alternative study would like to reuse the same data.

During FESTA a list of functions and use cases was produced based on technically mature ICT systems and functions on the market. The list was consolidated based on the feedback from a stakeholders workshop and a dedicated questionnaire.

The process of defining the use cases will help the FOT for the next steps: the definition of the research questions and hypotheses and finally the identification of the needed indicators. The scenarios as they are defined at this stage of the FOT are not detailed enough for data analysis purposes. For this reason, after the definition of the indicators, the scenarios (and their situations) will need to be further described in terms of *events* for data analysis purposes. Only then, the scenarios can be classified with a quantitative measurement tools in function of the defined indicators.

2.3 Step 3: Identification of the Research Questions

The research questions specific to an FOT can only be identified once the overall goal of an FOT has been established.

In general terms the goal of any FOT is to investigate the impacts of mature ICT technologies in real use. The core Research Questions should therefore focus on <u>impacts</u> but there are other questions that 'surround' this core. The range of possible questions is listed below. This list below should be considered a first step in any FOT and not a comprehensive set of questions.

LEVEL OF SYSTEM USAGE

Which factors affect usage of the functions? Examples are

- Purpose of journeys where system is used
- Familiarity with routes where system is used
- Portion of journey for which system is used
- Types of road on which system is used
- Traffic density
- Headway
- Weather condition
- Ambient lighting

How do driver characteristics affect usage of the functions? Examples are

- Personal characteristics (e. g. age, vision)
- Socio-economic characteristics (e. g. family, friends, employment status)
- Journey-related characteristics (e. g. other car occupants, shared driving)

IMPACTS OF SYSTEM USAGE

What are the impacts on safety?

- exposure
- risk of accident or injury
- incidents and near accidents
- accidents?

What are the impacts on <u>personal</u> mobility?

- individual driving behaviour
- travel behaviour
- Comfort

What are the impacts on traffic efficiency?

- traffic flow (speed, travel time, punctuality)
- traffic volume
- Accessibility

What are the impacts on the environment?

- CO_2 emissions
- Particles
- Noise

IMPLICATIONS OF MEASURED IMPACTS

What are the implications for policy?

- Policy decisions
- Laws, directives & enforcement
- Future funding
- Public authority implications
- Emergency service implications

What are the implications for business models?

- Predictions for system uptake
- User expectations
- Pricing models

What are the implications for system design & development?

- HMI design & usability
- Perceived value of service
- Device design
- Communications networks
- Interoperability issues

What are the implications for the public

- Public information/education
- Changes in legislation
- Inclusive access to systems
- Data protection

2.4 Step 4: Creation of Hypotheses

Once the key research questions for the FOT have been identified, hypotheses can be derived. The process of formulating hypotheses translates the general research questions into more specific and statistically testable hypotheses.

There is no process that can assure that all the "correct" hypotheses are formulated. To a large extent, creating hypotheses is an intuitive process, in which a combination of knowledge and judgement is applied. Nevertheless, a number of recommendations can be made about how this process should be conducted. These recommendations have been tested in a FESTA workshop and modified based on the experience of and feedback from that workshop.

Two complementary ways to develop hypotheses have been used. Both ways need to be followed, while it is not of importance which step is taken first. One of the steps follows the sequential check of specific areas in which functions can have an impact; the other step is fully based on the description of specific scenarios. While the one step results mainly in general hypotheses, the other step triggers the development of very specific hypotheses in specific driving situations or scenarios.

2.4.1 Deriving hypotheses from the scenarios

The main reasoning to describe functions, their use cases, situations and scenarios in detail according to Steps 1 and 2 is to trigger the generation of hypotheses for very specific scenarios. The hypotheses generation should be conducted by a team of experts, consisting of human factors experts, development engineers and traffic engineers and all of them need to fully understand the functions/ systems with all aspects and limitations.

Scenarios should be covered systematically. It is recommended that a structured approach be used and that the situations are checked sequentially for related hypotheses.

2.4.2 The six areas of impact

The six areas of impact defined by FESTA are based on Draskóczy et al. (1998). Although this approach was originally designed for formulating hypotheses on traffic safety impacts, it is in fact equally applicable for efficiency and environmental impacts.

The six areas are:

- Direct effects of a system on the user and driving.

- Indirect (behavioural adaptation) effects of the system on the user.
- Indirect (behavioural adaptation) effects of the system on the non-user (imitating effect).
- Modification of interaction between users and non-users (including vulnerable road users).
- Modifying accident consequences (e. g. by improving rescue, etc. — note that this can effect efficiency and environment as well as safety).
- Effects of combination with other systems.

It is not of particular importance to which of these areas a particular hypotheses is allocated. The six areas are instead to be used as a checklist to ensure consideration of multiple aspects of system impact.

In applying this procedure, it should be noted that:

- Area 1 includes the human-machine interaction aspects of system use.
- The driving task (see Table 2.2) can be defined, following Michon (1985) into the three levels of strategic, tactical and control (operational) aspects.
- Consideration should be given to such mediating factors as user/driver state, experience, journey purpose, etc.

Eliminato: Table 2.2

It should also be noted that the effects of system use may be:

- Short-term or long-term in terms of duration and
- Intended or unintended in terms of system design.

This additional step for hypotheses generation assures that very general hypotheses are not forgotten as well as hypotheses on unintended, short term and long term effects. It is intended to serve as a means for crosschecking.

Table 2.2: Levels of the Driving Task by Michon (1985)

Level	Explanation/ example
Strategic	Finding the way through a road network (navigation) including • Modifying modal choice • Modifying route choice • Modifying exposure (frequency and/or length of travel)
Tactical	e. g. changing lanes, keeping the vehicle on the lanes, including modifying speed choice
Control/ Operational	Maintaining speed/ headway and distance to other vehicles

2.4.3 Prioritising the hypotheses

The prioritization among the generated hypotheses is a difficult process. No specific advice can be given on how to proceed, but there are some general guidelines:

A complete list of the hypotheses that have been developed should be recorded. If it is considered that some are too trivial or too expensive to address in the subsequent study design and data collection, the reasons for not covering them should be recorded. In general, it should be left to the judgement of the experts acting as hypotheses generators which hypotheses are likely to reflect the real driving situation. Those should then be prioritized, keeping in mind that also unintended effects are very important.

2.5 Step 5: Link Hypotheses with indicators for quantitative analyses

Some of the hypotheses will already incorporate an indicator which needs to be measured, e. g. a very concrete hypothesis like “The function will increase time-to-collision (TTC)”. In this case it is obvious which indicator to choose, while the method to measure TTC might include complicated procedures and/ or costly measurement equipment. Chapter 5 in the FESTA Handbook gives an overview about many reasonable indicators. One should consider these indicators when planning the experimental design, since a detailed description how to calculate the indicators from measurements is also provided.

Other hypotheses might be rather unspecific, but still reasonable after rephrasing into testable ones. This rephrasing goes hand in hand with the identification of related reasonable indicators. For example, a hypothesis like “The function will increase lane changing performance” is not directly testable, since “lane change performance” is not an indicator itself. Hence, surrogate measures must be identified to evaluate lane change performance. These surrogate measures or indicators can e. g. be found in publications of corresponding research projects. If appropriate information cannot be found or is not accessible, new performance indicators need to be developed. Those indicators and the measurement methodology must be valid, reliable and sensitive, that is, the measurement must actually measure what it is supposed to measure, they must be reproducible and the measurands must be sensitive to changes of the variable. A sensitivity analysis should be performed beforehand during a pilot study to make sure that the new performance indicator is suitable. When one or more surrogate measures have been identified, the initial hypothesis can be reformulated into one or more testable hypotheses. In the above mentioned example, reasonable indicators associated to “lane change performance” might be: use of turning indicator or the number of lane change warnings. The initial hypothesis will then be reformulated into: “The system will increase the use of the turning indicator.” and “During the system use, the number of lane departure warnings will decrease.”. The next step is then to evaluate how the indicators “use of turning indicator” and “lane departure warnings” can be measured. In this context, D 2.1 provides useful information.

3 Conclusions & Recommendations for the Cooperative Systems

Expected difficulties while performing an FOT for cooperative systems:

- Cooperative systems have some geographical limitations. High frequency communication is limited by the line of sight and this is limited by topography!
- How much radio propagation is dampened by atmosphere depends on the output power of the radios but bad weather might reduce the communication range a little.
- Communication will use its own (communication congestion control), that is power control for reduction of range and avoiding redundant messages by intelligent protocols.
- In the case of C2C applications, the end user can only benefit if there are a large number of similar-equipped vehicles. This is a burden on FOTs for cooperative systems as well. It will be necessary to establish well defined scenarios with application relevant situations and the presence of equipped cars.

It is most likely that the initial market drive will be for C2I-based applications until there is a critical mass of equipped cars on the road. Filed operational tests will asses the technological and business feasibility.

4 References

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Annex A

A.1 Systems and Functions

A.1.1 Hazard Warning

System Name and Abbreviation	Function Classification		KEY
Hazard Warning	**Cooperative System**		**C01**
Connected Use Cases		Connected Hypotheses	
USE_COOPS_01		RQ_HW1 RQ_HW2 RQ_HW3	
Description	c2c & i2c communication system		
Functionality	System detects hazards, communicates them by store and forward or networking mechanisms. Drivers are informed about obstacles or hazards on the road ahead, if they are on the critical path. The system tackles bad friction and reduced visibility situations, as well as obstacle cars. Information from road side units especially at work zones or dangerous spots serves as an infrastructure channel.		
System/ function is designed to? Need addressed and potential benefits	Driver is aware of approaching critical situation and better prepared to react appropriate. Driver is more relaxed.		
Boundary Conditions: Infrastructure requirements	Other equipped cars sending information, infrastructure sending local information about work zones and hazardous spots.		
Boundary Conditions: Demographical requirements/ driver requirements	n/ a		
Boundary Conditions: Road context	The specific geometry of some geographical areas may make communication hard.		
Boundary Conditions: Environmental restrictions	Bad weather may interfere with cooperative communication.		
Boundary Conditions: Traffic context	bad weather conditions, equipped cars		
Boundary Conditions: Other limitations	It cannot be guaranteed that a warning is given, because detection and communication depends on other cars in that area. It has to be proved by relevance checks or other vehicles that the warning is valid.		

A.1.2 Decentralised Floating Car Data

System Name and Abbreviation	Function Classification	KEY
Decentralised Floating Car Data	**Cooperative System**	**C02**

Connected Use Cases	Connected Hypotheses
USE_DFCD_0	RQ_DFCD1 RQ_DFCD2 RQ_DFCD3 RQ_DFCD4

Description		c2c & c2i & i2c communication system
Functionality		The DFCD traffic information is used as input for the vehicle navigation system to obtain an optimal dynamic routing to the destination. It is complementary to the established systems such as RDS-TMC. Furthermore, the driver is informed about hazardous situations such as an end traffic jam behind a curve or stopped vehicles ahead. The system can also provide detailed information on the position of the vehicle inside the traffic jam and the estimated remaining time to pass through it. An uplink/downlink channel to a traffic server helps at low equipment rates and combines DFCD and RDS-TMC messages.
System/ function are designed to? Need addressed and potential benefits		Decentralized Floating Car Data (DFCD) is based on inter-vehicle and infrastructure communication. The application informs drivers of traffic jams ahead and improves the individual travel times by choosing alternative routes and traffic efficiency in general by better use of the road network. Vehicles exchange data on the local traffic situation by broadcast communication. Gaps, in which no direct vehicle-to-vehicle communication partner is available, are closed by communication with oncoming vehicles, or infrastructure. In this way, up to date traffic information can be obtained for a large local area (e.g. >50 km) even if only a low fraction of all vehicles is equipped with the inter-vehicle communication. Multi-hop routing on the network layer is not required.
Boundary Conditions	Infrastructure requirements	Equipped cars and infrastructure channel.
	Demographical requirements/ driver requirements	n/ a
	Road context	The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Bad weather may interfere with cooperative communication.
	Traffic context	dense traffic, traffic jams, equipped cars
	Other limitations	It cannot be guaranteed that a warning is given, because detection and communication depends on other cars in that area. It has to be proved by relevance checks or other vehicles that the information is valid.

A.1.3 Road Intersection Safety

System Name and Abbreviation	Function Classification	KEY
Road Intersection Safety	**Cooperative System**	**C03**

Connected Use Cases	Connected Hypotheses
USE_RIS_0	RQ_RIS1 RQ_RIS2 RQ_RIS3

Description		c2c & c2i & i2c communication system
Functionality		Lateral safety applications (LATC) are addressing the avoidance of the risk of lateral collision through an early warning to the driver. Specifically for road intersection safety, the focus is on accident avoidance (when already occurred), support in case of obstructed view and right-of-way denial. Two types of urban intersections can occur: the first type with infrastructure sensors and V2I communication ; the second type (longer term) assuming all of the involved vehicles having V2V capabilities implemented (with or without the support of the infrastructure)
System/ function is designed to? Need addressed and potential benefits		Driver is aware of approaching critical situation and better prepared to react appropriate. Driver is more relaxed.
Boundary Conditions	Infrastructure requirements	Infrastructure sends information about accident occurred, denial of right-of-way; other equipped cars broadcast its presence.
	Demographical requirements/ driver requirements	n/ a
	Road context	Intersections with/without right of way, with functioning/ non-functioning lights (eventually simulated) The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	low light for reduced perception of traffic Bad weather may interfere with cooperative communication."
	Traffic context	dense traffic, non-functioning traffic lights, equipped cars
	Other limitations	It cannot be guaranteed that a warning is given, because detection and communication depends on other cars in that area. It has to be proved by relevance checks or other vehicles that the information is valid.

A.1.4 Curve Warning

System Name and Abbreviation	Function Classification	KEY
Curve Warning	**Cooperative System**	**C04**

Connected Use Cases	Connected Hypotheses
USE_CW_0	RQ_CW_1

Description		c2c & c2i & i2c communication system
Functionality		Road departure applications (RODP) are related to the sharing with other vehicles of the information of a slippery road status, or a bad road condition (can be due to weather condition, ice, fog...), or other factors – especially in curve - that may lead to the risk of a road departure. Specifically, for curve warning, information is gathered and delivered with a sufficient anticipation to the driver about the road curvature and the adequate speed to keep in the specific black spot. Conditions that may dynamically change the speed and the trajectory to keep in the curve (road works, static obstacles) are also provided.
System/ function is designed to? Need addressed and potential benefits		Driver is aware of approaching critical situation and better prepared to react appropriate. Driver is more relaxed.
Boundary Conditions	Infrastructure requirements	Vehicle sends information to infrastructure (transponder) on speed adopted in curve
	Demographical requirements/ driver requirements	n/ a
	Road context	Rural roads, with sharp curves. The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Bad weather may interfere with cooperative communication.
	Traffic context	bad weather conditions, equipped vehicles
	Other limitations	It cannot be guaranteed that a warning is given, because detection and communication depends on other cars in that area. It has to be proved by relevance checks or other vehicles that the information is valid.

A.1.5 Cooperative Collision Warning

System Name and Abbreviation	Function Classification	KEY
Cooperative Collision Warning	**Cooperative System**	**C05**

Connected Use Cases	Connected Hypotheses
UC_CCW_01	RQ_CCW1 RQ_CCW2

Description		The cooperative collision warning function warns the driver of a possible collision with ahead-driving (or standing) vehicle.
Functionality		"The cooperative collision warning function warns the driver of a possible collision with ahead-driving (or standing) vehicle. Vehicles driving ahead permanently send their exact position and, preferably, velocity and acceleration data. The driver's vehicle can identify dangerous situations and warn the driver. A two level functional concept (warning/intervention) will adapt to the different danger potential depending on the distance between the own vehicle and the ahead-driving vehicle: • Warning driver of a possible collision (when reaching braking distance to position of ahead-driving vehicles) • Autonomous intervention if drivers do not react properly"
System/ function is designed to? Need addressed and potential benefits		Mitigation and avoidance of tailgate and head-on accidents
Boundary Conditions	Infrastructure requirements	Position, kinematics and braking information are permanently transmitted by other vehicles.
	Demographical requirements/ driver requirements	n/ a
	Road context	The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	"Bad weather may interfere with cooperative communication. "
	Traffic context	n/ a
	Other limitations	n/ a

A.1.6 Cooperative Low Friction Warning

System Name and Abbreviation	Function Classification	KEY
Cooperative Low Friction Warning	**Cooperative System**	**C06**

Connected Use Cases	Connected Hypotheses
UC_LFW_01	RQ_LFW1

Description		Cooperative Low friction warning function informs the driver about the presence of parts with low friction (snow, ice, etc.) on the road ahead.
Functionality		"Low friction warning function informs the driver about the presence of parts with low friction (snow, ice, etc.) on the road ahead. If the received data also contains position information the driver can be warned in front of such a road part in due time. The detection of low μ parts can be obtained from μ-estimations made by the ESP-ECU of vehicles ahead or oncoming. Alternatively, the information can directly be obtained from a suitable infrastructure like a road weather information service."
System/ function is designed to? Need addressed and potential benefits		Prevent accidents and indicidents due to slippery areas. Increase performance for existing safety systems, like ESP, Collision mitigation/avoidance systems.
Boundary Conditions	Infrastructure requirements	Information on weather conditions and ice on the road are permanently transmitted by infrastructure or other vehicles.
	Demographical requirements/ driver requirements	n/ a
	Road context	The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Should be tested in areas with frequent rain or snow or in winter season. Bad weather may interfere with cooperative communication.
	Traffic context	n/ a
	Other limitations	The algorithm determining the probability of crossing may depend on presence of zebra crossing in the digital maps inside the vehicle. As a consequence this function can be limited any time the map are not accurate.

A.1.7 Cooperative Lane Change Aid

System Name and Abbreviation	Function Classification	KEY
Cooperative Lane Change Aid	**Cooperative System**	**C07**

Connected Use Cases	Connected Hypotheses
UC_LCA_01 UC_LCA_02	RQ_LCA1

Description		The cooperative lane change aid function warns the driver in case of intended lane changes in the presence of vehicles on the destination lane.
Functionality		This function supports two sub-functionalities, information on traffics density in a certain area and information on traffic light signals ahead. Traffic density information are collected from infrastructure beacons and displayed inside the navigation display. Based on this information the driver can choose by his own a different route to his destination. The traffic lights information provides the signal status and the time, when the next green light phase will occur. With this information the driver can adapt his speed to support optimized traffic flow.
System/ function is designed to? Need addressed and potential benefits		Support of foresight driving, in particular in urban areas, to reduce waiting time, queues and therefore fuel consumption.
Boundary Conditions	Infrastructure requirements	Infrastructure support is necessary to get data of traffic density and traffic lights incl. time until phase change.
	Demographical requirements/ driver requirements	n/ a
	Road context	Urban areas The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Bad weather may interfere with cooperative communication.
	Traffic context	n/ a
	Other limitations	n/ a

A.1.8 Traffic Light and Traffic Flow Information

System Name and Abbreviation	Function Classification		KEY
Traffic Light and Traffic Flow Information	**Cooperative System**		**C08**
Connected Use Cases		Connected Hypotheses	
UC_TLFI_01		RQ_TLFI1	
Description		The traffic flow information system informs the driver of the traffic density and traffic light status in his area.	
Functionality		"This function supports two sub-functionalities, information on traffics density in a certain area and information on traffic light signals ahead. Traffic density information are collected from infrastructure beacons and displayed inside the navigation display. Based on this information the driver can choose by his own a different route to his destination. The traffic lights information provides the signal status and the time, when the next green light phase will occur. With this information the driver can adapt his speed to support optimized traffic flow."	
System/ function is designed to? Need addressed and potential benefits		Support of foresight driving, in particular in urban areas, to reduce waiting time, queues and therefore fuel consumption.	
Boundary Conditions	Infrastructure requirements	Infrastructure support is necessary to get data of traffic density and traffic lights incl. time until phase change.	
	Demographical requirements/ driver requirements	n/ a	
	Road context	Urban areas. The specific geometry of some geographical areas may make communication hard. "	
	Environmental restrictions	Bad weather may interfere with cooperative communication.	
	Traffic context	n/ a	
	Other limitations	A navigation system must support the display of traffic density data within their map.	

A.1.9 Vulnerable Road User Accidents Avoidance

System Name and Abbreviation	Function Classification	KEY
Vulnerable Road User Accidents Avoidance	**Cooperative System**	**C09**

Connected Use Cases	Connected Hypotheses
UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03	H_S19_01 H_S19_02 H_S19_03 H_S19_04 H_S19_05 H_S19_06 H_S19_07 H_S19_08 H_S19_09 H_S19_10 H_S19_11 H_S19_12 H_S19_13 H_S19_14 H_S19_15 H_S19_16 H_S19_17 H_S19_18 H_S19_19

Description		This function warns the driver when there is a sufficiently high probability that the trajectory of a vulnerable road user and the trajectory of the ego-vehicle will collide
Functionality		This function warns the driver depending on the probability that a vulnerable user will cross the ego-vehicle trajectory in order to avoid a collision. Information about the vulnerable road user is obtained from cooperative communication from another vehicle and/or an infrastructure and/or a vulnerable road user...
System/ function is designed to? Need addressed and potential benefits		Prevent accidents and incidents between vulnerable road users and vehicles.
Boundary Conditions	Infrastructure requirements	Infrastructure and/or other vehicle able to recognize and/or broadcast vulnerable user information and other vehicles information are needed for this function to work.
	Demographical requirements/ driver requirements	n/ a
	Road context	The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	"Bad weather may interfere with cooperative communication. "
	Traffic context	High density traffic may limit the ability of recognizing vulnerable road users.
	Other limitations	The algorithm determining the probability of crossing might depend on presence of pedestrian crossing in the digital maps inside the vehicle. As a consequence this function can be limited any time the map are not accurate.

A.1.10 Parking Zone Management

System Name and Abbreviation	Function Classification	KEY
Parking Zone Management	**Cooperative System**	**C10**

Connected Use Cases	Connected Hypotheses
USE_CVIS_01	RQ_CVIS1 RQ_CVIS2 RQ_CVIS3

Description		c2c & c2i & i2c communication system
Functionality		System gets data from parking zones as an input from road site units and provides to the CVIS units in vehicles (trucks and vans) the advanced reservation and scheduling of urban parking and interurban resting areas.
System/ function is designed to? Need addressed and potential benefits		Driver of truck will be informed about availability of urban parking zones (e.g. loading bays at train stations) or resting area on interurban roads. Drivers are guided to the parking area and will be informed on changes and delays. Management is based on logistics and freight management centre and CVIS units in vehicles and road site units with continuous IP connectivity.
Boundary Conditions	Infrastructure requirements	CVIS units are integrated in vehicles and road site units (RSU) with a continuous IP connectivity. RSU provide short and medium range communications. Vehicles are also connected via long range communication (2-3G) with traffic management centre.
	Demographical requirements/ driver requirements	Truck drivers
	Road context	Urban parking zones and loading bays for trucks and vans. Interurban resting areas for trucks. The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Bad weather may interfere with cooperative communication.
	Traffic context	
	Other limitations	

A.1.11 City Guardian

System Name and Abbreviation	Function Classification	KEY
City Guardian	**Cooperative System**	**C11**

Connected Use Cases	Connected Hypotheses
USE_CVIS_02	RQ_CVIS2

Description		c2c & c2i & i2c communication system
Functionality		Road site units (RSU) provides access rights for road sections, intersections, lanes, tunnels, parking areas, etc to trucks and other vehicles. System will monitor, route and query vehicles with dangerous goods, oversize transports or other specific transport vehicles.
System/ function is designed to? Need addressed and potential benefits		Vehicle (driver) gets access rights from road site units (RSU) to road sections, intersections, lanes, tunnels, parking areas, etc.. Access could be restricted for vehicles with dangerous goods. Vehicles get routing information and guidance from a control centre. The control centre monitors, plans and queries dangerous and oversize good transports. In the case of violation of access rights public authorities will be informed to take countermeasures.
Boundary Conditions	Infrastructure requirements	CVIS units are integrated in vehicles and road site units (RSU) with a continuous IP connectivity. RSU provide short and medium range communications. Vehicles are also connected via long range communication (2-3G) with traffic management centre.
	Demographical requirements/ driver requirements	Truck drivers and drivers of specific vehicles
	Road context	City entrance. The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Bad weather may interfere with cooperative communication.
	Traffic context	
	Other limitations	

A.1.12 Speed Advice

System Name and Abbreviation	Function Classification	KEY
Speed Advice	**Cooperative System**	**C12**

Connected Use Cases	Connected Hypotheses
USE_CVIS_03	RQ_CVIS1 RQ_CVIS2 RQ_CVIS3 RQ_CVIS6

Description		c2c & c2i & i2c communication system
Functionality		Road site units (RSU) provide actual traffic regulations and advice to vehicles and drivers. In-vehicle display show dynamic traffic signs to drivers and informs about actual, dynamic speed advice and lane specific speed limits.
System/ function is designed to? Need addressed and potential benefits		In-vehicle display of dynamic traffic signs and on-board provision of actual traffic regulations and advices.
Boundary Conditions	Infrastructure requirements	CVIS units are integrated in vehicles and road site units (RSU) with a continuous IP connectivity. RSU provide short and medium range communications. Vehicles are also connected via long range communication (2-3G) with traffic management centre.
	Demographical requirements/ driver requirements	n/ a
	Road context	The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Bad weather may interfere with cooperative communication.
	Traffic context	
	Other limitations	

A.1.13 Traffic prioritization

System Name and Abbreviation	Function Classification	KEY
Traffic prioritization	**Cooperative System**	**C13**

Connected Use Cases	Connected Hypotheses
USE_CVIS_04	RQ_CVIS1 RQ_CVIS3 RQ_CVIS5 RQ_CVIS6

Description		c2c & c2i & i2c communication system
Functionality		Road site units (RSU) receive authorization from specific vehicles (e.g. emergency vehicles with sirens) and give them priority (e.g. green wave) at a series of intersections equipped with traffic lights. RSU informs vehicles in the vicinity about emergency case. System will monitor, route emergency vehicles.
System/ function is designed to? Need addressed and potential benefits		Green wave will be provided to emergency vehicles. Drivers in the vicinity will be informed about emergency case.
Boundary Conditions	Infrastructure requirements	CVIS units are integrated in vehicles and road site units (RSU) with a continuous IP connectivity. RSU provide short and medium range communications. Vehicles are also connected via long range communication (2-3G) with traffic management centre.
	Demographical requirements/ driver requirements	Drivers of emergency vehicles
	Road context	Urban areas with traffic lights at intersections The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	"Bad weather may interfere with cooperative communication. "
	Traffic context	
	Other limitations	

A.1.14 Dynamic allocation of lanes and road sections

System Name and Abbreviation	Function Classification	KEY
Dynamic allocation of lanes and road sections	**Cooperative System**	**C14**

Connected Use Cases	Connected Hypotheses
USE_CVIS_05	RQ_CVIS1 RQ_CVIS3 RQ_CVIS5 RQ_CVIS6

Description		c2c & c2i & i2c communication system
Functionality		Road site units (RSU) provide access rights or restrictions for the usage of specific lanes and road sections to vehicles and drivers. In-vehicle display shows to the driver the dynamic lane and road section specific access rights and warns in the case of violation.
System/ function is designed to? Need addressed and potential benefits		Dynamic allocation of bus lanes and specific road intersections for individual and public transport to optimise the overall traffic flow. Road sections and specific lanes may also be used for traffic in both directions to channel traffic of commuters.
Boundary Conditions	Infrastructure requirements	CVIS units are integrated in vehicles and road site units (RSU) with a continuous IP connectivity. RSU provide short and medium range communications. Vehicles are also connected via long range communication (2-3G) with traffic management centre.
	Demographical requirements/ driver requirements	Drivers of public transport vehicles
	Road context	Urban areas with specific lanes for public transport The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Bad weather may interfere with cooperative communication.
	Traffic context	
	Other limitations	

A.1.15 Informing driver about current speed limit

System Name and Abbreviation	Function Classification	KEY
Informing driver about current speed limit	**Cooperative System**	**C15**

Connected Use Cases	Connected Hypotheses
CV-UC-SP3.2-0017 CV-UC-SP3.2-0011	RQ_CVIS2 RQ_CVIS4

Description		c2c & c2i & i2c communication system
Functionality		The cooperative systems keeps informed the driver about the suggested speed to keep all the traffic flow fluid and harmonised in the highway or interurban road section he/she is travelling.
System/ function is designed to? Need addressed and potential benefits		The traffic is harmonised and fluid, the headway is kept under control to achieve minimum risk of accidents, lowering the probability of congestions, lowering pollution.
Boundary Conditions	Infrastructure requirements	CVIS units are integrated in vehicles and road site units (RSU) with a continuous IP connectivity. RSU provide short and medium range communications. Vehicles are also connected via long range communication (2-3G) with traffic management centre.
	Demographical requirements/ driver requirements	n/a
	Road context	Interurban roads, motorways. The specific geometry of some geographical areas may make communication hard.
	Environmental restrictions	Bad weather may interfere with cooperative communication.
	Traffic context	
	Other limitations	

A.2 Use Cases

A.2.1 USE_COOPS_01

Use Case Name and Abbreviation			KEY
USE_COOPS_01			**UC_01**
Connected Systems			Connected Hypotheses
Hazard Warning			RQ_HW1 RQ_HW2 RQ_HW3
Description		System detects hazards, communicates them by store and forward or networking mechanisms. Drivers are informed about obstacles or hazards on the road ahead, if they are on the critical path. The system tackles bad friction and reduced visibility situations, as well as obstacle cars. Information from road side units especially at work zones or dangerous spots serves as an infrastructure channel.	
System and Vehicle Specification	System Status	ON	
	System Action Status	No active control - information only	
	Vehicle Characteristics	Performance is independent from vehicle characteristics	
	Interaction between Systems	n/ a	
Environmental Specifications	Traffic Conditions	Quality of hazard warnings depends up to a certain degree on traffic density. Without minimum number of vehicles = traffic density * equipment rate no proper support is feasible. Store and forward of messages within a certain distance or time interval is assumed.	
	Environmental Situation	Source of information is bad visibility, slippery road, obstacles, and road works. Thus support is best under bad weather conditions.	
	Road Characteristics	On curved roads with bad foresight the benefit is higher than on wide straight roads.	
	Geographical Characteristics	System should be tested in winter with ice and snow or heavy rain.	
Driver	Driver Specification	normal sample of driver population	
	Driver Status	n/ a	
Frequency		rare	

A.2.2 USE_DFCD_0

Use Case Name and Abbreviation			KEY
USE_DFCD_0			**UC_02**
Connected Systems			Connected Hypotheses
Decentralised Floating Car Data			RQ_DFCD1 RQ_DFCD2 RQ_DFCD3 RQ_DFCD4
Description		The DFCD traffic information is used as input for the vehicle navigation system to obtain an optimal dynamic routing to the destination. It is complementary to the established systems such as RDS-TMC. Furthermore, the driver is informed about hazardous situations such as an end traffic jam behind a curve or stopped vehicles ahead. The system can also provide detailed information on the position of the vehicle inside the traffic jam and the estimated remaining time to pass through it. An uplink/downlink channel to a traffic server helps at low equipment rates and combines DFCD and RDS-TMC messages.	
System and Vehicle Specification	System Status	ON	
	System Action Status	No active control - information only	
	Vehicle Characteristics	Performance is independent from vehicle characteristics	
	Interaction between Systems	n/ a	
Environmental Specifications	Traffic Conditions	Quality of traffic information depends up to a certain degree on traffic density. Without minimum number of vehicles = traffic density * equipment rate no proper support is feasible. Store and forward of messages within a certain distance or time interval is assumed. Infrastructure information uplink and downlink to and from a traffic centre overcome problems with low equipment rates.	
	Environmental Situation	Source of information is speed, travel times, and traffic jams. Thus support is best for heavy traffic.	
	Road Characteristics	System is useful on autobahns and highways or other overcrowded stretches of road.	
	Geographical Characteristics	n/ a	
Driver	Driver Specification	normal sample of driver population	
	Driver Status	n/ a	
Frequency		rare	

A.2.3 USE_RIS_0

Use Case Name and Abbreviation			KEY
USE_RIS_0			**UC_03**
Connected Systems			Connected Hypotheses
Road Intersection Safety			RQ_RIS1 RQ_RIS2 RQ_RIS3
Description		Lateral safety applications (LATC) are addressing the avoidance of the risk of lateral collision through an early warning to the driver. Specifically for road intersection safety, the focus is on accident avoidance (when already occurred), support in case of obstructed view and right-of-way denial. Two types of urban intersections can occur: the first type with infrastructure sensors and V2I communication ; the second type (longer term) assuming all of the involved vehicles having V2V capabilities implemented (with or without the support of the infrastructure)	
System and Vehicle Specification	System Status	ON	
	System Action Status	No active control - information only. Maybe control over speed?	
	Vehicle Characteristics	Performance is independent from vehicle characteristics	
	Interaction between Systems	Interaction with Hazard Warning?	
Environmental Specifications	Traffic Conditions	Quality of accident warning propagation messages depends on the equipment rate of vehicles or intersections. Store and forward of messages within a certain distance or time interval is assumed.	
	Environmental Situation	Less visibility will increase the importance of the system.	
	Road Characteristics	n/ a	
	Geographical Characteristics	Different typologies of intersections: with traffic signals, right of way	
Driver	Driver Specification	normal sample of driver population	
	Driver Status	n/ a	
Frequency		rare	

A.2.4 USE_SO_0

Use Case Name and Abbreviation		KEY
USE_SO_0		**UC_04**
Connected Systems		Connected Hypotheses
		RQ_SO_1
Description		Lateral safety applications (LATC) are addressing the avoidance of the risk of lateral collision through an early warning to the driver. Specifically for safe overtaking, the focus is on prevention of collision among vehicles in an overtake situation (integration of blind spot and early notification to the preceding driver of the intention to overtake of the vehicle behind). Road user at particular risk are PTWs.
System and Vehicle Specification	System Status	ON
	System Action Status	No active control - information only. Maybe control over speed?
	Vehicle Characteristics	Performance depends on type of vehicle (e.g. commercial heavy vehicle, PTW)
	Interaction between Systems	Interaction with Hazard Warning?
Environmental Specifications	Traffic Conditions	Quality of system depends on the traffic: low traffic may lead to less attention; high traffic increases probability of presence of other vehicles but increases driver attention.
	Environmental Situation	Less visibility will increase the importance of the system.
	Road Characteristics	n/ a
	Geographical Characteristics	Highways are the preferred situation
Driver	Driver Specification	n/ a
	Driver Status	n/ a
Frequency		rare

A.2.5 USE_CW_0

Use Case Name and Abbreviation		KEY
USE_CW_0		**UC_05**
Connected Systems		Connected Hypotheses
Curve Warning		RQ_CW_1
Description		Road departure applications (RODP) are related to the sharing with other vehicles of the information of a slippery road status, or a bad road condition (can be due to weather condition, ice, fog...), or other factors – especially in curve - that may lead to the risk of a road departure. Specifically, for curve warning, information is gathered and delivered with a sufficient anticipation to the driver about the road curvature and the adequate speed to keep in the specific black spot. Conditions that may dynamically change the speed and the trajectory to keep in the curve (road works, static obstacles) are also provided.
System and Vehicle Specification	System Status	ON
	System Action Status	No active control - information only. Maybe control over speed?
	Vehicle Characteristics	Performance depends on type of vehicle (e.g. commercial heavy vehicle, PTW)
	Interaction between Systems	Interaction with Hazard Warning?
Environmental Specifications	Traffic Conditions	Traffic should have a minimal density, to allow estimation of speed under the same weather conditions.
	Environmental Situation	Weather conditions may have an impact on the correct speed in curve. Thus traffic should have a minimal density.
	Road Characteristics	Rural roads with sharp curves
	Geographical Characteristics	Rural roads
Driver	Driver Specification	passenger vehicle drivers and PTW drivers
	Driver Status	n/ a
Frequency		rare

A.2.6 UC_CCW_01

Use Case Name and Abbreviation		KEY
UC_CCW_01		**UC_06**
Connected Systems		Connected Hypotheses
Cooperative Collision Warning		RQ_CCW1 RQ_CCW2
Description		Cooperative Collision Warning: The vehicle under test is driving with activated system.
System and Vehicle Specification	System Status	ON
	System Action Status	n/ a
	Vehicle Characteristics	passenger vehicle truck
	Interaction between Systems	n/ a
Environmental Specifications	Traffic Conditions	Other traffic members with activated system are necessary to get proper functionality
	Environmental Situation	n/ a
	Road Characteristics	n/ a
	Geographical Characteristics	Urban vs. extra-urban areas should be considered
Driver	Driver Specification	normal sample of driver population
	Driver Status	n/ a
Frequency		rare

A.2.7 UC_LFW_01

Use Case Name and Abbreviation			KEY
UC_LFW_01			**UC_07**
Connected Systems			Connected Hypotheses
Cooperative Low Friction Warning			RQ_LFW1
Description		Cooperative Low Friction Warning: The vehicle under test is driving with activated system.	
System and Vehicle Specification	System Status	ON	
	System Action Status	n/ a	
	Vehicle Characteristics	passenger vehicle truck	
	Interaction between Systems	Interaction with stability control system possible	
Environmental Specifications	Traffic Conditions	Other traffic members with activated system are necessary to get proper functionality	
	Environmental Situation	n/ a	
	Road Characteristics	n/ a	
	Geographical Characteristics	n/ a	
Driver	Driver Specification	Age and gender of drivers should be considered	
	Driver Status	n/ a	
Frequency		rare	

A.2.8 UC_LCA_01

Use Case Name and Abbreviation		KEY
UC_LCA_01		**UC_08**
Connected Systems		Connected Hypotheses
Cooperative Lane Change Aid		RQ_LCA1
Description		Cooperative Lane Change Aid in urban areas: The vehicle under test is driving with activated system.
System and Vehicle Specification	System Status	ON
	System Action Status	n/ a
	Vehicle Characteristics	passenger vehicle truck
	Interaction between Systems	n/ a
Environmental Specifications	Traffic Conditions	Other traffic members with activated system are necessary to get proper functionality
	Environmental Situation	n/ a
	Road Characteristics	Function is assisting the driver only on roads with more then one lane per direction.
	Geographical Characteristics	Optimized for assistance in urban area
Driver	Driver Specification	n/ a
	Driver Status	n/ a
Frequency		rare

A.2.9 UC_LCA_02

Use Case Name and Abbreviation		KEY
UC_LCA_02		**UC_09**
Connected Systems	Connected Hypotheses	
Cooperative Lane Change Aid	RQ_LCA1	
Description	Cooperative Lane Change Aid on highways: The vehicle under test is driving with activated system.	
System and Vehicle Specification	System Status	ON
	System Action Status	n/ a
	Vehicle Characteristics	passenger vehicle truck
	Interaction between Systems	n/ a
Environmental Specifications	Traffic Conditions	Other traffic members with activated system are necessary to get proper functionality
	Environmental Situation	n/ a
	Road Characteristics	n/ a
	Geographical Characteristics	Optimized for assistance on highways
Driver	Driver Specification	Age and gender of drivers should be considered
	Driver Status	n/ a
Frequency	rare	

A.2.10 UC_TLFI_01

Use Case Name and Abbreviation		KEY
UC_TLFI_01		**UC_10**
Connected Systems		Connected Hypotheses
Traffic Light and Traffic Flow Information		RQ_TLFI1
Description		Traffic Light and Traffic Flow Information: The vehicle under test is driving with activated system.
System and Vehicle Specification	System Status	ON OFF
	System Action Status	n/ a
	Vehicle Characteristics	Passenger car Truck Bus motorcycle
	Interaction between Systems	Interaction with other traffic information systems could be possible.
Environmental Specification	Traffic Conditions	n/ a
	Environmental Situation	n/ a
	Road Characteristics	n/ a
	Geographical Characteristics	Optimized for assistance in urban area
Driver	Driver Specification	Age and gender of drivers should be considered
	Driver Status	n/ a
Frequency		rare

A.2.11 UC_VRUAA_01

Use Case Name and Abbreviation		KEY
UC_VRUAA_01		**UC_11**
Connected Systems	Connected Hypotheses	
Vulnerable Road User Accidents Avoidance	H_S19_01 H_S19_02 H_S19_03 H_S19_04 H_S19_05 H_S19_06 H_S19_07 H_S19_08 H_S19_09 H_S19_10 H_S19_11 H_S19_12 H_S19_13 H_S19_14 H_S19_15 H_S19_16 H_S19_17 H_S19_18 H_S19_19	
Description		The ego-vehicle under test is driving with activated function and it is approaching a zebra crossing.
System and Vehicle Specification	System Status	ON OFF
	System Action Status	n/ a
	Vehicle Characteristics	Passenger car Truck Bus motorcycle
	Interaction between Systems	Interaction with other traffic information systems could be possible especially at HMI level.
Environmental Specifications	Traffic Conditions	Other vehicles and/or infrastructure may be necessary for the cooperative application to work.
	Environmental Situation	Driver ability to see a pedestrian may depend on visibility. As a consequence, this function may have a higher impact on safety when visibility is low.
	Road Characteristics	A pedestrian crossing must be present.
	Geographical Characteristics	Depending on the different driving habits in different countries, vehicles may be more or less prone to slow down in proximity of a zebra crossing independently from the warning.
Driver	Driver Specification	Age, gender, experience, level of distraction and drowsiness should be considered.
	Driver Status	n/ a
Frequency		rare

A.2.12 UC_VRUAA_02

Use Case Name and Abbreviation		KEY
UC_VRUAA_02		**UC_12**
Connected Systems		Connected Hypotheses
Vulnerable Road User Accidents Avoidance		H_S19_01 H_S19_02 H_S19_03 H_S19_04 H_S19_05 H_S19_06 H_S19_07 H_S19_08 H_S19_09 H_S19_10 H_S19_11 H_S19_12 H_S19_13 H_S19_14 H_S19_15 H_S19_16 H_S19_17 H_S19_18 H_S19_19
Description		The ego-vehicle under test is driving with activated function and a pedestrian is in the proximity with intention of crossing the ego-vehicle trajectory.
System and Vehicle Specification	System Status	ON OFF
	System Action Status	n/ a
	Vehicle Characteristics	Passenger car Truck Bus motorcycle
	Interaction between Systems	Interaction with other traffic information systems could be possible especially at HMI level.
Environmental Specifications	Traffic Conditions	"Other vehicles and/or infrastructure may necessary for the cooperative application to work. One or more pedestrian need to be in proximity of the ego-vehicle."
	Environmental Situation	Pedestrian recognition may depend on cameras. As a consequence, different environment situations such as fog, rain, snow should be tested.
	Road Characteristics	Urban road are probably more likely to have pedestrian crossing.
	Geographical Characteristics	Depending on the different driving habits in different countries, vehicles may be more or less prone to slow down when a pedestrian is on the border of the road independently from the warning.
Driver	Driver Specification	Age, gender, experience, level of distraction and drowsiness should be considered.
	Driver Status	n/ a
Frequency		rare

A.2.13 UC_VRUAA_03

Use Case Name and Abbreviation		KEY
UC_VRUAA_03		**UC_13**
Connected Systems	Connected Hypotheses	
Vulnerable Road User Accidents Avoidance	H_S19_01 H_S19_02 H_S19_03 H_S19_04 H_S19_05 H_S19_06 H_S19_07 H_S19_08 H_S19_09 H_S19_10 H_S19_11 H_S19_12 H_S19_13 H_S19_14 H_S19_15 H_S19_16 H_S19_17 H_S19_18 H_S19_19	
Description		The ego-vehicle under test is driving with activated function and its trajectory and a vulnerable road user trajectory are colliding.
System and Vehicle Specification	System Status	ON OFF
	System Action Status	n/ a
	Vehicle Characteristics	Passenger car Truck Bus motorcycle
	Interaction between Systems	Interaction with other traffic information systems could be possible especially at HMI level.
Environmental Specifications	Traffic Conditions	A vulnerable road user following a trajectory potentially colliding with the ego-vehicle should be present. The ego-vehicle should get the information about the vulnerable road user trajectory from a cooperative communication (either an infrastructure, or another vehicle, or the vulnerable road user itself).
	Environmental Situation	"Pedestrian recognition may depend on cameras. As a consequence, different environment situations such as fog, rain, snow should be tested. However, driver ability to see a vulnerable road user may depend on visibility. As a consequence, this function may have a higher impact on safety when visibility is low."
	Road Characteristics	Road geometry can influence vulnerable road user recognition from the driver. As a consequence, roads with geometry (such as slope and curvature) which makes harder to have a good visibility may be the best candidate for showing this function effectiveness.
	Geographical Characteristics	Depending on the different countries, the density of vulnerable road users on the road and the road geometry can be different and impact the function performance.
Driver	Driver Specification	Age, gender, experience, level of distraction and drowsiness should be considered.
	Driver Status	n/ a
Frequency		rare

A.2.14 USE_CVIS_01

Use Case Name and Abbreviation	KEY

USE_CVIS_01			**UC_14**
Connected Systems			Connected Hypotheses
Parking Zone Management			RQ_CVIS1 RQ_CVIS2 RQ_CVIS3
Description		Parking Zone Management: The vehicle under test is driving with activated system.	
System and Vehicle Specification	System Status	ON OFF	
	System Action Status	Control via Road Side Unit or Control Centre	
	Vehicle Characteristics	Truck Van	
	Interaction between Systems	n/ a	
Environmental Specifications	Traffic Conditions	n/ a	
	Environmental Situation	Source of information is bad visibility, slippery road, obstacles, and road works. Thus support is best under bad weather conditions.	
	Road Characteristics	Urban parking zones and interurban rest areas	
	Geographical Characteristics	Parking zones and resting areas	
Drive r	Driver Specification	normal sample of truck drivers	
	Driver Status	n/ a	
Frequency		rare	

A.2.15 USE_CVIS_02

Use Case Name and Abbreviation			KEY
USE_CVIS_02			**UC_15**
Connected Systems		Connected Hypotheses	
City Guardian		RQ_CVIS2	
Description		City Guardian: The vehicle under test is driving with activated system.	
System and Vehicle Specification	System Status	ON OFF	
	System Action Status	Control via Road Side Unit or Control Centre	
	Vehicle Characteristics	Truck Special vehicles	
	Interaction between Systems	n/ a	
Environmental Specification	Traffic Conditions	n/ a	
	Environmental Situation	n/ a	
	Road Characteristics	Tunnels, bridges, highway checkpoints	
	Geographical Characteristics	Checkpoints at city entrance	
Driver	Driver Specification	normal sample of truck drivers	
	Driver Status	n/ a	
Frequency		rare	

A.2.16 USE_CVIS_03

Use Case Name and Abbreviation		KEY
USE_CVIS_03		**UC_16**
Connected Systems		Connected Hypotheses
Speed Advice		RQ_CVIS1 RQ_CVIS2 RQ_CVIS3 RQ_CVIS6
Description		Speed Advice: The vehicle under test is driving with activated system.
System and Vehicle Specification	System Status	ON OFF
	System Action Status	Control via Road Side Unit or Control Centre
	Vehicle Characteristics	Passenger vehicle truck
	Interaction between Systems	Interaction between local RSU based control and control centre
Environmental Specifications	Traffic Conditions	n/ a
	Environmental Situation	Source of information is speed, travel times, and traffic jams. Thus support is best for heavy traffic.
	Road Characteristics	Road stretches with Variable Message Signs
	Geographical Characteristics	n/ a
Drive r	Driver Specification	normal sample of driver population
	Driver Status	n/ a
Frequency		rare

A.2.17 USE_CVIS_04

Use Case Name and Abbreviation		KEY
USE_CVIS_04		**UC_17**
Connected Systems		Connected Hypotheses
Traffic prioritization		RQ_CVIS1 RQ_CVIS3 RQ_CVIS5 RQ_CVIS6
Description		Traffic prioritization: The vehicle under test is driving with activated system.
System and Vehicle Specification	System Status	ON OFF
	System Action Status	Control via Road Side Unit or Control Centre
	Vehicle Characteristics	Emergency vehicle passenger vehicle truck
	Interaction between Systems	Interaction between local RSU based control and control centre information
Environmental Specifications	Traffic Conditions	Other traffic members with activated system are necessary to get proper functionality
	Environmental Situation	n/ a
	Road Characteristics	System is useful in crowed and traffic jammed urban stretches of road
	Geographical Characteristics	urban areas with intersections equipped with traffic lights
Driver	Driver Specification	drivers of emergency vehicles and normal sample of drivers
	Driver Status	n/ a
Frequency		rare

A.2.18 USE_CVIS_05

Use Case Name and Abbreviation			KEY
USE_CVIS_05			**UC_18**
Connected Systems			Connected Hypotheses
Dynamic allocation of lanes and road sections			RQ_CVIS1 RQ_CVIS3 RQ_CVIS5 RQ_CVIS6
Description		Dynamic allocation of lanes and road sections: The vehicle under test is driving with activated system.	
System and Vehicle Specification	System Status	ON OFF	
	System Action Status	Control via Road Side Unit or Control Centre	
	Vehicle Characteristics	Passenger vehicle Truck bus	
	Interaction between Systems	Interaction between VMS and control centre information	
Environmental Specifications	Traffic Conditions	Other traffic members with activated system are necessary to get proper functionality	
	Environmental Situation	n/ a	
	Road Characteristics	System is useful in crowed and traffic jammed urban stretches of road	
	Geographical Characteristics	urban areas with specific lanes for public transport	
Drive r	Driver Specification	sample of bus drivers and normal sample of drivers	
	Driver Status	n/ a	
Frequency		rare	

A.2.19 CV-UC-SP3.2-0017

Use Case Name and Abbreviation			KEY
CV-UC-SP3.2-0017			**UC_19**
Connected Systems			Connected Hypotheses
Informing driver about current speed limit			RQ_CVIS2 RQ_CVIS4
Description		Informing driver about current speed limit: The vehicle under test is driving with activated system.	
System and Vehicle Specification	System Status	ON OFF	
	System Action Status	Control via Road Side Unit or Control Centre	
	Vehicle Characteristics	Passenger vehicle Truck bus	
	Interaction between Systems	Interaction among vehicle, traffic control centres, service centre	
Environmental Specifications	Traffic Conditions	n/ a	
	Environmental Situation	n/ a	
	Road Characteristics	Application achieve better results on interurban roads and motorways	
	Geographical Characteristics	Interurban roads and motorways	
Drive r	Driver Specification	normal sample of driver population	
	Driver Status	n/ a	
Frequency		rare	

A.2.20 CV-UC-SP3.2-0011

Use Case Name and Abbreviation		KEY
CV-UC-SP3.2-0011		**UC_20**
Connected Systems		Connected Hypotheses
		RQ_CVIS1 RQ_CVIS2 RQ_CVIS3 RQ_CVIS7
Description		On trip cooperation: The vehicle under test is driving with activated system.
System and Vehicle Specification	System Status	ON OFF
	System Action Status	Control via Road Side Unit or Control Centre
	Vehicle Characteristics	Passenger vehicle Truck bus
	Interaction between Systems	Interaction among vehicle, traffic control centres, service centre
Environmental Specifications	Traffic Conditions	n/ a
	Environmental Situation	n/ a
	Road Characteristics	Application achieve better results on interurban roads and motorways
	Geographical Characteristics	Interurban roads and motorways
Driver	Driver Specification	normal sample of driver population
	Driver Status	n/ a
Frequency		rare

A.3 Research Questions and Hypotheses

<table>
<tr><td colspan="4">Hypothesis
Approaching critical situation or obstacles driver is prepared to react.</td><td>KEY
RQ_HW1</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="3"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="3">Hazard Warning</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="3">USE_COOPS_01</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="3">approaching speed to critical situations or obstacles
Brake reaction time on critical situations or obstacles
Brake force on critical situations or obstacles is lower or is higher</td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td>+</td><td colspan="2">Less accidents, because drivers are prepared to react.</td></tr>
<tr><td>Environmental impacts</td><td>+</td><td colspan="2">Less accidents lead to fewer accident related congestions, resulting in less emmission.</td></tr>
<tr><td>Transport and traffic efficiency</td><td>+</td><td colspan="2">Less accidents lead to fewer accident related congestions.</td></tr>
<tr><td>Usage, acceptance and trust</td><td></td><td colspan="2"></td></tr>
</table>

<table>
<tr><td colspan="4">Hypothesis
Driver is more relaxed</td><td>KEY
RQ_HW2</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="3"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="3">Hazard Warning</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="3">USE_COOPS_01</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="3">Workload</td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td>+</td><td colspan="2">Reduced workload enables better anticipation of irregular situations.</td></tr>
<tr><td>Environmental impacts</td><td></td><td colspan="2"></td></tr>
<tr><td>Transport and traffic efficiency</td><td></td><td colspan="2"></td></tr>
<tr><td>Usage, acceptance and trust</td><td>+</td><td colspan="2">If the systems reduced workload, drivers are likely to accept and trust it.</td></tr>
</table>

Hypothesis			KEY
Driver is more incautious			**RQ_HW3**
Related Research Question			
Related System	Hazard Warning		
Related Use Case	USE_COOPS_01		
Proposed indicator	approaching speed to critical situations or obstacles, Brake reaction time on critical situations or obstacles Brake force on critical situations or obstacles is lower or is higher		
Estimated impact on: Traffic Safety and safety related driving performance	-	The driver expectation that he always will be warned for not for seen hazards could cause inattentive driving.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis			KEY
With system less time in traffic jams			**RQ_DFCD1**
Related Research Question			
Related System	Decentralised Floating Car Data		
Related Use Case	USE_DFCD_0		
Proposed indicator	Quotient: estimated driving time at beginning / effective driving time is greater with DFCD then without DFCD or Quotient: estimated driving time at beginning / effective driving time is smaller with DFCD then without DFCD		
Estimated impact on: Traffic Safety and safety related driving performance			
Estimated impact on: Environmental impacts	+	The informed driver will spend less time driving from origin to destination.	
Estimated impact on: Transport and traffic efficiency	+	The fewer additional vehicles are part of a congestion, the sooner it might break up.	
Estimated impact on: Usage, acceptance and trust	+	Effective avoidance of congestions might lead to a high acceptance of the system	

Hypothesis			KEY
Driving with system is more relaxed			**RQ_DFCD2**
Related Research Question			
Related System	Decentralised Floating Car Data		
Related Use Case	USE_DFCD_0		
Proposed indicator	Workload		
Estimated impact on: Traffic Safety and safety related driving performance	+	Driving is more relaxed, because the driver needs less attention finding the best route.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust	+	High acceptance is expected for a system providing means for less stressful driving.	

Hypothesis			KEY
Total driving time is longer			**RQ_DFCD3**
Related Research Question			
Related System	Decentralised Floating Car Data		
Related Use Case	USE_DFCD_0		
Proposed indicator	Quotient: estimated driving time at beginning / effective driving time is greater with DFCD then without DFCD or Quotient: estimated driving time at beginning / effective driving time is smaller with DFCD then without DFCD		
Estimated impact on: Traffic Safety and safety related driving performance			
Estimated impact on: Environmental impacts	-	If the information is not correct it might lead to a longer driving time.	
Estimated impact on: Transport and traffic efficiency	-	Increased travel times imply less efficient travel.	
Estimated impact on: Usage, acceptance and trust	-	If a system results in considerable longer travel times, low acceptance might be the result.	

Hypothesis **DFCD has no effect on driving time**			KEY **RQ_DFCD4**
Related Research Question			
Related System	Decentralised Floating Car Data		
Related Use Case	USE_DFCD_0		
Proposed indicator	approaching speed to critical situations or obstacles Brake reaction time on critical situations or obstacles Brake force on critical situations or obstacles is lower or is higher		
Estimated impact on: Traffic Safety and safety related driving performance			
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis **Approaching critical situation driver is prepared to react.**			KEY **RQ_RIS1**
Related Research Question			
Related System	Road Intersection Safety		
Related Use Case	USE_RIS_0		
Proposed indicator	approaching speed to critical situations or obstacles		
Estimated impact on: Traffic Safety and safety related driving performance	+	Less accidents, because drivers are prepared to react earlier.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis			KEY
Driver is more relaxed			**RQ_RIS2**
Related Research Question			
Related System	Road Intersection Safety		
Related Use Case	USE_RIS_0		
Proposed indicator	Workload		
Estimated impact on	Traffic Safety and safety related driving performance	+	Reduced workload enables better anticipation of irregular situations.
	Environmental impacts		
	Transport and traffic efficiency		
	Usage, acceptance and trust	+	If the systems reduced workload, drivers are likely to accept and trust it.

Hypothesis			KEY
Driver is always supported			**RQ_RIS3**
Related Research Question			
Related System	Road Intersection Safety		
Related Use Case	USE_RIS_0		
Proposed indicator			
Estimated impact on	Traffic Safety and safety related driving performance	+	Less accidents, because drivers is prepared to react.
	Environmental impacts		
	Transport and traffic efficiency		
	Usage, acceptance and trust	+	If the systems reduced workload, drivers are likely to accept and trust it.

Hypothesis			KEY
This function will reduce the number of accidents and near accidents on overtaking manoeuvres.			**RQ_SO_1**
Related Research Question			
Related System			
Related Use Case	USE_SO_0		
Proposed indicator			
Estimated impact on: Traffic Safety and safety related driving performance	+	Less accidents, because the driver will cancel overtaking manoeuvres in time.	
Estimated impact on: Environmental impacts	+	Less accidents lead to less accident related congestions, resulting in fewer emmissions	
Estimated impact on: Transport and traffic efficiency	+	Less accidents lead to less accident related congestions, resulting in lower travel time.	
Estimated impact on: Usage, acceptance and trust			

Hypothesis			KEY
This function will reduce the number of road departure events.			**RQ_CW_1**
Related Research Question			
Related System	Curve Warning		
Related Use Case	USE_CW_0		
Proposed indicator			
Estimated impact on: Traffic Safety and safety related driving performance	+	Less accidents, because drivers will reduce speed.	
Estimated impact on: Environmental impacts	+	Less accidents lead to less accident related congestions, resulting in fewer emmissions	
Estimated impact on: Transport and traffic efficiency	+	Less accidents lead to less accident related congestions, resulting in lower travel time.	
Estimated impact on: Usage, acceptance and trust			

Hypothesis			KEY
Cooperative Collision Warning system reduces the number or severity of accidents			**RQ_CCW1**
Related Research Question			
Related System	Cooperative Collision Warning		
Related Use Case	UC_CCW_01		
Proposed indicator			
Estimated impact on: Traffic Safety and safety related driving performance	+	Less severe accidents, because drivers is prepared to react.	
Estimated impact on: Environmental impacts	+	Less severe accidents might lead to less severe congestions.	
Estimated impact on: Transport and traffic efficiency	+	Less severe accidents might lead to less severe congestions, resulting in less delay.	
Estimated impact on: Usage, acceptance and trust			

Hypothesis			KEY
The driver will be alienated when he gets a collision warning where the obstacle is invisible.			**RQ_CCW2**
Related Research Question			
Related System	Cooperative Collision Warning		
Related Use Case	UC_CCW_01		
Proposed indicator			
Estimated impact on: Traffic Safety and safety related driving performance			
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust	-	The driver might be confused when he gets a warning and he does not understand the reason.	

Hypothesis			KEY
Cooperative Low Friction Warning system reduces the number or severity of accidents			**RQ_LFW1**
Related Research Question			
Related System	Cooperative Low Friction Warning		
Related Use Case	UC_LFW_01		
Proposed indicator			
Estimated impact on	Traffic Safety and safety related driving performance	+	Reduced number of accidents.
	Environmental impacts	+	Less accidents lead to less accident related congestions, resulting in fewer emmissions
	Transport and traffic efficiency	+	Less accidents lead to less accident related congestions, resulting in lower travel time.
	Usage, acceptance and trust		

Hypothesis			KEY
Cooperative Lane Change Aid system reduces the number or severity of accidents			**RQ_LCA1**
Related Research Question			
Related System	Cooperative Lane Change Aid		
Related Use Case	UC_LCA_01 UC_LCA_02		
Proposed indicator			
Estimated impact on	Traffic Safety and safety related driving performance	+	Reduced number of accidents.
	Environmental impacts	+	Less accidents lead to less accident related congestions, resulting in fewer emmissions
	Transport and traffic efficiency	+	Less accidents lead to less accident related congestions, resulting in lower travel time.
	Usage, acceptance and trust		

Hypothesis			KEY
Continuously driving with Traffic Light and Traffic Flow Information reduces travel time and fuel consumption			**RQ_TLFI1**
Related Research Question			
Related System	Traffic Light and Traffic Flow Information		
Related Use Case	UC_TLFI_01		
Proposed indicator			
Estimated impact on	Traffic Safety and safety related driving performance	+	Reduced travel time reduces exposure to risk of having an accident.
	Environmental impacts	+	Reduced CO_2 emission.
	Transport and traffic efficiency	+	Reduced travel time
	Usage, acceptance and trust		

Hypothesis			KEY
This function will decrease the number of incidents and accidents between vulnerable road users and vehicles.			**H_S19_01**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Number of incidents and accidents from questionnaires, police reports, and video analysis.		
Estimated impact on	Traffic Safety and safety related driving performance	+	Reduced number of accidents that involve vulnerable road users
	Environmental impacts		
	Transport and traffic efficiency		
	Usage, acceptance and trust	+ or -	Will be either a plus or minus depending on the level of missed and/or false alarms, which are critical parameters especially in urban context where the number of vulnerable road users is high and not all of them are to be identified as a potential risk.

Hypothesis			KEY
This function will decrease vehicle speed when a warning is issued.			**H_S19_02**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Mean spot speed, Mean speed		
Estimated impact on: Traffic Safety and safety related driving performance	+	Reduced number of accidents.	
Estimated impact on: Environmental impacts	+	Reduced mean speed reduces emmission	
Estimated impact on: Transport and traffic efficiency	+	Reduced mean speed results in higher usage of the available capacity of road networks	
Estimated impact on: Usage, acceptance and trust			

Hypothesis			KEY
This function impact will be higher in urban road and where road geometry and environment conditions impair visibility.			**H_S19_03**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Mean spot speed		
Estimated impact on: Traffic Safety and safety related driving performance	+	Reduced number of accidents.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

<table>
<tr><td colspan="3">Hypothesis
This function will increase awareness of pedestrian crossing risk in specific locations, thus inducing the driver to slow down even without a warning in these locations.</td><td>KEY
H_S19_04</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="2"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="2">Vulnerable Road User Accidents Avoidance</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="2">UC_VRUAA_01
UC_VRUAA_02
UC_VRUAA_03</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="2">Mean spot speed, Number of incidents and accidents</td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td>+</td><td>Reduced number of accidents.</td></tr>
<tr><td>Environmental impacts</td><td></td><td></td></tr>
<tr><td>Transport and traffic efficiency</td><td></td><td></td></tr>
<tr><td>Usage, acceptance and trust</td><td></td><td></td></tr>
</table>

<table>
<tr><td colspan="3">Hypothesis
This function will increase driver reliance on the function and increase risk of incidents/accidents with vulnerable users when missing to warn the driver or not available.</td><td>KEY
H_S19_05</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="2"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="2">Vulnerable Road User Accidents Avoidance</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="2">UC_VRUAA_01
UC_VRUAA_02
UC_VRUAA_03</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="2">Mean spot speed, Number of incidents and accidents</td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td>+</td><td>Reduced number of accidents.</td></tr>
<tr><td>Environmental impacts</td><td></td><td></td></tr>
<tr><td>Transport and traffic efficiency</td><td></td><td></td></tr>
<tr><td>Usage, acceptance and trust</td><td></td><td></td></tr>
</table>

Hypothesis **This function will increase driver load by augmenting the amount of HMI information**			KEY **H_S19_06**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Workload		
Estimated impact on: Traffic Safety and safety related driving performance	-	The function might increase the risk of accidents especially in situations with high workload.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust	-	Increased amount of information might lead to information overflow for the driver, resulting in reduced acceptance of the overall vehicle system.	

Hypothesis **This function impact will be higher when the driver is not alert or is drowsy.**			KEY **H_S19_07**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Driver alertness		
Estimated impact on: Traffic Safety and safety related driving performance	+	Reduced number of accidents.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis				KEY
This function will influence the driver route planning: the driver may decide to avoid roads where vulnerable road users are often crossing.				**H_S19_08**
Related Research Question				
Related System	Vulnerable Road User Accidents Avoidance			
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03			
Proposed indicator	Route from GPS, Route from GPS, Questionnaire			
Estimated impact on	Traffic Safety and safety related driving performance	+	Reduced number of accidents.	
	Environmental impacts	-	Function might lead to longer travel routes and higher travel time, increasing emmisions.	
	Transport and traffic efficiency	-	Function might lead to longer travel routes and higher travel time, increasing the time in traffic and hence the usage of the traffic system	
	Usage, acceptance and trust			

Hypothesis				KEY
This function will be turned off in urban roads because too annoying.				**H_S19_09**
Related Research Question				
Related System	Vulnerable Road User Accidents Avoidance			
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03			
Proposed indicator	Questionnaire, Function activation			
Estimated impact on	Traffic Safety and safety related driving performance			
	Environmental impacts			
	Transport and traffic efficiency			
	Usage, acceptance and trust	-	Function will not be used.	

<table>
<tr><td colspan="4">Hypothesis
Vulnerable users will start to rely on the vehicles stopping because using this function and pay less attention while crossing.</td><td>KEY
H_S19_10</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="3"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="3">Vulnerable Road User Accidents Avoidance</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="3">UC_VRUAA_01
UC_VRUAA_02
UC_VRUAA_03</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="3">Number of read-end incidents from videos, Indicator for over-reliance</td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td>-</td><td colspan="2">Higher accident risk.</td></tr>
<tr><td>Environmental impacts</td><td></td><td colspan="2"></td></tr>
<tr><td>Transport and traffic efficiency</td><td></td><td colspan="2"></td></tr>
<tr><td>Usage, acceptance and trust</td><td>-</td><td colspan="2">Misuse from the vulnerable road users.</td></tr>
</table>

<table>
<tr><td colspan="4">Hypothesis
Car not equipped with this function will be annoyed by the equipped-car slowing down and try to pass when not safe or drive more aggressively.</td><td>KEY
H_S19_11</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="3"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="3">Vulnerable Road User Accidents Avoidance</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="3">UC_VRUAA_01
UC_VRUAA_02
UC_VRUAA_03</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="3">Acceleration and GPS from following vehicles.</td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td>-</td><td colspan="2">Unneccessary and dangerous overtaking maneuvres at pedestrian crossings</td></tr>
<tr><td>Environmental impacts</td><td></td><td colspan="2"></td></tr>
<tr><td>Transport and traffic efficiency</td><td></td><td colspan="2"></td></tr>
<tr><td>Usage, acceptance and trust</td><td>-</td><td colspan="2">Inadequate behaviour change of users with not equipped cars.</td></tr>
</table>

Hypothesis			KEY
This function will have a higher penetration among drivers who often use the road as vulnerable road users or have relatives who are normally vulnerable road users.			**H_S19_12**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator			
Estimated impact on: Traffic Safety and safety related driving performance	+	High penetration of equipped vehicles on roads with high pedestrain densitiy	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis			KEY
This function will have a higher penetration for small trucks who often deliver in urban areas.			**H_S19_13**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator			
Estimated impact on: Traffic Safety and safety related driving performance	+	High penetration of equipped vehicles on roads with high pedestrain densitiy	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis **This function will increase the probability of traffic jams especially during rush hours in city centres.**			KEY **H_S19_14**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Mean speed in traffic flow,		
Estimated impact on	Traffic Safety and safety related driving performance		
	Environmental impacts		
	Transport and traffic efficiency	-	Reduced traffic efficiency.
	Usage, acceptance and trust		

Hypothesis **This function will increase the probability of rear-end incidents.**			KEY **H_S19_15**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Number of read-end incidents from videos,		
Estimated impact on	Traffic Safety and safety related driving performance	+	Higher accident risk.
	Environmental impacts		
	Transport and traffic efficiency		
	Usage, acceptance and trust		

Hypothesis **This function will be more useful for elderly drivers than for young drivers.**			KEY **H_S19_16**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Questionnaire		
Estimated impact on: Traffic Safety and safety related driving performance	+	Support for elderly driver to preceive the surrounding traffic situation.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis **This function will decrease the probability of distraction in urban roads.**			KEY **H_S19_17**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Driver alertness		
Estimated impact on: Traffic Safety and safety related driving performance	-	Higher accident risk.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis **This function will be more useful in bad weather or low visibility conditions.**			KEY **H_S19_18**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Mean spot speed, Weather conditions		
Estimated impact on: Traffic Safety and safety related driving performance	+	Support for drivers to preceive the surrounding traffic situation.	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis **This function will be more useful for busses than for trucks and cars.**			KEY **H_S19_19**
Related Research Question			
Related System	Vulnerable Road User Accidents Avoidance		
Related Use Case	UC_VRUAA_01 UC_VRUAA_02 UC_VRUAA_03		
Proposed indicator	Questionnaire		
Estimated impact on: Traffic Safety and safety related driving performance	+	Support for drivers to preceive the surrounding traffic situation, especially in the are of bus stops with a high pedestrian density	
Estimated impact on: Environmental impacts			
Estimated impact on: Transport and traffic efficiency			
Estimated impact on: Usage, acceptance and trust			

Hypothesis **Vehicles equipped with this function are less time in traffic**			KEY **RQ_CVIS1**
Related Research Question			
Related System	Parking Zone Management Speed Advice Traffic prioritization Dynamic allocation of lanes and road sections		
Related Use Case	USE_CVIS_01 USE_CVIS_03 USE_CVIS_04 USE_CVIS_05 CV-UC-SP3.2-0011		
Proposed indicator			
Estimated impact on	Traffic Safety and safety related driving performance	+	Less exposure to traffic means less probablity to have an accident
	Environmental impacts	+	Reduced CO2 emission.
	Transport and traffic efficiency	+	More efficient use of the traffic systems
	Usage, acceptance and trust		

<table>
<tr><td colspan="3">Hypothesis
The driver is more relaxed when such a system is installed</td><td>KEY
RQ_CVIS2</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="2"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="2">Parking Zone Management
City Guardian
Speed Advice
Informing driver about current speed limit</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="2">USE_CVIS_01
USE_CVIS_02
USE_CVIS_03
CV-UC-SP3.2-0017
CV-UC-SP3.2-0011</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="2">Workload</td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td>+</td><td>Reduced workload enables better anticipation of irregular situations.</td></tr>
<tr><td>Environmental impacts</td><td></td><td></td></tr>
<tr><td>Transport and traffic efficiency</td><td></td><td></td></tr>
<tr><td>Usage, acceptance and trust</td><td></td><td></td></tr>
</table>

Hypothesis			KEY
The driver can calculate a more reliable time of arrival			**RQ_CVIS3**
Related Research Question			
Related System	Parking Zone Management Traffic prioritization Dynamic allocation of lanes and road sections		
Related Use Case	USE_CVIS_01 USE_CVIS_03 USE_CVIS_04 USE_CVIS_05 CV-UC-SP3.2-0011		
Proposed indicator	approaching speed to critical situations or obstacles		
Estimated impact on	Traffic Safety and safety related driving performance	+	
	Environmental impacts		
	Transport and traffic efficiency		
	Usage, acceptance and trust	+	

Hypothesis			KEY
Reduction of possible traffic accidents			**RQ_CVIS4**
Related Research Question			
Related System	Informing driver about current speed limit		
Related Use Case	CV-UC-SP3.2-0017		
Proposed indicator			
Estimated impact on	Traffic Safety and safety related driving performance	+	Less accidents, because drivers will reduce speed.
	Environmental impacts		
	Transport and traffic efficiency		
	Usage, acceptance and trust		

<table>
<tr><td colspan="3">Hypothesis
Driver is prepared to react by approaching of prioritized vehicles</td><td>KEY
RQ_CVIS5</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="2"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="2">Traffic prioritization
Dynamic allocation of lanes and road sections</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="2">USE_CVIS_04
USE_CVIS_05</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="2"></td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td>+</td><td>Less accidents, because drivers are prepared to react.</td></tr>
<tr><td>Environmental impacts</td><td></td><td></td></tr>
<tr><td>Transport and traffic efficiency</td><td></td><td></td></tr>
<tr><td>Usage, acceptance and trust</td><td></td><td></td></tr>
</table>

<table>
<tr><td colspan="3">Hypothesis
Increased traffic throughput</td><td>KEY
RQ_CVIS6</td></tr>
<tr><td colspan="2">Related Research Question</td><td colspan="2"></td></tr>
<tr><td colspan="2">Related System</td><td colspan="2">Speed Advice
Traffic prioritization
Dynamic allocation of lanes and road sections</td></tr>
<tr><td colspan="2">Related Use Case</td><td colspan="2">USE_CVIS_03
USE_CVIS_04
USE_CVIS_05</td></tr>
<tr><td colspan="2">Proposed indicator</td><td colspan="2"></td></tr>
<tr><td rowspan="4">Estimated impact on</td><td>Traffic Safety and safety related driving performance</td><td></td><td></td></tr>
<tr><td>Environmental impacts</td><td>0</td><td>Using the available capacity more efficient means less emission per vehicle, but might also result in higher overall emmisions, since more traffic might be induced</td></tr>
<tr><td>Transport and traffic efficiency</td><td>+</td><td>Higher traffic efficiency.</td></tr>
<tr><td>Usage, acceptance and trust</td><td></td><td></td></tr>
</table>

Hypothesis			KEY
Additional information while driving/ travelling may change drivers route planning			**RQ_CVIS7**
Related Research Question			
Related System			
Related Use Case	CV-UC-SP3.2-0011		
Proposed indicator			
Estimated impact on	Traffic Safety and safety related driving performance		
	Environmental impacts		
	Transport and traffic efficiency	+	Higher traffic efficiency.
	Usage, acceptance and trust		